Acute Stroke Intervention

Andrew P Gard, MD
Assistant Professor – Neurosurgery
Disclosures

None
Objectives

• Acute stroke intervention – patient selection
• Endovascular instruments and techniques in acute stroke intervention
Stroke

- CNS infarction of the brain, spinal cord, and/or retina due to ischemia with symptoms lasting > 24 hours. Includes: ischemic stroke, intracerebral hemorrhage, subarachnoid hemorrhage, cerebral venous thrombosis

- Ischemic: 80%
- Hemorrhagic: 15-20%

[Diagram showing stroke categories: Ischemic 80%, Hemorrhagic 15%, SAH 5%]
Stroke

- Stroke is the 5th leading cause of death in the U.S. killing more than 130,000 each year – 1 of every 20 deaths
- Every 4 minutes, someone dies of stroke
- Disability – reduces mobility in more than half of survivors >= 65 y/o
- Cost – $33 billion annually
Stroke kills twice as many women as breast cancer does every year.
Recognizing Stroke

In one survey, only 38% were aware of all major stroke symptoms and knew to call 9-1-1

Fang J et al. MMWR 2008;57:481-5

www.strokecenter.org
Recognizing Stroke

FACE.
Has their face fallen on one side? Can they smile?

ARMS.
Can they raise both arms and keep them there?

SPEECH.
Is their speech slurred?

TIME.
Time to call 999 if you see any single one of these signs.

WHEN STROKE STRIKES,
ACT F.A.S.T.

National Health Service – www.nhs.uk
“Time is Brain”

The typical patient looses:

- 1.9 million neurons
- 14 billion synapses
- 7.5 miles of myelinated fibers every minute in which a stroke is untreated

Saver JL. Stroke 2006;37:273-6
“Time is Brain”

Salvageable area after stroke
Area of dead tissue

Salvageable area after stroke
Area of dead tissue

Area of dead tissue

0 hours days

BPJ 2010;26:33-37
“Time is Brain”

Marler JR. Neurology 2000;55:1649
Table 10. Inclusion and Exclusion Characteristics of Patient With Ischemic Stroke Who Could Be Treated With IV rtPA Within 3 Hours From Symptom Onset

Inclusion criteria

- Diagnosis of ischemic stroke causing measurable neurological deficit
- Onset of symptoms <3 hours before beginning treatment
- Aged ≥18 years

Exclusion criteria

- Significant head trauma or prior stroke in previous 3 months
- Symptoms suggest subarachnoid hemorrhage
- Arterial puncture at noncompressible site in previous 7 days
- History of previous intracranial hemorrhage
- Intracranial neoplasm, arteriovenous malformation, or aneurysm
- Recent intracranial or intraspinal surgery
- Elevated blood pressure (systolic >185 mm Hg or diastolic >110 mm Hg)
- Active internal bleeding
- Acute bleeding diathesis, including but not limited to
- Platelet count <100,000/mm³
- Heparin received within 48 hours, resulting in abnormally elevated aPTT greater than the upper limit of normal
- Current use of anticoagulant with INR >1.7 or PT >15 seconds
- Current use of direct thrombin inhibitors or direct factor Xa inhibitors with elevated sensitive laboratory tests (such as aPTT, INR, platelet count, and ECT; TT; or appropriate factor Xa activity assays)
- Blood glucose concentration <50 mg/dL (2.7 mmol/L)
- CT demonstrates multilobal infarction (hypodensity >1/3 cerebral hemisphere)

Relative exclusion criteria

- Recent experience suggests that under some circumstances—with careful consideration and weighting of risk to benefit—patients may receive fibrinolytic therapy despite 1 or more relative contraindications. Consider risk to benefit of IV rtPA administration carefully if any of these relative contraindications are present:
- Only minor or rapidly improving stroke symptoms (clearing spontaneously)
- Pregnancy
- Seizure at onset with postictal residual neurological impairments
- Major surgery or serious trauma within previous 14 days
- Recent gastrointestinal or urinary tract hemorrhage (within previous 21 days)
- Recent acute myocardial infarction (within previous 3 months)

Table 11. Additional Inclusion and Exclusion Characteristics of Patients With Acute Ischemic Stroke Who Could Be Treated With IV rtPA Within 3 to 4.5 Hours From Symptom Onset

Inclusion criteria

- Diagnosis of ischemic stroke causing measurable neurological deficit
- Onset of symptoms within 3 to 4.5 hours before beginning treatment

Relative exclusion criteria

- Aged >80 years
- Severe stroke (NIHSS>25)
- Taking an oral anticoagulant regardless of INR
- History of both diabetes and prior ischemic stroke
## NIH Stroke Scale

<table>
<thead>
<tr>
<th>Tested Item</th>
<th>Title</th>
<th>Responses and Scores</th>
</tr>
</thead>
</table>
| IA          | Level of consciousness | 0—Alert  
1—Drowsy  
2—Obtunded  
3—Coma/unresponsive |
| 1B          | Orientation questions (2) | 0—Answers both correctly  
1—Answers 1 correctly  
2—Answers neither correctly |
| 1C          | Response to commands (2) | 0—Performs both tasks correctly  
1—Performs 1 task correctly  
2—Performs neither |
| 2           | Gaze | 0—Normal horizontal movements  
1—Partial gaze palsy  
2—Complete gaze palsy |
| 3           | Visual fields | 0—No visual field defect  
1—Partial hemianopia  
2—Complete hemianopia  
3—Bilateral hemianopia |
| 4           | Facial movement | 0—Normal  
1—Minor facial weakness  
2—Partial facial weakness  
3—Complete unilateral palsy |
| 5           | Motor function (arm) | a. Left  
0—No drift  
1—Drift before 5 seconds  
2—Falls before 10 seconds  
3—No effort against gravity  
4—No movement  
  b. Right  
0—No drift  
1—Drift before 5 seconds  
2—Falls before 10 seconds  
3—No effort against gravity  
4—No movement |
| 6           | Motor function (leg) | a. Left  
0—No drift  
1—Drift before 5 seconds  
2—Falls before 5 seconds  
3—No effort against gravity  
4—No movement  
  b. Right  
0—No drift  
1—Drift before 5 seconds  
2—Falls before 5 seconds  
3—No effort against gravity  
4—No movement |
| 7           | Limb ataxia | 0—No ataxia  
1—Ataxia in 1 limb  
2—Ataxia in 2 limbs |
| 8           | Sensory | 0—No sensory loss  
1—Mild sensory loss  
2—Severe sensory loss |
| 9           | Language | 0—Normal  
1—Mild aphasia  
2—Severe aphasia  
3—Mute or global aphasia |
| 10          | Articulation | 0—Normal  
1—Mild dysarthria  
2—Severe dysarthria |
| 11          | Extinction or inattention | 0—Absent  
1—Mild (loss 1 sensory modality lost)  
2—Severe (loss 2 modalities lost) |
# Field Assessment Stroke Triage for Emergency Destination

<table>
<thead>
<tr>
<th>Facial palsy</th>
<th>FAST-ED</th>
<th>NIHSS Score</th>
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</thead>
<tbody>
<tr>
<td>Normal or minor paralysis</td>
<td>0</td>
<td>0–1</td>
</tr>
<tr>
<td>Partial or complete paralysis</td>
<td>1</td>
<td>2–3</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Arm weakness</th>
<th>FAST-ED</th>
<th>NIHSS Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>No drift</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Drift or some effort against gravity</td>
<td>1</td>
<td>1–2</td>
</tr>
<tr>
<td>No effort against gravity or no movement</td>
<td>2</td>
<td>3–4</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Speech changes</th>
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<tr>
<td>Absent</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mild to moderate</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Severe, global aphasia, mute</td>
<td>2</td>
<td>2–3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Eye deviation</th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Absent</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Partial</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Forced deviation</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Denial/Neglect</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Extinction to simultaneous stimulation in 1 modality</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Doesn’t recognize own hand</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
Field Assessment Stroke Triage for Emergency Destination
A Simple and Accurate Prehospital Scale to Detect Large Vessel Occlusion Strokes

Figure 2. Proportion of patients with large vessel occlusion strokes according to the Field Assessment Stroke Triage for Emergency Destination (FAST-ED) scale. Hosmer and Lemeshow test: 0.62.

Lima FO. Stroke 2016;47
Field Assessment Stroke Triage for Emergency Destination
A Simple and Accurate Prehospital Scale to Detect Large Vessel Occlusion Strokes

Figure 3. Proportion of patients with large vessel occlusion strokes according to the Field Assessment Stroke Triage for Emergency Destination (FAST-ED) scale and most proximal site of occlusion. ICA indicates internal carotid artery; and MCA, middle cerebral artery.
CT imaging
ASPECTS
CENTRAL ILLUSTRATION: Endovascular Stroke Trials and Impact on Stroke Care Systems: Key Elements of Stroke Systems of Care

Endovascular Ischemic Stroke

Presentation
• FAST (face, arm, speech, time)
• Acute onset, often awake with deficits

Evaluation
• History & Exam
  - NIHSS
• Imaging
  - CT Head (non-contrast)

Management (no hemorrhage on CT)
• Time since symptom onset
tPA if within 4.5 hrs
• Transfer for endovascular intervention within 6 hrs
Endovascular Ischemic Stroke
Case #1

54 y/o fitness enthusiast, typical strenuous workout then quite tired

- LKN – 13:00
- Husband heard thud as she rolled off of couch
- Global aphasia and dense hemiplegia
- NIHSS 16
- IV tPA not given due to history of traumatic epidural hematoma
T_{max}>10.0s volume: 166 ml
T_{max}>8.0s volume: 200 ml
T_{max}>6.0s volume: 247 ml
T_{max}>4.0s volume: 362 ml
90 day mRS = ?
Lin MP, Sanossian N. Cardiology Clinics, 2015
Thrombectomy Devices for Acute Ischemic Stroke:

A. First Generation

B. Second Generation

C. Third Generation

Dumont et al. JNIS 2014
Case #2

78 y/o female presents to outside facility with AIS

- LKN – 19:00 after dinner
- Found down by husband unable to get up with slurred speech 2 hrs later
- IV tPA at outside facility and transferred to Nebraska Medical Center
- Arrived at 0330
Case #2
Case #2
CBF<30% volume: 0 ml

Mismatch volume: 37 ml
Mismatch ratio: infinite

Tmax>6.0s volume: 37 ml
Tmax > 10.0s volume: 0 ml
Tmax > 8.0s volume: 0 ml
Tmax > 6.0s volume: 37 ml
Tmax > 4.0s volume: 299 ml
90 day mRS = 1
ELVO
Emergent Large Vessel Occlusion
Imaging-Based Endovascular Therapy for Acute Ischemic Stroke due to Proximal Intracranial Anterior Circulation Occlusion Treated Beyond 8 Hours From Time Last Seen Well

Retrospective Multicenter Analysis of 237 Consecutive Patients

Tudor G. Jovin, MD; David S. Liebeskind, MD; Rishi Gupta, MD; Marilyn Rymer, MD; Ansaar Rai, MD; Osama O. Zaidat, MD, MS; Alex Abou-Chebl, MD; Blaise Baxter, MD; Elad I. Levy, MD; Andrew Barreto, MD; Raul G. Nogueira, MD

Background and Purpose—Current selection criteria for intra-arterial therapies in the anterior circulation use time windows of 8 hours. Modern neuroimaging techniques have identified individuals with salvageable penumbra who present beyond this timeframe. We sought to assess safety, procedural, and clinical outcomes of MRI or CT perfusion imaging-based endovascular therapy in patients with anterior circulation stroke treated beyond 8 hours from time last seen well.

Methods—We conducted a multicenter retrospective review of consecutive patients meeting the following criteria: (1) acute proximal intracranial anterior circulation occlusion; (2) endovascular treatment initiated >8 hours from time last seen well; and (3) treatment selection based on MRI or CT perfusion imaging.

Results—Two hundred thirty-seven patients were identified (mean age, 63.8±16 years; mean baseline National Institutes of Health Stroke Scale, 15±5.5; mean time last seen well to treatment, 15±11.2 hours; male gender, 46%). Successful revascularization was achieved in 175 of 237 (73.84%) patients. Parenchymal hematoma occurred in 21 of 237 (8.86%) patients. The 90-day mortality rate was 21.5% (51 of 237). The rate of good outcomes was 45% (100 of 223) in the 223 patients with available modified Rankin Scale data at 90 days or time of hospital discharge. In multivariate analyses, age (OR, 0.96; 95% CI, 0.94 to 0.98; \( P=0.002 \)), admission National Institutes of Health Stroke Scale (OR, 0.93; 0.87 to 0.98; \( P=0.016 \)), and successful revascularization (OR, 4.32; 1.99 to 9.39; \( P<0.0001 \)) were identified as independent predictors of good outcomes.

Conclusions—Endovascular therapy can be instituted with acceptable safety beyond 8 hours from time last seen well when selection is based on advanced neuroimaging. Successful revascularization is significantly associated with higher rates of good outcomes. The benefit of this approach compared with standard medical therapy should be assessed in a prospective randomized trial. (Stroke. 2011;42:2206-2211.)
Response to endovascular reperfusion is not time-dependent in patients with salvageable tissue

Maarten G. Lansberg, MD, PhD*
Carlo W. Cereda, MD*
Michael Mlynash, MD, MS
Nishant K. Mishra, MBBS, PhD
Manabu Inoue, MD, PhD
Stephanie Kemp, BS
Søren Christensen, PhD
Matus Straka, PhD
Greg Zaharchuk, MD, PhD
Michael P. Marks, MD
Roland Bammer, PhD
Gregory W. Albers, MD

For the Diffusion and Perfusion Imaging Evaluation for Understanding Stroke Evolution 2 (DEFUSE 2) study, they conducted a study to assess if the timing of treatment modifies the effect of endovascular reperfusion in stroke patients with evidence of salvageable tissue on MRI.

**Objective:** To evaluate whether time to treatment modifies the effect of endovascular reperfusion in stroke patients with evidence of salvageable tissue on MRI.

**Methods:** Patients from the Diffusion and Perfusion Imaging Evaluation for Understanding Stroke Evolution 2 (DEFUSE 2) cohort study with a perfusion-diffusion target mismatch were included. Reperfusion was defined as a decrease in the perfusion lesion volume of at least 50% between baseline and early follow-up. Good functional outcome was defined as a modified Rankin Scale score ≤2 at day 90. Lesion growth was defined as the difference between the baseline and the early follow-up diffusion-weighted imaging lesion volumes.

**Results:** Among 78 patients with the target mismatch profile (mean age 66 ± 16 years, 54% women), reperfusion was associated with increased odds of good functional outcome (adjusted odds ratio 3.7, 95% confidence interval 1.2–12.2, p = 0.03) and attenuation of lesion growth (p = 0.02). Time to treatment did not modify these effects (p value for the time × reperfusion interaction is 0.6 for good functional outcome and 0.3 for lesion growth). Similarly, in the subgroup of patients with reperfusion (n = 46), time to treatment was not associated with good functional outcome (p = 0.2).

**Conclusion:** The association between endovascular reperfusion and improved functional and radiologic outcomes is not time-dependent in patients with a perfusion-diffusion mismatch. Proof that patients with mismatch benefit from endovascular therapy in the late time window should come from a randomized placebo-controlled trial. *Neurology®* 2015;85:708–714
Benefit of thrombectomy decays over time and may not exist beyond 7.3 hrs of stroke onset.

Current AHA guidelines 6 h window.

Individual variations in compensating for ischemia – not purely time based.

Core mismatch may benefit from reperfusion regardless of time to treatment.
DEFUSE 3 Trial

- Multicenter (38 U.S. centers)
- 182 patients
- Thrombectomy vs. medical management alone
- LKW 6 to 16 hrs
- Aimed at salvageable ischemic tissue on imaging by perfusion imaging

- Infarct core < 70 mL
- Ratio of ischemic tissue to infarct > 1.8
Volume of Ischemic Core, 23 ml

Volume of Perfusion Lesion, 128 ml

Mismatch volume, 105 ml
Mismatch ratio, 5.6

Albers GW, et al. NEJM 2018
<table>
<thead>
<tr>
<th>Outcome</th>
<th>Endovascular Therapy (N=92)*</th>
<th>Medical Therapy (N=90)</th>
<th>Odds Ratio or Risk Ratio (95% CI)†</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary efficacy outcome: median score on modified Rankin scale at 90 days (IQR):‡</td>
<td>3 (1–4)</td>
<td>4 (3–6)</td>
<td>2.77 (1.63–4.70)§</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Secondary efficacy outcome: functional independence at 90 days — no. (%)¶</td>
<td>41 (45)</td>
<td>15 (17)</td>
<td>2.67 (1.60–4.48)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Safety outcomes — no. (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Death at 90 days</td>
<td>13 (14)</td>
<td>23 (26)</td>
<td>0.55 (0.30–1.02)</td>
<td>0.05</td>
</tr>
<tr>
<td>Symptomatic intracranial hemorrhage∥</td>
<td>6 (7)</td>
<td>4 (4)</td>
<td>1.47 (0.40–6.55)</td>
<td>0.75</td>
</tr>
<tr>
<td>Early neurologic deterioration</td>
<td>8 (9)</td>
<td>11 (12)</td>
<td>0.71 (0.30–1.69)</td>
<td>0.44</td>
</tr>
<tr>
<td>Parenchymal hematoma type 2</td>
<td>8 (9)</td>
<td>3 (3)</td>
<td>2.61 (0.73–14.69)</td>
<td>0.21</td>
</tr>
<tr>
<td>Imaging outcomes**</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median infarct volume at 24 hr (IQR) — ml</td>
<td>35 (18–82)</td>
<td>41 (25–106)</td>
<td>—</td>
<td>0.19</td>
</tr>
<tr>
<td>Median infarct growth at 24 hr (IQR) — ml</td>
<td>23 (10–75)</td>
<td>33 (18–75)</td>
<td>—</td>
<td>0.08</td>
</tr>
<tr>
<td>Reperfusion &gt;90% at 24 hr — no./total no. (%)</td>
<td>59/75 (79)</td>
<td>12/67 (18)</td>
<td>4.39 (2.60–7.43)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Complete recanalization at 24 hr — no./total no. (%)</td>
<td>65/83 (78)</td>
<td>14/77 (18)</td>
<td>4.31 (2.65–7.01)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>TICI score of 2b or 3 — no./total no. (%)</td>
<td>69/91 (76)</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>
DAWN Trial

Inclusion criteria:

• Occlusion of ICA or proximal MCA
• LKW 6–24 hrs
• Mismatch between clinical deficit and infarct volume
• Age > 18 y/o
• Pre-stroke mRS
• No hemorrhage
• No infarct > 1/3 of MCA

<table>
<thead>
<tr>
<th>Group</th>
<th>Age</th>
<th>NIHSS</th>
<th>Infarct Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>&gt; 80</td>
<td>&gt; 10</td>
<td>&lt; 21 mL</td>
</tr>
<tr>
<td>Group B</td>
<td>&lt; 80</td>
<td>&gt; 10</td>
<td>&lt; 31 mL</td>
</tr>
<tr>
<td>Group C</td>
<td>&lt; 80</td>
<td>&gt; 20</td>
<td>31 – 51 mL</td>
</tr>
</tbody>
</table>
DAWN Trial Design

- Multicenter (26 centers)
- Randomized trial with Bayesian adaptive-enrichment
- Funded by Stryker Neurovascular (Trevo device only)
- Assigned in 1:1 ratio
- Stratified according to Group A/B/C, LKW interval, ICA/MCA

Endpoints:
- Disability on UW-mRS at 90d
- Functional independence (mRS 0 – 2)
- Stroke related death at 90d
- Neurologic deterioration (NIHSS increase 4)
- Symptomatic intracranial hemorrhage
- Powered 86% to detect mean difference of UW-mRS of 1.0
6-24h

NCCT/DWI:
<1/3 MCA Territory

CTA/MRA:
ICA-T and/or MCA-M1
(Tandem Occlusions Allowed)

Control

90-day mRS

1:1 Randomization:
- CIM subgroup
- ICA-T vs M1
- 6-12 vs 12-24h

Informed Consent

RAPID CTP/DWI CIM:
A. ≥80 y/o:
1. NIHSS ≥10 + core <21cc
B. <80 y/o:
2. NIHSS ≥10 + core <31cc
3. NIHSS ≥20 + core <51cc

Thrombectomy

- U-W mRS
- mRS 0-2

TRIAL ENROLLMENT RATE AND TERMINATION

<table>
<thead>
<tr>
<th>Site Status</th>
<th>Actual</th>
<th>Projected</th>
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<tbody>
<tr>
<td>Sites Qualified</td>
<td>36</td>
<td>31</td>
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<tr>
<td>Contracts Executed</td>
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<tr>
<td>Sites Initiated</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Sites Activated to Enroll</td>
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<td></td>
</tr>
<tr>
<td>IRB/EC Approvals</td>
<td>31</td>
<td>206</td>
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<tr>
<td>Subjects Enrolled</td>
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</tbody>
</table>

Actual / Projected Enrollment

Enrollment stopped at DSMB recommendation.

*Boundary for first enrichment not crossed*
## DAWN Results

### Table 2. Efficacy Outcomes.*

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Thrombectomy Group (N = 107)</th>
<th>Control Group (N = 99)</th>
<th>Absolute Difference (95% CI)</th>
<th>Adjusted Difference (95% Credible Interval)</th>
<th>Posterior Probability of Superiority</th>
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</thead>
<tbody>
<tr>
<td><strong>Primary end points</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Score on utility-weighted modified Rankin scale at 90 days§</td>
<td>5.5±3.8</td>
<td>3.4±3.1</td>
<td>2.1 (1.2–3.1)</td>
<td>2.0 (1.1–3.0)</td>
<td>&gt;0.999</td>
</tr>
<tr>
<td>Functional independence at 90 days — no. (%)¶</td>
<td>52 (49)</td>
<td>13 (13)</td>
<td>36 (24–47)</td>
<td>33 (21–44)</td>
<td>&gt;0.999</td>
</tr>
<tr>
<td><strong>Secondary end points</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early response — no. (%)</td>
<td></td>
<td></td>
<td>51 (48)</td>
<td>19 (19)</td>
<td>29 (16–41)</td>
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<tr>
<td>Recanalization at 24 hr — no. (%)††</td>
<td>82 (77)</td>
<td>39 (39)</td>
<td>40 (27–52)</td>
<td>2 (2–4)</td>
<td>&lt;0.001**</td>
</tr>
<tr>
<td>Change from baseline in infarct volume at 24 hr — ml†††</td>
<td></td>
<td></td>
<td></td>
<td>0.003‡‡‡</td>
<td></td>
</tr>
<tr>
<td>Median</td>
<td>1</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interquartile range</td>
<td>0–28</td>
<td>0–42</td>
<td></td>
<td></td>
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<tr>
<td>Infarct volume at 24 hour — ml††</td>
<td></td>
<td></td>
<td></td>
<td>&lt;0.001‡‡‡</td>
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<tr>
<td>Median</td>
<td>8</td>
<td>22</td>
<td></td>
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<tr>
<td>Interquartile range</td>
<td>0–48</td>
<td>8–68</td>
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<tr>
<td>Grade of 2b or 3 on mTICI scale — no. (%)§§§</td>
<td>90 (84)</td>
<td>NA</td>
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<tr>
<td>Subgroup</td>
<td>Adjusted Difference between Thrombectomy and Control (95% Credible Interval)</td>
<td>Posterior Probability</td>
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</tr>
<tr>
<td>----------------------------------</td>
<td>--------------------------------------------------------------------------------</td>
<td>------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>2.0 (1.1 to 3.0)</td>
<td>&gt;0.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mismatch criteria</td>
<td></td>
<td>0.47</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Group A</td>
<td>2.3 (0.3 to 4.2)</td>
<td>0.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group B</td>
<td>1.8 (0.6 to 2.9)</td>
<td>&gt;0.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group C</td>
<td>2.5 (-0.6 to 5.5)</td>
<td>0.95</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td>0.14</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1.8 (0.2 to 3.2)</td>
<td>0.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>2.6 (1.3 to 4.0)</td>
<td>&gt;0.99</td>
<td></td>
<td></td>
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<tr>
<td>Age</td>
<td></td>
<td>0.42</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>&lt;80 yr</td>
<td>1.9 (0.8 to 2.8)</td>
<td>&gt;0.99</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>≥80 yr</td>
<td>2.3 (0.3 to 4.2)</td>
<td>0.99</td>
<td></td>
<td></td>
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<tr>
<td>Baseline NIHSS score</td>
<td></td>
<td>0.71</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 to 17</td>
<td>2.4 (1.0 to 3.7)</td>
<td>&gt;0.99</td>
<td></td>
<td></td>
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<tr>
<td>&gt;17</td>
<td>1.8 (0.6 to 3.1)</td>
<td>&gt;0.99</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Occlusion site</td>
<td></td>
<td>0.77</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intracranial internal carotid artery</td>
<td>3.0 (0.8 to 5.2)</td>
<td>&gt;0.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First segment of the middle cerebral artery</td>
<td>2.0 (0.9 to 3.1)</td>
<td>&gt;0.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of stroke onset</td>
<td></td>
<td>0.21</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>On awakening</td>
<td>2.3 (1.0 to 3.6)</td>
<td>&gt;0.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Witnessed stroke</td>
<td>3.0 (0.5 to 5.9)</td>
<td>0.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unwitnessed stroke</td>
<td>1.4 (-0.5 to 3.2)</td>
<td>0.93</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interval between time that patient was last known to be well and randomization</td>
<td>1.8 (0.4 to 3.4)</td>
<td>&gt;0.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 to 12 hr</td>
<td></td>
<td>0.22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;12 to 24 hr</td>
<td>2.4 (1.1 to 3.6)</td>
<td>&gt;0.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time from first observation of symptoms to randomization</td>
<td>0.70</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 to 6 hr</td>
<td>2.0 (0.9 to 3.2)</td>
<td>&gt;0.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;6 hr</td>
<td>2.4 (0.8 to 3.9)</td>
<td>&gt;0.99</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
90 Day mRS 0-2 by TLSW to Randomization

<table>
<thead>
<tr>
<th>Time</th>
<th>Trevo</th>
<th>MM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-12h</td>
<td>55.1%</td>
<td>20.0%</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>12-24h</td>
<td>43.1%</td>
<td>7.4%</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
DAWN Results

- Stroke due to ICA or MCA occlusion w/ LKW 6-24 h with mismatch of clinical deficit and infarct volume – disability and functional independence outcomes were better with thrombectomy than medical management alone

<table>
<thead>
<tr>
<th></th>
<th>Trevo</th>
<th>MM</th>
<th>Treatment benefit (95% CI)</th>
<th>Bayesian probability of superiority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 90 weighted mRS</td>
<td>5.5 ± 3.8</td>
<td>3.4 ± 3.1</td>
<td>2.1 (1.20, 3.12)</td>
<td>&gt;0.9999*</td>
</tr>
<tr>
<td>Day 90 mRS (0-2)</td>
<td>48.6%</td>
<td>13.1%</td>
<td>35.5% (23.9%, 47.0%)</td>
<td>&gt;0.9999*</td>
</tr>
</tbody>
</table>

NNT for 90-day functional independence = 2.8
Case #3

54 y/o female who presented with significant deficits and decreased LOC

- Right MCA occlusion
## 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

<table>
<thead>
<tr>
<th>Mechanical Thrombectomy</th>
<th>COR</th>
<th>LOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients eligible for IV tPA should receive IV tPA even if endovascular therapy is being considered</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>In patients under consideration for thrombectomy, observation after IV tPA to assess for clinical response should not be performed</td>
<td>III: Harm</td>
<td>B-R</td>
</tr>
</tbody>
</table>

### Mechanical Thrombectomy

<table>
<thead>
<tr>
<th>Patients should receive mechanical thrombectomy with a stent retriever if they meet all the following criteria: (1) prestrike mRS of 0 to 1; (2) causative occlusion of ICA or MCA (3) age ≥ 18 y/r (4) NIHSS ≥ 6 (5) ASPECTS ≥ 6 (6) groin puncture w/n 6h of onset</th>
<th>COR</th>
<th>LOE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>A</td>
</tr>
</tbody>
</table>

| Although the benefits are uncertain, the use of thrombectomy may be reasonable for carefully selected patients within 6h with M2 or M3 occlusion | IIb | B-R |
| | IIb | C-E0 |

| Although the benefits are uncertain, the use of thrombectomy may be reasonable for carefully selected patients within 6h with ACA, vertebral, basilar, or PCA occlusions | IIb | C-E0 |

<table>
<thead>
<tr>
<th>Mechanical Thrombectomy</th>
<th>COR</th>
<th>LOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Although benefits uncertain, mechanical thrombectomy may be reasonable in acute stroke patients within 6h of onset and how have prestroke mRS &gt; 1, ASPECTS &lt; 6, or NIHSS &lt;6 with ICA or proximal M1 occlusion</td>
<td>IIb</td>
<td>B-R</td>
</tr>
<tr>
<td>Selected patients with acute stroke within 6 – 16h of last known normal who have LVA in anterior circulation and meet other DAWN or DEFUSE3 eligibility, mechanical thrombectomy is recommended</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>Selected patients with AIS within 16– 24h of last known normal who have LVO in anterior circulation and meet DAWN criteria, thrombectomy is reasonable</td>
<td>IIa</td>
<td>B-R</td>
</tr>
<tr>
<td>Mechanical Thrombectomy</td>
<td>COR</td>
<td>LOE</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------------</td>
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<td>-----</td>
</tr>
<tr>
<td>Technical goal of thrombectomy is reperfusion to a mTICI 2b/3 angiographic result to maximize the probability of a good functional clinical outcome</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>As with IV tPA, reduced time from symptom onset to reperfusion with thrombectomy is highly associated with better outcomes</td>
<td>I</td>
<td>B-R</td>
</tr>
<tr>
<td>Use of stent retrievers is indicated in preference to MERCI device</td>
<td>I</td>
<td>A</td>
</tr>
<tr>
<td>Mechanical Thrombectomy</td>
<td>COR</td>
<td>LOE</td>
</tr>
<tr>
<td>-------------------------</td>
<td>-----</td>
<td>------</td>
</tr>
<tr>
<td>Mechanical thrombectomy devices other than stent retrievers as first-line may be reasonable, but stent retrievers remain first choice</td>
<td>IIb</td>
<td>B-R</td>
</tr>
<tr>
<td>Use of balloon guide catheter or large bore distal access catheter rather than cervical guide catheter alone may be beneficial</td>
<td>IIa</td>
<td>C-LD</td>
</tr>
<tr>
<td>Use of salvage technical adjuncts including intra-arterial thrombolysis may be reasonable to achieve mTICI 2b/3 angiographic result</td>
<td>IIb</td>
<td>C-LD</td>
</tr>
<tr>
<td>Mechanical Thrombectomy</td>
<td>COR</td>
<td>LOE</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------------</td>
<td>------</td>
<td>-------</td>
</tr>
<tr>
<td>Select an anesthetic technique during thrombectomy on the basis of patient risk factors, technical performance, other clinical characteristics</td>
<td>IIa</td>
<td>B-R</td>
</tr>
<tr>
<td>Maintain BP &lt; 180/105 mm Hg during and for 24h after the procedure</td>
<td>IIa</td>
<td>B-NR</td>
</tr>
<tr>
<td>Successful reperfusion it might be reasonable to maintain BP &lt; 180/105</td>
<td>IIb</td>
<td>B-NR</td>
</tr>
</tbody>
</table>
