Have You Lost Your Neurons?

Carolinas Medical Center Code Stroke Lean Process Improvement Project

Presenters:
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Dale Strong, BS – Information and Analytics Services Clinical Analyst
Process Improvement Team

- Jeremy Rhoten, RN, BSN – Carolinas Medical Center Stroke Program Coordinator
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- Andrew Asimos, MD – Carolinas Stroke Network Medical Director
- Rahul Karamchandani, MD – Carolinas Medical Center Stroke Medical Director
- Kathy Barnard, RN, BSN – Carolinas Medical Center Emergency Department Medical Educator
- Emergency, Radiology, Neuroscience Intensive Care Unit, and Pharmacy
Stroke Statistics

• Stroke = 5th leading cause of death
• Stroke = Leading cause of disability
• Close to 800,000 strokes occur in the United States every year
• Classifications = Ischemic Stroke, Hemorrhagic Stroke, Transient Ischemic Attack
• Ischemic Stroke accounts for almost 87% of all cases

*All statistics from American Stroke Association Website
Large Vessel Occlusion

Normal anatomy

- Anterior cerebral artery
- Middle cerebral artery
- Internal carotid artery
- Basilar artery
- Posterior inferior cerebellar artery
- Anterior spinal artery
- Anterior communicating artery
- Posterior communicating artery
- Posterior cerebral artery
- Superior cerebellar artery
- Anterior inferior cerebellar artery
- Vertebral artery
Code Stroke Workflow

- Patient Arrival
- Recognition of Symptoms
- Radiological Imaging
- Treatment Decision

Time Is Brain!

Door to ED Physician: 10 mins
Door to Code Stroke: 15 mins
Door to CT Performed: 25 mins
Door to CTA Performed: 45 mins
Door to IVtPA: 60 mins, 45 mins (Stretch)
Door to Groin Puncture: 90 mins, 60 mins (Stretch)
Process Improvement in Healthcare

• Limitations
  • Complex environment
  • Highly dependent on skilled workers
  • Constantly changing

• Advantages
  • Large area for improvement
  • High volume of hospitals and patients
  • Business, Manufacturing, and other sectors of industry have many tools and experiments to use as models
  • Constantly changing
Process Improvement Methodologies

- PDSA = Plan, Do, Study, Act

- DMAIC = Define, Measure, Analyze, Implement, Control
Our Process Improvement Toolbox

1. Brainstorming
2. Cause & Effect
3. Value Stream Mapping
4. 5 Whys
5. PICK Chart
6. FMEA
Assessment of Code Stroke Workflow
(Pre Project Implementation)

Accuracy = Ability to hit your target and/or goal
Precision = Ability to consistently hit the same spot
Code Stroke Workflow Trend Over Time

Trends of Process Metrics

- Door to tPA
- Door to CT Interp
- Door to CT Performed
- Door to CS
- Door to EDP

Project Implementation

Atrium Health
### Background

Stroke is the 5th leading cause of death and the number 1 leading cause of disability in the United States. At CMC – Main in 2017 we had 467 Code Stroke Patients present through the Emergency Department with 333 of them arriving via EMS (71.3% of the total ED Code Stroke population). Stroke is an extremely time-sensitive pathology where in serious stroke cases, a Large Vessel Occlusion (LVO) in the brain can lead to the death of 1.9 million neurons every minute if untreated, and an average accelerated aging of 3.1 weeks per minute. The CMC-Main Comprehensive Stroke Program set out to utilize prenotification from EMS teams to streamline the Code Stroke Process and treat patients quicker and more efficiently.

### Previous condition (2017 Averages Before Implementation)

<table>
<thead>
<tr>
<th>PLAN</th>
<th>Door to Code</th>
<th>Door to Code Stroke Activation</th>
<th>Door to CT</th>
<th>Door to CT Interpretation</th>
<th>Door to IV</th>
<th>Door to CTA</th>
<th>Door to Puncture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>8.3</td>
<td>20.3</td>
<td>30.3</td>
<td>45.5</td>
<td>59.1</td>
<td>46.3</td>
<td>48.2</td>
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<tr>
<td>Median</td>
<td>4.0</td>
<td>12.0</td>
<td>22.0</td>
<td>37.5</td>
<td>52.0</td>
<td>36.0</td>
<td>46.0</td>
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<tr>
<td>Max</td>
<td>92.0</td>
<td>171.0</td>
<td>188.0</td>
<td>227.0</td>
<td>163.0</td>
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<td>Min</td>
<td>0.0</td>
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<td>4.0</td>
<td>11.0</td>
<td>26.0</td>
<td>15.0</td>
<td>21.0</td>
</tr>
</tbody>
</table>

### Goal / Target Condition

**IA Process Timeline Goals:**

- ED Arrival to ED Physician: 10 Min
- ED Arrival to Code Stroke Activation: 15 min
- ED Arrival to CT: 25 min
- ED Arrival to CTA: 60 min
- ED Arrival to IVPA: 90 min

IVPA and Inter-Arterial Rescue Therapy are the gold standard treatments for Stroke Patients and the quicker blood flow can be restored to the brain the more brain can be salvaged for the patient.

### Root Cause Analysis

- Delays in treatments outside program’s time goals
- Delays in IVPA administration average only 1 min below program goal
- Delays in Code Stroke Alert process delays actual Code Stroke Page
- Delays in imaging lead to delays in treatment decision making process
- Transport between ED and CT prolongs treatment and affects access to transport of patient
- Notification of providers after patient arrival results in slower response times to Code Stroke Page

### Countermeasures (experiments)

<table>
<thead>
<tr>
<th>DO</th>
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<tbody>
<tr>
<td>1. Reduce Variability in ED Arrival to Code Stroke Activation by removing Code Stroke Alert</td>
</tr>
<tr>
<td>2. Allowed Code Stroke to be paged based on EMS calling in a patient with Primary Impression of Stroke</td>
</tr>
<tr>
<td>3. Shorten time from SIH to CT Scan by implementing Direct Door to CT Protocol</td>
</tr>
<tr>
<td>4. Decrease excess patient transport by allowing patient to stay in “holding bay” outside of CT Scan while treatment decision process takes place</td>
</tr>
<tr>
<td>5. Allow stable patients to be given IVPA in holding bay reducing the need to transport back to ED</td>
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</table>

### Confirmation (2017 Averages After Implementation)

<table>
<thead>
<tr>
<th>CHECK</th>
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<tbody>
<tr>
<td>Analyze performance of all aspects of process and give monthly team updates monthly via REDCap and PowerBI. Probe team members involved in specific cases both bad and good for feedback about what worked well and what did not to adjust workflow accordingly.</td>
</tr>
</tbody>
</table>

### Follow up (actions)

- We are looking into adapting stricter time goals, ideally a 60 min Door to IVPA goal.
- Continue to monitor all cases and report failures to the team and help restructure the workflow to mitigate future failures.
- Evaluate our process for patients who arrive by private vehicle and help streamline that process to help reduce critical time metrics for that smaller patient population as well.
EMS Code Stroke PI Project - DEFINE

- 2017 CMC had 467 Code Stroke (CS) Patients present through the ED
  - 333 via EMS = 71.3% of total ED CS Volume
  - 134 via Private Vehicle = 28.7% of total ED CS Volume
- For Large Vessel Occlusion Strokes 1.9 million neurons die every minute a patient goes without treatment
  - Average Door to Bolus Time for IVtPA 2017 (Jan-Jun) = 59.1 min [Goal = 60 min]
  - Average Door to Groin Puncture for IA 2017 (Jan-Jun) = 111.3 min [Goal = 90 min]

5 Whys? Technique

Why? Why? ROOT CAUSE
EMS Code Stroke PI Project - DEFINE

• Project Selection:
  • Patients arrive via EMS, Private Vehicle, or Inter-Facility Transfer
  • “Ranked” each arrival mode to determine which patient population/workflow to focus on for the PI Project

<table>
<thead>
<tr>
<th>Project</th>
<th>Volume</th>
<th>Feasibility</th>
<th>Potential Impact</th>
<th>CMC Ownership</th>
<th>Total (Multiply all)</th>
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</thead>
<tbody>
<tr>
<td>EMS Arrival</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>54</td>
</tr>
<tr>
<td>Private Vehicle Arrival</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>36</td>
</tr>
<tr>
<td>Transfer Arrival</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>12</td>
</tr>
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</table>
EMS Code Stroke PI Project - MEASURE

Door to ED Physician 10 mins
Door to Code Stroke Activation 15 mins
Door to CT Performed 25 mins
Door to CTA Performed 45 mins
Door to IV tPA Bolus 45 mins (Stretch)
Door to IV tPA Puncture 60 mins (Stretch)
Door to Final Revascularization 90 mins (Stretch)

Pre-Implementation Data

<table>
<thead>
<tr>
<th></th>
<th>Door to ED Physician</th>
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<th>Door to Puncture</th>
<th>Door to Final Revascularization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>8.1</td>
<td>20.3</td>
<td>29.6</td>
<td>46.3</td>
<td>59.1</td>
<td>111.3</td>
<td>137.0</td>
</tr>
<tr>
<td>Median</td>
<td>4.0</td>
<td>12.0</td>
<td>22.0</td>
<td>36.0</td>
<td>52.0</td>
<td>108.0</td>
<td>134.5</td>
</tr>
</tbody>
</table>

*All values in minutes
EMS Code Stroke PI Project - ANALYZE

Current State Workflow

- **#1**
  - Medic calls with possible Code Stroke.
  - ED RN notifies TL/Physician to hold major front room, get gurney stretcher.

- **#2**
  - ED TL/Care RN
    - Pt. taken immediately to Major Treatment Room.
    - ED Physician notified – possible Code Stroke
    - (1) Stroke Packet
    - (2) Vital Signs
    - (3) Start IV x 2
    - (4) NS + KVO
    - (5) Begin Monitoring
    - (6) Keep Pt NPO
    - (7) Weigh patient

- **#3**
  - EM Physician:
    - (1) Verify symptom onset ≤ 6 hrs
    - (2) Assess Pt w/ NIHSS within 15
    - (3) Consider treating high BP

- Patient NOT a Code Stroke

- Triage RN

- EM Physician:
  - (1) Activates Code Stroke Protocol
  - (2) Signs “ED Adult - Code Stroke Assessment” Powerplan
  - (3) Begins Intravenous rt-PA Eligibility Checklist

Tool Used = “Going to the gemba” or observing the process in real time

Atrium Health
EMS Code Stroke PI Project - ANALYZE

• DOWNTIME = 8 Sources of Waste
  • Extra Processing = 3 different personnel view patient before CS Activation Page
  • Transportation = moving patient between ED and Radiology multiple times
  • Waiting = depending on treatment strategy the patient was spending excess time waiting for decisions/supplies
  • Motion = clinical decision makers are also tasked with moving patient multiple times while making the best decision for the patient caused excess motion in the process
EMS Code Stroke PI Project - IMPROVE

- Innovative new workflow that placed patient at the center of attention
- Core Value Stream flows through patient not the clinical team
- Patient may never enter the ED helping reduce arrival time to treatment
- Full implementation took approx. 1 month beginning June 5th, 2017 and ending July 17th, 2017
**EMS Code Stroke PI Project - IMPROVE**

**Post-Implementation Data Analysis**

<table>
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<tr>
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<th>Door to Puncture</th>
<th>Door to Final Revascularization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average</strong></td>
<td>6.8</td>
<td>14.1</td>
<td>25.6</td>
<td>37.4</td>
<td>49.4</td>
<td>90.5</td>
<td>113.3</td>
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<tr>
<td><strong>Median</strong></td>
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<td>7.0</td>
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<td>26.5</td>
<td>41.5</td>
<td>79.0</td>
<td>111.0</td>
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**Improvements Observed (Change Between Pre and Post)**

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<th>Door to Puncture</th>
<th>Door to Final Revascularization</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average</strong></td>
<td>1.3</td>
<td>6.2</td>
<td>3.9</td>
<td>8.9</td>
<td>9.7</td>
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<tr>
<td><strong>Median</strong></td>
<td>1.0</td>
<td>5.0</td>
<td>5.0</td>
<td>9.5</td>
<td>10.5</td>
<td>29.0</td>
<td>23.5</td>
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*All values in minutes*
• Door to IVtPA Bolus improved by 9.7 mins

• Door to Final Revasc. Improved by 23.7 mins
  • Average savings of **45.03 million neurons** per patient with LVO
  • Average savings of **73.47 weeks of life expectancy** per patient with LVO

• Patient population observed a decrease Length of Stay on average of 2,603 mins (approx. 1.8 days) saving an estimated cost of $1,940 per patient

• NIHSS at discharge improved 1.94 points

• mRS at discharge improved by 0.50 points
  • Mean lifetime cost of an ischemic stroke was $140,048 (est. in 2010)
  • Improved function prior to discharge can drastically impact overall cost
Re-Assessment of Code Stroke Workflow
(2018 YTD as of end of June)

Increased “Accuracy” in all metrics by lowering our average
Increased “Precision” in 5 of 6 metrics by increasing our goal reached %
Thank you for your attention!

Questions?

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**IHI National Forum**

on Quality Improvement in Health Care

December 9–12, 2018
Orlando, FL

**Invitation to Present**

Dear Jeremy,

The Institute for Healthcare Improvement (IHI) is thrilled to invite you to present at the 2018 IHI National Forum on Quality Improvement in Health Care.

This year’s Forum will be held December 9–12, 2018 at the Orlando World Center Marriott Resort and Convention Center. The agenda consists of half-day Learning Labs on December 9 and December 10, full-day Quick Courses on December 10, and the two-day General Conference, including four keynote presentations, on December 11 and 12. Your presentation will be a valuable contribution to health care quality improvement and we are excited to showcase your work at the National Forum.

We invite you to present the following:

**Sunday Learning Labs**

**Have You Lost Your Neurons?**

Sunday, December 9, 2018

CMC underwent a process improvement project utilizing lean methodology to decrease door to treatment times for Code Stroke patients. We achieved an average decrease of 10 minutes for IV/PA and 21 minutes for thrombectomy therapy. There was a 24-minute reduction in door-to-revascularization, saving approximately 45 million neurons and 74 weeks of life expectancy per LVO patient. We also decreased LOS by approximately 1.8 days, a potential cost savings of $2,000 per visit in this population.

**Key Presenter:** Dale Strong

**Co-Presenter(s):** Jeremy Rhoten; Andrew Asimos; Kathy Barnard