Update on Neurointerventional Therapies: Stroke and Aneurysms

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Disclosures:

Scientific Advisory Board / Consultant:
  - Sequent/Microvention
  - Neurvana Medical

Educational Grants
  - MicroVention
  - Medtronic
  - Codman
Update on Neurointerventional Therapies: **Stroke** and Aneurysms

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Early Window stroke trials

- <6-8 hours from onset of stroke
- CT assessment of low density, large volume CT infarct excluded
- Work flow optimized for speed to recanalization
Positive Randomized Stroke clinical trials

NEW ENGLAND JOURNAL OF MEDICINE, 2014-2015

A Randomized Trial of Intravenous Treatment for Acute Ischemic Stroke


Study Design Factors

- Documented large vessel occlusion with imaging
- Timely treatment
- New generation devices (primarily stent-retrievers)


MR CLEAN
EXTEND-IA
ESCAPE
REVASCAT
SWIFT
PRIME
Summary Endovascular Trials for Ischemic Stroke

- Reduction in disability in the endovascular arm
- Increase in number of patients achieving functional independence at 90 days (Difference in outcome between endovascular arm and medical arm ranging between 14-31%)
- No increase in symptomatic intracranial hemorrhage in endovascular arm compared to medical arm
- Number needed to treat to achieve one additional good outcome: 4
## Stroke Treatment Impacts

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Number Needed to Treat</th>
<th>Benefit Per Hundred Treated Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Endarterectomy 70-99% stenosis Prevent ischemic event</td>
<td>6</td>
<td>17</td>
</tr>
<tr>
<td>Endarterectomy 50-69% stenosis Prevent ischemic event</td>
<td>15</td>
<td>7</td>
</tr>
<tr>
<td>Stroke – 3h tPA vs No tPA Nondisabled</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Stroke – Thrombectomy vs Medical (usually IV tPA) Nondisabled</td>
<td>4</td>
<td>25</td>
</tr>
</tbody>
</table>
HERMES collaboration to pool patient-level data

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

Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials


Lancet 2016; 387: 1723–31
Endovascular Intervention for Acute Ischemic Stroke

Additional Comments

• Advanced age is not a contraindication to endovascular intervention
  • Subgroup analysis show benefit in patients below and above 80 years of age

• Severe stroke patients benefit from endovascular intervention
  • Subgroup analysis show benefit across all ranks of NIHSS

• Advanced neuroimaging is necessary for selection of patients that benefit from endovascular intervention
  • Identify volume of dead tissue
  • Confirm large vessel intracranial occlusion
Figure Legend:

Association of Time From Symptom Onset to Actual Reperfusion Among Patients in the Endovascular Thrombectomy Group Achieving Substantial Reperfusion With 90-Day Disability Outcomes Using an Adjusted Ordinal Logistic Regression Model Data are from the 390 endovascular group patients in whom substantial reperfusion (modified Thrombolysis in Cerebral Infarction score of 2b or 3) was achieved. Rows are intercepts from a single model using all 390 patients, treating time as a continuous variable. Model adjusted for age, sex, baseline stroke severity (National Institutes of Health Stroke Scale), target occlusion location, and concomitant intravenous tissue plasminogen activator.

Earlier the better
Summary

Endovascular Trials for Ischemic Stroke

• Reduction in disability in the endovascular arm

• Increase in number of patients achieving functional independence at 90 days (Difference in outcome between endovascular arm and medical arm ranging between 14-31%)

• No increase in symptomatic intracranial hemorrhage in endovascular arm compared to medical arm

• Number needed to treat to achieve one additional good outcome: 4
Multimodal MRI Imaging

- **DWI**
  - Tissue Status
  - Bioenergetic Compromise

- **PWI**
  - Perfusion Status
  - Hemodynamic Compromise

- **MRA**
  - Vessel Status
  - Occlusions or Stenoses
Multimodal CT Imaging

CT
- Tissue Status
- Bioenergetic Compromise

CTP
- Perfusion Status
- Hemodynamic Compromise

CTA
- Vessel Status
- Occlusions or Stenoses
Late Window Stroke Trials

Brief Review of DAWN/DEFUSE3
Dawn Imaging Inclusion Criteria

Clinical Imaging Mismatch (CIM) defined as one of the following on RAPID MR-DWI or CTP-rCBF maps:

a. 0-20 cc core infarct and NIHSS ≥ 10 (and age ≥ 80 years old)
b. 0-30 cc core infarct and NIHSS ≥ 10 (and age < 80 years old)
c. 31 cc to ≤ 50 cc core infarct and NIHSS ≥ 20 (and age < 80 years old)
## Co-primary Endpoints

<table>
<thead>
<tr>
<th></th>
<th>Trevo</th>
<th>Medical</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  
NNT for any lower disability 2.0  

*Similar to p<0.0001
Defuse 3: Imaging Selection

- CTA/MRA
  - M1 or ICA occlusion (includes tandem occlusions)

- Target Mismatch Profile: CT perfusion or MR
  - RAPID software
    - Core volume <70cc
    - Mismatch volume ≥15cc
    - Mismatch ratio >1.8
Defuse 3: Subgroup Analyses.

<table>
<thead>
<tr>
<th>Subgroup</th>
<th>No. of Patients</th>
<th>Endovascular Therapy</th>
<th>Medical Therapy</th>
<th>Risk Ratio for Functional Independence at Day 90 (95% CI)</th>
<th>P Value for Interaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>182</td>
<td>45</td>
<td>17</td>
<td>2.67 (1.60–4.48)</td>
<td>0.21</td>
</tr>
<tr>
<td>Time from stroke onset to randomization</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 9 hr</td>
<td>50</td>
<td>40</td>
<td>28</td>
<td>1.43 (0.65–3.15)</td>
<td>0.47</td>
</tr>
<tr>
<td>9–12 hr</td>
<td>72</td>
<td>50</td>
<td>17</td>
<td>3.00 (1.35–6.68)</td>
<td>0.21</td>
</tr>
<tr>
<td>&gt; 12 hr</td>
<td>60</td>
<td>42</td>
<td>7</td>
<td>6.08 (1.64–24.95)</td>
<td>0.47</td>
</tr>
<tr>
<td>Volume of ischemic core</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 10.0 ml</td>
<td>92</td>
<td>42</td>
<td>20</td>
<td>2.04 (1.04–3.99)</td>
<td>0.47</td>
</tr>
<tr>
<td>10.0–25.0 ml</td>
<td>44</td>
<td>55</td>
<td>13</td>
<td>4.40 (2.41–7.93)</td>
<td>0.21</td>
</tr>
<tr>
<td>&gt; 25.0 ml</td>
<td>46</td>
<td>42</td>
<td>14</td>
<td>3.06 (1.01–9.57)</td>
<td>0.21</td>
</tr>
<tr>
<td>Baseline NIHSS score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>≤ 13</td>
<td>55</td>
<td>69</td>
<td>46</td>
<td>1.49 (0.92–2.42)</td>
<td>0.20</td>
</tr>
<tr>
<td>13–18</td>
<td>55</td>
<td>48</td>
<td>12</td>
<td>4.18 (1.16–14.67)</td>
<td>0.21</td>
</tr>
<tr>
<td>&gt; 18</td>
<td>72</td>
<td>21</td>
<td>0</td>
<td>—</td>
<td>1.00</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 70 yr</td>
<td>84</td>
<td>59</td>
<td>28</td>
<td>2.15 (1.33–3.70)</td>
<td>0.05</td>
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<tr>
<td>≥ 70 yr</td>
<td>98</td>
<td>31</td>
<td>8</td>
<td>3.91 (1.36–10.46)</td>
<td>0.05</td>
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<tr>
<td>ASPECTS</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>&lt; 8</td>
<td>57</td>
<td>32</td>
<td>7</td>
<td>2.46 (1.34–4.44)</td>
<td>0.06</td>
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<tr>
<td>≥ 8</td>
<td>85</td>
<td>46</td>
<td>24</td>
<td>3.88 (1.99–7.60)</td>
<td>0.06</td>
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<tr>
<td>Site of occlusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Middle cerebral artery</td>
<td>113</td>
<td>48</td>
<td>21</td>
<td>2.53 (1.29–4.19)</td>
<td>0.04</td>
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<tr>
<td>Internal carotid artery</td>
<td>68</td>
<td>38</td>
<td>8</td>
<td>4.50 (1.39–13.62)</td>
<td>0.04</td>
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<tr>
<td>Baseline imaging method</td>
<td></td>
<td></td>
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<tr>
<td>CT</td>
<td>133</td>
<td>39</td>
<td>16</td>
<td>2.50 (1.32–4.76)</td>
<td>0.08</td>
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<tr>
<td>MRI</td>
<td>49</td>
<td>61</td>
<td>19</td>
<td>3.17 (1.35–7.45)</td>
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<tr>
<td>Determination of time of stroke</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Time that patient was last known to be well</td>
<td>116</td>
<td>38</td>
<td>13</td>
<td>2.96 (1.38–6.36)</td>
<td>0.08</td>
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<tr>
<td>Exact time of symptom onset</td>
<td>66</td>
<td>58</td>
<td>23</td>
<td>2.54 (1.29–5.01)</td>
<td>0.08</td>
</tr>
<tr>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Female</td>
<td>92</td>
<td>35</td>
<td>13</td>
<td>2.67 (1.35–4.21)</td>
<td>0.08</td>
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<tr>
<td>Male</td>
<td>90</td>
<td>54</td>
<td>20</td>
<td>2.66 (1.41–5.06)</td>
<td>0.08</td>
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<tr>
<td>Race</td>
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<td></td>
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<tr>
<td>White</td>
<td>158</td>
<td>46</td>
<td>16</td>
<td>2.84 (1.64–4.93)</td>
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<tr>
<td>Other or unknown</td>
<td>24</td>
<td>36</td>
<td>20</td>
<td>1.79 (0.42–7.38)</td>
<td>0.08</td>
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<tr>
<td>Ethnic group</td>
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<tr>
<td>Hispanic</td>
<td>24</td>
<td>57</td>
<td>10</td>
<td>5.71 (1.31–23.73)</td>
<td>0.06</td>
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<tr>
<td>Non-Hispanic</td>
<td>137</td>
<td>43</td>
<td>18</td>
<td>2.45 (1.43–4.12)</td>
<td>0.06</td>
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<tr>
<td>Age реlation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Yes</td>
<td>62</td>
<td>38</td>
<td>4</td>
<td>10.72 (1.05–104.11)</td>
<td>0.02</td>
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<tr>
<td>No</td>
<td>100</td>
<td>48</td>
<td>23</td>
<td>2.14 (1.26–3.66)</td>
<td>0.06</td>
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<tr>
<td>Eligible for DAWN trial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>112</td>
<td>38</td>
<td>13</td>
<td>3.00 (1.39–6.69)</td>
<td>0.05</td>
</tr>
<tr>
<td>No</td>
<td>70</td>
<td>56</td>
<td>24</td>
<td>2.36 (1.20–4.65)</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Later
Bigger volume
Older
More damage
Bigger clot/more stroke
Neuroimaging Criteria for Patient Selection for Endovascular Therapies

• No consensus of best method for patient selection
  • Each trial used different criteria for patient exclusion
• “Proximal occlusion, small core” may be most rational approach
  • “Proximal occlusion” – identify proximal vascular occlusions unlikely to be recanalized by IV-TPA alone
    • Intracranial ICA, M1 segment MCA
    • Long segment thrombus >8 mm
  • “Small core” – prevent futile mechanical recanalization and reduce risk of hemorrhage
    • NCCT: ASPECTS exclusion cutoff ranged from 5-6
    • DWI: Infarct core > 50-70 cc relative exclusion
Infarct Volume Strongly Correlates with Clinical Outcomes

Associations between 90-day modified Rankin Scale (mRS) and 27-h infarct volume.

Gregory W. Albers et al. Stroke. 2015;46:2786-2794
Infarct Core: NCCT and ASPECTS

- Quantification of infarct size challenging on NCCT
- Systematic approach to assess and quantify early infarct change on NCCT
- Divides MCA territory into 10 regions
- Single point subtracted from ten for each region affected
- But, not exactly volume, and doesn’t show what will infarct

Infarct Core: ASPECTS and Patient Selection
(HERMES; Lancet 2016; 387: 1723–310)

- ASPECTS 9-10 and 6-8: Both strongly associated with improved functional outcome
  - Similar benefit conferred between ASPECTS 9-10 and 6-8
  - ASPECTS 6-10 may be appropriate for ET selection

- ASPECTS 0-5: No statistically significant benefit for functional outcomes
  - Majority of trials excluded ASPECTS <5

Aspects sees the stroke, but the unseen collaterals determine (along with reperfusion) the outcome.
Large Baseline Infarct Core?

- 56 pt with core >50 cc by CTP
  - Favorable shift in MRS scores
  - Higher rates of functional independence (MRS 0-2, 25% vs 0%; P=0.04) and smaller final infarct volumes (87 cc vs 242 cc, P<0.002)
  - No significant difference in PH
- Core >70 cc (n=12)
  - Smaller final infarct volumes, but no significant improvement in MRS (but trend better)

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  - No significant difference in PH
- Core >70 cc (n=12)
  - Smaller final infarct volumes, but no significant improvement in MRS (but trend better)

Large Baseline Infarct Core?

- THRACE: Large DWI lesions
  - 53 pts with DWI>70cc
  - 12 (23%) mRS≤2 @ 3 months
  - M1, but not ICA
  - Superficial>deep
  - None>75 y/o


DAWN/DEFUSE 3: NNT 3!
Must consider what you can reopen
CASE 1

03/15/2018

70 y/o RH F with history of atrial fibrillation s/p ablation, not on anticoagulation (due to cost), hypothyroidism, who was LKW 3/9/18 at 9 pm and brought in the following evening at 9:25 pm (24 hours) by EMS, after her neighbor found her on the floor with her door open. NIHSS 18.
CBF < 30% volume: 9 ml

Mismatch volume: 47 ml
Mismatch ratio: 6.2

Tmax > 6.0s volume: 56 ml
Tmax>10.0s volume: 14 ml
Tmax>8.0s volume: 29 ml
Tmax>6.0s volume: 56 ml
Tmax>4.0s volume: 96 ml
AIF and VOF Locations
<table>
<thead>
<tr>
<th>Three Areas of Focus</th>
<th>Primary Outcomes</th>
<th>Systems of Care</th>
<th>Techniques and Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluate the clinical efficacy and safety of mechanical thrombectomy in the treatment of patients with AIS due to LVO</td>
<td>Analyze the effect of interhospital transfer on time to endovascular treatment and clinical outcomes in a large cohort of stroke patients</td>
<td>Evaluate the angiographic and clinical outcomes based on different adjunctive technique approaches</td>
<td></td>
</tr>
</tbody>
</table>
984 subjects from 55 sites were analyzed.

- 539 direct; 445 transfer

Median time from stroke onset to revascularization was 202 minutes for direct vs. 312 minutes for transfer patients (p<0.0001).

- Difference of mean onset-to-revasc times = 100 min
- Difference of mean alarm-to-revasc = 116 min
TIME DIFFERENCES FOR tPA + Mechanical Thrombectomy

Median Times from Stroke Onset to Revascularization

- Stroke Onset to 911 call: 118 minutes
- 911 call to EMS Scene Arrival: 23 minutes
- EMS Scene Arrival to Door [Initial Hospital]: 14 minutes
- Door to Picture [Initial Hospital]: 42 minutes
- Picture to IV t-PA [Initial Hospital]: 47 minutes
- IV t-PA to Departure [Initial hospital]: 35 minutes
- Transfer time (Departure initial hospital to Door Enrolling Hospital): 15 minutes
- EMS Scene Arrival to Door [Enrolling Hospital]: 42 minutes
- Door to Picture [Enrolling Hospital]: 37 minutes
- Picture to IV t-PA [Enrolling Hospital]: 16 minutes
- IV t-PA to Puncture [Enrolling Hospital]: 29 minutes
- Puncture to Revascularization [Enrolling Hospital]: 13 minutes

- P<0.0001

Median Time for Transfer: 311.5 minutes
Median Time for Direct: 192 minutes

Puncture to Revascularization [Enrolling Hospital]: 34 minutes

P<0.0001
TIME DIFFERENCES FOR Mechanical Thrombectomy ALONE

Median Times from Stroke Onset to Revascularization

- **Transfer**
  - 31.5 minutes
  - 8
  - 29
  - 16.5
  - 75
  - 35
  - 13
  - 36
  - 35

- **Direct**
  - 39.5 minutes
  - 8
  - 29
  - 14
  - 78.5
  - 35

**Median Total Times**

- **Transfer**
  - 311.5 minutes
  - P<0.0001

- **Direct**
  - 229 minutes

- **311.5 minutes**
  - Transfer time (Departure initial hospital to Door Enrolling Hospital)

- **Picture to Departure [Initial Hospital] 311.5 minutes**

- **P<0.0001**

- **EMS Scene Arrival to Door [Initial Hospital]**

- **Door to Picture [Initial Hospital]**

- **Door to Picture [Enrolling Hospital]**

- **Picture to Puncture [Enrolling Hospital]**

- **Puncture to Revascularization [Enrolling Hospital]**
In this large, real-world study, interhospital transfer was associated with significant delays to treatment, and significantly lower chance of good outcome.
Reasons for the futile transfer.

Blanca Fuentes et al. Stroke. 2015;46:2156-2161
Clinical Imaging Factors Associated With Infarct Progression in Patients With Ischemic Stroke During Transfer for Mechanical Thrombectomy


Collaterals, Transfer and Aspects decline

Table 3. Multivariable Analysis of Variables Associated With Increasing Odds of ASPECTS Decay

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR (95% CI)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age^b_</td>
<td>0.98 (0.95-1.01)</td>
<td>.27</td>
</tr>
<tr>
<td>Female</td>
<td>1.55 (0.65-3.73)</td>
<td>.32</td>
</tr>
<tr>
<td>RH NIHSS^b</td>
<td>1.13 (1.05-1.22)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Initial ASPECTS^b</td>
<td>0.33 (0.21-0.47)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>TCSC CTA occlusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not proximal</td>
<td>1 [Reference]</td>
<td>NA</td>
</tr>
<tr>
<td>Proximal</td>
<td>2.04 (0.83-5.18)</td>
<td>.12</td>
</tr>
<tr>
<td>No or poor collateral blood flow at the TCSC</td>
<td>5.14 (2.20-12.70)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Interval time, h^p</td>
<td>1.05 (0.96-1.16)</td>
<td>.24</td>
</tr>
</tbody>
</table>

Abbreviations: ASPECTS, Alberta Stroke Program Early CT Score; CTA, computed tomography angiography; NA, not applicable; NIHSS, National Institutes of Health Stroke Score; OR, odds ratio; RH, referring hospital; TCSC, thrombectomy-capable stroke center.

^a Factors available at the RH plus CTA assessment of proximal occlusion and collateral status are included.

^b Per unit change in regressor.
Outcome with reperfusion not time dependent with favorable tissue profile

• Landsberg, et al. Neurology; Aug 2015
DWI Growth Rates are Highly Variable: DEFUSE2

Poor collaterals - Fast progressors despite early time: poor outcomes 20%
Intermediate collaterals 30%
Good collaterals - Slow progressors with later times: good outcomes 50%

Dawn/Defuse: Late Window Paradox

Small core infarct late +
Large vessel occlusion =
Good collaterals (excludes early progressors!)

But, Medical group has eventual collateral failure, expansion of infarct, and worse relative outcomes than earlier window trials
Using advanced collateral imaging

Early presentation with Poor collaterals=Fast progressors= need for speed!
Late presentation with Good collaterals=Slow progressors. Identify and treat

Absolute Benefit mRS 0-2
THRACE 11%
MR CLEAN 14%
EXTEND IA 31%
DAWN/D3 32%

Systems of care: Collateral Assessment

• In a system of care, can collateral imaging and/or CT-clinical mismatch help us to triage, manage and apply care protocols? Especially in the era of >6 hour presentation.

  • Collateral assessment: identify slow progressors, may be useful for transfer algorithms
  • Consider CTA (multiphase>single phase) to determine method of transfer or futility of transfer?
  • Consider non-contrast CT (stroke core) and NIHSS or other clinical scale mismatch as substitute?
  • Can we identify a substitute for DAWN and DEFUSE3 criteria at initial center?
  • Consider Cloud based image sharing for decisions on management
Update on Neurointerventional Therapies: Stroke and Aneurysms

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Division of Interventional Neuroradiology
David Geffen School of Medicine at UCLA
Long Beach Memorial Medical Center
Current Luminal Stents & Mesh Density

0% 10% 20% 30% 35% 40%

Coiling Support

Antiplatelet need

Parent Artery Repair
Intra-saccular Flow Disrupter
The Web Intrasaccular Therapy (WEB-IT)

Study Leadership
- Study PI: Adam Arthur, MD, David Fiorella, MD
- Steering Committee:
  G. Duckwiler, C. Strother, A. Molyneux, L. Pierot, A. Arthur, D. Fiorella

Primary Effectiveness Endpoint
Complete occlusion at 12m w/o re-Tx, SAH, parent artery stenosis (>50%)

Primary Safety Endpoint
Major stroke and all death through 30d, major ipsilateral stroke or neurological death at 12m

Inclusion Criteria:
Patient whose age ≥18 and ≤75 years.
A single ruptured or unruptured intracranial aneurysm requiring treatment.
Patient must sign and date an IRB/EC-approved written informed consent

Exclusion Criteria:
Patient has an IA with characteristics unsuitable for endovascular treatment
Patient has stroke-in-evolution within the prior 60 days
Patient has had an SAH (subarachnoid hemorrhage) from a nonindex IA or any other intracranial hemorrhage within 90 days
Patient's index IA was previously treated
Patient is pregnant
The Web Intrasaccular Therapy (WEB-IT)

<table>
<thead>
<tr>
<th>Treatment Feasibility</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WEB Implanted</td>
<td>148 (98.7%)</td>
</tr>
<tr>
<td>WEB not implanted</td>
<td>2 (1.3%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adjunctive Devices</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Stent</td>
<td>2 (1.3%)</td>
</tr>
<tr>
<td>Coils</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Balloon</td>
<td>5 (3.3%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technical Events</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>WEB exchanged for different size</td>
<td>52 (34.7%)</td>
</tr>
<tr>
<td>WEB removed for suspected device malfunction</td>
<td>6 (4%)</td>
</tr>
</tbody>
</table>

Primary Safety Endpoint

Peri-procedural M&M  0.67% (1/150)

Fiorella, et al SNIS2016
ARTISSE IDE Study (2017 Q1)

**Study Leadership**
- Study PI: Alexander Coon
- Steering Committee: Satoshi Tateshima, Michel Piotin

**Primary Effectiveness Endpoint**
Successful occlusion at 12m w/o re-Tx

<table>
<thead>
<tr>
<th></th>
<th>Artisse™ Intrasaccular Device</th>
<th>Luna™ AES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Delivery Microcatheter ID</strong></td>
<td>0.021” ID: 4.5 mm to 8 mm 0.027” ID: 9 mm to 12 mm</td>
<td>0.027” only</td>
</tr>
<tr>
<td><strong>Shape(s)</strong></td>
<td>Spheroid and Flared</td>
<td>Spheroid only</td>
</tr>
<tr>
<td></td>
<td>• Addresses Saccular and Wide-Neck Aneurysms</td>
<td></td>
</tr>
<tr>
<td><strong>Implant Diameter Sizes (mm)</strong></td>
<td>4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 9.0, 10.0, 11.0, 12.0</td>
<td>4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5</td>
</tr>
<tr>
<td><strong>Visualization</strong></td>
<td>RO Markers and “Visualized” Nitinol Braids</td>
<td>RO Markers only</td>
</tr>
<tr>
<td><strong>Fully Resheathable</strong></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Detachment System</strong></td>
<td>Portable Handheld Electrolytic</td>
<td>Mechanical</td>
</tr>
</tbody>
</table>
Medina Coil

• Linear self-expandable mesh
  Provides a scaffold for ingrowth
• Immediately reduces blood flood
• Fully radiopaque
• 0.021-inch micro catheter compatible

Device Configurations
  Framers – Protect the neck: 6 - 9mm
  Fillers – 5 - 8mm
Half dish design enables oversizing the device without concern for elongation.

Per Dr. Tufail Patankar. “Happy with the follow up results”
eCLIPS by Evasc

- Accumulated 40 clinical cases
- 16 in Canada under Health Canada’s Special Access program
- 27 in EU after CE Mark  (Dr. Michael Kelly SNIS 2016)
No direction specific deployment needed
The Barrel VRD

- Ongoing FDA IDE Study (PI J Mocco)
- FDA IDE Enrolling patients. (completed!)
- CE Marked 2014

**Inclusion Criteria:**

- Wide-neck aneurysm: neck $\geq 4$mm or a dome-to-neck ratio $< 2$
- Parent vessel diameter $\geq 2$mm and $\leq 4$mm
- Bifurcating MCA or Basilar Tip
- No prior stent utilization
- Case review by PI prior to enrollment *(Rigorous Selection)*

 BV3550, BV3560, BV4065, BV4070, BV4580
Bifurcation Span

New dimension to consider for the barrel stenting
• HR Vaso CT showing that 2/3 of the neck (dotted red line) are now covered with the Barrel

• The left part of the neck (blue line) is not protected by the Barrel

• Coiling with one or several complex-shaped coil(s) should now be possible
CASE REPORT

Treatment of wide-necked basilar tip aneurysm not amenable to Y-stenting using the PulseRider device

Sunil A Sheth,¹ Nirav S Patel,² Ameera F Ismail,² Dena Freeman,³ Gary Duckwiler,¹ Satoshi Tateshima¹

Figure 2  PulseRider stent-assisted coiling of basilar tip aneurysm. (A, B) Initial angiogram showed aneurysm. The dysplastic base with incorporation of the bilateral posterior cerebral arteries (PCAs) is seen. (C) PulseRider deployment into the neck of the aneurysm with protection of the PCA origins. (D, E) Post packing and robust PCA flow with no residual contrast within the aneurysm dome.
Pre: recurrence post 2\textsuperscript{nd} treatment
Placement of Pulserider
AP view 6 months post
Lateral view 6 months post
MRA: 3 years post
MR: 3 years post
# ANSWER Study

**Adjunctive Neurovascular Support for Wide-neck aneurysm Embolization & Reconstruction**

<table>
<thead>
<tr>
<th>Study</th>
<th>n</th>
<th>Neck</th>
<th>Procedural Complications</th>
<th>Ischemic Postop</th>
<th>Raymond Immediate</th>
<th>Raymond FU</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAPS</td>
<td>13</td>
<td>5.6mm</td>
<td>6.6%</td>
<td>8.8%</td>
<td>I: 21.2%</td>
<td>I: 45.7%</td>
</tr>
<tr>
<td>Hett, et al. 2015</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>LVIS</td>
<td>31</td>
<td>4.6mm</td>
<td>NA (6.5% not deployed)</td>
<td>6.5%</td>
<td>I: 15%</td>
<td>I: 75%</td>
</tr>
<tr>
<td>Fiorella, 2015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Y stent</td>
<td>19</td>
<td>8.5mm</td>
<td>31.6%</td>
<td>10.5%</td>
<td>I: 26.3%</td>
<td>I: 63.2%</td>
</tr>
<tr>
<td>Spiotta, et al. 2011</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Y stent</td>
<td>45</td>
<td>6.9mm</td>
<td>11.1%</td>
<td>8.9%</td>
<td>I: 40%</td>
<td>I: 60%</td>
</tr>
<tr>
<td>*Fargen, et al. 2013</td>
<td></td>
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</tr>
<tr>
<td>ANSWER</td>
<td>34</td>
<td>5.2mm</td>
<td>8.8%</td>
<td>5.8%</td>
<td>I: 52.9%</td>
<td>I: 60.6%</td>
</tr>
<tr>
<td>Neurosurgery</td>
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<td></td>
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<td></td>
<td></td>
<td>I: 26.5%</td>
<td>I: 27.3%</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>I: 20.6%</td>
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<td>III: 12.1%</td>
</tr>
</tbody>
</table>

Neurosurgery. 2017 Jul 1;81(1):56-65
Thank You