

AALNC Annual Forum 2024  
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# Emergency Department Evaluation and Management of Acute Stroke

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## Conflict of Interest Disclosure

• I, Jacob Kleinman, MD FACEP, certify that, to the best of my knowledge, no affiliation or relationship of a financial nature with a commercial interest organization has significantly affected my views on the subject which is being presented.

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## Learner Outcomes/Objectives

- To understand the prevalence and impact of acute stroke
- To understand the common types and presentation of acute stroke
- To understand the appropriate Emergency Department (ED) evaluation of acute stroke
- To understand the candidates for, and spectrum of, acute stroke treatment options

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### What is a stroke?

- Vascular condition that disrupts blood flow to the central nervous system, causing neuronal cell injury or death and neurologic impairment.
- Two main types: either ischemic (87%) or hemorrhagic (13%)

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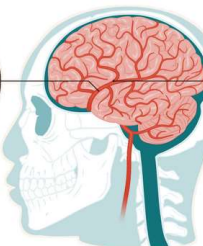
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### Ischemic vs hemorrhagic strokes



**Ischemic stroke:**  
Blood clot blocks blood flow to part of the brain



**Hemorrhagic stroke:**  
Artery ruptures, causing bleeding around the brain

Image credit: Healthline

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### Hemorrhagic strokes

- Intracranial bleeding leading to
  - Compression of brain tissue or
  - Decreased cerebral flow from injured arteries
- Common causes:
  - Trauma
  - Aneurysms
  - Hypertension
  - Vascular malformations/tumors



Image credit: Radiopaedia.org

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### Ischemic Strokes

- Strokes caused by occlusion of cerebral arteries
- Brain tissue with decreased blood flow becomes injured and then dies
- Causes of blockages:
  - Native atherosclerosis/thrombi
  - Traveling embolic clots
  - Tearing or "dissection" of arteries




Image credit: Radiopaedia.org

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### TIA vs stroke

- Transient Ischemic Attack (TIA or "mini stroke")
  - Transient episode of neurologic dysfunction caused by focal brain ischemia, without acute infarction
  - Typical symptoms last for < 24 HRs
  - Risk of stroke ~10% at 2 days, ~13% at 30 days, and ~17% at 90 days
    - Should be admitted to search for cause and initiate secondary prevention
- Stroke
  - Stroke defined by infarction of brain tissue
  - Typical symptoms last for > 24 HRs

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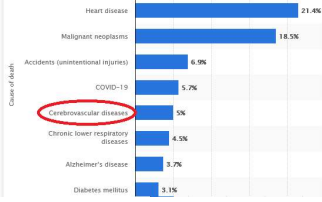
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### Why is this important?

- Approx. 800,000 cases per year in US
- A leading cause of death & disability
  - In hospital mortality:
    - 5% to 10% for ischemic stroke
    - 40% to 60% for hemorrhagic stroke
  - 10-15% of survivors recover completely
  - 30-35% recover with minor impairments
  - 40-45% recover with moderate to severe impairments
- Estimated healthcare cost of \$46 billion
- A leading cause of referral for med-mal review

**leading causes of death in the US in 2022**



Cause of death	Percentage
Heart disease	21.4%
Malignant neoplasms	18.5%
Accidents (unintentional injuries)	6.9%
COVID-19	5.7%
Cerebrovascular disease	5%
Chronic lower respiratory diseases	4.5%
Alzheimer's disease	3.7%
Diabetes mellitus	3.1%

Data source: CDC

Cause of death

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### How do stroke patients present?

## Spot a Stroke: BE FAST

B	E	F	A	S	T
<b>BALANCE</b>	<b>EYES</b>	<b>FACE</b>	<b>ARM</b>	<b>SPEECH</b>	<b>TIME</b>
Does the person have a sudden loss of balance or coordination?	Is your loved one experiencing double vision or are they unable to see out of one eye?	Is one side of the face drooping? Ask the person to smile.	Does one arm drift downward? Have the person raise both arms in the air.	Is he or she slurring their speech or having difficulty getting the words out right? Have the person repeat a simple phrase.	<b>Time to act!</b> Call 9-1-1 and get the person to a certified stroke center immediately.

Image credit: St. Mary's Health System

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### How do stroke patients present?

- Symptoms depend on part of brain becoming ischemic
- Anterior Circulation
  - Unilateral numbness or weakness
  - Difficulty Speaking
- Posterior circulation
  - Dizziness/Difficulty walking

Image credit: Neuppy

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### How do we evaluate stroke patients in the Emergency Department?

- Should be evaluated rapidly, **time is brain!**
- Most EMS systems have protocols for advance notice of impending arrival to EDs
- Most hospitals have "stroke/neuro alert" protocols
  - Allows for assembling appropriate team of providers with stroke training
  - Allows for more rapid evaluation of acute stroke patients

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### How do we evaluate stroke patients in the Emergency Department?

- History
- Exam
- Diagnostic testing
- Consultations
- Treatment

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### Important goals of history

- Differentiate stroke from other causes of neuro changes:
  - seizures, syncope, migraine, hypoglycemia
- Establish “Last Known Well Time” or “LKWT”
  - Often involves information from family/paramedics/etc.
  - Critical for determining eligibility for treatment
- Assess for allergies to contrast/treatments
- Assess for contraindications for treatment

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### Acute stroke physical exam

- Orientation
  - Person, Place, Time, Situation
- National Institute of Health Stroke Scale (NIHSS)
- Posterior circulation testing
  - Nystagmus
  - Test of skew
  - Finger-to-nose/heel-to-shin
  - Romberg/truncal ataxia
  - Ambulation

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### Types of CT Scans

- Non-contrast CT
- CT Angiogram
- CT perfusion

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### Non-contrast Head CT

- Performed rapidly after patient arrival
- Very sensitive in ruling out hemorrhage
- Cannot rule out acute ischemic stroke
- Typically no evidence until ~6-24 HRs post stroke
- Only imaging used in initial tPA trials, and only imaging required to initiate thrombolytic treatment



Image credit: Dr. Frank Gaillard

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### Non-contrast Head CT

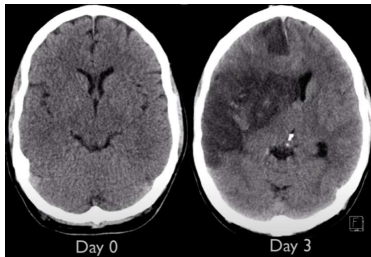


Image credit: Dr. Frank Gaillard

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### CT Angiogram (CTA)

- CT performed with IV contrast to evaluate for blood vessel occlusions or dissections
- Can be performed stat at most facilities
- Critical to help determine candidates for endovascular treatment
- Should be performed stat on all patients presenting with disabling symptoms within 24 HRs of LKWT

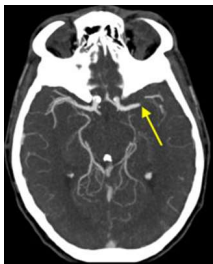


Image credit: Department of Radiology, St Vincent's University Hospital

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### CT Perfusion

- Enables differentiation of salvageable ischemic brain tissue (the penumbra) from irrevocably damaged infarcted brain (the infarct core)
- Helps determine candidates for endovascular treatment
- Available in most advanced stroke centers
- If available, should be performed on all patients presenting with disabling symptoms within 24 HRs of LKWT

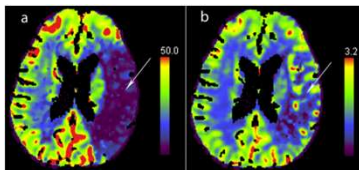


Image credit: Dr. Jackson Liang

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### Magnetic resonance imaging (MRI)

- More sensitive for acute stroke
- Changes seen within minutes
- Time consuming
- Limited availability
- Not required in ED evaluation of acute stroke
- More often performed inpatient

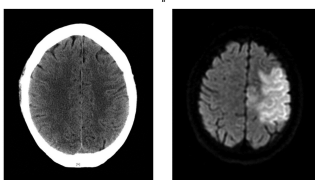


Image credit: The Journal of Emergency Medicine

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### Consultations

- Hemorrhagic stroke
  - Neurosurgery
- Ischemic stroke
  - Neurology
    - Only needed in ED if patient is patient is within time window for urgent treatment
    - Often performed with use of telemedicine
  - Stroke interventionalist
    - If endovascular treatment indicated

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### Hemorrhagic stroke treatment options

- Urgent neurosurgical consultation
- Reversal of anticoagulation
- Control of blood pressure
- Drain placement/surgical evacuation when appropriate
- Deadly: 40-60% in-hospital mortality
- Fewer med/mal cases
  - More obvious presentations
  - Fewer treatment options

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### Ischemic Stroke treatment options

- Thrombolytics
  - tPA/TNK
- Endovascular treatment
  - Mechanical clot retrieval
- Antiplatelet agents
  - Aspirin/Plavix
- Risk factor modification
  - BP control, statins, etc.

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### What are thrombolytics?

- “Clot-busting” drugs that break up and dissolve blood clots
- Enzymes that kick off the process of breaking down proteins (fibrins) that form clots
- Common thrombolytics:
  - tPA (alteplase) vs. TNK (Tenecteplase)

Image credit: American Journal of Emergency Medicine

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### tPA vs TNK

	Alteplase (tPA)	Tenecteplase (TNK)
Mechanism	Recombinant version of naturally occurring enzyme	Bioengineered variant of tPA, increased specificity to fibrin and more resistant to degradation
Effectiveness	Similar	Similar
Safety	Similar	Similar
Preparation	Complex, ~ 5 minutes	Simple, ~1-2 minutes
Administration	60 min (IV bolus + infusion)	5-10 seconds (IV bolus)
Cost	~\$8300/dose	\$6100/dose
FDA Approval	FDA approved	Not FDA Approved, may be “reasonable to choose” per 2018 AHA stroke guidelines

Image credit: American Journal of Emergency Medicine

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### Candidates for Thrombolytics

- Stroke patients with disabling symptoms (typically NIHSS > 5)
- Considered in NIHSS <5, if symptoms considered disabling
  - deficits judged to interfere with ADLs or to prevent return to work
- Last known well time (LKW) within 3-4.5 hours of treatment

**Absolute Contraindications to tPA**

- Ischemic stroke, head trauma, or neurosurgery (intracranial or intraspinal) within previous 3 months
- Previous intracranial hemorrhage
- Active internal bleeding
- Intracranial neoplasm, AVM, or aneurysm
- SBP > 185mmHg or DBP > 110mmHg
- Platelet count < 100,000/mm<sup>3</sup>
- Therapeutic anticoagulation
- Arterial puncture at noncompressible site within the past 7 days

Image credit: Dr. Eric Strong

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### Candidates for Thrombolytics

- Treatment within 3-4.5 hours of LKWT
- LKWT is *not* the time symptoms were discovered
- Earlier that treatment is initiated, the greater the benefit
- ~5-20% of stroke patients will be candidates

Management Component	Target Time Frame
Door to doctor	10 min
Door to CT completion	25 min
Door to CT scan reading	45 min
Door to treatment	60 min
Access to neurologic expertise <sup>a</sup>	15 min
Access to neurosurgical expertise <sup>a</sup>	2 h

<sup>a</sup> By phone or in person.  
Image credit: Rosen's Emergency Medicine

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### Risks of Thrombolytics

- Obtaining consent important
- Symptomatic intracranial hemorrhage: ~6%
- Major systemic hemorrhage: ~2%
- Angioedema: ~5%

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### Thrombolytics: How effective are they?

- Controversy in the emergency medicine/neurology communities due to mixed results in literature
  - Has become the standard of care
- FDA approval of tPA based on NINDS trial published in 1995
  - At 3 months patients treated with tPA were at least 30% more likely to have minimal or no disability (mRS 0-2)
- TNK has similar results

0	No symptoms
1	No significant disability. Able to carry out all usual activities, despite some symptoms.
2	Slight disability. Able to look after own affairs without assistance, but unable to carry out all previous activities.
3	Moderate disability. Requires some help, but able to walk unassisted.
4	Moderate/severe disability. Unable to attend to own bodily needs without assistance, and unable to walk unassisted.
5	Severe disability. Requires constant nursing care and attention, bedridden, incontinent.
6	Dead

Image credit: Dr. Claudio Sandroni

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### Endovascular Thrombectomy (EVT)

- Procedure involves insertion of a catheter into an artery (in groin or wrist) and guided up to the site of blocked artery in the brain
- Device called a stent retriever is used to capture and remove the blood clot, restoring blood flow to the affected area of the brain
- 10-15% of stroke patients are candidates
- Timely access is limited:
  - Only ~300 EVT capable centers in US
  - ~20% of the US population live within 15 mins
  - ~50% of the US population live within 60 mins

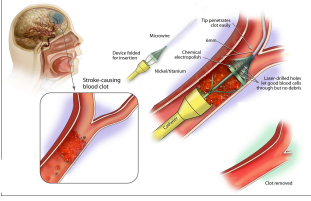


Image credit: US National Science Center

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### Candidates for Endovascular Therapy

- Strokes caused by large vessel occlusions (LVO)
  - Strong evidence for tx of anterior circulation occlusions (ICA, MCA, ACA)
  - Moderate evidence for posterior circulation occlusion (basilar artery)
- Disabling stroke symptoms with NIHSS > 6
- LKWT < 24 HRs
- Ideally with reassuring CT perfusion imaging
  - Small irreversible core infarction compared to size of the salvageable ischemic penumbra
- Can be performed after thrombolytics
- ~10-20% of stroke patients will be candidates

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### Risks of Endovascular Therapy

- ~5% risk of new ischemic stroke in a different vascular territory within 90 days of treatment
- Small risk of access site hematoma and pseudoaneurysm, arterial perforation
- Small risk of transient intraprocedural vasospasm
- Most recent data shows no significant increased rates of symptomatic intracranial hemorrhage

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### Efficacy of Endovascular Therapy

- As with thrombolytics, the earlier that treatment is initiated, the greater the benefit
- 0-6 hrs from LKWT: Meta-analysis shows functional independence (i.e., a 90-day mRS of 0 to 2) significantly greater for EVT vs control (46% vs 27%)
- 6-24 hrs from LKWT: Similar results (45.9% versus 19.3%)

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### Antiplatelet Agents

- Predominantly geared to secondary prevention (preventing recurrent stroke)
- Do not treat current stroke
  - Can be started inpatient, not required by standard of care in ED
- Aspirin
  - Given within 24-48 hours of stroke presentation to reduce risk of early recurrent stroke
  - For patients with low risk TIA (ABCD<sup>2</sup> score <4) or moderate to severe stroke (NIHSS >3)
  - Impact is small
    - 2.8% vs 3.9% risk recurrent stroke within 14 days
    - NNT 79 to prevent death/dependency from recurrent stroke
- Dual antiplatelet therapy (DAPT) with clopidogrel (Plavix) added to Aspirin
  - Given within 24 hours of stroke to reduce recurrent stroke
  - Added to aspirin for high risk TIA (ABCD<sup>2</sup> score ≥4), & mild stroke (NIHSS ≤3)
  - 4.4% vs 6.3% risk recurrent stroke within 90 days compared to aspirin alone

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### Anticoagulation (IV Heparin/IM Lovenox/Warfarin/DOACs)

- Recommended for TIA patients with clear indication (atrial fibrillation, venous thromboembolism, mechanical heart valve)
- Otherwise not recommended for treatment of acute stroke by AHA/ASA guidelines
  - No clear benefit in preventing early recurrent stroke, halting neurological worsening, or improving outcomes after stroke

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### Risk factor Modification

- Blood pressure control
  - Should be kept to under 185/110 for thrombolytic patients
  - Otherwise permissive hypertension allowed up to 220/120 mm Hg for the first 24–48 hours
  - After 48 hours, tighter control to prevent future strokes
- Further interventions initiated as inpatients typically
  - DVT prophylaxis
    - Intermittent pneumatic compression should be added for immobile patients
    - Benefit of prophylactic heparin/lovenox unclear
  - Statins
    - Should be started “in-hospital” for patients without contraindications
  - Smoking cessation/Diet/Lifestyle changes

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### Case #1

- A 75-year-old man presents to the Emergency Department with right arm and leg weakness and numbness. LKWT was 2 hours before arrival. NIHSS is 8. No large vessel occlusions seen on CT scan.

What urgent treatment is likely indicated?

- A. Thrombolytics only
- B. Thrombolytics + Endovascular treatment
- C. Endovascular treatment only
- D. None, admit for work-up and initiation of secondary prevention measures

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### Case #2

- A 65-year-old man presents to the Emergency Department with left arm and leg weakness and numbness. LKWT was 3.5 hours before arrival. NIHSS is 10. A large vessel occlusion is seen on CTA.

What urgent treatment is likely indicated?

- A. Thrombolytics only
- B. Thrombolytics + Endovascular treatment
- C. Endovascular treatment only
- D. None, admit for work-up and initiation of secondary prevention measures

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**Case #3**

• A 55-year-old man presents to the Emergency Department with right arm and leg weakness and numbness. He noticed the symptoms when he woke in the am, 8 hours after going to bed. NIHSS is 14. A large vessel occlusion is seen on CTA.

What urgent treatment is likely indicated?

- A. Thrombolytics only
- B. Thrombolytics + Endovascular treatment
- C. Endovascular treatment only
- D. None, admit for work-up and initiation of secondary prevention measures



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**Case #4**

• A 80-year-old woman presents to the Emergency Department with difficulty speaking, left arm and leg weakness and numbness. She was last seen normal by family 30 hours prior. NIHSS is 20. A large vessel occlusion is seen on CTA.

What urgent treatment is likely indicated?

- A. Thrombolytics only
- B. Thrombolytics + Endovascular treatment
- C. Endovascular treatment only
- D. None, admit for work-up and initiation of secondary prevention measures



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**Case #5**

• A 50-year-old man presents to the Emergency Department with difficulty speaking, left arm and leg weakness and numbness. The symptoms lasted for 45 minutes but have since resolved. No large vessel occlusion is seen on CTA.

What urgent treatment is likely indicated?

- A. Thrombolytics only
- B. Thrombolytics + Endovascular treatment
- C. Endovascular treatment only
- D. None, admit for work-up and initiation of secondary prevention measures



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### Questions?

#### How to Reach Me:

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