Objectives

• Discuss clinical evaluations and the use of stroke scale tools in decision-making
• Discuss neuro-imaging tools in the assessment of patients with TIA and acute stroke
• Discuss care map / protocol tools in facilitating quality stroke care
CT Insensitive for Stroke
CT is often normal for gross signs of infarction for the first 6-12 hours, though subtle, early changes are seen in up to 67%


Clinical Diagnosis
Stroke Assessment Tools

Stroke Mimic in about 3% of Patients Treated with tPA

ROSIER Scale: Stroke Recognition Tool

Symptom onset: Date __________ Time __________
GCS E= M= V=
BP / BS: 0 BS < 60 treat urgently and reasseessment
- Has there been loss of consciousness or syncope? Y (-1) □ N (0) □
- Has there been seizure activity? Y (1) □ N (0) □
- Asymmetric facial weakness Y (+1) □ N (0) □
- Asymmetric arm weakness Y (+1) □ N (0) □
- Asymmetric leg weakness Y (+1) □ N (0) □
- Speech disturbance Y (+1) □ N (0) □
- Visual field defect Y (+1) □ N (0) □

Total Score _______ (-2 to +5)
Provisional diagnosis: Stroke □ Non-stroke (specify) ___________________
* Stroke is likely if total scores are > 0. Scores of ≤ 0 have a low possibility of stroke but not completely excluded.


TIA: ABCD² Assessment Tool

- 20% to 50% of strokes preceded by a TIA
- 75% resolve in <15 minutes; 97% <3 hours
- New definition: event lasting less than 1 hour and not associated with changes on neuroimaging
- ABCD² for risk stratification

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt; 60 y</td>
<td>1</td>
</tr>
<tr>
<td>Blood Pressure &gt;140/90 mm Hg</td>
<td>1</td>
</tr>
<tr>
<td>Clinical features (maximum 2)</td>
<td>2</td>
</tr>
<tr>
<td>Unilateral weakness (2)</td>
<td></td>
</tr>
<tr>
<td>Speech difficulty without weakness (1)</td>
<td></td>
</tr>
<tr>
<td>Duration (maximum 2)</td>
<td>2</td>
</tr>
<tr>
<td>&gt;60 min (2)</td>
<td></td>
</tr>
<tr>
<td>10-59 min (1)</td>
<td></td>
</tr>
<tr>
<td>&lt;10 min (0)</td>
<td></td>
</tr>
<tr>
<td>Diabetes</td>
<td>1</td>
</tr>
<tr>
<td>Maximum total score</td>
<td>7</td>
</tr>
</tbody>
</table>

# NIH Stroke Scale Score

- 11 Domains
  - 1-5 minor
  - 6-20 moderate
  - >20 severe
- Stroke scales help quantify the deficit, facilitate communication, identify location, provide prognosis, direct testing
- Severe strokes are associated with increased risk of sICH
- “Minor” strokes are a relative contraindication for tPA
  - Studies suggest that patients with minor or rapidly improving deficits may benefit from treatment**


# Posterior Circulation Strokes

- CT misses 60%-90% of acute ischemic strokes in the brainstem or cerebellum
- MRI with diffusion-weighted imaging is more reliable than CT, but is still misses 15%-20% of patients with posterior circulation stroke in the early period
- HINTS is reported to be up to 99% sensitive when performed by an experienced clinician
- www.emcrit/misc/posterior-stroke-video/


# Non-Contrast CT

- Sensitive
- Available
- Fast
- Findings on CT related to:
  - Size of infarct
  - Severity of ischemia
  - Time of onset
- Hypodensity or mass effect associated with 8x increase risk of sICH

Alberta Stroke Program Early CT Score (ASPECTS)

- 10 points quantitative topographic CT score
- Defined scan protocol
- Developed to provide a reliable grading system
- Early ischemic change predict outcome and risk
  - Focal parenchymal hypodensity
  - Cortical swelling with sulcal effacement / loss of gray white differentiation
  - Hyperdense MCA sign
- Scoring is limited to MCA strokes
- www.aspectsinstroke.com

MRI – DWI

- 88%-100% sensitivity
- Better than CT (Level IA)
- Takes 6 minutes
- Visible minutes after infarct
- Better than CT for distinguishing acute vs chronic lesions
- Better than CT for small CVAs, posterior fossa

MRI – Gradient Echo

- Blood dependent on age and pulsing sequences used
- As accurate as CT for acute hemorrhage
- Micro-hemorrhages
- Relevance?

Vascular Imaging

- Digital Subtraction Angiography
  - Gold standard
  - Risks, time-consuming
- CT w/o contrast + CTA
  - Equivalent to DSA (Level IB evidence)
- MRI (DWI, FLAIR, GRE/SWI +/- PWI) +/- MRA
  - Equivalent to DSA (Level IB evidence)

American Society of Neuroradiology, the American College of Radiology, and the Society of NeuroInterventional Surgery, 2013

Acute Ischemic Stroke: Overcoming Barriers by Improving Systems of Care

Imaging in Acute Ischemic Stroke

- P’s of acute stroke imaging:
  - Parenchyma (brain), Pipes (vasculature), Perfusion (blood flow), and Penumbra (at-risk tissue).
- Multimodal imaging
  - Sequence studies: Image, angiography, perfusion, diffusion
  - Enhances the sensitivity of emergent neuroimaging for acute ischemic processes
  - Identifies patients who may benefit from endovascular interventions


Does the Penumbra Matter?

- Relative Contraindications:
  - Minor or rapidly improving symptoms
  - Pregnancy
  - Seizure at onset
  - Major surgery or serious trauma within previous 14 days
  - Recent GI or urinary tract hemorrhage within 21 days
  - Recent AMI within previous 3 months

Indications/Contraindications

- Contraindications:
  - Current intracranial bleeding/SAH
  - Active internal bleeding
  - Head or spine surgery or severe TBI within 3 months
  - History of serious intracranial conditions
    - i.e., AVM, neoplasm, aneurysm
  - Bleeding diathesis
  - Current uncontrolled hypertension

- Relative Contraindications:
  - Minor or rapidly improving symptoms
  - Pregnancy
  - Seizure at onset
  - Major surgery or serious trauma within previous 14 days
  - Recent GI or urinary tract hemorrhage within 21 days
  - Recent AMI within previous 3 months

Is IV r-tPA safe and effective for patients with acute ischemic stroke if given within 3 hours of symptom onset?

- Level A Recommendation – none
- Level B Recommendation – with a goal to improve functional outcomes, IV r-tPA should be offered and may be given to selected patients with AIS within 3 hours of symptom onset at institutions where systems are in place to safely administer the medication. The increased risk of sICH should be considered when deciding whether to administer IV r-tPA to patients with AIS.
- Level C Recommendation – when feasible, shared decision-making between the patient (and/or their surrogate) and a member of the health care team should include a discussion of potential benefits and harms prior to the decision whether to administer IV r-tPA for AIS.

Is IV r-tPA safe and effective for patients with acute ischemic stroke treated between 3-4.5 hours of symptom onset?

- Level A Recommendation – none
- Level B Recommendation – despite the known risk of sICH and the variability in the degree of benefit in functional outcomes, IV r-tPA may be offered and may be given to carefully selected patients with AIS within 3-4.5 hours after symptom onset at institutions where systems are in place to safely administer the medication.
- Level C Recommendation – when feasible, shared decision-making between the patient (and/or their surrogate) and a member of the health care team should include a discussion of potential benefits and harms prior to the decision whether to administer IV r-tPA for AIS.

Tools: Guidelines / Protocols

- AHA/ASA Get With The Guidelines: Stroke program registry of 58,353 tPA treated patients
- Faster onset to treatment time in 15 minute increments led to:
  - Reduced in-hospital mortality (OR=0.96; 95% CI: 0.95, 0.98*)
  - Symptomatic intracranial bleeding (OR=0.96; 95% CI: 0.95, 0.98*)
  - Increase of independent ambulation at discharge (OR=1.04; 95% CI: 1.02, 1.05*)
  - Discharge to home (OR=1.03; 95% CI: 1.02, 1.04*)
- Conclusion: Rapidity or treatment significantly influences outcomes with IV t-PA in AIS

Conclusions

- Stroke scales are helpful in identifying stroke, determining severity and prognosis
- The history and physical findings direct type of neuroimaging
- CT, MRI equivalent for detecting hemorrhage
- Micro-hemorrhages seen on MRI may predict hemorrhagic response to tPA
- MRI clearly superior for detecting acute stroke
- Multiple options for vascular imaging
- Unclear relevance of penumbra
- MRI findings in TIA may predict recurrence/CVA
- Protocols are useful tools for safety and efficiency

Objectives

Attendees will be able to discuss:
- Mechanisms for coordinating stroke care to improve door-to-needle/door-to-groin
- Experiences of individual hospital systems of care
- Lessons from Get With The Guidelines (GWTG) efforts and Target Stroke
Lessons Learned Over 20 Years

- Reperfusion is critical
  - Minimize delay to reperfusion
  - Maximize penumbral salvageability by:
    - Collateral flow
    - Physiologic optimization
- Time to reperfusion
  - Predicts clinical outcomes
  - Significant tolerance-heterogeneity in populations
  - Should drive all system development

Stroke Care in 2015

- New guidelines and policies imminent
  - Guideline update July 2015
- Measured national goals
  - Door to Needle (DTN) Time < 60 min (soon even lower?)
  - Computed Tomography (CT) to Thrombectomy Time < 90 min*
  - Treatment rates by percent eligible for intravenous (IV) and intra-arterial (IA)
- New US Food and Drug Administration (FDA) product label
Stroke Care in 2015

- It is simple
  - Do it fast
  - Do it safely
  - Do it as a team

Stroke Chain of Survival

- Detection: Early recognition
- Dispatch: Early EMS activation
- Delivery: Transport & management
- Door: ED triage
- Data: ED evaluation & management
- Decision: Neurology input, therapy selection
- Drug: Thrombolytic & future agents
- Disposition: Admission or transfer

NINDS Recommendations and ACLS Guidelines

<table>
<thead>
<tr>
<th>Time (mins)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Door-to-MD</td>
<td>10</td>
</tr>
<tr>
<td>Door-to-Stroke team notification</td>
<td>15</td>
</tr>
<tr>
<td>Door-to-CT scan</td>
<td>25</td>
</tr>
<tr>
<td>Door-to-Drug</td>
<td>60*</td>
</tr>
<tr>
<td>Door-to-Admission</td>
<td>180</td>
</tr>
</tbody>
</table>

*80% Compliance
Learn From Finland – Where There is a Will...

- Funnel all to a well-resourced institution
  - No PSC or CSC, all go to Helsinki University Hospital
  - 24/7 neurology presence in ED
  - Proximate CT

- Act on encode
  - EMS talks to neurologist
  - Clinical history from EMR
  - Premix IPA
  - Bolus while in CT

Learn From Industry – Toyota Value Stream Analysis

Pre-VSA Acute Stroke Protocol

- Toyota Way: NURSES
- Neuro MD: Calls Chief Resident to make decision
- RN: BP med administration, calculates dose and prepares IPA
- Tech: ECG

Post-VSA Acute Stroke Protocol

- Toyota Way: NURSES
- Neuro MD: Calls Chief Resident to make decision
- RN: BP med administration, calculates dose and prepares IPA
- Tech: ECG

© 2015 Vindico Medical Education
Maximize Resources, Predefined Roles, Parallel Processing

Code Stroke

Admitting CT tech Nurse #1 Nurse #2 ED resident Neurology resident Social worker ED tech Pharmacist

- Patient ID
- Registration
- Room assign
- CT scan
- IV placement
- Monitor hook-up
- Vital sign monitoring
- Lab draw
- Weight estimate

History• Medical history of stroke• NIHSS score

- ED witness
- Time of onset
- Emergent transport of bloods to lab
- Calculate rtPA dose
- Prepare rtPA

Decision

- Bolus & Infuse rtPA

Target: Stroke - Strategies

- National quality initiative (QI) to increase rates of DTN < 60 mins
  - Pre 2003-2009 / Post 2010-2013
- Interventions
  - EMS prehospital notification
  - Stroke tools and tool kits
  - Rapid triage protocol and stroke team notification
  - Single call activation system
  - Direct transfer to CT scanner
  - Rapid CT and interpretation
  - Rapid laboratory testing / POC
  - Mix rtPA ahead of time
  - Rapid access & rtPA initiation
  - Team-based approach
  - Prompt data feedback

Target: Stroke

<table>
<thead>
<tr>
<th>Study Period</th>
<th>Preintervention (n=27,319)</th>
<th>Postintervention (n=43,850)</th>
<th>Adjusted OR (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preintervention (n=27,319)</td>
<td>77 (94.0)</td>
<td>67 (95.4)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>Preintervention (n=43,850)</td>
<td>7 (10.5)</td>
<td>7 (10.5)</td>
<td>1.00 (0.98-1.02)</td>
<td>.58</td>
</tr>
<tr>
<td>End of Each Period</td>
<td>26.6 (27.8-31.9)</td>
<td>53.3 (51.5-55.3)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>Improvement in DTN time ≤ 60 mins, % per year (95% CI)</td>
<td>1.26 (1.19-1.34)</td>
<td>1.26 (1.19-1.34)</td>
<td>&lt;.001</td>
<td></td>
</tr>
<tr>
<td>Improvement in hospital all-cause mortality, %</td>
<td>3.66</td>
<td>5.35</td>
<td>0.60 (0.02-0.38)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Discharge to home, %</td>
<td>37.6</td>
<td>40.4</td>
<td>0.14 (0.09-0.20)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Independent ambulatory status, %</td>
<td>42.2</td>
<td>45.4</td>
<td>1.00 (0.97-1.10)</td>
<td>.31</td>
</tr>
<tr>
<td>Symptomatic intracranial hemorrhage within 36 h, %</td>
<td>5.68</td>
<td>4.68</td>
<td>0.60 (0.57-0.64)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

© 2015 Vindico Medical Education
What Are Other Patient-Centered Outcome of These Systems?

- Triage to most appropriate hospital
  - PSC more likely to have a plan and administer tPA
- Increased EMS prehospital activation
  - Decreases Door to MD, CT, and Needle times
- Decreases Onset to Needle Time
  - 30' decrease increases relative favorable outcome 10%
- Decreases Onset to Reperfusion Time
  - 30' decrease increases absolute favorable outcome 10%

Monitoring Stroke Center Quality

- Comparison of Performance Achievement Award (PAA) Recognition With Primary Stroke Center Certification for Acute Ischemic Stroke Care
- 1356 hospitals in GWTG-Stroke from 2010 to 2012 reviewed
- After adjustment PSC and PAA improved measure adherence

"While both PSC certification and GWTG-Stroke PAA recognition identified hospitals providing higher conformity with care measures for patients hospitalized with acute ischemic stroke, PAA recognition was a more robust identifier of hospitals with better performance."


In-patient Stroke

- Review of in-patient stroke cases from 2006 to 2012 in GWTG-Stroke
- After adjustment and in comparison to community-onset ischemic stroke, inpatient strokes were:
  - Less likely discharged home (odds ratio [OR] 0.37)
  - Less likely ambulatory at discharge (OR 0.42)
  - In-hospital mortality also higher (OR 2.72)

Timing Is Critical – IMS I & II


Team Member Roles in Parallel Intra-arterial Therapy (IAT) Workflow


Disposition: Early Stroke Care

- Begin Acute Stroke Pathway
- ICU / Stroke Unit admission now
  - 24 hrs for tPA
  - Q 12 X 6 hours, Q 1"x18 hours
- Facilitate medical or surgical measures to improve outcome after stroke
  - Optimize blood pressure, glucose, temp
- Begin to prevent subacute complications
- Plan for long-term therapies to prevent recurrent stroke
- Start efforts to restore neurological function

Acute Ischemic Stroke: Overcoming Barriers by Improving Systems of Care

Disposition (Care Transition)

- Hyperacute patient - ischemic stroke
  - ED Care
  - DX and RX
  - Advanced imaging
  - Possible IV tPA
  - Continue evaluation
  - Monitoring for progression and bleeding
  - Begin prevention measures
  - Prepare for rehab

- Hyperacute patient - large ischemic stroke
  - Transfer to Stroke Unit
  - ED Care
  - DX and RX
  - Advanced imaging
  - Possible IV tPA
  - IV tPA
  - Endovascular Tx
  - Anesthesia support
  - Ongoing care
  - Monitor for complications

- Hyperacute patient with ICH/SAH
  - ED Care
  - DX and RX
  - Begin imaging
  - Control/reverse bleeding
  - Post-op care
  - Monitor for complications
  - Hematoma removal
  - Aneurysm clipping
  - Hemicraniectomy

Conclusions

- “Time is Brain” is more than just a saying—every minute counts
- Stroke systems of care must be organized to maximize efficiency and effectiveness
- Application of best practice can reduce time to reperfusion in every hospital setting

Endovascular Strategies to Complement r-tPA: Assessing the Evidence

Philip B. Gorelick, MD, MPH
Professor, Translational Science & Molecular Medicine
Michigan State College of Human Medicine
Medical Director, Mercy Health Hauenstein Neurosciences
Grand Rapids, MI
Objectives

- In relation to endovascular strategies to complement tPA, learners will be able to discuss:
  1. Set-up time (work processes) for tPA versus endovascular intervention
  2. MR CLEAN, ESCAPE, SWIFT PRIME, EXTEND-IA, & REVASCAT
  3. Prior endovascular trial data SYNTHESIS, SYNTHESIS Expansion, IMS III, & MR RESCUE
  4. The next steps for intravenous (IV) & intra-arterial (IA) reperfusion

Process Time for IV tPA & Endovascular Therapy

Need to Eliminate Redundancies and Need for Speed to Groin Puncture and Reperfusion

More Efficient (“LEAN”) Systems Hospital Strategies & Door-to-Needle Time

- 304 AHA Get with the Guideline-Stroke Hospitals
- 5460 patients receiving tPA within 3 hours
- Median door-to-needle time: 72 minutes
- Rapid triage: 8.1 minutes
- Single-call activation system: 4.3 minutes
- Tissue plasminogen activator (tPA) stored in ED: 3.5 minutes
- Each strategy shortened door-to-needle time by 1.3 minutes (adjusted mean difference)
- Total minutes saved if all strategies used: 14 minutes

Process Touch Points/Times of Interest in Acute Ischemic Stroke (AIS) Therapy

**Stroke onset to:**
1. Study randomization
2. CT head study
3. Start of IV alteplase therapy
4. Groin puncture
5. CT head study to 1st reperfusion
6. 1st reperfusion


What the New Trials Accomplished: Reduction in Median Time from Stroke Onset to Reperfusion

- IMS III: Mean time from onset to IA end/reperfusion: 325 (5 hours, 25 minutes): range: 180-418
- MR CLEAN: (stroke onset to groin puncture: 260 minutes)
- SWIFT PRIME: (stroke onset to first stent deployment: 252 minutes)
- ESCAPE: 241 minutes
- EXTEND-IA: 248 minutes
- REVASCAT: 355 minutes


Approaches to Set-up

**Scenario #1:**
A. Treat acute ischemic stroke with IV tPA in field in mobile stroke unit to soften or dissolve clot & pre-notification by EMS to ED
B. Transfer from ED door to CT/CTA machine or MRI/MRA next to or in angiography suite
C. If appropriate, ICA or MCA thrombosis → neurothrombectomy procedure

**Scenario #2:**
A. Pre-notification by EMS → ED door to CT/CTA machine & mix tPA
B. If appropriate findings, give tPA in CT room
C. Transfer next door to angiography suite & start angiography procedure → if appropriate lesion → neurothrombectomy procedure

© 2015 Vindico Medical Education
5 Neurothrombectomy Studies Published in the New England Journal of Medicine – 2015

**MR CLEAN:** Multicenter Randomized Trial of Endovascular Therapy for Acute Ischemic Stroke in the Netherlands

**EXTEND-IA:** Extending the Time for Thrombolysis in Emergency Deficits—Intra-Arterial

**ESCAPE:** Endovascular Treatment for Small Core and Anterior Circulation Proximal Occlusion with Emphasis on Minimizing CT to Recanalization Times

**SWIFT PRIME:** Solitaire with the Intention for Thrombectomy as Primary Endovascular Treatment

**REVASCAT:** Randomized Trial of Revascularization with Solitaire FR Device versus Best Medical Therapy in the Treatment of Acute Stroke Due to An Anterior Circulation Large Vessel Occlusion Presenting within Eight Hours of Symptomatic Onset

---

**Key Study Features of 5 Trials***

<table>
<thead>
<tr>
<th>Feature</th>
<th>MR CLEAN</th>
<th>EXTEND-IA</th>
<th>ESCAPE</th>
<th>SWIFT PRIME</th>
<th>REVASCAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Age (years)</td>
<td>65.8</td>
<td>70.2</td>
<td>71</td>
<td>66.4</td>
<td>65.7</td>
</tr>
<tr>
<td>2. Atrial fibrillation</td>
<td>28.3%</td>
<td>31%</td>
<td>37%</td>
<td>39%</td>
<td>34%</td>
</tr>
<tr>
<td>3. Systolic BP (mm Hg)</td>
<td>146</td>
<td>---</td>
<td>147</td>
<td>---</td>
<td>142</td>
</tr>
<tr>
<td>4. NIHSS Score</td>
<td>17</td>
<td>13</td>
<td>16</td>
<td>17</td>
<td>17</td>
</tr>
<tr>
<td>5. ASPECTS</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>6. Site</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Intra ICA</td>
<td>9.4%</td>
<td>31%</td>
<td>27.6%</td>
<td>18%</td>
<td>25.5%</td>
</tr>
<tr>
<td>2. ICA/MI</td>
<td>25.3%</td>
<td>---</td>
<td>51%</td>
<td>68.1% (NIHSS &lt;72 hrs)</td>
<td>77%</td>
</tr>
<tr>
<td>3. M1</td>
<td>68.1%</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>7. Stroke onset to start IV tPA (minutes)</td>
<td>85</td>
<td>145</td>
<td>110</td>
<td>117</td>
<td>117.5</td>
</tr>
</tbody>
</table>

ASPECTS: Alberta Stroke Program Early CT score, NIHSS: National Institutes of Health Stroke Scale

*All features are recorded as medians unless otherwise specified


---

**Comparison of 4 AIS Mechanical Thrombectomy Trials**

<table>
<thead>
<tr>
<th>Study Character</th>
<th>AIR CLEAN</th>
<th>SWIFT PRIME</th>
<th>EXTEND-IA</th>
<th>ESCAPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV-PA vs IV tPA + Endovascular</td>
<td>Yes (~90%)</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Time Window</td>
<td>6 hours</td>
<td>6 hours</td>
<td>8 hours (IV alteplase within 4.5 hrs)</td>
<td>12 hours</td>
</tr>
<tr>
<td># of Patients</td>
<td>N=500</td>
<td>N=196</td>
<td>N=70</td>
<td>N=314</td>
</tr>
<tr>
<td>Primary Device</td>
<td>Stentreivers in 81.5% (IA thrombolysis allowed)</td>
<td>Solitaire</td>
<td>Solitaire</td>
<td>Solitaire</td>
</tr>
<tr>
<td>Primary Endpoint</td>
<td>Ordinal Rankin shift</td>
<td>Rankin shift</td>
<td>Reperfusion at 24 hrs w/o sICH &lt;2 hrs</td>
<td>NIHSS 0-2 or Rankin 0-2 at 90 days</td>
</tr>
<tr>
<td>Trial Status</td>
<td>Completed</td>
<td>Efficacy met, trial stopped</td>
<td>Efficacy met, trial stopped</td>
<td>Efficacy met, trial stopped</td>
</tr>
</tbody>
</table>

**Acute Ischemic Stroke: Overcoming Barriers by Improving Systems of Care**

### REVASCAT

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>REVASCAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV-PA vs IV-PA + Endovascular</td>
<td>Yes: 88.0% in thrombectomy group &amp; 77.7% in control group</td>
</tr>
<tr>
<td>Time Window</td>
<td>8 hours</td>
</tr>
<tr>
<td># of Patients</td>
<td>N= 206</td>
</tr>
<tr>
<td>Primary Device</td>
<td>Solitaire</td>
</tr>
<tr>
<td>Primary Endpoint</td>
<td>modified Rankin scale (shift analysis)</td>
</tr>
<tr>
<td>Trial Status</td>
<td>Terminated (loss of equipoise based on reported trials)</td>
</tr>
</tbody>
</table>


### Comparison of 4 AIS Mechanical Thrombectomy Trials

<table>
<thead>
<tr>
<th>Trial</th>
<th>Therapy Arm</th>
<th>Good Outcome (mRS = 0-2) at 90 days (%)</th>
<th>P-value (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR CLEAN</td>
<td>IAT Medical</td>
<td>33</td>
<td>19</td>
</tr>
<tr>
<td>ESCAPE</td>
<td>IAT Medical</td>
<td>53</td>
<td>29</td>
</tr>
<tr>
<td>EXTEND IA</td>
<td>IAT Medical</td>
<td>71</td>
<td>40</td>
</tr>
<tr>
<td>SWIFT PRIME</td>
<td>IAT Medical</td>
<td>60</td>
<td>36</td>
</tr>
</tbody>
</table>

IAT = intra-arterial therapy

### Relationship Between Flow Grade and Achievement of mRS 0-2

<table>
<thead>
<tr>
<th>Study</th>
<th>IAT Flow: TICI 2b3</th>
<th>IAT mRS= 0-2</th>
<th>Control mRS= 0-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWIFT PRIME</td>
<td>88%</td>
<td>60%</td>
<td>36%</td>
</tr>
<tr>
<td>EXTEND IA</td>
<td>86%</td>
<td>71%</td>
<td>40%</td>
</tr>
<tr>
<td>ESCAPE</td>
<td>72%</td>
<td>53%</td>
<td>29%</td>
</tr>
<tr>
<td>REVASCAT</td>
<td>66%</td>
<td>44%</td>
<td>28%</td>
</tr>
<tr>
<td>MR CLEAN</td>
<td>59%</td>
<td>33%</td>
<td>19%</td>
</tr>
</tbody>
</table>

IAT = intra-arterial thrombectomy; mRS= modified Rankin Scale; TICI= thrombolysis in cerebral infarction

Conclusion: Achieving good outcome is proportionate to reperfusion
2015 AHA/ASA Focused Update of the 2013 Guidelines for Early Management of Patients with AIS Regarding Endovascular Therapy

1. Patients eligible for IV rtPA should receive it even if endovascular treatments are being considered (Class I, level of evidence A)

2. Endovascular therapy with a stent retriever is indicated according to the following criteria (Class I, level of evidence A):
   A. Pre-stroke mRS score 0 to 1
   B. AIS receiving rtPA within 4.5 hours of onset according to guidelines from professional medical societies
   C. Causative occlusion of internal carotid artery or MCA (M1)
   D. Age: ≥ 18 years
   E. NIHSS score of ≥ 6
   F. ASPECTS of ≥ 6
   G. Treatment can be initiated (groin puncture) within 6 hours of symptom onset

H. If contraindication to IV tPA, stent retrievers within 6 hours is reasonable (Class IIa, LOE C)
I. Stent retrievers may be reasonable for M2, M3, ACA, vertebral, basilar, PCA (Class IIb, LOE C)
J. Stent retrievers may be reasonable for those <18 yrs. & within 6 hours (Class IIb, LOE C)
K. Stent retrievers may be reasonable for pre-stroke mRS=1, ASPECTS <6, NIHSS <6 & occluded ICA or M1 (Class IIb, LOE B-R)
L. Salvage intra-arterial tPA may be reasonable (Class IIb, LOE B-R)
M. Initial treatment with intra-arterial thrombolysis is beneficial in selected patients of ≤ 6 hours with MCA occlusion (Class I, LOE B-R)
N. It might be reasonable to favor conscious sedation over general anesthesia (Class IIb, LOE C)


SYNTHESIS*, SYNTHERESIS Expansion, IMS III, & MR RESCUE

* A Pilot Study
3 Negative Endovascular Trials in AIS in 2013

<table>
<thead>
<tr>
<th>Study</th>
<th>Study Question</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interventional Management of Stroke III (IMS-III):</td>
<td>Is endovascular therapy after administration of IV tPA in moderate-to-severe AIS more effective (and safe) compared to IV tPA alone within 3 hours after symptom onset?</td>
<td>Primary Endpoint mRS ≤ 2: Endovascular 40.8% IV tPA 38.7% (P=0.70)</td>
</tr>
<tr>
<td>Mechanical Retrieval and Revascularization of Stroke Clots Using Embolectomy (MR RESCUE)</td>
<td>1. Does presence of substantial penumbral tissue predict patients most likely to respond to mechanical embolectomy? 2. Do embolectomy patients have improved functional outcome compared to randomized controls?</td>
<td>For mRS (0,1), P=0.18</td>
</tr>
<tr>
<td>SYNTHESIS Expansion</td>
<td>AIS patients within 4.5 hours randomized to endovascular therapy (IA thrombolysis with tPA, mechanical clot disruption or retrieval or a combination of approaches vs IV tPA)</td>
<td></td>
</tr>
</tbody>
</table>

Lessons From 3 Negative Trials

- Too slow to treat
- Need for better neurothrombectomy devices
- Make sure target lesion (clot) is present
- Take into account collaterals

Next Steps for Intravenous (IV) and Intra-arterial (IA) Reperfusion Therapies

Emphasis on Maximizing Pre-hospital Processes
Maximizing Pre-hospital Processes

1. Delivery of tPA in the field (mobile unit teleneurology/teleradiology, point-of-care lab & CT scanner)*
2. Real-time monitoring & tracking by app of mobile stroke unit to hospital
3. Bypass to Comprehensive Stroke Centers if high NIHSS
4. From ED door to CTA or angiography suite

*If no mobile stroke unit, tele-neurology can be deployed in ambulance

Conclusions

1. Highly efficient workflow processes are needed in the field, in transfer to the ED, and from the ED door to the CT/CTA/MRI/MRA and angiography suites
2. IV tPA plus endovascular neuro-thrombectomy are the standard of care for appropriate intracranial occlusions in acute ischemic stroke
3. Emphasis on maximizing pre-hospital processes is a current focus of attention to reduce treatment times
Acute Ischemic Stroke: Overcoming Barriers by Improving Systems of Care

Acute Stroke Triage To Improve Access To IV tPA

Site of stroke

Patient history, vitals, CT scan

Triage decision: ED physician/neurologist confirms stroke diagnosis

Negative CT

Positive CT

A New Era Dawns

Endovascular Clot Retrieval Therapy: Implications for the Organization of Stroke Systems of Care in North America

Eric E. Smith, MD, MPH; Lee H. Schwamm, MD

Abstract—Endovascular acute ischemic stroke therapy is now proven by randomized controlled trials to produce large, clinically meaningful benefits. In response, stroke systems of care must change to increase timely and equitable access to this therapy. In this review, we provide a North American perspective on implications for stroke systems, focusing on the United States and Canada, accompanied by initial recommendations for changes. Most urgently, every community must create access to a hospital that can safely and quickly provide interdisciplinary stroke-care physicians and immediately transfer appropriate patients to a more capable center as required. Safe and effective therapy in the community setting will be ensured by certification programs, performance measurement, and skin entry integrity. (Stroke. 2015;46:1462-1467. DOI: 10.1161/STROKEAHA.115.000365.)

2015: Pre-Hospital Triage Pathways for Acute Stroke

Factors:
- tPA candidate?
- EVT candidate?
- Solutes
- Run Times
- Site Review
- Availability of Services
- Stroke Center
- Medical Control
- ABC stable
- Dispatch Criteria
- Public vs. Private EMS
- Patient Preference
How Must We Change in Light of the Compelling EVT Evidence of Benefit?

• Who are the right patients?
  – How can we detect them reliably?
• What are the right places?
• How soon is the right amount of time?
• How should we accomplish this?

Most Patients Don’t Come with a Note Pinned to their Chest that says “Get me a thrombectomy!”

“Sy says — When having a stroke, get to the hospital as soon as possible — within the first 6 hours. Ask for a TPA.”


Major Strokes: How to Define?

Penumbra (at risk)

Core (irreversibly damaged)
By Imaging Criteria? Preserved Parenchyma & Good Collaterals if CTA Available and Reliable

Collaterals: From Rags ………………………………………………………to Riches

TSA Pre✓
Expedited screening in this lane.
No need for
- MRI-DWI
- CT
- Vessel Imaging
- Perfusion Imaging
- Removing Shoes

Clinical Criteria: Basically, It's a Bad Stroke

- NIHSS: PPV 86.4% for NIHSS ≥9; 84.4% for NIHSS ≥7
- sNIHSS is a valid short form for prehospital use
- The Los Angeles Motor Scale (LAMS) for LVO, 5 versus 2 points, had sensitivity 81%, specificity 89%
- Cincinnati Prehospital Stroke Severity Scale to identify stroke patients with NIHSS ≥15 (sensitivity 92%) or with LVO (sensitivity 83%)
- Rapid Arterial occlusion Evaluation (RACE) scale to detect LVO had sensitivity 85%, specificity 68%, PPV 42%, NPV 94%


© 2015 Vindico Medical Education
Acute Ischemic Stroke: Overcoming Barriers by Improving Systems of Care

How Must We Change in Light of the Compelling EVT Evidence of Benefit?

• Who are the right patients?
• What are the right places?
  – First Stop vs Transfer
• How soon is the right amount of time?
• How should we accomplish this?

The Joint Commission Made 24/7 Availability of Mechanical Thrombectomy a Requirement for CSC Designation

Comprehensive Stroke Center
Neurosurgeon & Neuroendovascular on site, All PSC functions plus endovascular thrombectomy and full spectrum of hemorrhagic stroke care

Goal: ~150-200

Primary Stroke Center: (JACHO, ASA, State)
Stroke Director & dedicated coordinator, Stroke Service/Unit, continuum of inpatient care

Goal: ~1200-1500

Acute Stroke Ready Hospitals:
IV rPA, CT scanner, 24x7 rapid access to stroke and imaging expertise on site or via TeleStroke support

Goal: ~1200-1500

Basic Care:
Assessment, identification, stabilization & transfer

Goal: ~1200-2500

EVT for Stroke: High Impact, Low Frequency, Widely Dispersed


Acute Ischemic Stroke: Overcoming Barriers by Improving Systems of Care

**Time Waits for No Man: Pick Someone Training for Success**

![Graph showing median door to needle time for tPA](unpublished data, MGH Stroke Service)

**Hypothetical Triage of AIS Patients <4.5 hr who EMS Considers Potentially Eligible for IV tPA +/- EVT**

<table>
<thead>
<tr>
<th>1st Entry</th>
<th>MSU</th>
<th>Basic</th>
<th>ASRH</th>
<th>PSC</th>
<th>CSC</th>
</tr>
</thead>
<tbody>
<tr>
<td>V. Mild sx</td>
<td>Opp cost</td>
<td>Not Good</td>
<td>OK</td>
<td>Ideal</td>
<td>Opp Cost</td>
</tr>
<tr>
<td>Mod sx</td>
<td>Ideal</td>
<td>Not Good</td>
<td>Ideal</td>
<td>Ideal</td>
<td>Opp Cost</td>
</tr>
<tr>
<td>Severe sx</td>
<td>Ideal</td>
<td>Not Good</td>
<td>OK</td>
<td>OK</td>
<td>Ideal</td>
</tr>
<tr>
<td>Mod-Ser HS</td>
<td>Ideal</td>
<td>Not Good</td>
<td>OK</td>
<td>OK</td>
<td>Ideal</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Admission</th>
<th>MSU</th>
<th>Basic</th>
<th>ASRH</th>
<th>PSC</th>
<th>CSC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benign Mimic</td>
<td>-</td>
<td>?</td>
<td>OK?</td>
<td>Prob Ideal</td>
<td>Opp Cost</td>
</tr>
<tr>
<td>V. Mild sx</td>
<td>-</td>
<td>Not Good</td>
<td>Maybe</td>
<td>Ideal</td>
<td>Opp Cost</td>
</tr>
<tr>
<td>Mod sx</td>
<td>-</td>
<td>Not Good</td>
<td>Not Good</td>
<td>Ideal</td>
<td>Maybe</td>
</tr>
<tr>
<td>Severe sx</td>
<td>-</td>
<td>Not Good</td>
<td>Not Good</td>
<td>Maybe</td>
<td>Ideal</td>
</tr>
<tr>
<td>Mod-Ser HS</td>
<td>-</td>
<td>Not Good</td>
<td>Not Good</td>
<td>Maybe</td>
<td>Ideal</td>
</tr>
</tbody>
</table>

* Unless airway compromise or unstable in BLS care

**Potential for Inequitable Access to Regional Advanced Centers**


© 2015 Vindico Medical Education
How Must We Change in Light of the Compelling EVT Evidence of Benefit?

- Who are the right patients?
- What are the right places?
- How soon is the right amount of time?
  - 6 vs 8 vs 12 hours?
  - Is time relevant if imaging is favorable?
- How should we accomplish this?

Drip and Ship: Turning tPA Treatment Online in Community Hospitals

Pick Your First Dance Partner Carefully

For EVT in Stroke: Median hospital-to-hospital distance was 14.7 (IQR 8.5–21.3) miles and median transfer time was 104 (IQR 80–135) min. Odds of treatment decrease by 2.5% for every min of transfer time.


© 2015 Vindico Medical Education
How Must We Change in Light of the Compelling EVT Evidence of Benefit?

- Who are the right patients?
- What are the right places?
- How soon is the right amount of time?
- How should we accomplish this?
  - What changes to the stroke system of care?
  - Focus on STEEEP, the 6 IOM domains of quality
    - Safe
    - Timely
    - Effective
    - Efficient
    - Equitable
    - Patient-centered

An Educated Consumer is our Best Customer, …In Any Language!

Paradigm for Regionalization of Stroke Care

© 2015 Vindico Medical Education
Going Beyond the mRS: The ICHOM Stroke Standard Set

<table>
<thead>
<tr>
<th>Category</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute complications</td>
<td>Symptomatic ICH after thrombolysis</td>
</tr>
<tr>
<td>Survival and disease control</td>
<td>All-cause mortality</td>
</tr>
<tr>
<td>Patient-reported health status</td>
<td>Self-report of new stroke after admission</td>
</tr>
<tr>
<td>Cognitive and Psychiatric Function</td>
<td>Move and dress, ability to communicate</td>
</tr>
<tr>
<td>Motor Function</td>
<td>Walking, transfer, self-care and dressing</td>
</tr>
<tr>
<td>Social Function</td>
<td>Ability to communicate</td>
</tr>
<tr>
<td>General Health Status</td>
<td>Patient-reported general health status</td>
</tr>
<tr>
<td>Health-related QOL</td>
<td>Global patient-reported health well - QOL</td>
</tr>
</tbody>
</table>

Discharge 90 days

- Single
- Single

Why Telemedicine for Acute Stroke?

- Cost effective sustainable way to staff a low frequency, high impact event
- Level playing field for smaller hospitals with limited neurology coverage
- Standardize care across a network or state
- Support development of stroke centers in community with high quality at lower cost setting
- Evaluate and treat more patients with tPA to reduce disability and save money
- Transfer appropriate cases for advanced treatments like thrombectomy
Acute Ischemic Stroke: Overcoming Barriers by Improving Systems of Care

INSTINCT: Barriers to tPA Use Survey

TeleStroke Addresses Each of These Barriers


TeleStroke is Spreading Across Europe and the US


TeleStroke is Cost Effective

- Payer
  - Short-term increase in costs w/break- even at 90 days

- Health Care System
  - Greater value per health care $ spent


© 2015 Vindico Medical Education
Acute Ischemic Stroke: Overcoming Barriers by Improving Systems of Care

Table 1. Recommendations

| Recommendation | Achievable
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Update to professional guidelines</td>
</tr>
<tr>
<td>2. Develop, or revamp, DBM and interhospital referral patterns</td>
</tr>
<tr>
<td>3. Implementation of CT angiography at EDs and ICUs</td>
</tr>
<tr>
<td>4. Programs to facilitate rapid administration of tPA should be maintained and strengthened</td>
</tr>
<tr>
<td>5. Participation in registries</td>
</tr>
<tr>
<td>6. Feedback on quality of care using standardized performance measures</td>
</tr>
<tr>
<td>7. Certification programs for interhospital-capable centers</td>
</tr>
</tbody>
</table>

Smith EE, Schwamm LH. Stroke. 2015;46:1462-1467.

Really Radical Redesign? Volunteers Giving IV tPA at the Minute Clinic!

Educational Tools for Your Clinical Practice

Downloadable handouts, patient education tools, and online resources all available now in one convenient location: VindicoCME.com/EducationalTools

© 2015 Vindico Medical Education