Building Stroke Systems of Care

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COMPREHENSIVE STROKE CENTER

Disclosures

- Research support
  - National Institutes of Health: SC-CaSIST / StrokeNet (hub); NETT (spoke)
  - Novo Nordisk (NIH): STOP-IT Study
  - Genentech: PRISMS Study
  - Ischemia Technologies: BASES Study
  - Covidien, Stryker, Penumbra: POSITIVE Study
  - Nolto, Inc (Brain Canada): FRONTIER Study (internal safety monitor)
  - ZZ Biotech, LLC (NIH): RHAPSODY Trial (DSMB)
- Consultant
  - Boehringer Ingelheim: NOAC reversal agent development
  - Pulse Therapeutics: Magnetic nanoparticles for stroke
- State and National Organizations
  - AHA/ASA committees and writing groups
  - JC Advisory Panels

Outline

- Why do we care?
- What changed in 2015?
- Discuss stroke systems of care in 2015
  - Regional systems
  - Local systems
  - Internal systems
- How to move SC forward, incorporating these new opportunities

Geographic Distribution of Stroke Mortality (2011-2013)


Stroke Outcomes

- In the 4 million US stroke survivors:
  10% Recover almost completely
  25% Recover with minor impairments
  40% Experience moderate to severe impairments requiring special care
  10% Require care in a nursing home or other long-term care facility
  15% Die shortly after the stroke
Competition for Resources

ED Visits and Number of ED’s in Community Hospitals 1992 - 2012

Increasing Boarding in EDs

Lessons Learned Over 20 Years

- Reperfusion critical
  - Minimize delay
  - Maximize penumbral salvageability
    - Collateral flow
    - Physiologic optimization
  - Time to reperfusion
    - Predicts clinical outcomes
    - Significant tolerance-heterogeneity in populations
    - Time is Brain must drive all system development

Understand the Limitations of IV tPA

- Generalizability
  - 4% utilization of tPA
  - ~25% present within 3 hours; 29% eligible
  - Keep in mind 12323 screened for 180 in PROACT II
- Big strokes are tough
  - Baseline NIHSS >10 and a dense MCA sign predicted poor clinical outcome
  - TTATS recanalization rate of no more than 30% for large vessel occlusion
  - Sustained recanalization in only 10-20%
  - Increased risk of sICH with larger strokes

IV rtPA Reperfusion Limitations

- Location
  - Vessel occlusion location prognostic of response
    - Distal ICA 4.4%
    - M1-MCA 32.3%
    - M2-MCA 30.8%
    - Basilar 4.0%
  - Reperfusion most predictive of outcome (RR 2.7)

- Clot size (<8mm)
  - Reperfusion remains strongly predictive
    - Mean discharge mRS
      - Reperfused 1.9
      - No reperfusion 4.4

2015 Trial Results – Finally!

- Thrombectomy within 4 hours after symptom onset in ischemic stroke
- New England Journal of Medicine
- Endovascular Therapy for Ischemic Stroke with Intra-Aneurysmal Stent Deployment
- Randomized Association of Rapid Embolization of Ischemic Stroke
Edward Jauch, MD MS

New Opportunities for IV rtPA

- FDAs new revised prescribing label 2/15

Recanalization Strategies

- FDA cleared interventions:
  - IV tPA (0-3 hours)  Approved 1996
  - IV tPA (3-4.5 hours)  2012 Guideline only
  - Thrombectomy devices  Cleared for clot removal

Partner with Others

- STEMI & post-cardiac arrest share similar issues
  - Time is Brain and Heart
  - Destination hospital key
  - Have similar resource needs

- Goals:
  - Identify stakeholders
  - Develop best practice for state
  - Build integrated systems of care in regions of the state
  - Build discrete time benchmarks

Changing Landscape for Acute Ischemic Stroke in 2015

- New guidelines and policies imminent
  - Guideline update  July 2015
  - Systems of care  Mission Lifeline

- Measured national goals
  - Door to Needle Time < 60
  - CT to Thrombectomy Time < 90 min*
  - Treatment rates by percent eligible for IV and IA

- New FDA product label

Now How Best Use These Treatments Trends in Stroke Organization

- Develop regionalization of stroke systems of care based on best practice
  - State-based / regional planning
    - Departments of Health critical to affecting change
    - All stakeholders engaged from the beginning
    - Build on previous regional success (STEMI)
  - Regionalization extends beyond EMS and triage, timely transfers to better equipped hospitals may need to occur

<table>
<thead>
<tr>
<th>Time Window</th>
<th>0-3 hrs</th>
<th>3-4.5 hrs</th>
<th>3-6 hrs</th>
<th>&gt; 6 hrs</th>
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<tbody>
<tr>
<td>IV tPA</td>
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<td>IV tPA</td>
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<tr>
<td>IA Lytic</td>
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Options

- IV tPA
- Device
- IV tPA
- Device
- IA Lytic
- Device
- Device?
Impact of Timely Transfer: STEMI

(Wang, JAMA. 2011;305(24):2540-2547)

Reasonable Time Benchmarks

<table>
<thead>
<tr>
<th>Goal</th>
<th>STEMI</th>
<th>Stroke</th>
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</table>
| FMC to MD (with 
  encoding)                             | <1 min         | <1 min        |
| FMC to Diagnostic                        | <10 min ECG    | <10 min CT    |
| FMC to Specialist                        | <10 min        |               |
| FMC to IV/Reperfusion                    | <30 min        | <45 min       |
| FMC to IDE/Reperfusion                   | <60 min        | <90 min       |
| Door In - Door Out                       | <30 min        | <45 min       |

Potential Impact of EMS Triage

EMS Transport  DTN  Transfer  Imaging to Reperfusion

30 mins  60 mins  90 mins  120 mins  150 mins  180 mins

Extra EMS time made up by faster DTN

Faster DTG without additional imaging and transfer

ASA Policy Recommendations

Recommendations for the Establishment of Stroke Systems of Care
Recommendations From the American Stroke Association’s Task Force on the Development of Stroke Systems

Stroke

Hospital Stroke Capabilities

<table>
<thead>
<tr>
<th></th>
<th>1000*</th>
<th>1060</th>
<th>90</th>
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<tbody>
<tr>
<td>Of 5000 (7/6/15)</td>
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(Schwamm, Circulation. 2005;111:1078-191)
(Higashida, Stroke 2013:44)
Optimal CSC Distribution

- 2010 US Stroke
  - 811 JC PSC, 0 CSC
  - 65.8% 60’ ground access to PSCs.
  - Adding up to 20 optimally located CSC per state, 63.1% 60’ ground access and 86.0% had 60’ ground/air access to a CSC

(Mullen, Neurology. 2015;84:1–10)

Strategic Creation of CSC

- Population-based planning in developing stroke systems of care is essential
- CSCs are resource-intensive
  - Personnel (neurology, neurosurgery, vascular surgery) and
  - Equipment (neurocritical care units, MRI, angiography suite)
  - Requires a minimum volume of cases for JC
- Actual number of CSCs is likely to be much less than 20 per state

(Mullen, Neurology. 2015;84:1–10)

South Carolina Stroke Systems of Care Act

- Ratified 6/08/2011
- Vetoed by the Governor 6/14/2011
- Veto overridden by Senate 6/21/2011
- Veto overridden by House 6/21/2011

SC Telestroke Alliance

Impact of Telestroke

96% of South Carolina residents live within an hour drive of expert stroke care
**Stroke Care in 2015**

- It is simple
  - It is a team sport
    - Do it fast
    - Do it safely
    - Do it as a team
  - For those who lead
    - Affable
    - Available
    - Able

**Impact of Telestroke**

- Detection: Early recognition
- Dispatch: Early EMS activation
- Delivery: Transport & management
- Door: ED triage
- Data: ED evaluation & management
- Decision: Neurology input, therapy selection
- Drug: Thrombolytic & future agents
- Disposition: Admission or transfer

**Dispatch: 911**
**Delivery: Transport & Management**
**Door: Triage**

- 911 dispatch
- EMS prehospital interventions
  - Neurologic evaluation / stroke recognition (CPSS, LAPSS, others?)
  - Time of onset
  - Glucose
  - Early hospital prenotification
  - Rapid transport (Air?)
  - Transport family
- **Triage** to the right center
LAMS – Can We Predict LVO?

- Like trauma and STEMI systems, triage based on specific patient characteristics
  - Severity, comorbidities, medications, etc.

<table>
<thead>
<tr>
<th>LAMS</th>
<th>Facial droop 0, 1</th>
<th>Arm drift 0, 1, 2</th>
<th>Grip strength 0, 1, 2</th>
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- LAMS ≥ 4
  - Sens 0.81
  - Spec 0.89
  - P/NLR 7.36 / 0.21

- NIHSS ≥ 11
  - Sens 0.91
  - Spec 0.87

(Naziel, Stroke. 2008;39:2264-2267)

Cincinnati Prehospital Stroke Severity Score for LVO

- CPSSS ≥ 2
  - AUC 0.89
  - Sens 92%
  - Spec 51%
  - PLV 3.3
  - NLV 0.15

(Katz, Stroke. 2015;46:online)

Rapid Arterial Occlusion Evaluation (RACE) Scale

- RACE comparable with NIHSS to predict LVO (c-statistic, 0.85; 95% CI, 0.81–0.89)
  - RACE > 4
    - Sens 85%, Spec 68%
    - PPV 0.42, NPV 0.94
  - Best overall accuracy for the NIHSS scale was achieved for a score of ≥11, with a sensitivity 0.88, specificity 0.72, and overall accuracy 0.76

(Kenez, Stroke. 2014;45:87-91)

EMS Triage

- Increasingly complex
  - Tiers of stroke care
  - Time windows
  - IV / IA potential
  - Stroke severity
  - Transport distances

Where To Treat Acute Strokes

- Perfect world
  - Fully equipped Neurologic Emergencies Department but at the risk of losing general ED engagement
- Optimal world
  - Dedicated stroke bed in general ED with comanagement by EM and stroke team
- Likely world
  - Shared critical care / resuscitation bed
  - Essential resources with stroke team driven care

Learn From Finland – Where There is a Will ...

- Funnel all to a well resourced institution
  - No PSC or CSC, all go to Helsinki University Hospital
  - 24/7 neurology presence in ED
  - Proximate CT
- Act on encode
  - EMS talks to neurologist
  - Clinical history from EMR
  - Premix tPA
  - Bolus while in CT

(Meretoja, Neurology. 2012;79:308-313)
Learn From Industry –
Toyota Value Stream Analysis

Maximize Resources, Predefined Roles, Parallel Processing

Target: Stroke - Strategies
- National QI to increase rates of DTN < 60 mins
  - 1030 GWTG-Stroke Hospitals
  - Pre 2003-2009 / Post 2010-2013
- Interventions
  - EMS prehospital notification
  - Stroke tools and tool kits
  - Rapid triage protocol and stroke team notification
  - Single call activation system
  - Direct transfer to CT scanner
  - Rapid CT and interpretation

Target: Stroke
- Prehospital notification
- Mix rtPA ahead of time
- Rapid access & rtPA initiation
- Team-based approach
- Prompt data feedback

Target: Stroke Part 2
- The success of Target Stroke has fostered Target Stroke Part 2
  - Increasingly data driven (GWTG)
  - Move the needle for IV rtPA
    - Reset the thermostat: Faster DTN
    - ASRH elements
    - More systems of care
    - EMS measures
    - Incorporate EVT into processes
    - Other forms of stroke

Future Stroke Dashboards
- Measure
  - Demographics / Volume
  - Certification
  - tPA ischemic stroke admissions
  - EVT ischemic stroke admissions
  - tPA intracerebral hemorrhage admissions
  - EVT intracerebral hemorrhage admissions
  - 90 day modified Rankin Score (median, mean)

(Ford, Stroke. 2012;43:3395-8)
Optimizing Processes for EVT

Time is Brain: EVT

What Are Other Patient-Centered Outcomes of These Systems?

Monitoring Stroke Center Quality

In-Patient Stroke
Future Stroke Dashboards

<table>
<thead>
<tr>
<th>Measure</th>
<th>Hospital A</th>
<th>Hospital B</th>
<th>Hospital C</th>
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<tbody>
<tr>
<td>Demographics</td>
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<td>CY ischemic stroke admissions</td>
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<td>CY intracerebral hemorrhage admissions</td>
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<td>CY subarachnoid hemorrhage admissions</td>
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<td>CY rtPA administration (#)</td>
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<td>CY EVT administration (#)</td>
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<tr>
<td>CY SAH aneurysms coilings (#)</td>
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Performance Measures

- DTN (mins – median, mean)
- DTG (min – median, mean)

Outcomes

- sICH rate (PH1, PH2) (%)
- 90 day modified Rankin Score (median, mean)

Other Considerations: Why EM is Your Friend

- Comorbidity management
  - CHF
  - AMI
  - Aortic dissection
- Complication management
  - Angioedema
  - Respiratory compromise
  - Bleeding / hypotension
  - Malignant cerebral edema
- No inpatient beds

Disposition: Early Stroke Care

- Begin Acute Stroke Pathway
- ICU / Stroke Unit admission now
  - 24 hrs for tPA
  - Q 15' x 6 hours, Q 1 hour
- Facilitate medical or surgical measures to improve outcome after stroke
- Optimize blood pressure, glucose, temp
- Begin to prevent subacute complications
- Plan for long-term therapies to prevent recurrent stroke
- Start efforts to restore neurological function

(Summers, Stroke. 2011)
(Jauch, Stroke. 2013)

Know How and Where to Transfer

- Blood pressure & bleeding precautions
- Angioedema
- Follow the neuro exam
- Ensure communication en route
- Know where to go when you get there
- Like EMS, provide feedback

The Future of Stroke

- Stroke is a team sport
  - No longer a chain
  - A cable of woven elements
- Integrated systems and teams including less resourced areas
- Multifaceted treatment approaches
- Patient-centric goals
SC Heart & Stroke Care Alliance

- 2016 Stroke Goals
  - Complete hospital survey of stroke capabilities
  - Introduce prehospital stroke severity score
    - Develop comprehensive prehospital provider educational materials
  - Investigate availability of data sets for benchmarking
    - GWTG:Stroke, NEMSIS, ORS
  - Prepare for Mission Lifeline: Stroke
  - Begin regional stroke systems of care