

# Overview of Stroke: Etiologies, Demographics, Syndromes, and Outcomes

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# Disclosure Statement of Financial Interest

Within the past 12 months, I or my spouse/partner have had a financial interest/arrangement or affiliation with the organization(s) listed below.

## Affiliation/Financial Relationship

- Consulting Fees/Honoraria

## Company

- The Medicines Co.
- Silk Road Medical

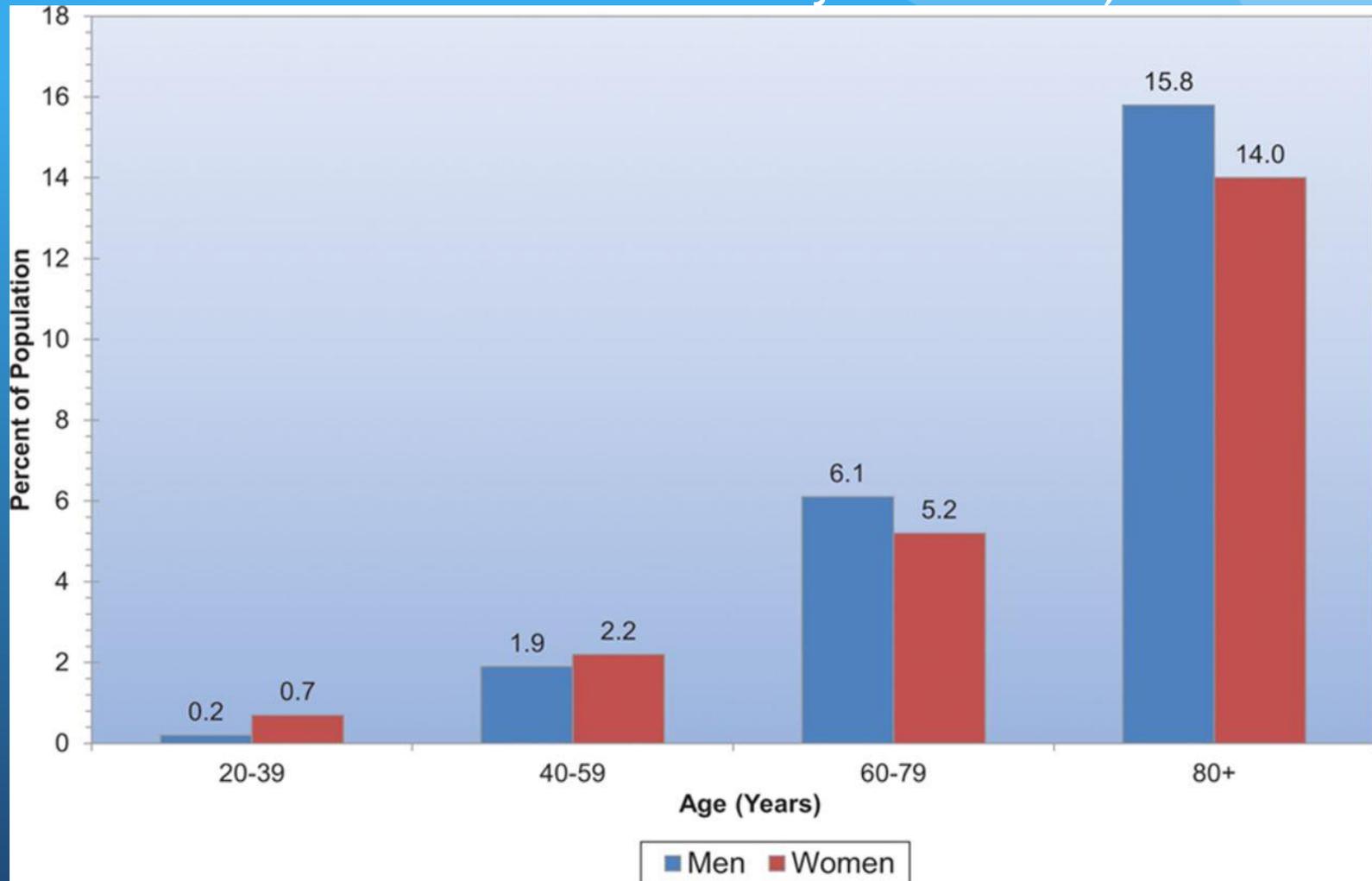
# Definitions

- Stroke - abrupt development of a focal neurological deficit due to a vascular cause associated with permanent neuronal injury
- Transient ischemic attack (TIA)- same clinical syndrome as a stroke but resolves completely < 24 hours
  - i.e. without permanent brain injury (old definition)
  - With modern imaging most events >several hours duration are associated with infarction.

# Epidemiology- USA

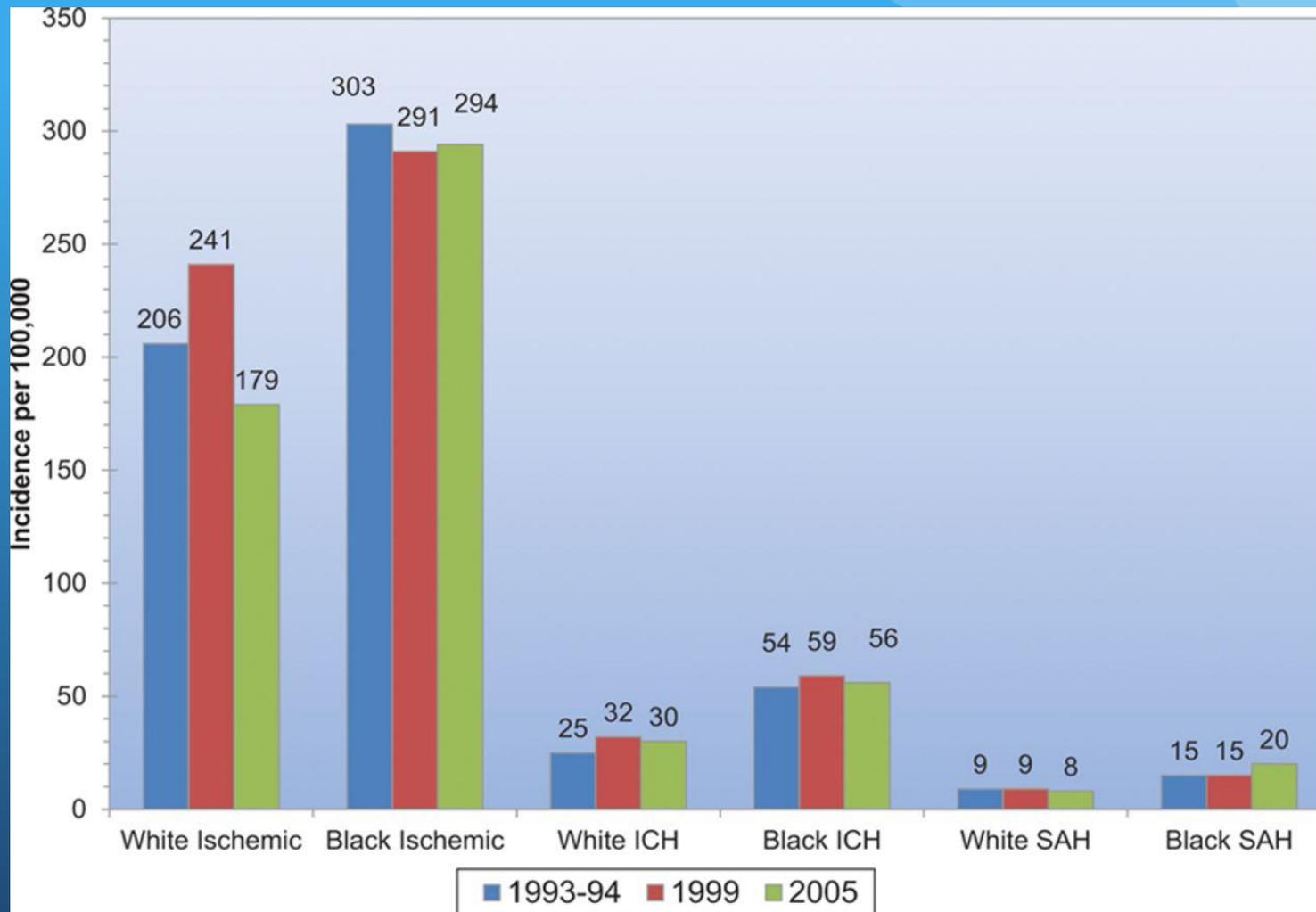
- ~795,000 new or recurrent stroke per year
  - 610,000 first attacks
  - 185,000 recurrent attacks
- 2001 to 2011 relative rate of stroke death fell 35.1%
  - Actual number of stroke deaths declined 23.0%
  - In 2011 stroke caused ~1 of every 20 deaths in USA
  - On average, 1 stroke every 40 seconds in USA
    - 1 Stroke death every 4 minutes
- There are ~ 4.5-5 million Stroke survivors
- Stroke is the leading cause of adult disability in USA
  - 15-30% of all stroke leads to permanent disability

# Prevalence of Stroke by Age and Sex (National Health and Nutrition Examination Survey: 2009-2012).



Dariush Mozaffarian et al. *Circulation*. 2015;131:e29-e322

# Annual Age-adjusted Incidence of First-ever Stroke by Race.



Dariush Mozaffarian et al. *Circulation*. 2015;131:e29-e322

# Aftermath of Ischemic Stroke

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- Stroke progression during hospitalization 24%
- Mortality
  - 30 days 8%-20%
  - 1 year 15%-25%
  - 5 years 40%-60%
- Complete or partial dependence 27%-53%
- 6-month decrease in Quality of Well-Being score 27%
- Dementia persisting at 1 year 34%

# Subsequent Stroke Risk After TIA or Stroke

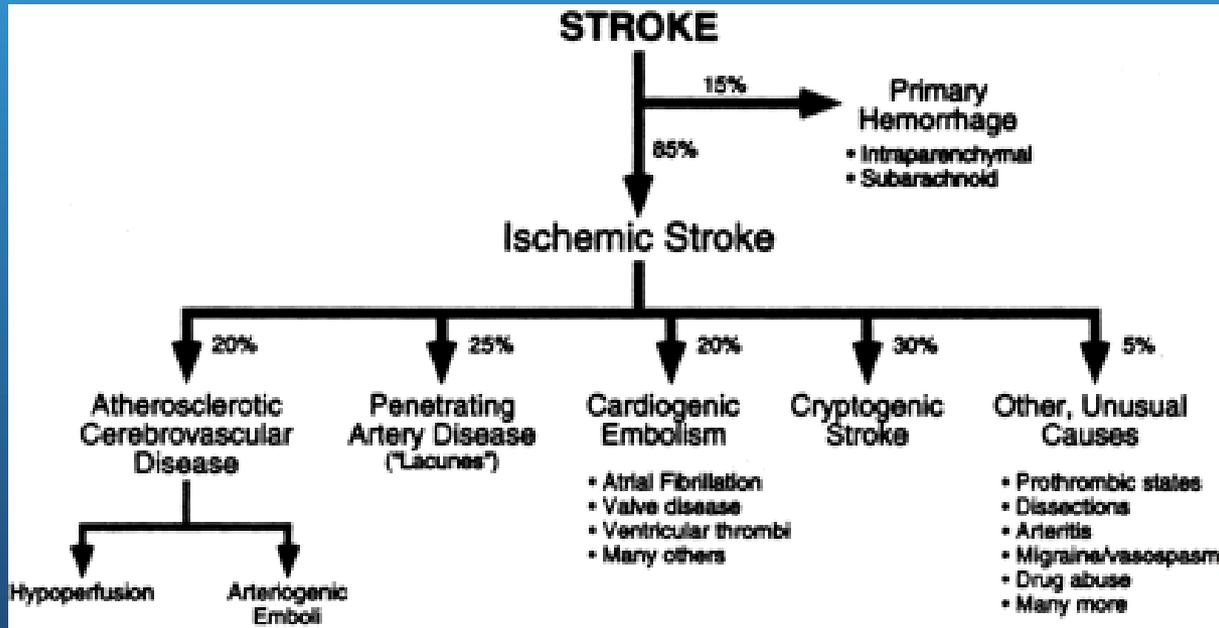
	After TIA <sup>1</sup>	After Stroke <sup>2</sup>
30 days	4-8%	3-10%
1 year	12-13%	5-14%
5 years	24-29%	25-40%

1. Feinberg, et al. *Stroke*. 1994;25:1320-1335.

2. Sacco. *Neurology*. 1997;49(suppl 4):S39-S44.

# Stroke is Heterogeneous

- Thrombi/Emboli of varying compositions



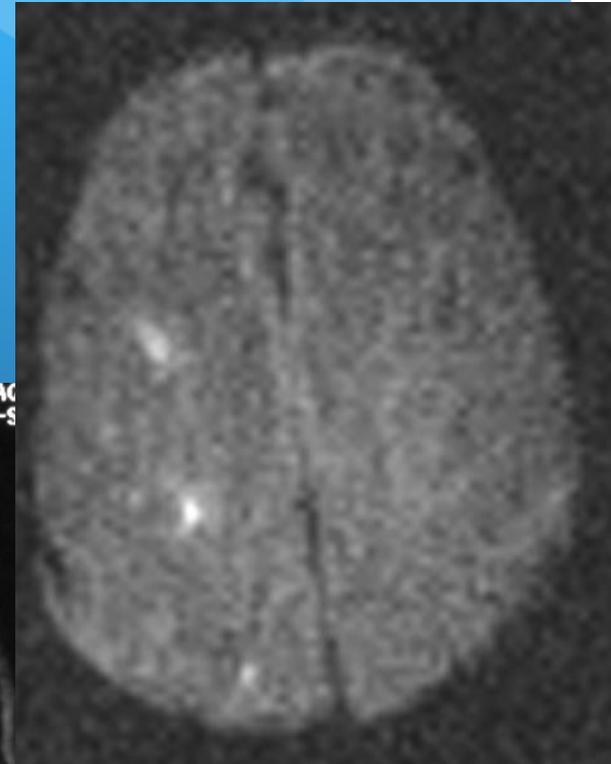
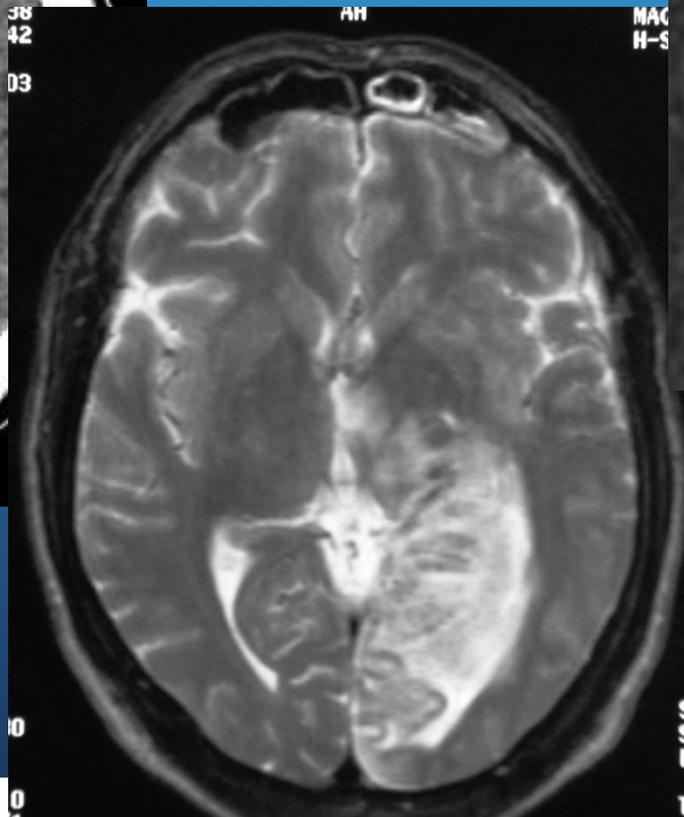
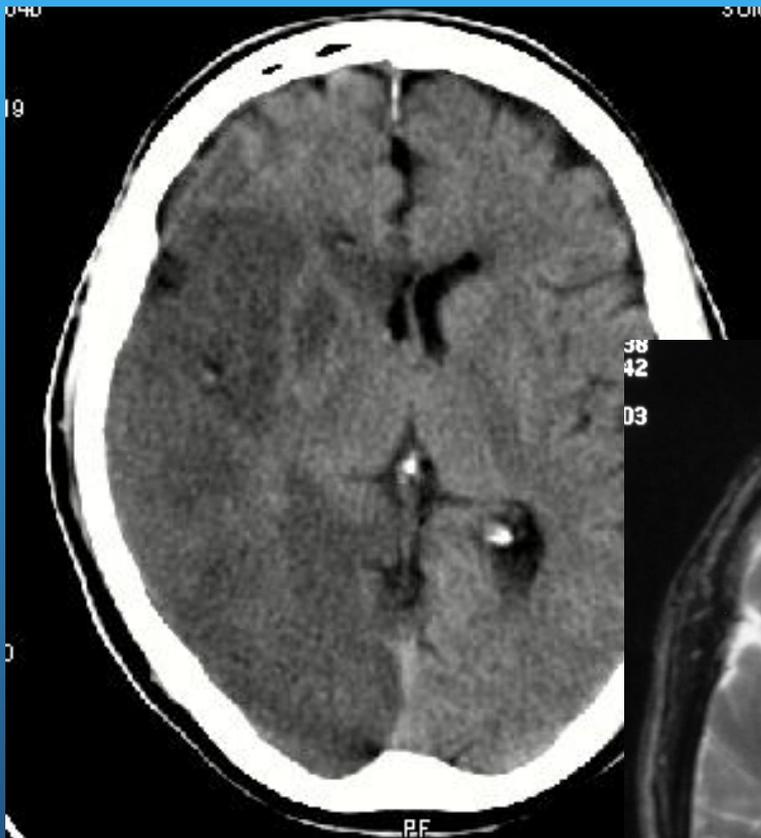
# Embolic

- Atrial fibrillation - most common embolic cause
  - Second most common cause of ischemic stroke
    - 36% of strokes in patients >80 years old
    - With better EKG tele (implantable) 20-30% of cryptogenic stroke likely due to AF
- Aortic atherosclerosis cause of 30% of “cryptogenic” stroke
- Acute anterior wall myocardial infarction
- Rare- Endocarditis, PFO, myxoma, hypercoagulable, air, fat,

# Large Vessel Thrombotic

- Carotid atherosclerosis- most common cause in USA
  - Usually in the presence of >70% stenosis but <50% stenosis can be symptomatic
- Intracranial atherosclerosis in 7-10%
  - African/Asian>Caucasian, Women>Men, DM>Non-DM
- Hypercoagulable states
- Dissection

# Large Vessel Strokes



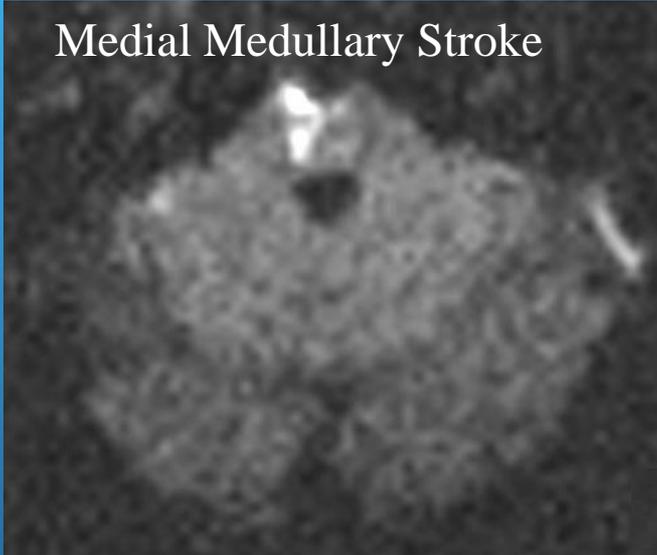
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# Small Vessel Thrombotic

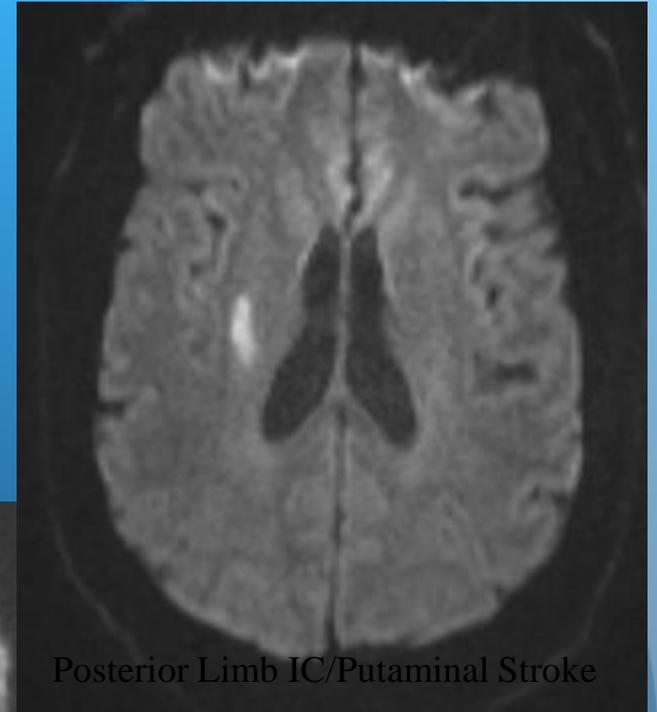
- Lipohyalinosis- small penetrating arteries (<2-400 $\mu$ m diameter)
  - MCA/BA Perforators -> disorganization and disruption of vessel lumen (hyaline material) -> occlusion -> ischemia -> necrosis -> “lacune”
- Hypertension most important risk factor
- Embolic origin <20%
- Increased incidence in African-Americans
- Single most common cause of stroke

# Typical Lacunar Strokes on MRI

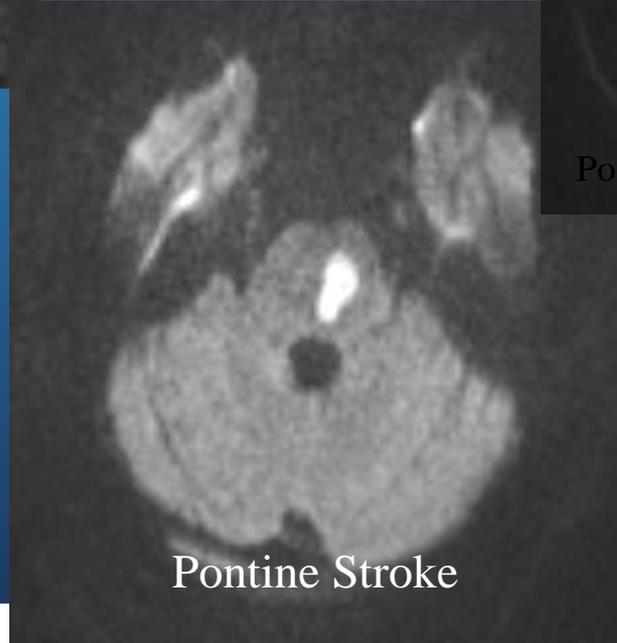
Medial Medullary Stroke



Posterior Limb IC/Putaminal Stroke



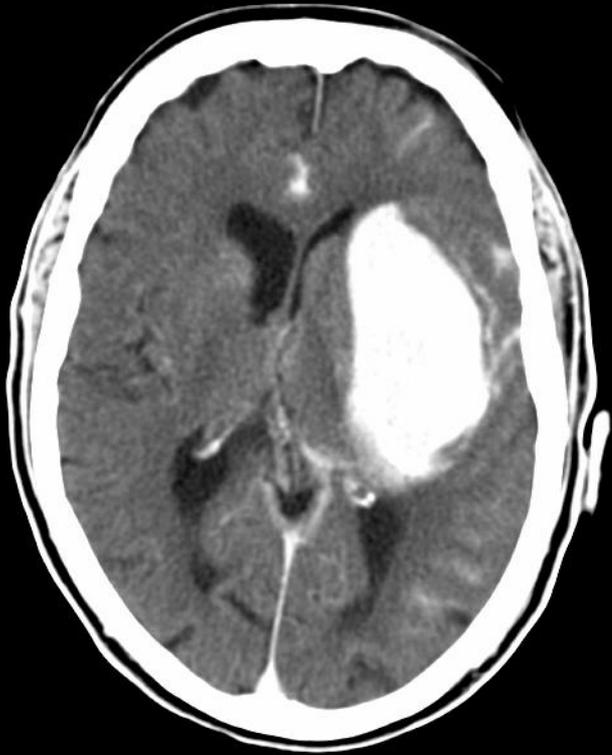
Pontine Stroke



# Intracerebral Hemorrhage

- Hemorrhage into the substance of Brain
  - Cerebral hemispheres (20%), basal ganglia (40%), thalamus (20%), pons (10%) or cerebellum (10%)
- Etiology
  - Hypertension (most common cause)
  - Anticoagulant therapy
  - Amyloid angiopathy- associated with dementia and increasing age
  - Vascular malformations (arteriovenous malformation), cavernous angioma, capillary, telangiectasia
  - Venous sinus thrombosis
  - Cerebral metastases
  - Trauma

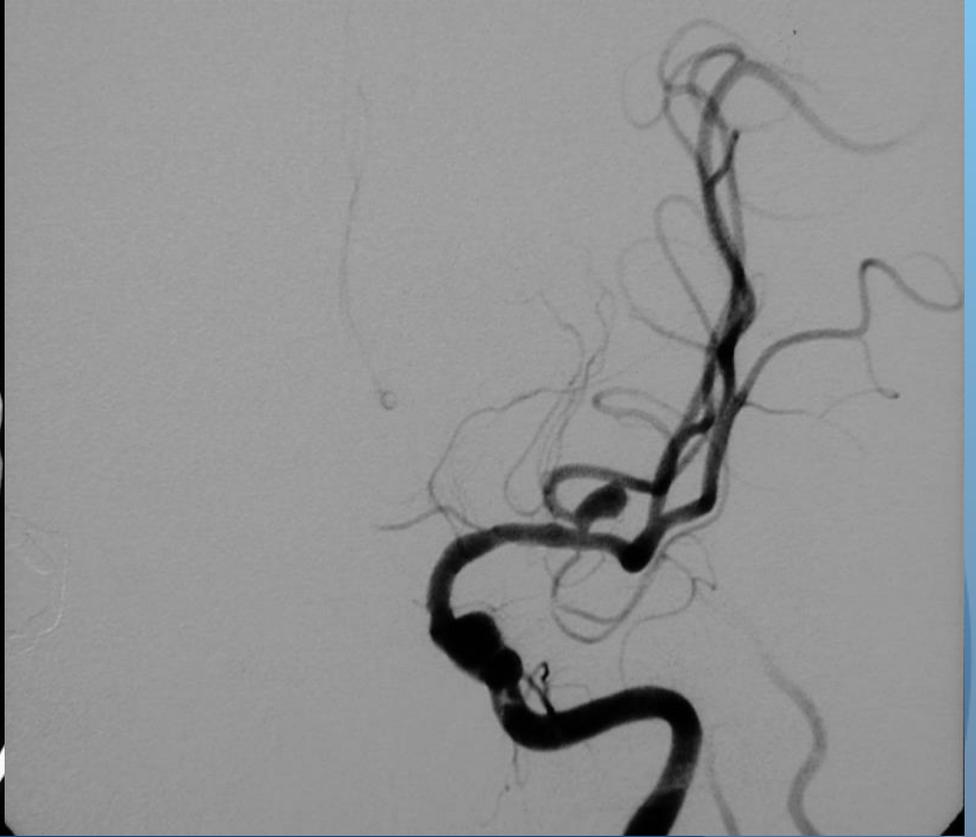
# ICH on CT



# Subarachnoid Hemorrhage

- Rupture of a Saccular aneurysm
  - Risk of hemorrhage dependent on aneurysm size and location
  - <10mm lowest risk 0.05% / year, cumulative
  - >10mm <25mm moderate risk 1% / year, cumulative
  - >25mm highest risk 6% / year, cumulative
  - Basilar tip location has highest risk of rupture (RR=13.8)
- Trauma
- Arteriovenous malformation
- Mycotic aneurysm- post endocarditis ischemic stroke

# Typical Subarachnoid Hemorrhage and Saccular Aneurysm



# Differential Diagnosis- Stroke Imitators

- Mass lesion- Primary brain carcinoma, metastases, meningioma, abscess
- Subdural hematoma
- Somatization
- Migraine
- Seizure
- Hyper/hypoglycemia
- Cerebritis- lupus
- Demyelination- Multiple sclerosis, acute disseminated encephalomyelitis
- Fever/infection in elderly with prior brain injury (especially urinary tract infections)
- Transient global amnesia
- Encephalitis- Herpes simplex type I
- Inherited metabolic derangements- Mitochondrial encephalopathies

# CLINICAL PRESENTATION

- Symptom onset
  - Large vessel ischemia
    - Embolic -> sudden/maximal at onset
    - Thrombotic -> symptoms maximal at onset or stuttering over minutes/hours
  - Small vessel ischemia -> progression over minutes or stuttering over hours/days
  - Intracranial hemorrhage
    - Intracerebral hemorrhage -> steadily progressive over minutes/hours -> nausea/vomiting -> headache
    - Subarachnoid hemorrhage -> headache instantaneous and maximal at onset- “thunderclap”

# Symptoms & Physical Findings

- Symptoms variable in type/intensity depending on vessel/brain region involved
  - Weakness, paralysis, or incoordination- Large Vessel or Small Vessel
  - Numbness or tingling- Large Vessel or Small Vessel
  - Visual loss (monocular- amaurosis fugax, binocular-hemianopsia)- Large Vessel
  - Cognitive dysfunction
    - Aphasia (dominant hemisphere, a disorder of language not articulation [dysarthria])- Large Vessel
    - Neglect (nondominant hemisphere)- Large Vessel
  - Ataxia, gait instability or vertigo- Large Vessel or Small Vessel

# Symptoms & Physical Findings -continued-

- Decreased level of consciousness- Large Vessel
- Sudden headache with nausea and vomiting- Hemorrhage
- Double vision- Large Vessel or Small Vessel
- Agitation or confusion- Large Vessel
- Memory loss- Large Vessel
- Transient loss of consciousness (very rare without other neurological signs)- Large Vessel, usually vertebrobasilar
  - The term vertebrobasilar insufficiency is over used
  - 95% of transient episodes of loss of consciousness are due to a cardiovascular rather than neurovascular cause

# Clinical Syndromes

- Lacunar
  - Pure Motor or sensory
  - Sensory-motor
  - Ataxic-hemiparesis
- Large Vessel
  - Cortical Dysfunction
    - Aphasia
    - Neglect
  - Hemiparesis/anesthesia
  - Hemianopsia
- Vertebrobasilar
  - Ataxia
  - Dizziness
  - Crossed sensory-motor
    - Wallenberg's
    - Weber's
  - Bulbar
  - Oculomotor
  - Hemianopsia
  - Early decrease consciousness

# Variability of Clinical Manifestations Dependent On

- Location of Occlusion/Thrombus
- Collateral Blood Flow
  - Cerebrovascular Reserve
- Size of Embolism
- Severity of Hypoperfusion
- Duration of Ischemia
- Underlying Brain Substrate
  - Neuronal Reserve
- Age
- Medical Co-morbidities
  - Hyper/Hypoglycemia
  - Hyperthermia

# Stroke Mechanisms

- Embolism
  - Most common
  - MCA >> ACA
- Thrombosis
- Hypoperfusion
- Combination
  - “Impaired Washout of Emboli”

# National Institutes of Health Stroke Scale- NIHSS

- 12 Item scale
- Points are given for deficits
  - 0= normal
  - 42=No neurological function
- Strict guidelines for interpreting and scoring
- Requires (minimal) training
  - Video
- Can be completed in 4-5 minutes by experienced examiner

# NIHSS

- 1- Alertness, Commands, Response
- 2- Horizontal Gaze
- 3- Visual Fields
- 4- Facial Movement
- 5- Arm Movement
- 6- Leg Movement
- 7- Ataxia
- 8- Sensation
- 9- Language
- 10- Speech Quality
- 11- Neglect
- 12- Hand Strength

# Modified Rankin Scale (mRS)

## Neurological Disability Scale

- | Grade | Description   | Grade | Description  |
|-------|---|-------|--|
| • 0   | No symptoms at all.   | • 4   | Moderate to severe disability: unable to walk without assistance, and unable to attend to own bodily needs without assistance. |
| • 1   | No significant disability despite symptoms: able to carry out all usual duties and activities.                        | • 5   | Severe disability: bedridden, incontinent, and requiring constant nursing care and attention.                                  |
| • 2   | Slight disability: unable to carry out all previous activities but able to look after own affairs without assistance. | • 6   | Death  |
| • 3   | Moderate disability: requiring some help, but able to walk without assistance.  |       |  |