Pre-Hospital and In-Hospital Systems of Care in Endovascular Therapy for Stroke—Radical Change is Needed

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Onset

Endovascular

FMC

Groin Puncture

First Image

Reperfusion
Systems of Care for Stroke

- **Patient Awareness**
  - Determine % of patients who come into ER via family members vs. EMS
  - Explore opportunities to enhance stroke education in the community

- **EMS Evaluation**
  - Tabulate % of patients correctly identified as LVO in the field
  - Utilize LAMS for early stroke severity assessment
  - Pre-hospital notification with direct-to-CT protocols
  - Air-life from the field to CSC
  - If EMS arrives at PSC, await for rapid evaluation for immediate CSC transport
  - Standardization of intake information at scene

- **Decision Making**
  - Use thin-cut reconstruction of NCCTs for evaluation
  - Minimize obtainment of CTAs
  - Upload images to PACS for early interpretation at CSC
  - Allow direct ER referrals to CSC
  - Explore opportunities for teleneurology

- **Patient Transportation**
  - Standardized approach for contacting EMS for transfer
  - Early activation of air life team
  - Facsimile transmission of medical records
  - Direct delivery of patients to helipad
  - Application of distance thresholds for transfers

- **CSC Processing**
  - Development of biplaner angiosuites
  - Early activation of interventional team
  - Reduction of repeat imaging within 60 minutes of most recent capture

- **Endovascular Procedure**
  - Development of new device technology
  - Utilization of conscious sedation
  - Implementation of neuroprotective strategies

- **Rehabilitation**
  - Financial considerations
  - Disposition status
  - Family support

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*Systems of Care for Stroke*  
Sun CJ, Gupta R, in Press Circulation
Distinguishing Two Patient Groups

• Patients brought directly to the ER
  - FMC to CT
  - FMC to Endovascular Contact
  - FMC to Groin Puncture

• Inter-facility transfers
  - Door in to Door out
  - D1 to D2
  - P2P
Defining Time Metrics and Process Improvement Strategies
Impact of Door In to Door Out to Mortality in STEMI

Standardize Metrics

FMC to Arrive at Outside ER

Time of CT

Time contacting EMS

Time of contacting CSC

Time EMS Leaves

Time EMS Arrives

Time Imaging obtained

Time EMS Arrives at CSC

Groin Puncture

Time Reperfusion achieved

Door In Door Out

P2P

Standardize Metrics

FMC to Arrive at Outside ER

Time of CT

Time contacting EMS

Time of contacting CSC

Time EMS Leaves

Time Imaging obtained

Time EMS Arrives at CSC

Groin Puncture

Time Reperfusion achieved

Door In Door Out

P2P
Standard metrics vital to compare across systems

Quality Assurance registries required to identify opportunities for process improvement.
Rapid Reperfusion Registry

- 478 consecutive patients from 9 hospitals treated between July 1, 2012 – December 31, 2012

- A QI project to assess door to groin puncture times and impact on outcomes. Second goal was to determine which metrics being captured.

- Prospective study being developed to integrate multiple centers across the country to standardize metrics

Door to GP times and impact on outcome

**Association between Door-to-GP and Good Outcomes (Model 1)**

<table>
<thead>
<tr>
<th>Time Intervals, min</th>
<th>Poor Outcome</th>
<th>Good Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60-100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>101-143</td>
<td></td>
<td></td>
</tr>
<tr>
<td>144-210</td>
<td></td>
<td></td>
</tr>
<tr>
<td>≥211</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjusted OR (95% CI)

LKN to treatment times comparing IV to IAT

%Good Outcome

LKN to Treatment (start of IV-tPA infusion or IAT arterial access)

Sun CJ, et al. Under Review
Picture to Puncture (P2P)

- Retrospective study performed at Grady Memorial Hospital from 2010-2012 comparing transferred patients to patients presenting in our ER

- Aim was to determine if transfer delays impacted neurological outcomes and opportunities to reduce transfer delays

- Defining a new metric “Picture to Puncture” (P2P) defined as time from CT to groin puncture

Flow of Patients

Transferred Patients

- All LVO Transfers  
  n=205
- All Consecutive IAT Patients  
  n=250

Local ED Patients

- All Local IAT  
  n=78

All Transferred Non-IAT  
  n=37
- Posterior Infarcts (n=6)
  Transferred Non-IAT  
  n=31

All Transferred IAT  
  n=172
- Posterior Infarcts (n=16)
- Incomplete Records (n=4)
  Transferred IAT Patients  
  n=152

Supplemental Table 2
- LKN unknown (n=2)
- LKN to GP > 9 hrs (n=18)

Supplemental Table 3
- LKN unknown (n=4)
- LKN to GP > 9 hrs (n=9)

Transferred IAT Patients (LKN to GP < 9 hrs)  
  n=132

Local IAT Patients (LKN to GP < 9 hrs)  
  n=61

Final Analysis: Table 1
Table 2. Binary Logistic Regression Model Identifying Factors Associated With Good Outcome After Endovascular Treatment for Acute Ischemic Stroke

<table>
<thead>
<tr>
<th>Variable</th>
<th>OR(95% CI)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>NIHSS Score</td>
<td>0.88 (0.82-0.95)</td>
<td>0.001</td>
</tr>
<tr>
<td>Successful Reperfusion</td>
<td>3.68 (1.42-9.53)</td>
<td>0.007</td>
</tr>
<tr>
<td>Picture to Puncture &quot;P2P&quot;</td>
<td>0.994 (0.990-0.999)</td>
<td>0.009</td>
</tr>
<tr>
<td>Age</td>
<td>0.972 (0.947-0.998)</td>
<td>0.032</td>
</tr>
<tr>
<td>Hypertension</td>
<td>0.49 (0.23-1.06)</td>
<td>0.070</td>
</tr>
<tr>
<td>Procedure Time</td>
<td>0.996 (0.988-1.004)</td>
<td>0.299</td>
</tr>
<tr>
<td>Male Gender</td>
<td>1.45 (0.70-2.98)</td>
<td>0.315</td>
</tr>
<tr>
<td>Symptomatic Hemorrhage</td>
<td>0.55 (0.09-3.44)</td>
<td>0.522</td>
</tr>
</tbody>
</table>

CI, confidence interval; OR, odds ratio; LKN, last known normal; Homser-Lemeshow test depicts goodness of fit to the model (P>0.05).
**Figure 2a:** Depiction of good outcome rates at differing time intervals of “Picture-to-Puncture”. Unadjusted good outcome rates and adjusted Odds Ratios are shown.

<table>
<thead>
<tr>
<th>P2P Time, min</th>
<th>Patients/Total (%)</th>
<th>Adjusted OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤90</td>
<td>17/31 (55.8)</td>
<td>Reference</td>
</tr>
<tr>
<td>91-180</td>
<td>24/73 (32.9)</td>
<td>0.30 (0.11-0.81)</td>
</tr>
<tr>
<td>181-270</td>
<td>18/52 (34.6)</td>
<td>0.32 (0.11-0.93)</td>
</tr>
<tr>
<td>&gt;270</td>
<td>10/37 (27.0)</td>
<td>0.18 (0.05-0.64)</td>
</tr>
</tbody>
</table>
Figure 3a: Graph depicting the time continuum from last known normal to reperfusion. Comparison is made between outside hospital transfers (OSH) and local emergency room (ED) admissions at the Comprehensive Stroke Center (CSC).

Figure 3b: Graph depicting areas of potential delays occurring at outside facilities prior to patient arrival at the Comprehensive Stroke Center. Referring physician data was not available for 13 patients; Only two patients at OSHs received CTP.

Opportunities to Improve Systems of Care: A Pragmatic Guide
Cincinnati stroke scale

Interpretation: if any of these 3 signs is abnormal, the probability of a stroke is 72%

**Facial Droop**
*The patient shows teeth or smile*
- Normal – both sides of the face move equally
- Abnormal – one side of the face does not move as well as the other side

**Arm Drift**
*The patient closes eyes and extends both arms straight out, with palms up for 10 seconds*
- Normal – both arms move the same or both arms do not move at all (other findings, such as pronator drift, may be helpful)
- Abnormal – one arm does not move or one arm drifts downward

**Abnormal Speech**
*The patient repeats “you can’t teach an old dog new tricks”*
- Normal – patient uses correct words with no slurring
- Abnormal – patient slurs words, uses the wrong words, or is unable to speak
First Medical Responders

- Identification of the severity of the stroke not just that it is a stroke
- Simplified scale such as hemiplegia/gaze preference or LAMS
- Direct contact from field to endovascular centers
- Direct to CT upon arrival
Hospital Evaluation

- Evaluation of patient in the CT scanner
- If NIHSS > 14 and CT negative for blood activate Endovascular team
- Concomitant evaluation with additional imaging, neurology consult, IV tPA evaluation, etc.
Suggested Time Metrics

• Door to CT: 5 minutes
• Door to Endovascular Contact: 30 mins.
• Door to Groin Puncture: 90 mins.
• Door to TICI 2B Reperfusion: 120 mins.

• Door at PSC to Groin Puncture at CSC < 120 mins. (Inter-facility transfer)
Conclusions

• With data convincingly showing impact of time on outcomes, reappraisal of endovascular pathway required

• Standardization of data being captured nationally

• Participation in a prospective national registry being supported through multi-industry initiative imperative

• Potentially linking systems of care to CMS reimbursement may drive rapid adoption