Code Stroke for Hospital Medicine: Clinical Challenges in Inpatient Care

William J. Hicks II, MD
Co-Director, Comprehensive Stroke Program
Riverside Methodist Hospital
Columbus, OH
What’s the big deal?
WHAT IS STROKE?

- 750,000 cases per year in the US
- 85% are ischemic
- Leading cause of disability
- Fifth Leading cause of death
- 4.5 million stroke survivors alive today
- Costs > $58 billion per year
Recent survey of Americans over 50:

38% didn’t know where strokes occurred in the body

17% couldn’t name *one stroke symptom*

19% felt nothing could be done to prevent a stroke

66% didn’t know time to treatment was important
In-Hospital Strokes

- **Roughly 2-17% of acute strokes**
  - likely under-recognized and under-reported
  - 31,000 to 134,000 strokes each

- Time-to-treatment for in-hospital strokes can be significantly longer compared with strokes that occur outside of the hospital
- Patient morbidity and mortality are also worse
- Factors like recent surgery and acute medical illness may limit the use of thrombolysis and other acute interventions, potentially adversely affect outcomes
- *Potential for rapid diagnosis and treatment*
In-Hospital Strokes

- The 30-day cost for an in-hospital stroke of “average severity” is roughly $17,500.
- Roughly 35,000 - 75,000 in-hospital strokes in the United States each year.
- Lifetime direct and indirect costs for these in-hospital strokes would be approximately $4.9-10.5 billion.
Who are they?
Many patients are there for surgical procedures or cardiac disorders (> 50%)

The stroke subtype is embolic in a large proportion, and there are various possible precipitating mechanisms

Cerebral hypoperfusion, global or focal, is another mechanism of in-hospital stroke

Global hypoxia after cardiac arrest or other states of hypoperfusion can result in diffuse hypoxic injury;

Carotid endarterectomy and cardiac surgery, particularly intra-cardiac procedures.

Arrhythmias, hypotension, and the arterial manipulation, +/- unstable plaque
In-Hospital Strokes

- Stroke is a less frequent complication of general surgery
- Other procedures such as cardiac and cerebral arteriography carry a small but well-recognized risk of stroke
- Interventional therapies, particularly thrombolysis, may still be possible options
- In the postoperative setting, mechanical thrombectomy is feasible and reasonably safe in carefully selected patients
In-Hospital Stroke Risk Factors

- Advanced age,
- Long-duration cardiopulmonary bypass,
- Recent myocardial infarction,
- Left-sided coronary-artery disease,
- Repeat cardiac surgery,
- Ventricular thrombus,
- Post-infarction angina,
- Cardiac failure,
- Diabetes,
- Smoking,
- Impaired renal function, fever, dehydration.
The risk factor most consistently linked with perioperative stroke is a previous history of stroke.
In-Hospital Strokes

- Most studies of in-hospital strokes have found a predominance of *ischemic stroke*
- *withdrawal of antithrombotic therapy*, noted in more than a quarter of all patients with in-hospital stroke
- Specific groups such as recipients of bone-marrow transplants have more hemorrhagic strokes, (up to 39% in one series) related to coagulopathy or thrombocytopenia
Median age was 73 years

53% occurred in women

49% were on antiplatelet therapy, and 17% were on anticoagulation before admission

The median National Institute for Health Stroke Severity (NIHSS) score was 9, which was more than twice the median severity for strokes from the community

Admitting diagnosis: cardiovascular (24%), neurology/neurosurgery (15%), hematology/oncology (8%), orthopedic/trauma (7%), gastrointestinal (7%), and respiratory (5%)
Factors hindering recognition and assessment

- Misdiagnosis
- Medication effect; brainstem stroke interpreted as effect of anesthetics, sedatives
- Aphasia interpreted as confusion
- Lack of urgent referral or review/Lack of resources
- Referring team not familiar with assessment of patients with acute stroke
- Referring team not aware of potential interventions
- Lack of facilities for urgent stroke assessment and treatment (triage)
Diagnosis
# Time Is Brain—Quantified

Jeffrey L. Saver, MD

## Estimated Pace of Neural Circuitry Loss in Typical Large Vessel, Supratentorial Acute Ischemic Stroke

<table>
<thead>
<tr>
<th></th>
<th>Neurons Lost</th>
<th>Synapses Lost</th>
<th>Myelinated Fibers Lost</th>
<th>Accelerated Aging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per Stroke</td>
<td>1.2 billion</td>
<td>8.3 trillion</td>
<td>7140 km/4470 miles</td>
<td>36 y</td>
</tr>
<tr>
<td>Per Hour</td>
<td>120 million</td>
<td>830 billion</td>
<td>714 km/447 miles</td>
<td>3.6 y</td>
</tr>
<tr>
<td>Per Minute</td>
<td>1.9 million</td>
<td>14 billion</td>
<td>12 km/7.5 miles</td>
<td>3.1 wk</td>
</tr>
<tr>
<td>Per Second</td>
<td>32 000</td>
<td>230 million</td>
<td>200 meters/218 yards</td>
<td>8.7 h</td>
</tr>
</tbody>
</table>
POSSIBLE STROKE SYMPTOMS

+ Decreased level of consciousness or unexplained coma
+ Aphasia (nonsensical speech, or word finding difficulty)
+ Visual field cut of one side
+ Neglect of one side of the body
+ Eye deviation to one side
+ Varying degrees of unilateral weakness and/or numbness
+ Stroke syndrome requiring intubation
+ Crossed symptoms-reports of weakness or numbness on one side of the body opposite from a facial droop
+ Double vision especially with skew deviation of eyes
+ Isolated loss of vision in one visual field
+ Fluctuating level of consciousness
+ Vertigo (especially > 50 years with history of vascular/risk factors)
+ Isolated slurred speech
+ Unsteadiness
+ Facial numbness
before

AFTER
## NIH Stroke Scale

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Level of Consciousness</td>
<td>0-3</td>
</tr>
<tr>
<td>1b</td>
<td>LOC Questions</td>
<td>0-2</td>
</tr>
<tr>
<td>1c</td>
<td>LOC Commands</td>
<td>0-2</td>
</tr>
<tr>
<td>2</td>
<td>Best Gaze</td>
<td>0-2</td>
</tr>
<tr>
<td>3</td>
<td>Best Visual</td>
<td>0-3</td>
</tr>
<tr>
<td>4</td>
<td>Facial Palsy</td>
<td>0-3</td>
</tr>
<tr>
<td>5</td>
<td>Motor Arm Left</td>
<td>0-4</td>
</tr>
<tr>
<td>6</td>
<td>Motor Arm Right</td>
<td>0-4</td>
</tr>
<tr>
<td>7</td>
<td>Motor Leg Left</td>
<td>0-4</td>
</tr>
<tr>
<td>8</td>
<td>Motor Leg Right</td>
<td>0-4</td>
</tr>
<tr>
<td>9</td>
<td>Limb Ataxia</td>
<td>0-4</td>
</tr>
<tr>
<td>10</td>
<td>Sensory</td>
<td>0-2</td>
</tr>
<tr>
<td>11</td>
<td>Neglect</td>
<td>0-2</td>
</tr>
<tr>
<td>12</td>
<td>Dysarthria</td>
<td>0-2</td>
</tr>
<tr>
<td>13</td>
<td>Best Language</td>
<td>0-3</td>
</tr>
<tr>
<td>Likely disabling</td>
<td>Likely non-disabling</td>
<td></td>
</tr>
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<tr>
<td>Dominant cortical hand (NIHSS score 0)</td>
<td>Non-dominant cortical hand without drift (NIHSS score 0)</td>
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Labs

• Only a **blood glucose** that must be measured in all acute stroke patients prior to IV tPA.

• **INR, PTT, platelets**
  
  • *IV alteplase treatment should not be delayed while waiting for hematologic or coagulation testing if there is no reason to suspect an abnormal test.*

• **ECG & troponin are recommended but should not delay initiation of IV alteplase.**
Acute Management

To tPA or not to tPA...
Part 1 - Improvement of 4 or more points on NIHSS or complete resolution of neurologic deficit within 24 hr.

Part 2 – 3 month outcome (BI, mRS, GOS, NIHSS)

Randomized double blind placebo controlled multi-center study

Efficacy of IV t-PA given within 3 hours of stroke onset
NINDS rt-PA Stroke Study Parts 1 and 2
Relation of Time to Treatment to Odds of Ratio of Favorable Outcome

Minutes from Stroke Onset To Start of Treatment

Data From 622 Patients. Odds Ratio of Minimal or No Disability At 3 Months For rt-PA Compared to Placebo-Treated patients. With 95% Confidence Interval. Range of times from 58 to 180 minutes. Mean time to treatment (μ) was 119.7 minutes.
Intravenous (IV) thrombolytic treatment rates for in-hospital stroke range from 2.6% to 11%
In Hospital IV tPA

Two significant differences appear in the literature relating to treatment delivery for this population:

1. **Medical/surgical contraindications** to IV thrombolysis are more common for patients with in-hospital stroke

2. **Time to evaluation and treatment** for in-hospital strokes have significant delays, exceeding quality benchmarks, and are prolonged compared to community-onset strokes.
Patients with in-hospital stroke appropriate for IV tPA appear to get equal benefit compared to patients with community-onset stroke.
tPA do’s

• IV tPA administration **within 3hrs** is equally recommended for adult patients, regardless of age.

• IV tPA treatment in the **3- to 4.5-h** time window is recommended for those patients **≤80 y of age**, **without a history of both diabetes mellitus and prior stroke**, NIHSS score ≤25, **not taking any OACs**, and **without imaging evidence of ischemic injury involving more than one third of the MCA territory**
tPA don’t’s

- Recent severe head trauma (within 3 mo)
- History of intracranial/spinal surgery (within 3 mo)
- History of intracranial hemorrhage and/or signs/symptoms of Subarachnoid hemorrhage
- Structural GI malignancy or recent bleeding event within 21 d of their stroke event should be considered “high risk”
- Platelets <100k, INR >1.7, aPTT >40 s, or PT >15 s
- Treatment dose of LMWH within the previous 24 h
- Use of direct thrombin inhibitors or direct factor Xa inhibitors within 48hrs
- Known endocarditis, intracranial neoplasm, aortic dissection
tPA do’s & don’t’s

- Those with initial glucose levels \(<50 \text{ or } >400 \text{ mg/dL}\) that are subsequently normalized and who are otherwise eligible may be reasonable

- May be reasonable in patients who have a history of warfarin use and an INR \(\leq 1.7\)

- Recent major trauma (within 14d) not involving the head, IV alteplase may be carefully considered, after a risk/benefit analysis
tPA do’s & don’t’s

- Major surgery in the preceding 14 days may be considered, after risk/benefit analysis.
- Concurrent AIS and acute MI, treatment with IV alteplase at the dose appropriate for cerebral ischemia, followed by percutaneous coronary angioplasty and stenting if indicated, is reasonable.
- History of recent MI in the past 3mo, treating the ischemic stroke with IV alteplase is reasonable if the recent MI was non-STEMI.
Mild Strokes, tPA Eligible

- For otherwise eligible patients with mild stroke presenting in the 3-to 4.5-hour window, treatment with IV alteplase may be reasonable.
- Treatment risks should be weighed against possible benefits
- Ok if moderate to severe ischemic stroke and demonstrate early improvement but remain moderately impaired and potentially disabled
- Reasonable in patients with a seizure at the time of onset of acute stroke if evidence suggests that residual impairments are secondary to stroke and not a postictal phenomenon.
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BP & tPA

Should have their BP carefully lowered so that their BP is $<185/110$ mmHg before IV tPA is initiated.
DTN = “door to tPA needle”

- A primary goal of achieving DTN times within 60 minutes in ≥50% of stroke patients treated with IV tPA should be established.

- It may be reasonable to establish a secondary DTN time goal of achieving DTN times within 45 minutes in ≥50% of stroke patients treated with IV alteplase.
Endovascular Thrombectomy
A new device is being used to remove stroke-causing blood clots in brain arteries. How the instrument, called Solitaire Flow Restoration Device, works:

1. Usually starting in the leg, a thin tube is threaded to the area of the clot in the brain; smaller inner tube, containing a stent, is pushed forward through the clot.

2. The inner tube is retracted; as the inner tube is removed, the stent expands into the soft blood clot.

3. A balloon is blown up to block blood flow; suction starts and the stent is pulled back into the tube, taking the clot with it.

Source: St. John Hospital

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Multimodal CT and MRI, including perfusion imaging, should not delay administration of IV alteplase.

For patients who otherwise meet criteria for mechanical thrombectomy, it is reasonable to proceed with CTA if indicated in patients with suspected intracranial LVO before obtaining a serum creatinine concentration in patients without a history of renal impairment.
The DAWN trial

(Clinical Mismatch in the Triage of Wake Up and Late Presenting Strokes Undergoing Neurointervention With Trevo)

- Used clinical imaging mismatch (a combination of NIHSS and imaging findings on CT Perfusion or Diffusion Weighted-MRI) as an eligibility criterion to select patients with large anterior circulation vessel occlusion for mechanical thrombectomy between 6 and 24 hours from last known normal.
- This trial demonstrated an overall benefit in functional outcome at 90 days in the treatment group (mRS score 0–2, 49% versus 13%; adjusted difference, 33%; 95% CI, 21–44; posterior probability of superiority >0.999)
The DEFUSE 3 trial

(Diffusion and Perfusion Imaging Evaluation for Understanding Stroke Evolution)

- Used perfusion-core mismatch and maximum core size as imaging criteria to select patients with large anterior circulation occlusion 6 to 16 hours from last seen well for mechanical thrombectomy.

- This trial showed a benefit in functional outcome at 90 days in the treated group (mRS score 0–2, 44.6% versus 16.7%; RR, 2.67; 95% CI, 1.60–4.48; P<0.0001).
How old is too old?
94 year old female...
94 year old female...
Help?!
Stroke Teams

• Community-onset strokes have a defined point of entry into the system (ED)
• Facilitates rapid evaluation through physical proximity to scanning facilities and a culture of urgency
• More players involved
Stroke Teams

• Any staff member should be capable of directly triggering the alert, and a single alert number provides a simple mechanism to activate the response team.

• Rapid Response team ------ > Stroke Team

• Process map of response for suspected in-hospital strokes.

• In-hospital stroke alerts have a higher rate of false alarms.
  • In an analysis of 6 stroke centers, approximately half of all alerts were for stroke mimics with wide variation in the false alarm rates between hospitals ranging from 28% to 67%.
# Inpatient Stroke Alert

Staff nurse recognizes patient showing signs/symptoms of stroke (Balance, Eyes, Face, Arms, Speech, Time of onset).

<table>
<thead>
<tr>
<th>Bedside staff will:</th>
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</thead>
<tbody>
<tr>
<td>- Obtain an accecheck and vital signs</td>
</tr>
<tr>
<td>- Page Rapid Response nurse (229-2945) who will assess the patient and activate the in-house stroke alert if needed</td>
</tr>
<tr>
<td>- RRT will direct a call to the operator to page In-House Stroke Alert Room, Pharmacy, Phlebotomy and Transport to bedside</td>
</tr>
<tr>
<td>- For In-House Stroke Alerts, the Acute Stroke Response NP will vocera “4 Silver Charge Nurse” if the Stroke Cart is needed.</td>
</tr>
<tr>
<td>- RN attempts to place 2 large-bore IVs, vocera “ED CT Desk Tech” when ready to transport (do not delay transport for IV)</td>
</tr>
<tr>
<td>- Rapid Response immediately transport patient to CT, notify CT Desk Tech of transport</td>
</tr>
<tr>
<td>- Stroke Team to order CT/CTA/CTP (as needed)</td>
</tr>
<tr>
<td>- CT tech to notify radiologist of stroke alert</td>
</tr>
<tr>
<td>- Stroke Team to communicate with Attending Physician and/or NeuroIR Physician</td>
</tr>
<tr>
<td>- Concurrent stroke alerts: activate stroke alert process, operator announces “2™ stroke alert”</td>
</tr>
<tr>
<td>- Rapid Response Team will notify NCC-Charge Nurse if they are unable to respond to a possible stroke call.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Alert to Doctor in 10 minutes</td>
</tr>
<tr>
<td>- Alert to CT in 25 minutes</td>
</tr>
<tr>
<td>- Alert to IV in 45 minutes</td>
</tr>
<tr>
<td>- Alert to Groin Puncture in 45 minutes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Prior to Stroke Alert</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Ensure normal glucose level</td>
</tr>
<tr>
<td>- Ensure normal blood pressure</td>
</tr>
<tr>
<td>- Ensure no sedating medications have been given</td>
</tr>
</tbody>
</table>

## CT Negative for Hemorrhage
- Stroke Team reviews CTA/CTP
- Stroke Team speaks with NeuroIR doc if needed
- Stroke Team communicates treatment plan to bedside nurse and RRT
- Stroke Team discusses treatment plan with family
- If indication for tPA, maintain BP < 180/105mmHg
- If tPA given document vital signs and neuro checks Q15 min

## CT Positive for Hemorrhage
- Stroke Team notifies Neurosurgery Team
- Stroke Team evaluates and/or treats HTN to achieve SBP <140mmHg
- Stroke Team evaluates and/or treats coagulopathy to achieve INR ≤ 1.4
- If surgical intervention needed transport to OR
- If NeuroIR intervention needed prepare patient for transport

## Patient Going to NeuroIR
- Stroke Team to coordinate in-house NeuroIR alert transport with RRT to NeuroIR lab 3 (2 Silver)
- RRT establish cardiac monitoring if NeuroIR staff not available
- Stroke Team call NCC for bed placement
- Family to be placed in 2 Silver consult room (near silver elevators) after discussion with Stroke Team
What is Telestroke?
Why Telestroke?

+ Treatment for stroke exists when it is recognized and treated quickly

+ Limitations in physician availability results in loss of time and compromises success of treatment

+ Delays in treatment and breech of treatment protocol result in unnecessary risks and failures

+ Individuals who see stroke patients more frequently and administer tPA more commonly can do each more efficiently
Current Partners

Regional Partners:
- Marion General Hospital ER
- Marion General Inpatient
- Grady Memorial Hospital
- Hardin Memorial Hospital
- Genesis HealthCare System
- Marietta Memorial Hospital
- Belpre Medical Campus
- Morrow County Hospital
- O'Bleness Memorial Hospital
- Pickerington Medical Campus
- Berger Health System
- Southern Ohio Medical Center
- Hocking Valley Community Hospital
- Licking Memorial Hospital
- Doctors Hospital
- Dublin Methodist Hospital
- Mansfield
- Shelby
- East Ohio Regional Hospital
- Westerville Medical Campus
- Ontario Free Standing ER
- Hilliard Free Standing ER

Hub Hospitals:
- Riverside Methodist Hospital
- Grant Medical Center
Conclusion

- Acute stroke care was essentially non-existent as late as the Michael Jordan era
- Stroke is now considered a reversible condition, with one caveat (TIME IS BRAIN)
- The majority of patients with in-hospital stroke are not initially cared for on a neurology/stroke unit or have a neurologist as the primary admitting attending
- Their strokes are often more severe, and more difficult to diagnose due to a multitude of factors
- Certain types of in-patients have a higher chance of enduring in-hospital strokes
- Emerging therapies will continue to revolutionize the field of stroke care
Questions?
Comments?
Concerns?