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GOLDMAN'S
CECIL
MEDICINE

西氏内科学

第24版

神经病学分册

LEE GOLDMAN
ANDREW I. SCHAFER

北京大学医学出版社

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24TH EDITION

LEE GOLDMAN, MD
ANDREW I. SCHAFER, MD

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PREFACE

The 24TH Edition of *Goldman's Cecil Medicine* symbolizes a time of extraordinary advances in medicine and in technological innovations for the dissemination of information. This textbook and its associated electronic products incorporate the latest medical knowledge in formats that are designed to appeal to learners who prefer to access information in a variety of ways.

The contents of *Cecil* have remained true to the tradition of a comprehensive textbook of medicine that carefully explains the *why* (the underlying normal physiology and pathophysiology of disease, now at the cellular and molecular as well as the organ level) and the *how* (now frequently based on Grade A evidence from randomized controlled trials). Descriptions of physiology and pathophysiology include the latest genetic advances in a practical format that strives to be useful to the nonexpert. Medicine has entered an era when the acuity of illness and the limited time available to evaluate a patient have diminished the ability of physicians to satisfy their intellectual curiosity. As a result, the acquisition of information, quite easily achieved in this era, is often confused with knowledge. We have attempted to counteract this tendency with a textbook that not only informs but also stimulates new questions and gives a glimpse of the future path to new knowledge. Grade A evidence is specifically highlighted in the text and referenced at the end of each chapter. In addition to the information provided in the textbook, the Cecil website supplies expanded content and functionality. In many cases, the full articles referenced in each chapter can be accessed from the Cecil website. The website is also continuously updated to incorporate subsequent Grade A information, other evidence, and new discoveries.

The sections for each organ system begin with a chapter that summarizes an approach to patients with key symptoms, signs, or laboratory abnormalities associated with dysfunction of that organ system. As summarized in Table 1-1, the text specifically provides clear, concise information regarding how a physician should approach more than 100 common symptoms, signs, and laboratory abnormalities, usually with a flow diagram, a table, or both for easy reference. In this way, *Cecil* remains a comprehensive text to guide diagnosis and therapy, not only for patients with suspected or known diseases but also for patients who may have undiagnosed abnormalities that require an initial evaluation.

Just as each edition brings new authors, it also reminds us of our gratitude to past editors and authors. Previous editors of *Cecil Medicine* include a short but remarkably distinguished group of leaders of American medicine: Russell Cecil, Paul Beeson, Walsh McDermott, James Wyngaarden, Lloyd H. Smith, Jr., Fred Plum, J. Claude Bennett, and Dennis Ausiello. As we welcome new associate editors—Wendy Levinson, Donald W. Landry, Anil Rustgi, and W. Michael Scheld—we also express our appreciation to Nicholas LaRusso and other associate editors from the previous editions on whose foundation we have built. Our returning associate editors—William P. Arend, James O. Armitage, David Clemmons, Jeffrey M. Drazen, and Robert C. Griggs—continue to make critical contributions to the selection of authors and the review and approval of all manuscripts. The editors, however, are fully responsible for the book as well as the integration among chapters.

The tradition of *Cecil Medicine* is that all chapters are written by distinguished experts in each field. We are also most grateful for the editorial assistance in New York of Theresa Considine and Silva Sergenian. These individuals and others in our offices have shown extraordinary dedication and equanimity in working with authors and editors to manage the unending flow of manuscripts, figures, and permissions. We also thank Faten Aberra, Reza Akari, Robert C. Brunham, Ivan Ciric, Seema Daulat, Gregory F. Erikson, Kevin Ghassemi, Jason H. Huang, Caron Jacobson, Lisa Kachnic, Bryan T. Kelly, Karen Krok, Heather Lehman, Keiron Leslie, Luis Marcos, Michael Overman, Eric Padron, Bianca Maria Piraccini, Don W. Powell, Katy Ralston, James M. Swain, Tania Thomas, Kirsten Tillisch, Ali Turabi, Mark Whiteford, and Y. Joseph Woo, who contributed to various chapters. At Elsevier, we are most indebted to Dolores Meloni and Linda McKinley, and also thank Cathy Carroll, Taylor Ball, Virginia Wilson, Linda Van Pelt, Suzanne Fannin, and Steve Stave, who have been critical to the planning and production process under the direction of Mary Gatsch. Many of the clinical photographs were supplied by Charles D. Forbes and William F. Jackson, authors of *Color Atlas and Text of Clinical Medicine*, Third Edition, published in 2003 by Elsevier Science Ltd. We thank them for graciously permitting us to include their pictures in our book. We have been exposed to remarkable physicians in our lifetimes and would like to acknowledge the mentorship and support of several of those who exemplify this paradigm—Robert H. Gifford, Lloyd H. Smith, Jr., Frank Gardner, and William Castle. Finally, we would like to thank the Goldman family—Jill, Jeff, Abigail, Mira, Daniel, and Robyn Goldman—and the Schafer family—Pauline, Eric, Pam, John, Evan, and Kate—for their understanding of the time and focus required to edit a book that attempts to sustain the tradition of our predecessors and to meet the needs of today's physician.

LEE GOLDMAN, MD
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XXV

NEUROLOGY

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APPROACH TO THE PATIENT WITH NEUROLOGIC DISEASE

ROBERT C. GRIGGS, RALPH F. JÓZEFOWICZ, AND MICHAEL J. AMINOFF

CLINICAL MANIFESTATIONS

The symptoms of nervous system diseases are a part of everyday experience for most normal people. Slips of the tongue, headaches, backache and other pains, dizziness, lightheadedness, numbness, muscle twitches, jerks, cramps, and tremors all occur in totally healthy persons. Mood swings with feelings of elation and depression, paranoia, and displays of temper are equally a part of the behavior of completely normal people. The rapid increase in information about neurologic diseases coupled with the intense interest of people in all walks of life in medical matters has focused public attention on both common and rare neurologic conditions.

Most older people are concerned that they or their spouse have or are developing Alzheimer's disease or stroke. The almost ubiquitous tremor of the elderly prompts concern about Parkinson's disease. Many younger patients are concerned about multiple sclerosis or brain tumor, and few normal people lack one or more symptoms suggesting the diagnosis of a serious neurologic disease. For most of these and other common diagnoses, the results of imaging and other tests are typically normal when symptoms first appear, and such tests should not be performed to reassure the patient or physician. Moreover, the widespread availability of neurodiagnostic imaging and electrophysiologic, biochemical, and genetic testing has led to the detection of "abnormalities" in many young and most elderly persons. In evaluating a patient's symptoms, it is imperative that a clinical diagnosis be reached without reference to a neurodiagnostic laboratory finding. Patients with disorders such as headache, anxiety, and depression do not usually have abnormal laboratory results. Abnormalities noted on various neurodiagnostic studies are often incidental findings whose treatment may be justified and necessary, but they do not improve the patient's symptoms. Abnormalities detected incidentally that are not accompanied by signs or symptoms may, as for disorders such as hypertension, require aggressive evaluation and treatment, but in general, the adage that it is difficult to improve an asymptomatic patient should be kept in mind. Thus, in elderly patients, few imaging or electrophysiologic studies are interpreted as "normal," but in the absence of specific complaints consistent with the findings, treatment and even further evaluation should reflect an estimate of the specificity and sensitivity of the test as well as the likelihood that the patient will require and benefit from treatment. It is a good rule of thumb that one should never perform (or refer to the result of) a neurodiagnostic procedure without a specific diagnosis or at least a differential diagnosis in mind.

It is important to allow patients to describe any symptoms in their own words. Direct questions are often necessary to fully characterize the problem, but suggested terms or descriptors for symptoms are frequently grasped by a patient unfamiliar with medical terminology and then parroted to subsequent interviewers. The patient's terms should always be used in recording symptoms. Terms such as *lameness, weakness, numbness, heaviness, cramps*, and *tiredness* may each mean pain, weakness, or alteration of sensation to some patients.

DIAGNOSIS

History

In neurologic diagnosis, the history usually indicates the nature of the disease or the diagnosis, whereas the neurologic examination localizes it and quantitates its severity. For many diseases, the history is almost the only avenue to explore. Examples of such disorders include headaches, seizures, developmental disorders, memory disorders, and behavioral diseases. In arriving at a diagnosis, the following points are useful. Consider the entire medical history of the patient. Early life events or long-standing processes such as head or spine trauma, unilateral hearing or visual loss, poor prowess in sports, poor performance in school, spinal curvature, and bone anomalies are easily overlooked but may point to the underlying disease process.

Consider the tempo and duration of the symptoms. Have the symptoms been progressive without remission, or have there been plateaus or periods of return to normal? Cerebral mass lesions (tumor, subdural) tend to have a progressive but fluctuating course; seizures and migraine, an episodic course; and strokes, an abrupt, ictal onset with worsening for 3 to 5 days, followed by partial or complete recovery.

Can one disease account for all of the symptoms and signs? The clinician should formulate a diagnostic opinion in anatomic terms. Is the history suggestive of a single (e.g., stroke or tumor) focus or multiple sites of nervous system involvement (e.g., multiple sclerosis), or is the process a disease of a system (vitamin B_{12} deficiency, myopathy, or polyneuropathy)?

The neurologic history is the most important component of neurologic diagnosis. A careful history frequently determines the cause and allows one to begin localizing the lesions, which aids in establishing whether the disease is diffuse or focal. Symptoms of acute onset suggest a vascular cause or seizure; symptoms that are subacute in onset suggest a mass lesion, such as a tumor or abscess; symptoms that have a waxing and waning course with exacerbations and remissions suggest a demyelinating cause; and symptoms that are chronic and progressive suggest a degenerative disorder.

The history is often the only way of diagnosing neurologic illnesses that typically have normal or nonfocal findings on neurologic examination. These illnesses include many seizure disorders, narcolepsy, migraine and most other headache syndromes, the various causes of dizziness, and most types of dementia. The neurologic history may often provide the first clues that a symptom is psychological in origin. The following are points to consider in obtaining a neurologic history.

- *Carefully identify the chief complaint or problem.* Not only is the chief complaint important in providing the first clue to the physician about the differential diagnosis, but it is also the reason that the patient is seeking medical advice and treatment. If the chief complaint is not properly identified and addressed, the proper diagnosis may be missed and an inappropriate diagnostic work-up may be undertaken. Establishing a diagnosis that does not incorporate the chief complaint frequently focuses attention on a coincidental process irrelevant to the patient's concerns.
- *Listen carefully to the patient for as long as necessary.* A good rule of thumb is to listen initially for at least 5 minutes without interrupting the patient. The patient often volunteers the most important information at the start of the history. During this time, the examiner can also assess mental status, including speech, language, fund of knowledge, and affect, and observe the patient for facial asymmetry, abnormalities in ocular movements, and an increase or a paucity of spontaneous movements as seen with movement disorders.
- *Steer the patient away from discussions of previous diagnostic test results and the opinions of previous caregivers.* Abnormal results of laboratory studies may be incidental to the patient's primary problem or may simply represent a normal variant.
- *Take a careful medical history, medication history, psychiatric history, family history, and social and occupational history.* Many neurologic illnesses are complications of underlying medical disorders or are due to adverse effects of drugs. For example, parkinsonism is a frequent complication of the use of metoclopramide and most neuroleptic agents. A large number of neurologic disorders are hereditary, and a positive family history may establish the diagnosis in many instances. Occupation plays a major role in various neurologic disorders, such as carpal tunnel syndrome (in machine operators and people who use computer keyboards) and peripheral neuropathy (caused by exposure to lead or other toxins).
- *Interview surrogate historians.* Because patients with dementia or altered mental status are generally unable to provide exact details of the history, a family member may need to provide the key details required to make an accurate diagnosis. This situation is especially common with patients who have dementia and certain right hemispheric lesions with various agnosias (lack of awareness of disease) that may interfere with their ability to provide a cogent history. Surrogate historians also provide missing historical details for patients with episodic loss of consciousness, such as syncope and epilepsy.
- *Summarize the history for the patient.* Summarizing the history is an effective way to ensure that all details were covered sufficiently for a tentative diagnosis to be made. Summarizing also allows the physician to fill in historical gaps that may not have been apparent when the history was initially taken. In addition, the patient or surrogate may correct any historical misinformation at this time.
- *End by asking what the patient thinks is wrong.* This question allows the physician to evaluate the patient's concerns about and insight into the

condition. Some patients have a specific diagnosis in mind that spurs them to seek medical attention. Multiple sclerosis, amyotrophic lateral sclerosis, Alzheimer's disease, and brain tumors are diseases that patients often suspect may be the cause of their neurologic symptoms.

Diagnostic Challenges

Two common situations provide special challenges to the diagnostic skills of the physician.

Physical Abuse as a Cause of Neurologic Symptoms

Traumatic injury inflicted by family members or others is usually difficult to detect by the medical history and examination. Physically battered babies, abused children, battered women, and traumatized seniors are often unable or unwilling to complain of this cause or contribution to symptoms. The only method to prevent overlooking of this frequent cause of common problems is systematic consideration of the possibility in every patient and awareness of the often subtle signs that suggest physical trauma: ecchymoses or fractures (often attributed to a logical cause), denial of expected symptoms, failure to keep appointments, and unexplained intensification of neurologic symptoms (headache, dizziness, ringing in the ears, blackouts).

Alcoholism and Drug Abuse

See Chapters 32 and 33. A host of neurologic disorders can be the result of intentional ingestion of toxins (Chapter 110). Patients do not give an accurate account of their use of these agents. Consequently, physical signs and laboratory screening test results that give evidence of drug-related hepatic and other metabolic abnormalities may point to a major underlying problem.

ACUTE NEUROLOGIC DISORDERS REQUIRING IMMEDIATE DIAGNOSIS AND TREATMENT

Most neurologic diagnoses are arrived at by a careful, thorough history and an appropriately complete examination. However, the tempo of illness and the availability of life-saving treatment that is effective only if it is administered within minutes of first evaluating a patient dictate rapid action in several specific circumstances. Coma (Chapter 411), repetitive seizures (Chapter 410), acute stroke (Chapters 414 and 415), suspected meningitis and encephalitis (Chapters 420 and 422), head and spine trauma (Chapter 406), and acute spinal cord compression are diagnosed by clinical and laboratory assessment, and urgent treatment must be instituted as soon as ventilation and cardiac status are stabilized.

NEUROLOGIC EXAMINATION

The neurologic examination is always tailored to the clinical setting of the patient. A complete neurologic examination of a child is much different from that of an elderly adult, and the examination of a patient with specific complaints focuses on findings pertinent to that patient. Thus, more detailed testing of cognition is indicated in patients with behavioral or memory disturbance, and more detailed testing of sensation should be performed in patients with complaints of pain, numbness, or weakness.

However, many tests of neurologic function are routinely indicated in all patients because they provide a baseline for future examination and are frequently helpful in detecting unsuspected neurologic disease in apparently normal persons or in patients whose symptoms initially suggest disease outside the nervous system. It is particularly important to perform all routine tests in patients with abnormalities in one sphere of neurologic dysfunction; otherwise, erroneous localization of a lesion or disease process is likely. For deviations from normal to be recognized and quantitated, it is essential for a physician to have extensive experience in the routine assessment of normal persons.

The General Examination

Specific neurologic symptoms or signs should prompt attention to the assessment of general findings. Head circumference should be measured in patients with central nervous system (CNS) or spinal cord disease (normally 55 ± 5 cm in adults). Head enlargement is occasionally a normal, often hereditary variant but should suggest a long-standing anomaly of the brain or spinal cord. The skin should be inspected for cafe au lait maculae, adenoma sebaceum, vascular malformations, lipomas, neurofibromas, and other lesions (Chapter 426). Neck range of motion, straight leg raising, and spinal curvature (scoliosis) should be assessed. Carotid auscultation for bruits is indicated in all older adults; carotid palpation is seldom informative. In patients with bladder, bowel, or leg symptoms, a rectal sphincter examination for tone and ability to contract voluntarily is usually indicated. Limitation of joint range of motion or painless swelling of joints is often a sign of an unsuspected neurologic lesion.

Neurologic Examination

The various aspects of the detailed neurologic examination are considered in specific symptom and disease sections noted later. The five major divisions of the examination should be assessed in all patients. During a careful medical history, mental status is often adequately assessed: level of consciousness, orientation, memory, language function, affect, and judgment. If any of these functions are abnormal, more detailed testing is needed. Cranial nerve function that should be tested in all patients includes visual acuity (with and without correction); optic fundi; visual fields; pupils (size and reactivity to direct and consensual light); ocular motility; jaw, facial, palatal, neck, and tongue movement; and hearing.

Examination of the motor system (Chapter 429) is essential in all patients because incipient weakness is generally overlooked by the patient. Muscle tone (flaccid, spastic, or rigid), muscle size (atrophy or hypertrophy), and muscle strength can be assessed rapidly. Muscle strength testing should always assess specific functional activities, including the ability to walk on heel and toe, to sit up from a supine position, to rise from a deep knee bend or deep chair, to lift the arms over the head, and to make a tight fist. Gait, stance, and coordination are assessed. The patient should be observed for tremor and other abnormal movements and the muscles inspected for fasciculations.

Sensory testing (Chapter 428) need not be detailed unless there are sensory symptoms. However, vibration perception in the toes and the normality of perception of pain, temperature, and light touch in the hands and feet should be assessed.

Muscle stretch reflexes and plantar responses should always be assessed by evaluating right-left symmetry and disparity between proximal and distal reflexes or arm and leg reflexes. Biceps, triceps, brachioradialis, quadriceps, and ankle reflexes should be quantitated from 1 to 4 (4 = clonus; 3 = spread; 2 = brisk; 1 = hypoactive).

The Comatose Patient

The rapid examination required for a patient with an altered state of consciousness is much different from that of an alert, aware individual (Chapter 411). Many aspects of the neurologic examination cannot be tested: cognitive function, subtleties of sensory perception, specific motor functions, coordination, gait, and stance. Moreover, the muscle stretch reflexes are likely to fluctuate from one moment to the next, and minor asymmetries are much less important than in an awake patient. Instead, attention should focus on examination of the level of consciousness, respiratory pattern, eyelid position and eye movements, pupils, corneal reflexes, optic fundi, and motor responses. Particular elements of the general examination must also be assessed quickly: evidence of cranial and spine trauma, tenderness of the skull to percussion, nuchal rigidity (but not in patients with head or neck trauma), and evidence of physical abuse.

COMMON COMPLAINTS OF POSSIBLE NEUROLOGIC ORIGIN

Weakness

It is axiomatic that patients typically have motor signs before motor symptoms and, conversely, sensory symptoms before sensory signs. Thus, patients with even severe weakness may not report symptoms of weakness. Somewhat paradoxically, patients who complain of "weakness" often do not have confirmatory findings on examination that document the presence of weakness.

Weakness, when it is actually a symptom of neurologic disease, is frequently caused by diseases of the motor unit (Chapters 418, 429, and 430) and is usually reported by a patient in terms of loss of specific functions, for example, difficulty with tasks such as climbing stairs, rising from a chair, sitting up, lifting objects onto a high shelf, or opening jars. Symptoms may also reflect the consequences of weakness, such as frequent falls or tripping. Such symptoms can be remarkably quantitative. A patient with leg muscle weakness who is falling even as infrequently as once a month almost invariably has severe weakness of the knee extensor muscles and can be shown on examination to have a knee extension lag, an inability to lift the leg fully against gravity and to lock the knee.

The symptom of weakness without findings of weakness on examination is not generally the result of neuromuscular disease but can be a sign of neurologic disease outside the motor unit or, more commonly, a symptom of disease outside the nervous system altogether (Table 403-1).

TABLE 403-1

Disorders of the motor unit
Upper motor neuron lesions—spasticity
Basal ganglia disorders—rigidity
General medical conditions
Heart failure
Respiratory insufficiency
Renal, hepatic, and other metabolic disease
Alcoholism and other toxin-related disease
Psychiatric and behavioral disorders
Depression
Malingering

TABLE 403-2

SPECIFIC DISORDER	LOCATION OF LESION	CHARACTERISTICS
Spastic gait	Bilateral corticospinal pathways within the thoracic or cervical cord or in the brain	Legs stiff, feet turning inward, "scissoring"
Hemiparetic gait	Unilateral central nervous system, cervical cord, or brain	Affected leg circumducted, foot extended, arm flexed
Sensory ataxia	Posterior columns of the spinal cord or peripheral nerve	Wide-based, high steps; Romberg's sign present
Cerebellar ataxia	Brain stem or cerebellum	Wide-based steps; Romberg's sign absent
Parkinsonian gait	Basal ganglia	Shuffling, small steps
Dystonic gait	Basal ganglia; also corticospinal pathways	Abnormal posture of the arms, head, neck
Gait disorder of the elderly	Multifactorial: bihemispheric disease, spinal cord disease, impaired proprioception, muscle weakness	Stooped posture, wide-based steps; often retropulsion
Steppage gait	Distal muscle weakness	High steps ("steppage")
Waddling gait	Proximal muscle weakness	Both legs circumducted to allow locking of the knees
Antalgic gait	Non-neurologic; reflects disease of joints, bones, or soft tissue	Minimizes pain in the hip, spine, leg
Hysterical gait	Psychiatric or behavioral disorder	Reeling side to side, associated astasia-abasia, bizarre arm and trunk movements

Fatigue

The complaints of "fatigue," "tiredness," and "lack of energy" are even less likely than the symptom of weakness to reflect definable neurologic disease. With the exception of neuromuscular junction disorders such as myasthenia gravis, fatigue is rarely a complaint of diseases of the motor unit. Fatigue can be a sign of upper motor neuron disease (corticospinal pathways) and is a common complaint of established multiple sclerosis and other multifocal CNS disease. Similarly, any process that produces bilateral corticospinal tract or extrapyramidal disease can cause fatigue. Examples include motor neuron disease (Chapter 418), spinal cord disease in the cervical cord region (Chapter 407), and Parkinson's disease (Chapter 416). In addition, disorders that impair sleep (Chapter 412) may include fatigue as a complaint.

Fatigue, like weakness, is much more often than not a sign of disease outside the central and peripheral nervous system. Depression and other psychiatric and behavioral disorders (Chapter 404) as well as the medical illnesses associated with a complaint of weakness are all frequent causes of fatigue.

Chronic fatigue syndrome and many cases of fibromyalgia (Chapter 282) have fatigue as a dominant, disabling symptom. These disorders are defined in part by the absence of consistent neurologic findings and lack of demonstrable disease in the nervous system.

Spontaneous Movements

Muscle tremors, jerks, twitches, cramps, and spasms (Chapter 417) are frequent symptoms. The cause of spontaneous movements can reside at any level of the nervous system. In general, movements that occur in an entire limb or in more than one muscle group concurrently are caused by CNS disease. Movements confined to a single muscle are likely to be a reflection of disease of the motor unit (including the motor neurons of the brain stem and spinal cord). When spontaneous movements of a muscle are associated with severe pain, patients often use the term *cramp.* Cramp is a medically defined disorder that reflects the intense contraction of a large group of motor units. Leg cramps are occasionally a sign of an underlying disease of the anterior horn cell, nerve roots, or peripheral nerve; however, cramps are frequent in normal persons and particularly common in older patients, and they are usually benign. When they are severe, cramps can produce such intense muscle contraction that muscle injury is caused and muscle enzyme (e.g., creatine kinase) levels are elevated in blood.

The rare muscle diseases in which an enzyme deficiency interferes with substrate use as fuel for exercise (e.g., McArdle's disease) are often associated with severe, exercise-provoked muscle *contractures.* These contractures are electrically silent on electromyography, in contrast to the intense motor unit activity seen with cramps. Contractures must not be confused with the limitation of joint range of motion resulting from long-standing joint disease or long-standing weakness—also termed contractures.

The intense muscle contractions of *tetany* are frequently painful. Although tetany is usually a reflection of hypocalcemia (Chapter 253), it can occasionally be seen without demonstrable electrolyte disturbance. Tetany results from hyperexcitability of peripheral nerves. Similarly, in the syndrome of *tetanus* produced by a clostridial toxin (Chapter 304), intensely painful, life-threatening muscle contractions arise from hyperexcitable peripheral nerves. A number of toxic disorders, such as strychnine poisoning and black widow spider envenomation, produce similar neurogenic spasms.

Muscle Pain

Acute muscle pain in the absence of abnormal muscle contractions is an extremely common symptom. When such pain occurs after strenuous exercise or in the context of an acute viral illness (e.g., influenza), it probably reflects muscle injury. In such patients, the serum creatine kinase level is often raised. It is uncommon for this frequent and essentially normal sign of muscle injury to be associated with weakness or demonstrable ongoing muscle disease. *Chronic* muscle pain is a common symptom but is seldom related to a definable disease of muscle.

Episodic and Intermittent Weakness

The complaint of attacks of severe weakness or paralysis occurring in a patient with baseline normal strength is an uncommon symptom. It is typical of the periodic paralyses and may also be seen with episodic ataxias and myotonic disorders (Chapter 429). All of these disorders are ion channelopathies. These channelopathies (e.g., the calcium channelopathy hypokalemic periodic paralysis) are rare but treatable disorders (Chapter 429). Episodic weakness is also seen in patients with neuromuscular junction disorders, such as myasthenia gravis and the myasthenic syndrome (Chapter 430). On occasion, patients with narcolepsy complain of intermittent paralysis as a reflection of *sleep paralysis* (Chapter 412).

Loss of Balance

Unsteadiness of gait is a common symptom. When it is associated with complaints of dizziness or vertigo (Chapter 436), disease of the labyrinth, the vestibular nerve, the brain stem, or the cerebellum is a probable cause. When unsteadiness and loss of balance are unassociated with dizziness, particularly if the unsteadiness appears to be out of proportion to other symptoms of the patient, a widespread disorder of sensation or motor function is likely.

Abnormal Gait and Posture

The ability to stand and to walk in a well-coordinated, effortless fashion requires the integrity of the entire nervous system. Relatively subtle deficits localized to one part of the central or peripheral nervous system produce characteristic abnormalities (Table 403-2).

Sensory Symptoms

Sensory symptoms can be negative or positive. Negative symptoms represent a loss of sensation, such as a feeling of numbness. Positive symptoms, by contrast, consist of sensory phenomena that occur without normal

stimulation of receptors and include paresthesias and dysesthesias. *Paresthesias* may include a feeling of tingling, crawling, itching, compression, tightness, cold, or heat and are sometimes associated with a feeling of heaviness. The term *dysesthesias* is used correctly to refer to abnormal sensations, often tingling, painful, or uncomfortable, that occur after innocuous stimuli, whereas *allodynia* refers to painful perception from a stimulus that is not normally painful. For some patients, it may be difficult to distinguish paresthesias and dysesthesias from pain. *Hypesthesia* and *hypalgesia* denote a loss or impairment of touch or pain sensibility, respectively. By comparison, *hyperesthesia* and *hyperalgesia* indicate a lowered threshold to tactile or painful stimuli, respectively, such that there is increased sensitivity to such stimuli.

With the use of a wisp of cotton, a pin, and a tuning fork, the trunk and extremities are examined for regions of abnormal or absent sensation. Certain instruments are available for quantifying sensory function, such as the computer-assisted sensory examination, which is based on the detection of touch, pressure, vibratory, and thermal sensation thresholds.

Alterations in pain and tactile sensibility can generally be detected by clinical examination. It is important to localize the distribution of any such sensory loss to distinguish between nerve, root, and central dysfunction. Similarly, abnormalities in proprioception can be detected by clinical examination when patients are unable to detect the direction in which a joint is moved. In severe cases, there may be pseudoathetoid movements of the outstretched hands, sensory ataxia, and sometimes postural and action tremors.

Disorders of peripheral nerves commonly lead to sensory disturbances that depend on the population of affected nerve fibers (Chapter 428). Some neuropathies are predominantly large-fiber neuropathies. Appreciation of movement and position is impaired, and paresthesias are common. Examination reveals that vibration, position, and movement sensations are impaired, and movement becomes clumsy and ataxic. Pain and temperature appreciation is relatively preserved. The tendon reflexes are lost early. In other neuropathies, it is the small fibers especially that are affected; spontaneous pain is common and may be burning, lancinating, or aching in quality. Pain and temperature appreciation is disproportionately affected in these neuropathies, and autonomic dysfunction may be present. Examples of small-fiber neuropathies include certain hereditary disorders, Tangier disease, and diabetes. Most sensory neuropathies are characterized by a distal distribution of sensory loss, whereas sensory neuronopathies are characterized by sensory loss that may also involve the trunk and face and tends to be particularly severe. Sensory changes in a radiculopathy conform to a root territory; in cauda equina syndromes, sensory deficits involve multiple roots and may lead to saddle anesthesia and loss of the normal sensation associated with the passage of urine or feces.

Lesions of the *posterolateral columns* of the cord, such as occur in multiple sclerosis (Chapter 419), vitamin B_{12} deficiency (Chapter 425), and cervical spondylosis (Chapter 407), often lead to a feeling of compression in the affected region and to a Lhermitte sign (paresthesias radiating down the back and legs on neck flexion). Examination reveals ipsilateral impairment of vibration and joint position senses, with preservation of pain and temperature appreciation. Conversely, lesions of the *anterolateral region* of the cord (as by cordotomy) or *central* lesions interrupting fibers crossing to join the spinothalamic pathways (as in syringomyelia; Chapter 426) lead to impairment in pain and temperature appreciation with relative preservation of vibration, joint position sense, and light touch. Motor deficits may also be present and help localize the lesion. Upper motor neuron dysfunction (Chapter 407) from cervical lesions leads to quadriplegia, whereas more caudal lesions lead to paraplegia; lesions below the level of the first lumbar vertebra may simply compress the cauda equina and result in lower motor neuron deficits from a polyradiculopathy as well as impairment of sphincter and sexual function.

NEUROLOGIC DIAGNOSTIC PROCEDURES

Lumbar Puncture

Sampling of cerebrospinal fluid (CSF) by lumbar puncture is crucial for accurate diagnosis of meningeal infections and carcinomatosis (Fig. 403-1). CSF analysis is also helpful in evaluating patients with central or peripheral nervous system demyelinating disorders and with intracranial hemorrhage, particularly when imaging studies are inconclusive.

The CSF formula often provides an important clue to the pathologic process involved (Table 403-3). An elevated white blood cell count is seen with infections and other inflammatory diseases as well as with carcinomatosis. The differential white blood cell count may point to a specific class of pathogen; polymorphonuclear leukocytes suggest a bacterial process, whereas mononuclear cells suggest a viral, fungal, or immunologic cause. The CSF glucose concentration is typically reduced in bacterial and fungal infections as well as with certain viral infections (e.g., mumps virus) and with sarcoidosis. The CSF protein concentration is elevated in a variety of disorders, including most infections and demyelinating neuropathies.

Specialized tests that can be performed on CSF include oligoclonal bands, a pathologic pattern of bands on CSF electrophoresis that is seen in up to 90% of patients with multiple sclerosis. The bands, which represent monoclonal immunoglobulins that are locally synthesized in the CNS, are not specific for multiple sclerosis and may be seen with other inflammatory and noninflammatory conditions, including systemic lupus erythematosus, human immunodeficiency virus infection, and stroke.

CSF polymerase chain reaction is a rapid, sensitive, and specific test for the diagnosis of herpes simplex encephalitis (Chapter 422), for which it has replaced brain biopsy as the diagnostic procedure of choice. The CSF VDRL (Venereal Disease Research Laboratory) assay is a specific although insensitive test for neurosyphilis (Chapter 327).

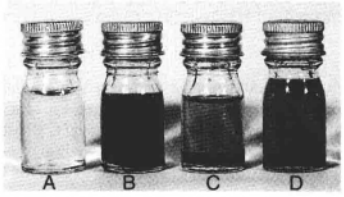

FIGURE 403-1. Cerebrospinal fluid examination. A, Normal crystal-clear CSF. **B**, Blood in the CSF, which could result from a traumatic (bloody) tap or from subarachnoid hemorrhage. In a traumatic tap, subsequent tubes of CSF are usually less bloody. **C**, Centrifuged CSF in a traumatic tap. The supernatant is nearly clear. **D**, CSF from a patient with subarachnoid hemorrhage. There is blood at the bottom of the tube and the supernatant is yellow (xanthochromic) as a result of breakdown of blood cells in the CSF before the lumbar puncture. (From Forbes CD, Jackson WD. *Color Atlas and Text of Clinical Medicine*, 3rd ed. London: Mosby; 2003, with permission.)

TABLE 403-3

	TURBIDITY AND COLOR	OPENING PRESSURE	WBC COUNT	DIFFERENTIAL CELLS	RBC COUNT	PROTEIN	GLUCOSE
Normal	Clear, colorless	70-180 mm H_2O	0-5 cells/μL^3	Mononuclear	0	<60 mg/dL	>⅔ serum
Bacterial meningitis	Cloudy, straw colored	↑	↑↑	PMNs	0	↑↑	↓
Viral meningitis	Clear or cloudy, colorless	↑	↑	Lymphocytes	0	↑	Normal
Fungal and tuberculous meningitis	Cloudy, straw colored	↑	↑	Lymphocytes	0	↑↑	↓↓
Viral encephalitis	Clear or cloudy, straw colored	Normal to ↑	↑	Lymphocytes	0 (herpes ↑)	Normal to ↑	Normal
Subarachnoid hemorrhage	Cloudy, pink	↑	↑	PMNs and lymphocytes	↑↑	↑	Normal (early); ↓ (late)
Guillain-Barré syndrome	Clear, yellow	Normal to ↑	0-5 cells/μL^3	Mononuclear	0	↑	Normal

PMN = polymorphonuclear leukocyte; RBC = red blood cell; WBC = white blood cell.

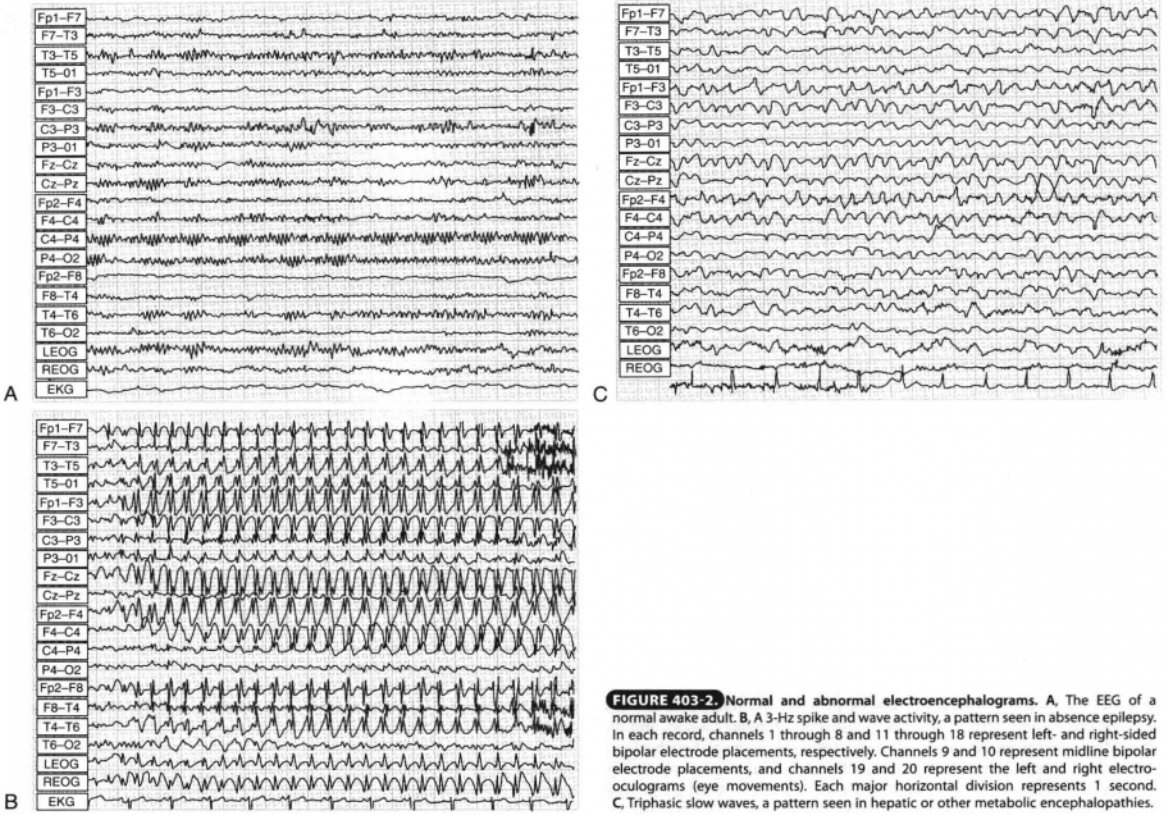

FIGURE 403-2. Normal and abnormal electroencephalograms. A, The EEG of a normal awake adult. **B,** A 3-Hz spike and wave activity, a pattern seen in absence epilepsy. In each record, channels 1 through 8 and 11 through 18 represent left- and right-sided bipolar electrode placements, respectively. Channels 9 and 10 represent midline bipolar electrode placements, and channels 19 and 20 represent the left and right electro-oculograms (eye movements). Each major horizontal division represents 1 second. **C,** Triphasic slow waves, a pattern seen in hepatic or other metabolic encephalopathies.

A lumbar puncture should not be performed in patients who have an obstructive, noncommunicating hydrocephalus or a focal CNS mass lesion causing raised intracranial pressure because reducing CSF pressure acutely in these settings by lumbar puncture may result in cerebral or cerebellar herniation. Lumbar puncture may be safely performed in patients with a *communicating* hydrocephalus, such as with idiopathic intracranial hypertension (pseudotumor cerebri), and it may even be an effective treatment in selected patients with this condition.

Electroencephalography

Electroencephalography is the recording and measurement of scalp electrical potentials to evaluate baseline brain functioning and paroxysmal brain electrical activity suggestive of a seizure disorder.

Electroencephalography is performed by securing 20 electrodes to the scalp at predetermined locations based on an international system that uses standardized percentages of the head circumference, the "10-20 system." Each electrode is labeled with a letter and a number, the letter identifying the skull region (Fp = frontopolar; F = frontal; P = parietal; C = central; T = temporal; O = occipital) and the number identifying the specific location, with odd numbers representing left-sided electrodes and even numbers right-sided electrodes. These electrodes are then connected in various combinations of pairs to generate voltage potential differences, and the potentials are recorded on a chart recorder.

To delineate the spatial distribution of the changing electrical field for an electroencephalogram (EEG), an orderly arrangement of electrode pairs is used, and each specific arrangement is known as a montage. Montages are generally of two types: *referential,* in which each electrode is connected to a single reference electrode, such as the ear; and *bipolar,* in which electrodes are connected sequentially to one another to form a chain. A standard EEG generally records about 30 minutes of brain activity, both in the awake state and in the first two stages of sleep. Various activating procedures are used during the recording of an EEG, including hyperventilation and photic stimulation. These activating procedures may precipitate seizure discharges in some patients with seizure disorders, thereby increasing the sensitivity of the test.

The amplitudes of scalp electrical potentials are quite low, averaging 30 to 100 μV. They represent a summation of excitatory postsynaptic potentials and inhibitory postsynaptic potentials that are largely generated by the pyramidal cells in layer 4 of the cerebral cortex. Action potentials are of too brief a duration to have an effect on the EEG.

The EEG is analyzed with respect to symmetry between each hemisphere; wave frequency and amplitude; and the presence of spikes (20 to 70 msec) and sharp waves (70 to 200 msec), which may indicate a seizure focus. Electroencephalographic frequencies are divided into four categories as follows: delta: <4 Hz; theta: 4-7 Hz; alpha: 8-13 Hz; beta: >13 Hz.

The normal waking EEG (Fig. 403-2A) in a patient with eyes closed contains rhythms of alpha frequency in the occipital leads and beta frequency in the frontal leads. Normal sleep causes a generalized slowing of electroencephalographic frequencies and an increase in amplitude in each stage of sleep such that stage 4 sleep consists of more than 50% large-amplitude delta rhythms. Electroencephalographic abnormalities are of two types: abnormalities in background rhythm and abnormalities of a paroxysmal nature (Table 403-4).

The major usefulness of electroencephalography is for diagnosis and categorization of a seizure disorder (Fig. 403-2B). EEGs are neither highly sensitive nor completely specific for diagnosis of seizures. Because seizures are paroxysmal events, it is not unusual for an EEG to be normal—or only minimally abnormal—in a patient with epilepsy if it is recorded during an interictal phase (the period between seizures). Only about 50% of patients with seizures show epileptiform activity on the first EEG. Repeating the EEG with provocative maneuvers, such as sleep deprivation, hyperventilation, and photic stimulation, may increase this percentage to 90%. Conversely, about

TABLE 403-4 ELECTROENCEPHALOGRAPHIC ABNORMALITIES

ELECTROENCEPHALOGRAPHIC ABNORMALITY	CLINICAL CORRELATE
BACKGROUND RHYTHM ABNORMALITIES	
Generalized slowing	Most metabolic encephalopathies
Triphasic waves	Hepatic, renal, and other metabolic encephalopathies
Focal slowing	Large mass lesions (tumor, large stroke)
Electrocerebral inactivity with lack of response to all stimuli	Brain death
PAROXYSMAL ABNORMALITIES	
3-Hz spike and wave, augmented by hyperventilation	Absence epilepsy
3- to 4-Hz spike and wave in light sleep or with photic stimulation	Primary generalized epilepsy
Central to midtemporal spikes	Benign rolandic epilepsy, other partial epilepsies
Anterior temporal spikes or sharp waves	Simple or complex partial seizures of mesial temporal origin
Hypsarrhythmia (high-voltage chaotic slowing with multifocal spikes)	Infantile spasms (West's syndrome)
Burst suppression	Severe anoxic brain injury, barbiturate coma

1% of adults and 3.5% of children who are neurologically normal and who never had a seizure have epileptiform activity on an EEG.

The EEG may provide clues to the diagnosis of certain neurologic conditions, including viral encephalitis, prion disorders, and some forms of coma. In each of these situations, the EEG can have specific patterns that suggest a specific neurologic diagnosis. In herpes simplex encephalitis, periodic lateralizing epileptiform discharges emanating from the temporal lobes are frequently present. Triphasic slow waves are common in hepatic encephalopathy (Fig. 403-2C) but are a nonspecific finding. Creutzfeldt-Jakob disease is characterized by the presence of bilateral synchronous repetitive sharp waves. The EEG is also helpful in evaluating comatose patients, in confirming brain death when an apnea test cannot be performed because of cardiac instability, and for staging sleep in polysomnography.

In the past, the EEG was often used to localize neurologic lesions such as stroke, brain tumor, and abscess. With the advent of neuroimaging, EEG is almost never used for these purposes.

Nerve Conduction Study

A nerve conduction study (NCS) is the recording and measurement of the compound nerve and muscle action potentials elicited in response to an electrical stimulus.

To perform a motor NCS, a surface (active) recording electrode is placed over the belly of a distal muscle that is innervated by the nerve in question. A reference electrode is placed distally over the tendon. The nerve is then supramaximally stimulated at a predetermined distance proximal to the active electrode, and the resultant compound motor action potential (CMAP) is recorded. The terminal latency, amplitude, and duration of the evoked potential are measured directly, and the conduction velocity is calculated from the latencies of the evoked potentials with stimulation at two different points; the distance between the two points (conduction distance) is divided by the difference between the corresponding latencies (conduction time) to derive a calculated velocity (conduction velocity = distance ÷ time).

To perform a sensory NCS, the active recording electrode is placed over the portion of the skin innervated by the nerve in question, and a sensory nerve action potential is recorded after electrical stimulation of the nerve, similar to that noted for a motor NCS. NCS abnormalities include reduced amplitudes, prolonged terminal latencies, conduction block, and slowed conduction velocities (Table 403-5).

The NCS is helpful in documenting the existence of a neuropathy, quantifying its severity, and noting its distribution (i.e., whether it is distal, proximal, or diffuse). In addition, the NCS can provide information on the modality involved (i.e., motor versus sensory) and can suggest whether the lesion is axonal or demyelinating. The NCS is also helpful in diagnosis of compressive mononeuropathies, such as carpal tunnel syndrome, ulnar palsy, peroneal nerve palsy, and tarsal tunnel syndrome.

TABLE 403-5 NERVE CONDUCTION STUDIES

ABNORMALITY	CLINICAL CORRELATE
Reduced CMAP amplitude	Axonal neuropathy
Prolonged terminal latency	Demyelinating neuropathy Distal compressive neuropathy
Conduction block	Severe focal compressive neuropathy Severe demyelinating neuropathy
Slowed conduction velocity	Demyelinating neuropathy

CMAP = compound muscle action potential.

F Wave and H Reflex

The F wave and H reflex are ways of looking at the conduction characteristics for proximal portions of nerves, including the nerve roots. The F wave is a late CMAP evoked intermittently from a muscle by a *supramaximal* electrical stimulus to the nerve, and it is due to antidromic activation (backfiring) of alpha motor neurons. F waves can be elicited from practically all distal motor nerves. The H reflex is a late CMAP that is evoked regularly from a muscle by a *submaximal* stimulus to a nerve, and it is due to stimulation of Ia afferent fibers (a spinal reflex). The H reflex can be routinely obtained from calf muscles only with stimulation of the tibial nerve in the popliteal fossa.

F waves are helpful in diagnosis of Guillain-Barré syndrome, in which demyelination is often confined to the proximal portions of nerves early in the course of the disease. The H reflex is often absent in patients with acute S1 radiculopathy.

Repetitive Stimulation Study

A repetitive stimulation study is a method of measuring electrical conduction properties at the neuromuscular junction. To perform a repetitive stimulation study, a surface recording electrode is placed over a muscle belly, and the nerve innervating that muscle is electrically stimulated with a supramaximal stimulus at a certain frequency. A series of electrical potentials are then recorded whose amplitude is roughly proportional to the number of muscle fibers that are being activated.

A repetitive stimulation study is helpful in diagnosis of neuromuscular junction disorders, such as myasthenia gravis and myasthenic syndrome (Lambert-Eaton syndrome). In myasthenia gravis, the amplitudes of evoked potentials become progressively smaller with repetitive stimulation in clinically involved muscles. Clinically uninvolved muscles often do not demonstrate this decrement. In myasthenic syndrome, an *increment* is seen in the amplitudes of evoked potentials with rapid repetitive electrical stimulation.

Electromyography

Electromyography (EMG) is the recording and study of insertional, spontaneous, and voluntary electrical activity of muscle. It allows physiologic evaluation of the motor unit, including the anterior horn cell, peripheral nerve, and muscle.

EMG is performed by insertion of a needle electrode into the muscle in question and evaluation of the motor unit action potentials both visually (on the oscilloscope screen) and aurally (over the loudspeaker). Muscles are typically studied at rest and during voluntary contraction. During EMG, the electrical activity of muscle is studied in four settings (Table 403-6): *insertional activity* (occurring within the first second of needle insertion), *spontaneous activity* (electrical activity at rest), *voluntary activity* (electrical activity with muscle contraction), and *recruitment pattern* (change in electrical activity with maximal contraction).

EMG is helpful in evaluation of patients with weakness in that it can help determine whether the weakness is due to anterior horn cell disease, nerve root disease, peripheral neuropathy, or an intrinsic disease of muscle itself (myopathy). EMG can differentiate acute denervation from chronic denervation and may thus give an indication about the time course of the lesion causing the neuropathy. In addition, on the basis of which muscles have an abnormal EMG pattern, it is possible to determine whether the neuropathy is due to a lesion of a nerve root (radiculopathy), the brachial or lumbosacral plexus (plexopathy), an individual peripheral nerve (mononeuropathy), or multiple peripheral nerves (polyneuropathy).

EMG is also helpful in differentiation of active (inflammatory) myopathies from chronic myopathies. Active myopathies include dermatomyositis, polymyositis, inclusion body myositis, and some forms of muscular dystrophy, such as Duchenne's dystrophy. Chronic myopathies include the other muscular dystrophies, the congenital myopathies, and some metabolic myopathies. Myotonic dystrophy and myotonia congenita produce characteristic myotonic discharges.

It may take several weeks for a muscle to develop EMG signs of acute denervation after nerve transection. For this reason, EMG performed in the acute setting after nerve injury should be interpreted with caution, and it may need to be repeated at a later date.

Evoked Potentials

Evoked potentials are ways of measuring conduction velocities for sensory pathways in the CNS by means of computerized averaging techniques. Three types of evoked potentials are routinely performed: visual, brain stem auditory, and somatosensory.

Pattern Reversal Visual Evoked Responses

The pattern reversal visual evoked response (PVER) assesses the function of central visual pathways, in particular the optic nerves. To perform this test, EEG electrodes are placed over the occipital regions of the scalp, and the patient is asked to look at the center of a black-and-white checkerboard screen with one eye patched. The color of the checks alternates about twice per second, a process known as pattern reversal. The scalp potentials elicited by approximately 100 such pattern reversals are then recorded and signal averaged by a computer. This signal averaging cancels the random EEG activity and differentially amplifies the evoked potential. A single waveform (P 100) is recorded for each eye, and its latency is measured. Normal latency for the P 100 waveform is approximately 100 msec. A prolonged P 100 latency in one eye, in the absence of ocular disease, implies slowed conduction velocity in the optic nerve and suggests demyelination of that nerve. PVER testing is helpful when multiple sclerosis is suspected clinically and it is necessary to document the presence of a second demyelinating lesion in the CNS that may not be clinically evident (Fig. 403-3).

TABLE 403-6

ABNORMALITY	CLINICAL CORRELATE
INSERTIONAL ACTIVITY	
Prolonged	Acute denervation Active (usually inflammatory) myopathy
SPONTANEOUS ACTIVITY	
Fibrillations and positive waves	Acute denervation Active (usually inflammatory) myopathy
Fasciculations	Chronic neuropathies Motor neuron disease (rare fasciculations may be normal)
Myotonic discharges	Myotonic disorders Acid maltase deficiency
VOLUNTARY ACTIVITY	
Neuropathic potentials: large-amplitude, long-duration, polyphasic potentials	Chronic neuropathies and anterior horn cell diseases
Myopathic potentials: small-amplitude, short-duration, polyphasic potentials	Chronic myopathies Neuromuscular junction disorders
RECRUITMENT	
Reduced	Chronic neuropathic disorders
Rapid	Chronic myopathies

Brain Stem Auditory Evoked Responses

The brain stem auditory evoked response (BAER) assesses function in the central auditory pathways in the brain stem. EEG electrodes are placed over the vertex and mastoid process, and a series of clicks at a frequency of 5 Hz are delivered to each ear separately for 3 minutes. The scalp potentials elicited by the clicks are then recorded and signal averaged by a computer. This signal averaging cancels the random EEG activity and differentially amplifies the evoked potential. A series of five waves are recorded for each ear, and each wave corresponds to a different point in the central auditory pathway (Table 403-7). The wave latencies for the right and left ears are compared, and a delay in any of the latencies suggests a lesion at that point in the central brain stem auditory pathway. BAER testing is helpful in diagnosis of acoustic schwannoma and other tumors in the cerebellopontine angle.

Somatosensory Evoked Responses

The somatosensory evoked response (SER) assesses conduction in the central somatosensory pathways in the posterior columns of the spinal cord, brain stem, thalamus, and primary sensory cortex in the parietal lobes. To perform SER testing, recording electrodes are placed over Erb's point and the

TABLE 403-7

WAVE	LOCATION
I	Auditory nerve
II	Cochlear nucleus
III	Superior olivary nucleus
IV	Lateral lemniscus
V	Inferior colliculus

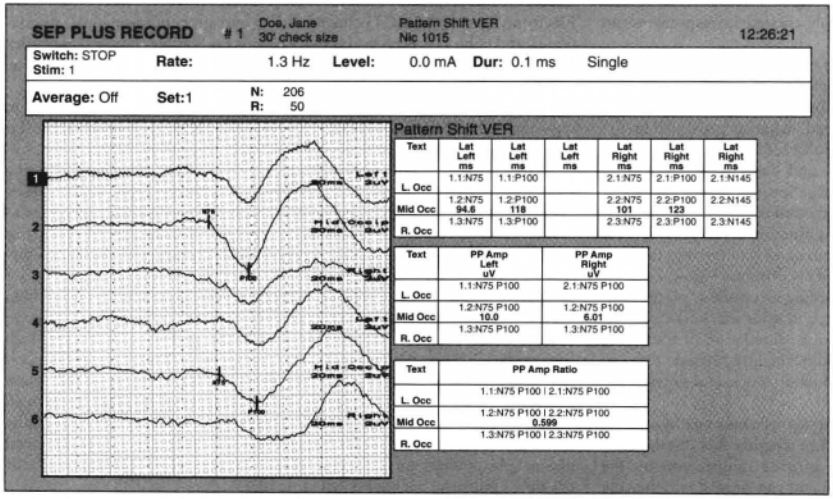

FIGURE 403-3. Abnormal pattern reversal visual evoked response in a patient with multiple sclerosis. The prolonged P 100 wave latency with left eye stimulation suggests a conduction defect in the left optic nerve. The top three channels represent right eye stimulation, and the bottom three channels represent left eye stimulation. Each horizontal division represents 20 msec.

TABLE 403-8 STRENGTHS AND WEAKNESSES OF SELECTED IMAGING MODALITIES

MODALITY	STRENGTHS	WEAKNESSES
Computed tomography (CT)	Fast; best test for acute intraparenchymal or subarachnoid hemorrhage and calcification; easy to monitor patients; excellent for bones	Less sensitive to parenchymal lesions than MRI; potential for significant reaction to contrast material; radiation exposure
Conventional angiography	Best imaging modality for aneurysms, vascular malformations, and vasculitis	Invasive and often lengthy; risk of stroke and other complications
Conventional myelography	Good images of nerve roots and small osteophytic lesions; accurate for bony stenosis; useful in patients with contraindications to MRI	Invasive, with risk of complications from lumbar puncture and instillation of contrast material; does not image intramedullary lesions well
CT myelography	Excellent for imaging nerve roots and detecting root compression from degenerative processes	Invasive, with risk of complications from lumbar puncture and instillation of contrast material
Magnetic resonance imaging (MRI)	Noninvasive; no radiation; multiplanar; extremely sensitive, safe contrast agent	Less sensitive than CT for detection of subarachnoid hemorrhage and calcification; less sensitive for bony skull fractures; contraindicated in patients with implanted metallic devices or foreign bodies; the patient must be able to cooperate and tolerate confined space; time-consuming relative to CT
Magnetic resonance angiography (MRA)	Noninvasive; good for screening for extracranial and intracranial vascular disease; may be performed with or without contrast agent	Need cooperative patient; technically demanding; may overestimate the degree of vascular stenosis (noncontrast MRA); cannot image distal vessels optimally without contrast agent; may miss small lesions (e.g., aneurysms)
Positron emission tomography (PET)	Limited role in helping to distinguish radiation necrosis from tumor; sometimes helpful in the diagnosis of Alzheimer's disease and epilepsy	Requires a cyclotron to generate radioisotopes with a short half-life; lower resolution and less available than MRI or CT
Single-photon emission computed tomography (SPECT)	Occasionally useful in epilepsy; sensitive for diffuse pathologic processes; easier to use than PET	Lower resolution than PET, MRI, or CT
Proton magnetic resonance spectroscopy	Localization of seizure focus; may help diagnose and classify dementias, such as Alzheimer's disease; may distinguish brain tumors from other mass lesions; may distinguish radiation necrosis from recurrent tumor	Specificity not yet determined; not routinely available; lower resolution; time-consuming
Ultrasonography	Fast; easy to use; can be performed at the bedside to assess vessel patency	Does not assess the vertebral arteries; less sensitive and specific than MRA; cannot visualize vessels in the upper neck and cranial base
Transcranial Doppler (TCD)	Fast; easy to use; assesses vascular velocities quantitatively; can assess cerebral vasospasm and occluded vessels	Does not provide images of vessels

Reproduced and modified from Hackney D. Radiologic imaging procedures. In: Goldman L, Ausiello D, eds. *Cecil Medicine*, 23rd ed. Philadelphia: Saunders Elsevier; 2008:2623-2627.

cervical spine (for medial or ulnar nerve stimulation), over the popliteal fossa and lumbar spine (for peroneal or tibial nerve stimulation), and over the scalp. A series of 1000 to 2000 electrical shocks at a frequency of 5 Hz are delivered to the median or ulnar nerve (for an upper extremity SER) or to the peroneal or tibial nerve (for a lower extremity SER). The scalp potentials elicited by the electrical shocks are then recorded and signal averaged by a computer. This signal averaging cancels the random EEG activity and differentially amplifies the evoked potential. A series of waves are recorded for each nerve stimulated, with each wave corresponding to a different point in the somatosensory pathways in the spinal cord, brain stem, and cerebral cortex. The wave latencies for the right and left limbs are compared, and a delay in any of the latencies suggests a lesion at that point in the somatosensory pathways.

SER testing, like PVER, is helpful when multiple sclerosis is suspected clinically and it is necessary to document the presence of a second demyelinating lesion in the CNS that may not be clinically evident. SER testing is also useful for monitoring of spinal cord function intraoperatively in patients undergoing spinal surgery.

Electronystagmography

Electronystagmography accurately records eye movements and nystagmus after certain provocative maneuvers. To perform this test, disc electrodes are placed over the bridge of the nose and lateral to each outer canthus, and the electrical leads from these discs are connected to an oscilloscope. Because the cornea is electropositive and the retina is electronegative, these electrodes accurately record lateral eye movements. The patient is first observed for spontaneous nystagmus with the eyes open and closed and then for nystagmus evoked with lateral gaze, for nystagmus induced by hot and cold air instilled in the outer ears (caloric induced), and for positional nystagmus. The last is performed by rotating the patient in a specialized chair. Spontaneous nystagmus suggests a vestibular pathologic lesion, as does an imbalance in the nystagmus evoked by these maneuvers in the right and left ears.

Imaging

On the basis of the relative advantages and disadvantages of computed tomography (CT), magnetic resonance imaging (MRI), and other neuroimaging modalities, different clinical entities can and should be assessed differently (Table 403-8). In acute ischemic stroke (Chapter 414) without bleeding, CT abnormalities typically appear within 4 to 12 hours and are seen even earlier with larger infarctions and embolic infarctions. CT detects hemorrhagic stroke (Chapter 415) acutely and can estimate its age. CT is also the preferred initial imaging modality for detection of intraparenchymal hemorrhage and subarachnoid hemorrhage, and it often suggests whether an aneurysm is the likely cause. Either CT angiography or magnetic resonance arteriography can display the three-dimensional anatomy of aneurysms with sufficient detail for therapy to be planned, but surgical treatment generally requires pre-procedure catheter arteriography. CT is the first-line method for evaluation of brain trauma and diagnosis of a subdural or epidural hematoma (Chapter 406), usually without requiring intravenous contrast material. However, MRI is better than CT to delineate the anatomy of a subdural hematoma and to estimate the age of the lesion. Many brain tumors are initially recognized on CT scans, but MRI is the preferred modality for detection and characterization of all brain tumors (Chapter 195).

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404 PSYCHIATRIC DISORDERS IN MEDICAL PRACTICE

JEFFREY M. LYNESS

OVERVIEW

Disorders in Psychiatry

Psychiatric disorders, also known as mental illnesses, are extraordinarily common and have a profound impact on well-being and functional status. Collectively, psychiatric disorders account for more aggregate disability than do those involving any other organ system, with depression alone being second only to cardiovascular disorders.

Psychiatric disorders are defined as *disorders of the psyche*, that is, as conditions that affect *thoughts*, *feelings*, or *behaviors*. By definition, such mental disturbances must be sufficient to produce significant *distress* in the patient or *impairment in role or other functioning*. Because the causes and pathogenesis of most psychiatric disorders are incompletely understood, current classification is based on clinical syndromes, which are defined by diagnostic criteria that have high inter-rater reliability because they emphasize discrete reportable or observable symptoms and signs.

TABLE 404-1 IMPORTANT CAUSES OF PSYCHIATRIC SYNDROMES

CENTRAL NERVOUS SYSTEM DISEASES
Trauma
Tumor
Toxins
Seizures
Vascular
Infections
Genetic/congenital malformations
Demyelinating diseases
Neurodegenerative diseases
Hydrocephalus
SYSTEMIC DISEASES
Cardiovascular
Pulmonary
Endocrine
Metabolic
Nutritional
Infections
Cancer
DRUGS (e.g., recreational, prescription, or over-the-counter drugs)
Drug intoxication
Drug withdrawal

Specific Syndromes

Because many *psychiatric disorders* result from the direct influence of neurologic conditions, systemic diseases, or drugs on brain functioning, assessment of any new or worsened psychiatric condition must include evaluation for their potential contributions (Table 404-1). Delirium (Chapter 27) and dementia (Chapter 409), which are *cognitive disorders* that are always the result of one or more neurologic, systemic, or drug causes, are defined by impairment in intellectual functions such as attention, memory, or language. Although cognitive impairment is the hallmark of cognitive disorders, these conditions may also be manifested as alterations in other aspects of mental status, including mood, thought content, thought process, and behavior. If a noncognitive psychiatric syndrome is caused by an identifiable underlying condition, it is known as a *secondary psychiatric disorder* (e.g., depression secondary to hypothyroidism).

The major nonsecondary, noncognitive psychiatric syndromes (Table 404-2) can coexist with multiple syndromes; for example, a patient with severe depression may have depressive, anxiety, and psychotic syndromes simultaneously. Substance use disorders, also known as addictions, are considered in Chapters 32 and 33.

Comorbid Conditions in Psychiatry

It is common for persons who suffer from mental disorders to meet the diagnostic criteria for more than one condition. Although such comorbidity may reflect the limitations of current approaches to diagnosis, psychiatric comorbidity influences the choices or sequence of indicated treatments and may worsen the overall prognosis. Comorbidity with general medical conditions, probably reflecting complex bidirectional causal relationships between physical and mental illnesses, is also common, and such comorbidity often worsens the overall prognosis for both conditions.

Treatments in Psychiatry

Treatments in psychiatry are intended to reduce or eliminate symptoms, thereby improving the patient's distress and dysfunction and averting suicidal behavior. Pharmacotherapy remains an evidence-based mainstay of the treatment of many psychiatric conditions despite the previously underestimated side effects of some drugs. The evidence for a number of forms of psychotherapy, administered in individual, group, or family contexts, supports its use as primary treatment or as co-treatment of many conditions. Other psychosocial interventions, ranging from self-help groups to the use of structured treatment or residential programs, are often important adjuncts to treatment.

TABLE 404-2 IMPORTANT PSYCHIATRIC SYNDROMES AND DISORDERS

SYNDROME	MAIN SYMPTOMS AND SIGNS	MAY OCCUR AS PART OF THESE DISORDERS
Cognitive	Deficits in intellectual functions, e.g., level of consciousness, orientation, attention, memory, language, praxis, visuospatial, executive functions	Cognitive disorders Mental retardation (if onset in childhood)
Mood	Depressive: lowered mood, anhedonia, negativistic thoughts, neurovegetative symptoms *or* Manic: elevated or irritable mood, grandiosity, goal-directed hyperactivity with increased energy, pressured speech, decreased sleep need	Cognitive disorders Mood disorders (primary or secondary) Psychotic disorders (schizoaffective disorder)
Anxiety	All include anxious mood and associated physiologic symptoms (e.g., palpitations, tremors, diaphoresis). May include various types of dysfunctional thoughts (e.g., catastrophic fears, obsessions, flashbacks) and behavior (e.g., compulsions, avoidance behavior)	Cognitive disorders Mood disorders (primary or secondary) Psychotic disorders (primary or secondary) Anxiety disorders (primary or secondary)
Psychotic	Impairments in reality testing: delusions, hallucinations, thought process derailments	Cognitive disorders Mood disorders (primary or secondary) Psychotic disorders
Somatoform	Somatoform symptoms: physical symptoms resulting from unconscious psychogenic causes	Mood disorders (primary or secondary) Anxiety disorders (primary or secondary) Somatoform disorders
Personality pathology	Enduring patterns of dysfunctional emotional regulation, thought patterns, interpersonal behavior, impulse regulation	Cognitive disorders (dementia) Change in personality because of general medical condition Personality disorders

Based on categories and criteria from American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV)*, 4th ed. Washington, DC: American Psychiatric Association; 2000.