Pre-Hospital Scales to Assist in the Detection of Severe Stroke Syndromes

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Kennestone Hospital
Acute Care of Ischemic Stroke
Acute Stroke Management

• Intravenous tissue Plasminogen Activator (IV tPA)
  • Standard of care – approved by FDA
  • Works by dissolving clots
  • Shown improved outcome at 3-month post-stroke compared to placebo
  • Strict time window
    • Within 4.5 hours from LAST KNOWN NORMAL
    • More restrictions for 3 to 4.5-hour window
• Problems:
  • Many patients arrive at ER too late, or without known onset/last known normal time
  • Contraindicated for most patients on anticoagulation
  • Contraindicated for patient who had recent major surgery
    • Becomes problem especially after surgeries with high post-op stroke risks, such as valve replacement or CABG
  • **May not work too well for LARGE VESSEL OCCLUSIONS**
Large Vessel Occlusion

• What is LARGE VESSEL OCCLUSION?
  • Occlusion of large blood vessels, such as internal carotid arteries, middle cerebral arteries, or basilar arteries
  • Usually results in severe stroke given the larger area of ischemic damage
Large Vessel Occlusion

If occlusion happens here (large vessel)...

If occlusion happens here (small vessel)...

[Images of brain scans showing large vessel and small vessel occlusions]
Acute Stroke Management

- Endovascular intervention
  - Include Mechanical thrombectomy and stenting
  - Removal of large clots by threading a catheter through a femoral artery up to the blocked blood vessel in the brain and physically removing a clot, or placing a stent to open a blood vessel acutely occluded and causing a stroke
  - Also can infuse intra-arterial tPA
  - Different devices are available – stent retriever, thrombo-aspiration, clot retriever, etc
Endovascular Intervention for Stroke – How does it work?
ESCAPE

- 22 centers in Canada, US, Korea, UK and Ireland

- Randomized, open-label with blinded outcome evaluation, parallel group trial
  - *Intervention*: Endovascular mechanical thrombolysis with an approved approach/device (use of retrievable stents and balloon guide catheters recommended)
  - *Control*: Guideline-based standard of care (IV tPA if <4.5 hrs / stroke unit care)

M Goyal et al. Randomized Assessment of Rapid Endovascular Treatment of Ischemic Stroke. NEJM published on February 11, 2015
Inclusion Criteria

- Acute ischemic stroke
- Age ≥ 18 years
- Last-seen-well time to randomization < 12 hours
- ASPECTS >5
- Baseline NIHSS >5 at time of randomization
- Good functional status: pre-stroke modified Barthel Index >95, not living in a nursing home; fully independent
- Confirmed symptomatic intracranial occlusion based on CTA in anterior anatomy (Carotid T/L, M1, 2 or more M2’s not including the anterior temporal artery)
- Moderate to good collaterals on CTA
- Endovascular treatment can be initiated within 60 minutes of baseline NCCT with target CT to first recanalization of 90 minutes

# Baseline Imaging

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Intervention (N=165)</th>
<th>Control (N=150)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT ASPECTS median (IQR)</td>
<td>9 (8-10)</td>
<td>9 (8-10)</td>
</tr>
<tr>
<td>CTA occlusion Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICA “T” or “L”</td>
<td>27.6%</td>
<td>26.5%</td>
</tr>
<tr>
<td>M1 or both/all M2</td>
<td>68.1%</td>
<td>71.4%</td>
</tr>
<tr>
<td>M2</td>
<td>3.7%</td>
<td>2.0%</td>
</tr>
<tr>
<td>Ipsilateral cervical carotid occlusion</td>
<td>12.7%</td>
<td>12.7%</td>
</tr>
</tbody>
</table>

Revascularization

mRS 0-2 at 90-days (N=311)

Common adjusted odds ratio: 1.7 (95% CI: 1.3 to 2.2)

NNT = 4
for independence

## Safety Endpoints / Mortality

<table>
<thead>
<tr>
<th>Serious Adverse Events</th>
<th>Intervention (N=165)</th>
<th>Control (N=150)</th>
<th>Adjusted RR (CI 95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>10.4%</td>
<td>19.0%</td>
<td>0.5 (0.3 to 0.8)</td>
</tr>
<tr>
<td>Large MCA / malignant MCA stroke</td>
<td>4.8%</td>
<td>10.7%</td>
<td>0.3 (0.1 to 0.7)</td>
</tr>
<tr>
<td>sICH (clinically determined at site)</td>
<td>3.6%</td>
<td>2.7%</td>
<td>1.2 (0.3 to 4.6)</td>
</tr>
<tr>
<td>Access site hematoma</td>
<td>1.8%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>MCA perforation</td>
<td>0.6%</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>

SWIFT PRIME

• Methods:
  • Randomized, open-label with blinded outcome evaluation, parallel group trial
    • *Intervention*: IV tPA with Solitaire™ FR Device
    • *Control*: IV tPA alone
  • 39 enrolling sites in the U.S. and Europe
Inclusion Criteria

- Acute ischemic stroke
- Age 18-80
- Pre-stroke mRS ≤ 1
- ASPECTS ≤ 6
- Baseline NIHSS 8-29 at time of randomization
- Initiation of IV tPA within 4.5 hours of onset of stroke
- CTA or MRA confirmation of large vessel occlusion in ICA, M1 segment of MCA or carotid terminus
- Endovascular treatment can be initiated within 6 hours of onset of stroke symptoms and within 90 minutes from CTA/MRA to groin puncture

Results of the SWIFT PRIME Trial were presented by Dr. Jeffery Saver at the International Stroke Conference in Nashville, TN on Wednesday, February 11, 2015.
### Baseline Imaging

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>N</th>
<th>Intervention</th>
<th>N</th>
<th>Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT ASPECTS median (IQR)</td>
<td>97</td>
<td>9.0 (7-10)</td>
<td>96</td>
<td>9.0 (8-10)</td>
</tr>
<tr>
<td>CTA occlusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ICA</td>
<td>93</td>
<td>4.3%</td>
<td>94</td>
<td>4.3%</td>
</tr>
<tr>
<td>Carotid Terminus</td>
<td></td>
<td>14.0%</td>
<td></td>
<td>11.7%</td>
</tr>
<tr>
<td>M1</td>
<td></td>
<td>67.7%</td>
<td></td>
<td>77.7%</td>
</tr>
<tr>
<td>M2</td>
<td></td>
<td>14.0%</td>
<td></td>
<td>6.4%</td>
</tr>
</tbody>
</table>

Results of the SWIFT PRIME Trial were presented by Dr. Jeffery Saver at the International Stroke Conference in Nashville, TN on Wednesday, February 11, 2015.
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mRS 0-2 at 90-days

OR: 2.75 (95% CI: 1.53 to 4.95)

NNT = 4

P=0.0008

Results of the SWIFT PRIME Trial were presented by Dr. Jeffery Saver at the International Stroke Conference in Nashville, TN on Wednesday, February 11, 2015.
Safety Endpoints / Mortality

<table>
<thead>
<tr>
<th>Serious Adverse Events</th>
<th>Intervention (N=98)</th>
<th>Control (N=97)</th>
<th>OR (CI 95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death (p=0.50)</td>
<td>9.2</td>
<td>12.4</td>
<td>0.72 (0.29 to 1.79)</td>
</tr>
<tr>
<td>Any serious adverse events</td>
<td>35.7%</td>
<td>30.9%</td>
<td>1.24 (0.68 to 2.25)</td>
</tr>
<tr>
<td>sICH at 27 hours</td>
<td>1%</td>
<td>3.1%</td>
<td>0.32 (0.03 to 3.16)</td>
</tr>
</tbody>
</table>

Results of the SWIFT PRIME Trial were presented by Dr. Jeffery Saver at the International Stroke Conference in Nashville, TN on Wednesday, February 11, 2015.
Evolution of IA Therapy Trials over time

Positive Trials
- PROACT II 1999
- MELT 2007
- MR Clean 2014
- ESCAPE 2015
- EXTEND IA 2015
- SWIFT PRIME 2015
- REVASCAT 2015
- THRAVE 2015
- THERAPY 2015

Negative Trials
- IMS III 2013
- MR Rescue 2013
- Synthesis 2013

Recanalization rate over time
- Micro-catheter 1990s
- MERCI 2004
- Penumbra 2008
- Stent-retriever 2012
The Number Needed to Treat:
In order to have as stroke patient independent at 90 days

Primary PCI vs. Thrombolysis for STEMI:
Prevention of MI/Stroke/Death
Evidence-Based Practice

• Large vessel occlusion; distal ICA, M1, A1, or proximal M2 or A2

• Small infarct volume (ASPECTS > 5 on non-contrast CT, < 70 cc core on CTP/MRI)

• Selection criterion can be either through ASPECTS scoring on non-contrast CT or CT perfusion

• Lower boundary of NIHSS threshold of 2-8 depending on trial; but > 75% of patients enrolled with NIHSS > 12

• Groin puncture < 6 hours from onset

  • Imaging to groin puncture <60 minutes
  • Imaging to reperfusion <90 minutes
Scenario 1

Within minutes a trained paramedic crew has established the diagnosis of acute myocardial infarction (AMI), and transmits an ECG electronically to a myocardial infarction center, where a coordinator mobilizes the catheter laboratory staff to prepare for angioplasty.

On instruction from the cardiologist coordinator, the trained staff administer drugs (Aspirin and plavix) and consents the patient for coronary intervention. The patient does not go to the nearest ER but rather the PCI capable facility
An ambulance arrives and the patient is taken to the nearest hospital, where an ECG establishes the diagnosis of an AMI. Intravenous streptokinase is given, but after 90 minutes chest pain continues and the ST segments have not shifted.

A decision is made to transfer the patient to a percutaneous coronary intervention (PCI) center. The process takes several hours
Problem

- There remain **significant** delays in stroke victims seeking and receiving medical attention
- TPA utilization remains low
Primary Stroke Center (PSC)
- Stabilize and provide emergency care for patients with acute stroke
- Either admit or transfer to a CSC
- Over 1,000 PSCs to date

Comprehensive Stroke Center (CSC)
- Have the capability to support all needed levels of care to stroke patients, including
  - Special interventions
  - Highly technical procedures
- 74 certified CSCs to date (began 9/2012)

http://www.qualitycheck.org/StrokeCertificationList.aspx
Current Stroke System of Care

CSC Hub

PSC Spoke

EMS

EMS

EMS

EMS

EMS
Assessing Time Delays in a System

Sun CH et al. Circulation 2013
How should we reorganize our stroke systems of care?

a) Where should EMS bring stroke patients?
b) Severity adjusted triage of patients by EMS
c) Mobile Stroke Units to facilitate early recognition, appropriate triage, and quicker rtPA and IAT treatment
Trauma Systems: Saving Lives

“...The Golden Hour is critical for injured patients. Getting them to the right place at the right time saves lives.”

1. Injury

2. Life Threatening Injuries
   - To Trauma Center
     - Ready Trauma Team Available 24/7
       - Trauma Surgeons
       - Trauma Nurses
       - Speciality Surgeons
       - Anesthesiologists
       - Other Specialists and Support
     - Specialty ICU Treatment
       - Trauma Program Manager
     - Rehabilitation
   - Home

3. Emergency Medical Systems (Pre-Hospital)
   - Triage
   - Stabilization
   - Communication
   - Transportation
   - To Emergency Room (ER) / Emergency Department (ED)
     - ER / ED Staff Available On-Call
       - Physicians
       - Nurses
       - Surgeons

4. Less Serious Injuries
   - Hospital Stay
Stroke Treatment Decisions Hinge on the CT Scan

- BP control
- IV tPA (clot buster)
- Transport to Primary Stroke Center

- BP control
- Warfarin reversal
- Mannitol
- Anti-epileptic medications
- Transport to Comprehensive Stroke Center
Future Stroke System of Care

CSC Hub

EMS

PSC Spoke

EMS

PSC Spoke

EMS

PSC Spoke

EMS

PSC Spoke

EMS
Stroke Screen/Scales
Stroke Screen/Scales

**IDENTIFY stroke**
“Is she/he having a stroke?”

- FAST
- MEND
- CPHSS
- LAPHSS

**DETERMINE SEVERITY of stroke**
“Does she/he need endovascular intervention?”

- RACE
- CPSSS
- LAMS
FAST

- FAST = Face, Arms, Speech, Time
- Designed for quick detection of stroke
- If any of the first three (face, arms, or speech) is positive (i.e. abnormal), TIME to call 911
- Pros
  - Simple and easy
  - Easy to remember
- Cons
  - False positives
CPHSS

- CPHSS = Cincinnati PreHospital Stroke Scale
- To identify stroke
- Pros: Easy to use, simple, quick
- Cons: Does not differentiate LVO

- If 1 of 3 positive - 72% probability of an stroke
- If all 3 findings positive – probability of an stroke is more than 85%

RACE

- RACE = Rapid Arterial Occlusion Evaluation
- To identify stroke AND DIFFERENTIATE LVO

- Score of ≥5 – high sensitivity (85%) and specificity (65%) to identify LVO

<table>
<thead>
<tr>
<th>Item</th>
<th>RACE Score</th>
<th>NIHSS Score Equivalence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial palsy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mild</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Moderate to severe</td>
<td>2</td>
<td>2-3</td>
</tr>
<tr>
<td>Arm motor function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal to mild</td>
<td>0</td>
<td>0-1</td>
</tr>
<tr>
<td>Moderate</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Severe</td>
<td>2</td>
<td>3-4</td>
</tr>
<tr>
<td>Leg motor function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal to mild</td>
<td>0</td>
<td>0-1</td>
</tr>
<tr>
<td>Moderate</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Severe</td>
<td>2</td>
<td>3-4</td>
</tr>
<tr>
<td>Head and gaze deviation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Present</td>
<td>1</td>
<td>1-2</td>
</tr>
<tr>
<td>Aphasia* (if right hemiparesis)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performs both tasks correctly</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Performs 1 task correctly</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Performs neither tasks</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Agnosia† (if left hemiparesis)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient recognizes his/her arm and the impairment</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Does not recognize his/her arm or the impairment</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Does not recognize his/her arm nor the impairment</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Score total</td>
<td>0-9</td>
<td></td>
</tr>
</tbody>
</table>
CPSSS

- CPSSS = Cincinnati Prehospital Stroke Severity Scale
- Sensitive for identifying severe stroke (NIHSS ≥15)
- Score ranges from 0-4
  - Score ≥2 – sensitive and specific in identifying NIHSS ≥15
  - For 222 of 303 IMS III subjects with LVO, score ≥2 was 83% sensitive, 40% specific in predicting LVO

**Cincinnati Prehospital Stroke Severity Scale**

- **2 points:** Conjugate gaze deviation (≥1 on NIHSS item for Gaze)
- **1 point:** Incorrectly answers at least one of two level of consciousness questions on NIHSS (age or current month) **and** does not follow at least one of two commands (close eyes, open and close hand) (≥1 on the NIHSS item for Level of Consciousness 1b and 1c)
- **1 point:** Cannot hold arm (either right, left or both) up for 10 seconds before arm(s) falls to bed (≥2 on the NIHSS item for Motor Arm)
LAMS

- LAMS = Los Angeles Motor Scale
- Predicts presence of large vessel occlusion with high sensitivity and specificity
- 1-2 goes to PSC, 3-5 (or AMS) goes to CSC
- Promising instrument for use by prehospital personnel to identify select stroke patients for direct transport to Comprehensive Stroke Centers capable of endovascular interventions (Stroke.2008;39:2264-2267)

Table 1
The Los Angeles Motor Scale (LAMS)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Facial droop</td>
<td>Absent</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Present</td>
<td>1</td>
</tr>
<tr>
<td>Arm drift</td>
<td>Absent</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Drifts down</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Falls rapidly</td>
<td>2</td>
</tr>
<tr>
<td>Grip strength</td>
<td>Normal</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Weak grip</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>No grip</td>
<td>2</td>
</tr>
</tbody>
</table>

Total Possible = 5
**Stroke Symptoms**

0-3.5 hours Symptom onset

- Hemiplegia
  - NO: Closest Stroke Center
  - YES: Go to Closest Stroke Center

- If travel time to Comprehensive Stroke Center < 30 min
  - NO: Go to Closest Stroke Center
  - YES: Direct to CSC

>3.5 hours, On anticoagulation, Wake up stroke

- Hemiplegia
  - NO: Closest Stroke Center
  - YES: Direct to CSC
New Technologies
Infrascanner 2000

• Near InfraRed (NIR) spectroscopy - based on the differential light absorption associated with the injured versus the non-injured parts of brain.
• Compares the left and right sides of the brain in four different areas. The NIRS sensor is placed successively in the left and right frontal, temporal, parietal, and occipital areas of the head and the absorbance of light at selected wavelengths is recorded.
• Measurement is completed within 2-3 minutes
• Detects hematomas greater than 3.5 cc in volume
• Detects hematomas up to 2.5 cm deep from the surface of the brain (or 3.5 cm from the skin surface)
• Accuracy: In patients with Epidural, Subdural and Intracerebral hematomas: Sensitivity = 88% / Specificity = 90.7%*

http://infrascanner.com/models/
Pulsara

- Pulsara App ([http://www.pulsara.com/stop-stroke](http://www.pulsara.com/stop-stroke))
  - Promising features – connects EMS, ED, neurologist, radiologist/CT in one click
  - Distance and ETA auto-calculated using GPS (available to see from ED/neurologist ends)
  - Information such as family contact entered by EMS immediately available to receiving stroke team – stroke care starts while the patient is en route!
  - Real-time updates from EMS
  - Easy case review for each cases – great feedback for improvement
New Technologies...

- Pulsara App (http://www.pulsara.com/stop-stroke)

GPS-navigated distance and ETA by entering destination and departure time

EMS can take pictures, put in contact info – ED and neurologist are able to access these information on their end
Mobile Stroke Units and Telestroke
Conclusions

- Exciting time for acute ischemic stroke patients as new treatments evolve

- Pre-hospital providers will be more engaged in the decision tree and triage of patients

- Technology that will image the brain in the field will be the EKG equivalent to help standardize triage approaches, clinical scales may be short term solutions

- Care must be taken to integrate CSC and PSC hospitals to provide optimal care for patients.
  * Overexuberance of bringing patients to CSC may lead to increased costs without benefits (i.e. patients with pre-existing disability)
  * Transparency of bed and operator availability to avert delays in patient care