STROKE NETWORK UPDATE

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DISCLOSURES

• None

OBJECTIVES

• Discuss
  • Regional stroke systems of care in NW OHIO
  • Evolution of Telestroke Network
  • Recent advances in endovascular stroke treatment
  • Endovascular stroke treatment outcomes
STROKE SYSTEM OF CARE

- A comprehensive, diverse, longitudinal system that address all aspects of stroke care in an organized and coordinated manner
- Spans the spectrum of stroke care from primary prevention, calling 9-1-1, acute care, secondary prevention, rehabilitation, return to the community
- As with any system, it is only as strong as its weakest link

STROKE SYSTEMS: EMS

- EMS - First point of contact
  - Trained dispatchers
  - Paramedics trained in stroke recognition
  - Deliver patients to nearest ER capable of acute stroke management
  - Pre-arrival notification

EMS

- Their initial assessments, actions, treatments, and decisions will have significant consequences in the patient's subsequent care
- Their role in patient triage, diversion, and routing cannot be under-estimated
CHARACTERISTICS OF DIFFERENT STROKE CENTERS

- Comprehensive Stroke Center
  - Academic Medical Center
  - Tertiary Care facility

- Primary Stroke Center
  - Wide range of hospitals:
  - standard stroke care; stroke unit;
  - use TPA

- Acute Stroke Ready Hospital
  - Rural hospitals; basic care;
  - drip and ship;
  - use tele-technologies

ACUTE STROKE READY HOSPITALS

- Typically small facilities
- Located remotely away from a PSC or CSC
- Typically serve small cities or rural populations
- Stroke population small; likely 1 patient a week on average
- Limited staffing and bed availability
- Concept: EMS would take patient to nearest ASRH for:
  - 1. initial diagnosis
  - 2. acute stabilization
  - 3. acute treatments
  - 4. then send patient to nearest PSC or CSC

STROKE SYSTEMS

- SPOKES / PRIMARY STROKE CENTER
  - Able to care for uncomplicated stroke patients
  - Have access to advance imaging (CT/CTA ± MRI/MRA) and emergent neurology support (In-house or via telestroke system)
  - Initiate IV tPA treatment in safe and efficient manner
  - Admit post IV tPA patient if they have stroke unit/primary stroke center designation
STROKE SYSTEMS

• HUB / COMPREHENSIVE STROKE CENTER
  • Able to care for complex stroke patients
  • Endovascular stroke, aneurysm coiling/clipping, AVM/AV fistulas treatments
  • Availability of
    • Vascular neurologists & Neurosurgeons
    • Neurointerventionalists
    • Neurointensivists
    • Neuroradiologist
    • Neuro-rehab team

• The creation of PSCs is strongly recommended (Class I, Level B).
• The development of CSC is recommended (Class I, Level C)
• Certification of stroke centers by an external body, such as JCAHO, is encouraged (Class I, Level B)
• Patients should be transported rapidly to the closest available certified PSC or CSC or, if no such centers exist, the most appropriate institution that provides emergency stroke care as described in the statement (Class I, Level of Evidence A). In some instances, this may involve air medical transport and hospital bypass. (Revised from the previous guideline13)

REGIONAL STROKE HUBS

University of Toledo Medical Center
Promedica Toledo Hospital

DISCLAIMER: NEITHER OF THESE HOSPITALS HAVE COMPREHENSIVE STROKE CENTER DESIGNATION AS OF NOW
TELESTROKE NETWORK – BRIDGE BETWEEN HUB & SPOKE

NETWORK PARTNERS

TOLEDO HOSPITAL
- Negro Hospital
- Perrine Hospital
- St. Luke’s Hospital
- Bellevue Hospital
- Lynn Municipal Hospital
- Defiance Hospital
- Flower Hospital
- Hillsdale Hospital, MI
- Mercy Hospital at Monroe, MI
- Rudy and Herrick Hospitals, MI

UTMC
- Henry County Hospital
- Wood County Hospital
- Firelands Regional Medical Center
- Magruder Hospital
- Fulton County Hospital
TELESTROKE SYSTEM

• Mobile cart at the spoke ER and ICUs
• Real time 2 way AV connectivity through desktop or portable device (laptop, smartphone etc.)

TELESTROKE

Audebert et al. Cerebrovasc Dis 2005

BENEFITS OF TELESTROKE SYSTEM OF CARE

• Outcomes comparable to Comprehensive Stroke Center
• No increase in complication rate
BENEFITS OF TELESTROKE SYSTEM OF CARE

Impact of Telemedicine Implementation in Thrombolytic Use for Acute Ischemic Stroke: The University of Pittsburgh Medical Center Telestroke Network Experience

Edilberto Amorim, MD,* Min-Mei Shih, MD,* Chou-Feng Chen†, Steven A. Koehler, MD,* Lori L. Maxson, CNS,‡ Syed F. Zaidi, MD,* Mohammad A. Jumaa, MD,* Vivek K. Reddy, MD,* Maxim D. Hammer, MD,* Tudor G. Jovin, MD,* and Lawrence R. Wechsler, MD,*

*Journal of Stroke and Cerebrovascular Diseases, Vol. 22, No. 4 (May), 2013, pp 527-531

• Increase # of tPA treatments
• Decreased instances of protocol deviation
• Improved timing and efficiency

IMPACT OF TELESTROKE

• 12 months prior to telestroke networking
  • # of IV tPA treatments = 2

• 12 months post telestroke networking
  • # of IV tPA treatments = 8

NEUROINTERVENTIONAL STROKE SERVICE

JUL 2012 – NOV 2014
IMS 3

- Started in 2004
- NIH funded
- IV tPA + Intervention VS. IV tPA – 2:1
- NIHSS 8 or >
- Planned >900 Pt
IMS III – Crossed Futility Boundary

- Upon recommendation of the DSMB, NINDS stopped enrollment for the IMS 3 trial in April 2012 because a predefined futility boundary was crossed, based upon the low conditional power, given an expected difference of 10% between the two groups and a sample size of 900. There were no significant safety concerns.
- 656 subjects had been enrolled.
- Executive Committee became unblinded in August after all subjects completed their 90 day follow-up.

90-Day Modified Rankin Scale by Baseline NIHSS Strata and Treatment

<table>
<thead>
<tr>
<th>NIHSS 5-10</th>
<th>NIHSS ≥20</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>IV LPA only</td>
<td>Endovascular</td>
<td>IV LPA only</td>
</tr>
<tr>
<td>MRS n=2 (%)</td>
<td>146 (48.8)</td>
<td>74 (89.3)</td>
</tr>
<tr>
<td>Risk Difference</td>
<td>4.01 (0.11, 7.90)</td>
<td>0.87 (0.04, 1.70)</td>
</tr>
<tr>
<td>CMH p-value</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td>Breakday p-value</td>
<td>0.27</td>
<td></td>
</tr>
</tbody>
</table>

Randomized (n=656)

- Endo (n=336)
  - Did not receive angiogram (n=111)
    - Endovascular therapy not administered (n=48)
    - Endovascular therapy administered (n=63)
  - Received angiogram (n=225)
    - IV only (n=221)
    - IV life only (n=219)
IMS - CRITICISMS

STUDY SPECIFIC
- Selection criteria
  - Vessel imaging not a requirement: 100/434 patients in the IA arm did not receive any treatment.
  - Perfusion studies not mandatory

SITE SPECIFIC
- Poor rate of recanalization
- Selection Bias
- Plenty of low volume centers

SNIS STATEMENT

- The most reasonable way to perform an analysis of the IMS3 cohort is to look at patients with large vessel occlusion on CTA prior to randomization.
- There were 282 patients with confirmed large vessel occlusion on CTA.
- Statistically significant difference by the Van Elteren test with \( p \) value of 0.01 which meet the stringent pre-defined alpha value for secondary analysis of 0.01
RECENT STUDIES

- MR CLEAN- Netherlands
- ESCAPE- North America- Europe
- EXTEND IA- Australia
- SWIFT PRIME- International
- REVASCAT- Spain

HISTORY

- 33 year old woman post C section day # 10
- Family history of hypercoagulable state
- Sudden onset stroke symptoms while visiting her newborn in NICU
- NIHSS 14
FOLLOW UP

• NIHSS 3 next Am
  • Left facial droop
  • Mild sensory loss
  • Sensory extinction
• 90 days mRS = 1

TOLEDO ENDOVASCULAR STROKE EXPERIENCE

• JUL 2012 – Nov 2014
• 162 PATIENTS
  1 patient is currently in-hospital

BASELINE

DEMOGRAPHICS, CLINICAL & RADIOLOGICAL PRESENTATION,
TREATMENT TIMES AND SPECIFICS
DEMOGRAPHICS

- Mean Age 68
- WOMEN 91/162 (56%)
- HTN 78%
- DM 40%
- AFIB 42%
- CAD 41%
- DYSLIPIDEMIA 70%
- SMOKING 30%

BASELINE CHARACTERISTICS

- Median NIHSS 18, IQR (14-22)
- Pretreatment scan for selection:
  - Plain Head CT: 118 (73%)
  - CT Perfusion: 37 (23%)
  - MRI DWI: 7 (4%)
  - Mean ASPECT score 8

CASE: MULTIMODAL NEUROIMAGING

49 YO WOMAN WITH SLURRED SPEECH & MILD LHP X 24 HRS – NIHSS 6
PRE & POST INTERVENTION

POST PROCEDURE SCAN

FOLLOW UP

- Clinically improved – NIHSS 5 @ 48 hrs
- Discharged to rehab
- mRS 2 @ 90 days
TREATMENT TIMES

- TIME TO ONSITE ARRIVAL (MINS)
  - Median 156 (IQR 68-312)
  - Mean 227 (SD 252)

- TIME TO GROIN PUNCTURE (MINS)
  - Median 258 (IQR 180-406)
  - Mean 354 (SD 325)

TIMES – CONT.

- TIME TO RECANALIZATION (MINS)
  - Median 339 (IQR 240-470)
  - Mean 430 (SD 351)

- PROCEDURE TIME (MINS)
  - MEDIAN 60 (IQR 45-95)
  - MEAN 71 (SD 41)

OCCLUSION SITE

- MCA M1 – 91 (56%)
- MCA M2 ONLY – 11 (7%)
- ICA T – 30 (18%)
- Tandem – 19(12%)
- Basilar – 11 (7%)
- Side – 52% Left hemispheric
81 yo woman with NIHSS 21. Last known well over 8 hrs ago …
FOLLOW UP

- Patient improved on the table
- Discharged home
- Mild expressive hesitancy – no other deficits
- Clinically back to baseline @ 3 months
- mRS - 0

TREATMENT SPECIFICS

- Pre treatment with IV tPA
  - IV tPA: 65/162 (40%)

- IA tPA – 21 (13%)

- IA tPA Only – 6 (4%)

TREATMENT SPECIFICS

- MERCI – 25 (15%)

- Stentreiver – 78 (48%)
### TREATMENT SPECIFICS

- Penumbra separator – 2 (1%)
- Proximal ICA stenting – 14 (12%)
- Aspiration Alone – 44 (27%). ADAPT:12, Manual 32

### MANUAL ASPIRATION

**Stroke**

Manual Aspiration Thrombectomy: Adjunctive Endovascular Recanalization Technique in Acute Stroke Interventions

Brian Jankowitz, Azim Aghaiehosseini, Alexander Zareh, Osas Sagijie, Saeid Zard, Mostyomad Javan, Guerino Reza, Ana, Michael Berwitz, and Talef V. Jovin

*Stroke. 2012;43(1):140-1411, originally published online March 1, 2012; doi: 10.1161/STROKEAHA.111.648317*

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### MANUAL ASPIRATION - ADAPT TECHNIQUE

Initial clinical experience with the ADAPT technique: A direct aspiration first pass technique for acute ischemic stroke.
RESULTS
RECANALIZATION, CLINICAL OUTCOMES & COMPLICATIONS

RECANALIZATION

COMMENTARY
TIMI, TICI, I Cast, I Saw, I Got Confused

Randomized trials of interventional treatments for acute ischemic stroke have not shown a consistent benefit, and it is crucial to confirm and extend the findings. Clinical studies and reviews continue to be conducted and published with different or similar methods of measurement of the primary endpoints. This is a relevant problem because most studies are performed in multiple centers, and the techniques and results may differ. The results of the recanalization of the middle cerebral artery "CACTUS" study are published with minor differences in terms of safety, efficacy, and outcomes.

A thorough analysis of the results of the updated literature analysis of the middle cerebral artery "CACTUS" study is published with minor differences in terms of safety, efficacy, and outcomes. A thorough analysis of the results of the updated literature analysis of the middle cerebral artery "CACTUS" study is published with minor differences in terms of safety, efficacy, and outcomes.
WHAT IS GOOD RECANALIZATION?

<table>
<thead>
<tr>
<th>TICI Grade flow</th>
<th>TIMI Grade Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>TICI0</td>
<td>TIMI 0</td>
</tr>
<tr>
<td>No perfusion</td>
<td>No perfusion</td>
</tr>
<tr>
<td>TICI1</td>
<td>TIMI 1</td>
</tr>
<tr>
<td>Penetration</td>
<td>Perfusion past the initial occlusion, but no distal branch filling</td>
</tr>
<tr>
<td>With Minimal Perfusion</td>
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</tr>
<tr>
<td>The contrast material passes beyond the area of obstruction but fails to opacify the entire cerebral bed distal to the obstruction for the duration of the angiographic run.</td>
<td></td>
</tr>
<tr>
<td>TICI2a</td>
<td>TIMI 2</td>
</tr>
<tr>
<td>Only partial filling (&lt;2/3) of the entire vascular territory is visualized.</td>
<td></td>
</tr>
<tr>
<td>TICI2b</td>
<td>TIMI 3</td>
</tr>
<tr>
<td>Complete filling of all of the expected vascular territory is visualized, but the filling is slower than normal.</td>
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</table>

RESULTS - RECANALIZATION

- TIMI 2 & 3
  - 138/162 (85%)
- TICI 2B & 3
  - 116/162 (72%)
RESULTS - OUTCOMES

Favorable outcome 66/162 (40.7%)

RESULTS - OUTCOMES BASED ON RECANALIZATION

Favorable outcome in TICI2B/3 group: 51%
Favorable Outcome in non-recanalized patients: 11%

RESULTS - OUTCOMES

• Overall mortality 39/162 (24%)
VARIABLES INFLUENCING OUTCOME

- Age
  - Mean age in patients with favorable outcome
    63 VS. 70, p 0.003

- Recanalization
  - 51% VS. 11%, p <0.01

AGE – THE “KEY” FACTOR
82 YEAR OLD WITH RT MCA OCCLUSION – NIHSS 20 – OTT 135 MINS

R ICA TERMINUS OCCLUSION
FOLLOW UP

• Excellent clinical recovery

• NIHSS 0 @ 24 hrs

• Discharged home on Day # 3
Sometimes you can not reach

56 yom with transient LOC and a residual visual field deficit became comatose on day of D/C. Not a tPA candidate

Sometimes you can not reach

Attempted access for 4 hours, injected 20 mg tPA in r occipital and L VA

Sometimes you can not reach

Patient was locked in for 45 days, died due to multi-system failure
Sometimes you should not try

75 yof with multiple comorbidities presented 2 hours after a R ICA syndrome with NIHSS of 18

Patient received IV tPA

CTA showed tandem occlusion

CTP showed severe perfusion profile

Sometimes you should not try

Angio shows tandem occlusion, stenting of proximal lesion was performed
Sometimes you should not try angioplasty and stenting was performed.

Sometimes you should not try balloon was reinflated to stop the bleeding. Patient did poorly.

Sometimes you can not win 48 YOF with multiple comorbidities was in cath lab holding area after NSTEMI when she had a severe L ICA syndrome, NIHSS 24.
Sometimes you can not win

CT head did not show any acute changes, tPA not given due to being on Heparin gtt and recent MI. Angio showed L ICA terminus occlusion, recanalized in 80 minutes from onset time.

Patient had a large stroke with rapid edema (likely reperfusion injury). She herniated within 24 hours. Family did not want surgical tx.

COMPLICATIONS

- HT 1 & 2 – 16%
- Parenchymal Hemorrhage – 10 (6%)
- Perforation/SAH – 2
- Distal embolization to a new territory – 5
### SOME PERSPECTIVE …

<table>
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<tr>
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<th>TREVO</th>
<th>SWIFT</th>
<th>IMS 3</th>
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<tbody>
<tr>
<td>Recanalization %</td>
<td>78</td>
<td>68.5*</td>
<td>44</td>
</tr>
<tr>
<td>90 Day mRS 0-2 %</td>
<td>55</td>
<td>36.3</td>
<td>40.8</td>
</tr>
<tr>
<td>90 Day Mortality %</td>
<td>20</td>
<td>17</td>
<td>19.1</td>
</tr>
<tr>
<td>Major Hemorrhage %</td>
<td>5</td>
<td>1.7</td>
<td>6.2</td>
</tr>
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### TOLEDO

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<tbody>
<tr>
<td>Recanalization %</td>
<td>72%</td>
<td></td>
</tr>
<tr>
<td>90 Day mRS 0-2 %</td>
<td>41%</td>
<td></td>
</tr>
<tr>
<td>90 Day Mortality %</td>
<td>24%</td>
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</tr>
<tr>
<td>Major Hemorrhage %</td>
<td>5.1%</td>
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### MR CLEAN (N) | TOLEDO (N 162)

<table>
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<tr>
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<th>MR CLEAN (N)</th>
<th>TOLEDO (N 162)</th>
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<tbody>
<tr>
<td>AGE</td>
<td>65</td>
<td>68</td>
</tr>
<tr>
<td>NIHSS</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>% IV tPA</td>
<td>87</td>
<td>40</td>
</tr>
<tr>
<td>% MCA</td>
<td>41</td>
<td>56</td>
</tr>
<tr>
<td>% RECANALIZATION</td>
<td>59</td>
<td>72</td>
</tr>
<tr>
<td>% FAV OUTCOME</td>
<td>33</td>
<td>41</td>
</tr>
</tbody>
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Thank you