Anatomy and Physiology Focus: The Nervous System
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Session Objectives

• Review the structure and function of the nervous system
• Describe diseases and disease processes and how they affect the nervous system
The Nervous System

Structures:
- Central nervous system
  - Brain
  - Spinal cord
- Peripheral nervous system
  - Nerves, ganglia
  - Somatic nervous system
  - Autonomic nervous system

Function:
- Control, regulatory, communication center
- Stimulation of movement
- Ability to analyze and respond to environment
- Interprets and integrates changes, decides course of action, responds by sending impulses through body
Cells and Tissues of Nervous System

Neurons (nerve cells)

- Electrically excitable cells: Process and transmit information by electrical and chemical signaling, neurotransmitters via synapses; axon picks up signal from cell body, conducts it to another neuron or organ
- Sensory (afferent) neurons: Carry impulses from receptors in skin and sense organs to brain and spinal cord; convert external stimuli from environment into internal stimuli
- Motor (efferent) neurons: Carry impulses from brain and spinal cord to muscles or glands; voluntary and involuntary responses
- Neurons pointed in same direction: Nerve cell bodies and dendrites form gray matter, myelinated axons form white matter
- Nervous tissue in PNS has limited ability to regenerate; cannot regenerate if cell body destroyed; can regenerate if cell body intact and sheath intact
Neuroglia (connective tissue)

- Surround neurons, hold them in place, supply nutrients and oxygen to neurons, insulate one neuron from another, destroy pathogens, remove dead neurons; common sites of tumors
- Astrocytes (top): Star-shaped; wrap around nerve cells, provide supporting network around neurons in brain and spinal cord; attach neurons to blood vessels
- Oligodendrocytes (lower right): Form rows of semi-rigid tissue between neurons in CNS; produce thick, fatty sheath, myelin, covering neurons; myelinated nerve fibers make up white matter; Schwann cells wrap around axons of motor and sensory neurons to form myelin sheath; neurolemma forms outermost layer of nerve fiber
- Microglia (lower left): Specialized neuroglia protect nervous system from disease by engulfing of pathogens, clearing debris
Central Nervous System (CNS)

**Brain**: Control center of body; monitors and regulates body's actions and reactions

- **Cerebrum**: Largest portion; surface, cerebral cortex, composed of gray matter; 6 layers of nerve cell bodies, billions of cells; under cortex, cerebral white matter, myelinated axons; as brain develops, cortex folds on itself, forms gyri, fissures, sulci; longitudinal fissure, almost completely separates hemispheres; connected by large bundle of transverse nerve cell fibers, corpus callosum; right/left hemispheres divided into 4 lobes, frontal, parietal, temporal, occipital

- Motor functions, muscle movement; interprets sensory input; emotional/intellectual processes

- Electrical potentials (brain waves) generated by nerve cells in cerebrum; can be recorded on EEG to diagnose epilepsy, narcolepsy, determine cause of nontraumatic loss of consciousness, dementia, determine extent of traumatic brain injury, differentiate between physiological conditions vs mental health issues to evaluate behavior; brain activity
- **Cerebellum**: Motor area of brain, controls unconscious movements in skeletal muscle for coordination, posture, balance; injury/trauma characterized by lack of muscle coordination, abnormal gait, may affect speech muscles; some cognitive functions such as attention, language, emotional functions such as fear and pleasure responses; does not initiate movement, contributes to coordination, precision, accurate timing; receives input from sensory systems and other parts of brain and spinal cord; integrates input to fine tune motor activity
Brain Stem

- **Medulla oblongata**: Most inferior part of brain; conducts impulses between brain and spinal cord; trauma to medulla may be fatal; non-fatal may cause cranial nerve malfunctions, paralysis/loss of sensation, respiratory problems

  - Principle conduction pathways:
    - Pyramids: Some fibers cross to opposite side, right cortex controls movement on left side and vice versa
    - Nuclei: Receive sensory impulses from ascending tracts of spinal cord, impulses processed on opposite side of brain
    - Four pairs of cranial nerves originate in medulla: Glossopharyngeal (CN IX), vagus (CN X), accessory (CN XI), hypoglossal (CN XII)
Brain Stem Structures and Function

- Vital reflex centers: Cardiac center regulates heartbeat, respiratory center adjusts rate and depth of breathing, vasoconstrictor center regulates diameter of blood vessels
- **Pons**: Above medulla, anterior to cerebellum; bridge from brain to spinal cord; white matter conducts signals from cerebrum to cerebellum and medulla, carries sensory signals to thalamus; contains sleep paralysis center of brain, generates dreams of REM sleep
- Four pairs of cranial nerves originate in pons: trigeminal (CN V); abducens (CN VI); facial (CN VII); acoustic/vestibulocochlear (CN VIII)
• **Midbrain**: Connects pons and cerebellum; vision, hearing, motor control, sleep/wake, arousal (alertness), temperature regulation; substantia nigra closely associated with motor system pathways of basal ganglia, dopaminergic neurons involved with some movement disorders
  – Two pairs of cranial nerves originate in midbrain: Oculomotor (CN III), trochlear (CN IV)

• **Thalamus**: Above brainstem, relays sensation, spatial sense, regulation of consciousness, sleep, and alertness, and motor signals to cerebral cortex; receives sensory signals, sends them to associated primary cortical area
• **Hypothalamus**: Below thalamus; links nervous system to endocrine via pituitary gland; responsive to olfactory stimuli; thermostat for body, sets desired body temperature, and stimulates either heat production/retention to raise temperature, or sweating/vasodilatation to lower temperature.
• **Pituitary**: Size of pea, protrusion off bottom of hypothalamus, rests in small, bony cavity (sella turcica); Anterior pituitary: Adrenocorticotropic hormone (ACTH), thyroid-stimulating hormone (TSH), human growth hormone (HGH), prolactin, gonadotropins, luteinizing hormone (LH), follicle-stimulating hormone (FSH), melanocyte-stimulating hormones; Posterior pituitary: Oxytocin, antidiuretic hormone (ADH)

  – Hormones secreted from pituitary gland help control growth, blood pressure, some aspects of pregnancy and childbirth, stimulation of uterine contractions during childbirth, breast milk production, male and female sex organ functions, thyroid, metabolism, water/ion regulation, reabsorption of water by kidneys, temperature regulation, stimulation of hunger and thirst sensations; makes endorphins to relieve pain and alter mood
Meninges

- Brain and spinal cord are protected by three layers of tissue, meninges
- Dura mater is outermost layer, forms tough protective coating
- Arachnoid mater is middle protective layer; space between arachnoid and underlying pia mater is subarachnoid space, contains cerebrospinal fluid (CSF)
- Pia mater is transparent layer containing blood vessels; adheres to surfaces of brain, spinal cord
Cerebrospinal Fluid (CSF)

- Protects brain/spinal cord; clear, colorless fluid in subarachnoid space and 4 communicating ventricles in ventricular system; 500 ml/day produced, turns over about 3.7 times/day; brain "floats" in it; cushions cortex, provides mechanical and immunological protection to brain inside; removes metabolic waste; obstruction to flow can result in hydrocephalus

Falx Cerebri

Cerebral Cortex

Corpus Callosum

Lateral Ventricle

Third Ventricle

Midbrain Aqueduct

Fourth Ventricle

Medulla Oblongata

Spinal Cord

Central Canal of Spinal Cord

Cerebellum

Pons Varolii
Spinal Cord

- Continuation of medulla, from foramen magnum at base of skull to level of 2nd lumbar vertebra; varying width, from $\frac{1}{2}"$ thick in cervical and lumbar regions (upper/lower extremities) to $\frac{1}{4}"$ thick in thoracic area; length of spinal cord shorter than length of bony spinal column.
- In upper part of vertebral column, spinal nerves exit directly from spinal cord, in lower part nerves pass further down column before exiting; terminal portion of spinal cord is called conus medullaris; cauda equina (“horse’s tail”), collection of nerves in vertebral column that continues to below conus medullaris; pia mater anchors spinal cord to coccyx.
- Three major functions: Conduit for motor information, which travels **down** spinal cord; conduit for sensory information, which travels up spinal cord; center for coordinating certain reflexes.
- TIP: Caudad=toward tail, cephalad= toward head.
Spinal Nerves

- 31 pairs from spinal cord distributed primarily to arms, legs, trunk; grouped according to level from which they stem, each nerve is numbered in sequence, 8 pairs cervical, 12 pairs thoracic, 5 pairs lumbar, 5 pairs sacral, 1 pair coccygeal; dermatomes

- Dorsal root, posterior or sensory, conducts impulses into spinal cord

- Ventral root, anterior or motor conducts impulses away from spinal cord

- Nerve plexus: Intersecting nerves that serve same area of body combine into one large grouped nerve:
  - Cervical plexus—head, neck and shoulders
  - Brachial plexus—chest, shoulders, arms, hands
  - Lumbar plexus—back, abdomen, groin, thighs, knees, calves
  - Sacral plexus—pelvis, buttocks, genitals, thighs, calves, feet
  - Solar plexus—internal organs
  - Coccygeal plexus—small region over coccyx
  - Auerbach's plexus—GI tract
Peripheral Nervous System (PNS)

- All neural tissue outside brain and spinal cord; main function to connect CNS to limbs and organs; divided into somatic and autonomic nervous systems
- Two types of neurons carry nerve impulses in different directions:
  - Sensory neurons, **afferent** neurons, relay nerve impulses **toward** CNS (A=arriving)
  - Motor neurons, **efferent** neurons, relay nerve impulses away from CNS (E=exiting)
Cranial Nerves

- I—Olfactory nerve: Smell
- II—Optic nerve: Vision
- III—Oculomotor nerve: Eyelid and eyeball movement
- IV—Trochlear nerve: Innervates superior oblique muscle, turns eye downward and laterally
- V—Trigeminal nerve: Chewing, face/mouth, touch/pain
- VI—Abducens nerve: Turns eye laterally
- VII—Facial nerve: Controls most facial expressions, secretion of tears & saliva, taste
- VIII—Acoustic/vestibulocochlear/auditory nerve: Hearing, equilibrium, sensation
- IX—Glossopharyngeal nerve: Taste, senses carotid blood pressure
- X—Vagus nerve: Senses aortic blood pressure, slows heart rate, stimulates digestive organs, taste
- XI—Spinal accessory nerve/accessory nerve: Controls trapezius & sternocleidomastoid muscles of shoulder and neck; muscles of swallowing
- XII—Hypoglossal nerve: Controls tongue and swallowing movements, articulation

Mnemonic for cranial nerves: On Old Olympus’s Towering Top, A Finn And German Viewed Some Hops
Divisions of PNS

• Somatic nervous system
  – Motor fibers running from CNS to skeletal muscle; carries motor and sensory information to and from central nervous system, sensory fibers from skeletal muscles, skin, viscera to CNS; controls all voluntary muscular systems; processes sensory information from external stimuli including sound, touch, sight, smell

• Autonomic nervous system
  – Largely involuntary, controls visceral functions, heart rate, digestion, respiration rate, salivation, perspiration, diameter of pupils, urination, sexual arousal; most actions are involuntary, some, such as breathing, work with conscious mind
  – Subdivisions of autonomic nervous system:
    • Sympathetic: Expends energy to maintain homeostasis; stimulating effects of epinephrine/norepinephrine; with extreme threat, dominates parasympathetic, produces “fight or flight” response
Divisions of PNS (continued)

– Diverts blood flow away from GI tract and skin via vasoconstriction; inhibits peristalsis
– Blood flow to skeletal muscles and lungs enhanced by as much as 1,200% in skeletal muscles
– Dilates bronchioles in lungs, allows for greater alveolar oxygen exchange
– Increases heart rate and contractility of cardiac cells, providing enhanced blood flow to skeletal muscles
– Dilates pupils, relaxes ciliary muscle to lens, allowing more light to enter eye, better distance vision
– Provides vasodilatation for coronary arteries
– Constricts all intestinal sphincters and urinary sphincter

• Parasympathetic: Works to restore and conserve energy; back to normal after sympathetic stimulation; inhibiting effects, neurotransmitter, acetylcholine
Other Functions of Nervous System

• Overlapping functions:
  – Sensory: Input gathered by millions of sensory receptors detect changes inside and outside body; temperature, light, sound, blood pressure, pH, CO\textsubscript{2} concentration
  – Integration: Sensory input converted to electrical impulses transmitted to CNS; impulses create sensations, thoughts, memories; conscious/unconscious decisions occur in CNS
  – Motor: Once sensory input is integrated, response is initiated, sending signals to effectors, tissues, organs, glands, eliciting response, muscle contraction, gland secretion; causing an effect in response (motor output/motor function) to directions from CNS
Nerve Impulses

• Irritability: Cells respond to stimuli, convert them to nerve impulses; size, type, condition of fibers determines speed of transmission of impulses; large, myelinated fibers transmit faster than smaller, unmyelinated fibers; sensory fibers detecting potentially dangerous stimuli in external environment generally larger than those controlling less critical stimuli

• Conductivity: Ability of nerve cell to transmit impulse to another nerve cell; receptor responds to stimulus, impulse passed to CNS, impulse blocked, transmitted on, rerouted; impulse transmitted to effector, eliciting response
Diseases, Disorders, Injuries, Other Conditions of Nervous System

Infectious/Parasitic Diseases

• **Encephalitis (brain)/encephalomyelitis (brain and spinal cord):** Inflammation, viral (herpes, measles, West Nile), bacterial, parasitic (malaria); may be mild or serious; fever, headache, stiff neck (nuchal rigidity), vomiting, confusion, may progress to seizures, paralysis; treatment symptomatic, antibiotics for bacterial

• **Meningitis:** Inflammation of meninges; usually involves dura mater/arachnoid; bacterial (staph, strep), viral (HIV, shingles, mumps), parasitic, fungal, noninfectious (SLE, metastases, meds, NSAIDS); acute, chronic; severe headache, neck stiffness, altered mental status; treatment based on cause
• **Herpes zoster** (shingles): Varicella virus; chickenpox, after initial infection, virus can stay dormant in some nerve cells, reactivated later to produce skin lesions, burning, extreme sensitivity and exquisite pain in skin along distribution of nerve; can develop post-herpetic neuralgia, residual pain for months/years; no cure, Valtrex, Zovirax, vaccine

• **Brain abscess**: Caused by inflammation and collection of infected material within brain tissue; ear infection, dental abscess, sinus infection, infected mastoid air cells, epidural abscess or remote (lung, heart, kidney) infectious sources; bacterial, staph, strep, pseudomonas; parasitic, fungal; most frequent presenting symptoms are headache, drowsiness, confusion, seizures, hemiparesis, speech difficulties with fever, rapidly progressive course; symptoms and findings depend largely on specific location of abscess in brain; appropriate antibiotics; blood-brain barrier
Neoplasms

- Primary CNS more common in brain than spinal cord; almost ½ brain tumors are benign, which can recur and be fatal; PNS may have malignant or benign lesions; most common sources of brain metastases, lung cancer, breast cancer, genitourinary tract, osteosarcoma, melanoma, head and neck, neuroblastoma, GI, especially colorectal and pancreatic, lymphoma
Malignant

- Gliomas: Most common, connective tissue
- Brain stem glioma
- Astrocytoma: Astrocytes; glioblastoma multiforme
- Oligodendroma: Arise from oligodendrocytes; malignant, common in cerebrum
Benign

• Neuroma: Benign lesion of nerve or thickening of nervous tissue; acoustic neuroma, Morton’s neuroma (foot)
• Neurofibromatosis: (von Recklinghausen disease); uncommon; genetic; benign tumors grow on nervous tissue, cause skin/bone abnormalities; tumors may cause bumps under skin, discoloration of skin (café au lait), skeletal problems, pressure on spinal nerve roots, other neurological problems; benign but can cause serious problems; “Elephant Man”
Benign, Malignant, or Uncertain Behavior

- Meningioma: Membrane covering brain/spinal cord; most benign, 10% malignant or atypical; radiation to scalp increases risk
- Ependymoma: Arises from cells lining ventricles and subarachnoid space surrounding brain/spinal cord; may be malignant, benign, uncertain behavior
- Schwannoma: PNS tumors; myelin sheath from Schwann cells; benign or malignant; Acoustic neuroma most common benign Schwannoma (CN VIII); malignant Schwannoma, sciatic nerve, brachial, sacral plexus
- **Benign does not necessarily mean NOT DANGEROUS!**
Movement Disorders

• Huntington’s disease (chorea): Autosomal dominant, inherited; overactivity of dopamine, causes dyskinesia, affects muscle coordination, leads to cognitive decline; typically becomes noticeable in middle age; earliest symptoms are general lack of coordination, unsteady gait; disease advances, uncoordinated, jerky, writhing body movements (choreoform) become more apparent, along with decline in mental abilities and behavioral and psychiatric problems; dementia, pneumonia, heart disease, physical injury from falls reduce life expectancy to around 20 years after symptoms begin; no cure

• Amyotrophic lateral sclerosis (ALS): Lou Gehrig’s disease; motor neurons in brain lose ability to control voluntary movement, all muscle control lost; loss of control of diaphragm and chest wall leads to ventilator dependence; rapidly progressive weakness, muscle atrophy and spasticity, dysarthria, dysphagia, respiratory compromise; most die from respiratory failure within 3–5 yrs of diagnosis; no known cause; low familial tendency (<5%)
Parkinson’s Disease

- Dopamine-producing cells in substantia nigra in brain become impaired or die; symptoms appear when 75–80% of cells destroyed; primary, cause unknown; secondary, environmental toxins, medications, encephalitis, cerebrovascular disease
- Risks: Age, males > females, family history, history of head trauma
- Symptoms: Resting tremor, bradykinesia (slowness of movement), rigidity, gait disturbance, postural instability (falls, fractures), speech and swallowing disturbances; alterations in cognition, mood, behavior often occur
- Treatment: No cure; meds to diminish motor symptoms, Levo-dopa, Carbidopa, Selegeline, anticholinergic medications, block neurotransmitter that helps regulate muscle movement; deep brain stimulation (brain pacemaker), not cure but helps reduce symptoms
Demyelinating Disease

- Multiple sclerosis (MS): Inflammatory disease; myelin sheaths around axons of brain and spinal cord are damaged, leading to demyelination/scarring, affects ability of nerve cells in brain and spinal cord to communicate; onset age 20–40, women > men; thought to be autoimmune, increased risk with first degree relative with disease, may be some environmental factors; visual problems may be first symptom, symptoms related to demyelinated area of CNS; no cure; treatment goals: attempt to slow progression of disease; steroids, disease modifying drugs, Interferon

- Relapsing-remitting (RR) MS, 65%–80% of individuals begin with this most common type; series of attacks followed by complete or partial disappearance of symptoms (remission) until another attack occurs (relapse), may be weeks to decades between relapses; goals: improving speed of recovery from attacks, reduce number of attacks

- Secondary-progressive-relapsing (SP) MS: Over several decades, most RR-MS persons will experience progression to SP-MS, characterized by steady decline in abilities accompanied by sporadic attacks
Neuromuscular Disorders

• Myoneural junction disorders, defect in transmission of impulses at synapses of neurons and muscles

  – **Myasthenia gravis**: Chronic, autoimmune disease; body produces antibodies that block, alter, or destroy acetylcholine receptors at neuromuscular junction, preventing normal muscle contraction; hallmark is fatigability; muscles controlling eye and eyelid movement, facial expression, chewing, talking, swallowing, especially susceptible, muscles that control breathing, neck and limb movements can also be affected; treatment with acetylcholinesterase inhibitors, Neostigmine and Pyridostigmine, immunosuppressants, thymectomy; not usually progressive, symptoms decrease over 3–5 yrs

  – **Muscular dystrophy**: Group of 30 distinct genetic diseases; progressive degeneration and weakness of skeletal muscles that control movement; some forms symptomatic in infancy/childhood, some in adolescence/adulthood; most types are multi-system disorders with manifestations in body systems including heart, GI, nervous systems, endocrine glands, skin, eyes, brain, may also lead to mood swings, learning difficulties; Duchenne’s most common, affects boys; no cure, treatment: PT, OT to maintain functioning, treatment of symptoms related to affected systems
Epilepsy, Seizure Disorders, Seizures

- Seizure caused by surge of electrical signals in all or part of brain; seizures due to abnormal neural connections as well as imbalances in neurotransmitters; medications, fever, metabolic imbalances among causes of seizures; not all seizures are epileptic; epilepsy and seizure disorder differ in etiology; epilepsy is seizure disorder but not all seizure disorders are epilepsy
- Epilepsy diagnosed after 2 or more episodes of unprovoked seizure activity not caused by some known medical condition
- Seizure often preceded by aura, may have loss of consciousness, blank staring, jerky movements of extremities (convulsions); many types of seizures, 2 broad categories, focal or partial, generalized; idiopathic or secondary to drugs, medical conditions
- Status epilepticus, life-threatening condition in which brain is in a state of persistent seizure; traditionally defined as one continuous, unremitting seizure lasting longer than 5 minutes, or recurrent seizures without regaining consciousness between seizures for greater than 5 minutes; always considered medical emergency
- Diagnosis: EEG, imaging, neuro exam, history
- Treatment: Anti-epileptic drugs, old and new, Dilantin, Gabapentin, Topamax; surgery for treatment resistant or seizures from focal abnormality in brain that can be located and treated
Headache

- **Migraine**: Vascular headache; trigeminal nerve (CNV) is triggered to release chemicals that irritate and cause dilatation of blood vessels on surface of brain; dilated blood vessels send pain signals to brainstem; women > men; pain typically felt unilaterally, around eye/temple area, may also occur in face, sinus, jaw or neck area; once attack is full-blown, many people are sensitive to anything touching head; sensitivity to light, sound, nausea/vomiting; may be preceded by aura or visual disturbances (scintillating scotoma); moderate to intense pain, interferes with functioning; may have triggers: food, stress, environmental; treatment: avoid triggers, abortive meds early in attack, Imitrex, Zomig, biofeedback; status migrainosus, >72 hours, risk of stroke

- **Cluster headache**: Attacks of headaches which may last from weeks to months, usually followed periods when headache attacks stop completely; excruciating unilateral headaches of extreme intensity, lasting 15–180 minutes, may experience 1–8 attacks in 24 hours; men > women; “suicide headache”; vascular, affects to trigeminal nerve; cause unknown, may be genetic, smoking, alcohol may trigger; avoid triggers, meds, inhalation of 100% O₂ may help
Other Conditions of Nervous System

• **Trigeminal neuralgia**
  – Intense pain in face, originating from trigeminal nerve (CN V); among most painful conditions known; may have no cause, may be post-herpetic; treatment: anticonvulsants; low dose antidepressant, Amitriptyline; Botox injection of trigeminal nerve; surgery to relieve pressure on nerve

• **Bell’s palsy**
  – Facial paralysis resulting from dysfunction of CN VII (facial nerve), results in inability to control facial muscles on affected side; inflammatory condition leads to swelling of facial nerve, cause unknown, may be associated with brain tumor, stroke, Lyme disease; treatment with steroids, resolves spontaneously in most people

• **Transient ischemic attacks**
  – TIAs, “mini-stroke” (not really stroke); interruption of blood supply to part of brain without tissue death; symptoms similar to stroke, resolve within 24 hours; unilateral numbness/weakness of face, arm, leg, difficulty speaking/understanding speech, visual changes in one/both eyes, dizziness, loss of balance; treatment, aspirin, Plavix, may need ant-coagulants; reduction of risk factors, control of B/P, diabetes, lipids; carotid endarterectomy
Stroke: Cardiovascular event, embolic or hemorrhagic, resulting in damage to brain tissue; depending on region of the brain affected, effects may be very different

- Effects of right hemisphere stroke: left-sided weakness (left hemiparesis) or paralysis (left hemiplegia) and sensory impairment; visual problems, including inability to see left visual field of each eye (homonymous hemianopsia); spatial problems with depth perception or directions; inability to localize or recognize body parts; inability to understand maps and find objects such as clothing or toiletry items; memory problems; behavioral changes such as lack of concern about situations, impulsivity, inappropriateness, and depression

- Effects of left hemisphere stroke: right-sided weakness (right hemiparesis) or paralysis (right hemiplegia) and sensory impairment; problems with speech and understanding language (aphasia); visual problems, including inability to see right visual field of each eye (homonymous hemianopsia); impaired ability to do math, organize, reason, analyze items; behavioral changes such as depression, cautiousness, hesitancy; impaired ability to read, write, and learn new information; memory problems
Hydrocephalus

• Acquired hydrocephalus
  – Occurs any time after birth, can occur at any age; may be caused by injury, disease such as hemorrhage, neoplasm, cystic lesion, infection
    • Communicating hydrocephalus: Flow of CSF blocked after exiting ventricles, still flows between ventricles
    • Noncommunicating hydrocephalus: Flow blocked along passageways connecting ventricles, preventing flow between them

• Normal pressure hydrocephalus (NPH): Increase in intracranial pressure due to abnormal accumulation of CSF in ventricles, may be due to impaired CSF reabsorption; may be idiopathic or secondary to head trauma, infection, tumor, cranial surgery; classic triad of gait disturbance, incontinence, dementia, often misdiagnosed as Alzheimer’s dementia, very similar symptoms; treatment, ventriculoperitoneal (V-P) shunt to drain excess cerebrospinal fluid to abdomen where it is absorbed; early diagnosis and treatment yields better results, especially with gait, incontinence symptoms
Alzheimer’s Disease

- Progressive, fatal brain disease; brain cell death in cortex, areas responsible for thinking, planning, remembering, and hippocampus, where new memory is formed
- As brain atrophies, ventricles enlarge; leads to memory loss, confusion, disruption of thought processes, behavioral problems; progresses to loss of bodily functions, death
- Cause unknown, thought to be amyloid plaques and neurofibrillary tangles in brain, reduced acetylcholine in brain; risks: close relative with AD, longstanding HTN, female gender, history of head trauma, genetic chromosomal mutations (APOE4 gene linked to late-onset Alzheimer's)
- No cure, some meds to slow progression by combating loss of acetylcholine (Aricept, Exelon, Namenda, Reminyl)
- Disease of exclusion, other causes of dementia must be ruled out, structural lesions, thyroid dysfunction, vitamin B12 deficiency, vascular dementia, normal pressure hydrocephalus
Differential Diagnosis of Dementia

4 Ds in assessing memory loss: dementia, delirium, depression, drugs

- Onset: Rapid vs slow onset; old vs young; fluctuating mental status; metabolic dysfunction, dehydration, fever, thyroid storm, hypoglycemia; liver failure; alcohol/drug withdrawal; head trauma, falls; infection, UTI, pneumonia; electrolyte imbalance; poisonings (carbon monoxide), medications, prescribed/OTC; post-anesthesia; usually reverses when cause resolved

- Underlying causes: AIDS dementia, vascular dementia (result of HTN), depression (difficulty concentrating), Lyme disease; normal pressure hydrocephalus; vitamin B12 deficiency, thyroid disease (hypo, hyper), hyperparathyroidism; diabetes

- Diagnostic testing: CT of head, r/o structural lesion, tumor, hydrocephalus, old infarcts/strokes; complete blood panel, thyroid, electrolytes, blood count, B-12/folate levels, tox screen, therapeutic blood levels of meds; neuropsychiatric testing; Folstein mini-mental exam (MMSE): brief 30-point test used to screen for cognitive impairment, also used to estimate severity of cognitive impairment at given point in time and to follow course of cognitive changes over time, effective way to document individual's response to treatment; tests memory, orientation, some executive functions

Complications of Procedures

• Surgical and other procedures:
  – CSF leak or spinal headache after spinal puncture
  – Intracranial hypotension following shunt
  – Post-procedural hemorrhage or hematoma of nervous system structure
  – Post-procedure infection
Injuries, Poisonings, Other External Causes

- Injuries, blunt force, crush, lacerations, GSW
- Traumatic brain injury; concussions; open, penetrating; accidents, sports
- Subarachnoid hemorrhage, traumatic, nontraumatic; subdural hematoma
- Poisoning/toxic effects from drugs, chemicals, under-/overdosing
- Complications from medical/surgical procedures, nervous system devices (shunts, deep brain stimulator)
Signs, Symptoms, Abnormal Findings

- May be present without specific diagnosis or causative condition, may indicate serious underlying condition; require diagnostic evaluation

S&S which could indicate nervous system or other serious problem:

- Abnormal involuntary movement (tremors, tics)
- Abnormalities of gait/mobility
- Problems with coordination
- Transient paralysis
- Convulsions
- Headache
- Visual disturbance
- Frequent falls
- Neck stiffness
- Incontinence
- Dysphagia
- Fatigue
- Speech disturbances
- Weakness
- Malaise
- Altered mental status
- Vertigo
- Disorientation/confusion
- Amnesia
- Stupor
- Coma
- Facial droop
- Drowsiness
- Abnormal reflexes
Abnormal Findings

• Laboratory:
  – Abnormal blood work, CBC, chemistry
  – Abnormal CSF fluid findings
  – Abnormal culture findings, blood, tissue
  – Abnormal enzymes, hormones, drugs, nonmedical substances
  – Abnormal cytological/histological findings

• Imaging:
  – Abnormal CT, MRI, MRA, PET scan(s), tumors, vascular malformations, pace occupying lesion of CNS (tumor, cyst, aneurysm)
  – Abnormal echoencephalogram (ultrasound study of intracranial structures
  – Abnormal EEG, seizures, brain activity
  – Abnormal EMG (nerve conduction studies)
References/Resources

- Advanced Anatomy and Physiology for ICD-10-CM/PCS. Contexto Media. 2010
- Comprehensive Anatomy and Physiology for ICD-10-CM Coding. OptumInsight, Inc., 2012

Internet Resources:
References/Resources (continued)


• Mini-mental status exam. [http://skepticallawyer.files.wordpress.com/2012/01/clinic-dementia_mmse.pdf](http://skepticallawyer.files.wordpress.com/2012/01/clinic-dementia_mmse.pdf) [error message. Fix?]


There is a TON of information available on the internet, all just a keystroke away!
• Great web site: HCPro, good resource for all things HCPro, good resource for all things HIM and more.

http://www.hcmarketplace.com/free/e-newsletters/index.cfm?s=EHCPR

Marketplace has extensive list of free newsletters on many topics. ICD-10 trainer is excellent. Daily email presenting cases related to specific diagnosis and coding.
Questions? Comments?
Thank You.

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