EMS Field Considerations and Mission: Lifeline Stroke
A Global, National & Local Perspective

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Disclosures

• Advisory Committee, American Stroke Association
• Vice-Chair, Stroke Council, American Stroke Association
• Employer-Washington University
  – Fixed salary based on academic rank, clinical hours worked, research and education productivity
• Speaker’s Bureau-Genentech (Resigned 2018)
Objectives

• Discuss Global Perspective of 2018 EMS Stroke Care
• Understand the implications of New Science for EMS
• Explain the Continual Resistance from EM Community
• Understand implications for EMS providers and SOC
Historical Stroke Care  (Prior to 2015)

- 63 y/o male with “stroke symptoms”
- Found in back yard
- LKW maybe 8 hours ago?
- CPSS ++ (face/arm/speech)
- FSBS 106, BP 156/87
- Brought to a Primary Stroke Center
- Stroke Team activated
- **Outside any treatment window**
- No intervention offered
- Discharged to a Rehabilitation Hospital
- Never Able to Return to Work
Burden of Stroke Worldwide

WHO - Global causes of death in 2015

Top 10 causes of death globally 2015

- Ischaemic heart disease
- Stroke
- Lower respiratory infections
- Chronic obstructive pulmonary disease
- Trachea, bronchus, and lung cancer
- Diabetes mellitus
- Alzheimer disease
- Diarrhoeal diseases
- Tuberculosis
- Road injury
Emergency Care Systems/Emergency Medical Services are crucial to improve global health.

- Preventative medicine & public health
- Chronic & infectious disease management
- Timely management of illness
It Takes EMS Systems to Save Lives

- Timely, acute management of illness is needed to improve morbidity and mortality
- It takes an **EMS System** to impact morbidity & mortality
- However, EMS remains **unrecognized & an underdeveloped area**
- This system starts in the community, leading to Emergency Service coordination with the hospital
- Existing EMS guidelines are more applicable for developed EMS systems. There are **no guidelines for developing EMS systems** which form most of the world’s healthcare system
MYTH 1: Developed Country = Developed EMS System

TRUTH: A Country’s Growth Doesn’t Reflect State of EMS
MYTH 2: Minimal Gain from EMS Systems Investment

TRUTH: EMS Systems Reduce Morbidity from Time Critical Conditions
MYTH 3: Most of the World Lies Here

TRUTH: Most of the World Lies Here

Chinese Megacity Guangzhou
Developing EMS Systems: Where Does the World Live?

MORE THAN HALF OF THE PEOPLE ON EARTH LIVE WITHIN THIS CIRCLE
MYTH 4: If the Basics are Not Addressed, We Cannot Discuss Improving Health Systems

TRUTH: Innovation Can Be Used Even in Low Resource Settings to Save Lives

Sustainable Development Goal #6
Clean Water and Sanitation

More people have a mobile phone than have a toilet.

myResponder App
A Life-saving Mobile Application that notifies myResponders to render first aid to nearby Cardiac Arrest cases before ambulance arrival

Learn how you can help at GlobalGiving.org/SDG
WHAT CAN STROKE LEARN FROM OUT OF HOSPITAL CARDIAC ARREST (OHCA) EXPERIENCE
Barriers to Implementation

- Geographic constraints
- Poor infrastructure
- Cultural mindset
- Lack of public awareness
- Lack of funding
- Low Public CPR skills
- Low AED availability & skills
- Low EMS Crew/dispatcher training
- Multiple, poorly regulated independent ambulance providers
- Ambulance crew training and attrition issues
- Hospital cooperativity and communications
- Data sharing issues

Developing EMS systems have difficulty implementing the GRA 10-steps due to a range of barriers, and require coordinated and targeted measures to create a milieu that enables implementation of the 10-steps.

GRA 10-Steps
1. Cardiac arrest registry
2. Telephone CPR
3. High Performance EMS CPR
4. Rapid Dispatch
5. Measurement of professional resuscitation using defibrillator
6. First responder AED program
7. Smart technologies for CPR/AED
8. Mandatory training for CPR/AED
9. Accountability
10. Culture of Excellence

Global Resuscitation Alliance
Community
- Recognize symptoms
- Make awareness of stroke recognition mandatory in schools and communities, first aid education and awareness campaigns

Dispatch
- Dispatch center
- Access number
- Destination matching
- Begin telephone training identifying symptoms of stroke with quality improve

Ambulance
- Centralized organization
- Medical oversight
- Crewing training and tiers
- Equipment acquisition & maintenance
- Checklist for basic/advanced requirements
- Standards of care
- Implement high performance stroke care on scene and during transport
- Crew career viability
- Mobile stroke units

Healthcare Facilities
- 24/7 ED
- Emergency care provider training
- Establish a stroke registry
- Sentinel stroke audit programs
- Telemedicine in community hospitals
## Inner Frame of Survival: Modifiable Factors

### Community
- **Recognize symptoms**
  - Make awareness of stroke recognition mandatory in schools and communities, first aid education and awareness campaigns

- **Good Samaritan’s Laws**
- **Health seeking behavior**
  - (appropriate use of EMS)

- **Strong EMS Leadership**

### Dispatch
- **Dispatch center**
- **Access number**
- **Destination matching**
- **Begin telephone training**
  - Identifying symptoms of stroke with quality improvement

### Ambulance
- **Centralized organization**
- **Medical oversight**
- **Crewing training and tiers**
- **Equipment acquisition & maintenance**
- **Checklist for basic/advanced requirements**
- **Standards of care**
- **Implement high performance stroke care on scene and during transport**
- **Crew career viability**
- **Mobile stroke units**

### Field-to-facility communication
- **Data available/sharing**
- **Staff motivation**

### Emergency Care Network
- **Healthcare Facilities**
  - **24/7 ED**
  - Emergency care provider training
  - Establish a stroke registry
  - Sentinel stroke audit programs
  - Telemedicine in community hospitals

### Relations with government, police, fire, hospitals

### Culture of Excellence
- Cost-effective smart technology e.g. GPS as CAD

### Regional Systems of Care with destination protocols

### EMS specialty development

### Ambulance/provider ratio

### Research projects
Outer Frame: Takes Longer Time and Effort to Modify

- Political commitment
- Legislative environment
- Basic state of preventive health (water, sanitation, vaccination)
- Cultural views of death and resuscitation
- Culture willingness to help strangers

Diagram:

- EMS specialty development
- Ambulance/provider ratio
- Community
  - Recognize symptoms
  - Make awareness of stroke recognition mandatory in schools and communities, first aid education and awareness campaigns
- Good Samaritan’s Laws
- Health seeking behavior (appropriate use of EMS)
- Willing and competent pool of bystander CPR/AED Providers
- QI
- Dispatch center
- Access number
- Destination matching
- Begin telephone training identifying symptoms of stroke with quality improve
- Staff motivation
- Data available/sharing
- Strong EMS Leadership
- Field-to-facility communication
- Relations with government, police, fire, hospitals
- Emergency Care Network
- Healthcare Facilities
- 24/7 ED
- Emergency care provider training
- Establish a stroke registry
- Sentinel stroke audit programs
- Telemedicine in community hospitals
- Cost-effective smart technology e.g. GPS as CAD
- Regional Systems of Care with destination protocols
- Reliable telecommunication
- Good road conditions
- Traffic congestion solutions
- Research environment
Putting it All Together

Bridging the Gap
<table>
<thead>
<tr>
<th>CARDIAC ARREST</th>
<th>EMERGENCY STROKE CARE</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 steps to improve survival after Cardiac Arrest into the field of Emergency Stroke Care by GRA</td>
<td>Suggested content in a translation of the 10 steps to improve survival after Cardiac Arrest into the field of Emergency Stroke Care</td>
</tr>
</tbody>
</table>

1. Establish a cardiac arrest registry | Establish a stroke registry |
2. Begin Telephone-CPR training with Quality Improvement | Begin Telephone training identifying symptoms of stroke with Quality Improvement |
3. Implement high performance CPR | Implementing high performance stroke care on scene and during transport |
4. Start rapid dispatch | Start rapid dispatch |
5. Measure professional resuscitations | Sentinel stroke audit programs |
6. Establish an AED program for first responders | Telemedicine in community hospitals |
7. Use smart technologies to extend CPR and identify AED locations | Mobile stroke units |
8. Make CPR and AED training mandatory in schools and communities | Make awareness of stroke recognition mandatory in schools and communities schools, first aid education and awareness campaigns. |
9. Work toward accountability | Work toward accountability |
10. Work toward a Culture of Excellence | Work toward a Culture of Excellence |
Next Steps
10 Pillars to Improve Stroke Care

- Stroke Recognition
- Early Recognition
- Rapid and Timely Dispatch
- Prehospital Stroke Care and Triage
- In-Hospital Basic and Advanced Care
- Smart Technologies
- Public Awareness
- Public Education
- Accountability
- Culture of Excellence
Closer to Home
Why Do We Care?

Not So Fast!
Still Much More to Do
Time Is Brain

WITH A STROKE,
TIME LOST IS BRAIN LOST.
TRADITIONAL ED STROKE (FAST) CARE

Door to treatment in ≤60 min

0 min
Suspected stroke patient arrives at ED

≤10 min
Initiate MD evaluation, including patient history and time last known well/symptom onset
Initiate labwork
Examine using NIHSS

≤15 min
Notify stroke team (including neurologic expertise)

≤25 min
Initiate CT scan

≤45 min
Interpret CT scan using ASPECTS
Review labs if available
Review patient eligibility for tPA

≤60 min
Give tPA bolus and initiate infusion in eligible patients
Still Pockets of Emergency Medicine Resistance?

EMS Needs a Receptive Destination
Effects of Alteplase for Acute Stroke on the Distribution of Functional Outcomes

Analysis of 9 Trials

No. patients with 'good' outcome

<table>
<thead>
<tr>
<th>Treatment delay (hours)</th>
<th>Common odds ratio (95% CI)</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1.2 (1.06-1.39)</td>
</tr>
<tr>
<td>4</td>
<td>1.4 (1.23-1.62)</td>
</tr>
<tr>
<td>5</td>
<td>1.6 (1.43-1.82)</td>
</tr>
<tr>
<td>6</td>
<td>1.8 (1.62-2.03)</td>
</tr>
</tbody>
</table>

Interaction: $\chi^2 = 4.26$ (p=0.039)

<table>
<thead>
<tr>
<th>lase 391</th>
<th>Control (n=3365)</th>
<th>Odds ratio* (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>.5%</td>
<td>391 (11.6%)</td>
<td>1.40 (1.22-1.62)</td>
</tr>
<tr>
<td>.8%</td>
<td>965 (28.7%)</td>
<td>1.28 (1.15-1.42)</td>
</tr>
<tr>
<td>.7%</td>
<td>1413 (42.0%)</td>
<td>1.16 (1.05-1.28)</td>
</tr>
<tr>
<td>.1%</td>
<td>1864 (55.4%)</td>
<td>1.17 (1.06-1.29)</td>
</tr>
<tr>
<td>.5%</td>
<td>2344 (69.7%)</td>
<td>0.99 (0.89-1.10)</td>
</tr>
<tr>
<td>.4%</td>
<td>2738 (81.4%)</td>
<td>0.93 (0.82-1.06)</td>
</tr>
</tbody>
</table>
Longer Clot Length = Less Chance to Work

Reidel et al. Stroke 2011
Anatomy: Unfavorable
Preliminary MED-IA Results

Benchtop Studies – Second Set of Experiments
(faster flow, slower MicroBead infusion, smaller MicroBead amount)
June 7th, 2017

CONFIDENTIAL
Symptomatic intracerebral hemorrhage within 36 hours after the onset of stroke occurred in 6.4 percent of patients given t-PA but only 0.6% of patients given placebo (P< 0.001)
For Many Strokes, There’s an Effective Treatment. Why Aren’t Some Doctors Offering It?

New York Times
March 26, 2018

In my experience, almost no one — after hearing a neutral version and then a positive version — chose T.P.A.,” Dr. Hoffman said.
Typical Day in the CSC ED
Endovascular (Stroke) Revolution
Thrombectomy of LVO

Across all RCTs, there is a consistent trend toward improved clinical outcomes when there is shorter time to reperfusion.¹

Outcomes After Reperfusion:

Outcomes = Collaterals

Time

↑ Time to Reperfusion = ↓ Good Clinical Outcome
4% of pts ↑ disability for every 15-min delay after ED arrival
Saver J et al. JAMA. 2016;316(12):1279-1288

↑ Time to Treatment = ↑ Basal Ganglia ICH
11% RR for every 10-min delay
Raychev R et al. ISC 2012
Early is Still Better, Right??

Why Larger Benefits with Late Treatment?

- Many patients with LVO have slow growth core up to 12 hours++
- Favorable collateral circulation keeps ischemic core small but eventually fails
- Outcomes in control groups of these trials influenced by whether tPA given or not

*Stroke. 2018;49:768-771*
The DAWN trial

Thrombectomy 6 to 24 Hours after Stroke with a Mismatch between Deficit and Infarct

The DEFUSE 3 Trial

ORIGINAL ARTICLE

Thrombectomy for Stroke at 6 to 16 Hours with Selection by Perfusion Imaging

Extension of Treatment Window
Higher Efficacious Now Out to 24 Hours

• TWO TRIALS now show benefit of thrombectomy beyond 6 hour window in carefully selected subjects

• NNT $\approx 4$
  – Low rate of favorable outcomes in medical group (NO RX)
  – Low rate of tPA usage in either group

• Now part of the AHA treatment guidelines (Jan 2018)
Mainstay Still IV tPA

<table>
<thead>
<tr>
<th></th>
<th>MR CLEAN</th>
<th>ESCAPE</th>
<th>EXTEND-IA</th>
<th>SWIFT PRIME</th>
<th>REVASCAT</th>
<th>IV tPA</th>
</tr>
</thead>
<tbody>
<tr>
<td>OR good outcome at 90d (mRS 0-2)</td>
<td>2.16</td>
<td>2.6</td>
<td>3.8</td>
<td>2.75</td>
<td>2.1</td>
<td>1.8</td>
</tr>
<tr>
<td>NNT for good outcome</td>
<td>6.1</td>
<td>4.2</td>
<td>3.2</td>
<td>4.0</td>
<td>6.4</td>
<td>8.0</td>
</tr>
</tbody>
</table>

- Lower efficacy for pMCA occlusions
- Applicable to larger population
- **Majority** of stroke patients
Relative Examples NNT

• BP Medication for 5 years:
  – NNT to prevent one death = 125
  – NNT to prevent one stroke = 67
  – NNT to prevent one MI = 100

• Antibiotics for sinusitis: NNT 18

• Warfarin x 1.5 years in Afib to prevent one Stroke: NNT 25

• CT lung cancer screening for high-risk smokers: NNT 217 to prevent one death

• ASA daily for one year
  – NNT to prevent one stroke or MI = 1,667
What Does This Mean for EMS?

Basic EMS Stroke Care (ABCs) Have Not Changed

BUT

Prehospital Triage by BOTH TIME and SEVERITY

AND

M1
2018 Acute Ischemic Stroke Guidelines
AHA/ASA Writing Group

- Released January 2018 at the ISC, Los Angeles, CA
- Coincided with release of DEFUSE 3 publication
- Not without controversy
- Several sections currently under review
- Why?
## 2018 AIS Guideline EMS-Related Recommendations

### 1.1.1. Public health leaders, along with medical professionals and others, should design and implement public education programs focused on stroke systems and the need to seek emergency care (by calling 9-1-1) in a rapid manner. These programs should be sustained over time and designed to reach racially/ethnically, age, and sex diverse populations.

<table>
<thead>
<tr>
<th>Recommendation revised from 2013 Stroke Systems of Care. COR and LOE added.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early stroke symptom recognition is essential for seeking timely care. Unfortunately, knowledge of stroke warning signs and risk factors in the United States remains poor. Blacks and Hispanics particularly have lower stroke awareness than the general population and are at increased risk of prehospital delays in seeking care. These factors may contribute to the disparities in stroke outcomes. Available evidence suggests that public awareness interventions are variably effective by age, sex, and racial/ethnic minority status. Thus, stroke education campaigns should be designed in a targeted manner to optimize their effectiveness.</td>
</tr>
</tbody>
</table>

### 1.1.2. Activation of the 9-1-1 system by patients or other members of the public is strongly recommended. 9-1-1 dispatchers should make stroke a priority dispatch, and transport times should be minimized.

<table>
<thead>
<tr>
<th>Recommendation and Class unchanged from 2013 AIS Guidelines. LOE amended to conform with ACC/AHA 2015 Recommendation Classification System.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency medical services (EMS) use by stroke patients has been independently associated with earlier emergency department (ED) arrival (onset-to-door time ≤3 hours; adjusted odds ratio [OR], 2.00; 95% confidence interval [CI], 1.93–2.08), quicker ED evaluation (more patients with door-to-imaging time ≤25minutes; OR, 1.89; 95% CI, 1.78–2.00), more rapid treatment (more patients with door-to-needle [DTN] time ≤60 minutes; OR, 1.44; 95% CI, 1.28–1.63), and more eligible patients being treated with Alteplase if onset is ≤2 hours (67% versus 44%; OR, 1.47; 95% CI, 1.33–1.64), 18 yet only ≈60% of all stroke patients use EMS. Men, blacks, and Hispanics are less likely to use EMS. Thus, persistent efforts to ensure activation of the 9-1-1 or similar emergency system by patients or other members of the public in the case of a suspected stroke are warranted.</td>
</tr>
</tbody>
</table>

### 1.1.3. To increase both the number of patients who are treated and the quality of care, educational stroke programs for physicians, hospital personnel, and EMS personnel are recommended.

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<thead>
<tr>
<th>Recommendation and Class unchanged from 2013 AIS Guidelines. LOE amended to conform with ACC/AHA 2015 Recommendation Classification System.</th>
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<tbody>
<tr>
<td>On 9-1-1 activation, EMS dispatch and clinical personnel should prioritize the potential stroke case, minimize on-scene times, and transport the patient as quickly as possible to the most appropriate hospital. A recent US-based analysis of EMS response times found that median EMS response time (9-1-1 call to ED arrival) in 184179 cases in which EMS provider impression was stroke was 36 minutes (interquartile range, 28.7–48.0 minutes). On-scene time (median, 15 minutes) was the largest component of this time, and longer times were noted for patients 65 to 74 years of age, whites, and women and in nonurban areas. Dispatch designation of stroke was associated with minimally faster response times (36.0 versus 36.7 minutes; P&lt;0.01). Notably, only 52% of cases were identified by dispatch as stroke.</td>
</tr>
</tbody>
</table>
# 2018 AIS Guideline EMS-Related Recommendations

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Class</th>
<th>LoE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.2.1. The use of a stroke assessment system by first aid providers, including EMS dispatch personnel, is recommended.</td>
<td>I</td>
<td>B-NR</td>
</tr>
<tr>
<td>1.2.2. EMS personnel should begin the initial management of stroke in the field. Implementation of a stroke protocol to be used by EMS personnel is strongly encouraged.</td>
<td>I</td>
<td>B-NR</td>
</tr>
<tr>
<td>1.2.3. EMS personnel should provide prehospital notification to the receiving hospital that a suspected stroke patient is en route so that the appropriate hospital resources may be mobilized before patient arrival.</td>
<td>I</td>
<td>B-NR</td>
</tr>
<tr>
<td>1.3.1. EMS leaders, in coordination with local, regional, and state agencies and in consultation with medical authorities and local experts, should develop triage paradigms and protocols to ensure that patients with a known or suspected stroke are rapidly identified and assessed by use of a validated and standardized instrument for stroke screening, such as the FAST (face, arm, speech test) scale, Los Angeles Prehospital Stroke Screen, or Cincinnati Prehospital Stroke Scale.</td>
<td>I</td>
<td>B-NR</td>
</tr>
<tr>
<td>1.3.2. Regional systems of stroke care should be developed. These should consist of the following: (a) Healthcare facilities that provide initial emergency care, including administration of IV Alteplase, and, (b)Centers capable of performing endovascular stroke treatment with comprehensive periprocedural care to which rapid transport can be arranged when appropriate.</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>1.3.3. Patients with a positive stroke screen and/or a strong suspicion of stroke should be transported rapidly to the closest healthcare facilities that can capably administer IV Alteplase.</td>
<td>I</td>
<td>B-NR</td>
</tr>
</tbody>
</table>

**In 1 study, the positive predictive value for a hospital discharge diagnosis of stroke/transient ischemic attack (TIA) among 900 cases for which EMS dispatch suspected stroke was 51% (95% CI, 47–54), and the positive predictive value for ambulance personnel impression of stroke was 58% (95% CI, 52–64). In another study of 21760 dispatches for stroke, the positive predictive value of the dispatch stroke/TIA symptoms identification was 34.3% (95% CI, 33.7–35.0), and the sensitivity was 64.0% (95% CI, 63.0–64.9). In both cases, use of a prehospital stroke scale improved stroke identification, but better stroke identification tools are needed in the prehospital setting.**

**In the Get With The Guidelines (GWTG) registry, EMS personnel provided prearrival notification to the destination ED for 67% of transported stroke patients. EMS prenotification was associated with increased likelihood of Alteplase treatment within 3 hours (82.8% versus 79.2%), shorter door-to-imaging times (26 versus 31 minutes), shorter DTN times (78 versus 80 minutes), and shorter symptom onset-to-needle times (141 versus 145 minutes).**

**The 2013 recommendation referred to initial emergency care as described elsewhere in the guidelines, which specified administration of IV Alteplase as part of this care. The current recommendation is unchanged in intent but reworded to make this clear.**
### 2018 AIS Guideline EMS-Related Recommendations

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Evidence Level</th>
<th>Recommendation Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3.4. When several IV Alteplase–capable hospital options exist within a defined geographic region, the benefit of bypassing the closest to bring the patient to one that offers a higher level of stroke care, including mechanical thrombectomy, is uncertain. Further research is needed.</td>
<td>IIb B-NR</td>
<td>New recommendation.</td>
<td>At least 6 stroke severity scales targeted at recognition of large vessel occlusion (LVO) in the prehospital setting to facilitate transfer to endovascular centers have been published. The performance of all available scales based on published literature was recently compared. All the scales were initially derived from data sets of confirmed stroke cases or selected prehospital cases, and there has been only limited study of their performance in the prehospital setting. For prehospital patients with suspected LVO by a stroke severity scale, the Mission: Lifeline Severity–based Stroke Triage Algorithm for EMS30 recommends direct transport to a comprehensive stroke center if the travel time to the comprehensive stroke center is &lt;15 additional minutes compared with the travel time to the closest primary stroke center or acute stroke-ready hospital. However, at this time, there is insufficient evidence to recommend 1 scale over the other or a specific threshold of additional travel time for which bypass of a primary stroke center or acute stroke-ready hospital is justifiable. Given the known impact of delays to IV Alteplase on outcomes, the known impact of delays to mechanical thrombectomy on outcome, and the anticipated delays in transport for mechanical thrombectomy in eligible patients originally triaged to a nonendovascular center, the Mission: Lifeline algorithm may be a reasonable guideline in some circumstances. Customization of the guideline to optimize patient outcomes will be needed to account for local and regional factors, including the availability of endovascular centers, door in–door out times for nonendovascular stroke centers, interhospital transport times, and DTN and door-to-puncture times. Rapid, protected, collaborative, regional quality review, including EMS agencies and hospitals, is recommended for operationalized bypass algorithms.</td>
</tr>
<tr>
<td>1.4.1. Certification of stroke centers by an independent external body, such as Center for Improvement in Healthcare Quality, Det Norske Veritas, Healthcare Facilities Accreditation Program, and The Joint Commission (TJC)* or a state health department, is recommended. Additional medical centers should seek such certification.</td>
<td>I B-NR</td>
<td>Recommendation reworded for clarity from2013 AIS Guidelines. Class unchanged. LOE amended to conform with ACC/AHA 2015Recommendation Classification System.</td>
<td>Data support the development of stroke centers to improve patient care and outcomes. Differences in stroke quality of care are associated with differences in certifying organization. Between 2010 and 2012, an analysis of 477297 AIS admissions from 977 certified primary stroke centers (73.8% TJC, 3.7% Det Norske Veritas, 1.2% Healthcare Facilities Accreditation Program, and 21.3% state based) participating in GWTG-Stroke was conducted. Composite care quality was generally similar among the 4 groups of hospitals, although state-certified primary stroke centers underperformed TJC-certified primary stroke centers in a few key measures. The rates of Alteplase use were higher in TJC and Det Norske Veritas (9.0% and 9.8%) and lower in state- and Healthcare Facilities Accreditation Program-certified hospitals (7.1% and 5.9%) (P&lt;0.0001). DTN times were significantly longer in Healthcare Facilities Accreditation Program hospitals. State primary stroke centers had higher in-hospital risk adjusted mortality (OR, 1.23; 95% CI, 1.07–1.41) compared with TJC-certified primary stroke centers.</td>
</tr>
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*Washington University in St. Louis School of Medicine*
AHA AIS Guideline EMS Cheat Sheet

• 911 is good
• Dispatch and EMS should be trained in stroke screening
• Pre-hospital notification is preferred
• EMS leaders should ensure any stroke screening tool is utilized
• Develop and streamline local Stroke Systems of Care
• Patients with + stroke severity screen should be triaged to TCSs
• Benefit of selective bypass to TSCs vs. the nearest-closet center is still unknown
• Certified Stroke Centers-TJC, DNV or HFAP or State DOH is recommended and leads to better stroke outcomes
As We Sitting Here, The Science is Evolving....And We’re Falling Behind
# Timeline of stroke therapy

<table>
<thead>
<tr>
<th>Year</th>
<th>Event Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996</td>
<td>NINDS Trial</td>
</tr>
<tr>
<td></td>
<td>Alteplace approval 0-3 hr window</td>
</tr>
<tr>
<td>2008</td>
<td>ECASS III</td>
</tr>
<tr>
<td></td>
<td>European approval 3-4.5 hr window</td>
</tr>
<tr>
<td>2015</td>
<td>Endovascular Trials (5)</td>
</tr>
<tr>
<td></td>
<td>Mechanical thrombectomy -7.3 hrs</td>
</tr>
<tr>
<td>2018</td>
<td>DAWN and DEFUSE 3</td>
</tr>
<tr>
<td></td>
<td>MT out to 24 hrs in select patients</td>
</tr>
<tr>
<td>2018</td>
<td>WAKE-UP Trial</td>
</tr>
<tr>
<td></td>
<td>IV Rx if &lt; 4.5 hr symptom discovery</td>
</tr>
<tr>
<td>2018</td>
<td>EXTEND-IA TNK</td>
</tr>
<tr>
<td></td>
<td>TNK as alternative thrombolytic</td>
</tr>
</tbody>
</table>
New Thrombolytics?

Tenecteplase versus Alteplase before Thrombectomy for Ischemic Stroke


CONCLUSIONS

Tenecteplase before thrombectomy was associated with a higher incidence of reperfusion and better functional outcome than alteplase among patients with ischemic stroke treated within 4.5 hours after symptom onset. (Funded by the National Health and Medical Research Council of Australia and others; EXTEND-IA TNK ClinicalTrials.gov number, NCT02388061.)
Time – Maybe Doesn’t Matter?

MRI-Guided Thrombolysis for Stroke with Unknown Time of Onset


MRI-based Selection for IV Thrombolysis out to 24 Hours if Symptom Discovery < 4.5 hours

NEJM 2018 August 16;379(7):611-622
Still Too Many Questions

Which Prehospital Severity Scale is Best?
Should Hospital Capability Matter for EMS Triage?
Is Pre-Hospital Triage Bypass Safe?
Who Provides the Best Care?
What Level of Data Transparency is Reasonable?
Role of EMS & EM in the SOC?
Access to Endovascular Therapy (EVT)

• By Ground or Air
  – 56% US population have access to endovascular capable hospital

Adeoye O. Stroke 2014
Attempt to Define Best Evidenced-Based Pre-Hospital Stroke Triage Practice to Triage the “Right” Patient to the “Right” Hospital in the “Right” Amount of Time to Get the “Right” Procedure, Without “Over Triaging” or “Under triaging”

- Created out of necessity in 2017 to address changing stroke treatments
- First time recommended EMS triage based upon BOTH Time LKW and Severity
- Controversial
- Helped to frame local System of Care discussions

- By 2018 quickly became outdated due publication of DAWN, DEFUSE III and WAKE UP
- Current UPDATED version under development with planned release at ISC 2019 in Hawaii
Next Steps?
Better Patient Selection

Precision Medicine in Stroke

“...diagnosis and therapy tailored to the individual patient...changes in clinical care from a one-size fits-all model to a more precise, individualized approach.”

Lin Y et al. *Front Biosci*. 2018 Mar 1;23:1338-1359
Stroke Care in the Past

• One Size Fits All
• Patient-Specific Data Not Applied
• Too Many Clinical Variables to Consider in the Chaos
• Outcome Based on Hope & Prayer
Stroke Biomarker

- EKG-No
- Imaging-No*
- Vital Signs-No
- History-No
- Exam-Maybe
- Blood Test-No
- Gut Feeling-No
- Imaging-YES

* Except Mobile Stroke Units
RAPID software infarct prediction

- **RAPID** ischemic core (dead brain) and hypoperfusion volumes (tissue at risk) predicted infarct size (final stroke)

- Baseline **core** predicts infarct volume in reperfusers (CBF<30%)

- Baseline **hypo-perfusion** predicts infarct in non-reperfusers (Tmax > 6 seconds)

- The image method used to select patients in DAWN and DEFUSE 3

RAPID processing: finished successfully
CBF<30.0% volume = 57 ml
Tmax>6.0s volume = 72 ml
Review results on the RAPID server.

Institution: Barnes-Jewish Hosp EDCT1
RAPID AnonID: 959_162
Patient Gender: Female
Patient Age: 087Y
Perfusion series: #7 VPCT Perfusion 10.0 H20f, 2018/01/21 17:09:58 (360 files)
Station: SIEMENS, SOMATOM Definition Flash

CBF/Tmax Mismatch

CBF<30% volume: 57 ml
Tmax>6.0s volume: 72 ml
Mismatch volume: 15 ml
Mismatch ratio: 1.3

Not for primary diagnosis. Warning: review source data quality and bolus timing.
RAPID processing: finished successfully
CBF<30.0% volume = 9 ml
Tmax>6.0s volume = 37 ml
Review results on the RAPID server.

Institution: Barnes-Jewish Hosp EDCT1
RAPID AnonID: 959_168
Patient Gender: Male
Patient Age: 077Y
Perfusion series: #3 VPCT Perfusion 10.0 H20f, 2018/01/20 13:00:50 (360 files)
Station: SIEMENS, SOMATOM Definition Flash

CBF/Tmax Mismatch

CBF<30% volume: 9 ml
Tmax>6.0s volume: 37 ml
Mismatch volume: 28 ml
Mismatch ratio: 4.1

Not for primary diagnosis. Warning: review source data quality and bolus timing.
RAPID processing: finished successfully

**CBF < 30.0% volume:** 36 ml

**Tmax > 6.0s volume:** 133 ml

Review results on the RAPID server.

**Institution:** Barnes-Jewish Hosp EDCT1

**RAPID AnonID:** 959_155

**Patient Gender:** Female

**Patient Age:** 076Y

**Perfusion series:** #3 VPCT Perfusion 10.0 H20f, 2018/01/19 09:05:47 (360 files)

**Station:** SIEMENS, SOMATOM Definition Flash

**CBF/Tmax Mismatch**

- **CBF < 30% volume:** 36 ml
- **Mismatch volume:** 97 ml
- **Mismatch ratio:** 3.7
- **Tmax > 6.0s volume:** 133 ml

Not for primary diagnosis.
RAPID processing: finished successfully

CBF<30.0% volume = 52 ml
Tmax>6.0s volume = 53 ml

Review results on the RAPID server

Institution: Barnes-Jewish Hosp EDCT1
RAPID AnonID: 856_64
Patient Gender: Female
Patient Age: 033Y
Perfusion series: #3 VPCT Perfusion 10.0 H20f, 2017/11/26 04:12:49 (360 flies)
Station: SIEMENS, SOMATOM Definition Flash

CBF/Tmax Mismatch

CBF<30% volume: 52 ml
Mismatches volume: 1 ml
Mismatch ratio: 1.0
Tmax>6.0s volume: 53 ml

Not for primary diagnosis.
“Use of advances neuroimaging for both the selection and prediction of prognosis for MT candidates should not depend on the elapsed time from symptom onset.”

Stroke. 2018;49:00-00.DOI:10.1161/STROKEAHA.118.022540
Priority Transport
Pre-Hospital Triage

Factors:
- Distance
- Run Times
- Designation Tiers
- Availability Services
- Diversion Status
- Medical Control
- ABC stable
- Dispatch Criteria
- Public/Private EMS
- Patient Preference
- Symptom onset
- Severity

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- Severity
Field Stroke Triage Scales

**RACE:** The Rapid Arterial Occlusion Evaluation Scale

**CPSS:** The Cincinnati Prehospital Stroke Severity Scale

**LAMS:** Los Angeles Motor Scale

**VAN:** Vision, Aphasia, Neglect

**FAST-ED:** Field Assessment Stroke Triage for Emergency Destination
Clinical Scales for Field Assessment

- Published cutoffs ≥ 20% LVOS sent to PSC
- Cutoffs reduce false-negative rate to 10% = sending all to CSC
- Scales will never be perfect:
  - ~ 15% stroke = hemorrhage
  - Lacunes & distal occlusions of eloquent branches can result in high stroke severity
- However, this is not simply about LVOS prediction. It is about best patient triage in the field:
  - False-Negative LVOS = LVOS with low severity = better collateral flow = better natural history, higher changes IV tPA response, longer window for MT. So, less harm if direct to PSC
  - False-Positive LVOS = Lacunes and eloquent distal occlusions = should use scales that minimize risk of lacune vs. LVOS misdiagnosis and have multi-topographic cortical representation.
So What Scale Is Best?
Drip ‘n Ship vs. Mothership for EVT: Modeling the Best Transportation Options for Optimal Outcomes

Table. List of Time Assumptions Made in the Model

<table>
<thead>
<tr>
<th></th>
<th>Drip ‘n Ship, min</th>
<th>Mothership, min</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset to-first medical response</td>
<td>30, 60, 90</td>
<td>30, 60, 90</td>
</tr>
<tr>
<td>Time on-scene</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Scene to door</td>
<td>Geographic model</td>
<td>Geographic model</td>
</tr>
<tr>
<td>Door-to-needle</td>
<td>30, 60, 90</td>
<td>30*</td>
</tr>
<tr>
<td>Needle-to-door-out</td>
<td>20</td>
<td>NA</td>
</tr>
<tr>
<td>PSC to CSC</td>
<td>Geographic model</td>
<td>NA</td>
</tr>
<tr>
<td>Door-to-reperfusion</td>
<td>115*</td>
<td>115*</td>
</tr>
</tbody>
</table>

CSC indicates Comprehensive Stroke Centers. DNT, door-to-needle time. NA, not available; and PSC, Primary Stroke Centers.

* Sensitivity analysis is performed on these constants. For Mothership, DNT at CSC of 60 min and door-to-reperfusion of 200 min is also included. Additionally, the tipping point of door to reperfusion in the Drip 'n Ship option is also modeled.

EMS METRICS M: LS
QUALITY THRU TRANSPARENCY

Program to mirror EMS Mission: Lifeline (STEMI)

• Collect data impacting stroke care and outcomes
• Utilize existing GWTG data platforms to collect
• Focus on measurable items
• Based upon best available evidence
• Allow for local/regional Qi/QA
• Opportunity for Mission: Lifeline Stroke recognition
New Measures: Prehospital Care

Recognition of A Key Link In Stroke Care
Background:

Continuous Quality Improvement Activity

Community Education

Primordial Prevention

Primary Prevention

Stroke Rehabilitation

Secondary Prevention

EMS Response

Acute Stroke Treatment

Source: Google Images. April 2018.
Percentage of confirmed stroke patients transported to your hospital by EMS and identified as suspected strokes.

Why is the measure needed?

- Low accuracy of stroke identification by EMS providers
Percentage of confirmed stroke patients transported to your hospital by EMS and for whom a time “Last Known Well” (LKW) or “Time of Discovery” of Stroke Symptoms was documented.

Why is the measure needed?

- Two terms are often inappropriately used interchangeably.
  - “Time of Last Known Well” refers to the time that the patient or a witness can confirm the patient was at their baseline
  - "Time of Symptom Discovery" refers to the time at which the symptoms were first noticed
Percentage of confirmed stroke patients transported to your hospital by EMS and for whom blood glucose was evaluated by EMS.

Why is the measure needed?

- Hypoglycemia symptoms often mimic stroke

Figure: Categorical graph displays the frequency of the response options that could be selected for Evaluation of Blood Glucose by EMS.

Source: Patient Management Tool (Test Data). April 2018
Percentage of confirmed stroke patients transported to your hospital by EMS and for whom a validated regional or national stroke screen tool was used with documentation of the outcome.

Why is the measure needed?

- Improve accuracy of triage of suspected stroke patients

Figure: Rate-based measure. Graph displays the comparison of the overall rate (screen completed and score (positive or negative) reported at your hospital to all hospitals for the selected time period.

Source: Patient Management Tool (Test Data). April 2018
Percentage of confirmed stroke patients transported to your hospital by EMS and for whom a validated regional or national severity screen tool was used with documentation of the outcome.

Why is the measure needed?

- Effectively triage patients to most appropriate level of care
  —Patients with large vessel occlusion

Figure: Rate-based measure. Graph displays the comparison of the overall rate (severity screen completed and score (numerical value) reported at your hospital to all hospitals for the selected time period.

Source: Patient Management Tool (Test Data). April 2018
Percentage of stroke transports where EMS called in a stroke alert prenotification to the receiving hospital and provided additional information about patient’s status (e.g., most recent BP reading, time LKW, etc.).

Why is the measure needed?

• Allows hospital resources to be mobilized prior to patient arrival
• Improve rate of prenotification (currently only 67%)

Source: Patient Management Tool (Test Data). April 2018
Distribution of times for suspected stroke patients transported to your hospital by EMS. Based on AHA Guidelines, the goal for EMS on-scene time is ≤ 15 minutes.

Why is the measure needed?

- Identify the intervals contributing to delays

Figure: Histogram displays the distribution of times, but the table includes the mean and median times.

Source: Patient Management Tool (Test Data). April 2018
Distribution of times for confirmed stroke patients transported to your hospital by EMS and were transferred to a higher-level stroke center (e.g. PSC, CSC, etc.) for time-critical therapy. Based on AHA Guidelines, the goal for DIDO is \( \leq 60 \) minutes.

Why is the measure needed?

- Rapid transport to higher-level stroke center for time-critical care (e.g., surgical, neurocritical)

Figure: Histogram displays the distribution of times for door-in-door out at 1st hospital, but the table includes the mean and median times.

Source: Patient Management Tool (Test Data). April 2018
Distribution of time for confirmed stroke patients transported to your hospital by EMS and the time from first medical contact (FMC) to time of first pass (i.e. deployment) of device for endovascular thrombectomy (EVT). Based on AHA Guidelines, the goal for time from FMC to EVT is \( \leq 60 \) minutes.

Why is the measure needed?

- Reduce system time to treatment

Source: Patient Management Tool (Test Data). April 2018

Figure: Histogram displays the distribution of times from first medical contact at patient to endovascular treatment, but the table displays the median time.
Stroke Care 2018 and Beyond

- 63 y/o male with “stroke symptoms”
- Found in back yard
- LKW maybe 8 hours ago?
- CPSS ++ (face/arm/speech)
- FSBS 106, BP 156/87
- EMS to Local PSC
- Stroke Team activated (NIHSS 13)
- Rapid transfer to CSC (1 hour DIDO)
- **Within new extended treatment window**
- RAPID CT Performed (favorable)
- Mechanical Thrombectomy performed
- Discharged to Home with HHS (NIHSS 1)
- Returns to Work in a Week
Summary

• **BIG PICTURE:** Worldwide Stroke Burden Is Increasing

• Stroke Science is Rapidly Changing

• With Change Comes Challenges & Opportunities

• Coordination/Cooperation Within Stroke Systems of Care is Vital

• Emphasis on Pre-Hospital Metrics and Transparency Is the Next Frontier
Thank You!!