Ischemic Stroke Secondary to Large Vessel Occlusion: Where are We Today?

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Disclosures

• Consultant/speakers bureau
  – Genentech, Penumbra, Stryker

• Research support
  – Cerenovus, Medtronic, Microvention, Penumbra, Stryker

• Stock ownership
  – Penumbra
Objectives

• The problem
• The options
• The evidence
• The solution
• The challenges
Stroke: The sudden death of brain cells due to lack of oxygen, caused by blockage of blood flow or rupture of an artery to the brain.
Stroke

Hemorrhagic: 13%

Ischemic: 87%

Ischemic stroke causes:
- Extracranial Carotid 8%
- Intracranial Carotid 8%
- Unknown 44%
- Lacunar 20%
- Cardioembolic 20%

Ischemic Stroke

- Stroke affects >800,000 people in US each year
- It is the 4th leading cause of death in North America
  - >150,000 deaths in US/year
- Morbidity
  - 15-30% permanently disabled
- Economic
  - 2012 direct and indirect cost of stroke: $45.5 billion

https://www.cdc.gov/stroke/
<table>
<thead>
<tr>
<th>Time</th>
<th>Neurons Lost</th>
<th>Synapses Lost</th>
<th>Accelerated Aging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Per Stroke</td>
<td>1.2 billion</td>
<td>8.3 trillion</td>
<td>36 yrs</td>
</tr>
<tr>
<td>Per Hour</td>
<td>120 million</td>
<td>830 billion</td>
<td>3.6 yrs</td>
</tr>
<tr>
<td>Per Minute</td>
<td><strong>1.9 million</strong></td>
<td>14 billion</td>
<td>3.1 weeks</td>
</tr>
<tr>
<td>Per Second</td>
<td>32,000</td>
<td>230 million</td>
<td>8.7 hrs</td>
</tr>
</tbody>
</table>

(Total number of neurons in the average human brain is 130 billion)

*Stroke* 2006;37:263-266
LVO Background - USA

Table 5: J.P. Morgan US Stroke Market Model

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>US Stroke Patients</td>
<td>795,000</td>
<td>818,850</td>
<td>843,416</td>
<td>868,718</td>
<td>894,780</td>
<td>921,623</td>
<td>949,272</td>
</tr>
<tr>
<td>% Ischemic</td>
<td>87%</td>
<td>87%</td>
<td>87%</td>
<td>87%</td>
<td>87%</td>
<td>87%</td>
<td>87%</td>
</tr>
<tr>
<td>US Ischemic Stroke Patients</td>
<td>691,650</td>
<td>712,400</td>
<td>733,771</td>
<td>755,785</td>
<td>778,458</td>
<td>801,812</td>
<td>825,866</td>
</tr>
<tr>
<td>% Large Vessel Strokes</td>
<td>43%</td>
<td>43%</td>
<td>43%</td>
<td>43%</td>
<td>43%</td>
<td>43%</td>
<td>43%</td>
</tr>
<tr>
<td>US Large Vessel Strokes</td>
<td>297,410</td>
<td>306,332</td>
<td>315,522</td>
<td>324,987</td>
<td>334,737</td>
<td>344,779</td>
<td>355,122</td>
</tr>
<tr>
<td>% Treatable with Salvageable Tissue</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
<td>50%</td>
</tr>
<tr>
<td>US Ischemic Stroke Patients with ELVO</td>
<td>148,705</td>
<td>153,166</td>
<td>157,761</td>
<td>162,494</td>
<td>167,369</td>
<td>172,390</td>
<td>177,561</td>
</tr>
<tr>
<td>% of US Ischemic ELVO Patients Treated</td>
<td>7.9%</td>
<td>11.5%</td>
<td>13.8%</td>
<td>17.3%</td>
<td>21.0%</td>
<td>25.0%</td>
<td>28.5%</td>
</tr>
<tr>
<td>US Ischemic ELVO Patients Treated</td>
<td>11,750</td>
<td>17,616</td>
<td>21,695</td>
<td>28,033</td>
<td>35,150</td>
<td>43,100</td>
<td>50,608</td>
</tr>
</tbody>
</table>

Thrombectomy - 100% increase, 2014 -> 2016, but We only treated < 20% of eligible patients in 2016
MRI/CT Abnormality: Bioenergetic Compromise = Core
Perfusion Abnormality: Hemodynamic Compromise = Ischemic
Diffusion/Perfusion Mismatch = Penumbra
Why is Time Important?

• The area peripheral to a core infarct where metabolism is active but blood flow is diminished is called the **ischemic penumbra**
  – This is salvageable tissue that is at risk for infarction.

• The penumbra lies in a 'no-man's land' between a zone of low blood flow that is < 25 ml/100 mg brain tissue/min and a zone where brain tissue is undergoing necrosis/death, flow of < 8-10 ml/100 mg/min\(^1\)

• Without restoration of blood flow/oxygen, the ischemic penumbra will convert to ischemic core or tissue death
The Options

• Medical supportive care
• Intravenous t-PA
  – Clot busting medicine
  – < 3 hours from symptom onset
• Thrombectomy
  – Endovascular clot removal
  – Appropriate for LVO (large vessel occlusion)
  – < 24 hours from symptom onset based upon advanced imaging based patient selection
Intravenous Recombinant Tissue Plasminogen Activator

- 333 patients, Published December 1995.
- Compared with patients given placebo vs. patients treated with t-PA within 3 hours
- Patients treated with t-PA were at least 30 percent more likely to have minimal or no disability at three months.
Options for Patients Experiencing an Ischemic Stroke

**IV tPA**
Gold-standard in ischemic stroke care. Drug is designed to break apart the clot.

**Medical Management**
Monitor vitals and provide secondary stroke prevention. Patient is send to rehab or a nursing facility when stable.

**Endovascular Clot Removal**
Mechanical disruption or removal of the clot using standard endovascular approaches.

**Bridging Therapy**

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Thrombectomy Goals

Normal → Occlusive clot → Thrombectomy → Normal

Occlusion
<table>
<thead>
<tr>
<th>TICI Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TICI 0</td>
<td>No perfusion</td>
</tr>
<tr>
<td>TICI 1</td>
<td>Limited Perfusion</td>
</tr>
<tr>
<td>TICI 2a</td>
<td>&lt; 50% vascular territory</td>
</tr>
<tr>
<td>TICI 2b</td>
<td>≥ 50% vascular territory</td>
</tr>
<tr>
<td>TICI 3</td>
<td>Full Perfusion</td>
</tr>
</tbody>
</table>

Mokin et al; Neurosurg Focus 2014
Reperfusion with IV rt-PA

MCA-M2: 31-44%
MCA-M1: 24-32%
ICA-T: 4-8%

Del Zoppo et al., Ann Neurol 1992
Endovascular clot removal is a type of minimally invasive surgery that allows the physician to access various parts of the body, including the brain, through the body’s major blood vessels.
Goal of Ischemic Stroke Treatment

To open the blocked blood vessel, thereby restoring oxygen and nutrients to the affected territories in the brain.

Before Intervention
The blood vessels in the circle are not visible because a blood clot is blocking blood flow to those vessels.

After Successful Intervention
Once the blood clot is removed, the blood vessels fill with blood and are visible again.
Three medical centers retrospectively assessed stroke patients with a NIHSS of ≥8, regardless of time from symptom onset, who had CT perfusion maps that defined salvageable penumbra and underwent intra-arterial revascularization.

Patients were divided into two groups for analysis: ≤8 h and >8 h from symptom onset to endovascular procedure.
CT Perfusion: Completed Infarct
CT Perfusion: Salvageable Penumbra

CBV

CBF

MTT
Thrombectomy Devices

MERCI Retriever

Aspiration

Stentriever
Rapid Evolution of Thrombectomy Approaches

Aspiration then Stent Retriever if needed

Solitaire, Trevo

5MAX™ Solumbra

ACE™ and ADAPT

Improvemnets Continue

Stent Retriever

Aspiration & Stent Retriever

ACE™ 64

 merci®

Original Penumbra System®

7 Trials Support Mechanical Thrombectomy
Improvements in Technology
Arrival of stentrievers and larger/more navigable aspiration catheters

- Easier to use
- More predictable outcomes
- Faster vessel recanalization

Stroke Case: Pre-Procedure

32 year old smoker, hypertension. Prior episodes of slurred speech but never sought medical attention. Witnessed onset of aphasia, Right hemiplegia and left gaze preference. Pre treatment NIHSS=20. IV tPA given
CT Scan RAPID analysis demonstrates a small area of infarct and a large area of hypoperfusion. There is also an old stroke on the contralateral (right) side.
Initial angiography confirms large vessel occlusion (left M1 segment)
Stroke Case

ADAPT direct aspiration technique. Puncture to recanalization 14 minutes. Repeat angiography demonstrates complete recanalization.
5 Min Post-Procedure

Puncture to recanalization: 14 mins.
24 hour NIHSS=1
24h Post-Procedure

90 day follow up neurologically intact; mRS=0
The Evidence

• IV t-PA has been approved for treatment of acute ischemic stroke since 1996.
• It has to be administered within 3 hours of symptom onset
  – Up to 4.5 hours based upon recent European trials
• Evidence for endovascular treatment
  – 2015
  – 2018
Since January 1\textsuperscript{st} of 2015, FIVE major prospective, randomized controlled trials have been published comparing mechanical thrombectomy to best medical management:

- MR CLEAN
- ESCAPE
- EXTEND-IA
- SWIFT PRIME
- REVASCAT
A Multicenter Randomized Clinical trial of Endovascular treatment for Acute ischemic stroke in the Netherlands (MR CLEAN)

- Sites: 16 centers in Netherlands
- Patients: 500
  - 233 randomized to IA thrombectomy
  - 267 randomized to medical management
- Age 18+
- Included mild-severe stroke severity
- Time: Treatment initiated within 6 hrs
- Primary Outcome: mRS at 90 days
- Treatment in IA arm: No requirement, but retrievable stent in majority

Berkhemer et al; *NEJM*, 2015
A Multicenter Randomized Clinical trial of Endovascular treatment for Acute ischemic stroke in the Netherlands (MR CLEAN)

Good Outcome (mRS 0-2):
- 33% in IA thrombectomy group
- 19% in medical group

Conclusion:
Significantly better outcomes with thrombectomy compared to medical management

Berkhemer et al; NEJM, 2015
Endovascular Treatment for Small Core and Proximal Occlusion Ischemic StrokE (ESCAPE)

- Sites: 22 centers mostly in N America
- Patients: 315 (halted early due to efficacy)
  - 165 randomized to IA thrombectomy
  - 150 randomized to medical
- Age 18+
- Included mild-severe strokes
- Time: Treatment within 12 hours of onset
- Primary Outcome: mRS at 90 days
- Treatment in IA arm: Retrievable stent

Goyal et al; NEJM, 2015
Endovascular Treatment for Small Core and Proximal Occlusion Ischemic Stroke (ESCAPE)

Good Outcome (mRS 0-2):
- 53% in IA thrombectomy group
- 29% in medical group

Conclusion:
Significantly better outcomes with thrombectomy compared to medical management

Goyal et al; NEJM, 2015
Extending the Time for Thrombolysis in Emergency Neurological Deficits – Intra-Arterial (EXTEND-IA)

- Sites: 10 centers mostly in Australia and New Zealand
- Patients: 70 (halted early due to efficacy)
  - 35 randomized to IA thrombectomy
  - 35 randomized to medical
- Age 18+
- Included mild-severe strokes
- Time: Within 6 hours of onset

Primary Outcomes:
1. Reperfusion at 24 hours (% reduction in perfusion-lesion volume)
2. Decrease in NIHSS of 8 or more points at 3 days, or NIHSS of 0 or 1 at 3 days

Treatment in IA arm: retrievable stent

Campbell et al; *NEJM*, 2015
Extending the Time for Thrombolysis in Emergency Neurological Deficits – Intra-Arterial (EXTEND-IA)

**Good Outcome (mRS 0-2):**
- 71% in IA thrombectomy group
- 40% in medical group

**Conclusion:**
Significantly better outcomes with thrombectomy compared to medical management

Campbell et al; *NEJM*, 2015
Solitaire With the Intention For Thrombectomy as PRIMary Endovascular treatment (SWIFT PRIME)

- Sites: 39 centers mostly in US and Europe
- Patients: 196 (halted early due to efficacy)
  - 98 randomized to IA thrombectomy
  - 98 randomized to medical
- Age 18-80
- Included moderate-severe strokes
- Time: Within 6 hours of onset and within 1.5 hours of imaging
- Primary Outcome: mRS at 90 days
- Treatment in IA arm: retrievable stent

Saver et al; *NEJM*, 2015
Solitaire With the Intention For Thrombectomy as PRIMary Endovascular treatment (SWIFT PRIME)

Good Outcome (mRS 0-2):
- 60% in IA thrombectomy group
- 35% in medical group

Conclusion:
Significantly better outcomes with thrombectomy compared to medical management

Saver et al; NEJM, 2015
Endovascular Revascularization With Solitaire Device Versus Best Medical Therapy in Anterior Circulation Stroke Within 8 Hours (REVASCAT)

- Sites: 4 centers in Spain
- Patients: 206
  - 103 randomized to IA thrombectomy
  - 103 randomized to medical
- Age 18-85
- Included mild-severe strokes
- Time: Within 8 hours of onset
- Primary Outcome: mRS at 90 days
- Treatment in IA arm: retrievable stent

Jovin et al; *NEJM*, 2015
Endovascular Revascularization With Solitaire Device Versus Best Medical Therapy in Anterior Circulation Stroke Within 8 Hours (REVASCAT)

Good Outcome (mRS 0-2):
44% in IA thrombectomy group
28% in medical group

Conclusion:
Significantly better outcomes with thrombectomy compared to medical management

Jovin et al; *NEJM*, 2015
Endovascular Stroke Trials

Good Outcome (%) Rankin 0-2 at 90 days

<table>
<thead>
<tr>
<th>Trial</th>
<th>MT</th>
<th>Control</th>
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<tbody>
<tr>
<td>MR CLEAN</td>
<td>33%</td>
<td>19%</td>
</tr>
<tr>
<td>REVASCAT</td>
<td>44%</td>
<td>28%</td>
</tr>
<tr>
<td>ESCAPE</td>
<td>53%</td>
<td>29%</td>
</tr>
<tr>
<td>SWIFT PRIME</td>
<td>60%</td>
<td>36%</td>
</tr>
<tr>
<td>EXTEND-IA</td>
<td>71%</td>
<td>40%</td>
</tr>
</tbody>
</table>

P-values:
- MR CLEAN: P<0.5
- REVASCAT: P<0.05
- ESCAPE: P<0.001
- SWIFT PRIME: P<0.001
- EXTEND-IA: P<0.01
ESCAPE Outcomes

**MEDICAL TREATMENT**
(No endovascular treatment)

- 29% Positive Outcome
- 52% Disability
- 19% Death

**ENDOVASCULAR TREATMENT**
(With medical treatment)

- 53% Positive Outcome
- 37% Disability
- 10% Death
THINK ABOUT IT

In order to have one additional stroke patient be independent at 90 days

- MR CLEAN
- ESCAPE
- EXTEND-IA
- SWIFT-PRIME

Primary PCI vs. Thrombolysis for STEMI: Prevention of MI/Stroke/Death
DAWN

DEFUSE 3
Conclusions from DAWN and DEFUSE 3

Selection should be based on imaging, not time
2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke

A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association

Reviewed for evidence-based integrity and endorsed by the American Association of Neurological Surgeons and Congress of Neurological Surgeons

Endorsed by the Society for Academic Emergency Medicine

William J. Powers, MD, FAHA, Chair; Alejandro A. Rabinstein, MD, FAHA, Vice Chair; Teri Ackerson, BSN, RN; Opeolu M. Adeoye, MD, MS, FAHA; Nicholas C. Bambakidis, MD, FAHA; Kyra Becker, MD, FAHA; José Biller, MD, FAHA; Michael Brown, MD, MSc; Bart M. Demaerschalk, MD, MSc, FAHA; Brian Hoh, MD, FAHA; Edward C. Jauch, MD, MS, FAHA; Chelsea S. Kidwell, MD, FAHA; Thabele M. Leslie-Mazwi, MD; Bruce Ovbiagele, MD, MSc, MAS, MBA, FAHA; Phillip A. Scott, MD, MBA, FAHA; Kevin N. Sheth, MD, FAHA; Andrew M. Southerland, MD, MSc; Deborah V. Summers, MSN, RN, FAHA; David L. Tirschwell, MD, MSc, FAHA; on behalf of the American Heart Association Stroke Council
### Mechanical Thrombectomy (Continued)

<table>
<thead>
<tr>
<th></th>
<th>COR</th>
<th>LOE</th>
<th>New, Revised, or Unchanged</th>
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<tbody>
<tr>
<td>7. In selected patients with AIS within 6 to 16 hours of last known normal who have LVO in the anterior circulation and meet other DAWN or DEFUSE 3 eligibility criteria, mechanical thrombectomy is recommended.</td>
<td>I</td>
<td>A</td>
<td>New recommendation.</td>
</tr>
<tr>
<td>8. In selected patients with AIS within 6 to 24 hours of last known normal who have LVO in the anterior circulation and meet other DAWN eligibility criteria, mechanical thrombectomy is reasonable.</td>
<td>IIa</td>
<td>B-R</td>
<td>New recommendation.</td>
</tr>
</tbody>
</table>

The DAWN trial used clinical imaging mismatch (a combination of NIHSS score and imaging findings on CTP or DW-MRI) as eligibility criteria to select patients with large anterior circulation vessel occlusion for treatment with mechanical thrombectomy between 6 and 24 hours from last known normal. This trial demonstrated an overall benefit in function outcome at 90 days in the treatment group (mRS score 0–2, 49% versus 13%; adjusted difference, 33%; 95% CI, 21–44; posterior probability of superiority >0.999). In DAWN, there were few strokes with witnessed onset (12%). The DEFUSE 3 trial used perfusion-core mismatch and maximum core size as imaging criteria to select patients with large anterior circulation occlusion 6 to 16 hours from last seen well for mechanical thrombectomy. This trial showed a benefit in functional outcome at 90 days in the treated group (mRS score 0–2, 44.6% versus 16.7%; RR, 2.67; 95% CI, 1.60–4.48; P<0.0001). Benefit was independently demonstrated for the subgroup of patients who met DAWN eligibility criteria and for the subgroup who did not. DAWN and DEFUSE 3 are the only RCTs showing benefit of mechanical thrombectomy >6 hours from onset. Therefore, only the eligibility criteria from these trials should be used for patient selection. Although future RCTs may demonstrate that additional eligibility criteria can be used to select patients who benefit from mechanical thrombectomy, at this time, the DAWN and DEFUSE-3 eligibility should be strictly adhered to in clinical practice.
9. The technical goal of the thrombectomy procedure should be reperfusion to a modified Thrombolysis in Cerebral Infarction (mTICI) 2b/3 angiographic result to maximize the probability of a good functional clinical outcome.

Mechanical thrombectomy aims to achieve reperfusion, not simply recanalization. A variety of reperfusion scores exist, but the mTICI score is the current assessment tool of choice, with proven value in predicting clinical outcomes. All recent endovascular trials used the mTICI 2b/3 threshold for adequate reperfusion, with high rates achieved. In HERMES, 402 of 570 patients (71%) were successfully reperfused to mTICI 2b/3. Earlier trials with less efficient devices showed lower recanalization rates, 1 factor in their inability to demonstrate benefit from the procedure (IMS III, 41%; MR RESCUE, 25%). The additional benefit of pursuing mTICI of 3 rather than 2b deserves further investigation.

10. As with IV alteplase, reduced time from symptom onset to reperfusion with endovascular therapies is highly associated with better clinical outcomes. To ensure benefit, reperfusion to TICI grade 2b/3 should be achieved as early as possible within the therapeutic window.
Timing is Critical

Each 30 minutes = 10% loss!

Cases with angiographic reperfusion

Cases without reperfusion

Khatri et al; *Neurology* 2009
Time to Treatment With Endovascular Thrombectomy and Outcomes From Ischemic Stroke: A Meta-analysis

Jeffrey L. Saver, MD; Mayank Goyal, MD; Aad van der Lugt, MD; Bijoy K. Menon, MD; Charles B. L. M. Majoie, MD; Diederik W. Dippel, MD; Bruce C. Campbell, MD, PhD; Raul G. Nogueira, MD; Andrew M. Demchuk, MD; Alejandro Tomasello, MD; Pere Cardona, MD; Thomas G. Devlin, MD; Donald F. Frei, MD; Richard du Mesnil de Rochemont, MD; Olvert A. Berkhemer, MD; Tudor G. Jovin, MD; Adnan H. Siddiqui, MD, PhD; Wim H. van Zwam, MD; Stephen M. Davis, MD; Carlos Castaño, MD; Biggya L. Sapkota, MD; Puck S. Fransen, MD; Carlos Molina, MD; Robert J. van Oostenbrugge, MD; Ángel Chamorro, MD; Hester Lingsma, PhD; Frank L. Silver, MD; Geoffrey A. Donnan, MD; Ashfaq Shuaib, MD; Scott Brown, PhD; Bruce Stouch, PhD; Peter J. Mitchell, MD; Antoni Davalos, MD; Yvo B. W. E. M. Roos, MD; Michael D. Hill, MD, MS; for the HERMES Collaborators

Process Efficiencies Matter after arrival at Endovascular Hospital

Figure 3. Relation Between In-Hospital Treatment Speeds and Functional Independence (mRS 0-3) at 3 Months Among Direct Arrival Patients in the Endovascular Thrombectomy Group Achieving Substantial Reperfusion (mTICI score, 2b or 3)

A. Functional independence (mRS 0-3) by time from emergency department arrival to actual substantial reperfusion

B. Functional independence (mRS 0-3) by time from brain imaging to actual substantial reperfusion

< 60 minutes

- Neurological evaluation
- Imaging evaluation
- Thrombectomy
Swedish Medical Center
Neurovascular Team

• 14 + hospitalist neurologists
  – Evaluate patients from 60 telemedicine hospitals in the western USA
  – Neurologist meets ALL stroke patients upon arrival
  – In suspected LVO patients, the INR team meets the patient upon arrival in CT - 24/7/365

• 4 neuro-interventional surgeons

• 6 stroke nurse practitioners
COMPREHENSIVE STROKE CENTERS

SOURCE: American Heart Association
Swedish Medical Center Spoke and Hub Treatment Area – 10 million population
Air Ambulance 2010 Program of the Year!

Health One
AirLife
DENVER

It's About The Experience!

Named #1 in the Country by the national Association of Air Medical Services (AAMS)

Since 1983
Sunday November 20, 2016

• 29 y.o. male transferred from Billings, Montana
• Marfans syndrome, intubated before transfer
2 hour fixed wing flight
600 miles
Sunday November 20, 2016

• 29 y.o. male transferred from Billings, Montana
• Marfans syndrome, intubated before transfer
• Door - 3:50 pm
• CT - 4:00 pm
Sunday November 20, 2016

• 29 y.o. male transferred from Billings, Montana
• Marfans syndrome, intubated before transfer
• Door – 3:50 pm
• CT - 4:00 pm
• Access - 4:23 pm
TICI 3 recanalization – 1 pass ACE 68
Sunday November 20, 2016

- 29 y.o. male transferred from Billings, Montana
- Marfans syndrome, intubated before transfer
- Door – 3:50 pm
- CT - 4:00 pm
- Access - 4:23 pm
- Recan. - 4:36 pm

Door – recanalization 46 minutes
Friday night, 7:00 pm, at my home, with visiting physicians from Japan

- 31 y.o. female – aphasia, right hemiplegia
- Cardiomyopathy, ejection fraction 10%
- Not therapeutic on coumadin
- CT/CTA at a hospital 9 miles away at 6:42 pm
  – Reviewed prior to arrival
24 hour MRI, NIHSS - 1

90 mRS - 0
LVO Stroke - Time is Brain

• 1.8 million neurons lost each minute
• Probability of a good outcome reduced 10% every 30 minutes until treated\(^1\)
• Every 30 minute delay to revascularization = 7% increased risk of moderate to severe disability and 11.8% increase in mortality\(^2\)

Passage of time from the start of the stroke occurs differently for every patient

- Data supports a time window, but is the window the same for all patients?
  - **Wake up Stroke**: “last time known well” excludes many from treatment
  - **Posterior Strokes**: tolerate ischemia longer than anterior stroke and may have viable penumbra beyond 6 or 8 hours
  - **Collateral Circulation**: affects a patient’s ability to tolerate an occluded vessel

- An alternative to the traditional time window may be advanced imaging techniques in selected patients
  - CT Perfusion
  - MRI Diffusion/Perfusion
Early Treatment = Better Outcome

The Solution
LVO Stroke Treatment – A Team Sport

- Community Education
- EMS appropriate triage to IA capable facility
- Rapid ED evaluation and triage to endovascular
- Acute Neurology/Neurointerventional Surgery consultation
- t-PA and/or Embolectomy
- Neurocritical care
- Rehabilitation
- Risk factor modification
Stroke Chain of Survival

- **Detection:** Early stroke recognition
- **Dispatch:** Early EMS activation
- **Delivery:** Transport, triage & management
- **Door:** ED triage
- **Data:** ED evaluation & management
- **Decision:** Neurology input, therapy selection
- **Drug:** Thrombolytics & Endovascular therapies
- **Disposition:** Admission or transfer
Is it a stroke? Check these signs **FAST**!

**Face**
- Does the face look uneven? Ask them to smile.

**Arm**
- Does one arm drift down? Ask them to raise both arms.

**Speech**
- Does their speech sound strange? Ask them to repeat a phrase.

**Time**
- Every second, brain cells die. Call 9-1-1 at any sign of stroke!

Act **FAST**. Call 9-1-1 at any sign of stroke!

Massachusetts Department of Public Health
Stroke scales mobile app

- Tool for first responders to assess stroke severity in the field
- Based on results, app recommends the type of facility to which the stroke patient should be transported.
Stroke scales mobile app

Facial droop with smile?
- No
- Yes

Lift both arms up in front of you.
- No arm drift
- Arm drifts down on one side
- Arm falls rapidly on one side

Grip strength?
- Normal
- Weak grip on one side

Results: Likely a large vessel occlusive stroke.
LAMS Score: 4 out of 4
Recommend endovascular capable stroke center.

E-mail Results
Text Results
Take Another LAMS Test
Change My Scale
Thank You
don.frei@riaco.com