EMS TRIAGE, ROUTING & BYPASS PROTOCOLS

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DISCLOSURES

• No financial conflicts of interest
OBJECTIVES

• The era of acute stroke treatment
• EMS triage in Utah
• Prehospital routing
• Stroke severity scales
• How stroke routing protocols might work in our region
A HISTORY OF STROKE

1 From the Greek Period to 1915, 3
2 Collateral Circulation, 29
3 Arteriography, 57
4 Cerebrovascular Surgery, 77
5 Medical Management of Cerebrovascular Disease, 104
6 Noninvasive Vascular Studies, 122
7 Hypertension and Stroke, 150
8 Epidemiology of Stroke, 169
9 Well-Known Persons Who Have Suffered Strokes, 177
Index, 203
TISSUE PLASMINOGEN ACTIVATOR FOR ACUTE ISCHEMIC STROKE

THE NATIONAL INSTITUTE OF NEUROLOGICAL DISORDERS AND STROKE rt-PA STROKE STUDY GROUP*
Role of Time – IV rtPA

Most Recent Pooled Analysis of IV rtPA Trials

- NINDS Part 1
- NINDS Part 2
- ATLANTIS A
- ATLANTIS B
- ECASS II
- ECASS III
- EPITHET

Lees et al., Lancet, 2010
TPA for Cerebral Ischemia within 3 Hours of Onset: Changes in Outcome Due to Treatment

Changes in final outcome as a result of treatment:
- **Green**: Normal or nearly normal
- **Light Green**: Better
- **White**: No major change
- **Red**: Worse
- **Dark Red**: Severely disabled or dead

Early course:
- **White**: No early worsening with brain bleeding
- **Medium Gray**: Early worsening with brain bleeding
EARLY CHALLENGES TO TPA USE

• Must be given 3-4.5 hours from sx onset
• Only 38% of stroke calls are made to EMS first
• Only 31.6% accessed the ED in <2 hours
• Only 8% of patients presenting to hospitals are eligible
• Only 1.8 – 8.5% of all US ischemic stroke patients receive tPA

EMS Assessment and Management Guidelines

Prompt stroke recognition and treatment by EMS is a critical component of acute stroke care. As an integral part of the Utah Stroke System, EMS will use a standardized prehospital treatment protocol for suspected stroke patients. The following model EMS stroke protocol is provided as a guideline.

On Scene:

In Transit:

1. **Rapidly transport to closest Primary Stroke Center or Stroke Receiving Facility, if available.**
2. Bring witness or family member if possible, or record the names and phone numbers of witnesses.
3. Alert the receiving emergency department that a suspected stroke patient is en-route, so they can begin to activate their acute stroke team and be ready on arrival.
4. Check and record blood glucose to assess for hypoglycemia.
5. Check and record blood pressure. Do NOT administer any hypertensive medication without physician approval.
6. Establish cardiac monitoring and IV access with large bore catheter, if possible.
7. Keep NPO.
8. Bring medications or medication list.

- **Arm Drift** (have patient hold arms out for 10 seconds)
  - Normal: Both arms move equally or not at all
  - Abnormal: One arm drifts compared to the other, or does not move at all

- **Speech** (have patient speak a simple sentence)
  - Normal: Patient uses correct words with no slurring
  - Abnormal: Slurred or inappropriate words, or mute

3. Establish and record an exact time, in military time, when patient was “Last Known Normal.”
UCLA PARAMEDICS: 4% OF RUNS ARE STROKES
HOW DO WE INCREASE TPA USE?

The solution to stroke: the D’s of Stroke Care

- Detection
- Dispatch: early activation (911) and dispatch of EMS
- **Delivery:** rapid EMS identification, mgmt, transport
- Door: appropriate triage to stroke center
- Data: rapid triage, evaluation, management within ED
- Decision: stroke expertise, therapy selection
- Drug: tPA, intra-arterial strategies
- Disposition: rapid admit to stroke or critical care unit
## Emergency Stroke Recognition Scores

*Purrucker et al. JNNP, 2014.*

<table>
<thead>
<tr>
<th>Stroke recognition</th>
<th>CPSS</th>
<th>FAST</th>
<th>LAPSS*</th>
<th>MASS</th>
<th>Med PACS</th>
<th>ROSIER</th>
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<tbody>
<tr>
<td>Consciousness/orientationn</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Gaze</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>●</td>
<td>–</td>
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<tr>
<td>Visual</td>
<td>–</td>
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<td>●</td>
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<tr>
<td>Facial palsy</td>
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<tr>
<td>Motor arm</td>
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<td>Motor leg</td>
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<td>–</td>
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<tr>
<td>Ataxia</td>
<td>–</td>
<td>●†</td>
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<td>–</td>
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<tr>
<td>Sensory</td>
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<td>–</td>
<td>–</td>
<td>–</td>
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<td>Language</td>
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<td>●†</td>
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<td>Dysarthria</td>
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<td>●†</td>
<td>–</td>
<td>●</td>
<td>●</td>
<td>●</td>
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<tr>
<td>Age limit (years)</td>
<td>–</td>
<td>–</td>
<td>45</td>
<td>45</td>
<td>–</td>
<td>–</td>
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<tr>
<td>History and acute seizures/Epilepsy†</td>
<td>–</td>
<td>–</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
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<tr>
<td>Symptom duration (hours)</td>
<td>–</td>
<td>–</td>
<td>&lt;1217</td>
<td>–</td>
<td>≤25</td>
<td>–</td>
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<tr>
<td>Ambulatory prior to ictus</td>
<td>–</td>
<td>–</td>
<td>●</td>
<td>●</td>
<td>–</td>
<td>–</td>
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<tr>
<td>Blood glucose level (mg/dL)</td>
<td>–</td>
<td>–</td>
<td>60–400§</td>
<td>50–400**</td>
<td>60–400§</td>
<td>≥63††</td>
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</table>
SENSITIVITY VS SPECIFICITY

• CPSS and FAST are simple & good
• More complex ≠ better
META-ANALYSIS: LAPSS VS CPSS

- LAPSS and CPSS had similar diagnostic capabilities
- Use what’s comfortable
# Recanalization: IV TPA Alone

<table>
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<tr>
<th>del Zoppo 1992</th>
<th>ICA</th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
<th>All MCA</th>
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<tr>
<td>%</td>
<td>8.7</td>
<td>35.3</td>
<td>53.8</td>
<td>65.9</td>
<td>52.9</td>
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<tr>
<td>n</td>
<td>23</td>
<td>34</td>
<td>25</td>
<td>44</td>
<td>104</td>
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## ESCAPE: REPERFUSION RATES

<table>
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<tr>
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<th>Control</th>
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<tbody>
<tr>
<td></td>
<td>IV tPA</td>
<td>IV tPA</td>
</tr>
<tr>
<td></td>
<td>No IV tPA</td>
<td>No IV tPA</td>
</tr>
<tr>
<td>TICI 2b/3</td>
<td>70.5%</td>
<td>---</td>
</tr>
<tr>
<td>mAOL 2-3</td>
<td>---</td>
<td>37.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7.1%</td>
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</table>
TPA: NEW LABELING REVISED INDICATIONS CRITERIA

New FDA Labeling

- Routine update by FDA to assure prescribing information (PI) was consistent with 2006 physician labeling rule:
  - Standardize format of human drug and biological products
  - Provide clear and concise PI that is easier access, read, and use

*No new data were requested or reviewed by the FDA as part of this update*
THE BIG PICTURE

- When it comes to IV tPA recommendations, we have:
  - Old FDA labeling recommendations
  - Replaced with new FDA labeling recommendations
  - 2013 AHA/ASA guidelines
  - Augmented with new 2015 AHA/ASA ‘Scientific Rationale’ guidelines
ALTEPLASE FDA LABELING CHANGES

- Significant changes in the language introducing the contraindications

- "significant disability or death" → "situations in which the risk of bleeding is greater than the potential benefit."
SPECIFIC LABELING CHANGES: CONTRAINDICATIONS

- **Seizure** at onset in patient with AIS was removed
- **Previous stroke** in patients with AIS was removed
- **History of ICH** in patients was moved to Warnings and Precautions, and states as ‘recent ICH’
- Examples of lab tests under **bleeding diatheses** were removed
- Examples of **hypertension cutoff levels** were removed
SPECIFIC LABELING CHANGES:
WARNINGS AND PRECAUTIONS

• Minor neurological deficit or rapidly improving symptoms was removed

• Blood glucose warnings were removed

• Severe neurological deficits was removed from Warnings and Precautions, but added to “Adverse Reactions”

• Major early infarct signs was removed
LARGE VESSEL OCCLUSIONS

Arterial Circulation of the Brain, Including Carotid Arteries

- Circle of Willis
- Right Middle Cerebral Artery
- Basilar Artery
- External Carotid Arteries
- Vertebral Arteries
- Common Carotid Arteries
- Anterior Cerebral Artery
- Left Middle Cerebral Artery
- Anterior Communicating Artery
- Posterior Cerebral Artery
- Posterior Communicating Artery
- Internal Carotid Arteries

4-h recanalization by TCD or CTA (%)\textsuperscript{16}
Thrombectomy within 8 Hours after Symptom Onset in Ischemic Stroke

Effect of time on achieving mRS score of 0-2: patients undergoing thrombectomy only and achieving mTICI 2b-3.

SWIFT-PRIME
REVASCAT

Findings We analysed individual data for 1287 patients (634 assigned to endovascular thrombectomy, 653 assigned to control). Endovascular thrombectomy led to significantly reduced disability at 90 days compared with control (adjusted cOR 2.49, 95% CI 1.76–3.53; p=0.0001). The number needed to treat with endovascular thrombectomy to reduce disability by at least one level on mRS for one patient was 2.6. Subgroup analysis of the primary endpoint showed no heterogeneity of treatment effect across prespecified subgroups for reduced disability (p_inclusion=0.43). Effect sizes

\[ \text{NNT} = 2.6 \]
HERMES POOLED DATA: CONTROL SUBJECTS
WHAT DOES THIS MEAN?

- Subset (~20%) of stroke patients have large vessel occlusion (LVO)
- LVO doesn’t benefit from IV tPA
- LVO patients need the vessel opened as fast as possible
  - LVO can only be opened at a few high-volume centers with endovascular / intervention
- However... transfers to these specialized centers take time
SWIFT-PRIME: TRANSFER PENALTY

A

Mothership n=126

Drip and ship n= 66

<table>
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<tr>
<th>Event</th>
<th>Minutes</th>
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<tr>
<td>Onset to ED</td>
<td>65</td>
</tr>
<tr>
<td>ED to Imaging Start</td>
<td>17.5</td>
</tr>
<tr>
<td>Imaging Start to Qualifying</td>
<td>10</td>
</tr>
<tr>
<td>Qualifying to Randomization</td>
<td>37</td>
</tr>
<tr>
<td>Randomization to Puncture</td>
<td>23</td>
</tr>
<tr>
<td>Puncture to Deployment</td>
<td>24</td>
</tr>
<tr>
<td>Deployment to Reperfusion</td>
<td>7</td>
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</table>

Minutes (Median)
HERMES: TRANSFER PENALTY

<table>
<thead>
<tr>
<th></th>
<th>Direct admit</th>
<th>Transfer</th>
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<tbody>
<tr>
<td>Onset to ED</td>
<td>65</td>
<td>207</td>
</tr>
<tr>
<td>ED to imaging start</td>
<td>21</td>
<td>15</td>
</tr>
<tr>
<td>Imaging to randomization</td>
<td>50</td>
<td>29</td>
</tr>
<tr>
<td>Randomization to puncture</td>
<td>32</td>
<td>31</td>
</tr>
<tr>
<td>Puncture to reperfusion</td>
<td>42</td>
<td>47</td>
</tr>
</tbody>
</table>
Potential Impact of EMS Triage

- EMS Transport and Triage
- DTN
- Imaging to Reperfusion

30 mins 60 mins 90 mins 120 mins 150 mins 180 mins

Extra EMS time made up by faster DTN 30'

Faster DTG without additional imaging and transfer >>60'
EMS TRIAGE IN UTAH
EMS PROVIDERS IN UTAH

Skills

Can provide all skills that all EMTs can provide plus:

Patient Assessment
- Focused physical exams

Airway / Ventilation / Oxygenation
- Cricothyrotomy
- End-tidal CO2 detection
- Extubation
- Foreign body removal in obstructed airways
- Nasal intubations
- Needle jet insufflation
- Newborn resuscitation
- Oral Intubation (with ET tube and dual lumen airways)
- Orotracheal intubation
- Placement of NG and OG tubes
- Pulse-oximetry
- Replace trach tube through stomas

Cardiovascular/Circulation
- Cannulation of external jugular veins
- Cannulation of peripheral veins
- Defibrillation
- Drawing blood samples
- Interpretation of basic cardiac dysrythmias
- Intraosseous infusions in infants and children
- Intraosseous needle placement and infusion
- Newborn resuscitation
- Subclavian IV access

Miscellaneous
- Needle chest decompression
- Measuring blood sugar levels
- Administer medications orally, rectally, intramuscularly, intravenously, subcutaneously, endotracheal

Utah Bureau of EMS https://health.utah.gov/ems/
EMS PROVIDERS IN UTAH

<table>
<thead>
<tr>
<th>EMS Certification</th>
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<tr>
<td>EMERGENCY MEDICAL RESPONDER</td>
<td>185</td>
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<tr>
<td>EMT</td>
<td>5333</td>
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<tr>
<td>EMT-BASIC</td>
<td>3</td>
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<tr>
<td>ADVANCED EMT</td>
<td>3349</td>
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<tr>
<td>EMT-INTERMEDIATE</td>
<td>1</td>
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<tr>
<td>EMT-INTERMEDIATE ADVANCED</td>
<td>26</td>
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<tr>
<td>PARAMEDIC</td>
<td>1894</td>
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<tr>
<td>EMERGENCY MEDICAL DISPATCHER</td>
<td>753</td>
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<tr>
<td>MEDICAL DIRECTOR</td>
<td>28</td>
</tr>
<tr>
<td>EMS INSTRUCTOR</td>
<td>777</td>
</tr>
<tr>
<td>COURSE COORDINATOR</td>
<td>188</td>
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<tr>
<td>TRAINING OFFICER</td>
<td>357</td>
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Utah Bureau of EMS https://health.utah.gov/ems/
ONE SKILL TO UNITE THEM ALL

triage
/trēˈæZH, trēˈæZH/

noun
noun: triage

1. (in medical use) the assignment of degrees of urgency to wounds or illnesses to decide the order of treatment of a large number of patients or casualties.
   - the process of determining the most important people or things from amongst a large number that require attention.

verb
verb: triage; 3rd person present: triages; past tense: triaged; past participle: triaged;
gerund or present participle: triaging

1. assign degrees of urgency to (wounded or ill patients).

Get the right patient
To the right place
In the right amount of time
EXTREME TRIAGE
When in doubt, transport to a trauma center.
OVERTRIAGE

- Transporting a mild stroke patient to a CSC
- Worst case scenario?
  - Stroke center overload
  - Unnecessary, expensive transfers
  - Inconvenience for the patient/family
  - Unstable patient in long ride
- Stroke systems accept a certain amount of overtriage in order to keep life-threatening undertriage low.

UNDERTRIAGE

- Transporting a very sick patient to a SRF that will have to transfer again
  - OH: 4 hour delay for transfers
- Worst case scenario? The patient dies or suffers complications or disabilities that are avoidable.
- Many geriatric patients are never transferred
PRE-HOSPITAL ROUTING
WHO SHOULD BE REROUTED?

LARGE VESSEL OCCLUSION (LVO)?

- Population studied in recent IR trials
- Requires vessel imaging
- Rare: ~20% of AIS

HIGHER STROKE SEVERITY?

- Benefit of CSC
  - Mimics
  - Hemicraniectomy
  - ICH
  - Mortality
    - Neurologic ICU
    - 24-hour Neurosurgery and Neurology
    - Stroke Units
    - Cost-effectiveness?
  - High NIHSS as a LVO surrogate

WHO SHOULD BE REROUTED?

LARGE VESSEL OCCLUSION (LVO)?
• Requires vessel imaging

HIGHER STROKE SEVERITY?
WHICH SEVERITY SCALE SHOULD WE BE USING?

• NIHSS
• LAMS
• 3-Item Stroke Scale
• RACE
• C-STAT (previously known as the CPSSS)
NIH STROKE SCALE (NIHSS)

• Too complicated for the field
# LA MOTOR SCALE (LAMS)

<table>
<thead>
<tr>
<th></th>
<th>LAMS</th>
<th>Definition</th>
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<tbody>
<tr>
<td>Facial Droop</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>0</td>
<td>NIHSS 0-1</td>
</tr>
<tr>
<td>Present</td>
<td>1</td>
<td>NIHSS 2-3</td>
</tr>
<tr>
<td>Arm Drift</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>0</td>
<td>NIHSS 0</td>
</tr>
<tr>
<td>Drift down</td>
<td>1</td>
<td>NIHSS 1</td>
</tr>
<tr>
<td>Falls Rapidly</td>
<td>2</td>
<td>NIHSS 2-4</td>
</tr>
<tr>
<td>Grip Strength</td>
<td></td>
<td></td>
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<tr>
<td>Normal</td>
<td>0</td>
<td>Admission Exam 5/5</td>
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<tr>
<td>Weak</td>
<td>1</td>
<td>Admission Exam 2-4/5</td>
</tr>
<tr>
<td>No Grip</td>
<td>2</td>
<td>Admission Exam 0-1</td>
</tr>
</tbody>
</table>

Positive LAMS: ≥ 4

Naziel B. Stroke, 2008
Ferguson KN. Stroke, 2002.
LA MOTOR SCALE (LAMS)

**PROS:**
- Pure motor: Easy to teach & perform
- High inter-rater reliability
- Fast: 20-30 seconds to perform
- Predicts LVO
- Correlated NIHSS scores (r=0.75)
- Performed by prehospital providers

**CONS:**
- Not validated in peer-review
- Low derivation population

---

Naziel B. Stroke, 2008.
Ferguson KN. Stroke, 2002.
# 3-ITEM STROKE SCALE (3ISS)

<table>
<thead>
<tr>
<th>3ISS</th>
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<tbody>
<tr>
<td>0</td>
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<tr>
<td>1</td>
<td>Drowsy</td>
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<tr>
<td>2</td>
<td>Unarousable or Arousal required vigorous stimuli</td>
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<table>
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<th>3ISS</th>
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<tr>
<td>Absent</td>
<td>0</td>
<td>Normal</td>
</tr>
<tr>
<td>Partial</td>
<td>1</td>
<td>Can cross midline</td>
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<tr>
<td>Forced</td>
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<th>Hemiparesis (arm and/or leg)</th>
<th>3ISS</th>
<th>Definition</th>
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<tr>
<td>Absent</td>
<td>0</td>
<td>NIHSS 0</td>
</tr>
<tr>
<td>Mild</td>
<td>1</td>
<td>1 arm and/or leg</td>
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<tr>
<td>Severe</td>
<td>2</td>
<td>2 arm and/or leg</td>
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</table>

Positive 3ISS: $\geq 4$
**3-ITEM STROKE SCALE (3ISS)**

**PROS:**
- Prospective (171 patients)
- Fast: 20-30 seconds
- Easy to perform
- Reproducible -- ICC score: 0.947
  - Performed by Stroke Doctors
- Correlation w/ NIHSS: 0.954
  - Only on 20 patients

**CONS:**
- Moderate sensitivity for LVO
- Not validated
- Low derivation population
- Not yet evaluated by EMS or in the prehospital setting

---

**Table: 3ISS**

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<tr>
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<tbody>
<tr>
<td>Publication Year</td>
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<tr>
<td>Derivation n</td>
<td>171 Prospective Single Center</td>
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<td>Goal of scale</td>
<td>LVO Severe Stroke</td>
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<tr>
<td>Validation n</td>
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<tr>
<td># of items scored</td>
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<tr>
<td>Time to complete</td>
<td>20-30 second</td>
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<tr>
<td>Sensitivity/specificity severe stroke</td>
<td>NIHSS 14 86%/95%</td>
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<tr>
<td>Sensitivity/specificity LVO</td>
<td>67%/92%</td>
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<tr>
<td>Evaluated in prehospital setting</td>
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# Rapid Arterial Occlusion Evaluation (RACE)

**Facial Droop**
- Absent: 0 (NIHSS 0)
- Mild: 1 (NIHSS 1)
- Moderate-Severe: 2 (NIHSS 2-3)

**Arm Drift**
- Normal-mild: 0 (NIHSS 0-1)
- Moderate: 1 (NIHSS 2)
- Severe: 2 (NIHSS 3-4)

**Leg Drift**
- Normal-mild: 0 (NIHSS 0-1)
- Moderate: 1 (NIHSS 2)
- Severe: 2 (NIHSS 3-4)

**Gaze**
- Absent: 0 (NIHSS 0)
- Present: 1 (NIHSS 1-2)

**Aphasia** (*if right hemiparesis)*
- Both tasks correctly: 0 (NIHSS 0)
- 1 task correctly: 1 (NIHSS 1)
- 0 tasks correctly: 2 (NIHSS 2)

**Agnosia** (*if left hemiparesis)*
- Recognizes arm & deficit: 0 (NIHSS 0)
- Recognizes either arm or deficit: 1 (NIHSS 1)
- Recognizes neither arm or deficit: 2 (NIHSS 2)

**Mini-NIHSS (anterior circulation)**

Positive RACE: \( \geq 4 \)

---

RAPID ARTERIAL OCCLUSION EVALUATION (RACE)

- **PROS:**
  - 654 derivation population
  - Validated in prehospital setting
    - 357 patients
  - Weights both hemispheres equally
  - Most similar to NIHSS
  - High sensitivity

- **CONS:**
  - Longest scale
  - Only for LVO
  - Weakness both arms

<table>
<thead>
<tr>
<th></th>
<th>RACE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publication Year</td>
<td>2014</td>
</tr>
<tr>
<td>Derivation n</td>
<td>654</td>
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<tr>
<td>Goal of scale</td>
<td>LVO</td>
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<tr>
<td>Independently Validated</td>
<td>Validated</td>
</tr>
<tr>
<td>Validation n</td>
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</tr>
<tr>
<td># of items scored</td>
<td>5-6</td>
</tr>
<tr>
<td>Time to complete</td>
<td>Variable</td>
</tr>
<tr>
<td>Sensitivity/specificity</td>
<td>N/A</td>
</tr>
<tr>
<td>severe stroke</td>
<td></td>
</tr>
<tr>
<td>Sensitivity/specificity</td>
<td>85%/65%</td>
</tr>
<tr>
<td>LVO</td>
<td></td>
</tr>
<tr>
<td>Evaluated in prehospital setting</td>
<td>Yes</td>
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</tbody>
</table>

# CINCINNATI - STROKE TRIAGE ASSESSMENT TOOL (C-STAT)

## Positive C-STAT: ≥ 4

<table>
<thead>
<tr>
<th>C-STAT</th>
<th>DEFINITION</th>
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<tbody>
<tr>
<td>Gaze</td>
<td></td>
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<tr>
<td>Absent</td>
<td>0</td>
</tr>
<tr>
<td>Present</td>
<td>2</td>
</tr>
<tr>
<td>Arm Weakness</td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>0</td>
</tr>
<tr>
<td>Present</td>
<td>1</td>
</tr>
<tr>
<td>Level of Consciousness</td>
<td></td>
</tr>
<tr>
<td>Absent</td>
<td>0</td>
</tr>
<tr>
<td>Present</td>
<td>1</td>
</tr>
</tbody>
</table>

Katz BS. Stroke, 2015.
CINCINNATI - STROKE TRIAGE ASSESSMENT TOOL (C-STAT)

**PROS:**
- Largest derivation/validation cohort
- Weighted scale: Gaze getting 2 points
- CART analysis & Neuroanatomy
- Present/Absent questions (Not graded)
- Fast: < 1 minute
- High Sensitivity
- Completed prospective EMS study

**CONS:**
- Moderate Specificity of LVO

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Katz BS. Stroke, 2015.

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<table>
<thead>
<tr>
<th></th>
<th>C-STAT</th>
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<tbody>
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<td>Publication Year</td>
<td>2015</td>
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<tr>
<td>Derivation n</td>
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<tr>
<td>Goal of scale</td>
<td>Severe Stoke LVO</td>
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<tr>
<td>Independently Validated</td>
<td>Yes</td>
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<tr>
<td>Validation n</td>
<td>650</td>
</tr>
<tr>
<td># of items scored</td>
<td>3</td>
</tr>
<tr>
<td>Time to complete</td>
<td>&lt; 60 seconds</td>
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<tr>
<td>Sensitivity/specificity</td>
<td>NIHSS 15 89%/72%</td>
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<tr>
<td>Severe stroke</td>
<td>NIHSS 10 79%/89%</td>
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<tr>
<td>Sensitivity/specificity</td>
<td>83%/40%</td>
</tr>
<tr>
<td>LVO</td>
<td></td>
</tr>
<tr>
<td>Evaluated in prehospital</td>
<td>Ongoing</td>
</tr>
<tr>
<td></td>
<td>LAMS</td>
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<td>--------------------------------</td>
<td>------</td>
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<td>Derivation n</td>
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<td>Goal of scale</td>
<td>LVO</td>
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<td></td>
<td></td>
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<tr>
<td>Independently Validated</td>
<td>Yes</td>
</tr>
<tr>
<td>Validation n</td>
<td></td>
</tr>
<tr>
<td># of items scored</td>
<td>3</td>
</tr>
<tr>
<td>Time to complete</td>
<td>20-30 second</td>
</tr>
<tr>
<td>Sensitivity/specificity severe stroke</td>
<td></td>
</tr>
<tr>
<td>Sensitivity/specificity LVO</td>
<td>81%/89%</td>
</tr>
<tr>
<td>Evaluated -- prehospital setting</td>
<td>Yes (FAST-MAG)</td>
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</tbody>
</table>
IMPACT ON POSITIVE PREDICTIVE VALUE (PPV) FOR LVO AS PREVALENCE CHANGES

<table>
<thead>
<tr>
<th>LVO Prevalence</th>
<th>Stroke Severity Screen</th>
<th>PPV</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2%</td>
</tr>
<tr>
<td>2%</td>
<td>81% Sensitivity and 89% Specificity</td>
<td>13%</td>
</tr>
<tr>
<td>5%</td>
<td>85% Sensitivity and 68% Specificity</td>
<td>5%</td>
</tr>
<tr>
<td>10%</td>
<td>83% Sensitivity and 40% Specificity</td>
<td>3%</td>
</tr>
</tbody>
</table>

De la Ossa MP et al. Stroke 2014;45:87-91.
NUMBER NEEDED TO BYPASS (NNB)

- Retrospective review in Polk County, Florida
- Stroke Severity Adjusted EMS triage
- For every 8 presumed acute severe strokes bypassed to a CSC, 1 received a neurosurgical or endovascular intervention not available at the PSC

NNB = 8

STROKE SEVERITY SCALES: SUMMARY

• C-STAT is the easiest to remember
  • You can’t use it if you don’t remember it

• LAMS might have the highest specificity
  • Fewest false positives

• 3ISS: too new

• RACE: too complicated

• Whatever you choose- be QUICK
HOW STROKE ROUTING PROTOCOLS MIGHT WORK IN OUR REGION
COMPONENTS OF A PREHOSPITAL STROKE ROUTING PROTOCOL

- Detailed knowledge of “isochrones”
- Symptom duration to qualify for routing
- Allowable transport time to bypass a SRF or PSC
  - 15-30 minutes?
- Acceptable rates of over/undertriage
  - STEMI: 15%
  - Trauma: 20 – 50%
VARIABILITY IN CRITERIA FOR EMS ROUTING OF ACUTE STROKE PATIENTS

- Among 33 EMS agencies serving 58 counties in California
  - All had time period from symptom onset to qualify for routing
    - 2 - 8 hours
    - 52% had maximum additional transport time of 30 minutes to qualify diversion
  - 97% had designated a prehospital stroke identification instrument
    - CPSS 72%
    - LAMS 7%

WHAT DO WE NEED TO KNOW?

- Relative transport times to closest acute stroke centers of varying levels ("isochrones")
- Facility performance
  - SRF
    - DtN for IV tPA
    - DiDo for transfer to CSC
    - Imaging capabilities
  - IA Facility
    - DtN for IV tPA
    - DtTICI 2b/3
ISOCHRONES

Stroke Receiving Facility Toolkit

Utah State Stroke System

plumbers always
plumbers usually
REGIONAL DIFFERENCES

URBAN

RURAL
UTAH IDEAS

- Not a severe stroke?
  - Race to nearest SRF for IV tPA

- Severe stroke, within ~2 hours of “last seen normal?”
  - Probably head to nearest SRF for IV tPA
  - SRF can triage / transfer

- Severe stroke, about 2-10 hours from “last seen normal?” (or wake-up stroke)
  - Accept a 15-30 minute penalty to reach IA facility
BETWEEN HOSPITAL TRIAGE

- Imaging at PSC
  - Centralized versus non-centralized imaging interpretation and/or viewing capability
  - Standardization
- Non-agreement among interventionalists on required imaging and overall candidacy
  - Posterior circulation
  - Wake-up strokes
BETWEEN HOSPITAL TRIAGE: IMAGING

- NIHSS
  - Threshold for transfer?
  - Unreliable for posterior circulation
- NCCT
  - ASPECTS reliability?
- CTA
  - NIHSS threshold to perform CTA
  - Imaging delay
  - Single vs multiphase

RECENT TRIALS SELECTED PATIENTS WITH CTA...

- Acute stroke guidelines mention CTA to identify candidates for endovascular treatment (proximal occlusion)
- Clot location guides likelihood of response to IV tPA

| Table. Imaging Techniques Used for Patient Selection and Workflow Time Metrics in the 4 Recently Positive Endovascular Trials |
|---------------------------------------------------------------|----------------|----------------|----------------|----------------|
| MR CLEAN | ESCAPE | EXTEND IA | SWIFT PRIME |
| Imaging modality for trial inclusion | Noncontrast CT | Yes | Yes* | Yes | Yes* |
| CTA | Yes | Yes | Yes | Yes | Yes |

...BUT CTA DELAYS TRANSFER

WHAT CAN STROKE CENTERS DO?
Parallel processing

Team A
- Imaging post processing.
- Understand RAPID
- Properly evaluate CTA

Team B
- Consent
- Equipoise
- Building a relationship with family

Team C
- Getting angio team together.
- Assessing patient.
- Anesthesia??

Team D
- Setting up the room
- Getting all the supplies ready

Communication between different teams
SHIFTING BOTTLENECKS

TELESTROKE
MORE TPA PATIENTS VIA TELESTROKE

**tPA Treats by Front Door v. Drip & Ship v. TeleStroke**

<table>
<thead>
<tr>
<th>Year</th>
<th>Front Door</th>
<th>Drip &amp; Ship</th>
<th>TeleStroke tPA treats</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>26</td>
<td>44</td>
<td>12</td>
</tr>
<tr>
<td>2012</td>
<td>31</td>
<td>18</td>
<td>18</td>
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<tr>
<td>2013</td>
<td>36</td>
<td>49</td>
<td>16</td>
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<tr>
<td>2014</td>
<td>17</td>
<td>58</td>
<td>25</td>
</tr>
<tr>
<td>2015</td>
<td>25</td>
<td>25</td>
<td>80</td>
</tr>
</tbody>
</table>
MOBILE STROKE UNITS
DISRUPTIVE TECHNOLOGY
A gallery of disruptive technologies

Estimated potential economic impact of technologies across sized applications in 2025, $ trillion, annual

1. Mobile Internet
2. Automation of knowledge work
3. Internet of Things
4. Cloud
5. Advanced robotics
6. Autonomous and near-autonomous vehicles
7. Next-generation genomics
8. Energy storage
9. 3-D printing
10. Advanced materials
11. Advanced oil and gas exploration and recovery
12. Renewable energy

SOURCE: McKinsey Global Institute
STROKE DOC ON DEMAND?
WEARABLES, IMPLANTABLES, CLOUD-BASED HEALTH
TAKE HOME POINTS

• Most stroke patients still need IV tPA ASAP
  • But some also need endovascular intervention

• No perfect routing system
  • When in doubt, be QUICK

• More research needed
  • Ripe field for EMS champions

• Which system works in which environments?
  • Probably not “one size fits all”
THANK YOU