Cerebrovascular anatomy for speech-language pathologists

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Outline & Objectives

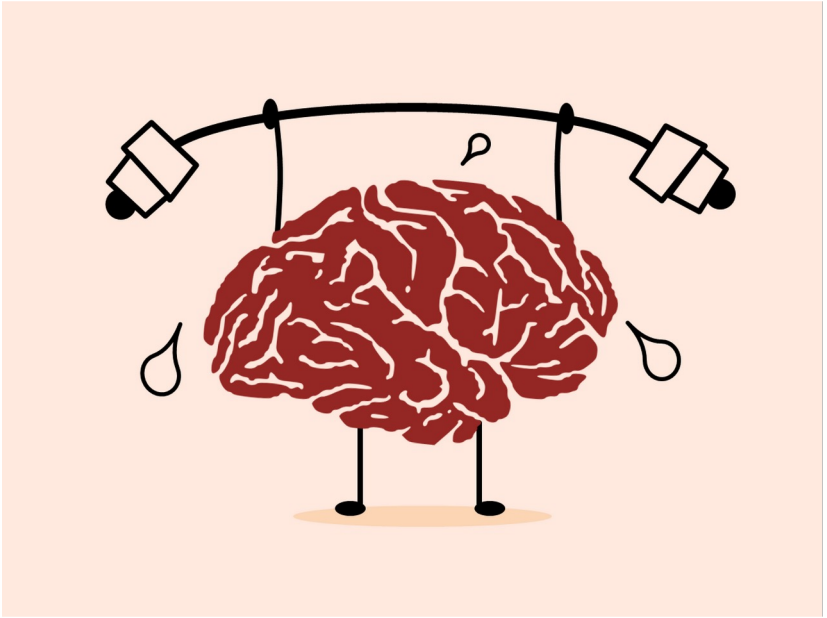
1. Explain why cerebrovascular anatomy is important

2. Identify the major arteries supplying the brain, including their origin and what parts of the brain they supply
    - Circle of Willis & the major cerebral arteries
    - Cerebellar arteries and small vessels
    - Branches of MCA & PCA

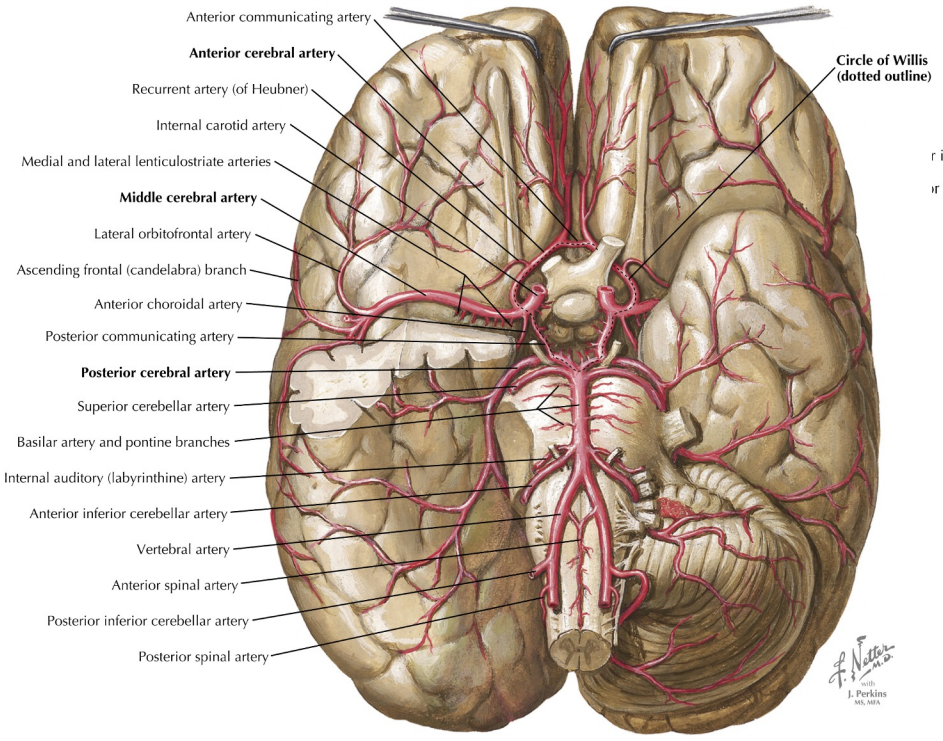
3. Explain the pathophysiology of stroke and how it relates to cerebrovascular anatomy
    - Pathophysiology & angiography of ischemic stroke (thrombotic & embolic)
    - Pathophysiology of hemorrhagic stroke (subarachnoid & intracerebral hemorrhage)

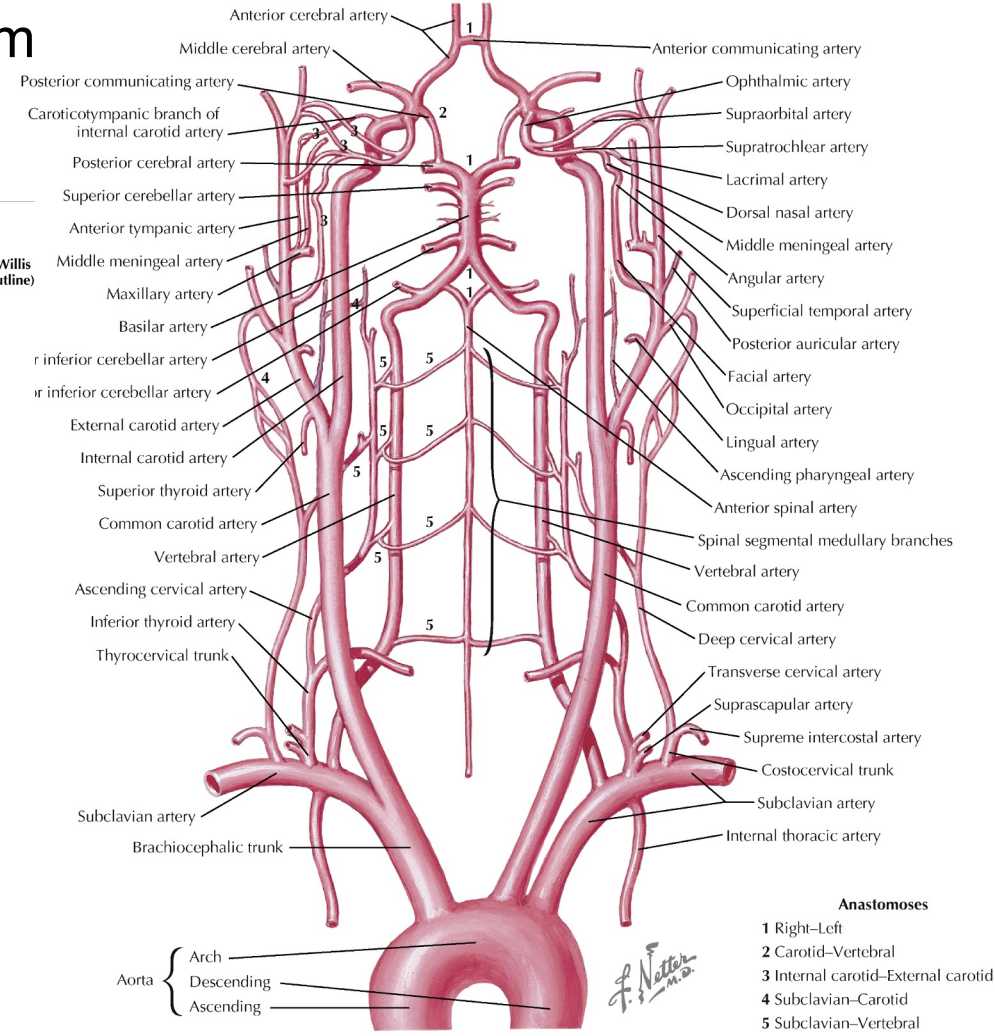
Perfusing the brain is critical

- The brain:
  - Receives 15-20% of the blood pumped by the heart (cardiac output)
  - Accounts for ~20% of the energy used by the entire body
  - Is only ~2% of the total body mass
- Vulnerable neurons begin to die ~5 minutes after ischemia onset
  - Compare to 20+ minutes for cardiomyocytes or hepatic cells
- So ensuring that blood constantly gets to the brain is **really important**



Overview of cerebrovascular system



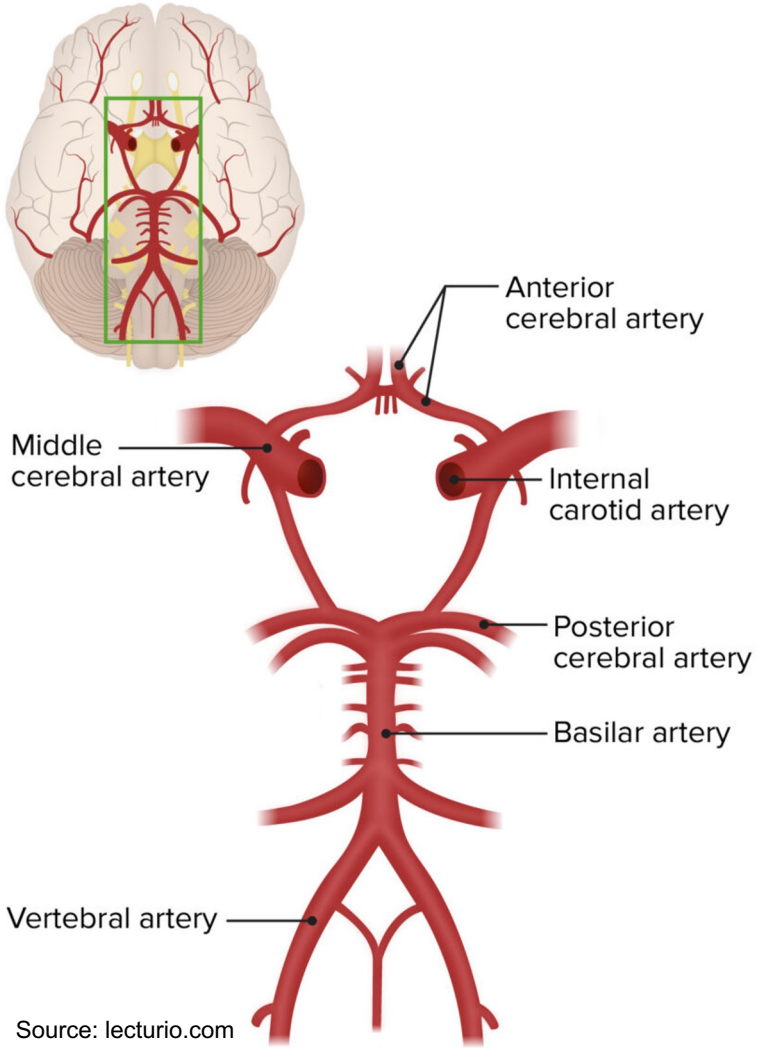


Source: Netter's Atlas of Neuroscience

Cerebral arteries & Circle of Willis

- Circle of Willis – redundancy!
  - If part of CoW is obstructed, can still get some flow through alternate routes
- Major cerebral arteries (MCA, PCA, ACA) come off of Circle of Willis
  - Cover most of the cortex

Source: physio-pedia.com



Source: lecturio.com

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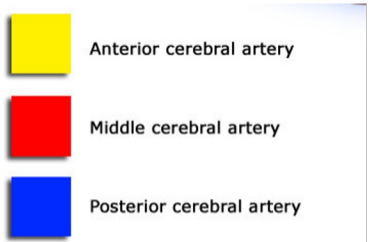
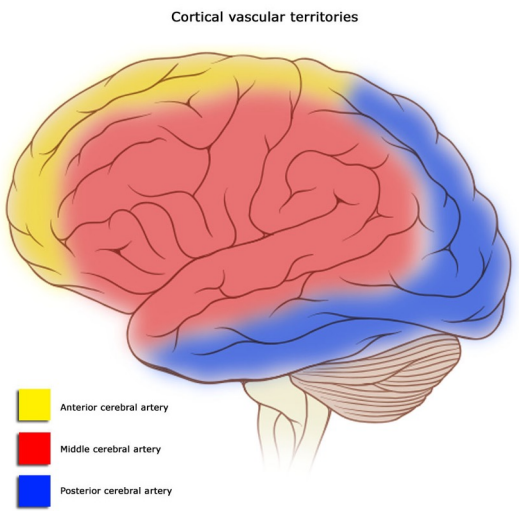
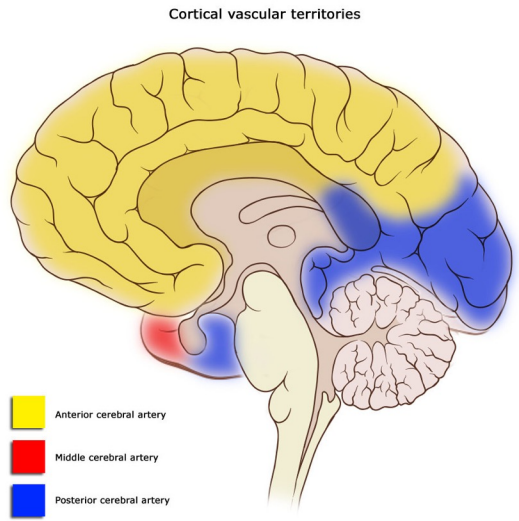
- Major cerebral arteries (MCA, PCA, ACA) come off of Circle of Willis
  - Cover most of the cortex
- But what about subcortical structures, cerebellum?

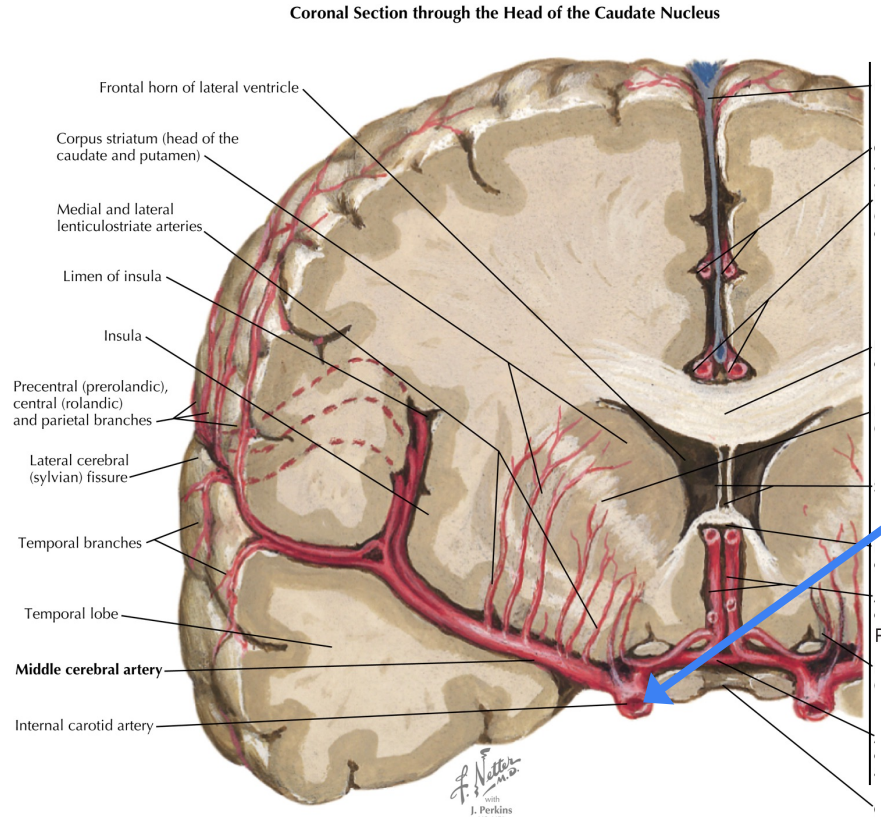






Source: John Lynch via Wikimedia

Cerebellar arteries and small vessels



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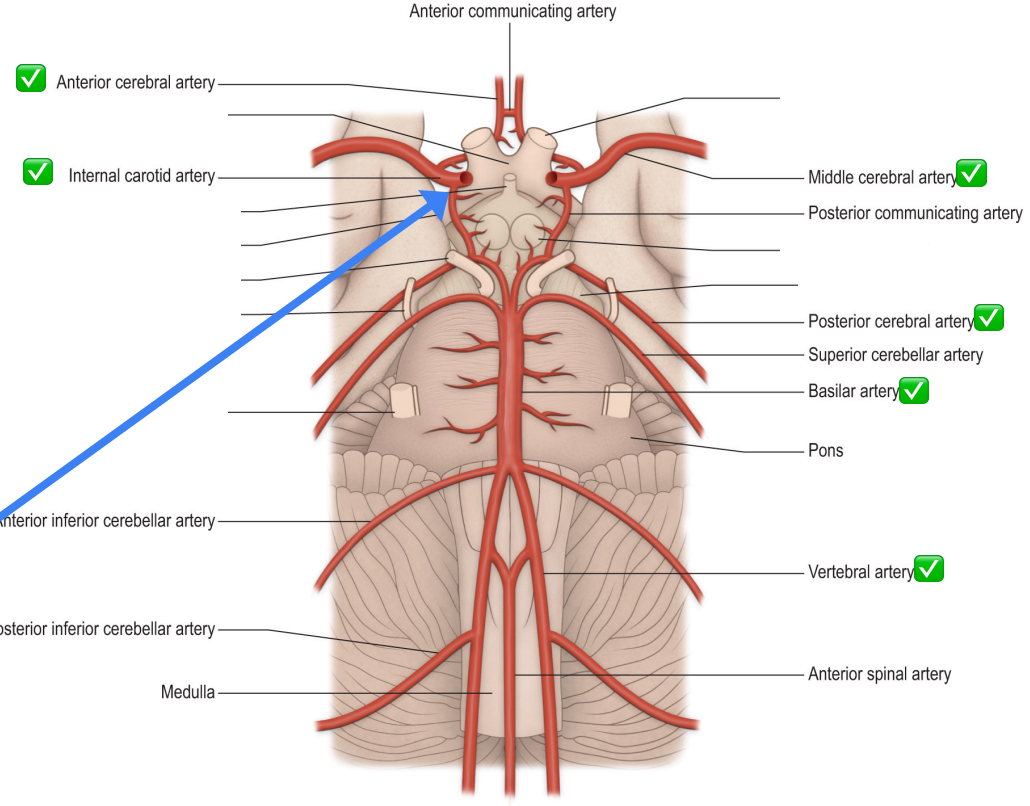
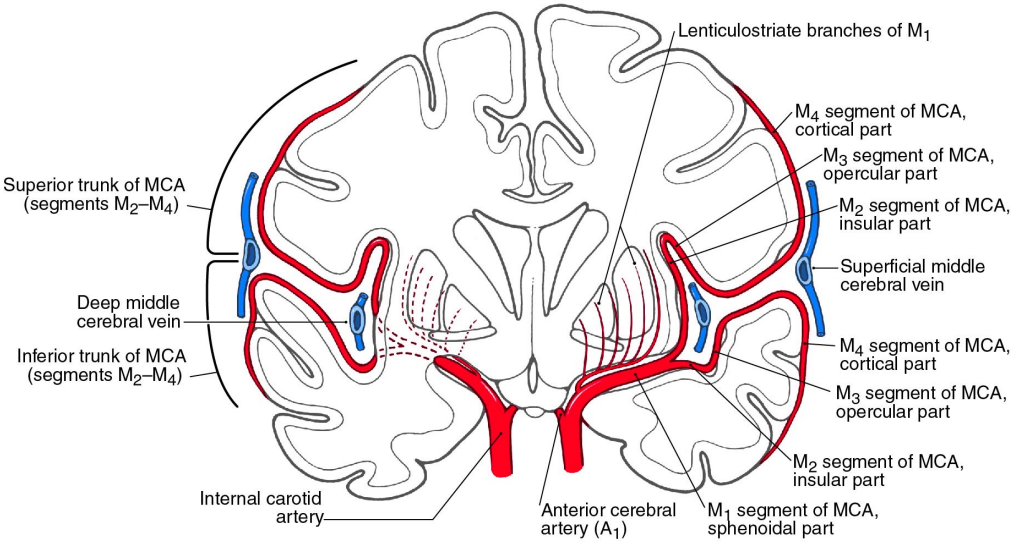
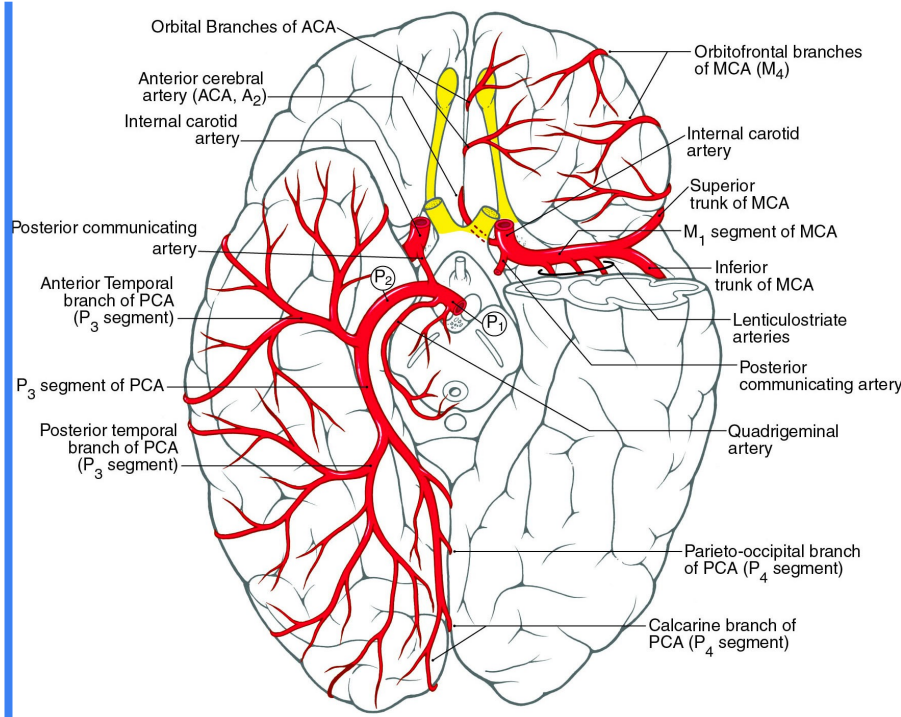


Source: Neuroanatomy: An Illustrated Colour Text

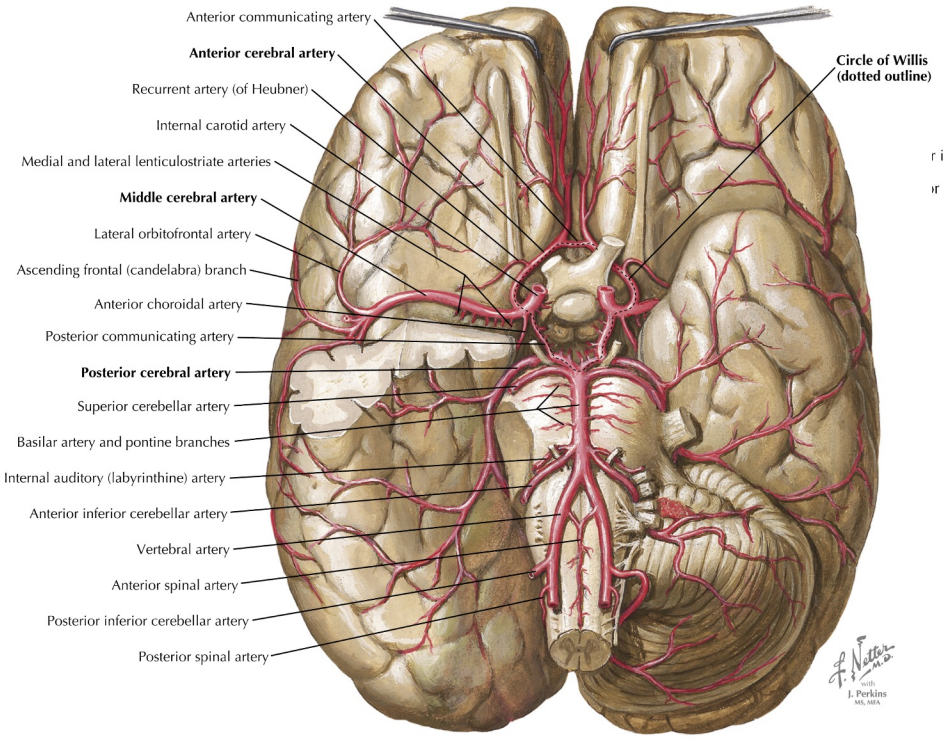
Branches of MCA and PCA

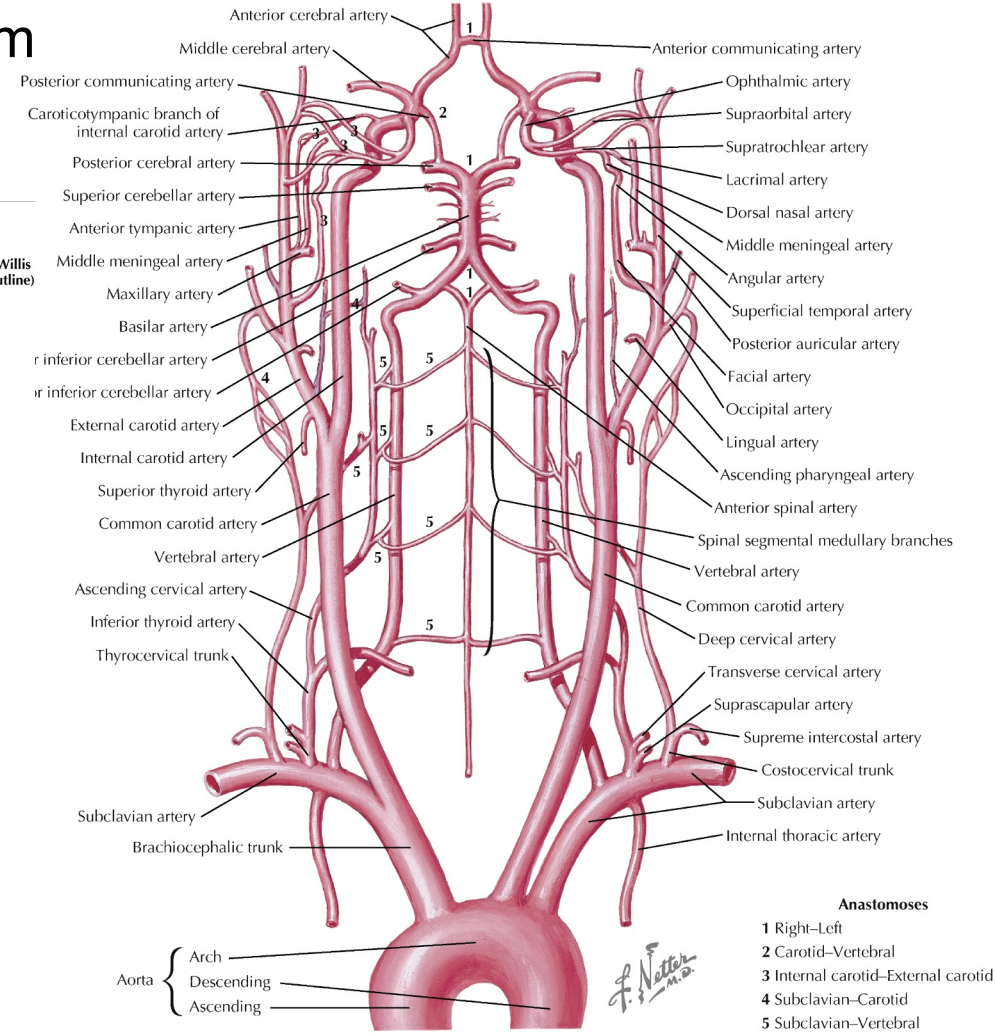




Source: Haines Neuroanatomy Atlas in Clinical Context

Overview of cerebrovascular system





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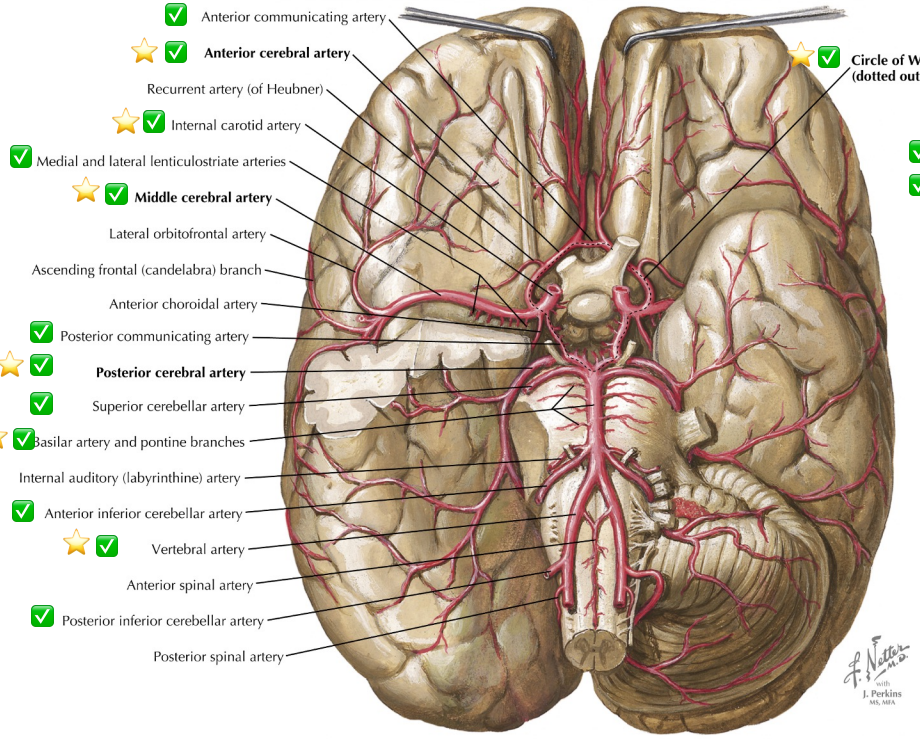
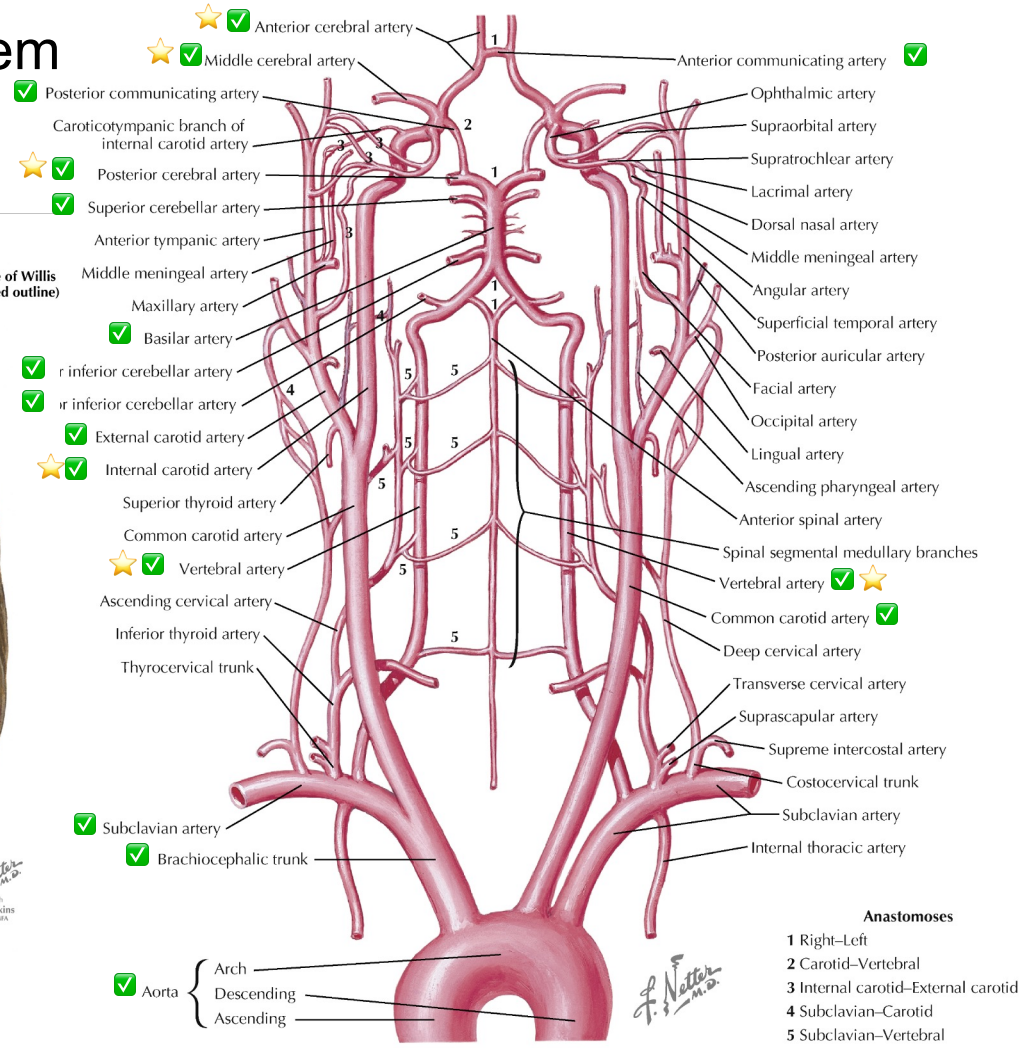
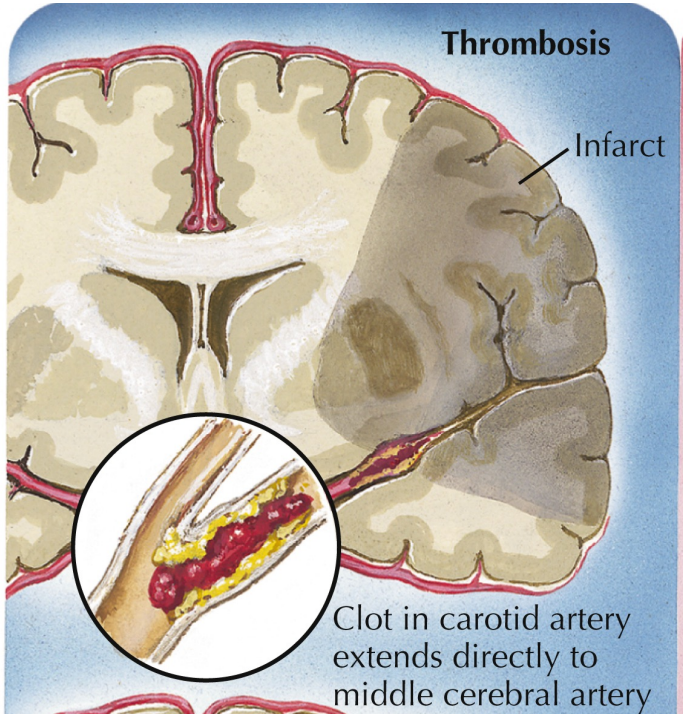


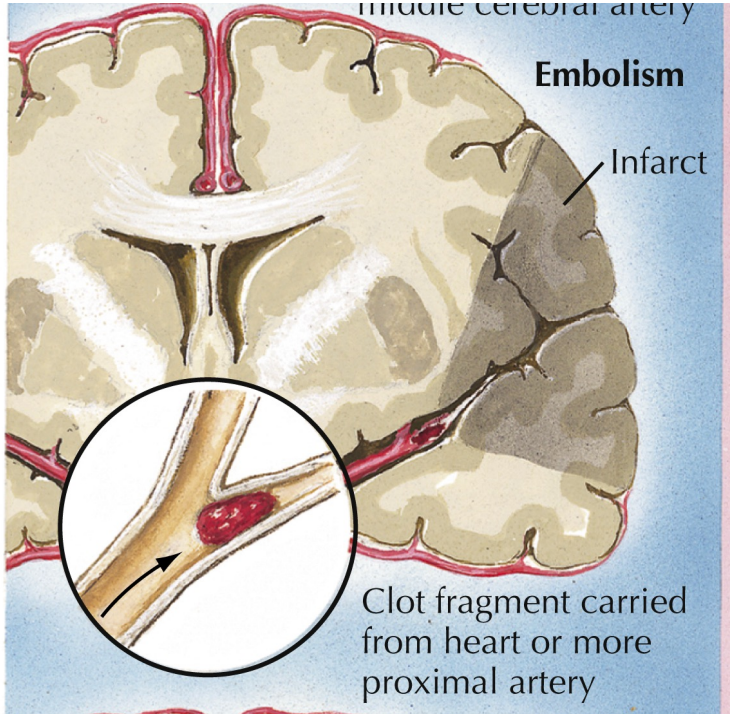


Source: Netter's Atlas of Neuroscience

Clinical correlates: Pathophysiology of stroke

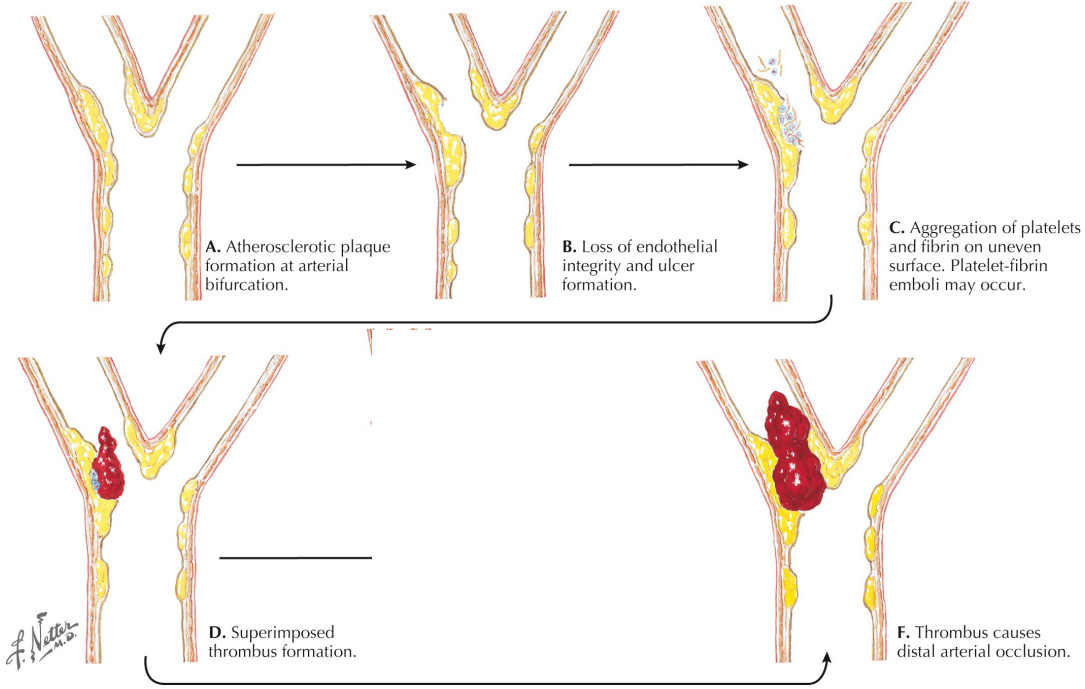
Ischemic stroke – how does a clot form?





Thrombotic ischemic stroke

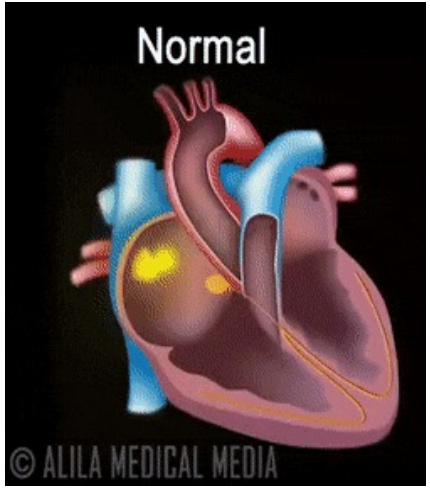
- Occurs when a clot forms in a blood vessel that supplies the brain
- Occurs most commonly in places where blood vessels bifurcate/split off
  - Turbulent flow
- Atherosclerosis is the most common cause of thrombotic stroke
  - Hyperlipidemia → plaque formation
  - Plaque ruptures → inflammatory response, clot formed



Embolic ischemic stroke

- Occurs when a clot (or other occlusion) forms upstream and is carried through circulation into the cerebral arteries

- Atrial fibrillation (AFib) is a common cause of cardioembolic stroke
    - Heart arrhythmia – discoordinated contraction of atria due to “faulty wiring”



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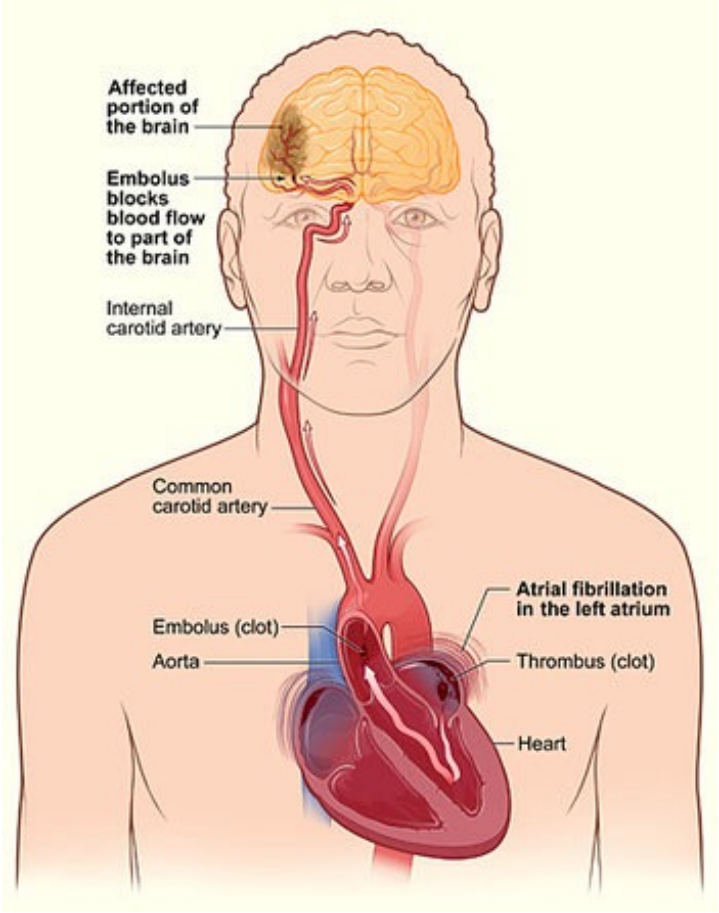
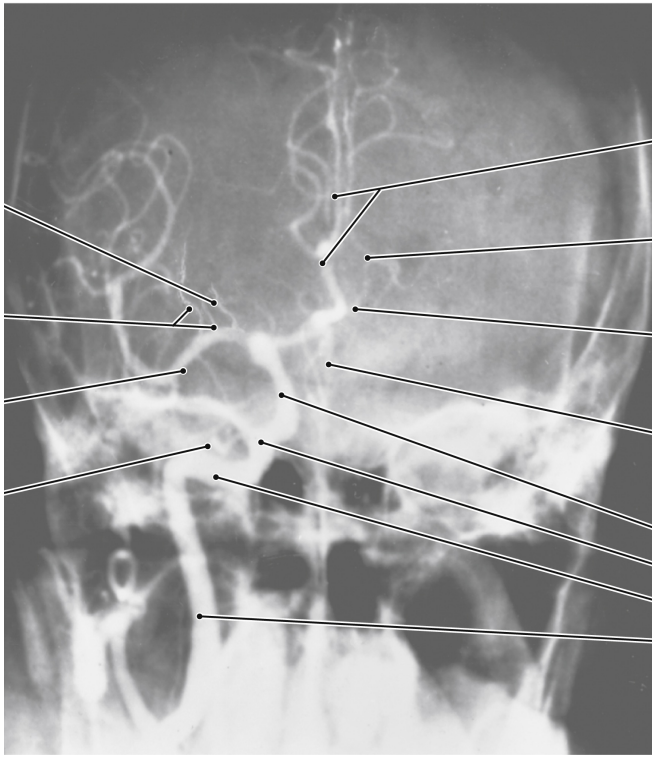
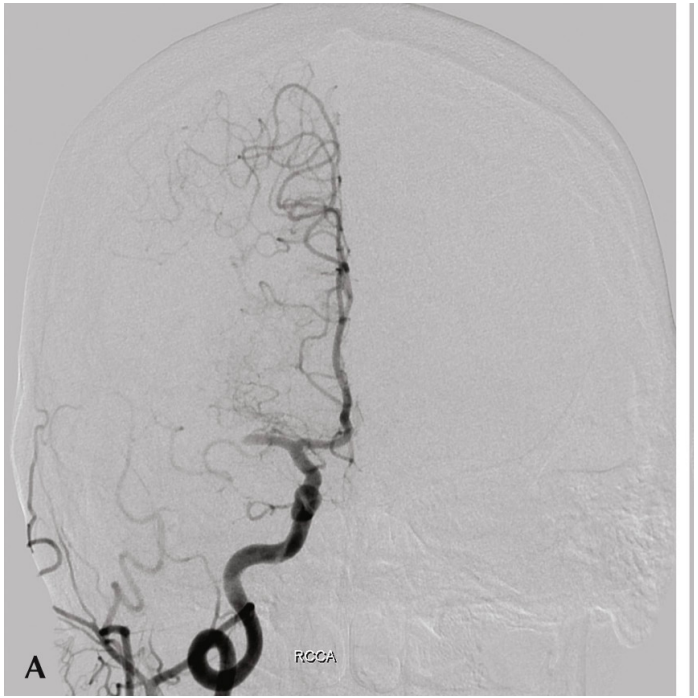
- Results in atrial blood stasis (pooling) → triggers thrombosis (clotting)
    - Embolized clot can then be passed through left ventricle → aorta → straight to brain

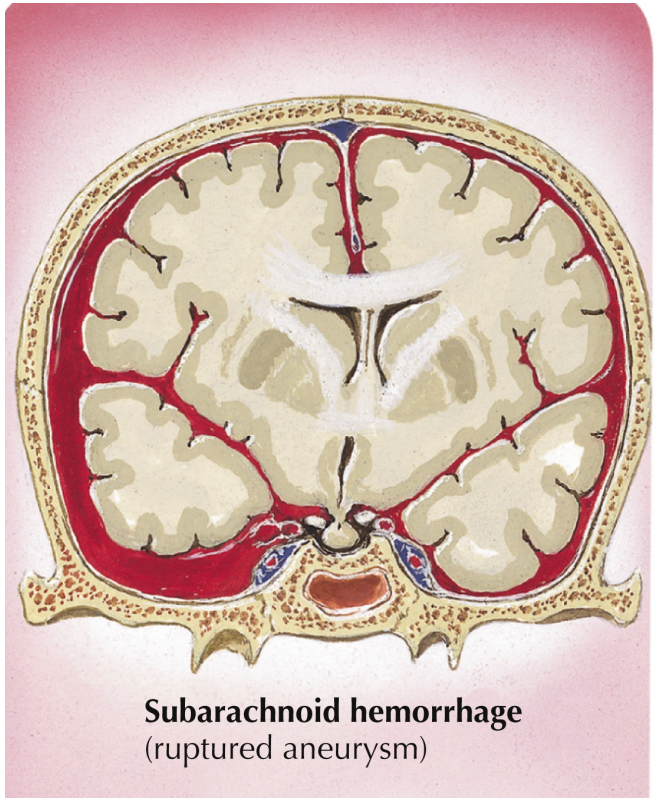


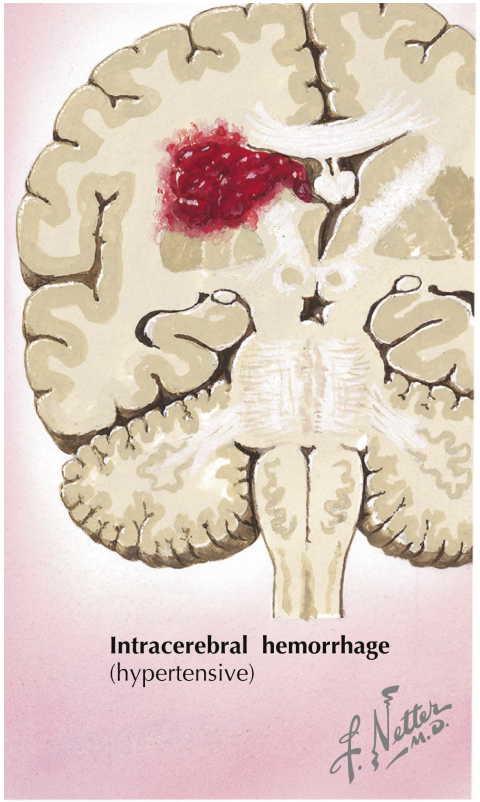
Angiography and ischemic stroke





Hemorrhagic stroke



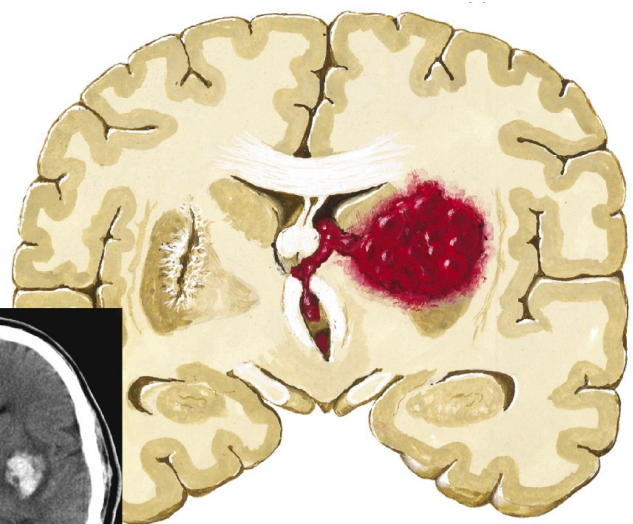


Source: Netter's Atlas of Neuroscience

Intracerebral hemorrhage (ICH)

- Roughly 2-3x as common as subarachnoid hemorrhage (SAH)
  - About 10% of all strokes in the U.S.

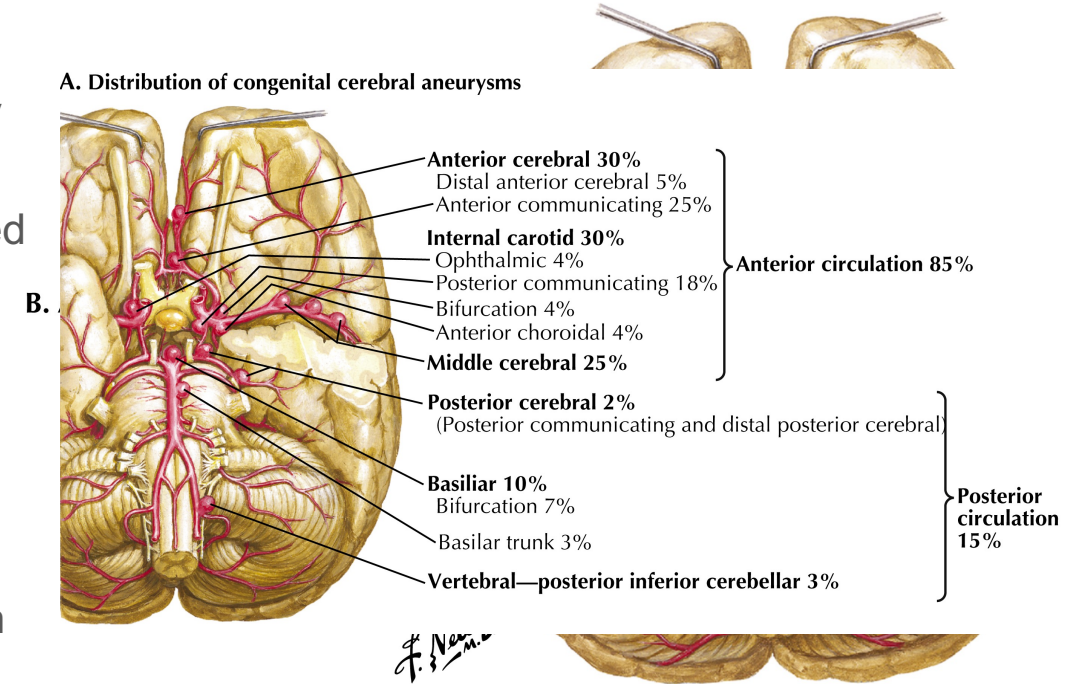
- Primary ICH caused by:
  1. High blood pressure (hypertension)
     - Associated with hemorrhage deeper in the brain
  2. Amyloid deposition (cerebral amyloid angiopathy, CAA)
     - Associated with more superficial hemorrhage



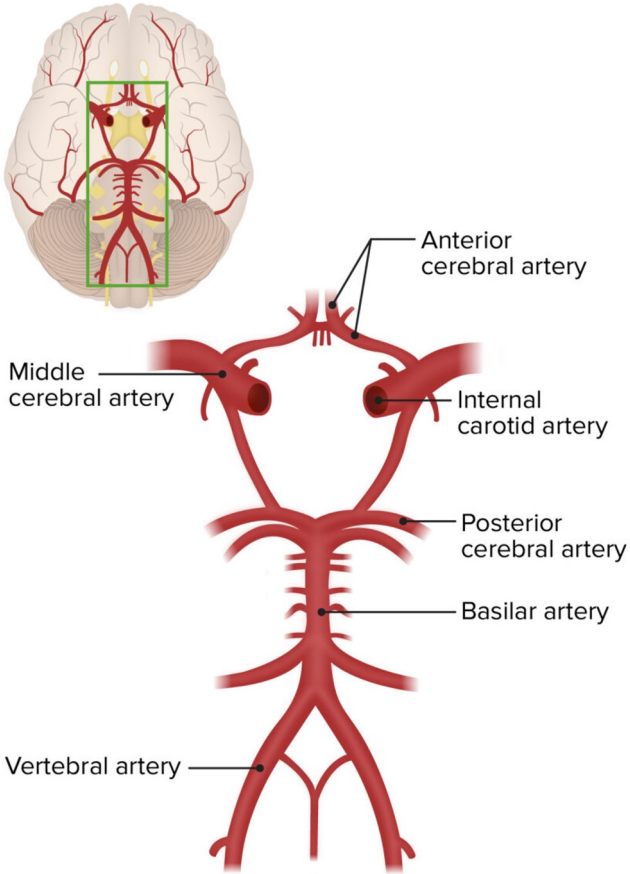
Moderate-sized intracerebral hemorrhage involving left putamen, with rupture into lateral ventricle; brain distorted to opposite side; scar of healed hemorrhage on right side

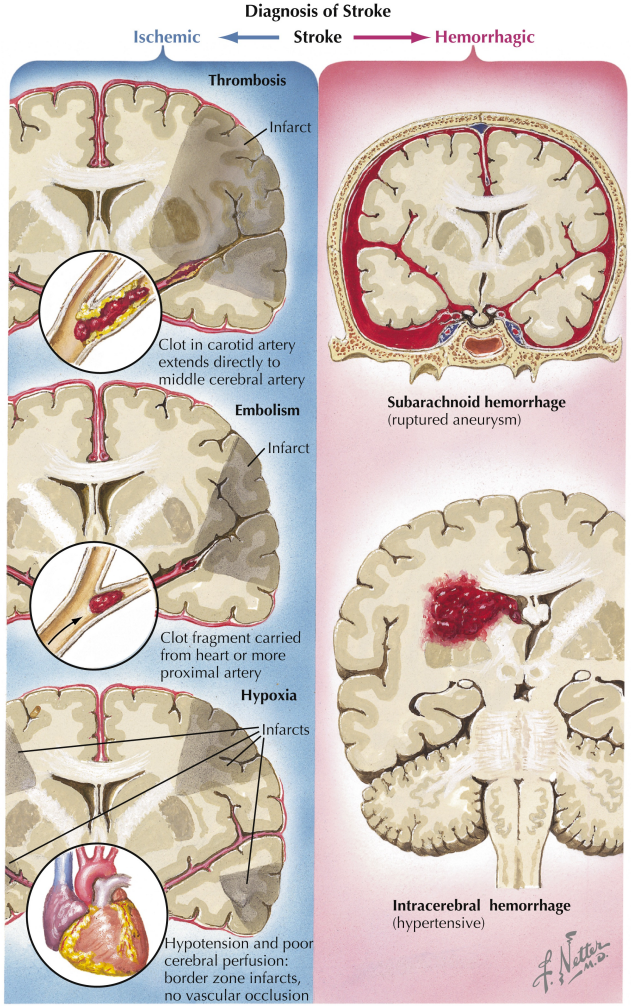
Aneurysm and subarachnoid hemorrhage (SAH)

- Constitutes ~5% of all strokes; high chance of poor outcome or mortality
- Most commonly results from ruptured saccular [“berry”] aneurysm
  - Outpouching of artery formed by high pressure and turbulent flow
- Saccular aneurysm most frequently occurs in anterior circulation (85%), particularly in ACA and at bifurcation of MCA



Summary


Anterior cerebral artery
Middle cerebral artery
Internal carotid artery
Posterior cerebral artery
Basilar artery
Vertebral artery


Diagnosis of Stroke
Ischemic
Stroke
Hemorrhagic
Thrombosis
Infarct
Clot in carotid artery extends directly to middle cerebral artery
Embolism
Infarct
Clot fragment carried from heart or more proximal artery
Hypoxia
Infarcts
Hypotension and poor cerebral perfusion: border zone infarcts, no vascular occlusion
Subarachnoid hemorrhage
(ruptured aneurysm)
Intracerebral hemorrhage
(hypertensive)
F. Netter M.D.

Thank you!

Questions?