What’s New in Stroke 2019 for the Anesthesiologist: Intervention for Acute Ischemic Stroke

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University of Michigan 22nd Annual Review
February 8, 2019
Objectives for today

• Review significant new trials expanding eligibility for endovascular intervention for acute ischemic stroke (AIS)
• Discuss current recommendations for anesthetic management of AIS
• Discuss requirements for institutional stroke certification

• I have no financial disclosures
Commonly used abbreviations

- AIS - acute ischemic stroke
- EVT - endovascular therapy
- IAT - intra-arterial therapy
- LVO - large vessel occlusion
- BAO - basilar artery obstruction
- LKW - last known well (last known normal)
Top 10 global causes of death 2016

Global Health Estimates, WHO 2018

Aging US Population

US Census Bureau

“Despite an increased risk of intracranial hemorrhage...tx with IV tPA within 3 hours of the onset of ischemic stroke improved clinical outcome at 3 months.”  NINDS Trial 1995
Since 2015 multiple RCT's support EVT for anterior large vessel occlusion

- NINDS 1995
- ECASS-3 2008
- SIESTA AnStroke 2016-2017
- ESCAPE
- MR. Clean
- REVASCAT
- SWIFTPRIME
- EXTEND-IA 2014-2015
- GOLIATH
- DAWN
- DEFUSE-3 2018
Collateral flow and time to recanalization are major predictors of outcome.

**Time Is Brain—Quantified**

<table>
<thead>
<tr>
<th></th>
<th>Neurons Lost</th>
<th>Synapses Lost</th>
<th>Myelinated Fibers Lost</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>
</tr>
<tr>
<td>Per Hour</td>
<td>120 million</td>
<td>830 billion</td>
<td>714 km/447 miles</td>
</tr>
<tr>
<td>Per Minute</td>
<td>1.9 million</td>
<td>14 billion</td>
<td>12 km/7.5 miles</td>
</tr>
<tr>
<td>Per Second</td>
<td>32 000</td>
<td>230 million</td>
<td>200 meters/218 yards</td>
</tr>
</tbody>
</table>

Stroke 2006; 37(1): 263-266

AJNR 2018:39:12
Effect of time on odds of good outcome with IV tPA

J Neurorad 2015;42(1):30 (adapted from Lees)
### National Institutes of Health Stroke Score (NIHSS)

#### Table 4. National Institutes of Health Stroke Scale

<table>
<thead>
<tr>
<th>Initial Item</th>
<th>Score</th>
<th>Response and Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of consciousness</td>
<td>0-4</td>
<td>Alert</td>
</tr>
<tr>
<td>Orientation questions</td>
<td>0-3</td>
<td>Answers both correctly</td>
</tr>
<tr>
<td>Response to commands</td>
<td>0-2</td>
<td>Performs both tasks correctly</td>
</tr>
<tr>
<td>Eye movements</td>
<td>0-2</td>
<td>Normal horizontal movements</td>
</tr>
<tr>
<td>Facial movement</td>
<td>0-2</td>
<td>Normal</td>
</tr>
<tr>
<td>Motor function</td>
<td>0-5</td>
<td>No drift</td>
</tr>
<tr>
<td>Limb strength</td>
<td>0-5</td>
<td>No strength</td>
</tr>
<tr>
<td>Sensory function</td>
<td>0-2</td>
<td>Normal</td>
</tr>
<tr>
<td>Language</td>
<td>0-3</td>
<td>Normal</td>
</tr>
<tr>
<td>Extremity or instruction</td>
<td>0-3</td>
<td>Absent</td>
</tr>
</tbody>
</table>

#### Stroke Severity

<table>
<thead>
<tr>
<th>Score</th>
<th>Stroke Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Stroke Symptoms</td>
</tr>
<tr>
<td>1-4</td>
<td>Minor Stroke</td>
</tr>
<tr>
<td>5-15</td>
<td>Moderate Stroke</td>
</tr>
<tr>
<td>16-20</td>
<td>Moderate to Severe Stroke</td>
</tr>
<tr>
<td>21-42</td>
<td>Severe Stroke</td>
</tr>
</tbody>
</table>

Adapted from Lyden et al. Copyright © 1994, American Heart Association, Inc.
NIHSS predictive of anterior LVO

Modified Rankin Scale (MRS)

0 No symptoms
1 No significant disability, despite symptoms; able to perform all usual duties and activities
2 Slight disability; unable to perform all previous activities but able to look after own affairs without assistance
3 Moderate disability; requires some help, but able to walk without assistance
4 Moderately severe disability; unable to walk without assistance and unable to attend to own bodily needs without assistance
5 Severe disability; bedridden, incontinent, and requires constant nursing care and attention
6 Death
2015 5 studies support endovascular rx for AIS

TICI 2b or 3 → reperfusion of > 50% of affected territory

James C. Grotta and Werner Hacke; Stroke 2015;46:1447-1452
New Findings Could Save Lives of More Stroke Patients

By DENISE GRADY    JAN. 24, 2018
Thrombectomy 6 to 24 Hours after Stroke with a Mismatch between Deficit and Infarct: DAWN Trial

- Enrollment based on tissue imaging rather than time since symptom onset
- 6-24 hours post-symptom onset
- 206 patients randomized to mechanical thrombectomy vs. standard care

3rd gen TREVO stent retrieval device
“Clinical-Core Mismatch”
### Intention-to-Treat Population

<table>
<thead>
<tr>
<th>Score on the Modified Rankin Scale</th>
<th>Thrombectomy (N=107)</th>
<th>Control (N=99)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>1</td>
<td>22</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>13</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>13</td>
<td>34</td>
</tr>
<tr>
<td>5 or 6</td>
<td>25</td>
<td>36</td>
</tr>
</tbody>
</table>

#### Outcome Rates

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Thrombectomy</th>
<th>Medical Mgmt</th>
</tr>
</thead>
<tbody>
<tr>
<td>mRS 0-2</td>
<td>48%</td>
<td>13%</td>
</tr>
<tr>
<td>mRS 3-5</td>
<td>32%</td>
<td>68%</td>
</tr>
<tr>
<td>Dead</td>
<td>19%</td>
<td>18%</td>
</tr>
</tbody>
</table>

NEJM 2018; 378(1):11-21
## Comparative number needed to treat (NNT) for key therapies

<table>
<thead>
<tr>
<th>THERAPY</th>
<th>NNT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decompressive Hemicraniectomy for middle cerebral artery infarction</td>
<td>2</td>
</tr>
<tr>
<td>Defibrillation for Cardiac Arrest</td>
<td>2.5</td>
</tr>
<tr>
<td>Thrombectomy for Acute Ischemic Stroke (DAWN)</td>
<td>2.8</td>
</tr>
<tr>
<td>Goal Directed Therapy for Acute Sepsis</td>
<td>5</td>
</tr>
<tr>
<td>Thrombolytics for Acute Ischemic Stroke &lt; 3 hours</td>
<td>8</td>
</tr>
<tr>
<td>Ipatropium and beta-agonist nebulizer for childhood asthma</td>
<td>11</td>
</tr>
<tr>
<td>Thrombolytics for Acute Ischemic Stroke &gt; 3 hours and &lt; 4.5 hours</td>
<td>15</td>
</tr>
<tr>
<td>PCI for high risk ST-elevation myocardial infarction</td>
<td>17</td>
</tr>
<tr>
<td>Aspirin for ST-elevation myocardial infarction</td>
<td>42</td>
</tr>
<tr>
<td>Antibiotics for the primary prevention of rheumatic fever</td>
<td>53</td>
</tr>
<tr>
<td>Bariatric Surgery on mortality in obese patients</td>
<td>77</td>
</tr>
</tbody>
</table>

Kamal, British J of Neurosurg 2018
Thombectomy for Stroke at 6 to 16 Hours with Selection by Perfusion Imaging: DEFUSE 3 Trial


**Figure 1.** Example of Perfusion Imaging Showing a Disproportionately Large Region of Hypoperfusion as Compared with the Size of Early Infarction.

- 1:1 randomization to thrombectomy plus standard medical care versus standard medical care alone within 16 hours
- Any FDA-approved thrombectomy device
- Randomization stratified by “penumbra-core mismatch
- 38 centers in the US (including UM)
NNT for mRS 0-2 = 3.6
Mechanical thrombectomy – is time still brain? The DAWN of a new era


To link to this article: https://doi.org/10.1080/02688697.2018.1426726

Published online: 08 Feb 2018.
AHA/ASA Guideline

2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke
A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

Reviewed for evidence-based integrity and endorsed by the American Association of Neurological Surgeons and Congress of Neurological Surgeons

Endorsed by the Society for Academic Emergency Medicine

<table>
<thead>
<tr>
<th>3.7. Mechanical Thrombectomy (Continued)</th>
<th>COR</th>
<th>LOE</th>
<th>New, Revised, or Unchanged</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. In selected patients with AIS within 6 to 16 hours of last known normal who have LVO in the anterior circulation and meet other DAWN or DEFUSE 3 eligibility criteria, mechanical thrombectomy is recommended.</td>
<td>I</td>
<td>A</td>
<td>New recommendation.</td>
</tr>
<tr>
<td>8. In selected patients with AIS within 6 to 24 hours of last known normal who have LVO in the anterior circulation and meet other DAWN eligibility criteria, mechanical thrombectomy is reasonable.</td>
<td>IIa</td>
<td>B-R</td>
<td>New recommendation.</td>
</tr>
</tbody>
</table>

Stroke. 2018 Mar;49(3):509-510
Posterior Circulation Strokes

- Posterior Circulation 20% of AIS
- BAO represents 1-4% of all AIS
- “Stuttering” symptoms which can be days-months prior to stroke
- “Crossed” syndromes pathognomonic
- Brainstem or cerebellar infarction can cause obstructive hydrocephalus
Hyperdense Basilar Artery

The Neurohospitalist July 2015 vol. 5 no. 3 142-150
Local Is Better Than General Anesthesia During Endovascular Acute Stroke Interventions

Rishi Gupta, MD

General Is Better Than Local Anesthesia During Endovascular Procedures

Caspar Brekenfeld, MD; Heinrich P. Mattle, MD; Gerhard Schroth, MD

Stroke 2010;41:2716-2719
Early studies strongly favored CS

Brinjikji  American Journal of Neuroradiology March 2015, 36 (3) 525-529

<table>
<thead>
<tr>
<th>Study name</th>
<th>Odds ratio</th>
<th>Lower limit</th>
<th>Upper limit</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugg et al, AJNR, 2010</td>
<td>0.12</td>
<td>0.01</td>
<td>1.03</td>
<td>0.05</td>
</tr>
<tr>
<td>Davis et al, Anesthesiology, 2012</td>
<td>0.11</td>
<td>0.04</td>
<td>0.30</td>
<td>0.00</td>
</tr>
<tr>
<td>Abou-Chebl et al, Stroke, 2010</td>
<td>0.52</td>
<td>0.40</td>
<td>0.68</td>
<td>0.00</td>
</tr>
<tr>
<td>Abou-Chebl et al, Stroke, 2014</td>
<td>0.49</td>
<td>0.29</td>
<td>0.83</td>
<td>0.01</td>
</tr>
<tr>
<td>Li et al, J Neurosurg Anesthesiol, 2014</td>
<td>0.74</td>
<td>0.22</td>
<td>2.51</td>
<td>0.63</td>
</tr>
<tr>
<td>Jumaa et al, Stroke, 2010</td>
<td>0.35</td>
<td>0.16</td>
<td>0.78</td>
<td>0.01</td>
</tr>
<tr>
<td>Nichols et al, JNIS, 2010</td>
<td>0.19</td>
<td>0.06</td>
<td>0.56</td>
<td>0.00</td>
</tr>
<tr>
<td>Hassan et al, Neurocrit Care, 2012</td>
<td>0.25</td>
<td>0.11</td>
<td>0.59</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Odds ratio and 95% CI

0.01 0.1 1 10 100
Prior to 2017 much of the literature suffered from:

- Selection bias
- Poor (read: no) hemodynamic information
- Poor definition of GA vs. CS
RCT’s comparing conscious sedation (CS) to general anesthesia (GA) for EVT

- SIESTA Trial 2016
- AnStroke 2017
- GOLIATH 2018
GOLIATH – clinical outcomes

Figure 2. Modified Rankin Scale (mRS) Score Distribution of Patients Treated Under General Anesthesia and Conscious Sedation

The shift toward better outcome in the general anesthesia group was significant. The odds ratio for a better outcome was 1.91 (95% CI, 1.03-3.56).
“Until further data are available, either method of procedural sedation is reasonable”
Relationship between admission SBP and outcomes

Castillo, Stroke. 2004;35:520-527
Considerations for blood pressure management during EVT

• In animal models CBF to penumbra dependent on MAP

• “Permissive” hypertension not an option for anesthetized patient

• Relationship between hypertension and risk of hemorrhagic conversion unclear

• Blood pressure augmentation not without risk
Suggested “sweet spot” for BP management

SURVIVAL

Systolic 140-180 mmHg

Hypotensive

Hypertensive

?
Considerations for anesthetic technique:

• Make an appropriate plan for the patient in front of you
• Interventionalist preference
• Patient co-morbidities
• Conscious sedation is a viable option more often than you might think
• Time to clot retrieval and blood pressure more important than anesthetic technique
Considerations for anesthetic technique

• Risks associated with time-pressured environment
• Timing of arterial access
• Choice of pressor
Perioperative Stroke

• Clinical presentation is rare
• Difficult to diagnose
• “Last known normal” frequently impossible to determine
• New data and extended eligibility may offer unique benefits to postoperative patients
The Role of Comprehensive Stroke Centers in Managing Stroke

Jenevra Foley, MSLc, RHIA
Operations Director, Comprehensive Stroke Center
Michigan Medicine
Ann Arbor, Michigan

Operations Director, Comprehensive Stroke Services
Metro Health  University of Michigan Health
Wyoming, Michigan
The Joint Commission offers four advanced levels of stroke certification for Joint Commission-accredited hospitals:

- Comprehensive Stroke Center Certification (CSC)
- Thrombectomy-Capable Stroke Center (TSC)
- Primary Stroke Center Certification (PSC)
- Acute Stroke Ready Hospital Certification (ASRH)

The Joint Commission also offers a core stroke certification for rehabilitation hospitals.

Joint Commission Advanced Certifications for CSC, TSC, PSC, and ASRH are offered in collaboration with the American Heart Association/American Stroke Association.
Comprehensive Stroke Certification

**CSC Guidelines**

**Eligibility**
- Must be able to demonstrate care for the following patients:
  - 20 subarachnoid hemorrhage by aneurysm per year
  - 15 endovascular coiling or surgical clippings per year for aneurysm
  - 25 IV thrombolytics eligible patients per year

**Standards & Guidelines**
- Uses advanced Disease-Specific Care standards and additional expectations for transitions of care
- Organization chooses and implements clinical practice guidelines

**Key Requirements**
- Acute stroke team available 24/7
- Dedicated neurointensive care unit beds for complex stroke patients 24/7
- Comprehensive diagnostic services
- **Ability to meet concurrent needs for two complex stroke patients 24/7**
- Neurosurgical services available 24/7
- On-site coverage for NICU by neurospecialist
- Participation in patient-centered research that is approved by an Institutional Review Board
- Tracking, monitoring, and reporting of performance measures
Growth of AIS interventions
University of Michigan Hospital

- 2016
- 2017
- 2018
Typical time line for individual patient
Endovascular Ischemic Stroke Median Treatment Times
All OSH Transfer Patients

Median Arrival to Arterial Access: 44 minutes

Two activations after arrival due to: 1. Symptoms worsened after arrival. 2. Required CTP.

Prepared By: Scott Dyo
10/22/2016

Jenewa Foley, Comprehensive Stroke Center Director
734-615-0747
OCS-comprehensive-stroke-program@med.umich.edu
Recommendations for improving a stroke program

• It’s a team effort
• Early notification of AIS vs. noise
• Establish care pathways when able
• Joint Commission very interested in patient hand-offs
Conclusions

• EVT for AIS progressing rapidly
• Our understanding of anesthetic techniques is lagging
• Extension of eligibility for EVT beneficial for post-surgical patients
• Anesthetic technique for AIS should be tailored for individual patient
• Blood pressure goals currently SBP 140-180 mmHg (220 mmHg wo tPA)