



TELESPECIALISTS™

ANYTIME. ANYWHERE.™

ACUTE CARE CEREBROVASCULAR EDUCATION

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OBJECTIVES

- To provide an understanding of key neuroanatomy and neurophysiology pertaining to stroke
- To promote ability to apply the basic principles of neurosciences to real life scenarios regarding cerebrovascular disease
- To gain understanding of diagnostic considerations and medical decision making for stroke patients
- To understand the basics of management for early treatment of acute ischemic stroke including
 - the guidelines for both early and late endovascular treatment options for ischemic stroke
 - Identification and management of intracerebral hemorrhages
 - the critical care issues for patients receiving tPA thrombolytic treatment



OVERVIEW – MODULE ONE

- Basic Neuroanatomy
 - Structural anatomy
 - Vascular Anatomy
- Basic Neurophysiology
 - Cerebral Cortex
 - Subcortical Structures
 - Brainstem and cerebellum
- Neurological Evaluation and lesion localization



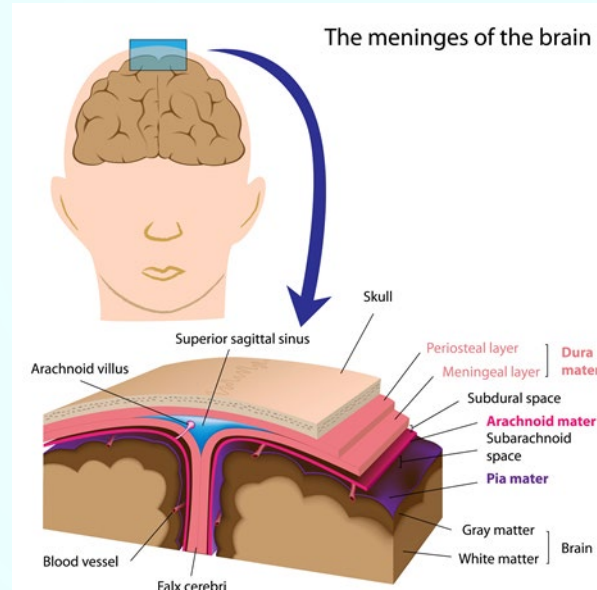
NERVOUS SYSTEM

- Central Nervous System (CNS)= Upper Motor Neuron (UMN)
 - Brain
 - Spine
- Peripheral Nervous System (PNS) = Lower Motor Neuron
 - Nerve root
 - Peripheral nerve
 - Neuromuscular Junction
 - Muscle

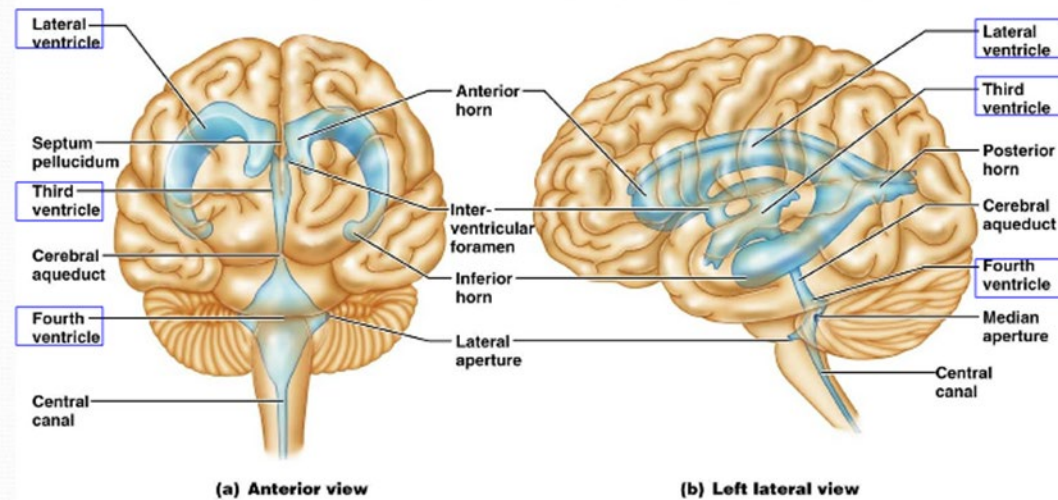


CRANIUM

- Skull
- Meninges
- Ventricles
- Brain
- Vessels



Ventricular System



BRAIN - CNS

- Clinically relevant brain regions
 - Cortex
 - Subcortical Region
 - Corona radiata/WM
 - Basal Ganglia/Internal Capsule
 - Thalamus
 - Brainstem
 - Midbrain
 - Pons
 - Medulla
 - Cerebellum



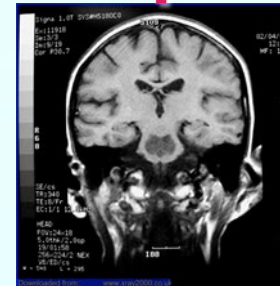
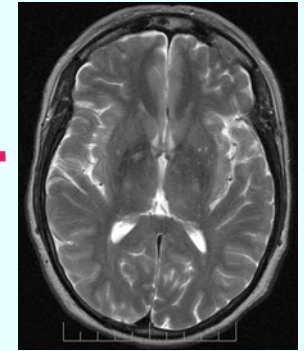
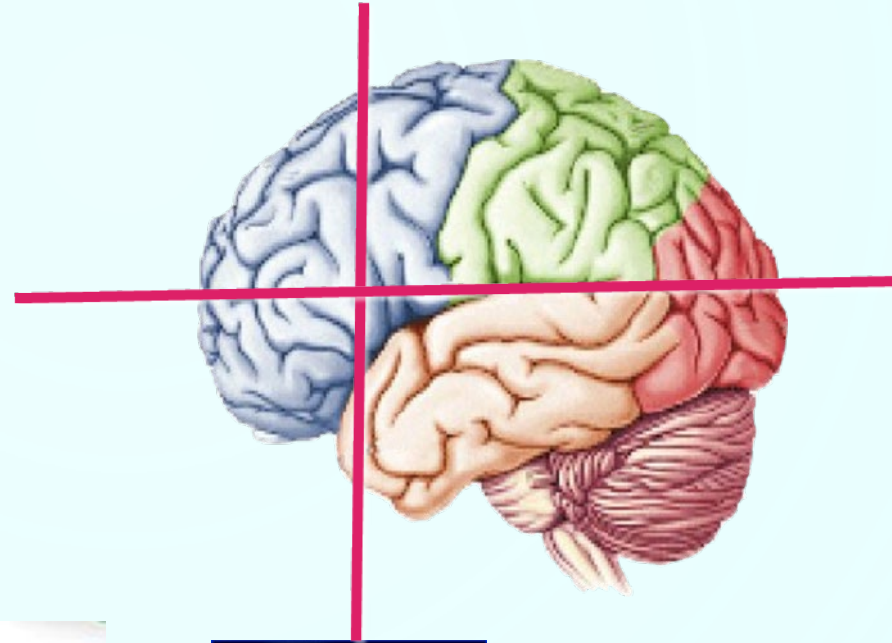
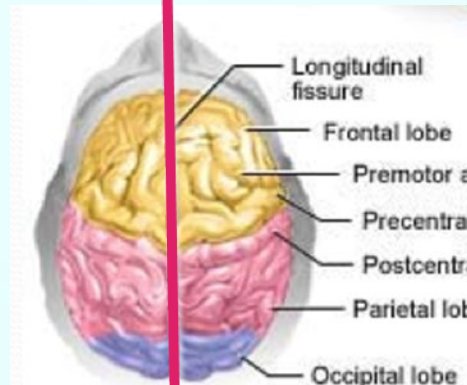
BRAIN OVERVIEW

- Different views

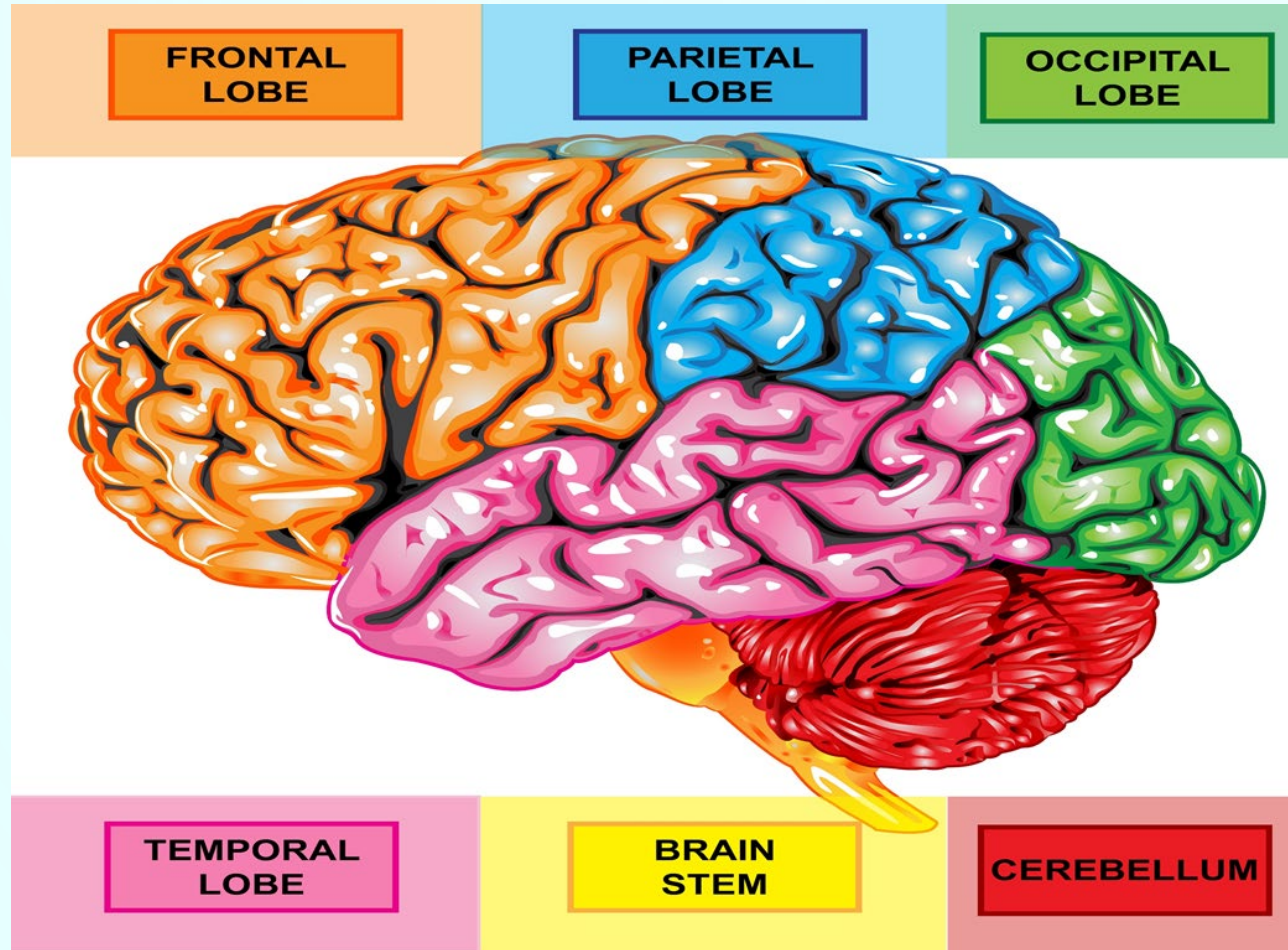
- * Axial

- * Saggital

- * Coronal



CORTICAL OVERVIEW



Frontal

Movement impairment
Personality changes
Cognitive impairment
Delayed initiation
Aphasia (Brocca)

Parietal

Somatosensory impairment
Spatial relations impairment
Homonymous visual deficits
Agnosia
Language comprehension impairment

Occipital

Homonymous hemianopsia
Eye movement impairment

Cerebellar

Ataxia
Ipsilateral dysmetria
Dysdiadochokinesia
Intention tremor

Temporal lobe

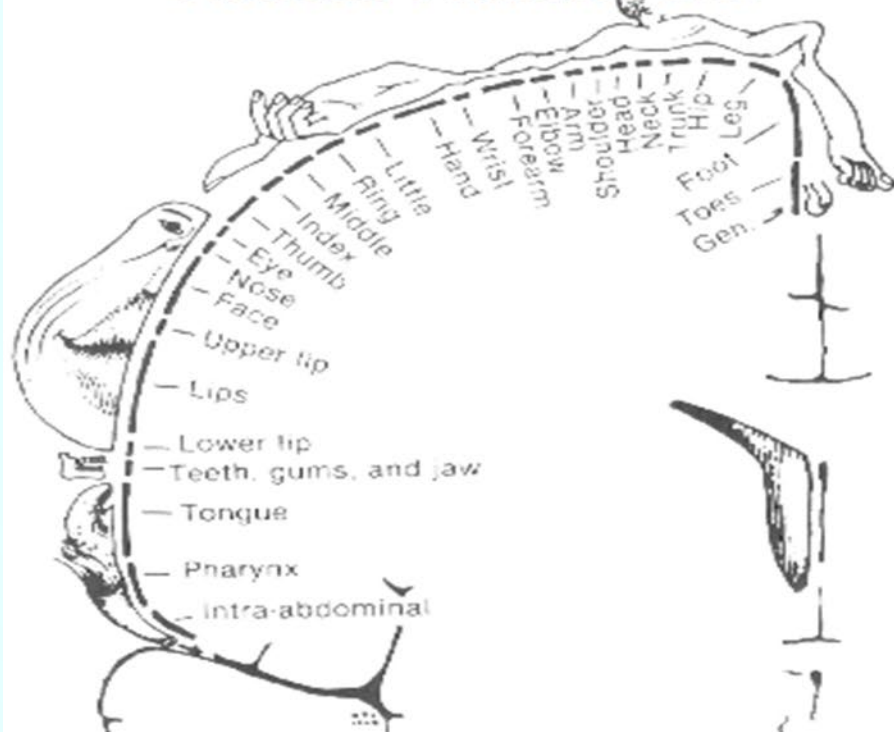
Auditory and perceptual impairment
Memory and learning impairment
Aphasia (Wernicke)



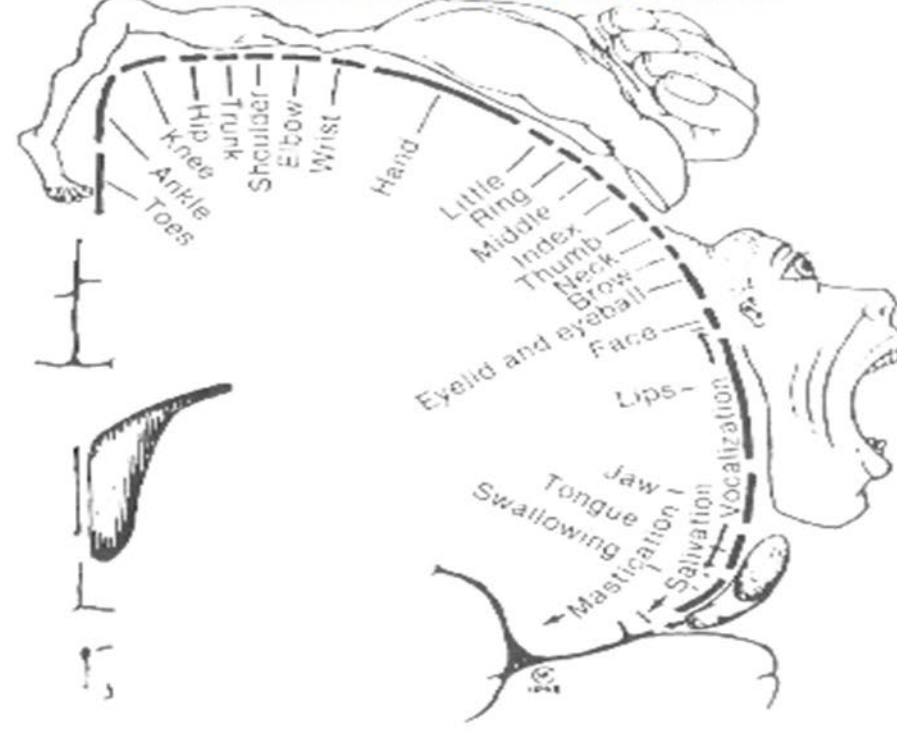
SOMATOTOPIC MAP = HOMUNCULUS

The Homunculus = "little man"

**Sensory Strip:
Anterior Parietal Lobe**

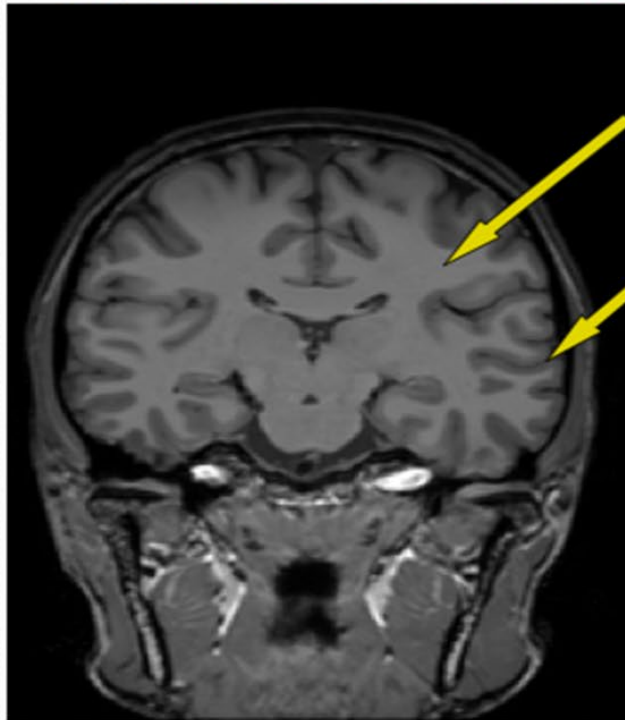


**Motor Strip:
Posterior Frontal Lobe**



CORTEX

White & Grey Matter



Subcortical Area (White Matter)

Cortex (Grey Matter)

- The cortex is the area of thought, memory, awareness, language; comprised of cell bodies (grey)
- Subcortical regions serve as tracts to and from these areas; contain myelinated neurons (white)

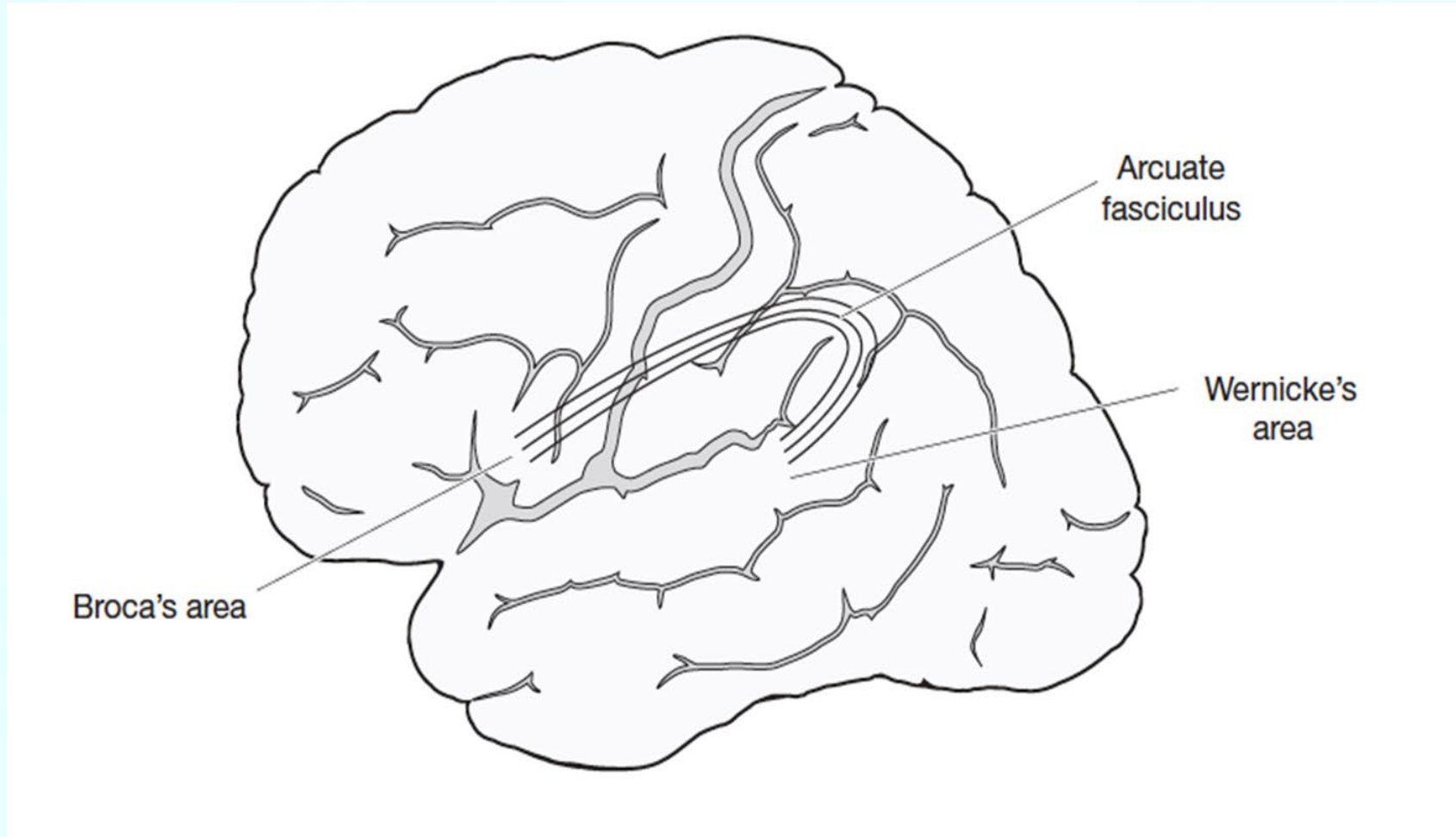


CORTICAL LOCALIZING SIGNS

- Reflect impairment of cortical function
- Usually seen in Large Vessel Occlusion strokes (more to come)
- Dependent on location
 - Dominant hemisphere ICA/MCA – aphasia
 - Non-dominant hemisphere ICA/MCA – neglect/gaze preference
 - Posterior/Occipital Lobes – Visual Field deficit – homonymous hemianopsia

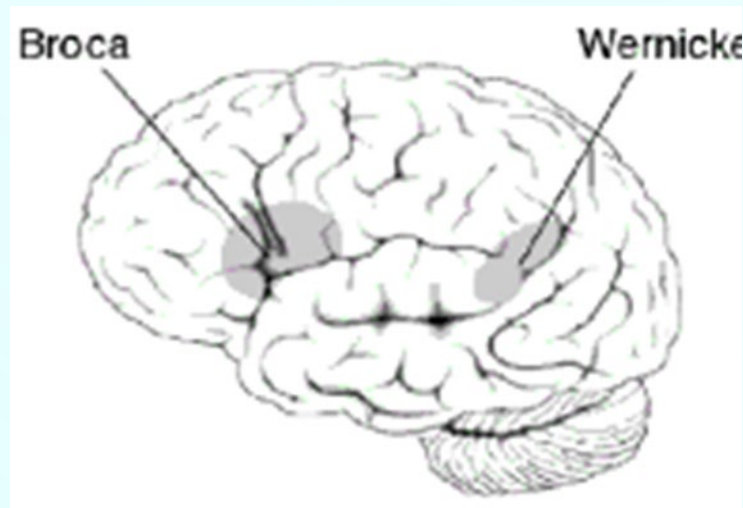


LANGUAGE FUNCTION



LANGUAGE EXAM COMPONENTS

- Naming – identifying pictures (motor speech)
- Repetition – repeating simple words/phrases
- Comprehension – processing speech (receptive/sensory speech)
- Fluency – ability to string words together in a normal pattern (motor speech)



LANGUAGE EXAM LOCALIZATION

	Broca's/Expressive Aphasia	Wernicke's/Receptive Aphasia
Naming	↓ ↓	↓ ↓
Repetition	↓ ↓	↓ ↓
Comprehension		↓ ↓
Fluency	↓ ↓	



BROCA'S/EXPRESSIVE APHASIA

- Anterior localization
- Broca's Area = posterior inferior frontal gyrus of DOMINANT HEMISPHERE
 - Non-fluent speech
 - Unable to name objects = APHASIA
 - Difficulty initiating language → labored, halting speech
 - Poor sentence construction
 - Lexicon disrupted = paraphasic errors, neologisms



WERNICKE'S/RECEPTIVE APHASIA

- Lateral/posterior localization
- Wernicke's Area = superior temporal gyrus of DOMINANT HEMISPHERE
 - Impaired language comprehension > production
 - Unable to name = APHASIA
 - Normal rhythm of words, normal syntax, no loss of fluency
 - However the content of those words/sentences is meaningless
 - Unable to utilize lexicon to effectively communicate



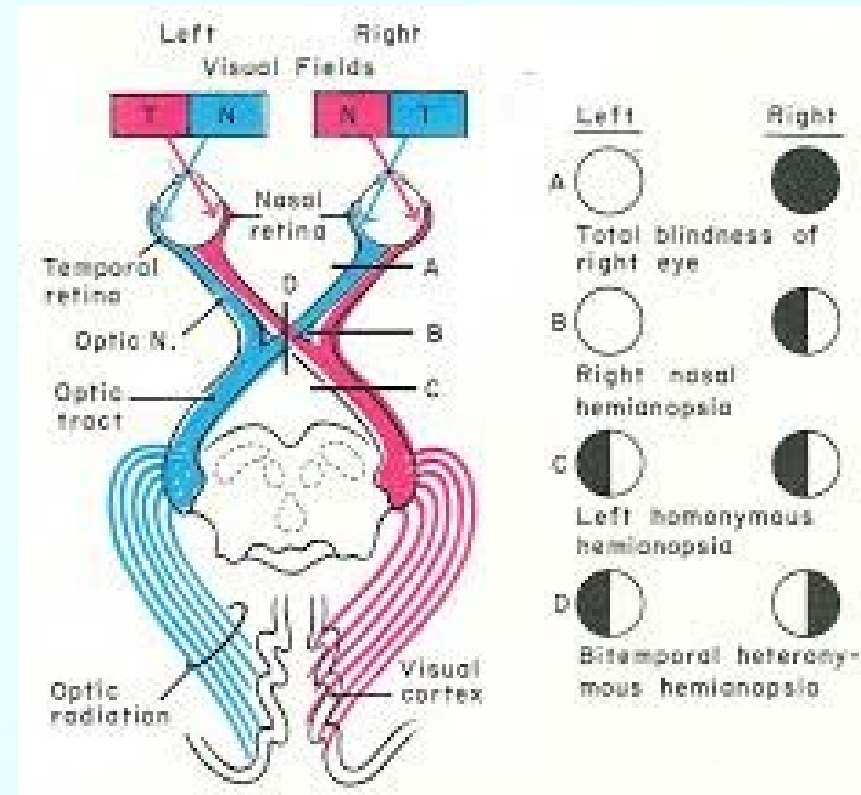
NON-DOMINANT HEMISPHERE/NEGLECT

- Less obvious cortical localizing sign
- Does not localize as well as types of aphasia
- Key exam components– double simultaneous stimulation
 - Eye/gaze deviation
 - Hemi-neglect
 - Double simultaneous stimulation
- Considerations
 - Most severely impaired have head turn/eye deviation away from effected side
 - Double simultaneous stimulation is a more subtle representation of neglect
 - Patient must have enough preserved primary sensation to complete the exam element
 - Patient must be alert enough to distinguish sensory stimulation on one v both sides



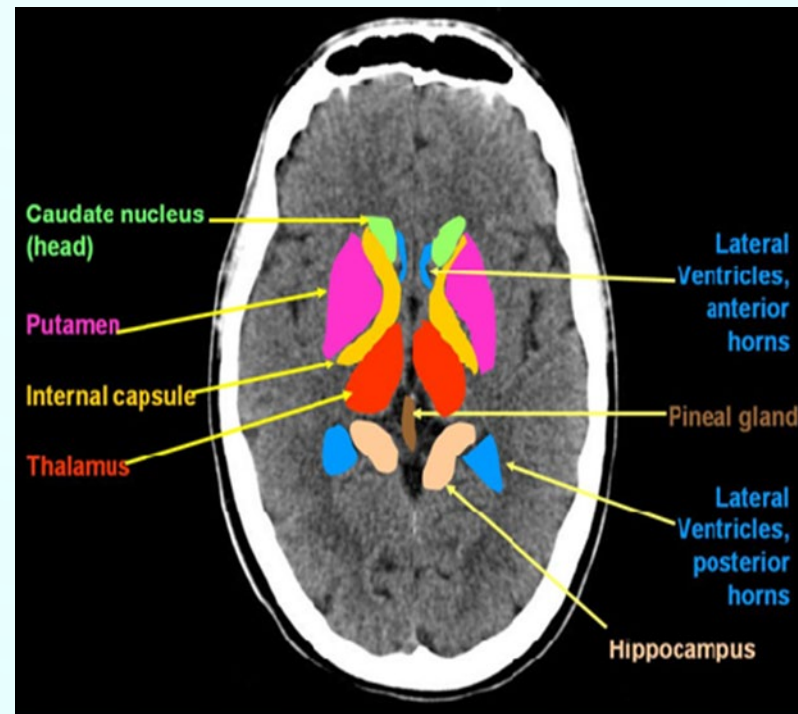
VISUAL FIELD DEFICIT

- Represents impairment in visual pathway beyond optic chiasm
- This includes optic tract, lateral geniculate in thalamus, optic radiations through temporal-parietal region, and into the occipital cortex
- Optimally done checking all 4 visual quadrants in each eye
- For the less alert/cooperative patient, checking blink to threat may be utilized



SUBCORTICAL STRUCTURES

- Basal Ganglia
 - Grey matter nuclei deep within the brain
 - Involved mainly in processing movement/motor function
- Internal Capsule
- Thalamus

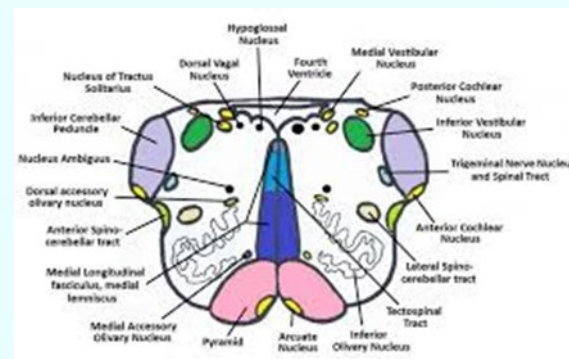
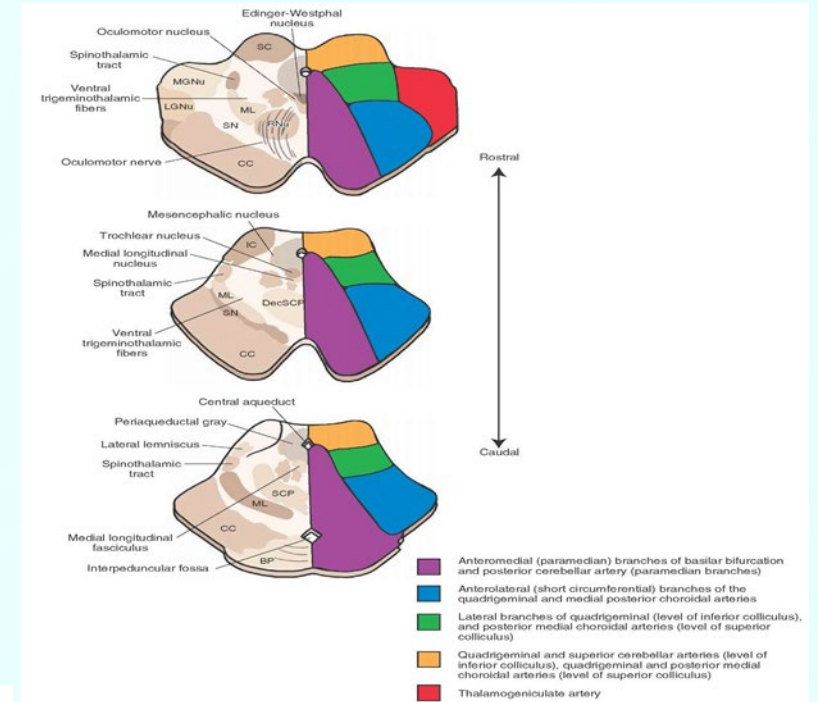
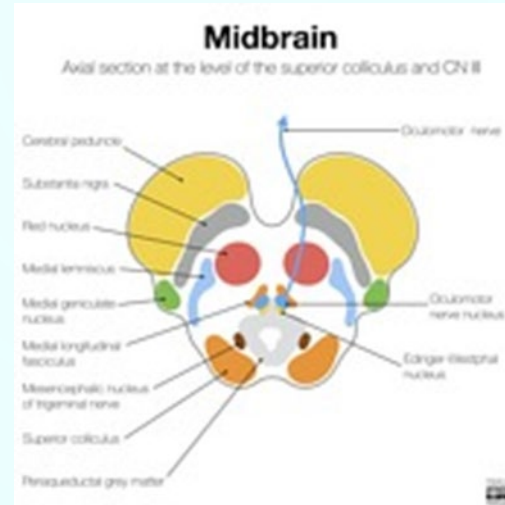
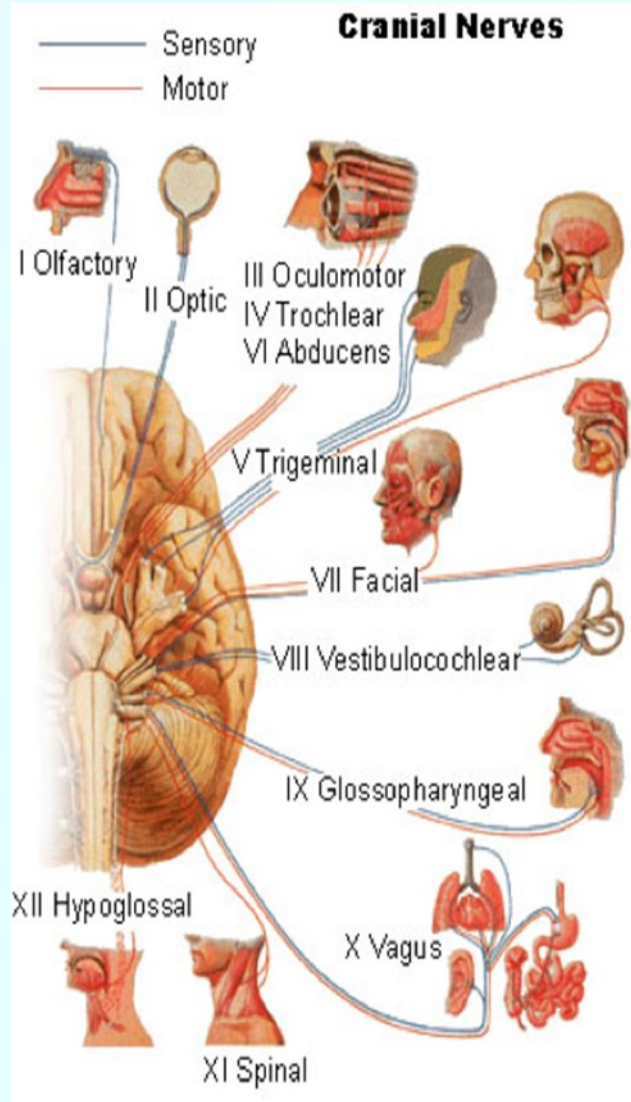


BRAINSTEM

- Input/Output to brain
- Posterior circulation supplied
- 3 divisions
 - Midbrain
 - Pons
 - Medulla Oblongata
- Contains
 - CN nuclei
 - Centers for reflexive/autonomic activity (HR, BP, respiratory drive, sleep/wake)
 - Connects forebrain to spinal cord and cerebellum with spinal cord



CRANIAL NERVES



CEREBELLUM

- Posterior circulation structure
 - Anterior Inferior Cerebellar Artery (AICA)
 - Posterior Inferior Cerebellar Artery (PICA)
 - Superior Cerebellar Artery (SCA)
- Two hemispheres joined by a central structure (vermis)
- Ipsilateral function → lesion in right CBL causes R sided coordination symptoms



VASCULAR SUPPLY

■ Anterior Circulation

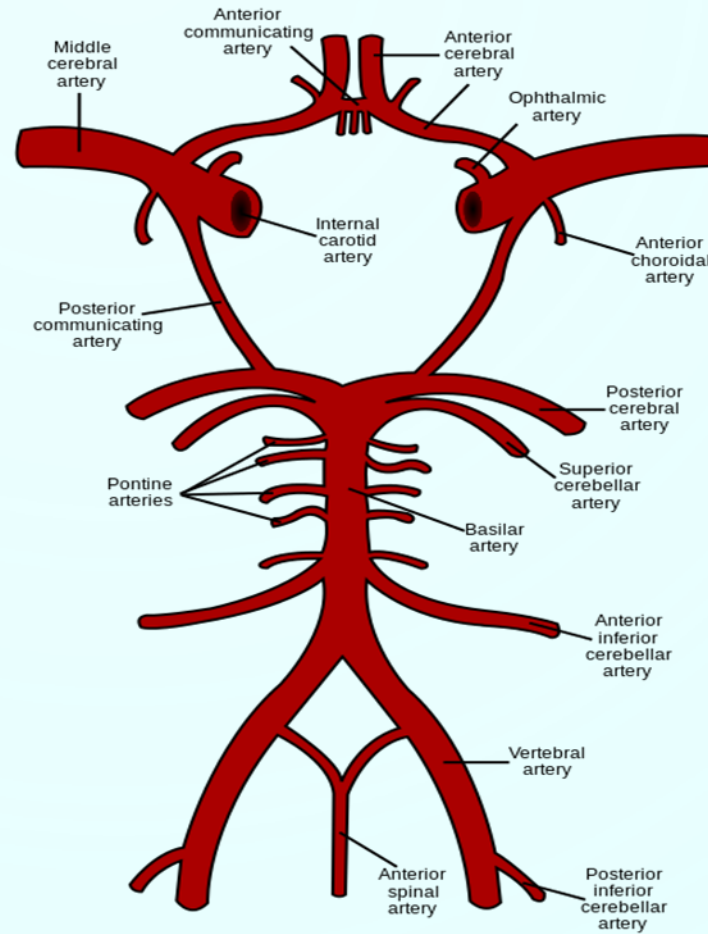
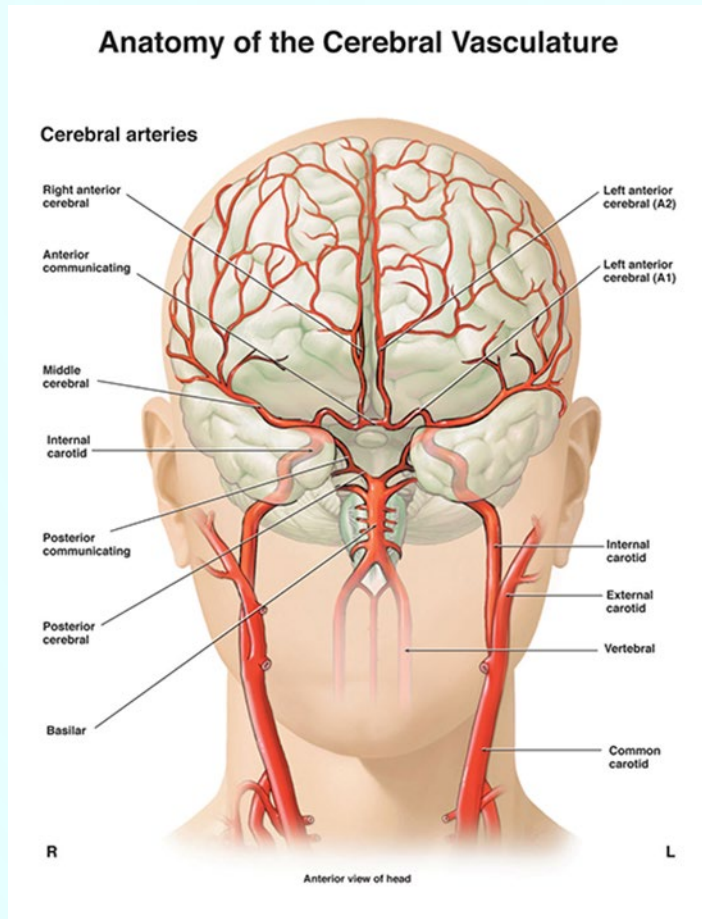
- 70% of cerebral blood supply
- Supplies anterior/superior 2/3 of brain
 - Common Carotid Artery
 - Internal Carotid Artery
 - Middle Cerebral Artery – BG,
 - Anterior Cerebral Artery

■ Posterior Circulation

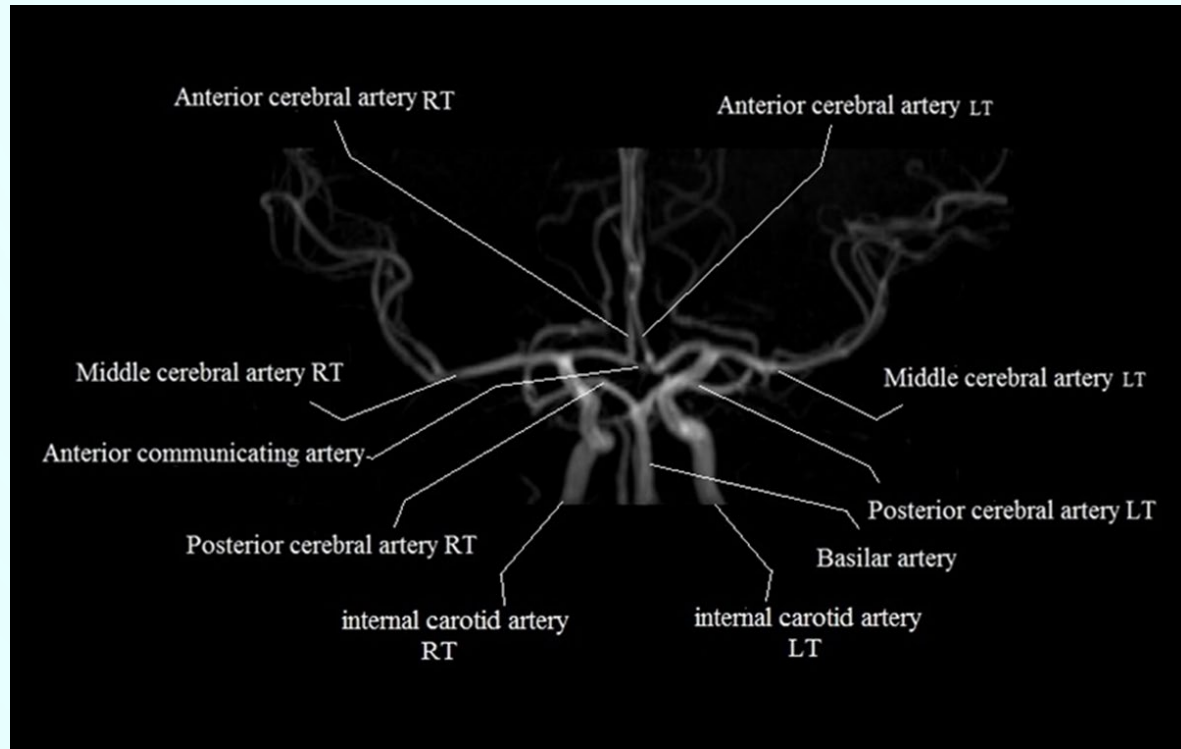
- Paired Vertebral Arteries – lower brainstem
- Basilar Artery – brainstem and cerebellum
- Posterior Cerebral Artery – occipital lobe, thalamus, mesial temporal lobe



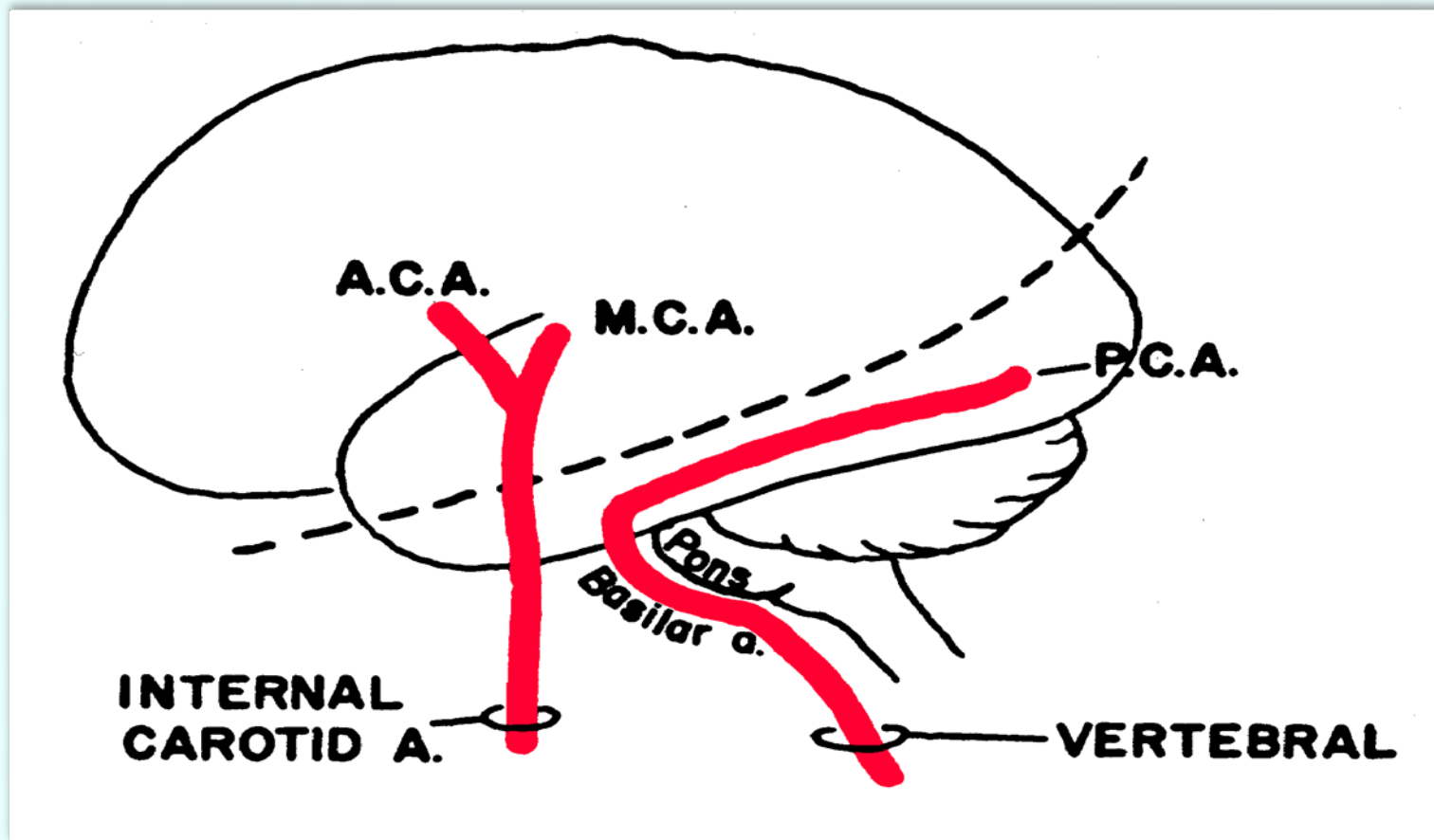
SCHEMATIC OF CEREBRAL VASCULAR SUPPLY



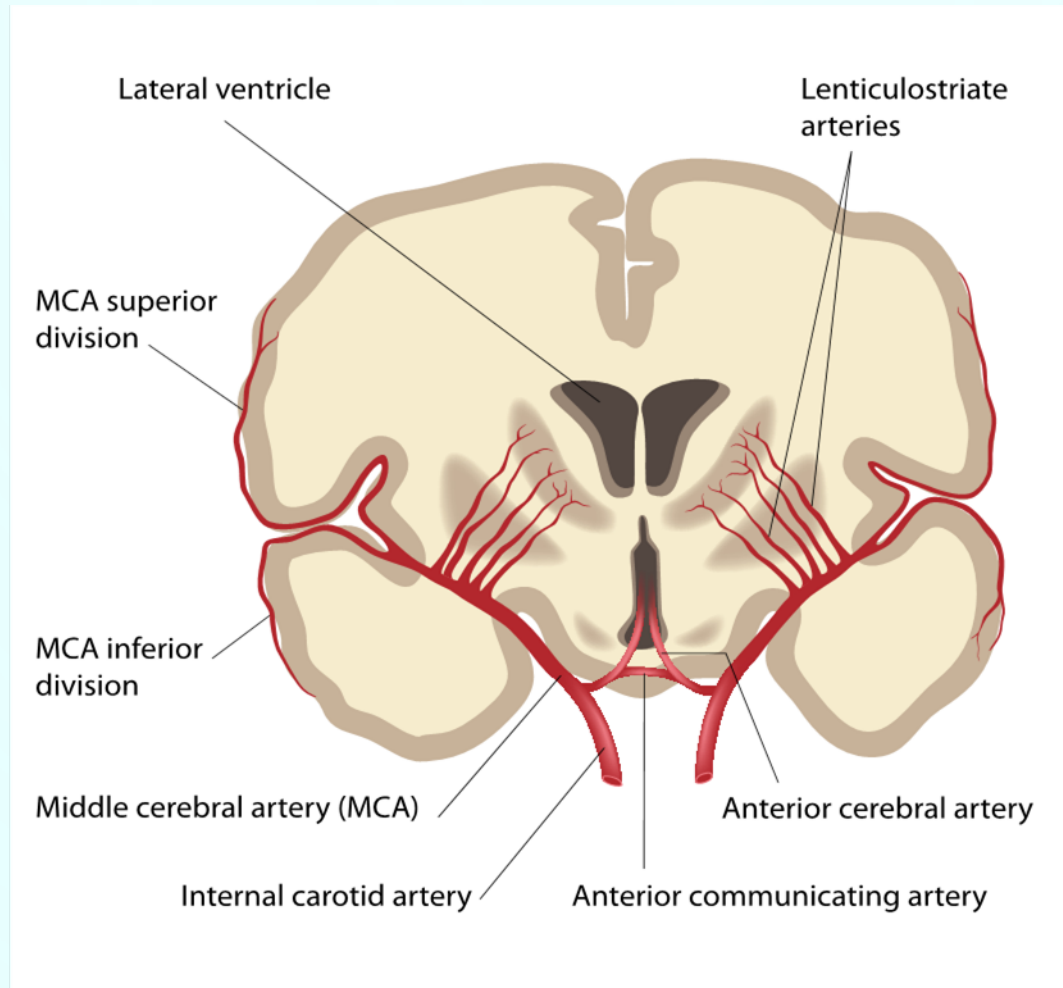
MRA REPRESENTATION OF INTRACRANIAL VASCULAR ANATOMY



ANTERIOR V POSTERIOR CIRCULATION

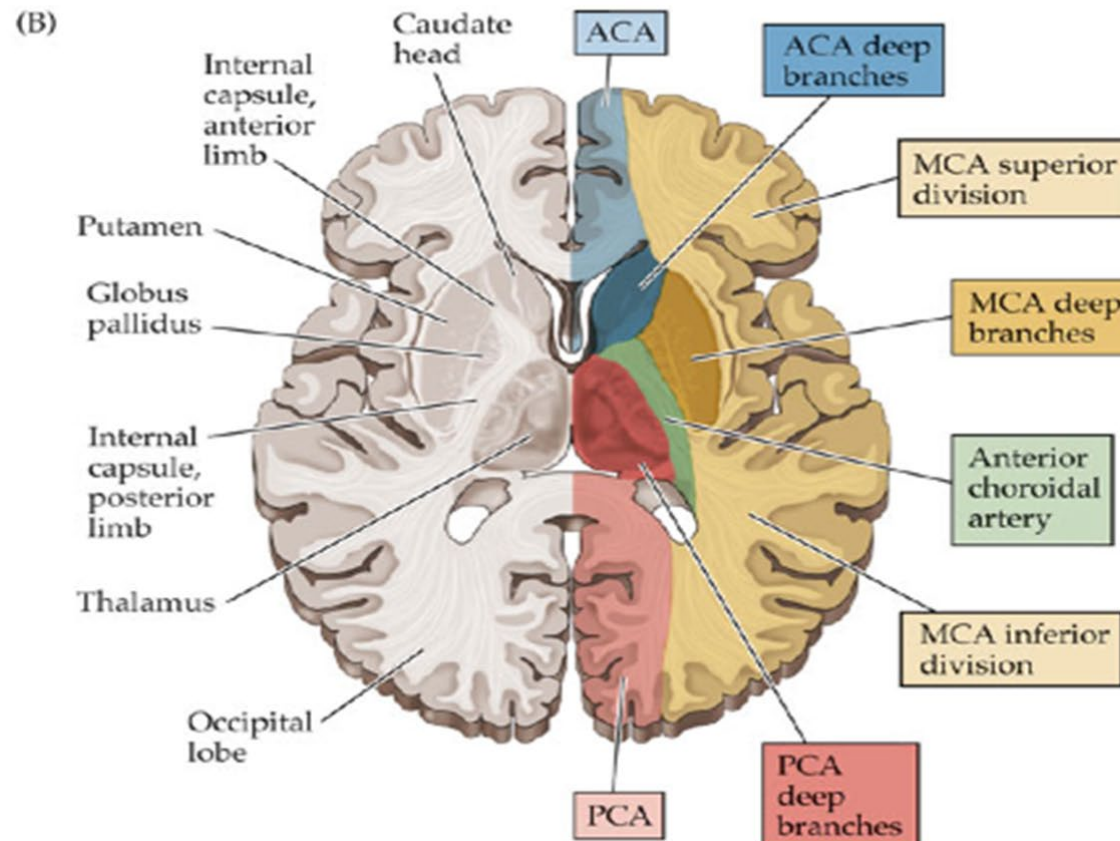


ANTERIOR CIRCULATION



CEREBRAL ARTERIES

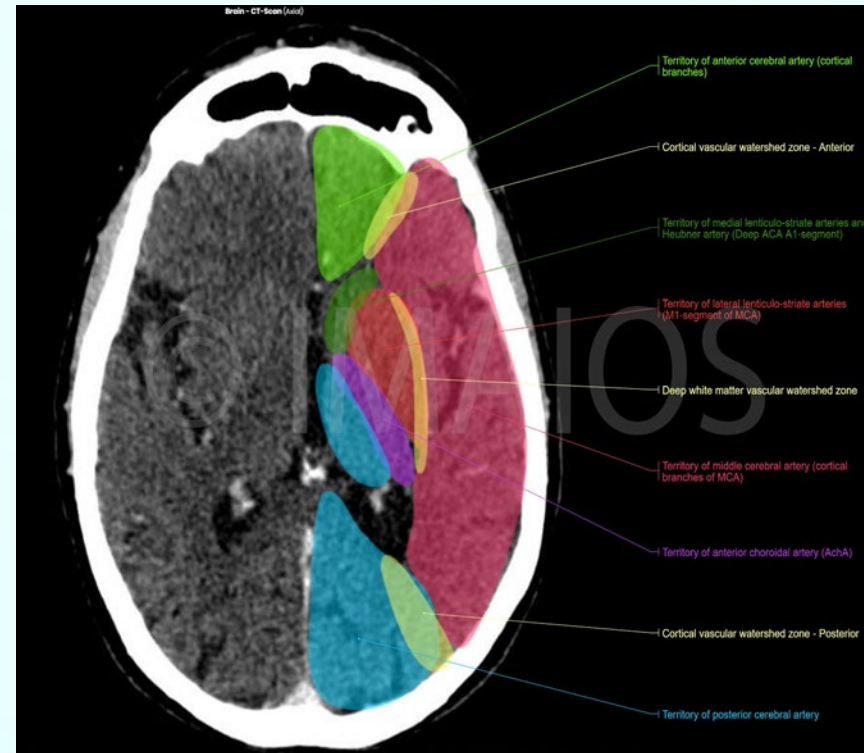
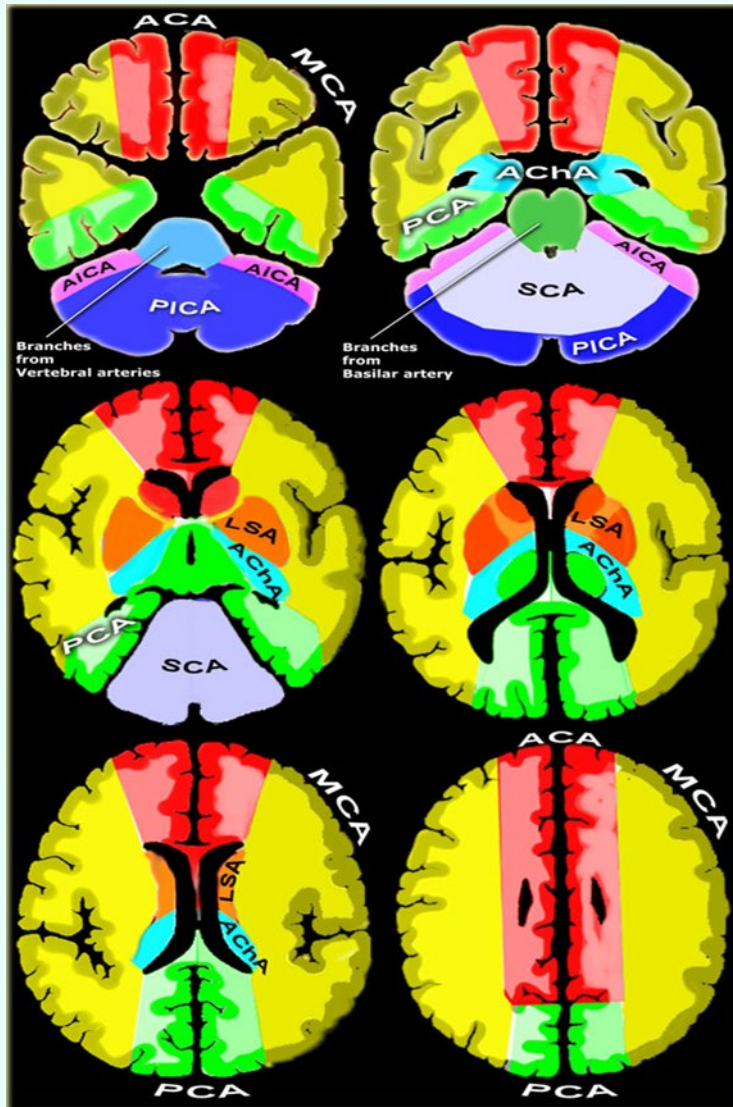
Cerebral Artery Territories



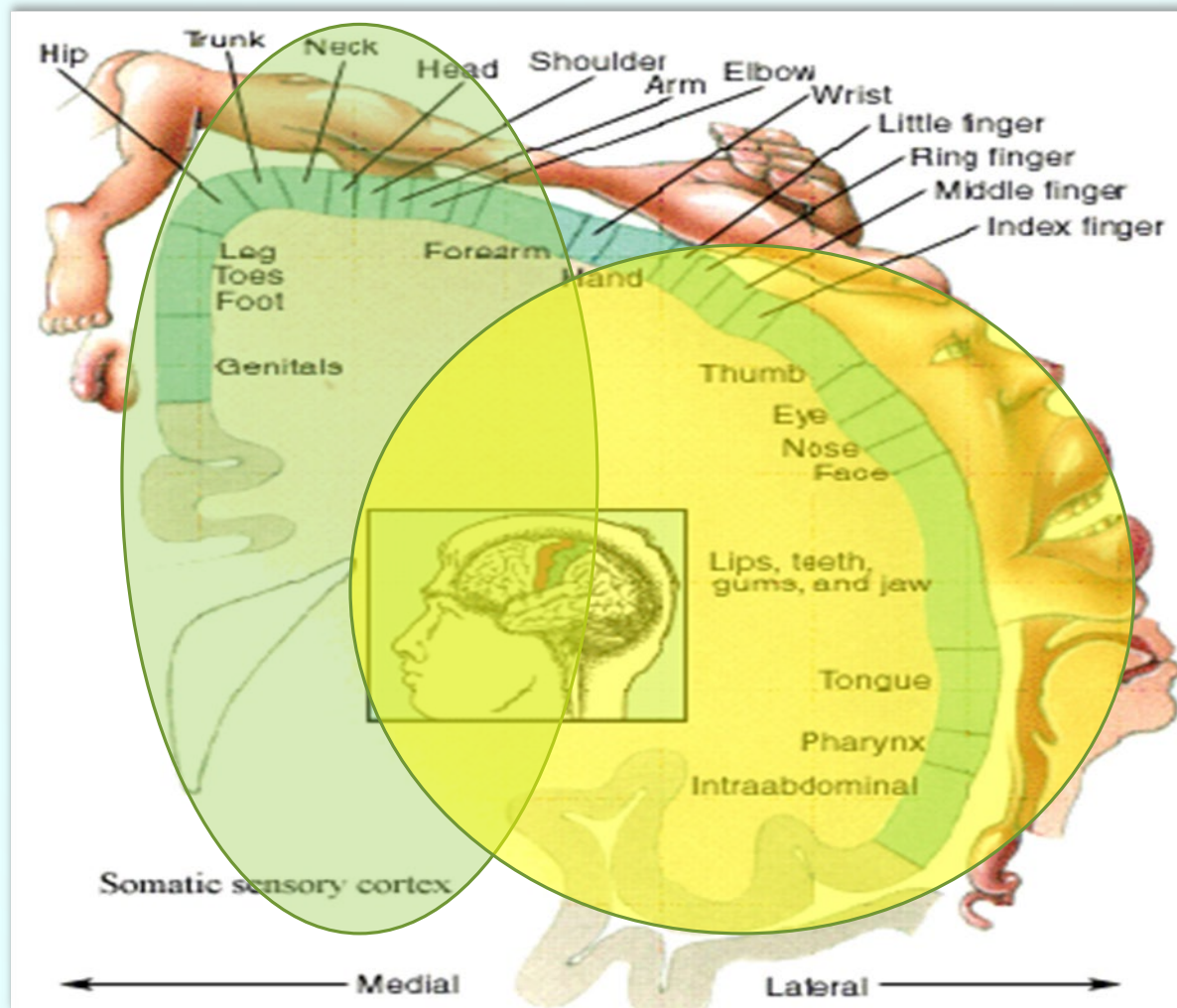
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VASCULAR MAPS OF THE BRAIN



VASCULAR-ANATOMICAL CORRELATION



QUESTIONS?



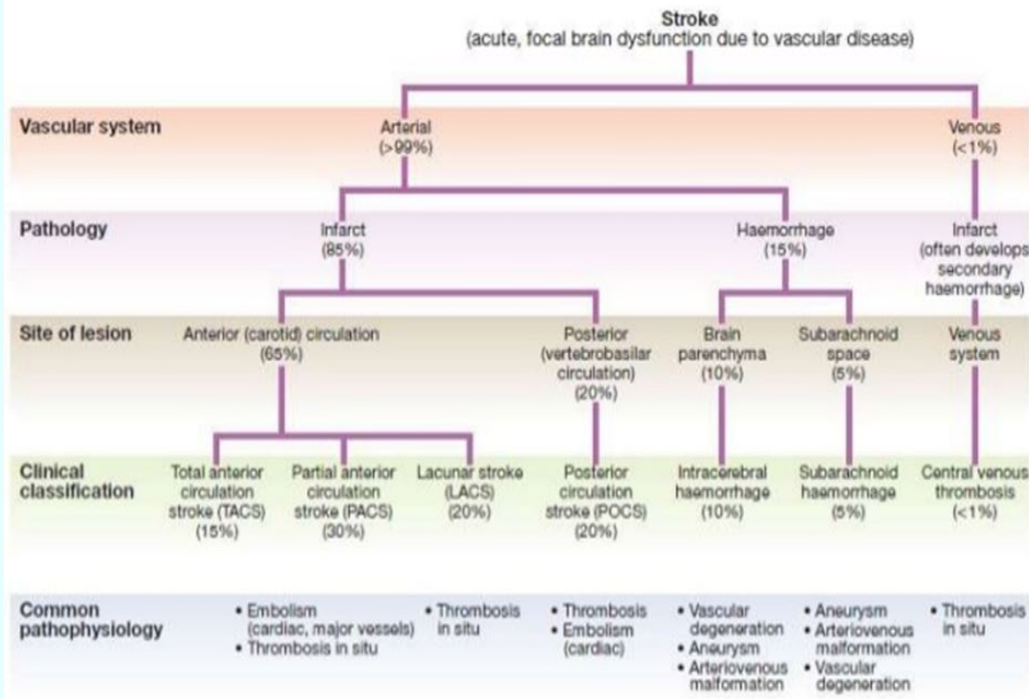
MODULE TWO

- Stroke classification
 - Hemorrhagic – brief description
 - Ischemic – focus of discussion
- Ischemic infarct: pathophysiology
- Stroke Alert (Code....)
- Signs and symptoms of stroke review
- Emergent Evaluation
 - Medical treatment – tPA considerations
 - Endovascular Treatment inclusion criteria

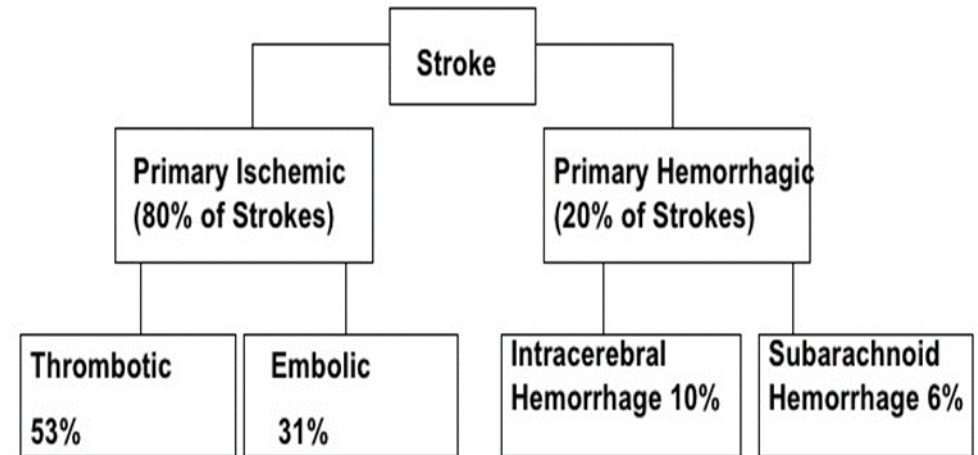


CLASSIFICATION OF STROKE

Classification of Stroke



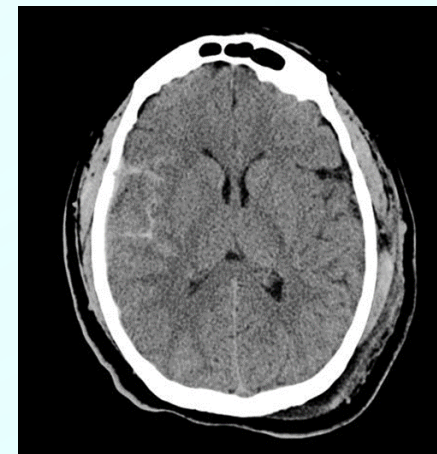
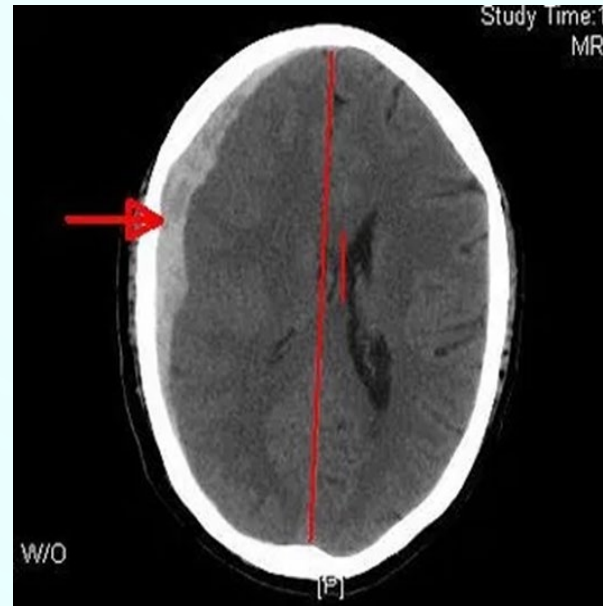
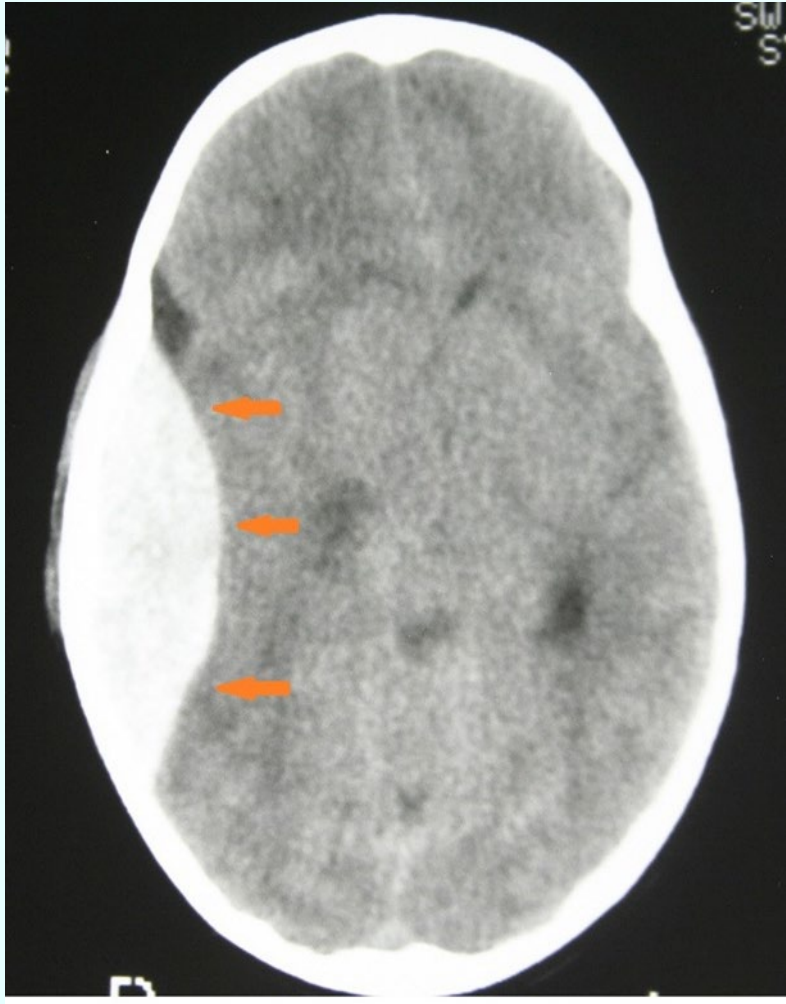
Classification of Stroke



HEMORRHAGES

- Epidural Hematoma
 - Arterial
 - Rapidly expanding, high mortality without rapid treatment
 - Traumatic injury to middle meningeal artery
- Subdural Hematoma
 - Venous
 - Usually in elderly and/or post-traumatic
- Subarachnoid Hemorrhage
 - Arterial
 - Between layers of arachnoid and pia
 - Typically ruptured aneurysm or trauma – depends on location, history
 - Thunderclap headache



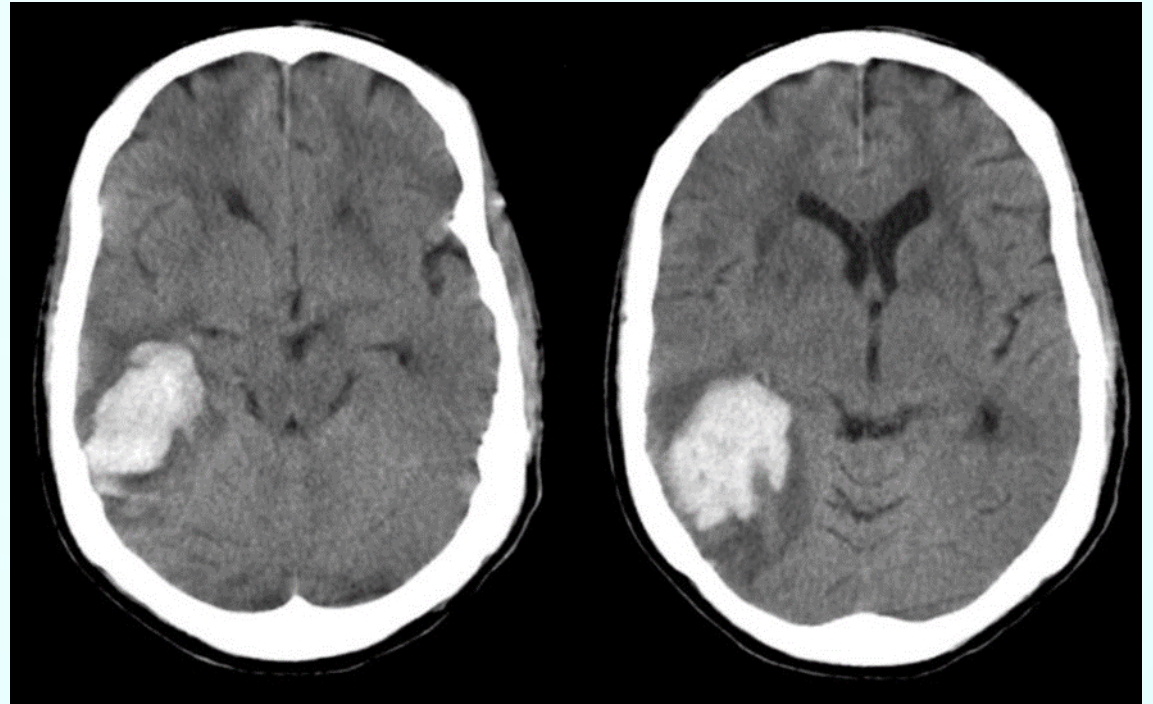


INTRACRANIAL HEMORRHAGE

- Hemorrhage within the brain
- Variable etiologies
 - HTN
 - Vascular Malformation
 - Mass
 - Cerebral Amyloid Angiopathy
 - Coagulopathy due to A/C use
 - Venous Sinus Thrombosis



SUBCORTICAL V LOBAR ICH APPEARANCE



ISCHEMIC STROKE

- Most common type of stroke
- Lack of blood flow- causes neuronal death
- Symptoms depend on “where”
- Pathophysiology:
 - Artery type involved
 - Large vessel disease
 - Small vessel disease
 - Mechanism
 - Embolic (can be large v small vessel)
 - Thrombotic (can be large v small vessel)
 - Hypoperfusion



ISCHEMIC STROKE

- Acute impairment of cerebral blood flow resulting in a variety of neurological deficits
 - Motor deficits
 - Sensory deficits
 - Language deficits
 - Aphasia – inability to name
 - Dysarthria – slurred speech
 - Visual Deficits
 - Monocular vision loss
 - Visual field deficit (homonymous = same in both eyes)



RISK FACTORS: NON-MODIFIABLE

- Age: after the age of 55- incidence doubles
- Gender: 19% higher incidence of stroke among men than women
- Ethnicity/ Race
- Family history of stroke



RISK FACTORS: MODIFIABLE

Well documented

- Hypertension
- Hyperlipidemia
- Diabetes Mellitus
- Smoking
- Carotid disease
- Atrial Fibrillation
- Sickle cell anemia

Less well documented

- Obesity
- Inactivity
- Impaired fasting glucose
- Diet/nutrition
- EtOH
- Hyperhomocysteinemia
- Drugs of Abuse
- Hypercoagulability
- Hormone replacement tx/Oral Contraceptive
- Inflammation
- Obstructive Sleep Apnea



PATHOGENESIS: ATHEROSCLEROSIS



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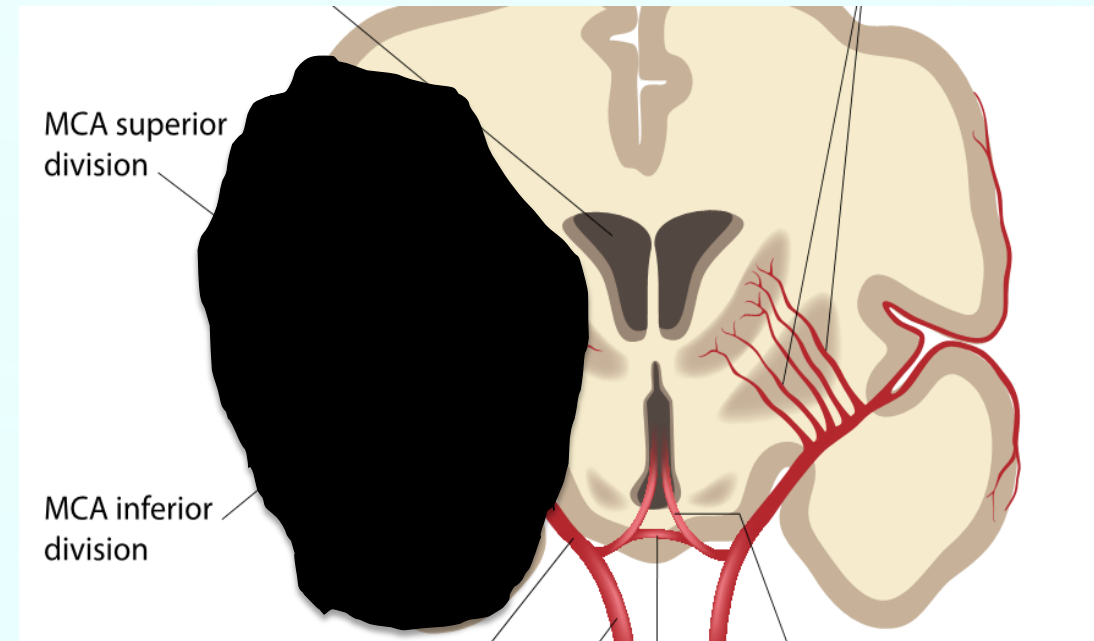
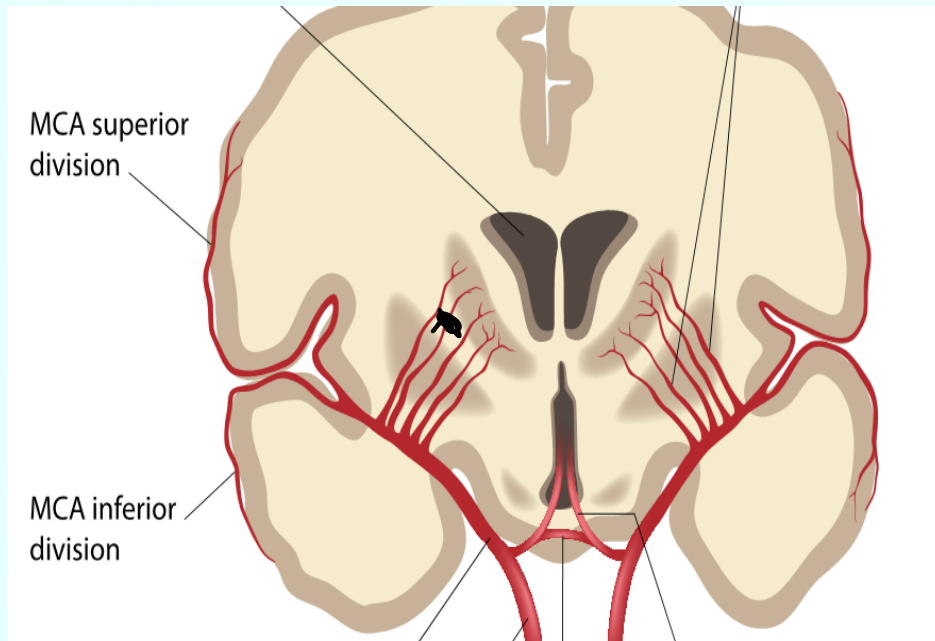


MECHANISMS OF STROKE: SIMPLIFIED

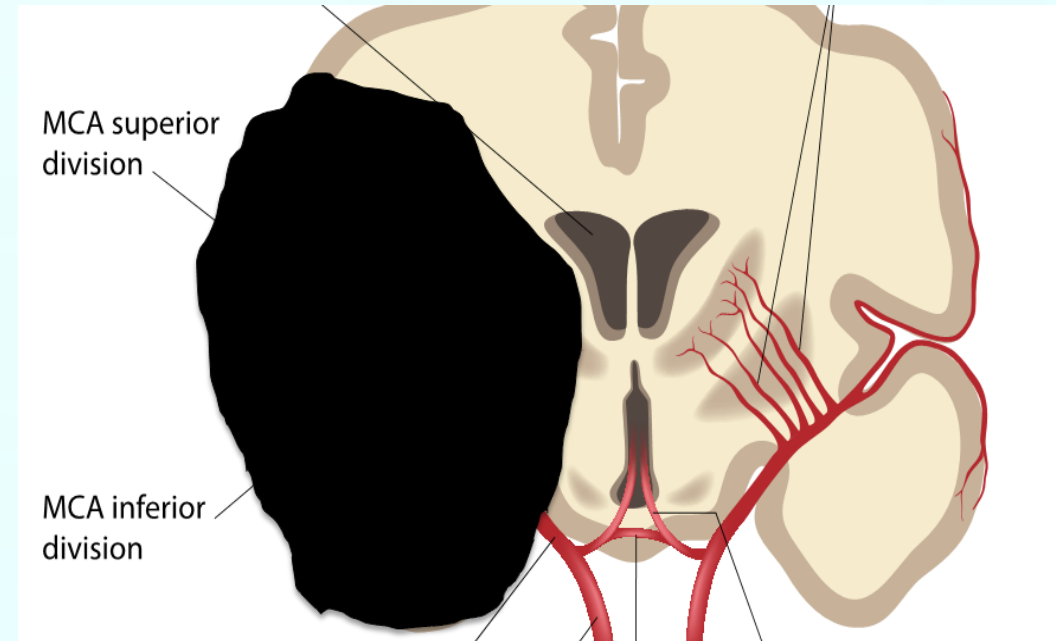
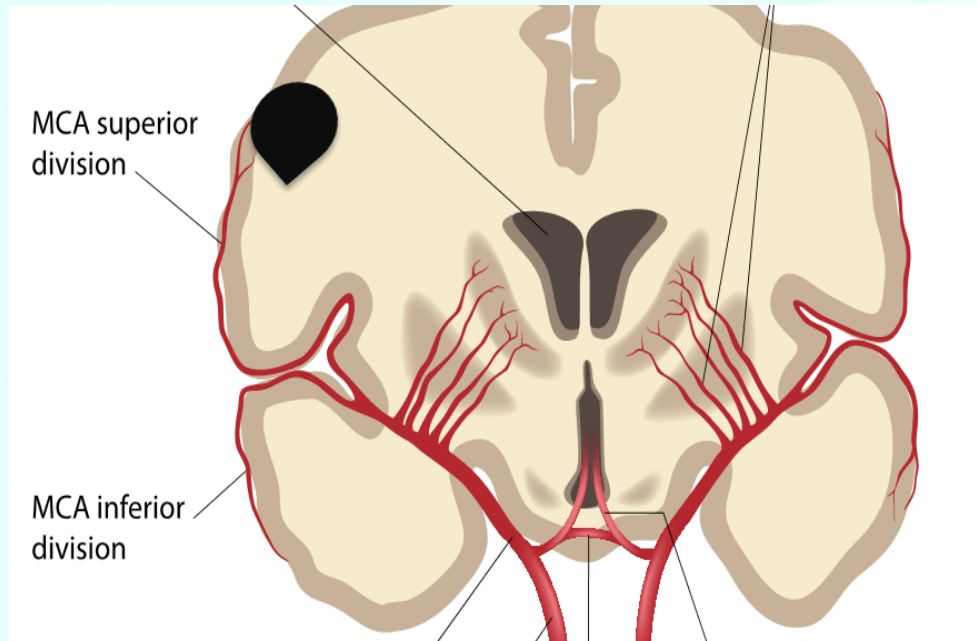
- Artery type involve
 - Large vessel disease
 - Small vessel disease
- Mechanism
 - Embolic (can be large v small vessel)
 - Thrombotic (can be large v small vessel)
 - Hypoperfusion



THROMBOTIC: SMALL ARTERY V LARGE ARTERY



EMBOLIC: SMALL V LARGE ARTERY



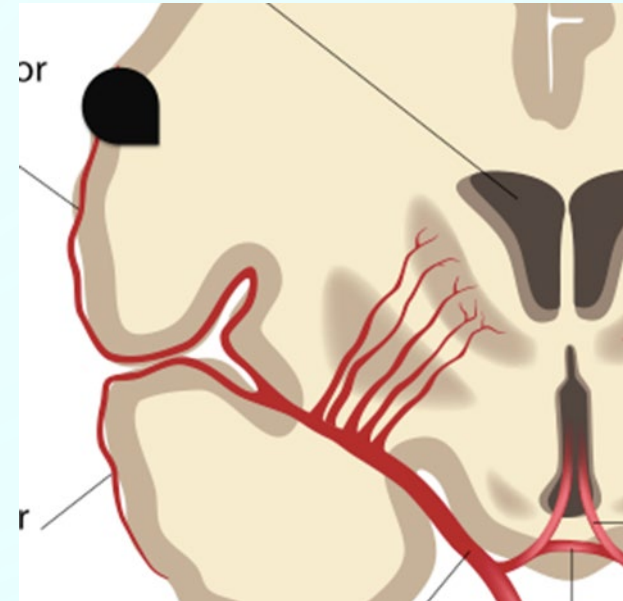
HEMISPHERIC DISTINCTIONS

- Dominant hemisphere (95% Left brain)
 - Language Function is affected = cortical localizing sign
 - Contralateral motor/sensory/Visual Field deficits (usually right)
- Non-dominant hemisphere (95% right brain)
 - Neglect (of left side)
 - Gaze preference (to right side)
 - Contralateral motor/sensory/visual field deficits (usually left)



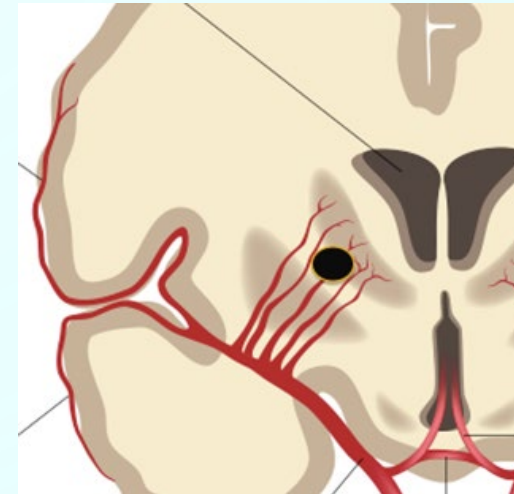
“CORTICAL” STROKE

- Pattern of hemiparesis or hemisensory deficit:
 - Face and Arm > leg : MCA
 - Leg > Face and Arm: ACA
- Presence of:
 - Aphasia (Dominant)
 - Neglect (Non-dominant)
 - Visual Field Deficit
 - Gaze Deviation (often)
 - Obtunded, confused

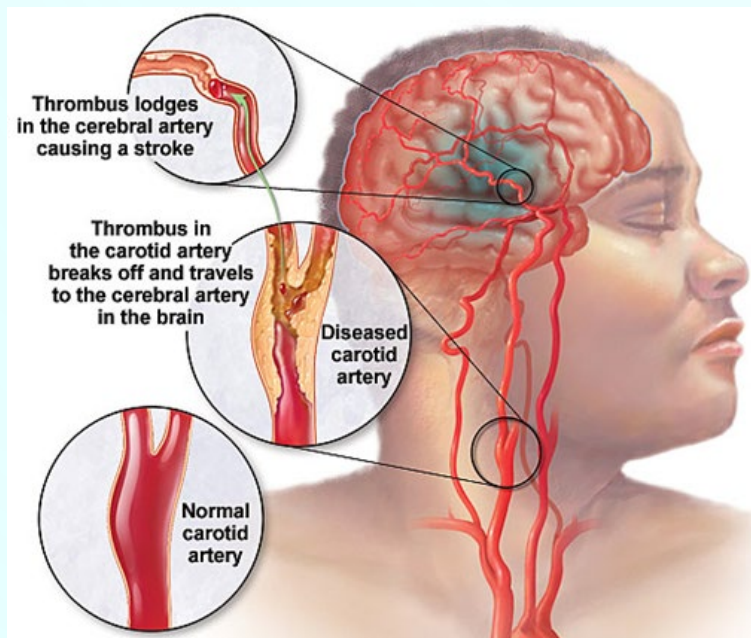
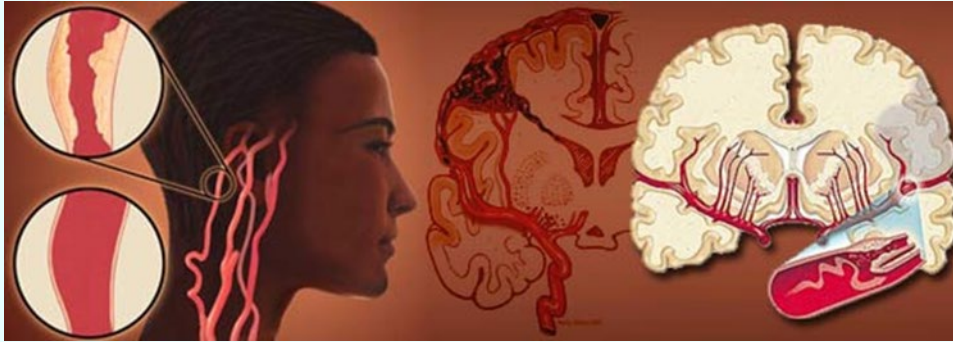


“SUBCORTICAL” STROKE

- Pattern of hemiparesis or hemisensory deficit:
 - Face/ Arm/ Leg almost equally affected (maybe dense)
- Absence of:
 - Aphasia (Dominant)
 - Neglect (Non-dominant)
 - Visual Field Deficit
 - Gaze Deviation (often)
 - Obtunded, confused



STROKE ALERT (CODE....)



LACK OF AWARENESS: PATIENT

- Stroke can change a person's level of consciousness
- Stroke can make a person confused
- Misunderstand seriousness: painless
- Non-dominant hemisphere: neglect



LACK OF AWARENESS: PROVIDER

- Aphasic patient thought to be confused
- A large PCA stroke may be missed if no visual field examination
- Ataxia may be missed if no one walks the patient
- Posterior fossa stroke may be missed when presenting with Vertigo, nausea, vomiting, 'dizziness'



Modified Cincinnati Stroke Scale

If any one of these three tests are abnormal and is a new finding, the Stroke Scale is abnormal and may indicate an acute stroke

Finding	Patient Activity	Interpretation
Facial Droop	Ask patient to smile and show teeth or grimace	Normal: Symmetrical smile or face Abnormal: Asymmetry (one side droops or does not move)
Arm Weakness	Ask patient to close both eyes and extend both arms out straight for 10 seconds	Normal: Both arms move symmetrically or do not move Abnormal: One arm drifts down or arms move asymmetrically Testing with patient holding palms upward is most sensitive way to check. Patients with arm weakness will tend to pronate (turn from palms up to sideways or palms down).
Speech Abnormality	Have the patient say the words, "You can't teach an old dog new tricks"	Normal: The correct words are used and no slurring of words is noted Abnormal: If the patient slurs words, uses the wrong words, or is unable to speak (aphasia)




TELESPECIALISTS INITIAL ASSESSMENT TOOL (2015)

- **Smile:** ask person to smile
- **Talk:**
 - Repetition:
 - 'No ifs, ands or buts about it'
 - 'She came home in a blue Cadillac and a flood of tears'
 - 'What time will the bus pick you up'
 - Naming
 - Two objects
- **Raise your arms:** limited motor exam
- **Look:** Visual field
- **Walk:** Rapid Gait assessment



TELESPECIALISTS INITIAL ASSESSMENT TOOL (2019)



Please complete this form for all patients seeking care in the Emergency Department ages 18 or older

SAVES TOOL

If patient is experiencing any of the below symptoms, patient is deemed SAVES +

Patient Sticker Here

*To be scanned into patient's ED medical Record

Facility: _____

Complete this portion only if patient SAVES +

HISTORY:

AGE: _____ M / F

TIME LAST KNOWN WELL: _____

♦ IF LAST KNOWN WELL < / = 24 HOURS OR WAKE UP SYMPTOMS ACTIVATE STROKE ALERT

STROKE ALERT ACTIVATED Yes No

ANTICOAGULATION USE: Yes No

If YES to above, list name of medication, dosage and when last taken

COMPLETED BY: _____

DATE: _____

SMILE

FACIAL WEAKNESS OR NUMBNESS

ARMS

WEAKNESS OR NUMBNESS IN UPPER LIMBS
 DRIFT

VISION

VISUAL FIELD DEFECT
 GAZE DEVIATION
 DIPLOPIA

EVEN BALANCE


GAIT SCREEN
 WEAKNESS OR NUMBNESS IN LOWER LIMBS
 DIZZINESS (in combination with other symptoms)

SPEECH







UNABLE TO NAME (SEE NIHSS)
 UNABLE TO REPEAT "NO IFS, ANDS OR BUTS"

SPOT A STROKE

LEARN THE WARNING SIGNS AND ACT FAST



B E F A S T

BALANCE

LOSS OF BALANCE, HEADACHE OR DIZZINESS

EYES

BLURRED VISION

FACE

ONE SIDE OF THE FACE IS DROOPING

ARMS


ARM OR LEG WEAKNESS

SPEECH

SPEECH DIFFICULTY

TIME

TIME TO CALL FOR AMBULANCE IMMEDIATELY



CALL 911 IMMEDIATELY



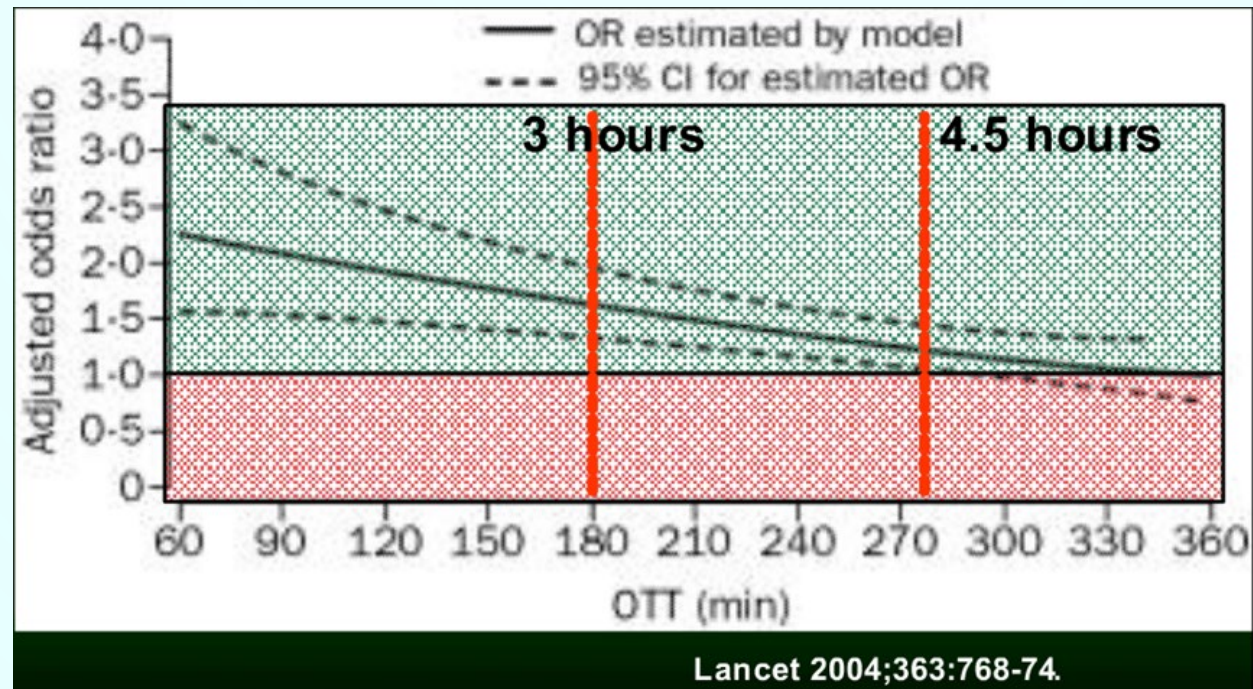
BRAIN METABOLISM

- Brains sole source of energy is aerobic or oxidative metabolism
- Therefore, the brain requires a constant supply of O₂ and glucose, 24/ 7/ 365
- At approximately 3 pounds, the brain accounts for roughly 2% of body mass
- Consumes 17% of cardiac output
- Responsible for 20% of oxygen consumption at rest



META-ANALYSIS OF RT-PA-BASED THROMBOLYTIC TRIALS

NINDS, ATLANTIS, AND ECASS



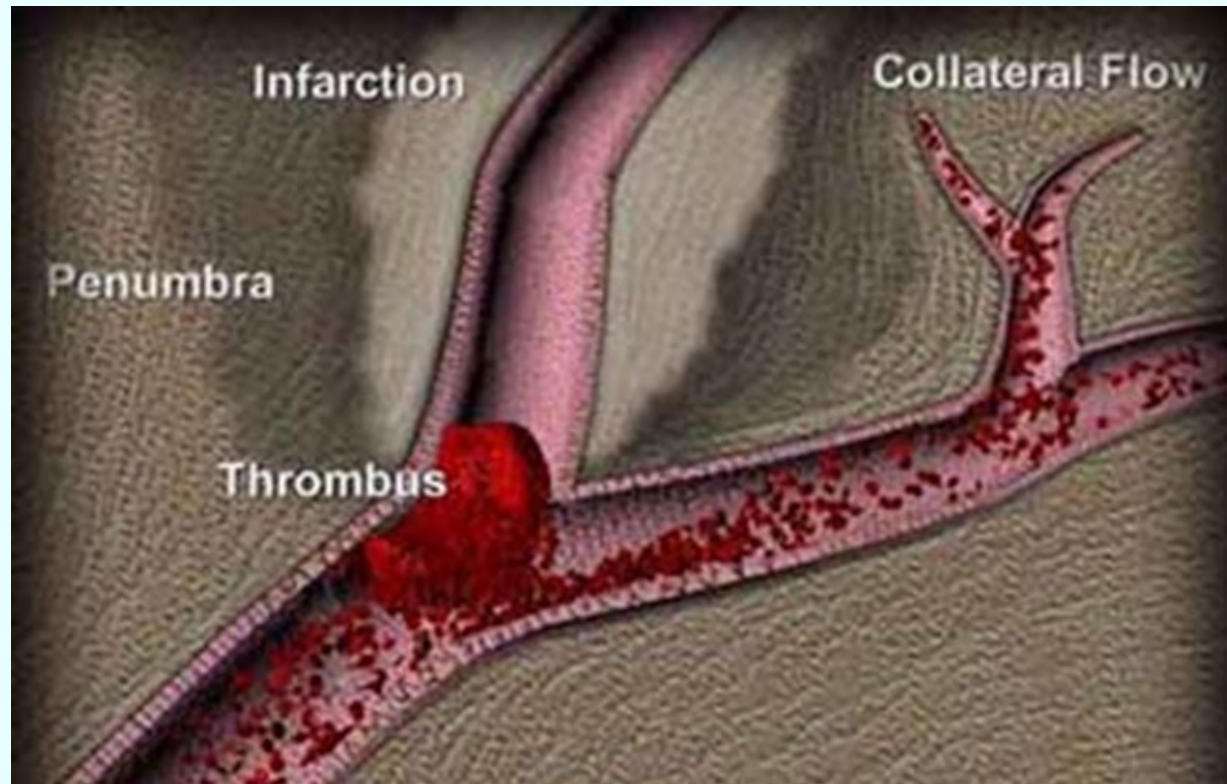
RISK OF INTRACRANIAL HEMORRHAGE WITHIN 36 HOURS

<u>ICH Type</u>	<u>t - PA</u>	<u>Placebo</u>
Part 1		
Symptomatic	8 (6%)	0
Fatal *	4	0
Asymptomatic	5 (3%)	3 (2%)
Part 2		
Symptomatic	12 (7%)	2 (1%)
Fatal *	5	1
Asymptomatic	9 (5%)	6 (4%)

* Values include all deaths attributed to hemorrhage



PENUMBRA



TREATMENT OF ACUTE STROKE: GOALS?

- Save penumbra (may remain viable for 6-12 hrs)
- Recanalization
 - Thrombolysis
 - Thrombectomy
- Reduce morbidity and mortality
 - Stroke is leading cause of disability in US
 - All stroke trial endpoints include modified Rankin Score 90 days



CLASSICAL 3 HOUR EXCLUSION CRITERIA

- SBP >185, DBP >110
- Minor or rapidly improving stroke
- Seizure at onset
- PT > 15 or INR >1.7
- Heparin given within last 48 hours with elevated PTT
- PLT < 100,000
- BG < 50 or > 400
- Acute MI
- Any prior intracranial hemorrhage, AVM, neoplasm, aneurysm
- Lumbar puncture in the last 7 days
- Any major surgery in the last 14 days
- Any GI or GU bleed in the last 21 days
- Any stroke or serious head trauma in last 3 months
- Pregnancy



4.5 HR WINDOW CRITERIA

- Same as 3 hr criteria, but following exclusions:
 - AGE more than 80 years
 - Oral anticoagulant use even if $INR < 1.7$
 - History of both prior stroke and diabetes



NEW WAY OF THINKING

AHA/ASA Scientific Statement

Scientific Rationale for the Inclusion and Exclusion Criteria for Intravenous Alteplase in Acute Ischemic Stroke

**A Statement for Healthcare Professionals From the American Heart
Association/American Stroke Association**



3-4.5 HOUR WINDOW TREATMENT PLAN

- 3-4.5 hours from 'last known well'
- 0.9 mg/kg up to maximum of 90 mg
- 10% dose given as bolus
- Remaining dose given over 60 minutes
- DO NOT give aspirin, heparin, warfarin



MONITORING AFTER TPA

- Neurologic assessment:
 - Q15 min during infusion and one hour post, then
 - Q30 min for the next 6 hours, then
 - Q1 hr for the first 24 hr period of time post Rx
- Watch for:
 - Acute headache, HTN, nausea, or vomiting
 - DISCONTINUE INFUSION and CT head STAT



EARLY SUPPORTIVE CARE

- Fever: antipyretics
- Hyperglycemia
- Fluids
- Passive range of motion, frequent turning, close skin surveillance, aspiration precautions
- DVT prophylaxis (SCDs)



BLOOD PRESSURE MANAGEMENT

- **Withhold** antihypertensive drugs unless BP is in hypertensive encephalopathy range, that is **SBP >220 or MAP >130**
- Exception: concurrent condition that requires moderation of BP; examples- acute MI, aortic dissection, acute renal failure due to HTN, 24 hrs after IV TPA

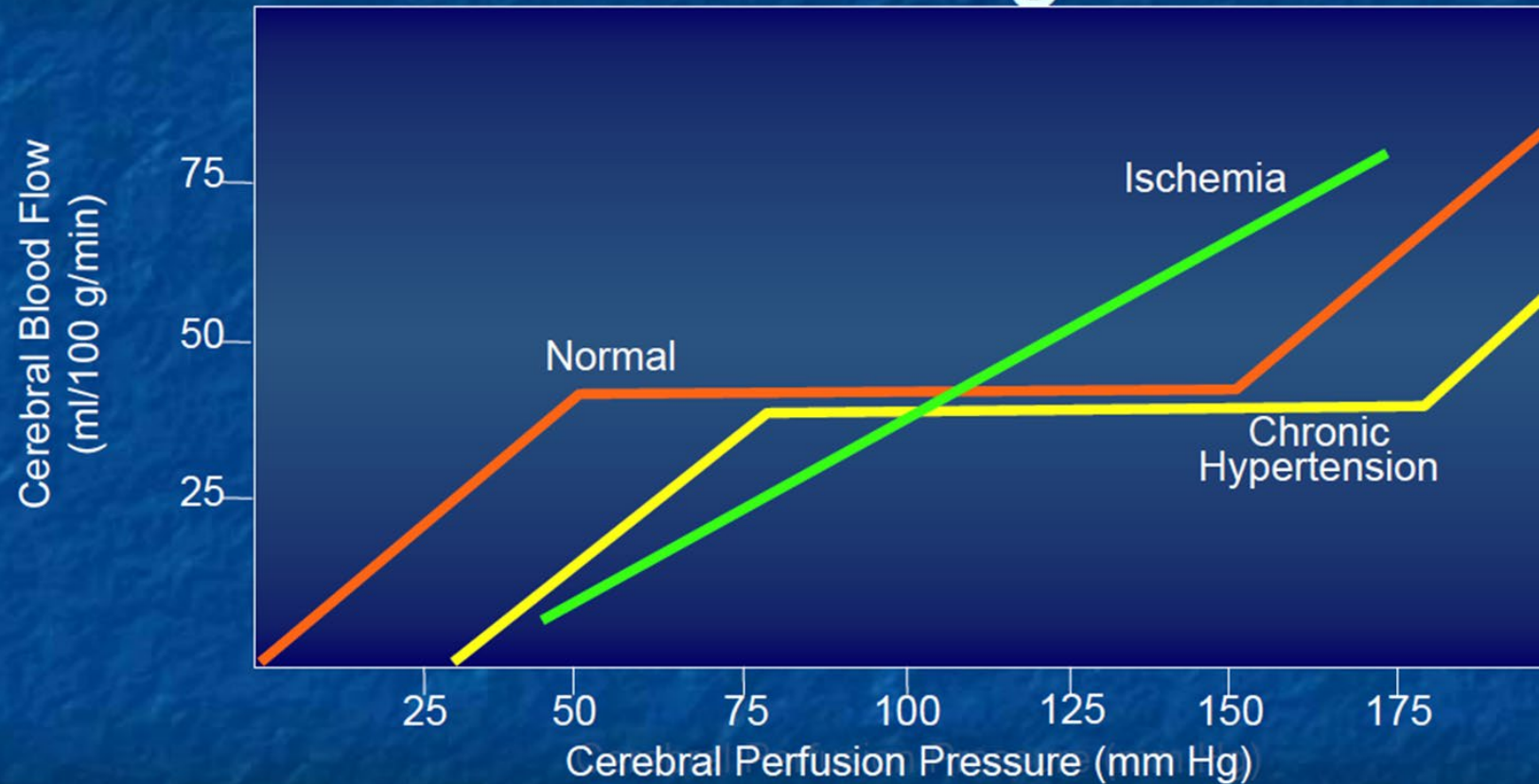


BLOOD PRESSURE REGULATION

- In ischemic fields, autoregulation is lost and cerebral blood flow varies directly with systemic blood pressure
- Brain is an end-organ, not pumping organ



Cerebral Autoregulation



$CPP = MAP - ICP$

Neurocrit care. Vol 1 (3) 2004



ENDOVASCULAR TREATMENT

- Suitable for large vessel occlusion syndromes
 - Posterior Circulation
 - Vertebral artery
 - Basilar Artery
 - Posterior Cerebral Artery
 - Anterior Circulation
 - Internal Carotid Artery
 - Middle Cerebral Artery
 - Anterior Cerebral Artery



STANDARD ENDOVASCULAR TREATMENT – 0-6 HOURS

- Compilation of data from trials published in late 2014-2015
 - MR CLEAN
 - ESCAPE
 - EXTEND IA
 - SWIFT-PRIME
 - REVASCAT
- All utilized newer technology clot retrieval with stent-retrievers
- All studies ended early due to the clear benefit to the treatment groups
- Standard inclusion criteria similar to NINDS trial, some included advanced imaging



STANDARD ENDOVASCULAR TREATMENT – 0-6 HOURS

- These studies led to an interim update in July 2015 of AIS guidelines
 - Patients eligible for tPA should receive tPA
 - Patients should receive EVT with stent retriever if following criteria met
 - Prestroke mRS 0-1
 - AIS receiving tPA within 4.5 hours of LKW
 - Causative occlusion of ICA or proximal MCA (M1)
 - Age ≥ 18
 - NIHSS ≥ 6
 - ASPECTS ≥ 6
 - Groin puncture within 6 hours of last known normal
 - Consider distal occlusions, patients not candidates for tPA, or times > 6 hours but a lower level of evidence



LATE ENDOVASCULAR TREATMENT 6-24 HOURS

- Latest update to clinical guidelines
- Based on findings from 2 recently published trials
 - DAWN
 - DEFUSE 3
- Slightly different study groups
- Candidates identified by combination of clinical and imaging characteristics
- Similar efficacy/benefits



DAWN

- Investigating benefit of EVT 6-24 hours since last known normal
- Clinical inclusion NIHSS ≥ 10
- Imaging used to estimate stroke volume
- In patients studied, there is a demonstrated benefit in patients treated with intervention



DAWN CRITERIA

- Patients < 80
 - NIHSS $\geq 10 \rightarrow$ core stroke on perfusion < 31 mL
 - NIHSS $\geq 20 \rightarrow$ core stroke on perfusion < 51 mL
- Patients ≥ 80
 - NIHSS $\geq 10 \rightarrow$ core < 21 mL
- For every 100 patients treated
 - 49 with less disabled outcome
 - 36 reach functional independence
 - NNT 2.8



DEFUSE 3

- Most recently published late EVT study
- Slightly different inclusion/exclusion versus DAWN
- Similar clinical/outcomes benefit



DEFUSE 3

- Enrolled patients < 90
- NIHSS ≥ 6
- 6-16 hours since last known normal
- Odds ratio of benefit is 2.8
- NNT is 2
- Paradoxical increase in benefit over 6-12 hours that is still being investigated



QUESTIONS?



