Large Vessel Occlusion Stroke From Dispatch To Discharge

How Integrated Systems of Care Lead to Better Patient Outcomes

IOMS 2023 Winter Scientific Seminar

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Outline

- Stroke Basics
- Pre-Hospital Stroke Triage
- Current Management of Emergent Large Vessel Occlusion Stroke
- Stroke Rehabilitation

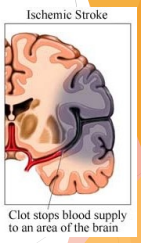
Stroke in the United States

#5 cause of death among adults in the U.S. and **#1 cause of disability**
About **795,000** Americans each year suffer a stroke each year
Every **40 seconds** someone has a stroke
On average, **every 4 minutes** someone dies of stroke
Kills **140,000** people a year – about **one of every 20 deaths**
80% can be **prevented**
Estimated costs to the U.S. Healthcare System: **$34 billion**

- Source: Centers For Disease Control https://www.cdc.gov/stroke/facts.htm

Large Vessel Occlusion (LVO):

A blood clot lodges in a brain artery and puts the brain beyond the blockage at risk of death from lack of oxygen and nutrients.

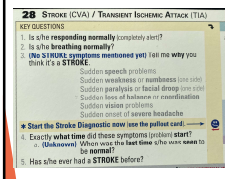


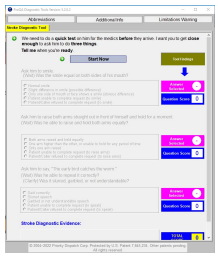
- **Common:** ~40% of ischemic strokes
- **Severe:** LVO strokes are responsible for 9 out of 10 deaths caused by ischemic stroke;
  - 5x higher mortality, 3-fold reduction in good outcome
- **Respond poorly to intravenous thrombolytic (tPA)**
  - Successful Opening of Occlusion by Intravenous tPA:
    Middle Cerebral Artery: 35%
    Carotid Terminus: Less than 10%

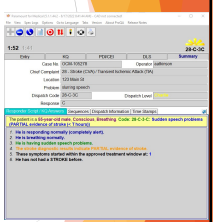
Goals of a Stroke "System of Care"

- 65 year old male
- Medical history: HTN (amlodipine), paroxysmal atrial fibrillation (on xarelto - been held for last 5 days for cataract surgery)
- 4pm on a Tuesday: acute onset of aphasia, left gaze deviation, right sided hemiparesis
- Family immediately notices change, calls 911, EMS arrives at 4:15p

EMS Stroke Dispatch







Initial EMS Management

- ABC's
  - Administer supplemental O2
- Check blood glucose
- Screen for stroke

Pre-Hospital Stroke Screening Tests

BEFAST

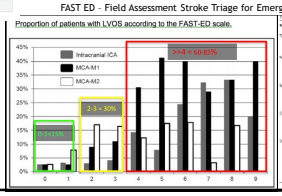
		ASSESS	ABNORMAL (ACUTE)
B	BALANCE	If able have patient walk and perform finger-to-nose	**Trouble walking** or Loss of balance, dizziness
E	EYES	Assess gaze and eye motion	**Fixed gaze deviation** or blurred, loss, or double vision
F	FACE	Assess smile symmetry	**Weakness** or numbness
A	ARM	Palms up, arms out, assess ability to hold position	**Weakness** or numbness on one side of he body
S	SPEECH	Have patient repeat a phrase and name common items	Difficulty speaking or comprehension
T	TIME	Establish last known well time	**< 24 hours** since symptom onset

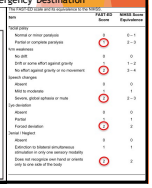
RACE - Rapid Arterial Occlusion Evaluation Scale for Stroke

FORMULA	RACE Score	Sensitivity	Specificity
	≤1	100%	13%
	≥2	97%	27%
	≥3	93%	40%
	≥4	89%	55%
	≥5	85%	68%
	≥6	72%	77%
	≥7	53%	89%
	≥8	32%	95%
	9	7%	99%

FAST ED - Field Assessment Stroke Triage for Emergency Destination

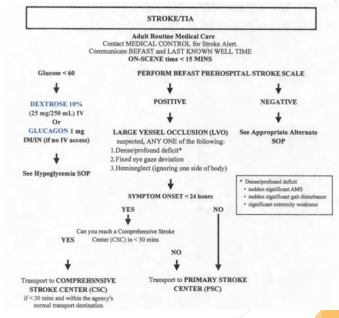
Proportion of patients with LVOS according to the FAST-ED scale.





Item	FAST-ED Score	NIHSS Score Equivalence
Facial palsy		
Normal or minor paralysis	0	0 – 1
Partial or complete paralysis	1	2 – 3
Arm weakness		
No drift	0	0
Drift or some effort against gravity	1	1 – 2
No effort against gravity or no movement	2	3 – 4
Speech changes		
Absent	0	0
Mild to moderate	1	1
Severe, global aphasia or mute	2	2 – 3
Eye deviation		
Absent	0	0
Partial	1	1
Forced deviation	2	2
Hemi / Neglect		
Absent	0	0
Extinction to bilateral simultaneous stimulation in only one sensory modality	1	1
Does not recognize own hand or orients only to one side of the body	2	2

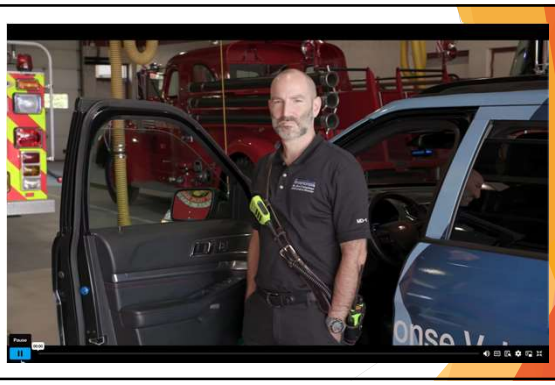
Next stop…



Primary versus Comprehensive Stroke Center?

Stroke Certification Programs – Program Concept Comparison

Program Concept	ASRH	PSC	CSC
Program Medical Director	Sufficient knowledge of cerebrovascular disease	Sufficient knowledge of cerebrovascular disease	Has extensive expertise, available 24/7; 8 hours of stroke education annually
Acute Stroke Team	Available 24/7, at bedside within 15 minutes; at least 4 hours of stroke education annually	Available 24/7, at bedside within 15 minutes; at least 8 hours of stroke education annually	Available 24/7, at bedside within 15 minutes; at least 8 hours of stroke education annually
Emergency Medical Services Collaboration	Access to protocols used by EMS	Access to protocols used by EMS	Access to protocols used by EMS, routing plans; records from transfer
Stroke Unit	No designated beds for acute care of stroke patients	Stroke unit or designated beds for the acute care of stroke patients	Dedicated neuro intensive care beds for complex stroke patients; stroke unit
Initial Assessment of Patient	Emergency Department physician; nurse practitioner, or physician assistant	Emergency Department physician	Emergency Department physician
Diagnostic Testing Capability	CT, MRI, labs 24/7	CT, MRI, labs, CTA, MRA, cardiac imaging 24/7	CT, MRI, labs, CTA, MRA, cardiac imaging, other cranial and carotid duplex ultrasound, TEE, TTE, vascular labs 24/7
Neurologist Accessibility	24/7 via in person or telemedicine	24/7 via in person or telemedicine	Meets concurrently emergent needs of multiple complex stroke patients; Written call schedule for attending physicians providing availability 24/7
Neurosurgical Services	Within 3 hours (provided through transferring the patient)	Within 2 hours; OR is available 24/7 in PSCs providing neurosurgical services	Neurosurgeon, Interventional Neuroradiologist, Neurologist; Neurosurgeon available 24/7
Telemedicine	Within 15 minutes of it being necessary	Available 24/7	Available 24/7
Treatment Capabilities	IV thrombolytics; May have the ability to perform MT; Anticipate transfer of patients who have received IV thrombolytics	IV thrombolytics; May have the ability to perform MT; Intracranial hemorrhage, ruptured aneurysms, Stenting of carotid arteries, Carotid endarterectomy, and Endovascular therapy	IV thrombolytics; Microsurgical neurovascular procedures; Intracranial hemorrhage, ruptured aneurysms; Stenting of extracranial carotid arteries, Carotid endarterectomy, Endovascular therapy
Transfer protocols	With one PSC or CSC	For neurosurgical emergencies	Receiving transfers and cooperatives for not accepting transferred patients
Staff Education Requirements	ED staff – a minimum of twice a year	ED staff – a minimum of twice a year	Nurses and other ED staff: 2 hours annually; Stroke nurses : 8 hours annually
Provision of Educational Opportunities	Provides educational opportunities to prehospital personnel	Provides educational opportunities to prehospital personnel; Provides at least 2 stroke education activities per year to public	Provides educational opportunities; 1 educational opportunities annually; 1/Yr and staff present 2 or more educational courses annually for internal staff or individuals referred to the comprehensive stroke center (e.g., referring hospitals)
Clinical Performance Measures	Non-Standardized Measures: Organization chooses 4 measures, at least 2 are clinical measures related to clinical practice guidelines	Standardized Measures: 8 core stroke measures	Standardized Measures: 8 core stroke measures and 8 comprehensive stroke measures for a total of 16
Research	N/A	N/A	Participates in patient-centered research that is approved by the IRB
Guidelines	Recommendations from Brain Attack Coalition for Acute Stroke Ready Hospitals, 2013	Recommendations from Brain Attack Coalition for Primary Stroke Centers, 2011	Recommendations from Brain Attack Coalition for Comprehensive Stroke Centers, 2005
Review	One Reviewer, One Day	One Reviewer, One Day	Two Reviewers, Two Days



LVO Patient Transfer Protocols

Drip and Ship Transfer Protocol

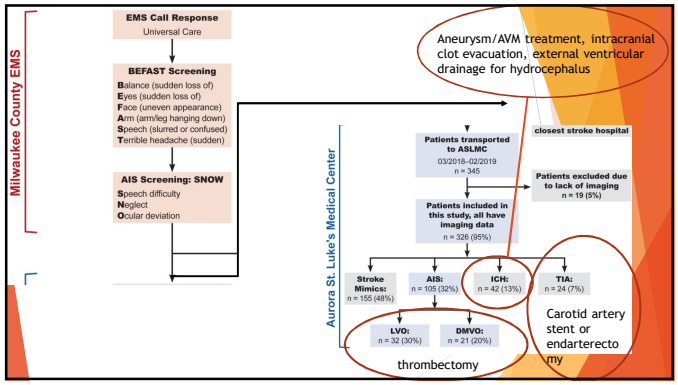
- tPA/TNK candidate patients (with concern for LVO) transferred to nearest PSC
- Assessed for LVO
- tPA/TNK given if indicated
- Patient transferred to CSC if candidate for manual thrombectomy

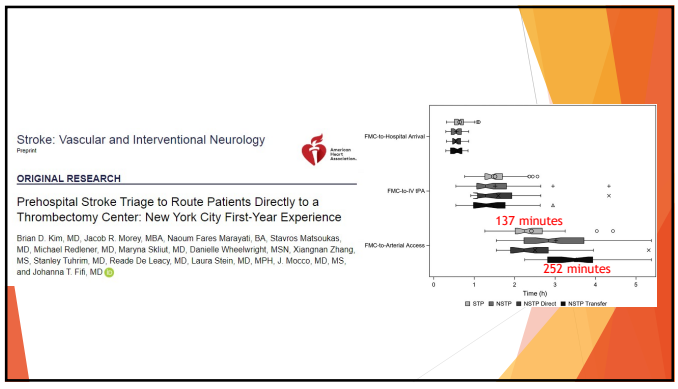
Mothership Transfer Protocol

- tPA/TNK candidate (with concern for LVO) patients skip the nearest PSC and go straight to CSC
- Assessed for LVO
- tPA/TNK given if indicated and patient brought to NIR suite for manual thrombectomy

Which transfer protocol is better?

- Analysis of the STRATIS Registry suggests that patients who underwent interhospital transfer prior to MT (Froehler, Circulation, 2017)
  - Less likely to have excellent outcome (38% versus 47%)
  - Less likely to achieve functional independence (52% versus 60%)
- *ASA/AHA Mission: Lifeline Stroke* expert consensus - EMS should bypass PSC to go to a CSC if additional travel time is less than 15 minutes
- Mathematical Modelling
  - "patients with acute ischemic stroke with suspected large vessel occlusion should be redirected to a CSC if the additional delay to IVT is <30 minutes in urban and 50 minutes in rural settings" (Nolte, Stroke, 2020)
  - "mothership was favored with an additional transport time to the comprehensive stroke center of <32 to 99 minutes for patients screened positive for an LVO and <28 to 39 minutes in the absence of screening (Xu, Stroke, 2019)





Calling Ahead: Pre-Hospital Notification

- EMS pre-notification protocols can decrease time to brain imaging and time to brain imaging interpretation in patients who are bought to the hospital by EMS (Patel, Stroke, 2011)
- Prenotification increases the likelihood of TPA administration (McKinney, Journal of Stroke and Cerebrovascular Disease, 2013)
- Door-to-needle times can be significantly reduced with pre-hospital notification (Kim, European Journal of Neurology, 2009)

Further Avenues of Pre-Hospital Stroke Care

- Mobile Stroke Units
- Better assessment of LVO Status
- Neuroprotection

Case Example:

- 65 year old male with atrial fibrillation who has been holding coumadin
- Acute onset of right sided arm and leg weakness, aphasia, fixed left gaze deviation (NIHSS 18) at 4:00pm
- 911 called, EMS arrives at 4:15pm and patient is noted to be positive for **BEFAST** and **LVO screen**. **PSC bypass initiated** and patient presents to Evanston Hospital at 4:40pm

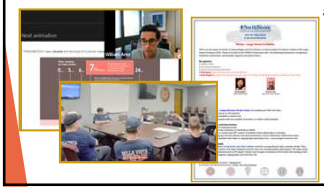
Community Oriented Stroke Care: EMS Education and Feedback Outreach

Education

- Provide yearly CME to our EMS/FD colleagues in all aspects of stroke and cerebrovascular care

Feedback

- For every patient that is dropped off by EMS who undergoes thrombectomy, we provide a short term update on their treatment and outcome



Acute Management of Large Vessel Occlusion Stroke

- IV TPA/TNK if last known well within 4.5 hours and no evidence of hemorrhage on non-contrast head CT
- Thrombectomy if last known well within 24 hours

TPA/TNK, Mechanical Thrombectomy, and LVO

TPA/TNK

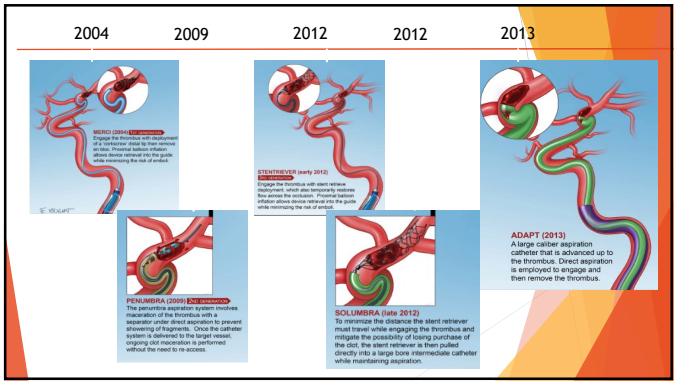
- 4.5 hour time window
- Contraindicated with: recent surgery, anticoagulation use, history of ICH
- Reperfusion efficacy:
  - 0% effective at ICA terminus occlusions
  - 33% effective at M1 occlusion

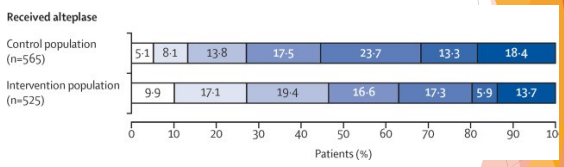
Christou, I., Burgin, W. S., Alexandrov, A. V., & Grotta, J. C. (2001). Arterial status after intravenous TPA therapy for ischaemic storke. A need for further interventions. *International angiology*, *20*(3), 208.

Thrombectomy

- 24 hour time window
- Contraindications: no absolute
- Reperfusion efficacy:
  - 71% successful revascularization (combined ICA and M1)

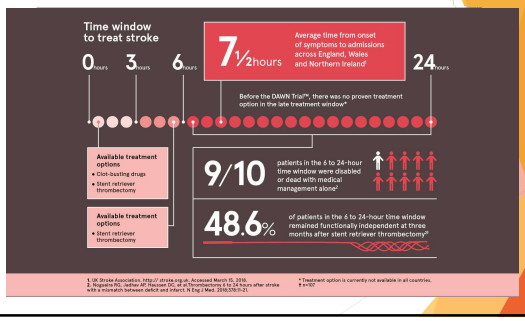
Goyal, Mayank, et al. "Endovascular thrombectomy after large-vessel ischaemic stroke: a meta-analysis of individual patient data from five randomised trials." *The Lancet* 387.10029 (2016): 1723-1731.





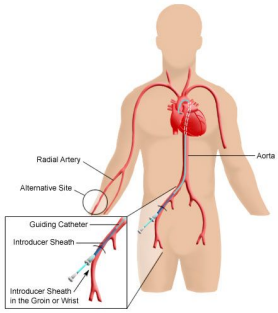
Favorable outcome (MRS 0-2) - 27% in TPA alone, 46.4% in TPA plus thrombectomy

THROMBECTOMY nearly **doubles** the likelihood of functional independence after a large vessel occlusion stroke (46% versus 26%)

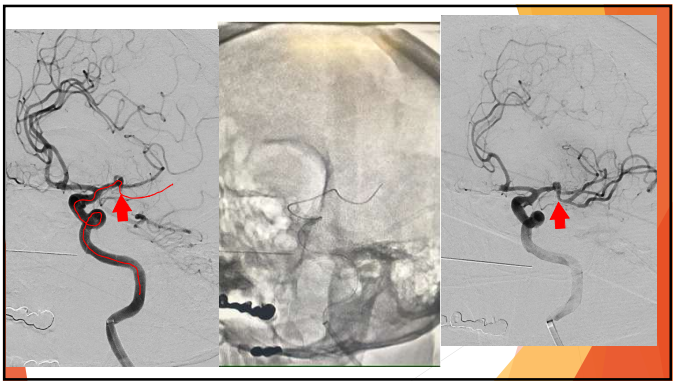


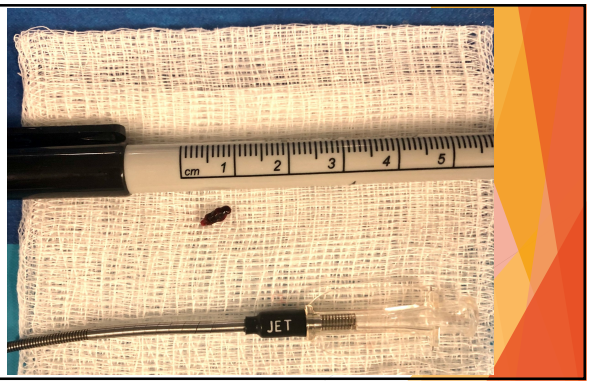
Case Example:

- Patient evaluated in emergency department and CT scan reveals left M1 occlusion
- TNK administered given last known well within 4.5 hours
- Patient in angiography suite at 5:00pm and procedure starts at 5:10pm

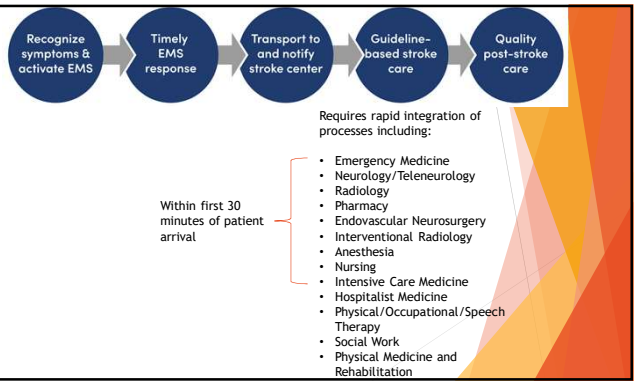


- Light sedation overseen by anesthesia team
- Femoral or radial artery access with large diameter catheter
- X-rays used to guide catheters into the appropriate carotid artery





- 5:19pm procedure complete and left MCA open
- 2 days post procedure: patient is wide awake, completely normal language function, walking around hospital without assistance and has mild right hand weakness (NIHSS 2) and is discharged to home



Stroke and Cerebrovascular Quality Improvement

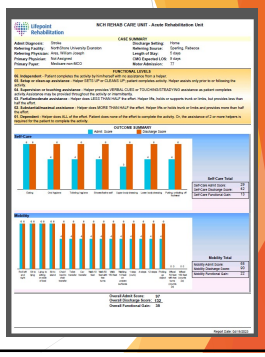
- In stroke care, time is brain
  - Goal door-to-TPA time is <45 minutes
  - Goal door to thrombectomy time is <90 minutes
- In our system, every TPA and thrombectomy case is reviewed to identify if target times are being hit, and if they aren't, what system related deficiencies can be fixed to improve outcomes

Stroke Rehabilitation

- More than 2/3 of patients who suffer a stroke receive rehabilitation services after hospitalization
- Goal of stroke rehab is to optimize functional recovery achieve independence
- Deficits following stroke can be:
  - Easily seen - hemiplegia, aphasia, dysarthria, dysphagia, cognitive difficulties
  - Not as easily seen - depression, central pain syndromes
- System integration across stroke rehab includes: PMR/physiatry, physical therapists, speech therapists, occupational therapists, psychiatry, psychology/neuropsychology, DME/orthotic experts, interventional pain doctors
- Traditional "therapy" is just the beginning of options for patients:
  - Virtual reality stroke rehab
  - Vagal nerve stimulation / deep brain stimulation for stroke rehab
  - Hyperbaric O2 treatment
- Don't forget management of secondary stroke risk factors and future stroke prevention!

Communication is KEY!

- Real time, objective communication between rehab team and medical team can help optimize the management of post-stroke patients
- Both integration of EMR as well as active updates during rehabilitation care keep treating teams appraised if progress.



How can we continue to improve outcomes?

- **Identification - first responders and are the key**
  - Maintain high suspicion for stroke
  - Thorough training for new recruits in BEFAST and LVO identifiers
  - Stroke continuing education with EMS and community education of signs of stroke
- **Optimization - efficiently get patients to the appropriate care**
  - Utilize PSC bypass procedures for patients with high likelihood of needing higher level of stroke care at a CSC
- **Integration - have hospital processes in place to get patients the care they need as quickly and safely as possible**
  - Constant quality improvement is needed to ensure all moving parts are working in concert
- **Imagination**
  - New ideas for stroke recovery are always needed. How can we leverage relationships across the spectrum of specialists taking care of stroke patients to come up with new ways to optimize recovery?

NorthShore University HealthSystem

The Joint Commission

American Heart Association®
American Stroke Association®

CERTIFICATION
Meets standards for
Comprehensive Stroke Center

Thank you for your time and attention.