



ACUTE STROKE

Internal Medicine Lecture

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Lauren E. Fournier, MD

Vascular Neurology Fellow at UTHealth

Slides adapted courtesy of Dr. Anjail Sharrief

OBJECTIVES

- Residents will be able to discuss epidemiology and risk factors for ischemic and hemorrhagic stroke.
- Residents will be able to recognize acute stroke symptoms and have an understanding of the NIHSS.
- Residents will be able to identify the different stroke subtypes and comment on management differences.

Epidemiology of Stroke

- Stroke is the 2nd leading cause of death in the world
- Stroke is the 4th leading cause of death in the United States
- Stroke is a leading cause of adult disability
- Approximately 800,000 strokes occur each year
 - Every 40 seconds, someone has a stroke in US
 - Every 4 minutes, someone dies of a stroke in the US

The Economic Impact

- Direct and indirect costs of 34.3 billion dollars
- Direct costs 18.8 billion dollars
- Average lifetime cost of ischemic stroke is \$140,000 per person
- Per capita cost of stroke estimates highest in African Americans
 - Largest component loss of earnings

Types of Stroke

- **Ischemic (87%)**
 - Extracranial Atherosclerosis
 - Intracranial Atherosclerosis
 - Cardioembolic
 - Small Vessel Disease
 - Other
- **Hemorrhagic - Intracerebral (10%)**
- **Subarachnoid Hemorrhage (3%)**

Transient Ischemic Attack

- In the past, defined as focal cerebral ischemic event with symptoms lasting < 24 hours
- Newer proposed definition (2002)
 - Brief episode of neurological dysfunction caused by focal brain or retinal ischemia, with clinical symptoms typically lasting less than one hour, and without evidence of acute infarction
- 15% of strokes are preceded by TIA
- Between 2-10% of patients with TIA will have a stroke within 2 days, up to 17% will have a stroke at 3 months
- Use of terminology “mini stroke” may minimize the importance of rapid evaluation and management of TIA events

Risk Factors for Ischemic Stroke

- **MODIFIABLE**

- Hypertension
- Tobacco Use
- Diabetes
- Dyslipidemia
- Coronary Artery Disease
- Atrial fibrillation
- Obstructive Sleep Apnea
- Substance abuse
- OCP/Hormone Use

- **NON-MODIFIABLE**

- Age
- Gender
- Race / Ethnicity
- Genetic predisposition
 - Hypercoagulable states
 - Malignancy

Risk Factors for Hemorrhagic Stroke

- Age, Race/ ethnicity, Gender
- **HYPERTENSION**
- Vascular abnormality
 - Arteriovenous malformation, arteriovenous fistula, aneurysm, cavernous malformation
- Coagulopathy
 - Iatrogenic: anticoagulation, chemotherapy
 - Other: liver disease, renal disease, etc
- Drugs of abuse (cocaine, amphetamines, etc)
- Trauma
- Cerebral Venous Sinus Thrombosis

Signs and Symptoms

Anterior Circulation

- Aphasia – difficulty with language
- Neglect / inattention
- Visual field cut
- Monocular vision loss
- Hemiparesis
 - Face, arm, leg on same side
- Hemisensory loss
 - Face, arm, leg on same side
- Dysarthria – difficulty with speech

Posterior Circulation

- Vertigo
- Ataxia
- Double vision
- Dysarthria
- Visual field cut
- Hemiparesis and hemisensory loss
 - Facial involvement may be contralateral to arm and leg weakness/ sensory loss

NIHSS

	Scoring
1a. Level of consciousness	0 = Alert ; keenly responsive. 1 = Not alert ; but arousable by minor stimulation to obey, answer, or respond. 2 = Not alert ; requires repeated stimulation to attend, or is obtunded and requires strong or painful stimulation to make movements (not stereotyped). 3 = Responds only with reflex motor or autonomic effects or totally unresponsive, flaccid, and areflexic.
1b. LOC Questions: - The current month? - Age?	0 = Answers both questions correctly. 1 = Answers one question correctly. 2 = Answers neither question correctly.
1c. LOC Commands: - Open and close the eyes. - Grip and release non-paretic hand.	0 = Performs both tasks correctly. 1 = Performs one task correctly. 2 = Performs neither task correctly.

NIHSS

	Scoring
2. Best Gaze	<p>0 = Normal.</p> <p>1 = Partial gaze palsy; gaze is abnormal in one or both eyes, but forced deviation or total gaze paresis is not present.</p> <p>2 = Forced deviation, or total gaze paresis not overcome by the oculocephalic maneuver.</p>
3. Visual	<p>0 = No visual loss.</p> <p>1 = Partial hemianopia.</p> <p>2 = Complete hemianopia.</p> <p>3 = Bilateral hemianopia (blind including cortical blindness).</p>

NIHSS

	Scoring
4. Facial Palsy	<p>0 = Normal symmetrical movements.</p> <p>1 = Minor paralysis (flattened nasolabial fold, asymmetry on smiling).</p> <p>2 = Partial paralysis (total or near-total paralysis of lower face).</p> <p>3 = Complete paralysis of one or both sides (absence of facial movement in the upper and lower face).</p>

NIHSS

5a. Motor Left Arm 5b. Motor Right Arm	<p>0 = No drift; limb holds 90 (or 45) degrees for full 10 seconds.</p> <p>1 = Drift; limb holds 90 (or 45) degrees, but drifts down before full 10 seconds; does not hit bed or other support.</p> <p>2 = Some effort against gravity; limb cannot get to or maintain (if cued) 90 (or 45) degrees, drifts down to bed, but has some effort against gravity.</p> <p>3 = No effort against gravity; limb falls.</p> <p>4 = No movement.</p> <p>UN = Amputation or joint fusion, explain:</p> <hr/>

NIHSS

<p>6a. Motor Left Leg 6b. Motor Right Leg</p>	<p>0 = No drift; leg holds 30-degree position for full 5 seconds. 1 = Drift; leg falls by the end of the 5-second period but does not hit bed. 2 = Some effort against gravity; leg falls to bed by 5 seconds, but has some effort against gravity. 3 = No effort against gravity; leg falls to bed immediately. 4 = No movement. UN = Amputation or joint fusion, explain: _____</p>
<p>7. Limb Ataxia</p> <ul style="list-style-type: none">- Finger-nose-finger- Heel-shin	<p>0 = Absent. 1 = Present in one limb. 2 = Present in two limbs. UN = Amputation or joint fusion, explain: _____</p>

NIHSS

8. Sensory	<p>0 = Normal; no sensory loss.</p> <p>1 = Mild-to-moderate sensory loss; patient feels pinprick is less sharp or is dull on the affected side; or there is a loss of superficial pain with pinprick, but patient is aware of being touched.</p> <p>2 = Severe to total sensory loss; patient is not aware of being touched in the face, arm, and leg.</p>

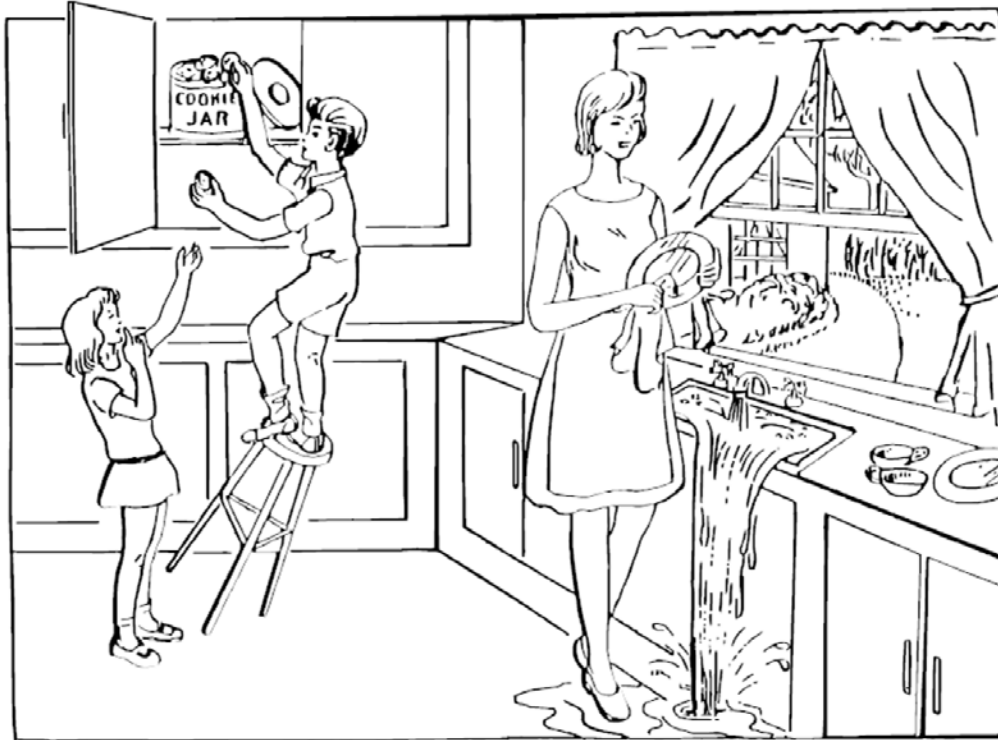
NIHSS

9. Best Language	<p>0 = No aphasia; normal.</p> <p>1 = Mild-to-moderate aphasia; some obvious loss of fluency or facility of comprehension, without significant limitation on ideas expressed or form of expression. Reduction of speech and/or comprehension, however, makes conversation about provided materials difficult or impossible. For example, in conversation about provided materials, examiner can identify picture or naming card content from patient's response.</p> <p>2 = Severe aphasia; all communication is through fragmentary expression; great need for inference, questioning, and guessing by the listener. Range of information that can be exchanged is limited; listener carries burden of communication. Examiner cannot identify materials provided from patient response.</p> <p>3 = Mute, global aphasia; no usable speech or auditory comprehension.</p>

NIHSS

10. Dysarthria	<p>0 = Normal.</p> <p>1 = Mild-to-moderate dysarthria; patient slurs at least some words and, at worst, can be understood with some difficulty.</p> <p>2 = Severe dysarthria; patient's speech is so slurred as to be unintelligible in the absence of or out of proportion to any dysphasia, or is mute/anarthric.</p> <p>UN = Intubated or other physical barrier, explain: _____</p>
11. Extinction and Inattention (formerly Neglect)	<p>0 = No abnormality.</p> <p>1 = Visual, tactile, auditory, spatial, or personal inattention or extinction to bilateral simultaneous stimulation in one of the sensory modalities.</p> <p>2 = Profound hemi-inattention or extinction to more than one modality; does not recognize own hand or orients to only one side of space.</p>

NIHSS



You know how.

Down to earth.

I got home from work.

**Near the table in the dining
room.**

**They heard him speak on the
radio last night.**

NIHSS



MAMA

TIP – TOP

FIFTY – FIFTY

THANKS

HUCKLEBERRY

BASEBALL PLAYER

NIHSS Tools

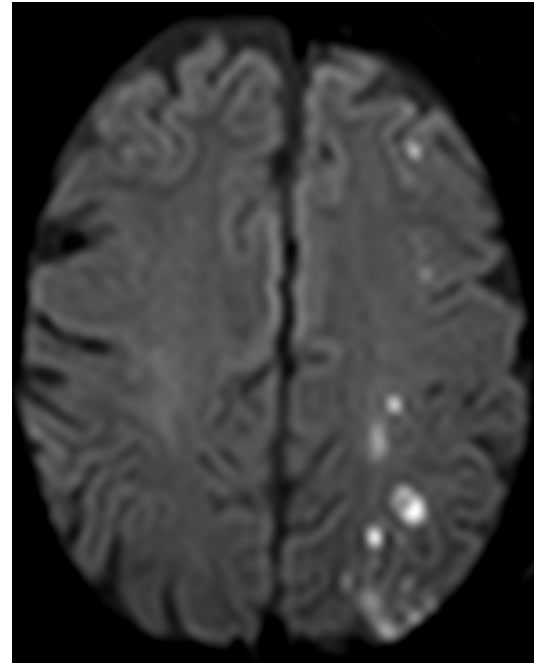
- <https://www.stroke.nih.gov/>
- <http://nihss-english.trainingcampus.net/>

ISCHEMIC STROKE SUBTYPES

More than the Basics

Extracranial Atherosclerotic Disease

- Involves carotid or vertebral arteries
- Stroke Mechanism
 - Artery to artery embolism
 - Acute occlusion of artery from plaque rupture
 - Reduced cerebral perfusion/flow-related
- Variable clinical presentation

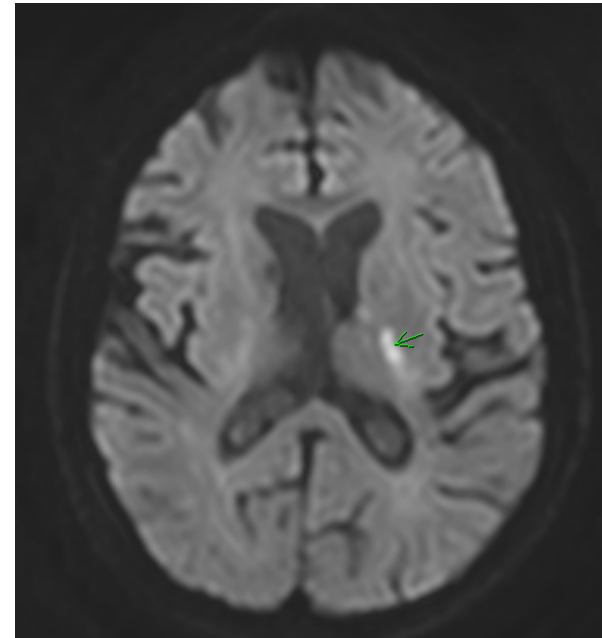


MRI of a 72 yo man with hypertension, tobacco use, internal carotid artery stenosis, carotid bruit, presenting with right-sided weakness and aphasia

Furie et al, *Stroke*. 2011;42:227-276

Small Vessel Disease

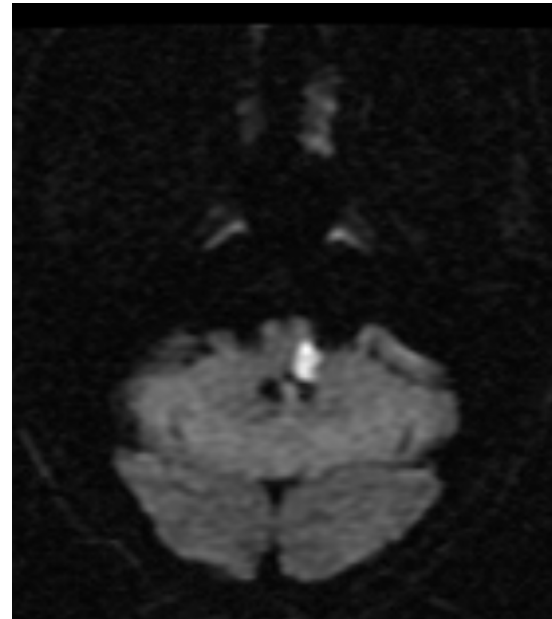
- Cause of small subcortical or “lacunar” strokes
- Mechanism of stroke
 - Occlusion of small deep penetrating end-arteries
 - Related to lipohyalinosis and microatheroma formation
- May have classic presentation
 - Pure motor / hemiparesis
 - Pure sensory stroke
 - Ataxic hemiparesis
 - Dysarthria/ clumsy hand
 - Mixed sensory/ motor



55 year old woman with hypertension and diabetes presenting with right arm and leg weakness

Intracranial Atherosclerosis

- Atherosclerosis in major intracranial vessels
 - Includes internal carotid, middle cerebral, vertebral, basilar, etc
- Mechanism of Stroke
 - Artery to artery embolism
 - Decreased perfusion related to limitation of flow
 - Acute plaque rupture and vessel occlusion
- Variable clinical presentation



57 year old man with hypertension and poorly controlled diabetes, p/w left facial weakness, dysarthria, unsteadiness, with vertebral and basilar artery atherosclerosis

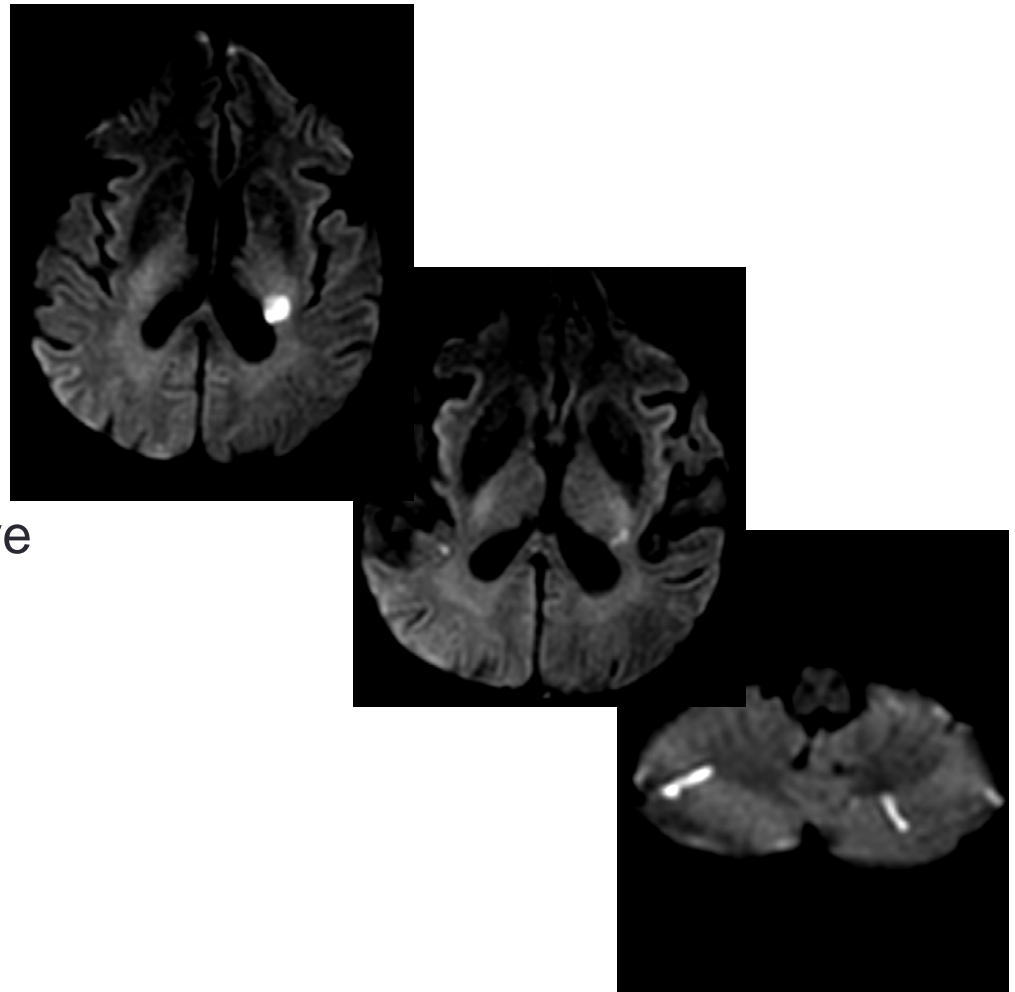
Cardioembolic Stroke

- Source

- Atrial fibrillation
- MI related left ventricular thrombus
- Cardiomyopathy
- Right to left shunt
- Thrombus formation on native or prosthetic valve
- Endocarditis
- Aortic arch disease

- Infarct appearance

- Multiple vascular territories
- Single vascular territory



Other Causes:

- Hypercoagulable States
 - May be associated with embolic appearing stroke or stroke in young
 - Antiphospholipid antibodies
 - Inherited Thrombophilias
 - Factor V Leiden mutation, prothrombin gene mutation, others
 - Malignancy
 - Pregnancy
- Carotid or vertebral artery dissection
- Cerebral venous sinus thrombosis
- Sickle Cell Disease
- Infectious or Inflammatory vasculopathies
- Autoimmune conditions with or without vasculitis
 - Sjogren's syndrome, Lupus

INPATIENT MANAGEMENT

Ischemic Stroke

Code Stroke at Memorial Hermann

- Acute onset of stroke symptoms in your patient
- **Dial 44444 or the operator to activate a “Code Stroke”**
- At the bedside, establish time of last seen normal with the help of nursing staff
- Gather other pertinent information, like medication list, kidney function, coagulation studies
- Stroke team will arrive to assess the patient
 - Stroke team consists of a fellow, senior resident and junior resident, sometimes medical students

Code Stroke at LBJ

- Acute onset of symptoms in your patient
- **Activate a rapid response first AND Code Stroke by calling 37800**
- Give a call back number for the neurology resident to reach you
- The rapid response team will come to the bedside, including the attending or hospitalist (if after hours) and charge nurse
- The on-call neurology resident will return your page, but is not always in-house

Acute Treatment

INTRAVENOUS TPA

- Proven effective treatment of ischemic stroke up to 4.5 hours after onset of symptoms
 - There are additional contraindications for the 3 to 4.5 hour time window
- Patients receiving tPA have increased likelihood of having minimal or no disability at 3 months
- Despite efficacy, fewer than 5% of individuals with ischemic stroke receive tPA. Many patients present out of the time window.

Acute Treatment

INTRAVENOUS TPA

- tPA Exclusion Criteria:
 - SBP >185 mmHg or DBP >110 mmHg
 - Stroke/head trauma in previous 3 months
 - Symptoms suggest SAH
 - Recent intracranial or intraspinal surgery
 - Previous intracranial hemorrhage
 - Intracranial neoplasm, AVM or aneurysm
 - INR >1.7
 - aPTT >40 sec
 - Platelet count <100K
 - Use of oral anticoagulant – direct thrombin inhibitors or direct factor Xa inhibitors
 - Serum glucose <50
 - Active bleeding or acute trauma
 - Non-compressive arterial puncture in last 7 days

Acute Treatment

INTRAVENOUS TPA

- tPA Relative Exclusion Criteria:
 - Only minor or rapidly improving stroke symptoms
 - Pregnancy
 - Seizure at onset with postictal residual neurological impairments
 - Major surgery or serious trauma within previous 14 days
 - Recent GI or urinary tract hemorrhage in previous 21 days
 - Recent MI within previous 3 months

Acute Treatment

MECHANICAL THROMBECTOMY

- Several RCTs have demonstrated efficacy of mechanical thrombectomy with *stent retrievers* at improving 90 day outcomes
- Intra-arterial thrombectomy (IAT) should be considered for all patients presenting with acute ischemic stroke and large vessel occlusion within 6 hours of symptom onset
- After two recent studies (DAWN and DEFUSE-3), IAT should also be considered when last seen normal is 6 – 24 hours in carefully selected patients
- All patients who are eligible should also receive tPA within the 4.5 hours time window

Initial Evaluation and Management

- CT head when patient arrives to ED or as soon as possible inpatient
 - Rule out hemorrhage
 - Changes from ischemic stroke may not be evident for several hours
- Blood vessel imaging
 - CTA head and neck
 - MRA head and neck (usually with MRI brain)
 - Carotid doppler/ TCD if renal function precludes above
- Determine eligibility for tPA and IAT
 - Call stroke and endovascular teams
- Blood pressure management
 - Control BP < 185/110 with IV medication prior to tPA administration
 - Permissive hypertension (220/100) if not administering tPA

Evaluation and Management

- MRI brain
 - Determine extent and pattern of infarct
 - Better evaluate prior ischemic / hemorrhagic insults
- Laboratory Studies
 - Fasting lipid panel, HgbA1c
 - TSH / Free T4 if atrial fibrillation
 - Hypercoagulable / inflammatory studies in select patients
- Cardiac Studies
 - Cardiac monitoring (at minimum 24 hours) for atrial fibrillation
 - Transthoracic ECHO with bubble to assess for PFO
 - Transesophageal ECHO if TTE negative for select patients

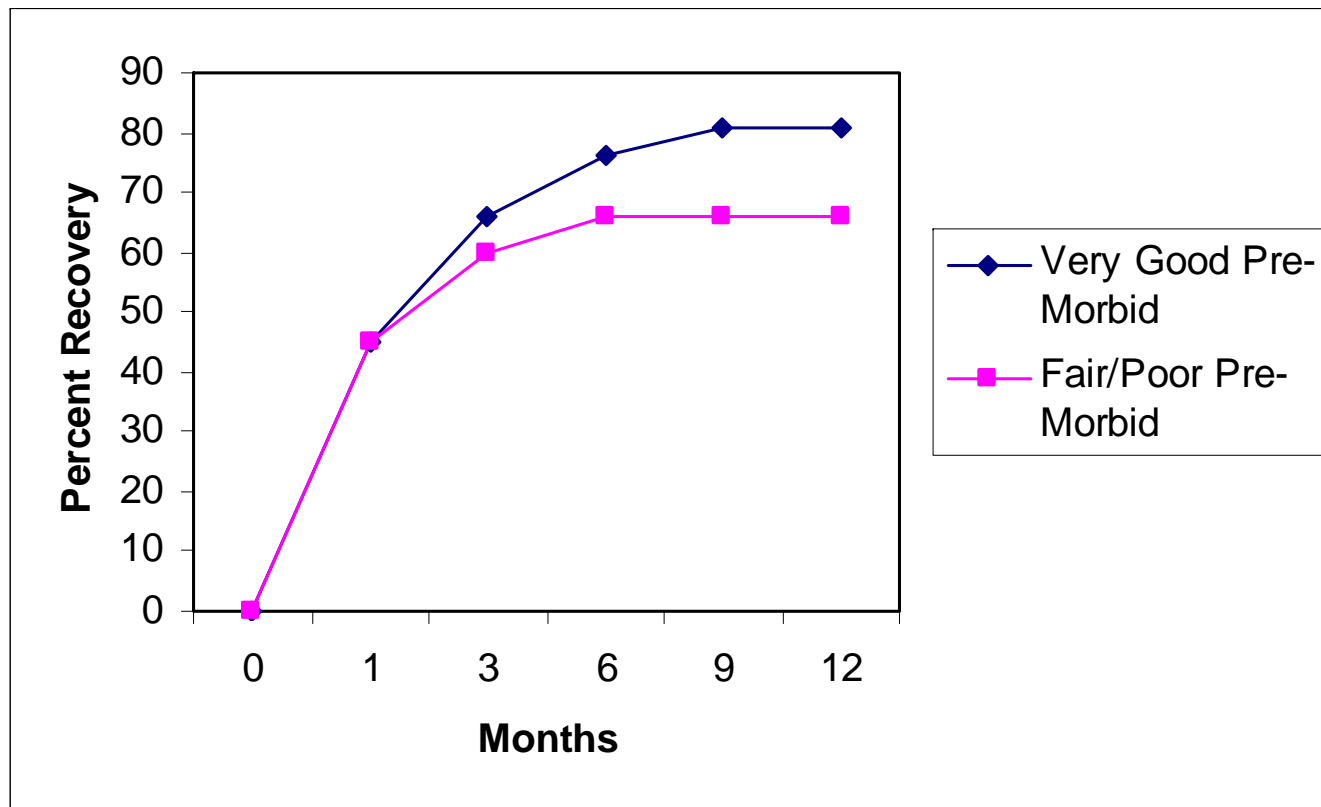
Medications

- Antiplatelets
 - aspirin, clopidogrel, aspirin-dipyridamole
 - Held for 24 hours post-tPA
- Anticoagulation
 - Typically held for one to two weeks after stroke
 - Initiated in the hospital for certain conditions
- High-intensity statin therapy
 - Atorvastatin 40 - 80mg
 - Rosuvastatin 20 - 40mg
- Long-acting anti-hypertensives
 - Initiation at 24 hours
 - BP reduction may be delayed in certain patients

Rehabilitation

- **Physical therapy and Occupational Therapy Evaluation**
 - Evaluate inpatient and long-term therapy needs
- **Speech/ Language evaluation**
 - Evaluation of swallowing function
 - Evaluation of aphasia
 - Evaluation of cognitive deficits
 - Determine inpatient and long-term therapy needs
- **Neurorehabilitation evaluation**
 - Physician specialist may be needed to help determine therapy needs

Recovery Curve



Discharge

- **Disposition**

- Inpatient rehabilitation
- Skilled nursing facility
- Home with Home Therapy
- Home with Outpatient Therapy
- Home without therapy needs

- **Additional Workup**

- May be sent with 30 day monitor to assess for paroxysmal atrial fibrillation if etiology not determined

INPATIENT MANAGEMENT

Hemorrhagic Stroke

Initial Evaluation and Management

- Airway/Breathing/Circulation
- CT head
- Blood pressure management
 - Control Blood Pressure: **SBP < 140 mmHg**
- Reverse Coagulopathy
 - Platelets for thrombocytopenia
 - Prothrombin complex concentrate/Vitamin K for Warfarin related ICH
 - Prothrombin complex concentrate/dabigatran antidote for NOAC related ICH
- Laboratory Studies
 - CBC, CMP, Coags, Urine Toxicology

Evaluation and Management

- Neurosurgery Consultation
 - External Ventricular Drain
 - Clot evacuation/ Decompression
 - Aneurysm clipping or coiling
 - AVM embolization or resection
- Blood vessel imaging
 - CTA head / MRA head
 - CTV head (sinus thrombosis)
- Other Studies
 - MRI Brain for selected patients
 - Cerebral Angiogram

CASES

Case 1

Patient is a 55 year old man with PMH of smoking and alcohol abuse and has not seen a physician in over 10 years who presented with right face, arm, and leg numbness. NIHSS is 2 (for sensory changes and mild dysarthria) on presentation. He was last seen normal 6 hours ago. Initial CT brain is negative. Blood pressure is 196/85, HR is 75.

What do you do next?

Case 1

He did not receive tPA because he was out of window. His NIHSS is also very low.

He is given an aspirin on admission. Blood pressure remains in 180's-190's systolic.

He is found to have a small left thalamic ischemic infarct on MRI. CTA of the head and neck shows mild atherosclerotic disease.

What other work up do you need?

Case 1

Transthoracic echocardiogram shows EF 60-65%, moderate LVH, no PFO. LDL is 110, HgbA1c is 5.0.

He is evaluated by physical therapy and occupational therapy and cleared for discharge home independently.

What medications would you start him on?

You discharge him with aspirin, atorvastatin 80 mg daily, and Lisinopril for his hypertension. You counsel him on smoking cessation.



Case 1

Stroke etiology?

Likely small vessel disease.

Case 2

Patient is a 65 year old man with history of HTN who presents with acute onset aphasia and right hemiparesis. He was last seen normal within 3 hours of symptom onset. NIHSS on initial evaluation is 12 (facial droop - 1, dysarthria -1, right sided paresis - 7, aphasia - 1, sensory - 1). Blood pressure is 175/85, HR is 80. The patient has no exclusions for tPA therapy. Head CT is negative for hemorrhage, and he receives IV tpA.

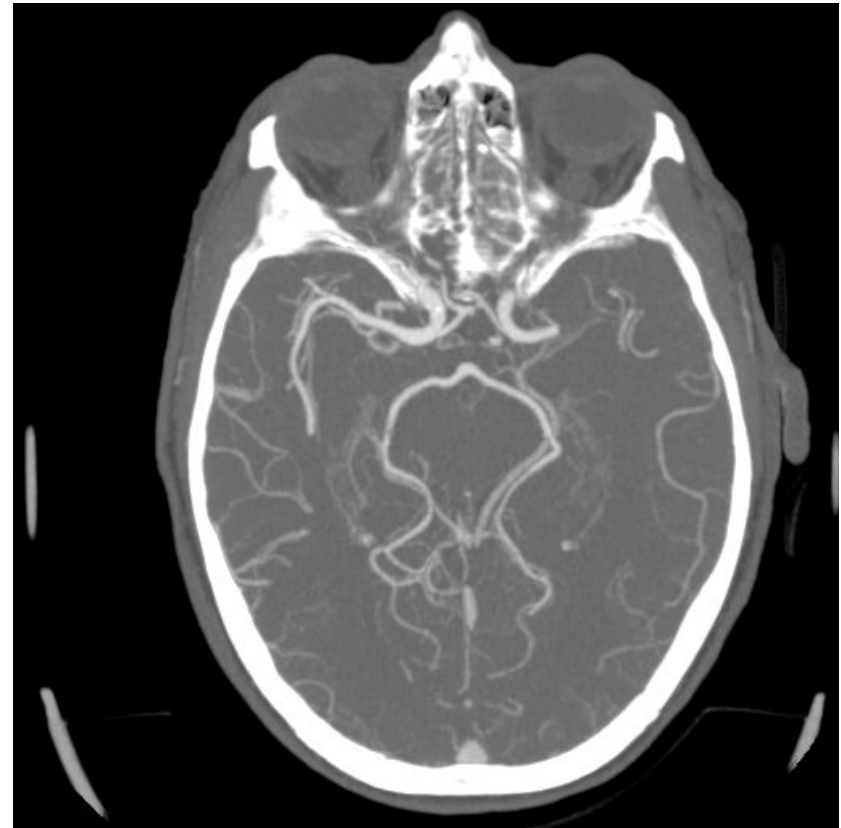
CTA shows proximal left M1 (middle cerebral artery) occlusion so he goes for IA thrombectomy.

Case 2

CT



CTA



Case 2

IAT is successful, and symptoms improve rapidly to NIHSS 2.

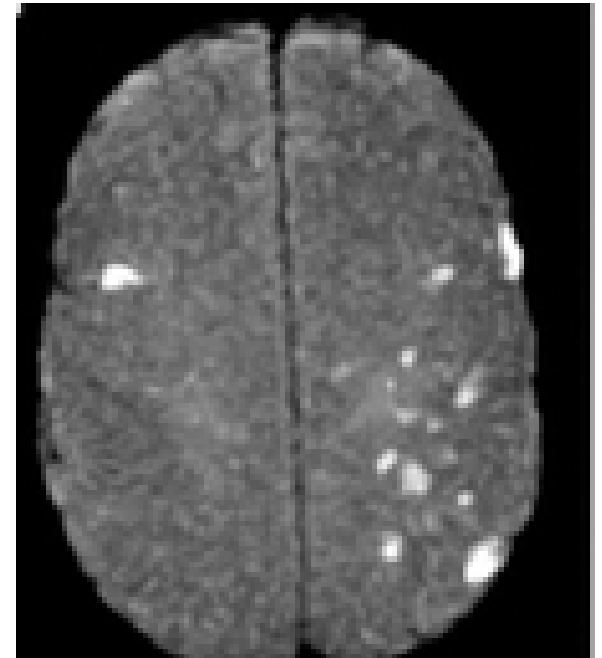
MRI shows embolic appearing stroke in left MCA distribution as well as small stroke in right MCA distribution.

What is the next important work up for this patient? What are you concerned about?

He undergoes further hospital workup:

- Cardiac Telemetry (48 hours)
- TTE and TEE – EF is 55%, no PFO, no thrombus, but LA is enlarged
- Lipid panel shows LDL is 140
- HgbA1c is 5.9

He is discharged home on aspirin, atorvastatin 80 mg, lisinopril 20mg.



Case 2

He presents to clinic for follow-up 2 weeks after discharge.

He inquires about further testing.

What do you recommend?

Case 2

You order event monitor and the following week, you are notified that he has atrial fibrillation.

His CHADS₂Vasc Score is 4, suggesting > 4% risk of stroke per year.

What is your next step in management?


- A. Continue aspirin since it is early to start anticoagulation
- B. Repeat CT and start anticoagulation if no hemorrhage
- C. Start anticoagulation now



Case 2

Stroke etiology?

Cardioembolic.

- 
- Questions?
 - Thank you for your attention!