The Changing Landscape of Stroke Treatment

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Case

- 70 y/o left handed female with medical history significant for breast cancer, had acute onset of L sided weakness and aphasia at 8:30 AM
- IV r-tPA given at 10:00 AM
- No improvement on r-tPA
- NIHSS 16
- Transferred for possible endovascular intervention
- Arrived at down town NCH at 12:30 PM – 4 hrs after onset
- CTA/CTP obtained
Post-op Course

• Post-operatively NIHSS reduced to 3
• Discharged POD #2 to home. NIHSS 0
Stroke Facts

- 795,000 people in the US suffer strokes every year
- 133,000 deaths in the US each year
- Stroke is the 4\textsuperscript{th} leading cause of death in the US
- A leading cause of disability
- On average, someone suffers a stroke every 40 seconds in the US
- Up to 80\% of all strokes are preventable through risk factor management
IV r-tPA, the “Gold Standard”

- Systemic “Clot Buster”
- FDA Approved for the treatment of AIS in 1996
- Only 8% of ischemic stroke patients are eligible for IV r-tPA
  - Narrow time window
  - Risk of cerebral and systemic hemorrhage
- Achieves early reperfusion in only 13-50% of large vessel occlusions


Systemic IV r-tPA Therapy Evidence: NINDS up to 3 hours and ECASS III up to 4.5 hours from ischemic stroke symptoms

Excellent outcome at 3 months on all scales

Global outcome statistic: OR=1.7, 50% vs. 38%=12% benefit
Impact of Clot Burden on Success Rate of IV tPA

~40% recanalization

Persistence Occlusion

35-40% of Ischemic Strokes are Considered “Large Vessel”

- This subset of ischemic stroke comprises blockages in the:
  - Internal Carotid Artery (ICA)
  - Middle Cerebral Artery (MCA)
  - Vertebral / Basilar Artery

- Patient prognosis with these types of stroke is poor

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Mortality Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICA</td>
<td>53%(^1)</td>
</tr>
<tr>
<td>MCA</td>
<td>27%(^2)</td>
</tr>
<tr>
<td>Basilar Artery</td>
<td>89-90%(^3)</td>
</tr>
</tbody>
</table>

2. Furlan A et al. PROACT II Trial
Overall Local and Systemic Therapy Improves the likelihood of better Outcome

% of patients with 90d mRS ≤ 2: IA, IV, and Control
Evolution of Endovascular Stroke Technology

- Question: Can endovascular therapy improve recanalization rates of large vessel occlusions?

Late 90’s: 50%  
Current: 85%
Turning Point
The Era of Stent-Retrievers

Technological advances

- Stent-retriever technology for safe, reliable performance

- Significant improvement in revascularization and patient outcomes vs older technology, proven in randomized clinical trials*


Image courtesy of Stryker Neurovascular.
Recent Stroke Trials

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

- Multicenter Randomized Clinical trial of Endovascular treatment for Acute ischemic stroke in the Netherlands
- 500 patients = randomized goal
- Sponsored by the Dutch government
  - No reimbursement unless enrolled in this trial

Design

- Multicenter (16 Centers in Netherlands), prospective, randomized trial, open label treatment and:
  - Blinded assessment of functional outcome at 90 days
  - Blinded assessment of neuro-imaging at baseline and follow-up
- Masked, web-based, 1:1 random treatment allocation
  - Intraarterial treatment (IA thrombolysis, mechanical treatment or both) plus usual care (could include IV tPA)
  - Usual care alone (control group)
- Inclusion Criteria
  - Acute ischemic stroke, Age ≥18, NIHSS ≥2
  - Intracranial anterior circulation occlusion (confirmed by CTA)
  - Initiation of IA treatment within 6 hours from onset

7x More Likely to Recanalize with Intra-Arterial Treatment*

Recanalization on CTA after 24 Hours

-Control (68/207) 33%
-Intervention (141/187) 75%

*Adjusted value odds ratio (95% CI) for “no intracranial occlusion on follow up CT angiography” in the intervention group versus the control group was 6.88 (4.34 to 10.94). Values were adjusted for age, NIHSS at baseline, time from onset to randomization, status with respect to previous stroke, atrial fibrillation, diabetes mellitus and occlusion of the ICAT. Data for follow up CT angiography were not available for 106 patients.

Outcome Results: Neurological Disability (mRS at 3 mo)

mRS in MR Clean trial comparing mRS 0-1, 0-2, and 0-3 between the groups, showing significantly better outcome with IAT than standard of care, with OR (odds ratio) 2.06, 2.05, and 1.89, respectively.

No Significant Between-Group Difference in the Occurrence of Serious Adverse Events @ 90 days (P=0.31)

<table>
<thead>
<tr>
<th>Serious Adverse Events</th>
<th>Intervention (N=233)</th>
<th>Control (N=267)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any serious adverse event</td>
<td>110 (47.2%)</td>
<td>113 (42.3%)</td>
</tr>
<tr>
<td>Parenchymal hematoma type 2</td>
<td>14 (6.0%)</td>
<td>14 (5.2%)</td>
</tr>
<tr>
<td>New ischemic stroke in different vascular territory*</td>
<td>13 (5.6%)</td>
<td>1 (0.4%)</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>25 (10.7%)</td>
<td>41 (15.4%)</td>
</tr>
<tr>
<td>Hemicraniectomy</td>
<td>14 (6.0%)</td>
<td>13 (4.9%)</td>
</tr>
<tr>
<td>Death</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within 7 days</td>
<td>27 (11.6%)</td>
<td>33 (12.4%)</td>
</tr>
<tr>
<td>Within 30 days</td>
<td>44 (18.9%)</td>
<td>49 (18.4%)</td>
</tr>
</tbody>
</table>

*P<0.001

MR CLEAN Study Conclusions:

IA Rx within 6 hrs from a stroke caused by an Intracranial anterior circulation occlusion is safe and effective!

This treatment leads to a clinically significant increase in the functional independence in daily life by 3 months, without an increase in mortality

ESCAPE

Endovascular treatment for Small Core and Anterior circulation Proximal occlusion with Emphasis on minimizing CT to recanalization times

M Goyal et. al. Randomized Assessment of Rapid Endovascular Treatment of Ischemic Stroke. NEJM published on February 11, 2015
ESCAPE Trial
Workflow and Intervention

- Acute ischemic stroke
- Age ≥ 18 years
- Last-seen-well time to randomization < 12 hours
- ASPECTS >5
- Baseline NIHSS >5 at time of randomization
- Randomization: standard of care vs standard of care + endovascular treatment
- Focus on speed – time targets:
  - CT head to groin puncture: 60 min
  - CT head to first recanalization: 90 min
- Use of retrievable stents recommended
- Use of balloon guide catheter recommended
- Avoid use of general anesthesia
<table>
<thead>
<tr>
<th>Process times min-median (IQR)</th>
<th>Intervention (N=165)</th>
<th>Control (N=150)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symptom onset to randomization (N=315)</td>
<td>169 (117-285)</td>
<td>172.5 (119-284)</td>
</tr>
<tr>
<td>Onset to IV alteplase (N=237)</td>
<td>110 (80-142)</td>
<td>125 (89-183)</td>
</tr>
<tr>
<td>CT to groin puncture</td>
<td>51 (39-68)</td>
<td>-</td>
</tr>
<tr>
<td>CT to first reperfusion</td>
<td>84 (65-115)</td>
<td>-</td>
</tr>
<tr>
<td>Onset to first reperfusion</td>
<td>241 (176-359)</td>
<td>-</td>
</tr>
<tr>
<td>Treatment with IV alteplase</td>
<td>72.7%</td>
<td>78.6%</td>
</tr>
</tbody>
</table>
mRS 0-2 at 90-days (N=311)

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

 Intervention  Control

53.0%  29.3%

NNT = 4 for independence

M Goyal et. al. Randomized Assessment of Rapid Endovascular Treatment of Ischemic Stroke. NEJM published on February 11, 2015
<table>
<thead>
<tr>
<th>Serious Adverse Events</th>
<th>Intervention (N=165)</th>
<th>Control (N=150)</th>
<th>Adjusted RR (CI 95%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>10.4%</td>
<td>19.0%</td>
<td>0.5 (0.3 to 0.8)</td>
</tr>
<tr>
<td>Large MCA / malignant MCA stroke</td>
<td>4.8%</td>
<td>10.7%</td>
<td>0.3 (0.1 to 0.7)</td>
</tr>
<tr>
<td>sICH (clinically determined at site)</td>
<td>3.6%</td>
<td>2.7%</td>
<td>1.2 (0.3 to 4.6)</td>
</tr>
<tr>
<td>Access site hematoma</td>
<td>1.8%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>MCA perforation</td>
<td>0.6%</td>
<td>0%</td>
<td></td>
</tr>
</tbody>
</table>
ESCAPE Study Conclusions

• Endovascular thrombectomy is a safe, highly effective procedure that saves lives and dramatically reduces disability **WHEN**:
  o Patients are carefully selected by imaging to identify proximal occlusions and exclude large core and exclude patients with absent collaterals
  o Treatment is extremely fast with target first slice
    • Imaging to groin puncture <60 minutes
    • Imaging to reperfusion <90 minutes
  o Safe effective technology (retrievable stents) is used

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

Solitaire FR With the Intention For Thrombectomy as Primary Endovascular treatment for acute ischemic stroke

Results of the SWIFT PRIME Trial were presented by Dr. Jeffery Saver and Dr. Michael D. Hill at the International Stroke Conference in Nashville, TN on Wednesday, February 11, 2015.
Inclusion Criteria

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

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

*Reperfusion measured by reperfusion ratio assessed by core lab:
reperfusion volume at 27 hrs + hypoperfusion lesion volume (Tmax>6s) at baseline
SWIFT PRIME Results: Dichotomized 90 Days mRS Disability Score Outcome (0-2)

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

Functional independence (mRS 0-2) at 90 days

- Solitaire + IV tPA: 60.2%
- IV tPA: 35.5%
# Safety Endpoints / Mortality

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

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

• In AIS patients with confirmed large vessel anterior circulation occlusions treated with IV tPA, rapid treatment with the Solitaire stent retriever lessens post-stroke disability over the entire outcome range and increases the proportion of patients who are alive and independent 3 months after stroke.

• For every two and a half patients treated, one more patient has a better disability outcome.

• For every four patients treated, one more patient is independent at long term follow up.

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

A randomized controlled trial of endovascular thrombectomy after standard dose intravenous t-PA within 4.5 hours of stroke onset utilizing dual target imaging selection

Inclusion Criteria

- Acute ischemic stroke
- Age ≥ 18 years
- Pre-stroke mRS 0-1
- Intra-arterial clot retrieval treatment can commence (groin puncture) within 6 hours of stroke onset.
- Imaging inclusion criteria. Dual target:
  - CTA reveals large artery occlusion in anterior anatomy (ICA, M1 or M2) AND
  - Mismatch - Using CT or MRI with a Tmax >6 second delay perfusion volume and either CT-rCBF or DWI infarct core volume.
    - Mismatch ratio of greater than 1.2 and
    - Absolute mismatch volume of greater than 10ml and
    - Infarct core lesion volume of less than 70mL

B.C.V. Campbell et. al. Endovascular Therapy for Ischemic Stroke with Perfusion-Imaging Selection. NEJM published on February 11, 2015
EXTEND-IA Trial Design

PROBE Design, Planned 100 Patients

Patient eligible for tPA <4.5 hr
No upper age limit, No NIHSS limits,
Premorbid mRS 0-1

Is there ICA/M1/M2 occlusion + mismatch (ratio >1.2, absolute >10 mL) with ischemic core <70 mL?
Randomize 50:50 (web-based)

IV tPA only

0.9 mg/kg IV tPA + Solitaire FR clot retrieval – start asap (<6 hr)

24 hr MRI reperfusion* (recan/growth/ICH)
24 hr NIHSS
3 day NIHSS*
90 day NIHSS & mRS

Blinded outcomes

*co-primary outcome
EXTEND-IA RAPID for CT and MRI

Fast standard, fully automated, quantitative threshold mismatch

CT reICBF/ Diffusion MRI

RAPID
Ischemic core
Segmentation
CT reICBF <30%

Tmax

RAPID
Tmax >6 sec segmentation

Ischemic core: 6 mL
Perfusion lesion: 58 mL
Mismatch ratio = 9.7
Absolute mismatch = 52 mL
Randomize patient

Ischemic core: 7 mL
Perfusion lesion: 55 mL
Mismatch ratio = 7.6
Absolute mismatch = 48 mL
Randomize patient
mRS 0-2 at 90-days

P = 0.01

NNT = 3.2 for independence

B.C.V. Campbell et. al. Endovascular Therapy for Ischemic Stroke with Perfusion-Imaging Selection. NEJM published on February 11, 2015
# Safety Endpoints / Mortality

<table>
<thead>
<tr>
<th>Serious Adverse Events</th>
<th>IV tPA Only (N=35)</th>
<th>IV tPA + Endovascular (N=35)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>20%</td>
<td>9%</td>
<td>0.18</td>
</tr>
<tr>
<td>sICH (SITS MOST)</td>
<td>6%</td>
<td>0%</td>
<td>0.49</td>
</tr>
<tr>
<td>PH</td>
<td>9%</td>
<td>11%</td>
<td>0.99</td>
</tr>
<tr>
<td>Wire Perforation</td>
<td></td>
<td>2.9%</td>
<td></td>
</tr>
<tr>
<td>Emboli</td>
<td></td>
<td>5.7%</td>
<td></td>
</tr>
</tbody>
</table>

B.C.V. Campbell et. al. Endovascular Therapy for Ischemic Stroke with Perfusion-Imaging Selection. NEJM published on February 11, 2015
Conclusions

• Early mechanical stent thrombectomy after tPA using Solitaire FR led to faster and more complete reperfusion

• In this population selected for vessel occlusion and salvageable tissue this translated to:
  - Improved early neurological recovery
  - Improved functional outcome at 3 months
  - No safety concerns

• tPA + mechanical stent thrombectomy should be the new standard of care
2015 – The Evidence

A Randomized Trial of Intraarterial Treatment for Acute Ischemic Stroke

Olav A. Berkhemner, M.D., Puck S.S. Fransen, M.D., Debbie Beumer, M.D., Lucie A. van den Berg, M.D., Hester F. Lingsma, Ph.D., Albert J. Yoo, M.D., Wouter J. Schoneveld, M.D., Jan Albert Vos, M.D., Ph.D., Paul J. Nederkoorn, M.D., Ph.D., Marieke J.H. Warmen, M.D., Ph.D., Marianne A.A. van Walderveen, M.D., Ph.D., Julie Staals, M.D., Ph.D., Jeanette Hofmeijer, M.D., Ph.D., Jacques A. van Coster, M.D., Ph.D., Gert J. Luyckx, M.D., Ph.D., and Jan S.P. van den Berg, M.D., Ph.D., Boudewijn A.A.M. van Hasselt, M.D., Leo A.M. Aarden, M.D., Ph.D., René J. Dallinga, M.D., Marlineke C. Visser, M.D., Ph.D., Joseph C.J. Bot, M.D., Ph.D., Patrick C. Vroomen, M.D., Ph.D., Omid Ghanjhu, M.D., Tobien H.C.M. Schreuder, M.D., Roel J.J. Heijboer, M.D., Koos Keizer, M.D., Ph.D., Alexander V. Tieleman, M.D., Ph.D., Helen M. den Hertog, M.D., Ph.D., Dick G. Gerrits, M.D., Renate V. den Berg-Vos, M.D., Ph.D., Giorgos B. Keras, M.D., Evouit W. Stemberg, M.D., Ph.D., Henk A. Marquering, M.D., Marlineke E.S. Sprengers, M.D., Ph.D., Sjoerd F.M. Jennisens, M.D., Ph.D., Ludo F.M. Beenen, M.D., René van den Berg, M.D., Ph.D., Peter J. Kouwstaal, M.D., Ph.D., Wim H. van Zwam, M.D., Ph.D., Yvo B.W.E.M. Roos, M.D., Ph.D., Aad van der Lugt, M.D., Ph.D., Robert J. van Oostenbrugge, M.D., Ph.D., Charles B.L.M. Majoie, M.D., Ph.D., and Diederik W.J. Dippel, M.D., Ph.D. for the MR CLEAN Investigators


Endovascular Therapy for Ischemic Stroke with Perfusion-Imaging Selection

Bruce C.V. Campbell, M.D., Peter J. Mitchell, M.D., Timothy J. Keilin, M.D., Helen M. Dewey, M.D., Leonid Churliriov, Ph.D., Nawaf Yassli, M.D., Bernard Yan, M.D., Richard J. Dowling, M.D., Mark W. Parsons, M.D., Thomas J. O’ney, M.D., Teddy Y. Wu, M.D., Mark Brooks, M.D., Marion A. Simpson, M.D., Ferdinand Millett, M.D., Christopher R. Levi, M.D., Martin Krause, M.D., Timothy J. Harrington, M.D., Kenneth C. Faulder, M.D., Brendan S. Steinfort, M.D., Mirem Pilialinger, M.D., Timothy Ang, M.D., Rebecca Scroop, M.D., Alan Barber, M.D., Ben McGuinness, M.D., Tessa Wijeratne, M.D., Thanh G. Phan, M.D., Winston Chong, M.D., Roni V. Chandra, M.D., Christopher F. Bladin, M.D., Monica Badve, M.D., Henry Rice, M.D., Laetitia de Villiers, M.D., Henry Ma, M.D., Patricia M. Desmond, M.D., Geoffrey A. Donnan, M.D., and Stephen M. Davis, M.D. for the EXTEND-IA Investigators


Randomized Assessment of Rapid Endovascular Treatment of Ischemic Stroke


Thrombectomy within 8 Hours after Symptom Onset in Ischemic Stroke

Tudor G. Jovin, M.D., Angel Chamorro, M.D., Erik Cobo, Ph.D., María A. de Miquel, M.D., Carlos A. Molina, M.D., Alex Rovira, M.D., Luis San Román, M.D., Joaquín Serena, M.D., Sonia Abilleira, M.D., Ph.D., Marco Ribó, M.D., Monica Millán, M.D., Xavier Urra, M.D., Pere Cardona, M.D., Elena López-Cancio, M.D., Alejandro Tomasello, M.D., Carlos Cañistro, M.D., Jordi Blasco, M.D., Lucía Aja, M.D., Laura Dorado, M.D., Helena Quesada, M.D., Marta Rubiera, M.D., María Hernandez-Pérez, M.D., Mayank Goyal, M.D., Andrew M. Demchuk, M.D., Rüdiger von Kummer, M.D., Miquel Gallí, M.D., and Antoni Dávalos, M.D. for the REVASCAT Trial Investigators


Stent-Retriever Thrombectomy after Intravenous t-PA vs. t-PA Alone in Stroke


NNT: 2.5-7
Think About This

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

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

For primary PCI vs. thrombolysis for STEMI: Prevention of MI/Stroke/Death
AHA/ASA Guideline
2015 AHA/ASA Focused Update of the Early Management of Patients With Acute Stroke Regarding Endovascular Treatment

• Patients eligible for intravenous r-tPA should receive intravenous r-tPA even if endovascular treatments are being considered (Class I; Level of Evidence A)

• Patients should receive endovascular therapy with a stent retriever if they meet all the following criteria (Class I; Level of Evidence A):
  a) Prestroke mRS score 0-1,
  b) Acute ischemic stroke receiving intravenous r-tPA within 4.5 hours of onset according to guidelines from professional medical societies,
  c) Causative occlusion of the internal carotid artery or proximal MCA (M1),
  d) Age ≥18,
  e) NIHSS score ≥6,
  f) ASPECTS of ≥6, and
  g) Treatment can be initiated (groin puncture) within 6 hours of symptom onset
Initial Assessment/Management

For the patient with potential ELVO, there are 5 initial assessment/management goals before endovascular reperfusion therapy:

1. Confirm an AIS (i.e., exclude hemorrhage)
2. Determine candidacy for IV r-tPA and rapidly administer to all eligible patients
3. Confirm or exclude the presence of a large vessel occlusion
4. Determine candidacy for embolectomy, and then activate the neurointerventional team (if at a CSC, or transfer to a CSC if patient at a PSC)
5. Provide optimal medical management to limit infarct expansion until reperfusion is established

Pre-notification
- Stroke team receives patient at ED door

ED staff
- Vitals and ABC
- IV lines
- Blood Drawn

Stroke team
- Fast Neuro Exam
- Relevant Past History
- Blood thinners/INR
- Pre-morbid quality of life

Imaging
- CT Head
- Review on CT console

Inform Neurointerventionist

CT Angiogram
- Proximal vessel occlusion
- Good collaterals
- CTP if needed. No MRI

INR team activated

Decision for endovascular treatment taken

Neurointerventionist
- Consent
- Rapport with family

Angio suite set up
- Standardized approach
- Pre-prepared stroke tray and kit
- Extensive training of angio staff

Angio procedure
- Use CTA to plan procedure
- Go straight to target
- Take short cuts wherever one can
- Stent retrievers

Post-procedure
- Talk to family
- Head CT
- Transfer to ICU

All teams converge at the angiography suite

5-7min

10-12min

15min

20-25min

5min

20min

20-25min

30-35min
<table>
<thead>
<tr>
<th>Action</th>
<th>Time (min)†</th>
<th>SNIS ‘ideal’ time‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Door to physician</td>
<td>&lt;10</td>
<td>On arrival</td>
</tr>
<tr>
<td>Door to NCCT/CTA</td>
<td>&lt;25</td>
<td>On arrival</td>
</tr>
<tr>
<td>Door to stroke team</td>
<td>&lt;15</td>
<td>&lt;10 min</td>
</tr>
<tr>
<td>Door to NCCT interpretation</td>
<td>&lt;45</td>
<td>&lt;15 min</td>
</tr>
<tr>
<td>Door to CTA interpretation</td>
<td>N/A</td>
<td>&lt;20 min (or 10 min after acquisition)</td>
</tr>
<tr>
<td>Door to IV tPA</td>
<td>&lt;60</td>
<td>&lt;30 min</td>
</tr>
<tr>
<td>Door to CTP/MRI (optional)</td>
<td>N/A</td>
<td>&lt;30 min</td>
</tr>
<tr>
<td>CSC Door to puncture</td>
<td>N/A</td>
<td>&lt;60 min</td>
</tr>
<tr>
<td>CSC Door to recanalization</td>
<td>N/A</td>
<td>&lt;90 min</td>
</tr>
<tr>
<td>PSC picture to CSC puncture§</td>
<td>N/A</td>
<td>&lt;90 min</td>
</tr>
</tbody>
</table>

*Assuming emergency medical services prenotification.
†AHA 2013 standard.
‡SNIS ideal.
§Assuming direct transfer to biplane neuroangiography suite when feasible.
AHA, American Heart Association; CTA, CT angiography; CTP, CT perfusion; CSC, Comprehensive Stroke Center; NCCT, non-contrast CT scan; PSC, Primary Stroke Center; SNIS, Society of NeuroInterventional Surgery; tPA, tissue plasminogen activator.
When you put this together

- Small core
- Patient worth fighting for
- Natural history likely to be bad
- WORK LIKE CRAZY TO ACHIEVE RECANALIZATION
  - Don’t waste time on extensive imaging and post processing
Components of Success

- Teamwork
- Organization
- Setting up the correct process