How Artificial Intelligence has Impacted the Hub and Spoke Stroke Transfer workflow

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Piedmont Healthcare
Objectives

01
Identify the main challenges and delays in acute stroke workflow

02
Discuss the most important principles of streamlining stroke workflow to decrease treatment time and transfer time

03
Identify how artificial intelligence has impacted the hub and spoke and transfer model

04
Discuss what is the clinical impact of streamlining transfer process on stroke patients
What is the Stroke Care Conundrum

• Worldwide stroke costs $70 billion annually
• The United States contributes $34 billion
• Patient’s having a stroke do not have the same level of care as those with a heart attack
  • Lack Urgency
  • No one tool to recognize stroke
• How do we tackle disparities in stroke Care
Stroke Behind the 8 Ball

- American Heart Association (AHA) was formed in 1924
- National Stroke Association (NSA) wasn’t formed until 1984
- FDA didn’t approve the first therapy (alteplase) for stroke until 1996
- American Stroke Association (ASA) finally formed in 1998

We’re just now figuring out that the brain is at least as important as any other organ!

... and it’s the only organ you can’t transplant (yet)
Stroke Center Levels

**Acute Stroke Ready**
- Basic stroke care
- “Drip and Ship” stroke management
- No advanced stroke therapies

**Primary Stroke Center**
- Able to keep patients who receive IV thrombolytics
- No advanced stroke therapies
- Adheres to quality stroke metrics
- Providers have specialized stroke education

**Thrombectomy Capable Center**
- Advanced stroke therapies
- Volume requirement - 15 thrombectomies in 12 months
- Advanced imaging capabilities
- ICU beds for acute ischemic stroke
- Post acute follow up

**Comprehensive Center**
- Care for SAH, ICH, and advanced stroke therapies
- Dedicated Neuro Critical Care
- 24/7 Neurosurgery availability
- Advanced imaging capabilities
Hub and Spoke Model

- Various access to acute stroke expertise impact treatment
- How do you provide expertise at the bedside to support the first responding physician— not a stroke expert
- Connects with expert for treatment decision
- Streamlines transfer to the right facility for the right treatment
For each 10 minute delay in ER arrival, treatment was 18 minutes faster!

Parkinson’s Law (see The Economist, November 19, 1955)
1 a teardrop line of contour offering the least possible resistance to a current of air, water, etc.

2 the path of a particle that is flowing steadily and without turbulence in a fluid past an object.

verb (used with object), streamlined, streamlining.

3 to make streamlined.

4 to alter in order to make more efficient or simple.

... offering the least possible resistance to an obstacle... million neurons die per minute while we are figuring things out

Streamlining Workflow
What Streamlining is NOT...

What Streamlining is NOT...

- Don’t let “streamlining” make you think that the word line is part of it... no one wants to be in line!
- Assembly lines were GREAT for the auto industry in 1913... not so much patients in 2020
Streamlining is **Dynamic!**

- Making use of **parallel processes** in a linear environment
- Eliminating waste while **eliminating** (vs overcoming) obstacles
- In the Acute Stroke process, that means **controlled** chaos
Who Governs Stroke Care?
Get With The Guidelines

NEW
(Because Stroke is a moving target)

Target Stroke™ Honor Roll

Starting in January 2020, hospitals will have the opportunity to be recognized with two new Target: Stroke Honor Roll levels. The existing and new Honor Roll levels will include:

- **Target: Stroke Honor Roll**: Door-to-needle times within 60 minutes for at least 75 percent of applicable patients.
- **Target: Stroke Honor Roll-Elite**: Door-to-needle times within 60 minutes for at least 85 percent of applicable patients.
- **Target: Stroke Honor Roll-Elite Plus**: Door-to-needle times within 45 minutes for at least 75 percent of applicable patients and door-to-needle times within 30 minutes for at least 50 percent of applicable patients.
- **Target: Stroke Honor Roll Advanced Therapy**: Door-to-device times in at least 50% of applicable patients within 90 minutes for direct arriving and within 60 minutes for transfers.
Controversial Disparities in Stroke Care

• The weekend/night effect
• Delayed recognition
• “Unknown” last known well time
• “Resolving symptoms”
• No advanced imaging due to “Low” NIHSS or NIHSS <6
• “Patient is still in time window”
• “They have no history”
Identifying Delays in Workflow
Stroke Care is complicated and challenging

Resulting in delayed treatment times of 3-5 hours

How Has A.I Evolved Workflow

- Reduction from Picture to Alert
- Early Suspected LVO Detection
- Reduction from Door to Puncture Times
- Reduction in Transfer Times
- Reduction in LOS
- Improvement in Outcomes
- Streamlined Workflow
- Streamlined Communication
SYNCHRONIZED HEALTHCARE

With Viz, every member of the on-call medical team is automatically alerted to suspected disease in their hub and spoke network within minutes.

<3 MINUTES PICTURE TO ALERT

Synchronized Stroke Care

Automated Detection & Triage

Viz LVO
A.I. powered and automated detection of suspected LVOs.

Viz CTP
Automated CT perfusion mapping and analysis.

Viz ICH
A.I. powered and automated detection of suspected ICH.

Viz VIEW
Mobile DICOM viewer for NCCT, CTA, and CTP images.

Viz HUB
Secure communication and workflow visualization.
INTEGRATED HIPAA COMPLIANT CHAT

VIZ HUB

Viz HUB is a secure, HIPAA-compliant text messaging and calling platform that empowers clinical teams to conveniently coordinate patient care and treatment decisions between hospitals in a hub/spoke network.

- HIPAA-Compliant, Group Text Messaging
- Convenient Colleague Directory & Calling
- Real-time NIHSS and ASPECTS Scoring
What Works in the Hub and Spoke Model

- **Frequent Contact = Quicker Treatment and Better Outcomes**
- **Education**
- **Solid Relationships for Feedback and Optimization**
- **Improved Communication through Shared Technology Platforms**
- **Clear Roles and Responsibility Delineations**
Synchronize Stroke Care

Viz LVO can scan an entire Hub & Spoke Network and simultaneously alert your stroke specialists.
SYNCHRONIZING STROKE CARE

Use of Artificial Intelligence Shows Significant Reduction in Door to Skin Puncture Times at a Stroke Center

WHAT IS VIZ?

Viz.ai is stroke detection and workflow synchronization software that utilizes artificial intelligence (A.I.) to automatically detect suspected LVO strokes on CT imaging, alert the on-call stroke team, and coordinate care via HIPAA-compliant mobile image viewing and communication.

STUDY DESIGN

- Single center, retrospective, investigator-initiated review
- Evaluate Viz’s impact on the time from hospital arrival (Door) to skin puncture (Puncture) for LVO patients initially presenting to the emergency department at a thrombectomy-capable stroke center. (n=37)

SYNCHRONIZED CARE WITH VIZ.AI

Viz resulted in statistically significant improvements in the percentage of patients with door to puncture times of less than 90 min (p < 0.001) and 60 min (p = 0.02).

<table>
<thead>
<tr>
<th></th>
<th>Pre-Viz</th>
<th>Post-Viz</th>
<th>P.Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>% DTSP &lt; 90 min</td>
<td>56%</td>
<td>100%</td>
<td>p &lt; 0.001</td>
</tr>
<tr>
<td>% DTSP &lt; 60 min</td>
<td>0%</td>
<td>29%</td>
<td>p = 0.02</td>
</tr>
</tbody>
</table>
Early Suspected LVO Detection

Viz LVO can analyze and alert stroke specialists within minutes

In 95.5% of true positive cases, Viz LVO alerted the neurovascular specialist to positive LVOs an average of 52 minutes earlier than in the standard of care.¹

And we’re viewing images on our phone literally within minutes after a scan without waiting on other physicians to call us or waiting for an outside radiologist to read the images. This is facilitating change like no other application to come before it. It’s the most powerful, impactful technology I’ve seen in many years.

¹ FDA De Novo DEN170073, Core Lab Study, 2 Centers, n=44, Sensitivity 87.8%, Specificity 89.6%. 2017.

Thomas Devlin, MD, PhD
Neurologist
Case Study

- 73F, sudden onset aphasia and right side hemiplegia.
- Taken to Spoke ED. Received IV tPA. Imaging completed and sent to Viz.ai - Immediately transferred.
Outcome

- Discharged to Rehab on Hospital Day 3
- Mild right hand weakness. Speech normal.
NIVR activated team before NEURO suggested.

NIVR activated based on mobile image viewer, and clinical assessment provided by stroke nurse.

This took 11 Minutes!

Quick change in decision- avoided team to come in for no reason.
FEB 14, 2020

AB
08:13
Looks like hyperdense left M1

L
08:20
Do we have an onset time?

AB
08:20
The nurse noted the change at 4am

08:21
Right sided weakness, neglect, and aphasia

L
08:22
Mca syndrome?

08:21
Ok calling team

AB
08:22
Ok

Seems as though he's not as agitated as

MAY 22, 2020

Interventional Radiologist
13:57
Right M1 occlusion, call neuro alert activate team

DP
13:57
IR aware. Dr Misra also

RH
15:35
Large clot removed... great job to the team!

AM
15:36
Awesome!
CLINICAL IMPACT

Viz demonstrated to CMS reduced time to treatment, improved clinical outcomes, and increased access to care for patients suffering a stroke.

Viz reduced PSC Picture to CSC Door time by 66 minutes (p = 0.0163) and reduced LOS and Neuro-ICU LOS by 2.5 days (p = 0.0324) and 3.5 days respectively (p = 0.0039).¹

Data From Mount Drs. J Mocco and Johanna Fifi at Mount Sinai

**REDUCE PSC TO CSC PUNCTURE**

Mean PSC Arrival to INR MD Alert Time (30 min saved, 55% Reduction)
Mean PSC Arrival to CSC Puncture Time (33 min saved, 17% Reduction)

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# IMPROVE CLINICAL OUTCOMES

Data From Mount Drs. J Mocco and Johanna Fifi at Mount Sinai

Mean 5-Day NIHSS and Discharge mRS; median 90-Day mRS (all p<0.05)

<table>
<thead>
<tr>
<th></th>
<th>PRE-VIZ</th>
<th>POST-VIZ</th>
<th>% CHANGE</th>
<th>P-VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5-Day NIHSS</strong></td>
<td>22</td>
<td>11</td>
<td>51%</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Discharge mRS</strong></td>
<td>4.6</td>
<td>2.9</td>
<td>37%</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>90-Day mRS</strong></td>
<td>5.0</td>
<td>3.0</td>
<td>40%</td>
<td>0.02</td>
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</tbody>
</table>

Burden of Stroke Care

- Worldwide stroke costs $70 billion annually
- The United States contributed $34 billion
- 50%-70% of strokes have Medicare as primary payer
- The cost of stroke care ≥ reimbursement = small or negative contribution margin
- Inefficient clinical pathways and above benchmark length of stay impact contribution margins negatively
## Stroke Contribution Margins

<table>
<thead>
<tr>
<th>DRG</th>
<th>Description</th>
<th>ALOS</th>
<th>GMLOS</th>
<th>Medicare Margin</th>
<th>Commercial Margin</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>Craniotomy with Major Device implants/ Acute complex Central Nervous System Principal Diagnosis W/MCC or Chemo Implant</td>
<td>10.57</td>
<td>7.58</td>
<td>$6,425</td>
<td>$47,984</td>
</tr>
<tr>
<td>24</td>
<td>Craniotomy with Major Device implants/ Acute complex Central Nervous System Principal Diagnosis W/O MCC or Chemo Implant</td>
<td>5.50</td>
<td>4.20</td>
<td>$6,530</td>
<td>$31,391</td>
</tr>
<tr>
<td>61</td>
<td>Acute Ischemic Stroke with use of Thrombolytic Agent W MCC</td>
<td>6.85</td>
<td>5.28</td>
<td>$1,480</td>
<td>$31,260</td>
</tr>
<tr>
<td>62</td>
<td>Acute Ischemic Stroke with Use of Thrombolytic Agent W/CC</td>
<td>4.30</td>
<td>3.69</td>
<td>$2,084</td>
<td>$16,661</td>
</tr>
<tr>
<td>63</td>
<td>Acute Ischemic Stroke with use of Thrombolytic Agent WO CC/MCC</td>
<td>3.01</td>
<td>2.74</td>
<td>$1,516</td>
<td>$24,525</td>
</tr>
<tr>
<td>64</td>
<td>Intracranial hemorrhage or Cerebral Infarction W MCC</td>
<td>6.14</td>
<td>4.48</td>
<td>$1,175</td>
<td>$10,224</td>
</tr>
<tr>
<td>65</td>
<td>Intracranial Hemorrhage or Cerebral Infarction W CC or IV t-PA in 24 hours</td>
<td>4.02</td>
<td>3.27</td>
<td>$901</td>
<td>$5,580</td>
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<tr>
<td>66</td>
<td>Intracranial Hemorrhage or Cerebral Infarction WO CC/MCC</td>
<td>2.72</td>
<td>2.31</td>
<td>$894</td>
<td>$4,277</td>
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<tr>
<td>67</td>
<td>Nonspecific CVA &amp; precerebral occlusion W/O infarct W MCC</td>
<td>4.78</td>
<td>3.56</td>
<td>-$477</td>
<td>$2,693</td>
</tr>
<tr>
<td>68</td>
<td>Nonspecific CVA &amp; precerebral occlusion W/O infarct W/O MCC</td>
<td>2.92</td>
<td>2.36</td>
<td>$548</td>
<td>$3254</td>
</tr>
<tr>
<td>69</td>
<td>Transient ischemia W/O thrombolytic</td>
<td>2.55</td>
<td>2.12</td>
<td>$317</td>
<td>$3264</td>
</tr>
</tbody>
</table>
Optimize Stroke Workflow to Impact Economics

- **Identify**: Identify patients for treatment quicker
- **Triage**: Triage to the right center quicker
- **Treat**: Treat eligible patients with thrombectomy to reduce disability
- **Increase**: Increase treatment rate with accurate identification
Faster Stroke Alert and Treatment Times

Mean PSC Arrival to INR MD Alert Time (30 min saved, 55% Reduction)
Mean PSC Arrival to CSC Puncture Time (33 min saved, 17% Reduction)

What is 33 Minutes?

132-day loss of disability free life

330-day loss of functional independence

$34,947 of median net revenue increase

EACH MINUTE DELAY IN THROMBECTOMY²⁻⁴ =

<table>
<thead>
<tr>
<th>4-DAY LOSS</th>
<th>10-DAY LOSS</th>
<th>$1,059 LOSS</th>
</tr>
</thead>
<tbody>
<tr>
<td>OF DISABILITY-FREE LIFE</td>
<td>OF FUNCTIONAL INDEPENDENCE (MRS 0-2)</td>
<td>OF MEDIAN NET MONETARY BENEFIT</td>
</tr>
</tbody>
</table>

$4,922 HOSPITALIZATION COSTS PER DAY⁵
Increasing Access to Care

**Pre-Viz**
Average MER 10%

**Post-Viz**
Average MER 17%-25%

**Revenue Increase**
$1.7 million @ 20% treatment rate

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**STROKE HOSPITAL AND FOLLOW UP COSTS**
by NIHSS at 5 Days and mRS at 90 Days

<table>
<thead>
<tr>
<th>5-Day NIHSS</th>
<th>EVT Hospital Cost</th>
<th>EVT FU Cost</th>
<th>90-Day mRS</th>
<th>EVT FU Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>$23,242</td>
<td>$9,984</td>
<td>0</td>
<td>$5,871</td>
</tr>
<tr>
<td>1 to 9</td>
<td>$28,140</td>
<td>$14,674</td>
<td>1</td>
<td>$10,419</td>
</tr>
<tr>
<td>10 to 19</td>
<td>$38,588</td>
<td>$52,325</td>
<td>2</td>
<td>$17,839</td>
</tr>
<tr>
<td>20+</td>
<td>$61,289</td>
<td>$62,283</td>
<td>3</td>
<td>$29,889</td>
</tr>
</tbody>
</table>

* Adjusted for age. FU indicates follow-up; EVT, endovascular therapy; mRS, modified Rankin Scale; NIHSS, National Institute of Health Stroke Scale.
Optimizing Length of Stay

Reduced LOS: Neuro-ICU and Hospital
55% Mean Reduction in Neuro-ICU LOS, 25% in Hospital LOS

- Develop clinical pathways based on treatment
- Map pathway based on length of stay benchmark
- Standardize order sets to align with pathways
- Track data to identify opportunities in operations
What does one day mean?

Patient leaves the hospital quicker

More ICU beds for patients with high acuity

Decrease cost & increased revenue to re-invest into stroke program
Consider an Administrator’s Brain

\[
\frac{d^{1/2} f}{dx^{1/2}} = ?
\]