Stroke Systems of Care and Optimizing Acute Stroke Care for All Patients

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MUSC Health
COMPREHENSIVE STROKE CENTER

Disclosures

- Research support
  - NIH/NINDS — SC-CoAST / StrokeNet (hub); NETT (spoke)
  - Genentech — PRISMS Study Executive Committee
  - Ischemia Technologies — BASES Study
  - Covidien, Penumbra — POSITIVE Study Executive Committee
  - NoNo, Inc (Brain Canada) — FRONTIER Study (internal safety monitor)
  - ZZ Biotech (NIH) — RHAPSODY Trial (DSMB)
- Consultant
  - Pulse Therapeutics — Magnetic nanoparticles for stroke
- State and National Organizations
  - AHA/ASA committees and writing groups
  - Chair, SC Department of Health Stroke Oversight Committee
  - Joint Commission ASRH, PSC, and CSC Technical Advisory Panels

Objectives

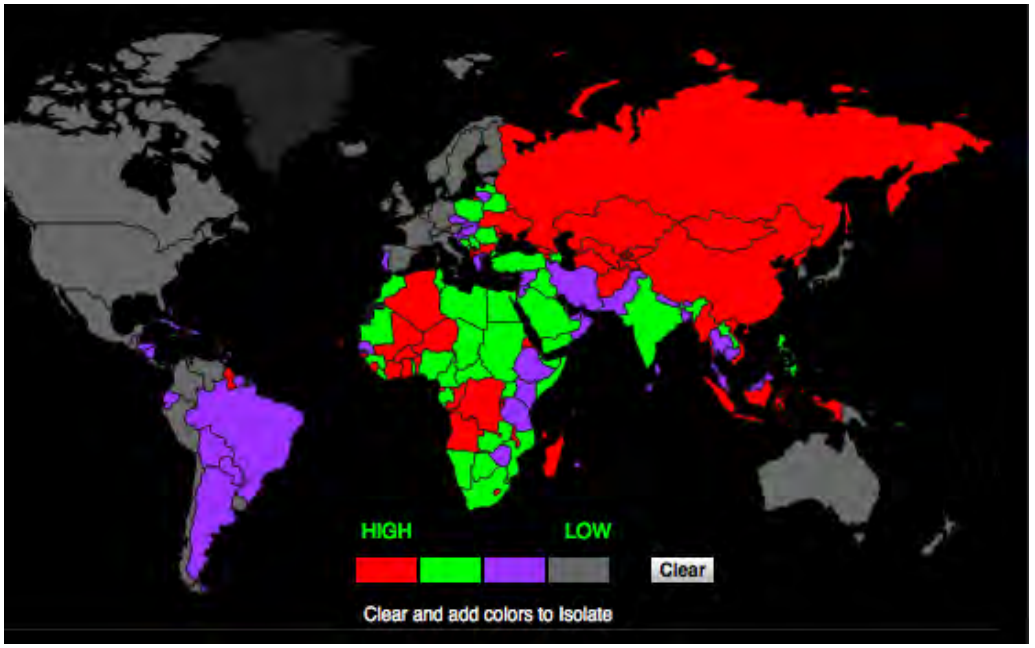
- Review and highlight current standard of care for stroke, especially new advances in large vessel occlusions
- Discuss creating regional stroke systems of care to optimize patient care
- Identify challenges and opportunities for addressing barriers to acute stroke care
- Discuss the near future of stroke care and how we will be measured

The Why: Global Stroke Mortality

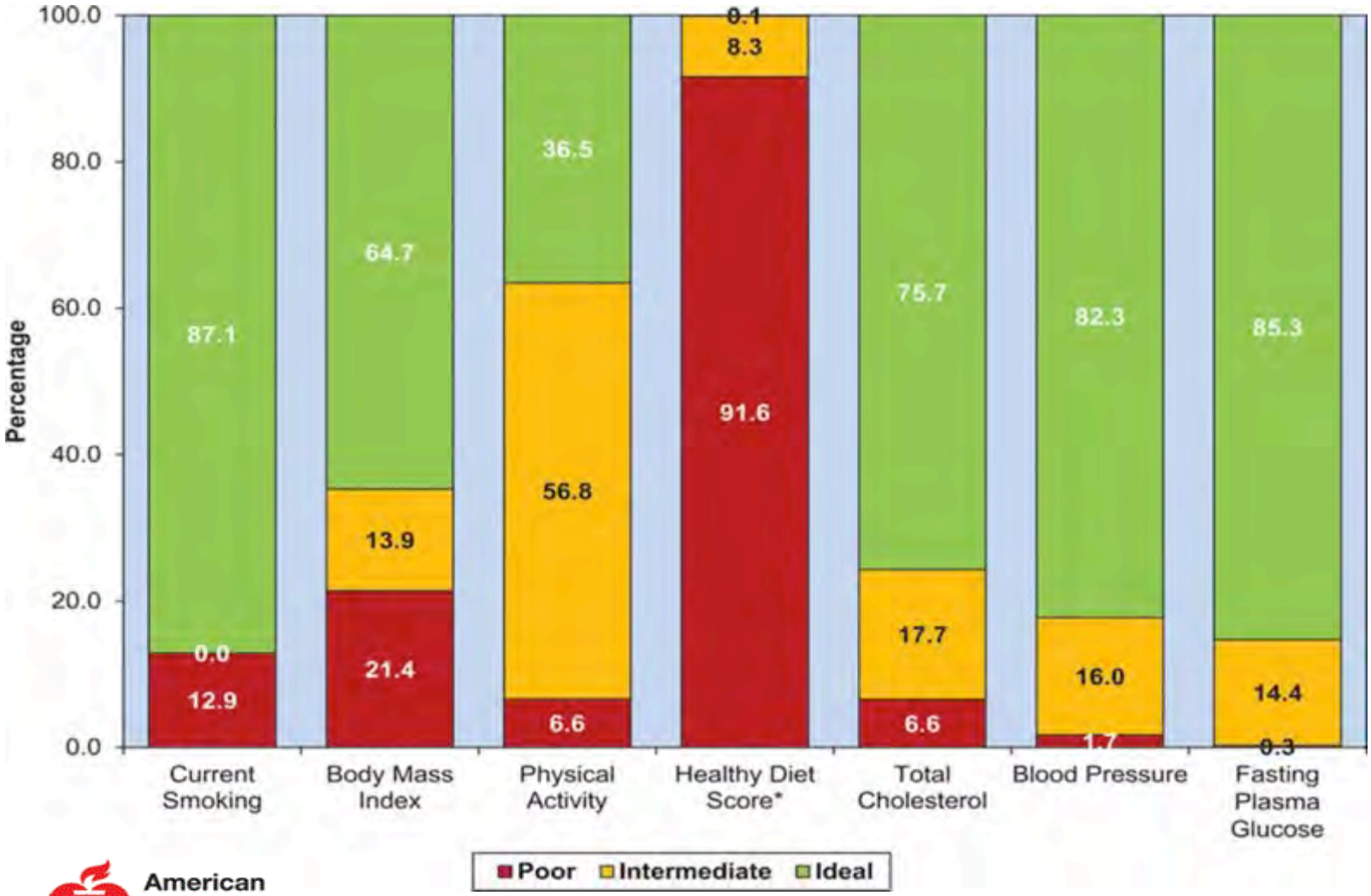
- Global burden

	Incidence	Mortality
US	250	25.94
SC		47.5
KSA	29.8*	126.77
Indonesia		200.2
Switzerland		21.2

Stroke Mortality



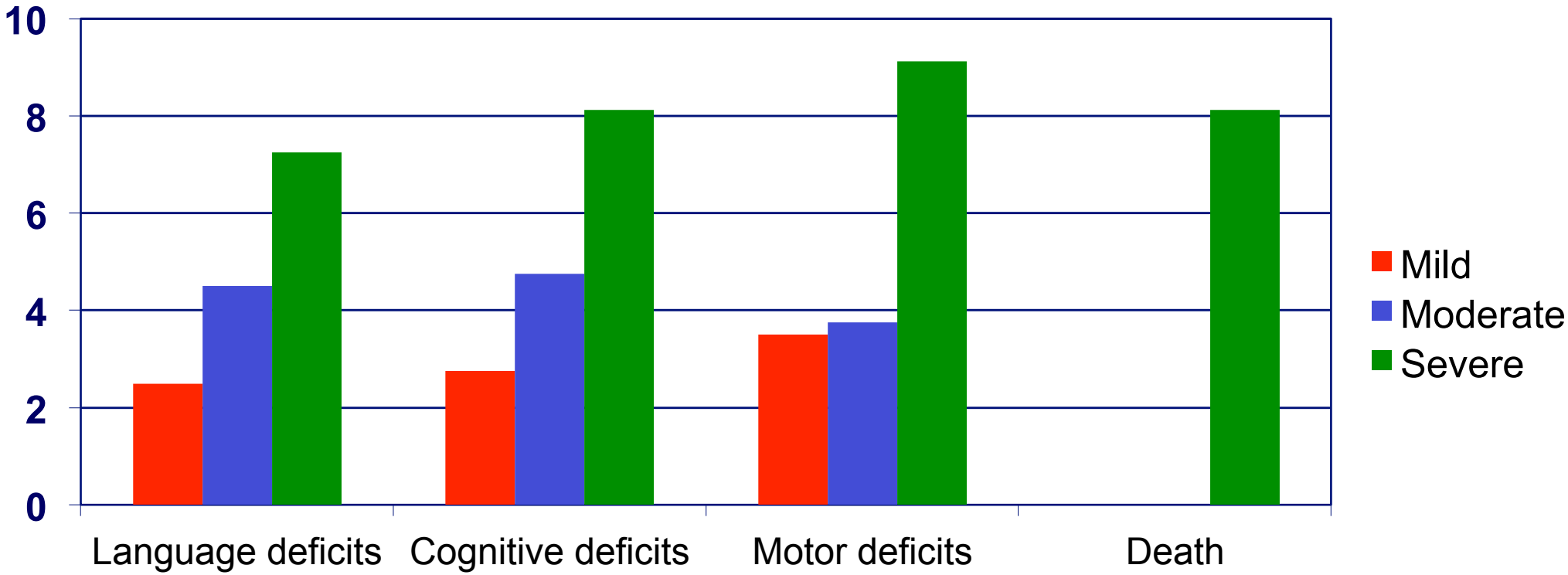
Prevalence (unadjusted) estimates for poor, intermediate, and ideal cardiovascular health for each of the 7 metrics of cardiovascular health in the American Heart Association 2020 goals, US children aged 12 to 19 years, National Health and Nutrition Examination Survey (NHANES) 2011 to 2012. *Healthy diet score data reflects 2009 to 2010 NHANES data.



American Heart Association

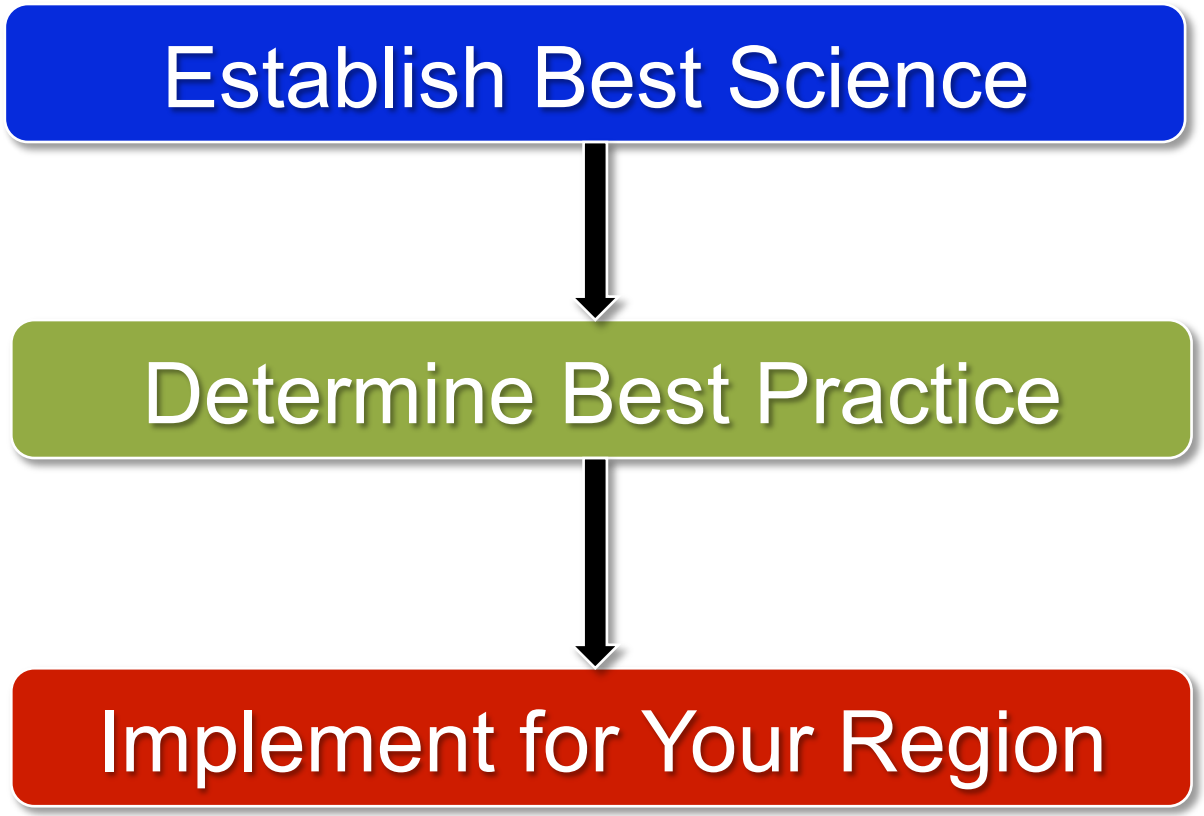
(Mozaffarian *Circulation*. 2015;131:e29-e322)

The Why:
Patient Aversion to Outcomes



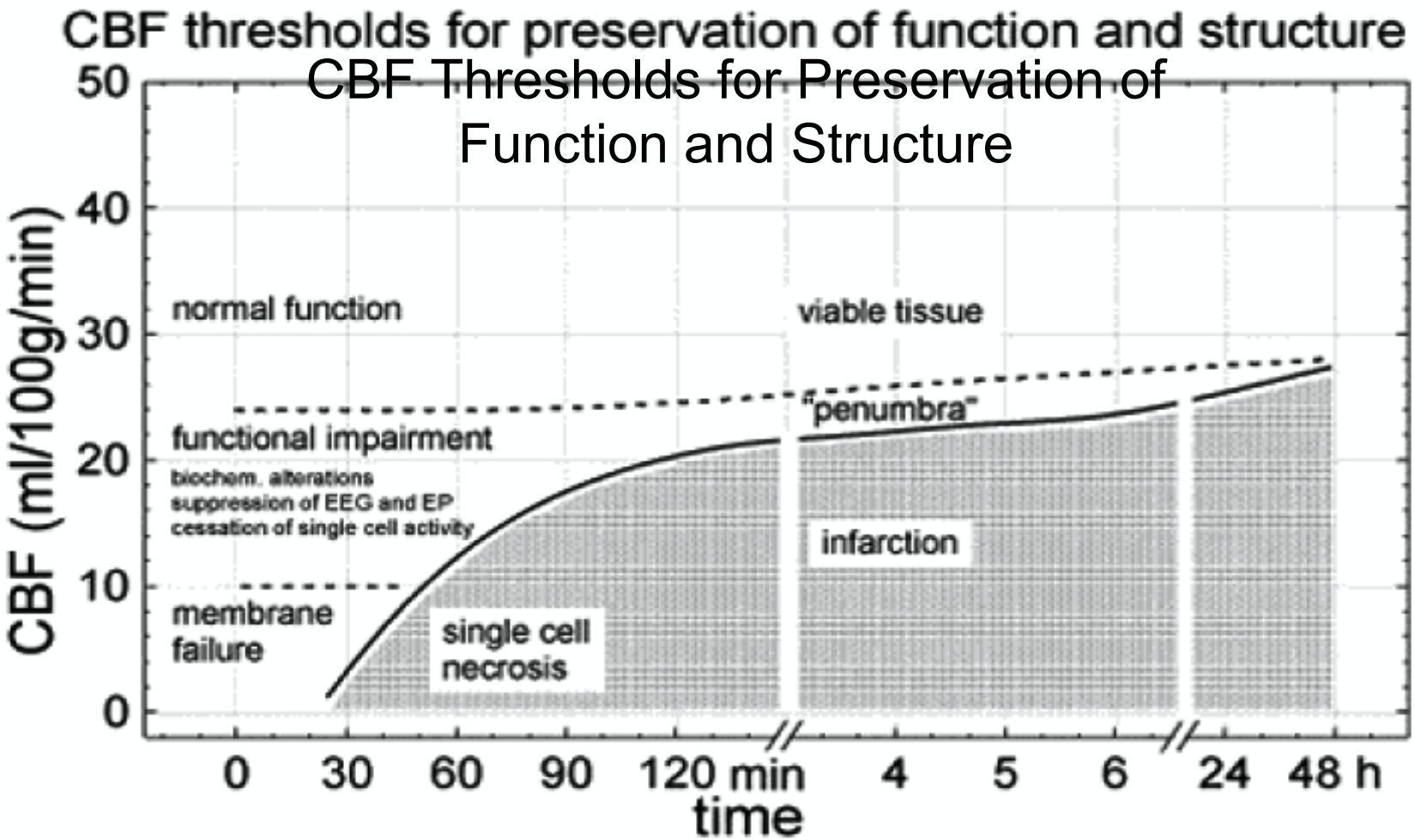
(Solomon, *Stroke*. 1994)

Science Translation: From Bench to Bedside



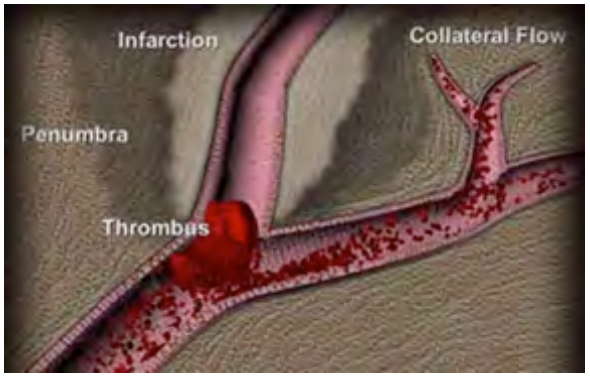
Establish Best Science

What Does this Mean in Stroke – What is Our Window?



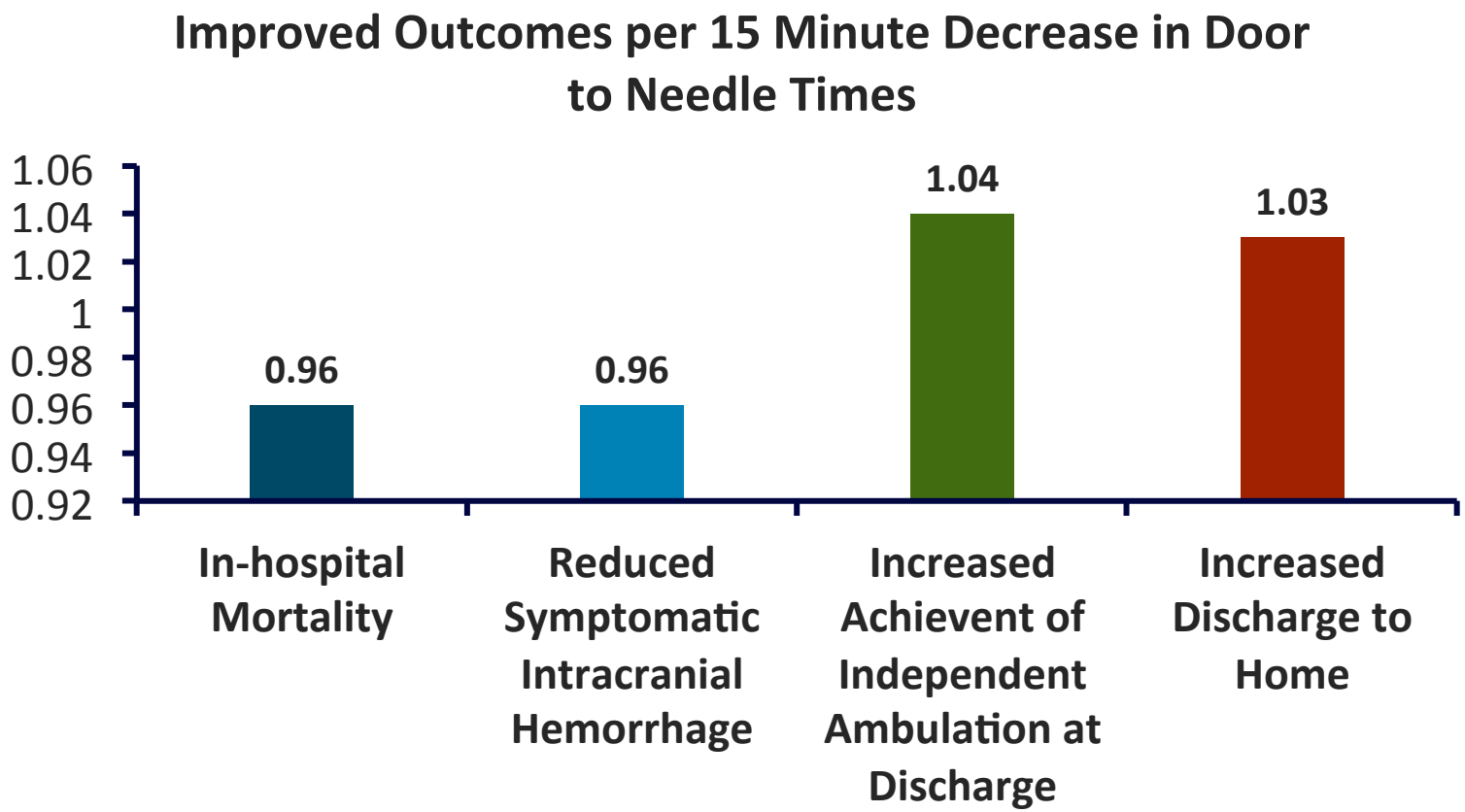
Lessons to Learned Over 20 Years

- Reperfusion critical
  - Minimize delay
  - Maximize penumbral salvageability
    - Collateral flow
    - Physiologic optimization



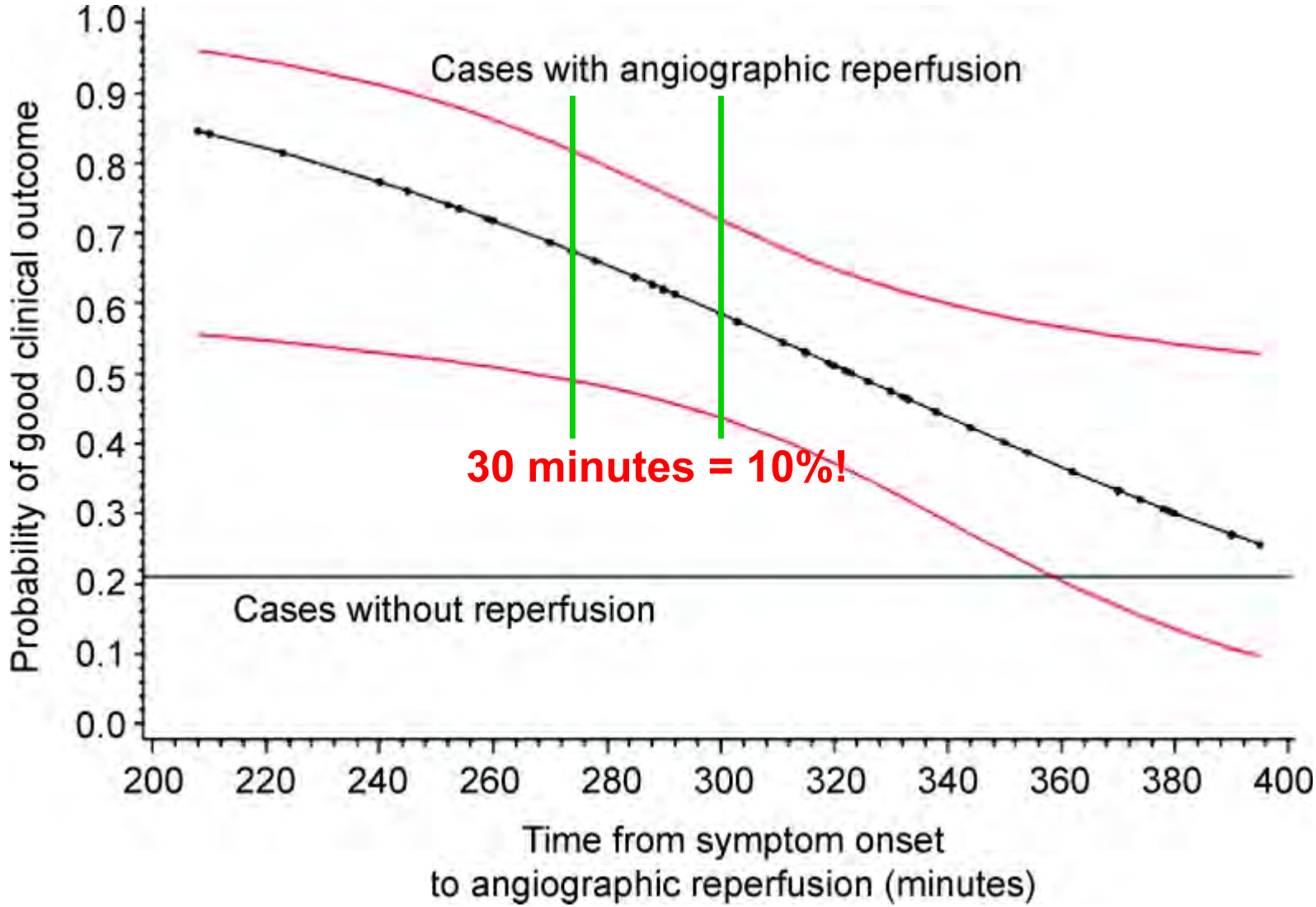
- Time to reperfusion
  - Predicts clinical outcomes
  - Significant tolerance-heterogeneity in populations
  - *Should* drive all system development

Importance of Reducing DTN



(Saver JL. *JAMA*. 2013;309:2480-2488)
(Hargis M. *Clin Neurol Neurosurg*. 2015;135:79-84)

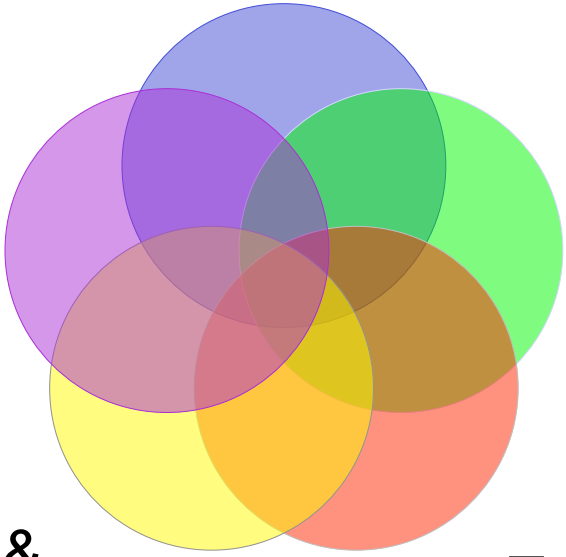
Time is Brain: EVT



Other Time Dependent Neurologic Emergencies Requiring Systems

Coma / Cardiac Arrest

Altered Mental Status

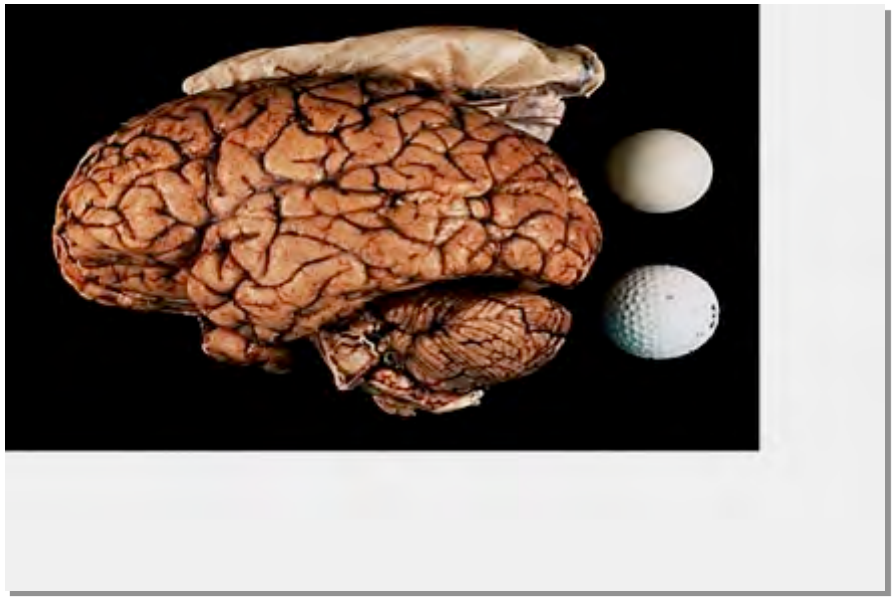


Stroke / TIA

Weak & Dizzy

Traumatic Brain Injury

Time is Brain: Intracerebral Hemorrhage



Ping-pong ball vs Golf ball
28.0 mL 40.8 ml

ICH (N=188)	**Overall mortality 44%**
0-29 cm^3	**Mortality 19%**
30-60 cm^3	**Mortality 20%-55%**
≥60 cm^3	**Mortality 91%**

Only 1 of 71 patients with ICH volume ≥30 cm^3 functioned independently at 30 days (Oxford Handicap Score ≤3)

(Broderick, *Stroke*. 1993;24:987-993)

Time is Brain:
Post Cardiac Arrest Cerebral Protection

Cool strategy saves runner

Therapeutic hypothermia used after 74-year-old collapses

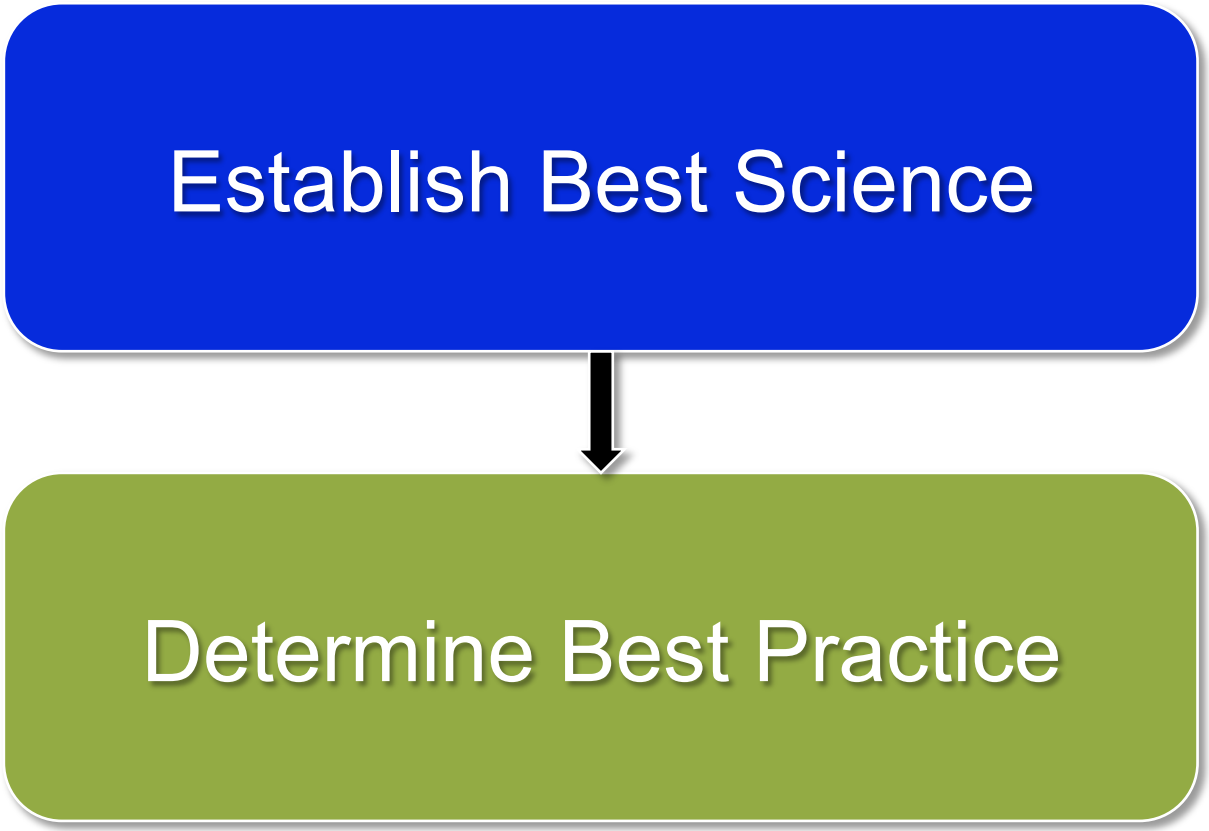
By **David Quick**
The Post and Courier
Tuesday, June 16, 2009

Herb Rawlings doesn't remember much about this year's Cooper River Bridge Run after he, his younger daughter and her husband split up at the base of bridge's incline.

But minutes later, nearing the crest, the 74-year-old Mount Pleasant man collapsed, suffering his second of two heart attacks in nearly nine years. Luckily, he was near emergency medical crews and received immediate treatment.

So, If Time Matters for the Brain

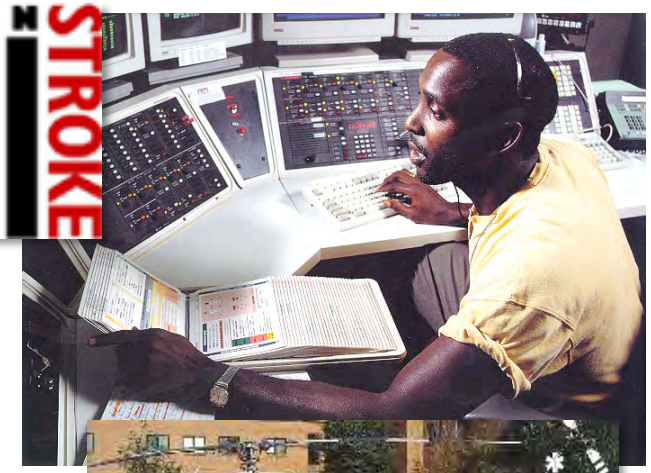
- Focus on what matters, *timely:*
  - Stroke recognition
  - EMS activation and transport
  - Initial reperfusion strategies
  - Initiation of secondary prevention strategies
  - Rehabilitation evaluation
  - Prevention of complications
  - Patient and family involvement


Establish Best Science
Determine Best Practice

Stroke Chain of Survival

- 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

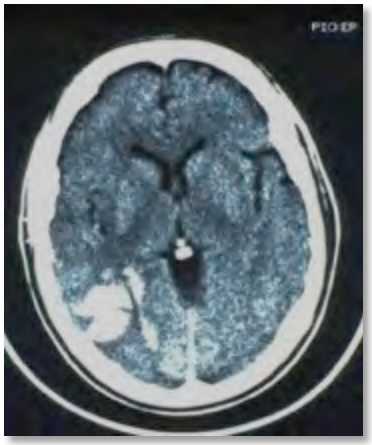
Dispatch: 911
Delivery: Transport & Management
Door: Triage



- 911 dispatch / EMD
- EMS prehospital interventions
  - Neurologic evaluation
  - Time of onset / LKN
  - Glucose
  - Early prehospital notification
  - Means of transport (air medical?)
  - Transport family
- Triage to the *appropriate* stroke center

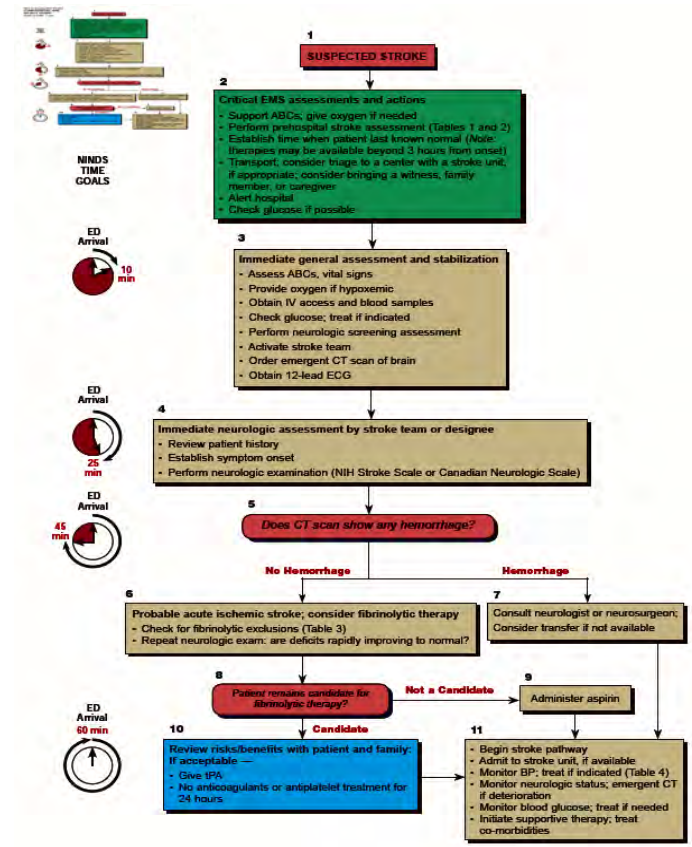
(Silliman *Stroke*. 2003;34:729 –733)

Door: Emergent Triage
Data: Emergent Evaluation



NINDS Recommendations and ACLS Guidelines

- Door-to-MD: 10 minutes
- Door-to-Stroke Team notification: 15 minutes
- Door-to-CT scan: 25 minutes
- Door-to-Drug: 60 minutes (80% compliance)
- Door-to-Admission: 3 hours



(Jauch, ACLS Stroke 2010)
(European Stroke Initiative Executive Committee, *Cerebrovasc Dis* 2003;16:311–337)
(NINDS National Symposium on Acute Stroke, 2003)

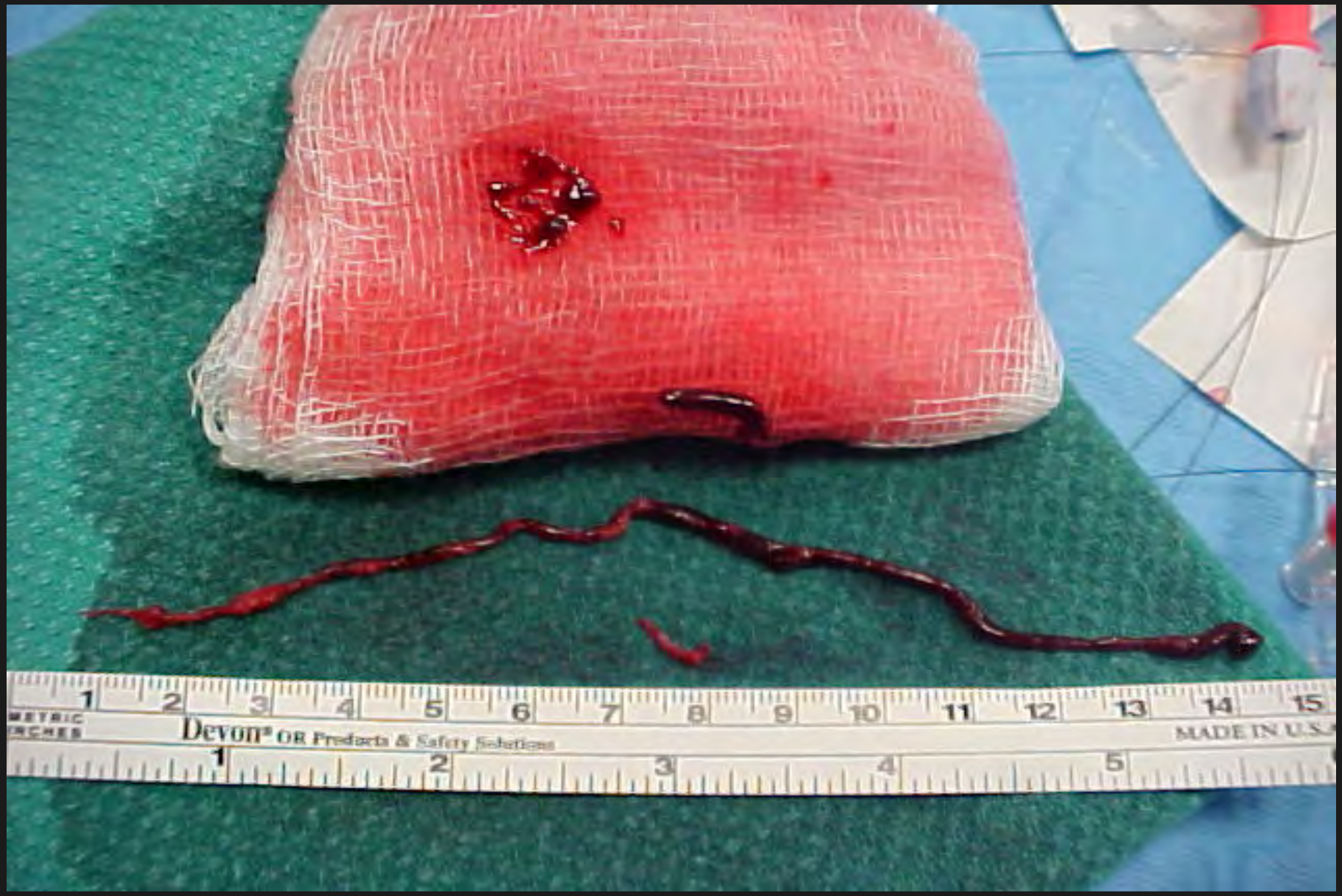
Decision: Team Approach

Drug: IV, IA, Mechanical, Other

Recanalization Strategies

- FDA cleared interventions:
  - IV tPA (0-3 hours) Approved 1996
  - IV tPA (3-4.5 hours) Denied request 2012
  - Thrombectomy devices Cleared for clot removal
  - Second generation EVT New guidelines for 2015

Time Window	0-3 hrs	3-4.5 hrs	4.5-6 hrs	> 6 hrs
Options	• IV tPA • Device	• IV tPA • Device	• Device	• Device? • Penumbra-based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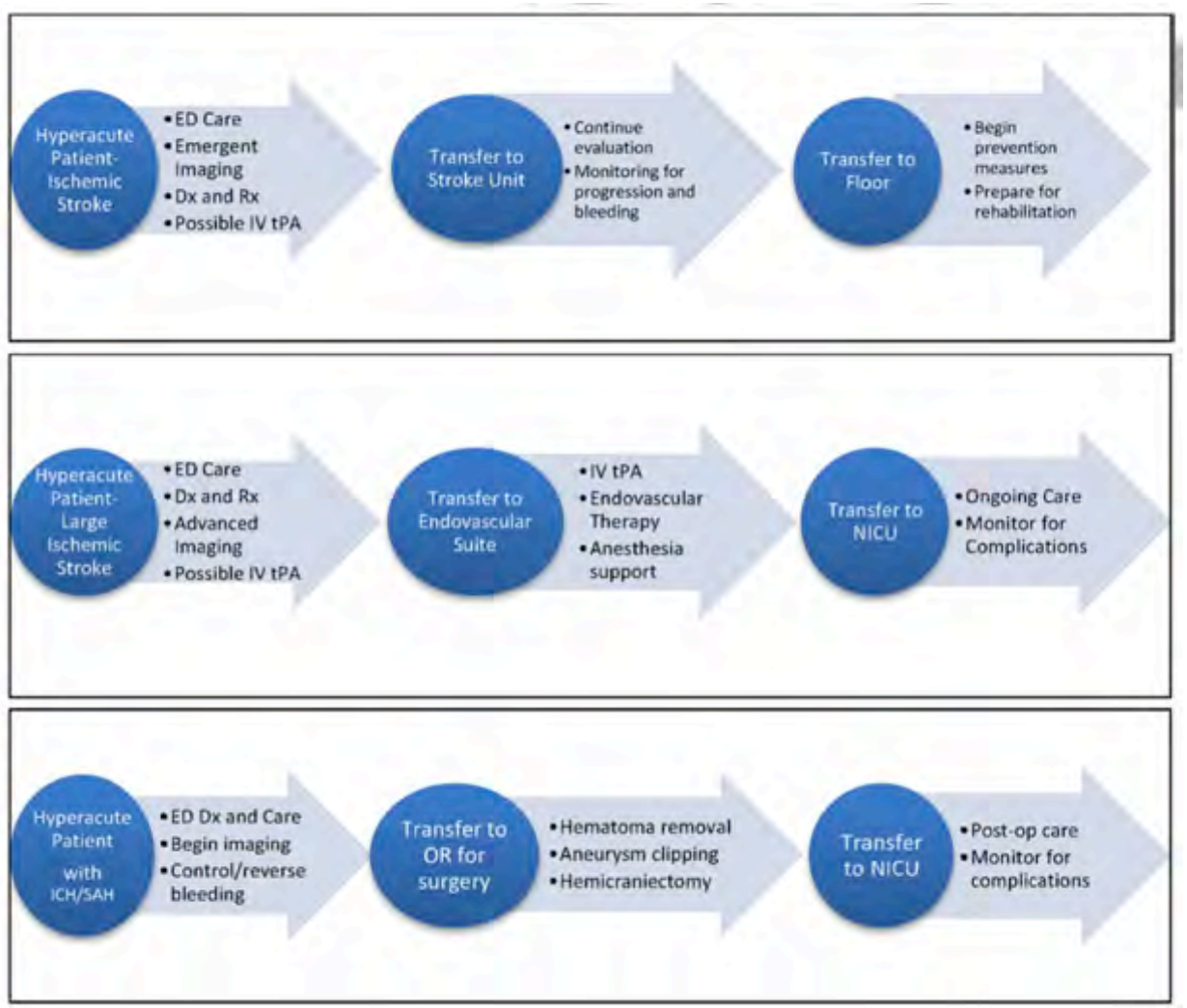
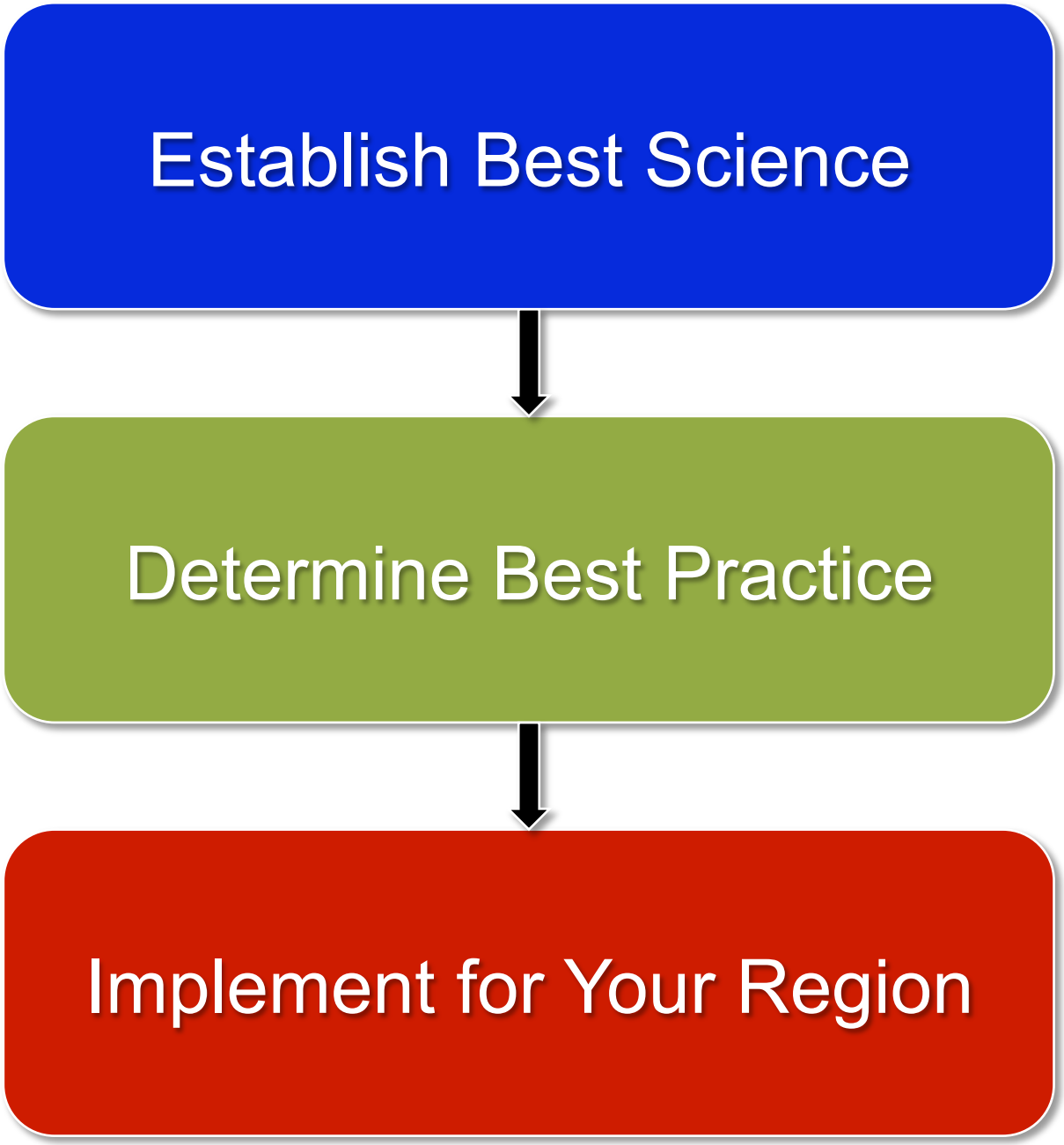
Disposition (Care Transition)



Other Considerations:
Why EM is Neurology's Friend

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


Establish Best Science
Determine Best Practice
Implement for Your Region

Stroke Care in 2016

- It is simple
  - Build a system
    - All stakeholders
  - Do it fast
  - Do it safely
  - Do it as a team
    - Regional system, EMS, in hospital

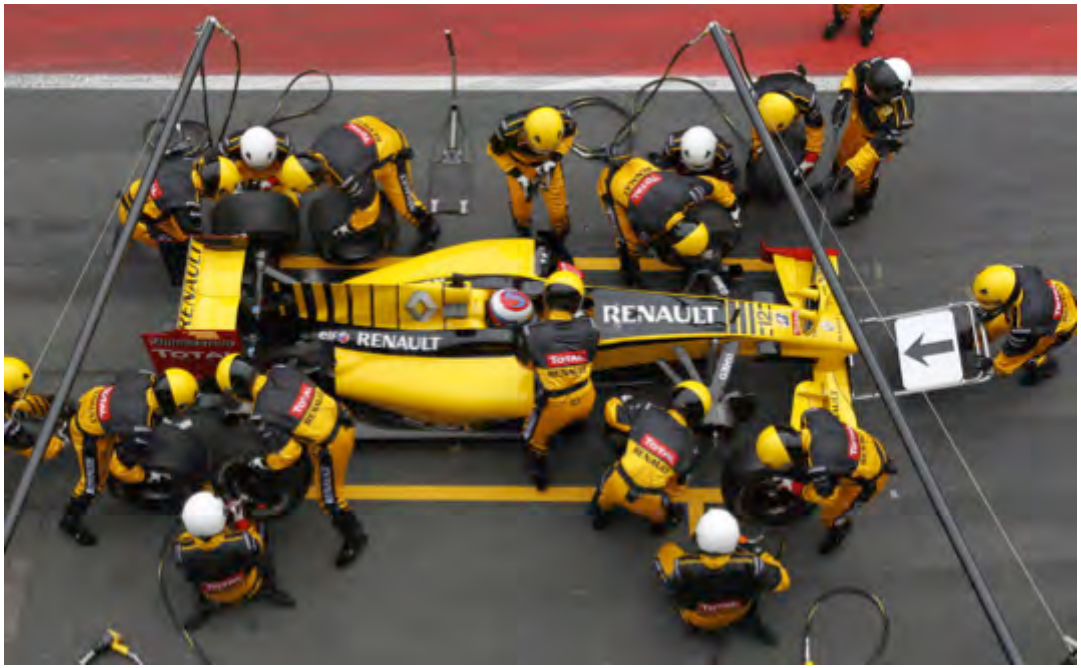


Table 4 The "big five" of teamwork[38]

Teamwork competencies	Definition	Behavioural examples
Team leadership[25 50 51]	Ability to direct and coordinate the activities of other team members, assess team performance, assign tasks, develop team KSA's, motivate team members, plan and organise, and establish a positive atmosphere.	Facilitate team problem solving Provide performance expectations and acceptable interaction patterns Synchronise and combine individual team member contributions Seek and evaluate information that impacts team functioning Clarify team member roles Engage in preparatory meetings and feedback sessions with the team
Mutual performance monitoring[6]	Ability to develop common understandings of the team environment and apply appropriate task strategies in order to accurately monitor team mate performance.	Identifying mistakes and lapses in other team members actions Providing feedback regarding team member actions in order to facilitate self correction
Backup behaviour[6 52]	Ability to anticipate other team members' needs through accurate knowledge about their responsibilities. Includes the ability to shift workload among members to achieve balance during high periods of workload or pressure.	Recognition by potential back up providers that there is a workload distribution problem in their team Shifting of work responsibilities to underutilised team members Completion of the whole task or parts of tasks by other team members
Adaptability/flexibility[50 53]	Ability to adjust strategies based on information gathered from the environment through the use of compensatory behaviour and reallocation of intrateam resources; altering a course of action or team repertoire in response to changing conditions (internal or external).	Identify cues that a change has occurred, assign meaning to that change, and develop a new plan to deal with the changes Identify opportunities for improvement and innovation for habitual or routine practices Remain vigilant to changes in the internal and external environment of the team
Team/collective orientation[54]	Propensity to take others' behaviour into account during group interaction and the belief in the importance of team goal's over individual member's goals.	Taking into account alternative solutions provided by team mates and appraising that input to determine what is most correct Increased task involvement, information sharing, strategising, and participatory goal setting

(Burke, Qual Saf Health Care 2004;13(Suppl 1):i96–i104)

Create an *Expert Team*

Hospital Stroke Capabilities

You will work in one of these

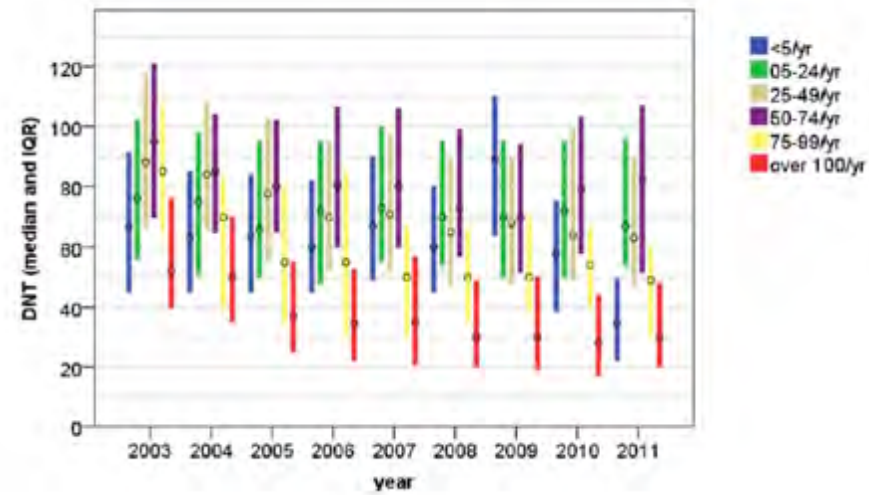
Table 1. Some Characteristics of Typical Acute Inpatient Stroke Care Facilities

	Hospital Type				
Characteristics	Non–Stroke Center	ASRH	PSC	TSC	CSC
Typical bed count	20–50	30–100	100–400		400–1500
Annual stroke admissions	10–50	25–50	50–300		>300
Rapid neuroimaging 24/7*	No	Performed and read within 45 min of order	Performed and read within 45 min of order		Performed and read within 45 min of order
IV tPA capability 24/7	No	60-min door-to-needle time	60-min door-to-needle time		60-min door-to-needle time
Acute stroke team available	No	At bedside within 15 min	At bedside within 15 min		At bedside within 15 min
Stroke unit	No	No†	Yes		Yes
Neurocritical care unit	No	No	No		Yes§
Access to neurosurgical services	No	Yes, within 3 h or by transfer‡	Yes, within 2 h, in-house or by transfer		Yes, 24/7 coverage and call schedule
Of 5000 (8/6/16)		1000*	1245		101

(Higashida, *Stroke* 2013;44)

Volume Matters

- Safe Implementation of Thrombolysis in Stroke registry
- *"**Center volume** had more robust effect on DTN than year of treatment, and the shortest DTNs were seen in centers with volumes ≥ 100 patients/year. Earlier enrollment period was also associated with shorter delays."*



(Strbian, *Stroke.* 2015;46:1275-1280)

Volume Matters

- Hospital Morbidity and Mortality Database managed by the Canadian Institute for Health Information

Results: Overall, 26,676 patients with ischemic stroke were admitted to 606 hospitals. Seven-day stroke mortality was 7.6% and mortality at discharge was 15.6%. Adverse outcomes were more frequent in patients treated in low-volume facilities (<50 strokes/year) than in those treated in high volume facilities (100 to 199 and >200 strokes patients/year) (for 7-day mortality: 9.5 vs 7.3%, $p < 0.001$; 9.5 vs 6.0%, $p < 0.001$; for discharge mortality: 18.2 vs 15.2%, $p < 0.001$; 18.2 vs 12.8%, $p < 0.001$). The difference persisted after multivariable adjustment or when hospital volume was divided into quartiles.

Conclusions: High annual hospital volume was consistently associated with lower stroke mortality. Our study encourages further research to determine whether this is due to differences in case mix, more organized care in high-volume facilities, or differences in the performance or in the processes of care among facilities.

(Saposnik, *Neurology*. 2011;69:1142–1151)

Benefits of Quality Improvement

- Studies suggest improved processes of care in GWTG-Stroke–participating hospitals
- This improved care now shown to translate into improved *clinical outcomes* compared with nonparticipating hospitals
  - 366 GWTG-Stroke hospitals, 88584 patients
  - 366 non–GWTG-Stroke hospitals 85401patients

(Song, *Stroke.* 2016;47:1-9)

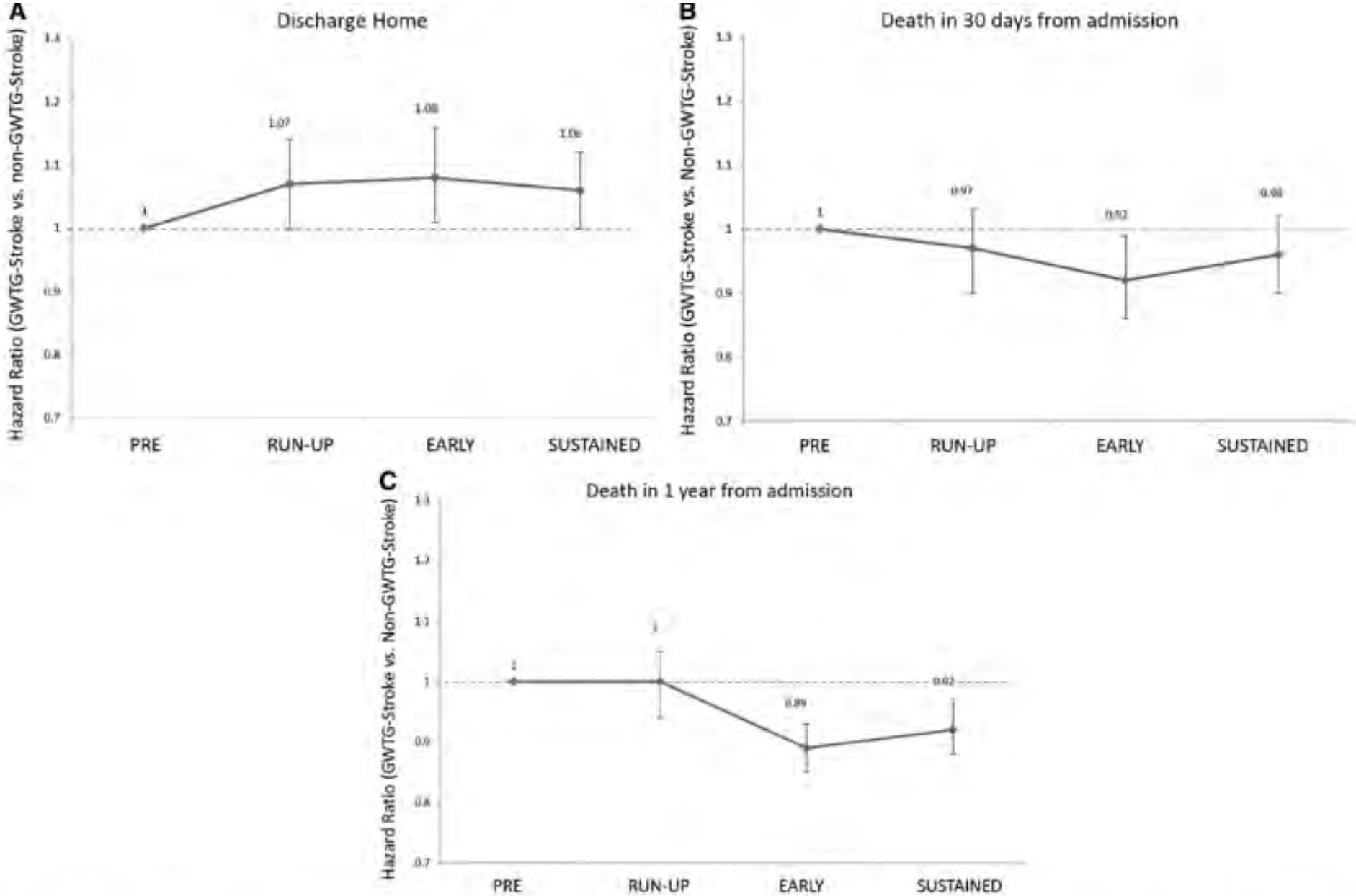


Figure 2. Ratio of changes in outcomes, from Pre time period to Run-Up, Warm-Up, and Sustained time periods, at Get With The Guidelines (GWTG)-Stroke hospitals vs matched non–GWTG-Stroke hospitals, for outcomes of discharge to home (**A**), 30-day mortality (**B**), and 1-year mortality (**C**).

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)
  - Increase hospital capabilities widely
  - Regionalization extends beyond EMS and triage, timely transfers to better equipped hospitals may need to occur

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

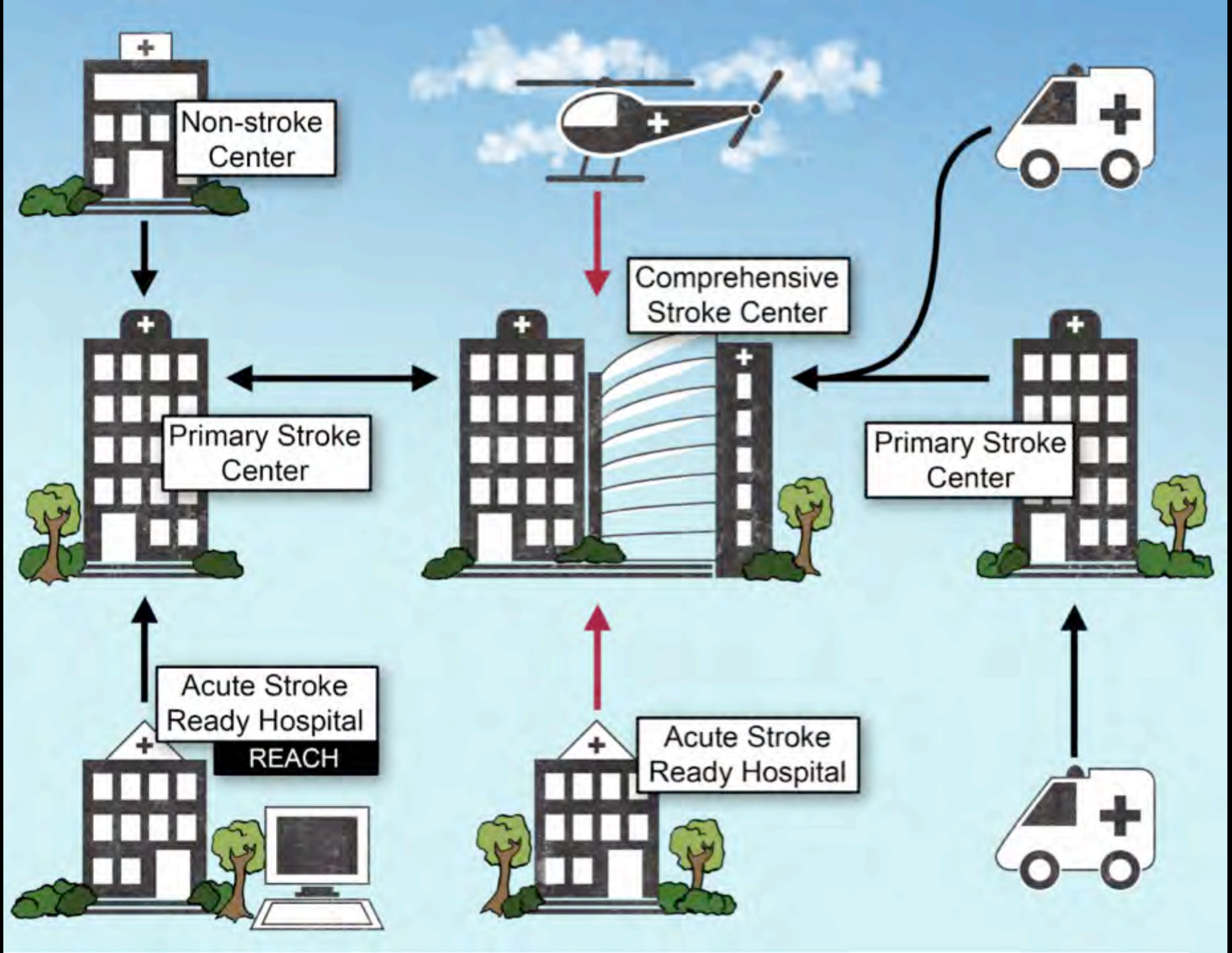
Journal of the American Heart Association

American Heart Association | American Stroke Association

Interactions Within Stroke Systems of Care: A Policy Statement From the American Heart Association/American Stroke Association

Randall Higashida, Mark J. Alberts, David N. Alexander, Todd J. Crocco, Bart M. Demaerschalk, Colin P. Derdeyn, Larry B. Goldstein, Edward C. Jauch, Stephan A. Mayer, Neil M. Meltzer, Eric D. Peterson, Robert H. Rosenwasser, Jeffrey L. Saver, Lee Schwamm, Debbie Summers, Lawrence Wechsler and Joseph P. Wood

(Schwamm, *Circulation* 2005;111:1078-191)
(Higashida, *Stroke* 2013;44)


Non-stroke Center
Comprehensive Stroke Center
Primary Stroke Center
Primary Stroke Center
Acute Stroke Ready Hospital
REACH
Acute Stroke Ready Hospital

The Challenge

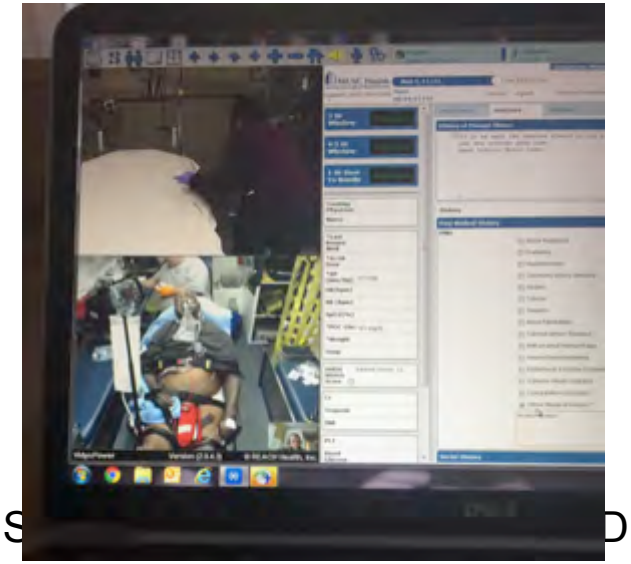
- Not every patients needs a CSC
- Goal: right place for the right patient the first time
  - CSC for SAH, ICH, severe AIS
  - “TSC” for regions without CSC
  - PSC for AIS and alteplase treatment, as well as stroke unit care
  - ASRH for AIS and timely transfer is essential
  - Ensuring appropriate interactions between system members will benefit our patients

CSC Care Is *Not* Just EVT!

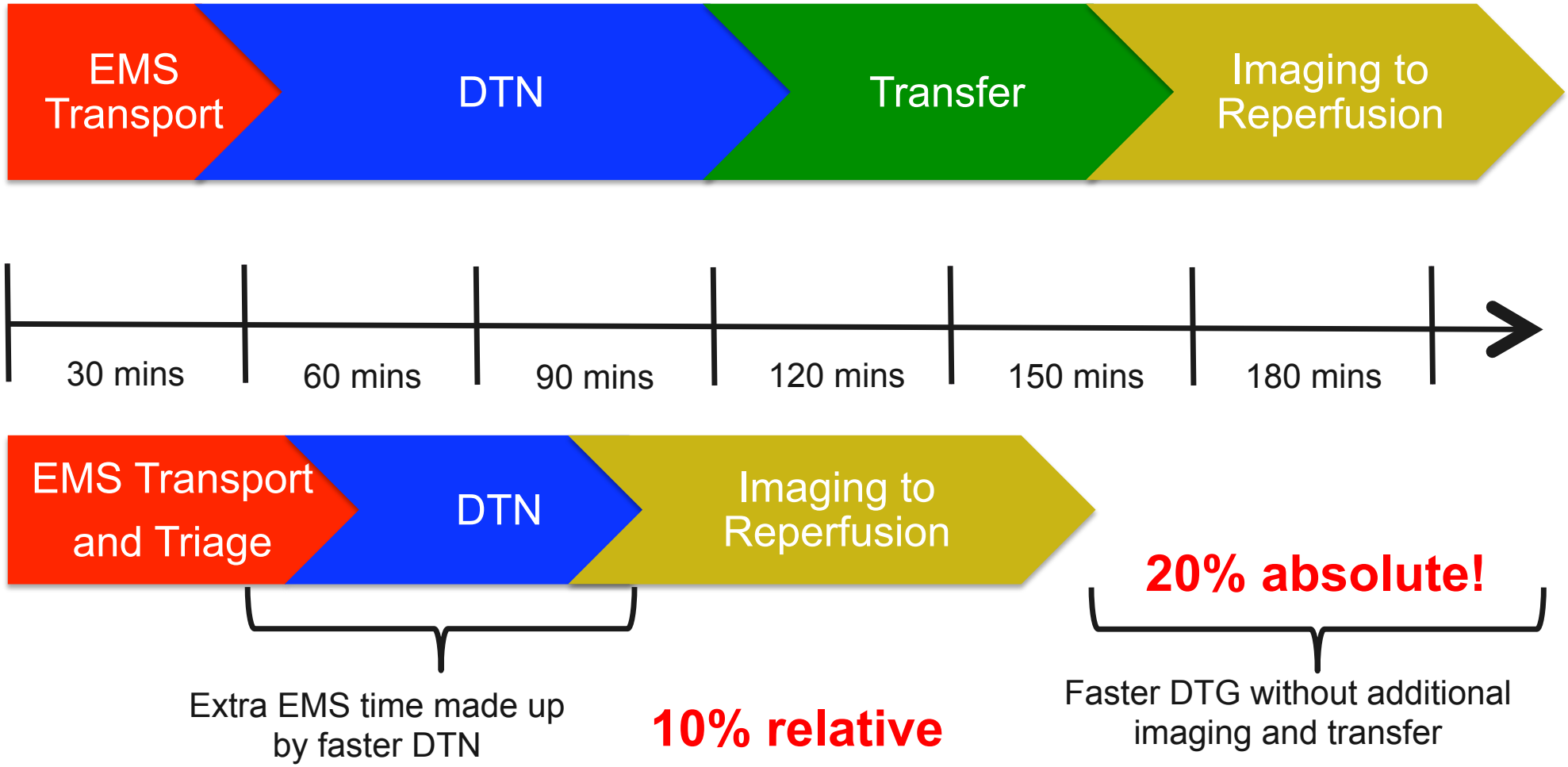
- Don't be mesmerized solely on EVT
- EVT is a great advance but
  - 10-20% eligible
  - Not all reperfuse
  - Not all do well
  - Many require NSICU
  - Global care, expert team and practice make the difference

Maximizing Pre-hospital Processes

- Real time evaluation, monitoring & tracking by app of mobile stroke unit to hospital
- Bypass to CSC if high NIHSS
- Direct ED door to CTA or angio suite
- Delivery of tPA in the field by mobile unit teleneurology / teleradiology, point-of-care lab & CT scanner
- Administration of other prehospital interventions (TEMPO-EMS)



Potential Impact of EMS Triage



Stroke Clinical Tools for EMS

Stroke Scales
Cincinnati Prehospital Stroke Scale (CPSS / FAST)
Los Angeles Prehospital Stroke Screen (LAPSS)
Melbourne Ambulance Stroke Screen (MASS)
Miami Emergency Neurologic Deficit (MEND)
Recognition of Stroke in the Emergency Room Score (ROSIER)

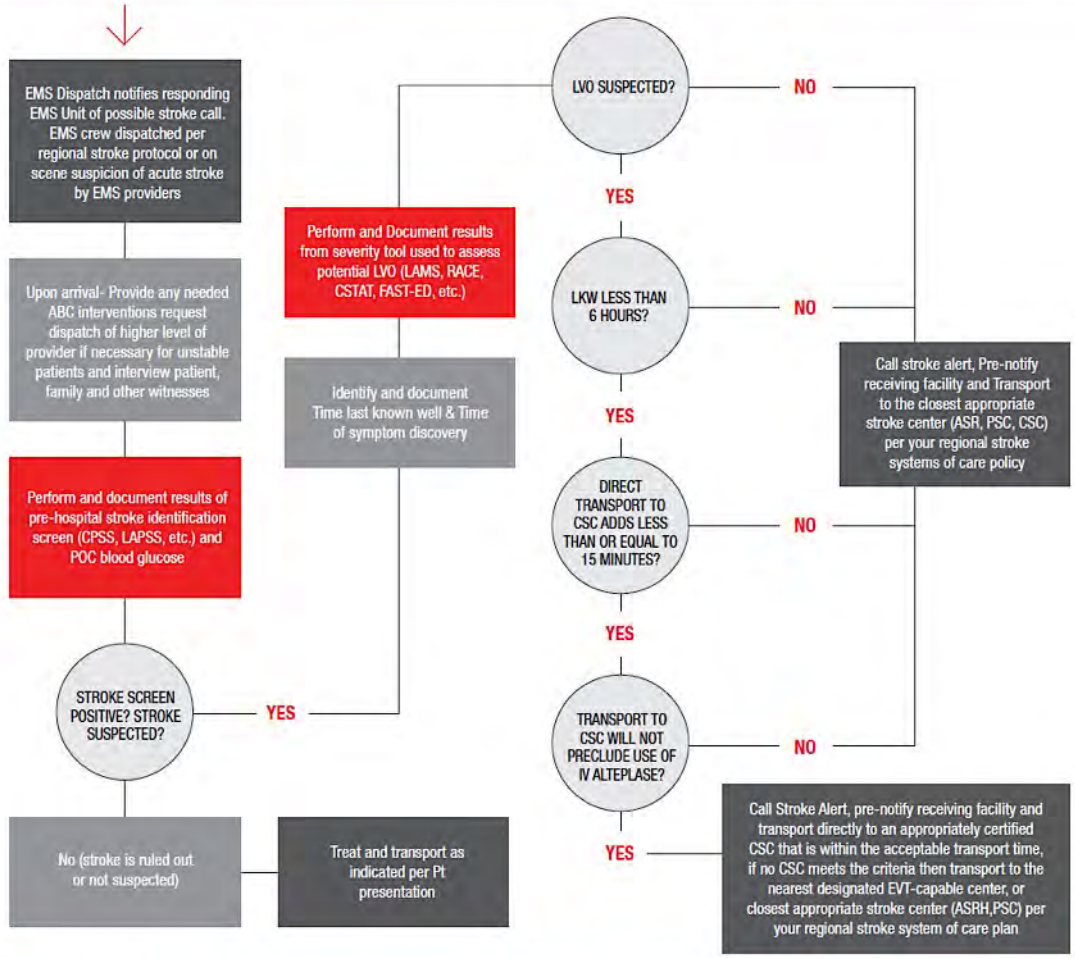
Stroke Scores
National Institute of Health Stroke Scale (NIHSS)
sNIHSS –5 / 8
Cincinnati Prehospital Stroke Severity Screen (CPSSS)
Field Assessment Stroke Triage for Emergency Destination (FAST-ED)
Los Angeles Motor Scale (LAMS)
Rapid Arterial Occlusion Evaluation Score (RACE)
Three Item Stroke Scale (3ISS)

So Where Do I Go?

SEVERITY-BASED STROKE TRIAGE ALGORITHM FOR EMS

American Heart Association | American Stroke Association. Together to End Stroke. Life is why.

MISSION: LIFELINE

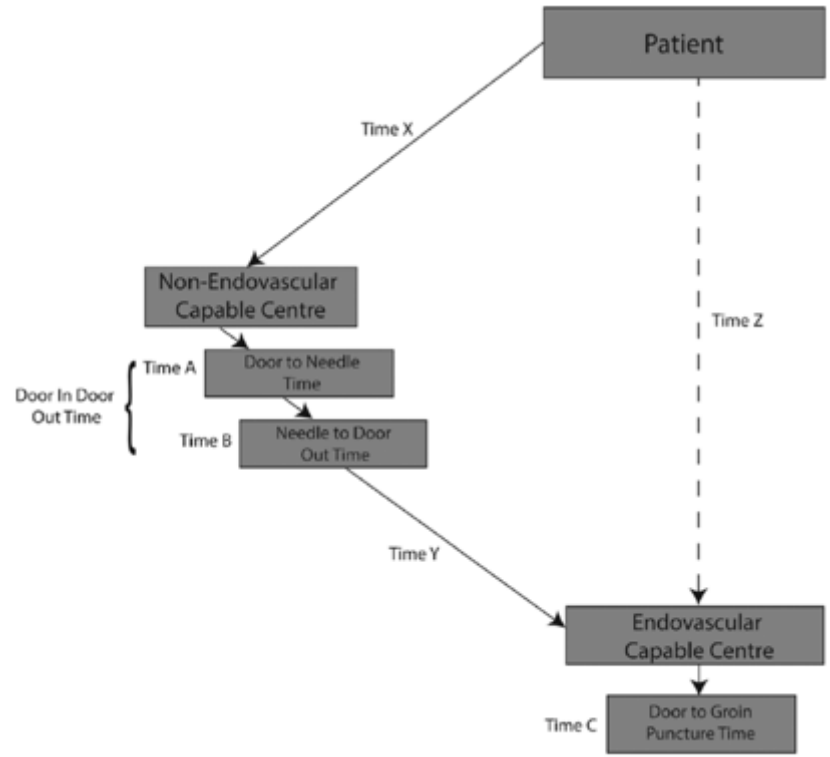


ON SCENE

- Interview patient, family members and other witnesses to determine Last Known Well (LKW) time and time of Symptom Discovery.
- Attempt to identify possible stroke mimics (eg, seizure, migraine, intoxication) and determine if patient has pre-existing substantial disability (need for nursing homecare or inability to walk without help from others).
- Encourage family to go directly to E.
- ED if not transported with patient and obtain mobile number of next of kin and witnesses.
- If Mobile Stroke Unit available—follow Mobile Stroke Unit Protocol
- Each EMS agency should utilize a published and validated stroke screen to assess patients with non-traumatic onset of focal neurologic deficits and validated tool to assess possible Large Vessel Occlusion (LVO).
- Patients who are eligible for IV Alteplase if transported to nearest ASRH or PSC should not be rerouted to a CSC or EVT-capable Center if doing so would result in a delay that would make them ineligible for IV Alteplase.
- Collect current medications (especially anticoagulants) and co-morbid conditions (eg. Serious kidney or liver disease, recent surgery, procedures or stroke) that may impact treatment decisions. Do not delay transport in collecting this information.

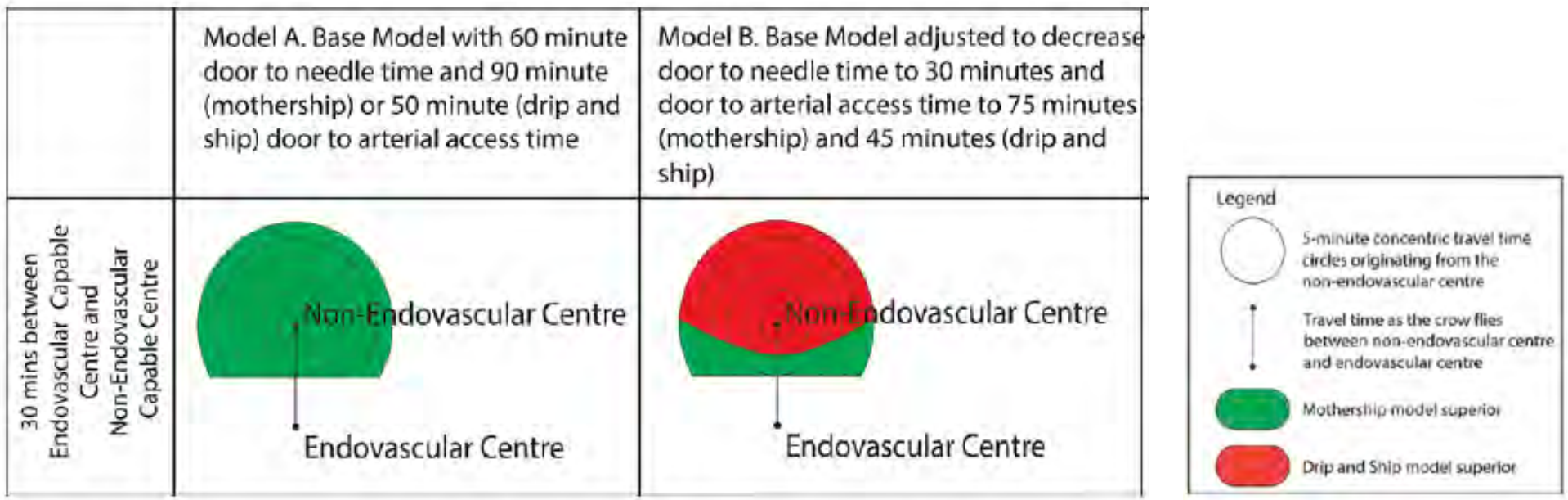
Transportation Options for Optimal Outcomes

- Statistical probability model comparing Drip ‘n Ship vs Mothership
- Data from ESCAPE and GWTG Stroke
- Assumes patients with LVO identified with LAMS >4



(Holodinsky, *Stroke.* 2017; 48:223-238)

Transportation Options for Optimal Outcomes



Actual Data

Ideal Performance

(Holodinsky, *Stroke.* 2017; 48:223-238)

Transportation Options for Optimal Outcomes

- Statistical probability model for California

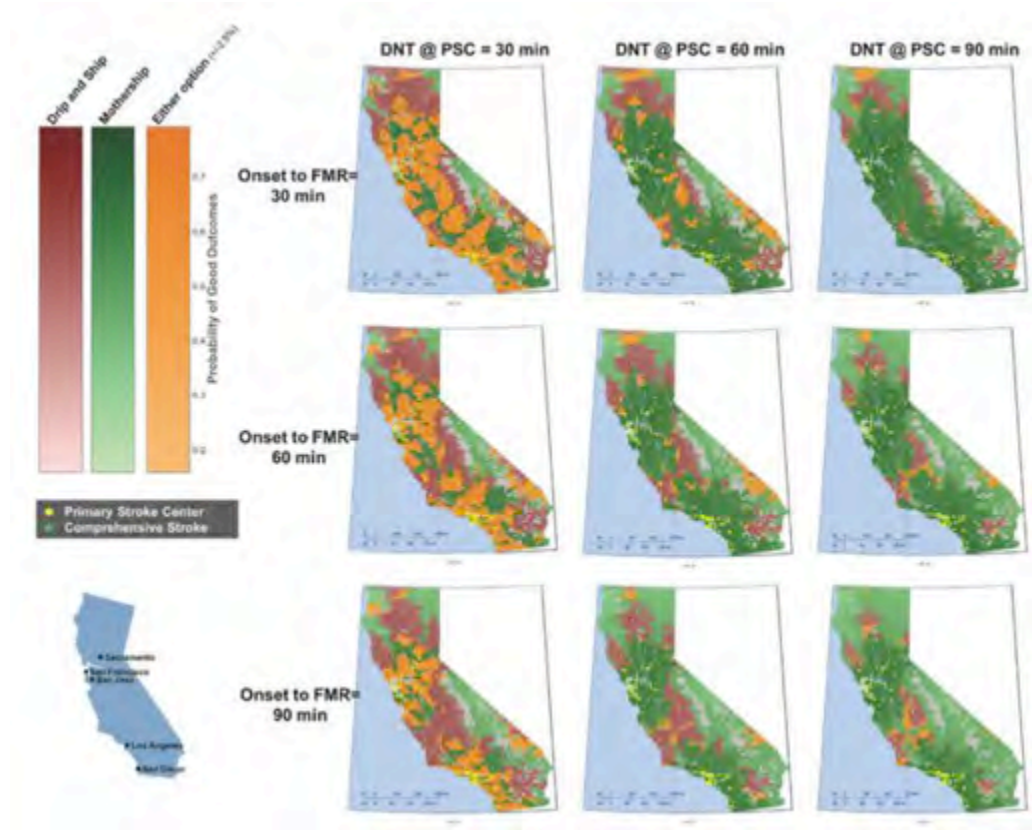
Table. List of Time Assumptions Made in the Model

	Drip 'n Ship, min	Mothership, min
Onset-to-first medical response	30, 60, 90	30, 60, 90
Time on-scene	25	25
Scene to door	Geographic model	Geographic model
Door-to-needle	30, 60, 90	30*
Needle-to-door-out	20	NA
PSC to CSC	Geographic model	NA
Door-to-reperfusion	115*	115*

(Milne, *Stroke.* 2017;48)

Transportation Options for Optimal Outcomes

- Does not model accuracy of LVO identification in the field
- Function of DTN and onset times
- *Mothership* best if
  - <30’ triage bypass
  - PSC DTN > 30’



(Milne, *Stroke.* 2017;48)

Limitations to the Models

- Does not address
  - LVO detection in field
  - Impact on transfer delay on remaining eligible for EVT on arrival (CTP, ASPECTS)
  - Geographic circumstances (weather, air/ground transport considerations, ambulance availability)
  - Day of week, time of day variations
  - Economic analyses required as part of the next iteration

What Could Go Wrong?

- EMS
  - Lack of specificity in LVO tools (FP, FN)
  - Longer transports, especially for rural agencies
- Hospitals
  - CSC over-crowding
  - Impedes PSC evolution to CSC
  - Limit non-CSC experience with severe strokes (nonreperfusion candidates, in-house, etc)

Maximize Resources, Predefined Roles, Parallel Processing

Code Stroke

Admitting	CT tech	Nurse #1	Nurse #2	ED resident	Neurology resident	Social worker	ED tech	Pharmacist
Patient ID Registration Room assign	CT scan	IV placement Monitor hook-up Vital sign monitoring Blood glucose Lab draw Weight estimate		History Meds/allergies Order r-tPA	NIHSS Neuro exam	ID witness Time of onset	Emergent transport of bloods to lab	Calculate r-tPA dose Prepare r-tPA

Decision

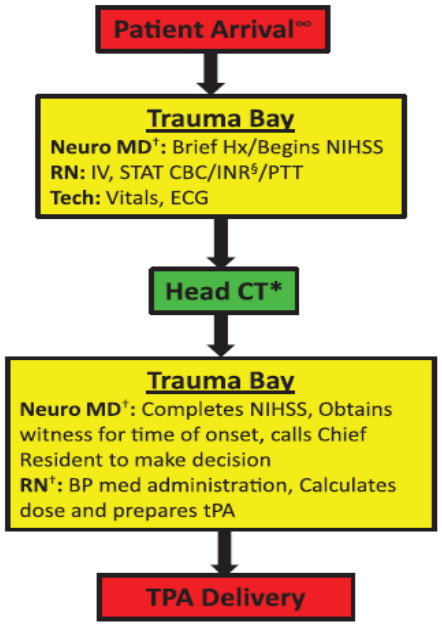
↓

Bolus and infuse r-tPA

(Ford *Stroke*. 2012;43:3395-3398)

Learn From Industry – Toyota Value Stream Analysis

A Pre-VSA Acute Stroke Protocol



B Post-VSA Acute Stroke Protocol

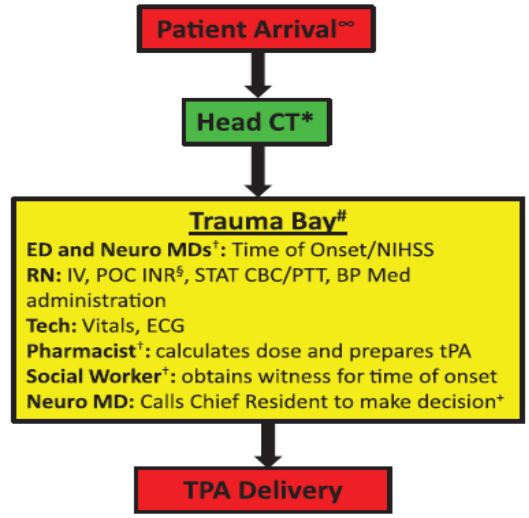


Table 2. Protocol Metrics and Outcomes Pre- and Post-VSA

	Pre-VSA January 1, 2009, to February 28, 2011 (N=132)	Post-VSA March 1, 2011, to March 1, 2012 (N=87)	*P* Value
Door-to-needle time, min*	60 [46–73]	39 [28–56]	<0.0001
Percent patients with DNT ≤60 min	52%	78%	<0.0001
Onset-to-needle time, min*	131 [105–165]	111 [80–158]	0.016
Door-to-CT time,†, min*	16 [10–22]	1 [0–4]	<0.0001
Door-to-CBC time,† min*	22 [16–29]	24 [17–34]	0.13
Door-to-PTT time,† min*	34 [29–42]	40 [31–47]	0.14
Symptomatic ICH	3.0%	3.4%	1.0
Favorable discharge location‡	76%	83%	0.24
90-d mRS 0 to 2§	49%	43%	0.34
Length of hospital stay, d*	4 [3–7]	3 [2–6]	0.056
Stroke mimic	6.8%	11.5%	0.33

(Ford *Stroke*. 2012;43:3395-3398)

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
Rapid laboratory testing / POC
Mix alteplase ahead of time
Rapid access & rtPA initiation
Team-based approach
Prompt data feedback

(Fonarow, *JAMA*. 2014;311:1632-1640)

Target: Stroke

	Study Period		Adjusted Odds Ratio (95% CI)	*P* Value
	Preintervention (n = 27 319)	Postintervention (n = 43 850)		
tPA DTN time, median (IQR), min	77 (60-98)	67 (51-87)		< .001
tPA DTN time ≤ 60 min, % (95% CI)	26.5 (26.0-27.1)	41.3 (40.8-41.7)		< .001
End of each period	29.6 (27.8-31.5)	53.3 (51.5-55.2)		< .001
Improvement in tPA DTN time ≤ 60 min, % per year (95% CI)	1.36 (1.04-1.67)	6.20 (5.58-6.78)		< .001
In-hospital all-cause mortality, %	9.93	8.25	0.89 (0.83-0.94)	< .001
Discharge to home, %	37.6	42.7	1.14 (1.09-1.19)	< .001
Independent ambulatory status, %	42.2	45.4	1.03 (0.97-1.10)	.31
Symptomatic intracranial hemorrhage within 36 h, %	5.68	4.68	0.83 (0.76-0.91)	< .001

(Fonarow, *JAMA.* 2014;311:1632-1640)

Impact of Timely Transfer: STEMI

Figure 1. Distribution of DIDO Times Among 14 821 Patients With STEMI Transferred for Primary Percutaneous Coronary Intervention

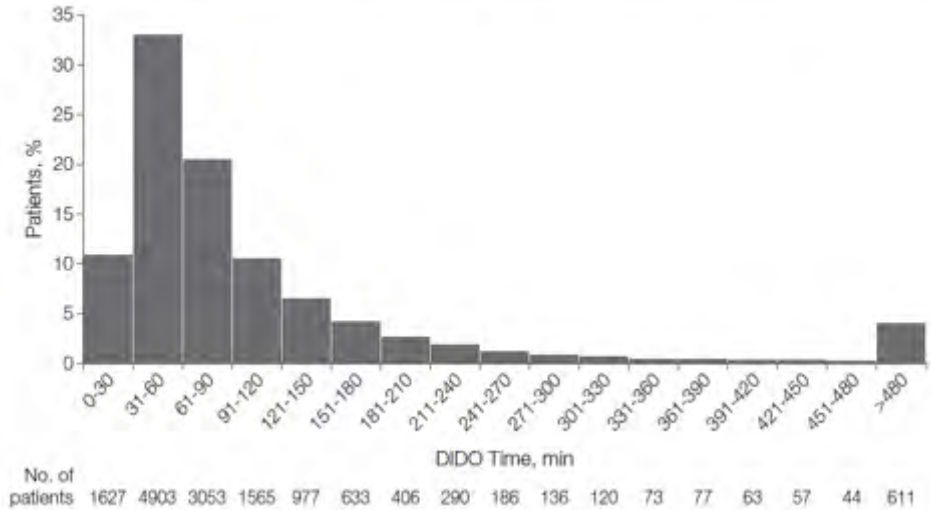
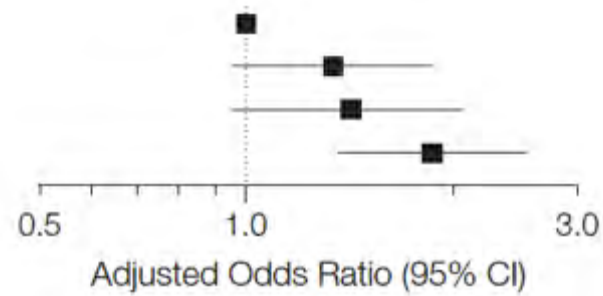


Figure 3. Association of DIDO Time With In-Hospital Mortality

DIDO Time, min	Mortality, No. of Patients/Total (%)	Adjusted Odds Ratio (95% CI)
≤30	43/1600 (2.7)	1.0 (Reference)
31-60	192/4841 (4.0)	1.34 (0.96-1.86)
61-90	146/3013 (4.9)	1.41 (0.96-2.06)
>90	430/5176 (8.3)	1.86 (1.36-2.54)



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

Optimizing Processes for Transfer

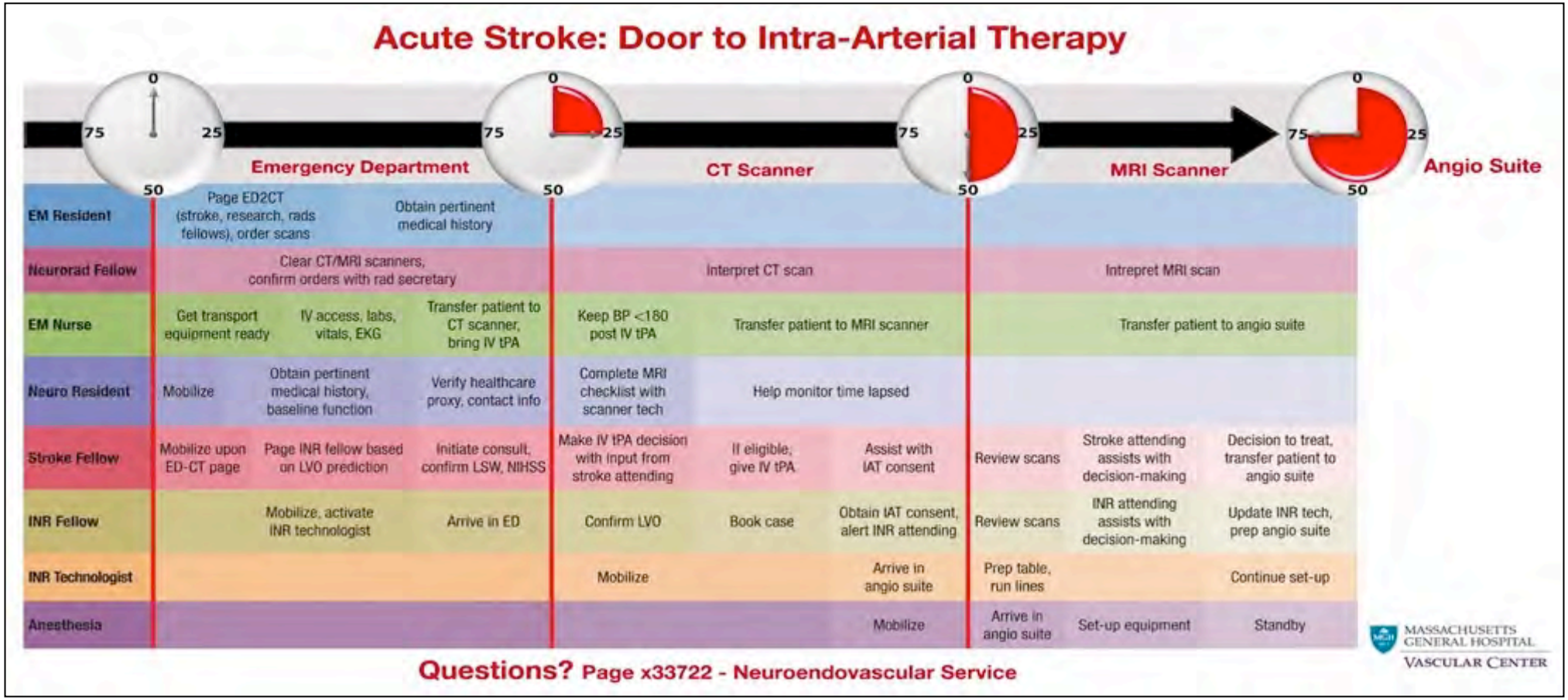
- Drip and Ship vs Mothership
  - ASPECTS >7 50% vs 76%
  - mRS 0-2 29% vs 51%
- Every minute delay in transfer decreased IAT eligibility by 1%
- Suggestions for optimizing transfer
  - Contact CSC early on (referring ED vs neurology)
  - Arrange transfer before CT based on severity
  - Transfer based on NCCT and NIHSS vs CTA
  - Straight to NIR is short transfer (vs ED / CT)

(Sun et al. *Circulation*. 2013;127:1139-1148)

Optimizing Processes for Transfer

- The nuts and bolt - Plan ahead!
  - Know who, how and when
  - Train on post-tPA protocol
    - 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

Optimizing Processes for EVT



(Mehta BP, et al. *J Am Heart Assoc.* 2014)

Future Accreditation for Performance

- AHA / ASA accreditation program
- Partner with certification organizations
  - AHA Guideline based – science focused
  - Expand expectations to be patient-centered and less infrastructure based
  - Use certification partners to work with hospitals
  - Use GWTG to monitor performance
  - Eventually public reporting of dashboards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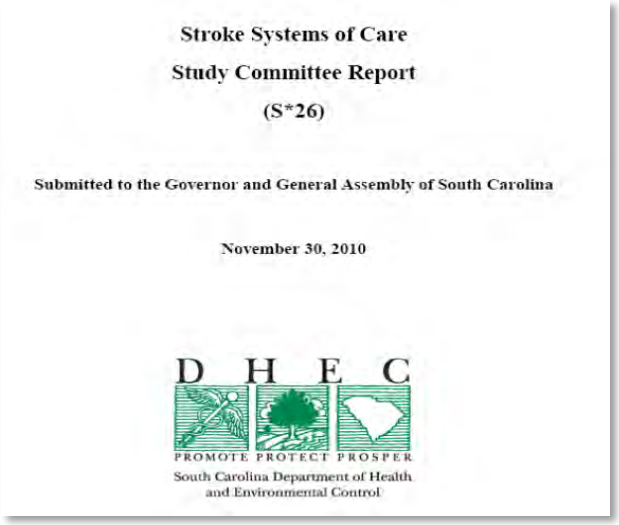
An Example from South Carolina Stroke Systems of Care Act



Stroke Systems of Care

Study Committee Report

(S*26)

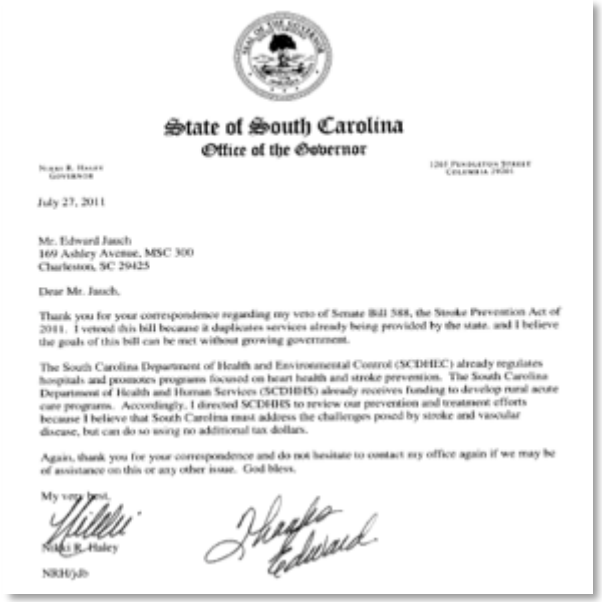
Submitted to the Governor and General Assembly of South Carolina

November 30, 2010

D H E C

PROMOTE PROTECT PROSPER

South Carolina Department of Health and Environmental Control



State of South Carolina

Office of the Governor

July 27, 2011

Mr. Edward Jauch
169 Ashley Avenue, MSC 300
Charleston, SC 29425

Dear Mr. Jauch,

Thank you for your correspondence regarding my veto of Senate Bill 588, the Stroke Prevention Act of 2011. I vetoed this bill because it duplicates services already being provided by the state, and I believe the goals of this bill can be met without growing government.

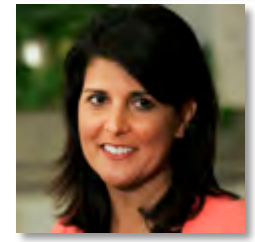
The South Carolina Department of Health and Environmental Control (SCDHEC) already regulates hospitals and promotes programs focused on heart health and stroke prevention. The South Carolina Department of Health and Human Services (SCDHHS) already receives funding to develop rural acute care programs. Accordingly, I directed SCDHHS to review our prevention and treatment efforts because I believe that South Carolina must address the challenges posed by stroke and vascular disease, but can do so using no additional tax dollars.

Again, thank you for your correspondence and do not hesitate to contact my office again if we may be of assistance on this or any other issue. God bless.

My very best,

Nikki R. Haley

NRH/jb

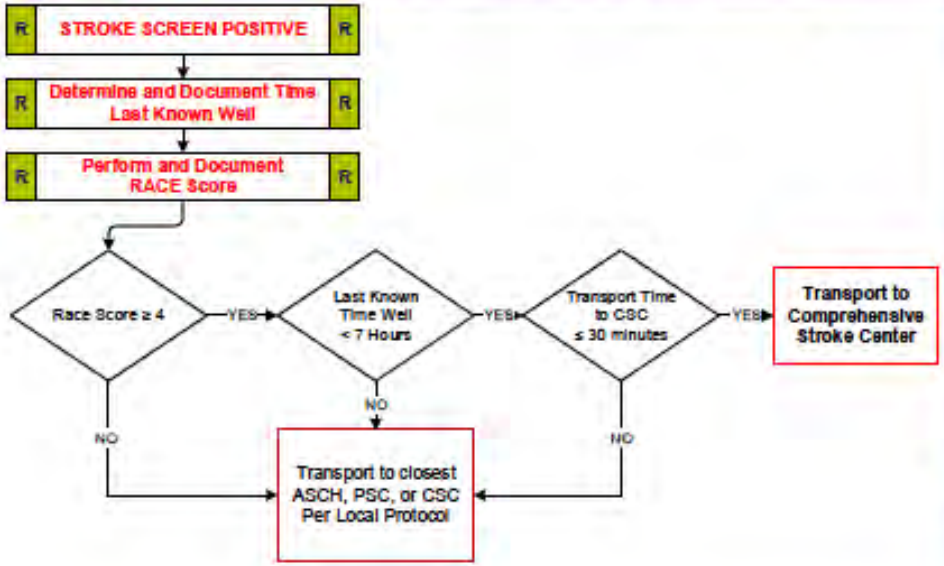


Ratified	6/08/2011
Vetoed by the Governor	6/14/2011
Veto overridden by Senate	6/21/2011
Veto overridden by House	6/21/2011
Ed's happy dance	6/22/2011

An Example from South Carolina Stroke Systems of Care Act

- Victory was sweet but brief – bill defunded
- It took 5 years to finally get funding
  - New director of health took on stroke with a passion
  - Hired FTE in Dept of Health
  - Created SC Stroke Advisory Committee
    - All stakeholders
    - Create guidance for Director
    - Created triage algorithm
    - Funding for state-wide stroke registry of *all* hospitals

Adult Stroke Patient Destination Determination by Stroke Center Capability



Comprehensive Stroke Center

- Physician / Nursing Staff trained in neurologic care on-site 24 hours a day
- Organized Emergency Department with written pathway for rapid identification and management of acute stroke patient
- CT of the head with technician on-site 24 hours a day
- Clinical Laboratory Services
- 24 / 7 Stroke Call and capabilities for IV tPA therapy for eligible patients
- 24 / 7 Endovascular Call and capabilities for endovascular therapy for eligible patients
- 24 / 7 Neurosurgery Call
- Neuro-Intensive Care Unit and neurointensivists
- Stroke Registry and Quality Improvement Process
- Accredited Comprehensive Stroke Center (CSC)

Primary Stroke Center

- Physician / Nursing Staff trained in neurologic care on-site 24 hours a day
- Organized Emergency Department with written pathway for rapid identification and management of acute stroke patient
- CT of the head with technician on-site 24 hours a day
- Clinical Laboratory Services
- 24 / 7 Stroke Call and capabilities for IV tPA therapy for eligible patients
- Stroke Registry and Quality Improvement Process
- Accredited Primary Stroke Center (PSC)

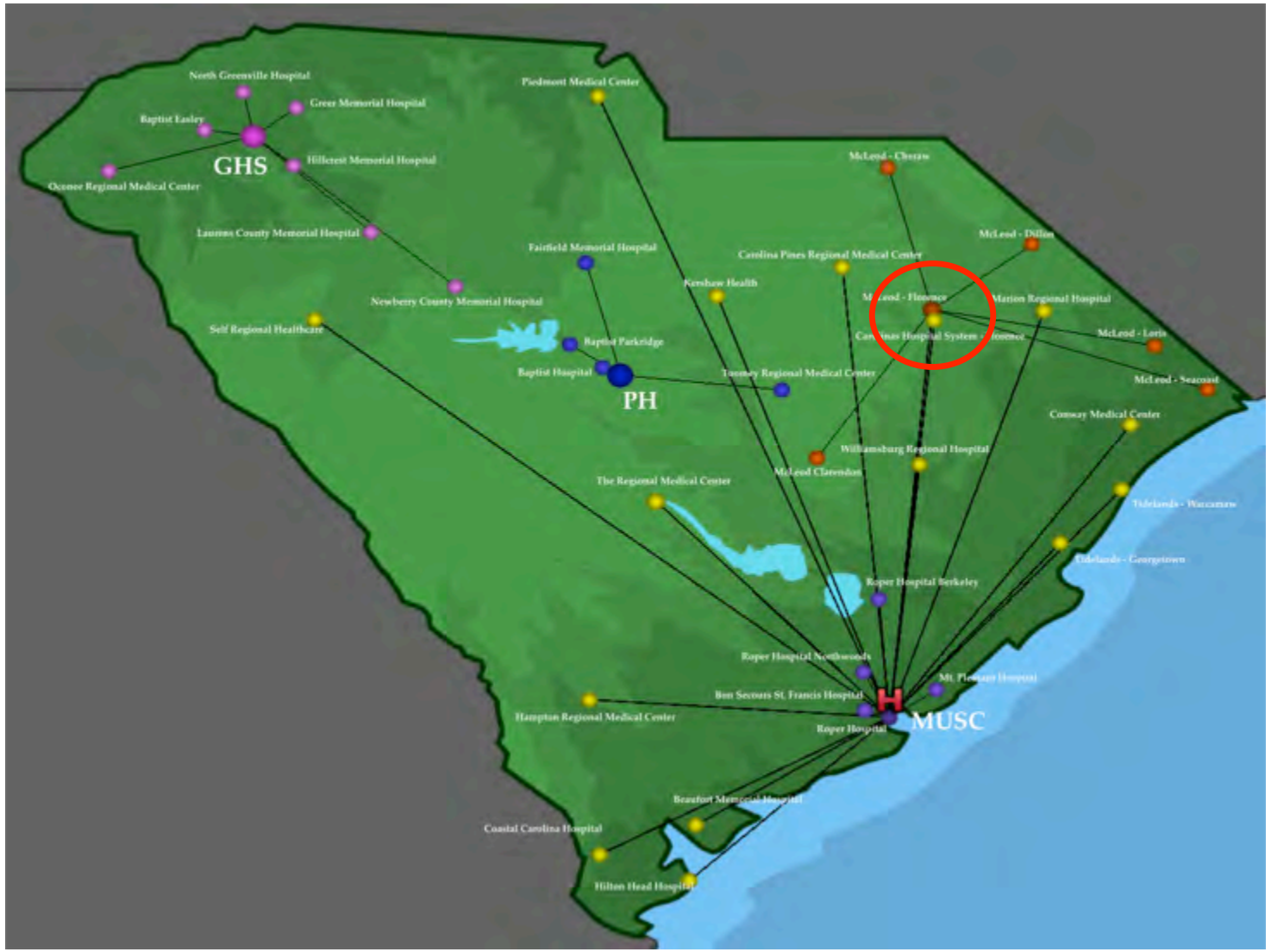
Non-Stroke Hospitals

No organized treatment for acute stroke

Acute Stroke Capable Center

- Emergency Department 24 hours a day with Physician or physician extender and nursing staff trained in neurological care on-site 24 hours a day.
- CT of the head with technician on-site 24 hours a day
- Clinical Laboratory Services
- Telestroke Video – Conferencing Capabilities
- 24 / 7 with Capabilities for IV tPA therapy for eligible patients
- Transfer agreement established in advance to ensure orderly transition from Level II Stroke Hospital to specialized stroke care facility
- Stroke Registry and Quality Improvement Process
- Accredited Acute Stroke Capable Hospital (ASCH)

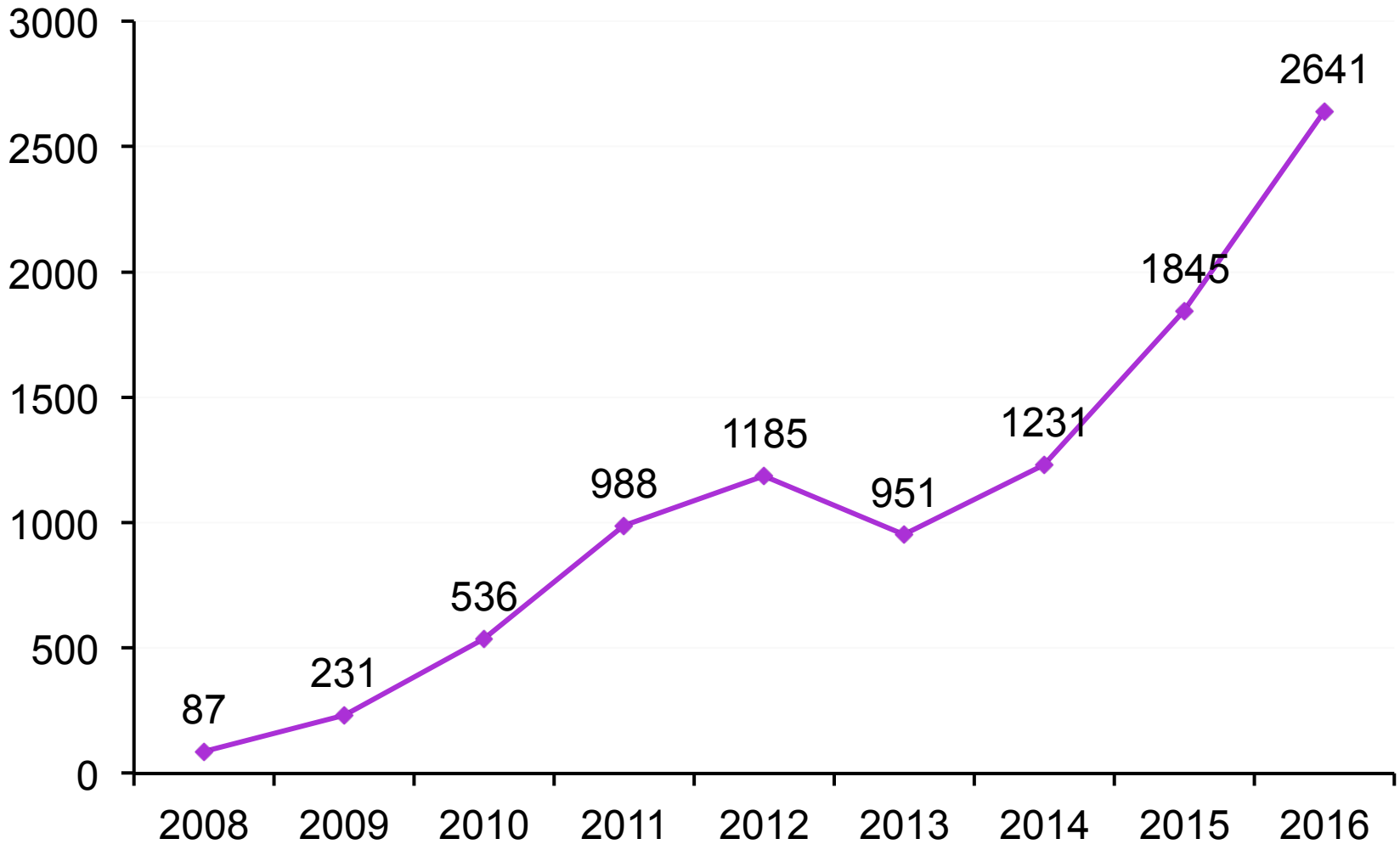
South Carolina Telestroke Alliance Map



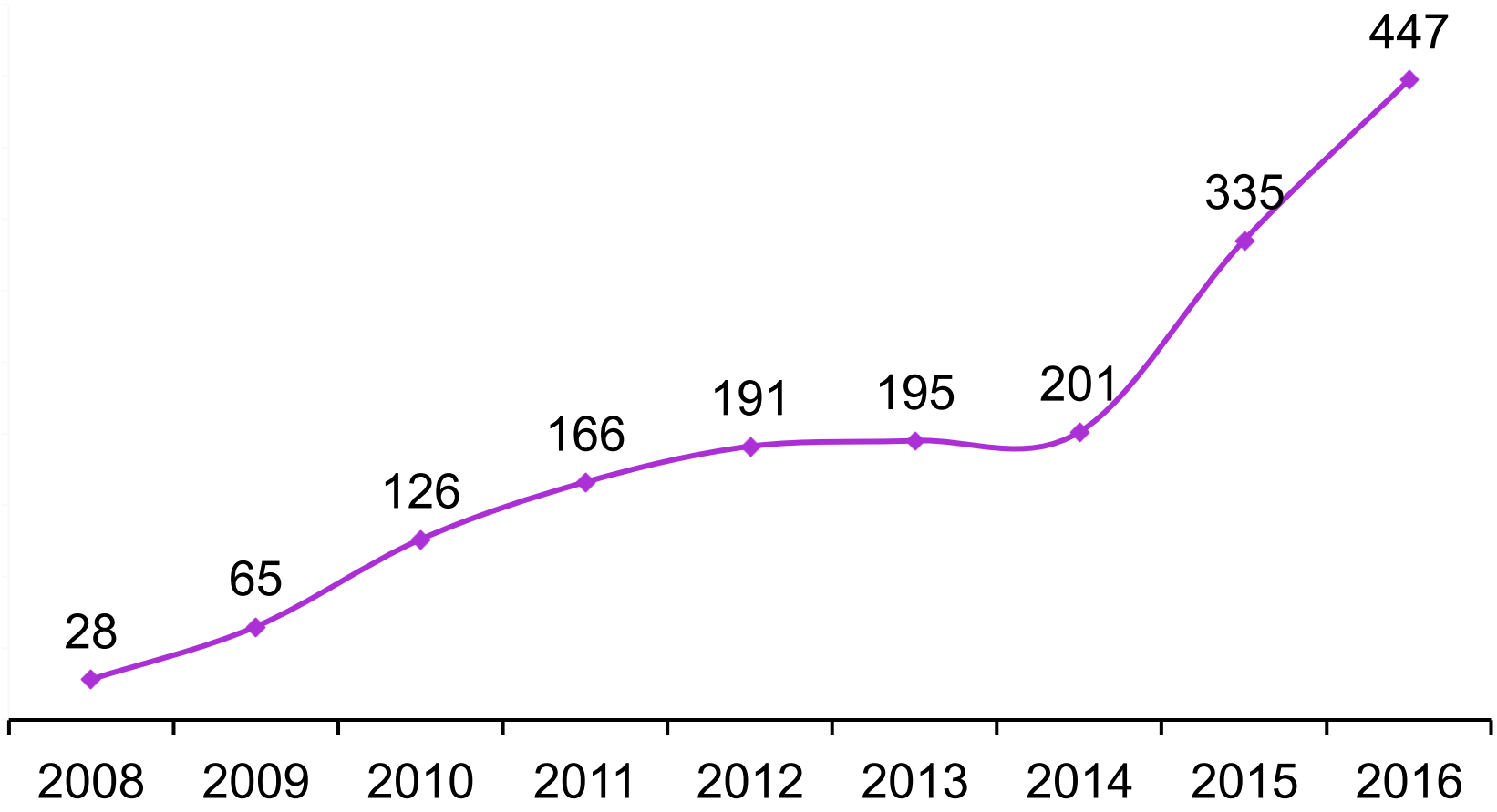
SC Primary Stroke Centers

AnMed Health	Anderson	SC	3/20/13
Medical University of South Carolina Medical Center	Charleston	SC	11/8/13
Roper Hospital, Inc.	Charleston	SC	3/6/13
Bon Secours St. Francis Xavier Hospital, Inc.	Charleston	SC	4/26/14
Trident Medical Center LLC	Charleston	SC	3/8/13
Palmetto Health Richland	Columbia	SC	4/26/13
McLeod Regional Medical Center of the Pee Dee, Inc.	Florence	SC	6/27/14
Georgetown Memorial Hospital	Georgetown	SC	7/8/14
Greenville Health System	Greenville	SC	9/24/13
Coastal Carolina Medical Center Inc.	Hardeeville	SC	11/22/14
East Cooper Medical Center	Mount Pleasant	SC	4/4/13
Waccamaw Community Hospital	Murrells Inlet	SC	7/8/14
Grand Strand Medical Center, LLC	Myrtle Beach	SC	3/14/13
Regional Medical Center of Orangeburg & Calhoun Counties	Orangeburg	SC	12/10/14
Piedmont Medical Center	Rock Hill	SC	12/17/14
Mary Black Health System, LLC	Spartanburg	SC	1/26/13

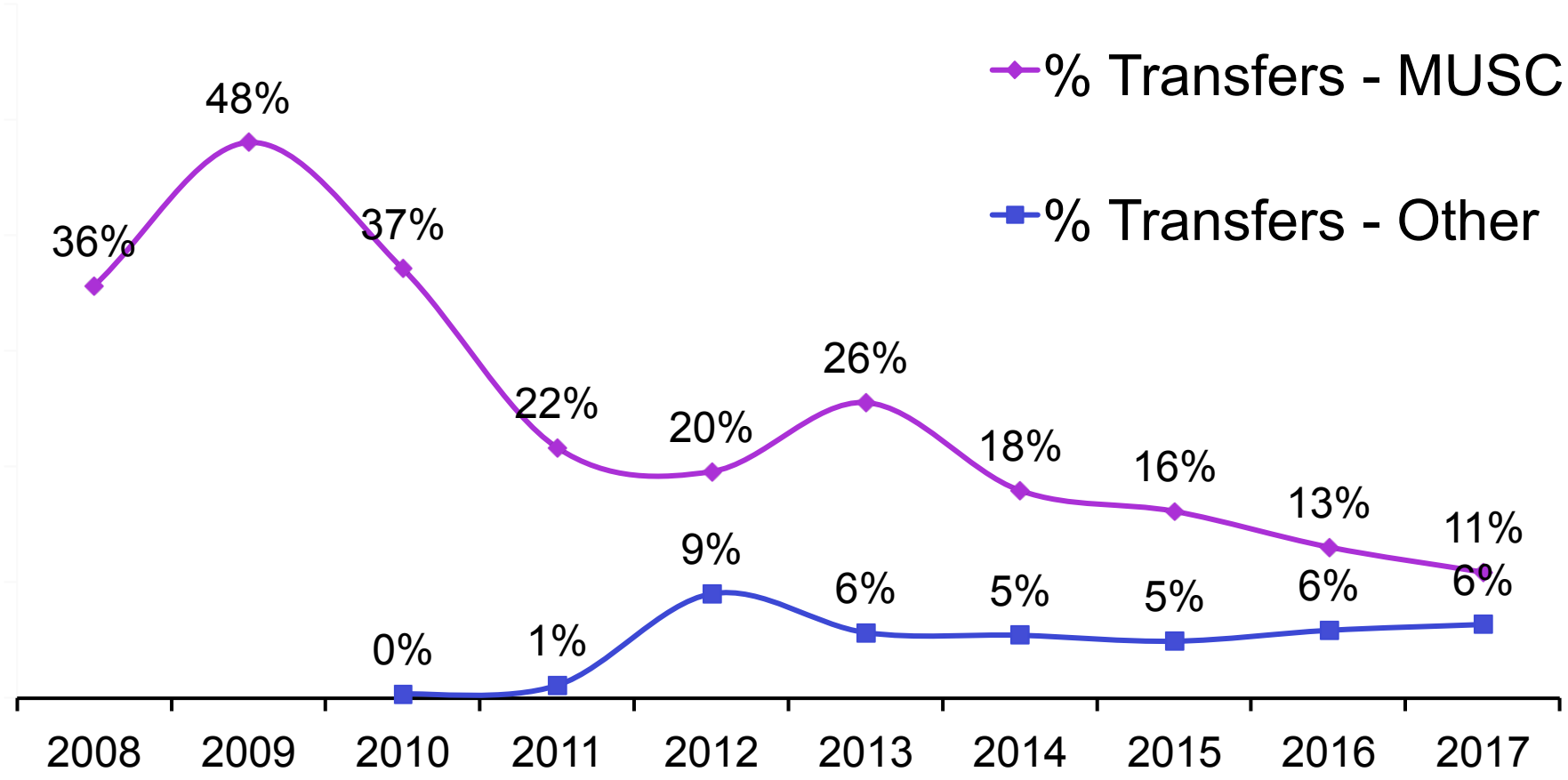
MUSC Telestroke Consults



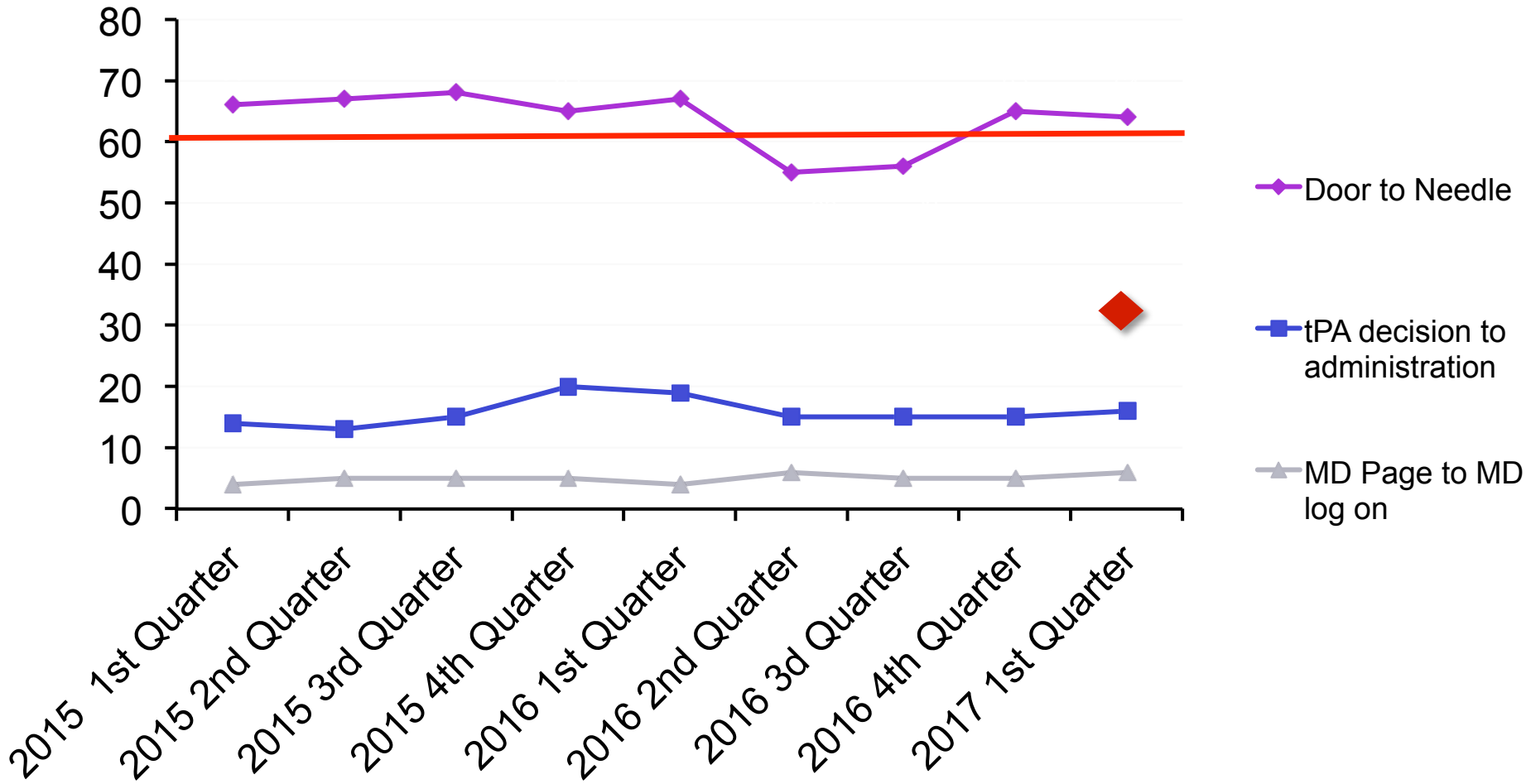
Recommendations for Alteplase



MUSC Telestroke Transfer Volume

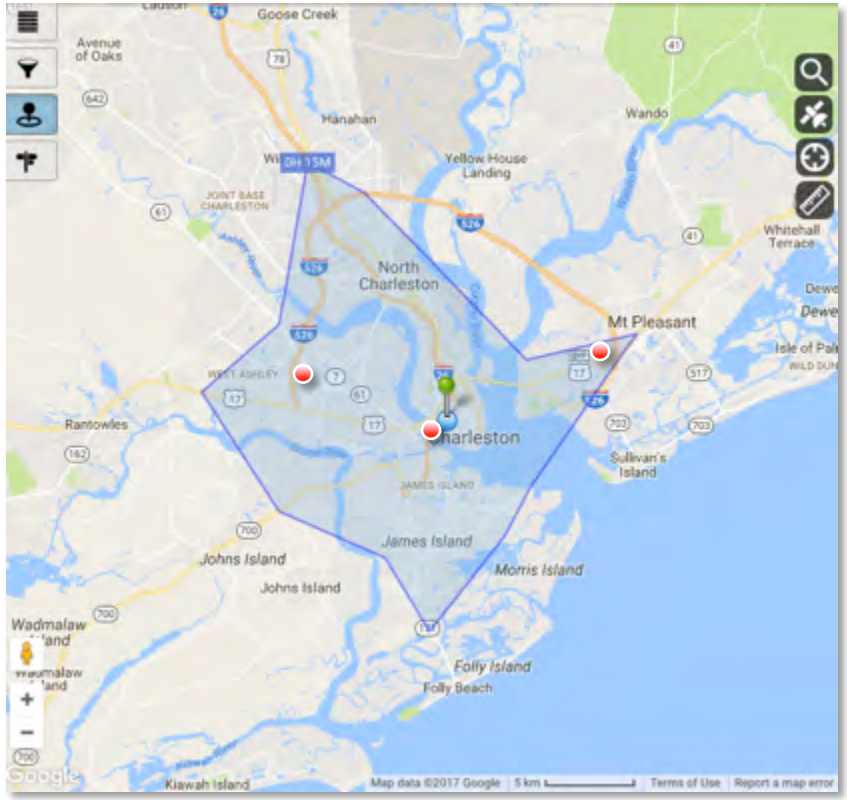


MUSC Telestroke DTN Times

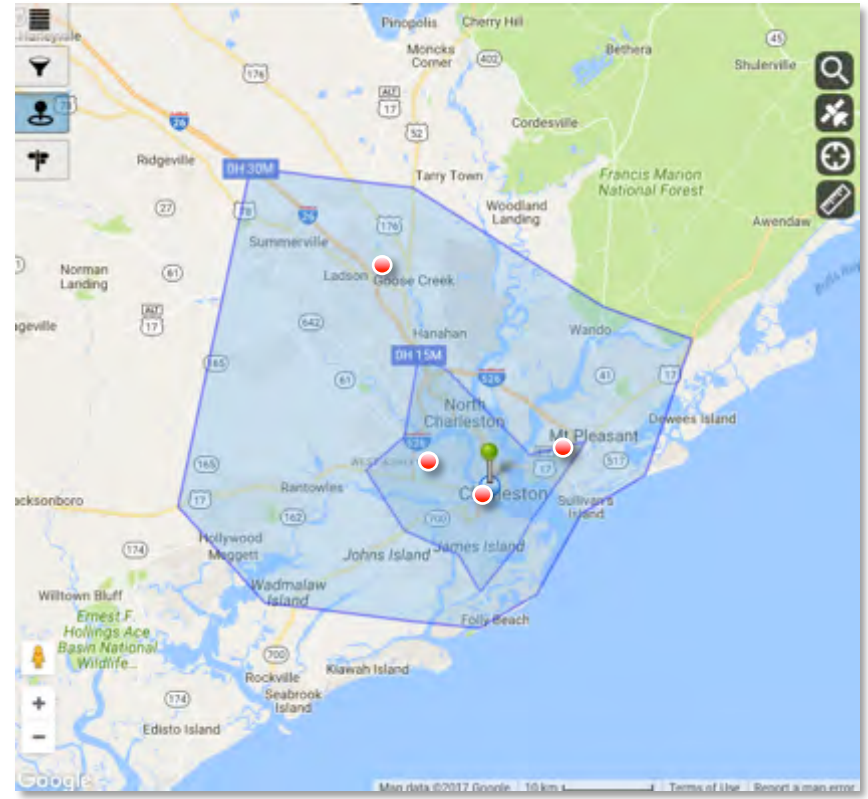


What Would Triage Look Like Here?

15 Minute Drive Time



30 Minute Drive Time



Final Thoughts

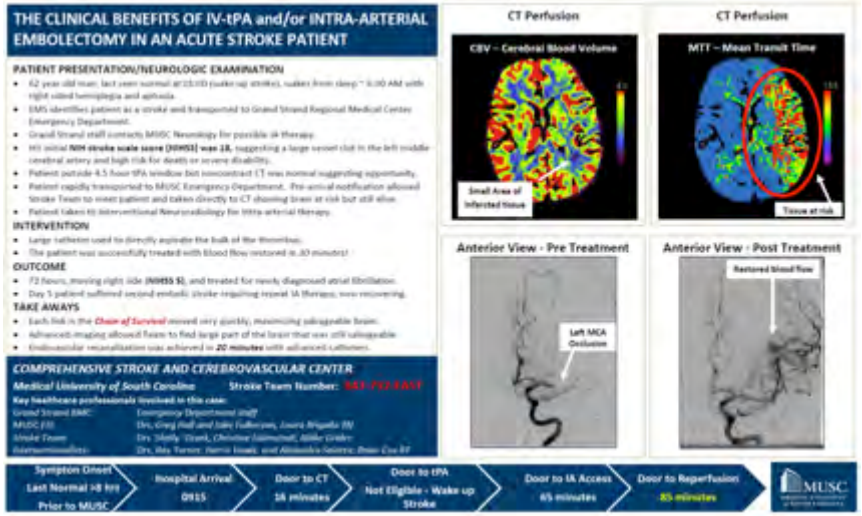
The True Secret Sauce

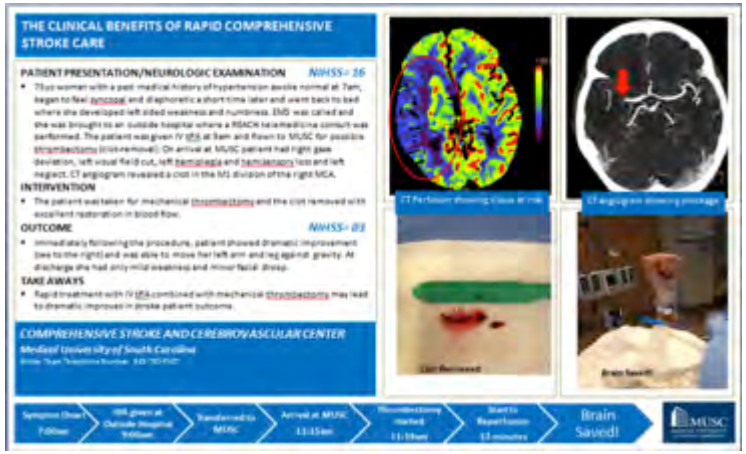
Your physician and nurse stroke champions make the difference and must be supported and worshiped. Without them the system fails.

Pay Attention to Detail

- Never forget your inpatients!
  - 10-20% of all strokes
  - Call a BAT just like a MET
    - Less likely discharged home (OR 0.37)
    - Less likely ambulatory at DC (OR 0.42)
    - In-hospital mortality higher (OR 2.72)
- Send somebody *big* to champion the stroke patient in the ED and push them through the system.

The Importance of Feedback





In-Patient Stroke

- Review of inpatient stroke cases from 2006 to 2012 in GWTG-Stroke
- After adjustment and in comparison to community-onset ischemic stroke, inpatient strokes were:
  - Less likely discharged home (OR 0.37)
  - Less likely ambulatory at discharge (OR 0.42)
  - In-hospital mortality also higher (OR 2.72)

(Cumbler, *Stroke*, 2014)

How Will You Be Judged?

- Moving forward is will not be so much on what you have but what you do!
- Centers of Excellence
  - Action based metrics (DTN, DTG, DIDO)
  - Outcomes based (mRS 90 days)
  - Systems based (do you play well with others)
  - Volumes (no more once a year)

Conclusion

- No mater where you practice you will see stroke
- Acute treatments' *efficacies* are nearly asymptotic
- Now the goal is to maximize their *effectiveness*
  - Build a resourced and supported ***team***
  - Apply best practices to each location in system
  - Measure success on outcomes not check boxes
- Recognize importance of sustained public education, secondary prevention and rehabilitation


77

Future Stroke Dashboards

Measure	Hospital A	Hospital B	Hospital C
Demographics / Volume			
Certification	ASRH	PSC	CSC
CY ischemic stroke admissions			
CY intracerebral hemorrhage admissions			
CY subarachnoid hemorrhage admissions			
CY tPA administration (#)			
CY EVT administration (#)			
CY SAH aneurysms coilings (#)			
Performance Measures			
DTN (mins – median, mean)			
DTN (% under 45 mins)			
DTG (min – median, mean)			
Outcomes			
sICH rate (PH1, PH2) (%)			
90 day modified Rankin Score (median, mean)			
Periprocedural complications			