

Chapter 33 Cerebrovascular Disorders

1

Epidemiology

- Stroke
 - 5th leading cause of death in U.S.
 - Often results in paralysis on one side of body
 - Because of rising number of elderly individuals, incidence of stroke increasing
 - Risk for African Americans greater

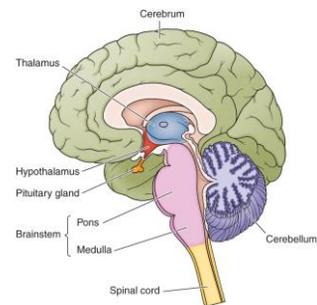
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Neuroanatomy and Neurophysiology

- Central nervous system (CNS)
 - Brain and spinal cord
- PNS (peripheral nervous system)
 - Cranial nerves and spinal nerves
- Spinal cord
 - Motor neurons descend
 - Sensory neurons ascend
- Upper neurons: within the brain
- Lower neurons: spinal cord

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Brain



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Neuroanatomy and Neurophysiology (continued_1)

- Corticospinal tract
 - Upper motor neurons that descend into spinal cord
 - Contralateral: cross over (80%)
 - Ipsilateral: remain on same side (20%)
 - Decussation: brainstem area of crossover
- Corticobulbar tract
 - Run parallel to corticospinal tract

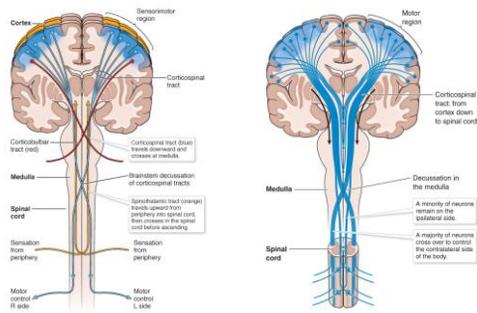
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Neuroanatomy and Neurophysiology (continued_2)

- Spinothalamic tract
 - Sensory neurons from periphery to brain
 - Cross over at some level spinal cord
- Cerebral injury
 - Presentation often on opposite side of body

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Tracts



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Central Nervous System

- Cerebrum
 - Upper most region of brain
 - Right and left hemisphere
 - Corpus callosum: connection
- Categorical hemisphere
 - Language, sequential-analytic
 - L hemisphere in most
- Representational hemisphere
 - Face recognition, music, visual-spatial
 - R hemisphere in most

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Central Nervous System (continued_1)

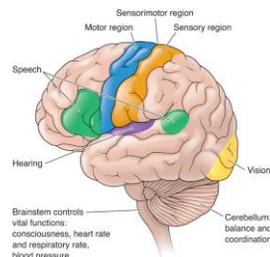
- Speech and language center
- Aphasia
 - Difficult to speak or understand language
- Broca's area
 - Speak language
 - Expressive aphasia
- Wernicke's area
 - Comprehend language
 - Receptive aphasia

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Brain (continued)



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Central Nervous System (continued_2)

Brainstem

- Cranial nerves originate
- Midbrain
 - Auditory and visual responses, motor movement
- Pons
 - Arousal, sleep
- Medulla oblongata
 - HR, respiratory function

Cerebellum

- Smooth movement
- Ataxic gait
 - Uncoordinated walking
- Posture and equilibrium
- Atherosclerosis can affect blood flow to cerebellum
- Vertebral-basilar insufficiency (VBI)
 - Can affect blood flow to cerebellum

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Cerebrovascular Circulation

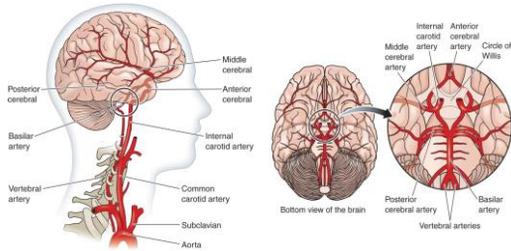
- R and L vertebral arteries
 - Feed posterior brain
- Internal and external carotids
 - Internal carotid
 - Serves brain's anterior and middle cerebral arteries
 - Anterior cerebral artery: frontal lobe
 - Middle cerebral artery: lateral cortex, 80% of brain's tissue
 - » Most strokes involve branch of this artery
- Circle of Willis
 - Base of brain, provides collateral circulation

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Cerebrovascular Circulation (continued)

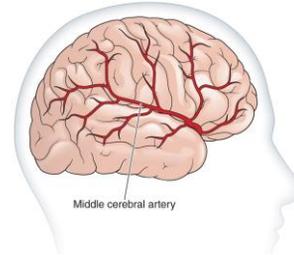


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Middle Cerebral Artery



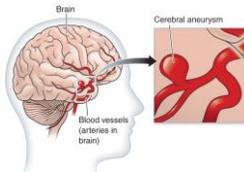
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Circle of Willis

- Base of brain
- Formed by posterior cerebral artery and internal carotid
- Common site for aneurysms (weakness in arterial wall)



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Cranial Nerves

- 12 pairs
- Number I through XII
- Either motor, sensory, or both
- Brain injury, tumor, or stroke can disrupt cranial nerve functioning
- Cranial nerve abnormalities may be a sign of increasing intracranial pressure

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Cerebral Metabolism

- Brain
 - Most energy-consuming organ
 - 20% of oxygen
 - Brain cells not capable of anaerobic metabolism
 - Irreversible damage may occur
- Glucose for energy
- Hypoglycemia and hypoxia affect brain functioning

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Stroke Overview

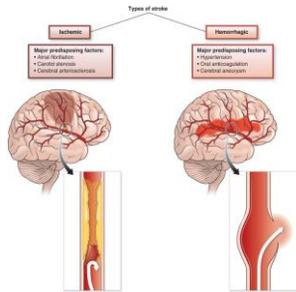
- Two types
 - Ischemic (85%)
 - Thrombus or embolus
 - Leads to cerebral infarction
 - Hemorrhagic (15%)
 - Rupture of cerebral artery
- Transient ischemic attack (TIA)
 - Ischemic injury, “mini-stroke” (inaccurate label)
 - Disruption of cerebral circulation lasting less than 24 hours
 - No permanent injury, but can warn of future attacks

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Types of Strokes



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Ischemic Stroke

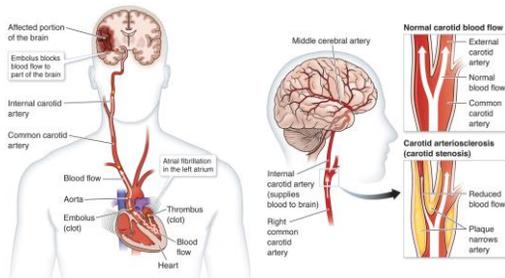
- Most common in internal carotid and middle cerebral artery
- Causes
 - Cerebral arteriosclerosis
 - Carotid stenosis
 - Atrial fibrillation
 - Stasis of blood leads to clot formation

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Ischemic Stroke (continued)



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Ischemia and Ischemic Penumbra

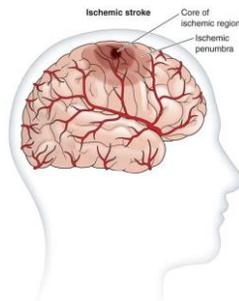
- Cerebral ischemia may develop gradually
 - If completely occluded: neurons in core area of ischemia suffer irreversible infarction within minutes
- Ischemic penumbra: perimeter of ischemic zone
 - Less perfusion but not irreversible damage
 - Rapid reperfusion is critical to recover cells
- Cerebral edema may also develop in the area causing further damage

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Core Ischemia and Ischemic Penumbra



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Glutamate Toxicity

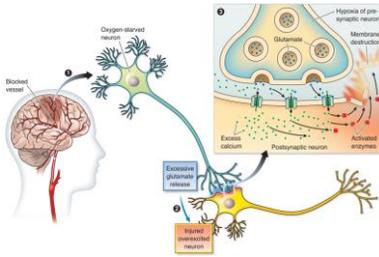
- Cellular ion pumps begin to fail
- Calcium ion influx results in release of glutamate, excitatory neurotransmitter
- Glutamate opens Na⁺ and Ca⁺⁺ channels
- Ca⁺⁺ influx activates degradative enzymes, causing further cell death

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Glutamate Toxicity (continued)



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Transient Ischemic Attacks (TIAs)

- Temporary and resolves
 - 20%–25% of TIAs progress to stroke
- Neurological changes may go unnoticed by patient
 - Observable by bystanders
 - TIA may be resolved by time medical help is received
 - Interview of patient and observers is key

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Transient Ischemic Attacks (TIAs) (continued)

- Lacunar infarct
 - Small infarcts in brain due to occlusion of tiny blood vessels

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Hemorrhagic Stroke

- Artery rupture results in bleeding
- Causes
 - Hypertension: most common cause
 - Aneurysm rupture
 - Most common location: Circle of Willis
 - Subarachnoid hemorrhage
 - Arterial branch in subarachnoid space ruptures

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Hemorrhagic Stroke (continued_1)

- Blood flows into brain, compresses and displaces brain tissue
- Blood causes vasospasm of adjacent blood vessels
- Blood released is toxic to surrounding cells
- Anoxic encephalopathy
 - Lack of oxygen delivery causes decreased level of consciousness

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Hemorrhagic Stroke (continued_2)

- Cerebral edema may occur, putting pressure on brain tissues
 - Pressure on brainstem causes alteration in HR, breathing, pupil dilation

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Hemorrhagic Stroke (continued_3)

- Cushing's triad: pressure on brainstem
 - Bradypnea or irregular respirations
 - Bradycardia
 - Hypertension
- If hemorrhage is large, hematoma and clot form; may expand in first 24 hours, worsening symptoms
 - Eventually, immune response and scar tissue form

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Risk Factors for Stroke

- Hypertension (HTN)
- Hyperlipidemia
- Diabetes
- Smoking
- Obesity
- Lack of exercise
- Atrial fibrillation
- Oral contraceptives
- Excess alcohol
- Family history
- Age 55+
- Gender
 - Male risk is greater than female
- Ethnicity
 - African American risk is greater than Caucasian
- Sickle cell disease
- Transient ischemic attack (TIA)
- Amyloid accumulation

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Signs and Symptoms of Stroke

- Ischemic and hemorrhagic strokes present with similar signs
- Middle cerebral artery most common stroke location
 - Speech, motor, sensory deficits
- Neurological deficits on one side of body
 - Slurred speech, loss of gag reflex, facial droop
 - Hemiparesis, hemiparalysis, loss of sensation
 - Vision loss
 - Some patients have disorientation, confusion

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SAH and VBI

- Subarachnoid hemorrhage (SAH)
 - Presents differently than most hemorrhagic strokes
 - Sudden onset ("worst headache ever," "thunderclap headache")
- Vertebrobasilar insufficiency (VBI)
 - Ischemia of vertebrobasilar circulation
 - Dizziness, vertigo, headache

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FAST

American Heart Association and American Stroke Association:

- **FAST**
 - Facial droop
 - Arm weakness
 - Speech difficulty
 - Time to call 911

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Diagnosis

- Any sudden changes in neurological function should be assessed
- No reliable clinical presentation to differentiate ischemic vs hemorrhagic stroke
- 1-sided symptoms and signs
 - Slurring speech, facial droop, hemiparalysis, etc., are key
- Rule out other pathologies that may present similar to stroke

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Diagnosis (continued_1)

- CT scans without contrast: acute phase
- Identify or exclude hemorrhagic stroke
- Treatment based on whether the stroke is ischemic or hemorrhagic
- CT scan with dye may allow better visualization of ischemia
- Magnetic resonance angiography (MRA)
 - Can distinguish between ischemic and hemorrhagic stroke

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Diagnosis (continued_2)

- Transcranial Doppler
- National Institutes of Health Stroke Scale (NIHSS)
 - Quantify deficits attributed to stroke
 - Monitor progress
 - Used in combination with diffusion weighted imaging MRI (DWI-MRI)

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Ischemic Stroke tPA Treatment

- Intravenous thrombolysis
- Rt-PA: recombinant tissue-type plasminogen activator
 - “Clot buster”
- Not all ischemic stroke patients are candidates
- Must be used within 4 hours of the beginning of the stroke symptoms

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Ischemic Stroke Treatment

- Aspirin or another antiplatelet drug
- Surgical thrombectomy for eligible candidates
- Rehabilitation
 - 1st 4 weeks post-stroke especially important to regain function

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Treatment for Cerebral Hemorrhage

- Hemodynamic stabilization
- Intubation and BP reduction
- Manage cerebral edema
- Surgical treatment

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