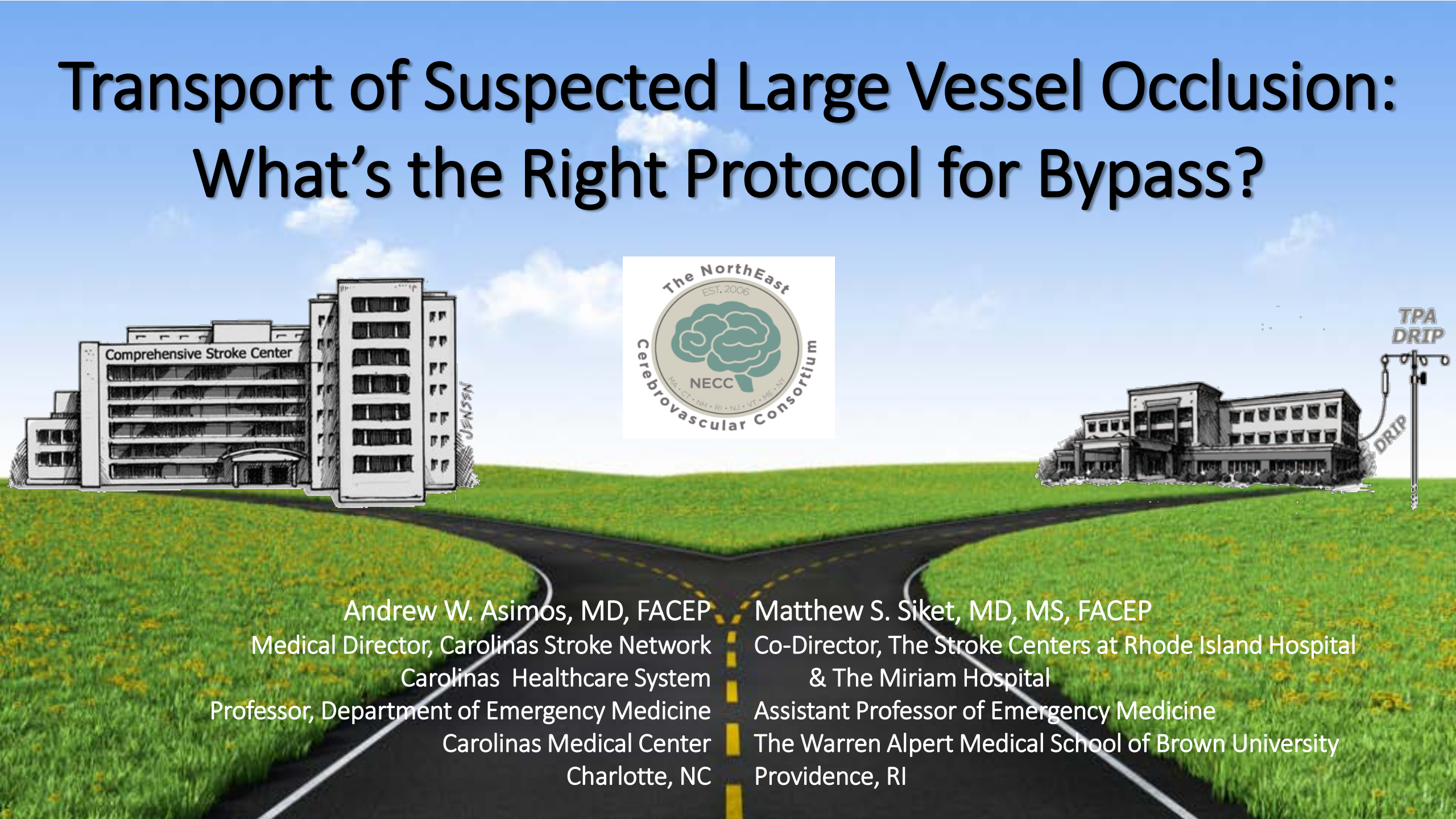
Transport of Suspected Large Vessel Occlusion: What's the Right Protocol for Bypass?



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Presenter Disclosure Information

Andrew W. Asimos, MD

Transport of Suspected Large Vessel Occlusion:

What's the Right Protocol for Bypass?

FINANCIAL DISCLOSURE:

Research Support: Stryker® Neurovascular

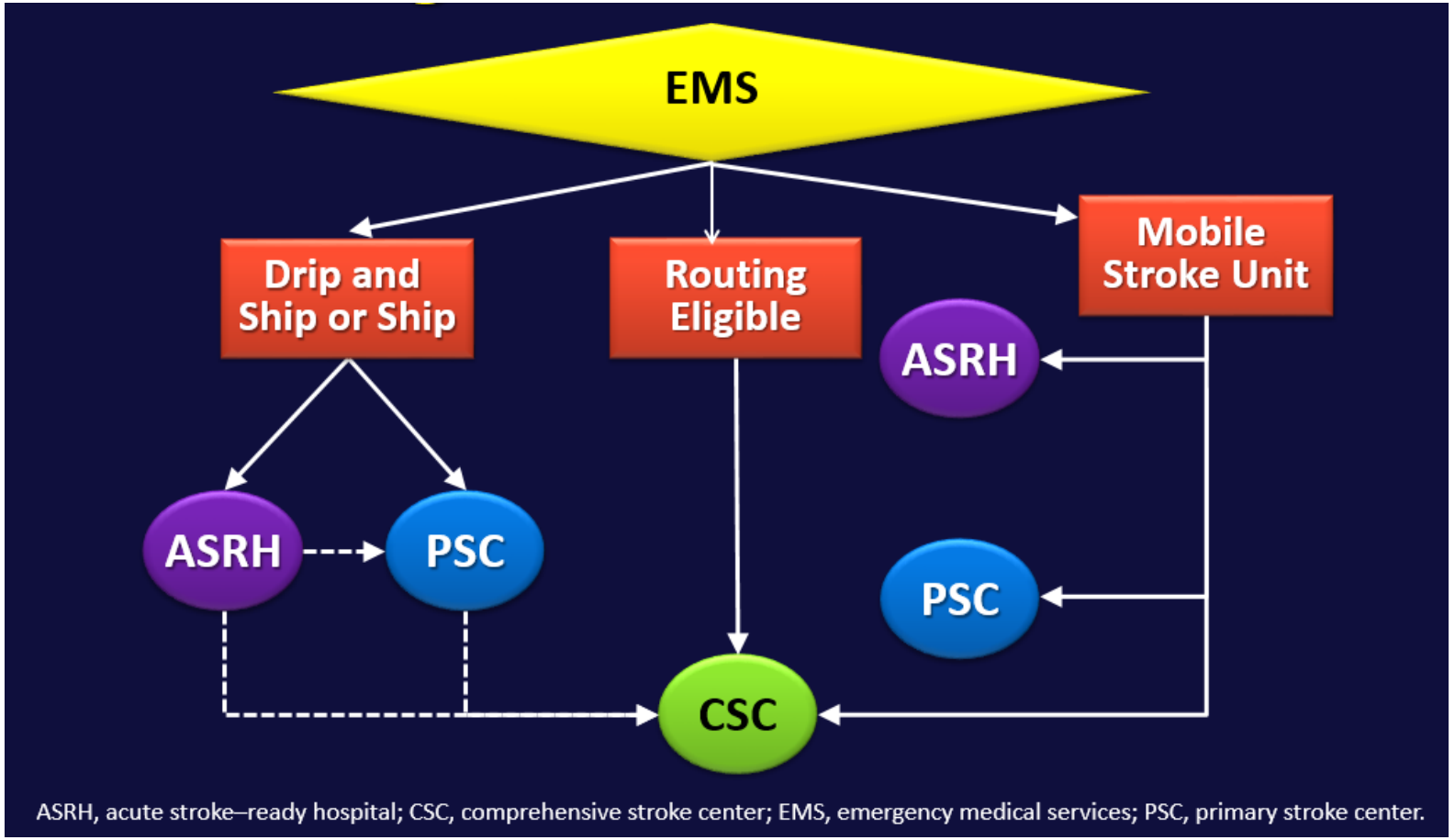
Teaching: Haymarket® Medical Education (underwritten by Medtronic Inc.)

Expert witness medical review in cases involving neurological emergencies

UNLABELED/UNAPPROVED USES DISCLOSURE:

IV tPA treatment of ischemic stroke beyond 3 hours of symptom onset

Stroke Triage and Destination Scenarios



ASRH, acute stroke–ready hospital; CSC, comprehensive stroke center; EMS, emergency medical services; PSC, primary stroke center.

Direct Routing Rationale

- An estimated 56% of patients live within one hour of a thrombectomy-capable hospital

  Smith EE, Schwamm LH. *Stroke*. 2015;46(6):1462-1467.

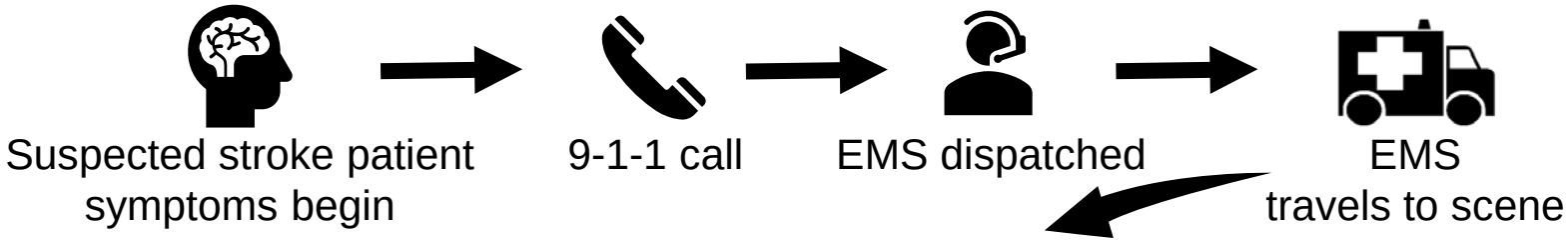
- Patients with Large Vessel Occlusion (LVO) Acute Ischemic Strokes (AIS) should be transported directly to an endovascular center
  - Delays in interhospital transfers for ET reduce the likelihood of performing endovascular intervention

    Prabhakaran S et al. *Stroke* 2011;42:1626-1630.

  - Interhospital transfer prior to thrombectomy is associated with delayed treatment and worse outcome

    Froehler MT et al. *Circulation* 2017; doi.org/10.1161/CIRCULATIONAHA.117.028920

Routing Algorithm



On Scene

EMS assessment of stroke severity

Positive screen for LVO and time since symptom onset ≤ 6 hours

Within permitted additional transport time to endovascular stroke center?

Yes

Patient transport to nearest endovascular stroke center

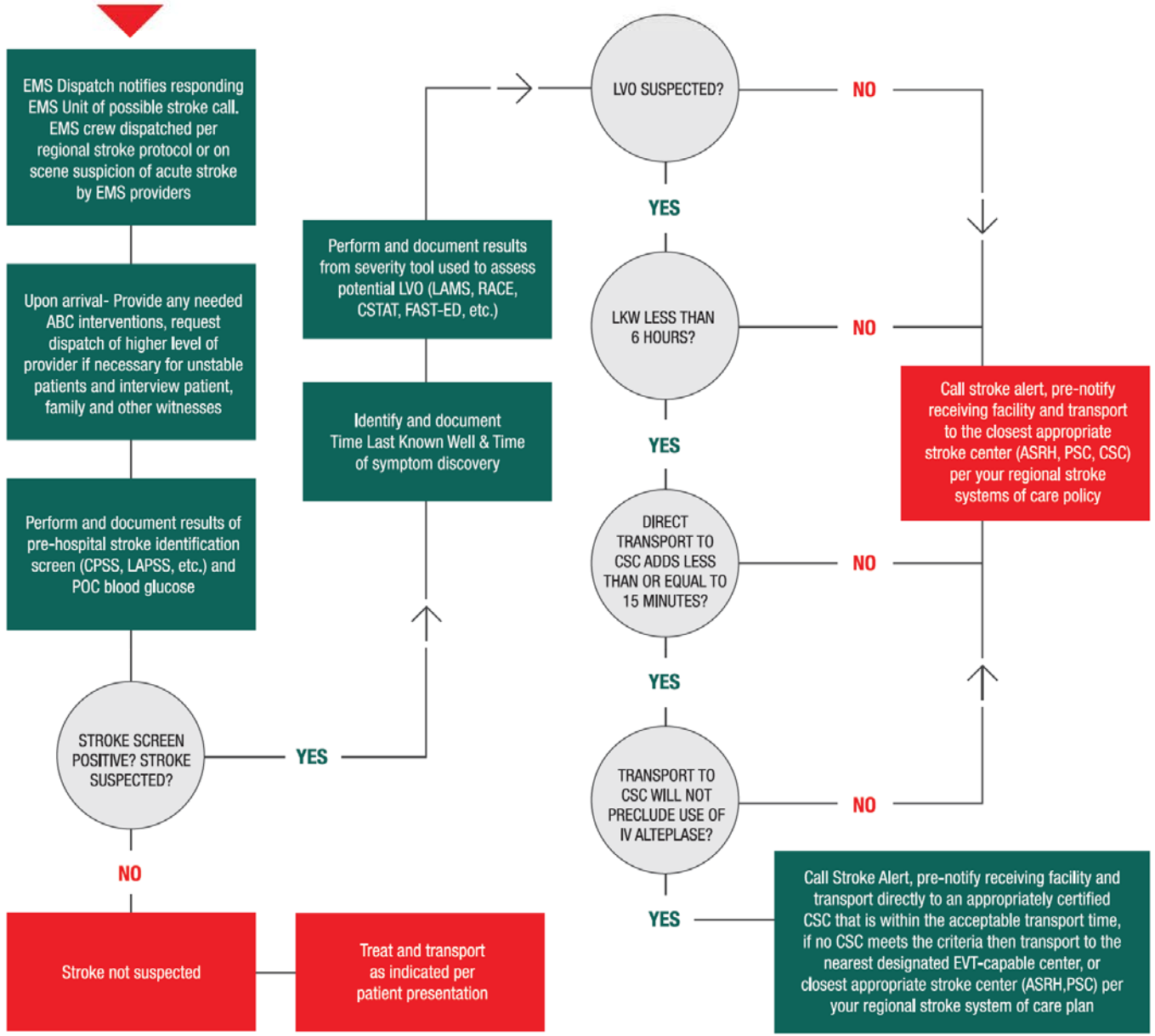
Negative screen for LVO or time since symptom onset > 6 hours

No

Patient transport to nearest hospital

SEVERITY-BASED STROKE TRIAGE ALGORITHM FOR EMS

American Heart Association | American Stroke Association — life is why
Together to End Stroke™
MISSION: LIFELINE



Questions you need to ask and answer before implementing a regional “routing” protocol

- What rates of suspected severe stroke over-/undertriage are acceptable regionally?
- What are the sensitivities/specificities of your EMS dispatchers for stroke?
- What is the prevalence of LVO and/or ICH in the population that your EMS agencies transport for suspected acute stroke?
- What is the inter-rater reliability and accuracy of the chosen stroke severity screen for identifying LVOs (and ICHs?)?
- How have any time stipulations within the severity based triage protocol been determined?
  (e.g. time since LKW for screening eligibility, maximum added allowable transport time for routing)

Where do you start?

At some point, either dispatch or the medics need to consider stroke as the diagnosis

EMS Dispatch notifies responding EMS Unit of possible stroke call. EMS crew dispatched per regional stroke protocol or on scene suspicion of acute stroke by EMS providers

Upon arrival- Provide any needed ABC interventions, request dispatch of higher level of provider if necessary for unstable patients and interview patient, family and other witnesses

The PLUMBER Study

The Prevalence of Large vessel occlUsion stroke in MecklenBurg County Emergency Response Study

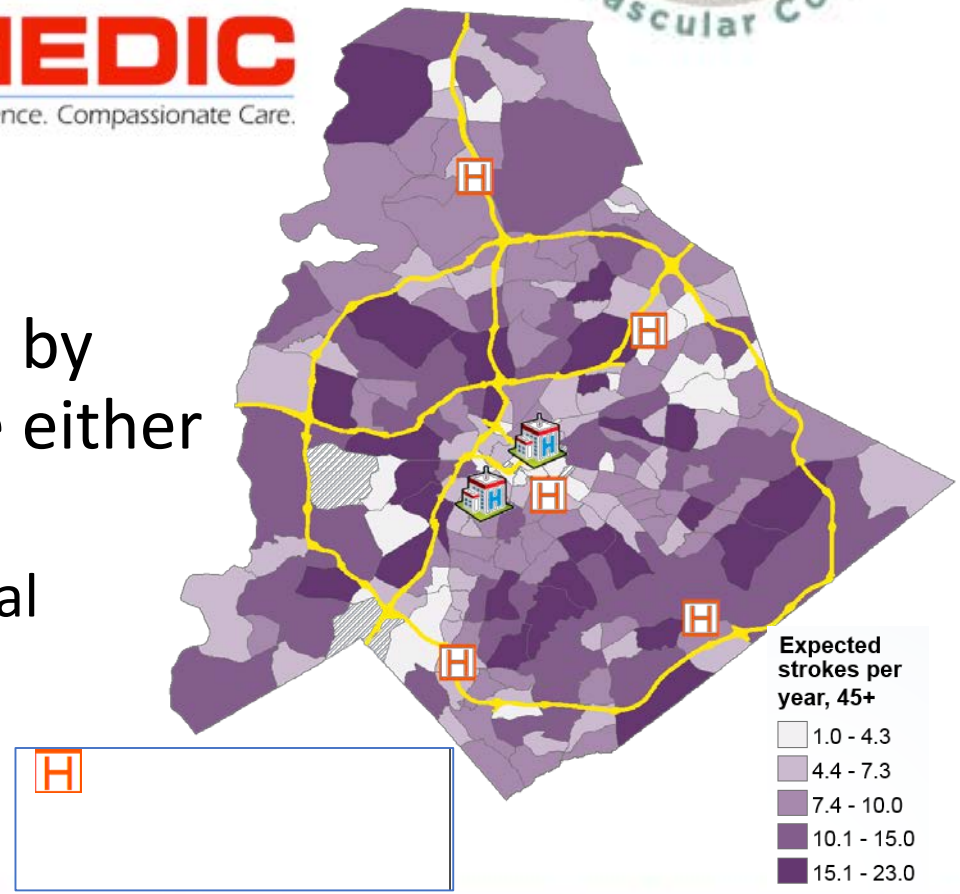
Carolinas HealthCare System

NOVANT HEALTH

MEDIC
Medical Excellence. Compassionate Care.

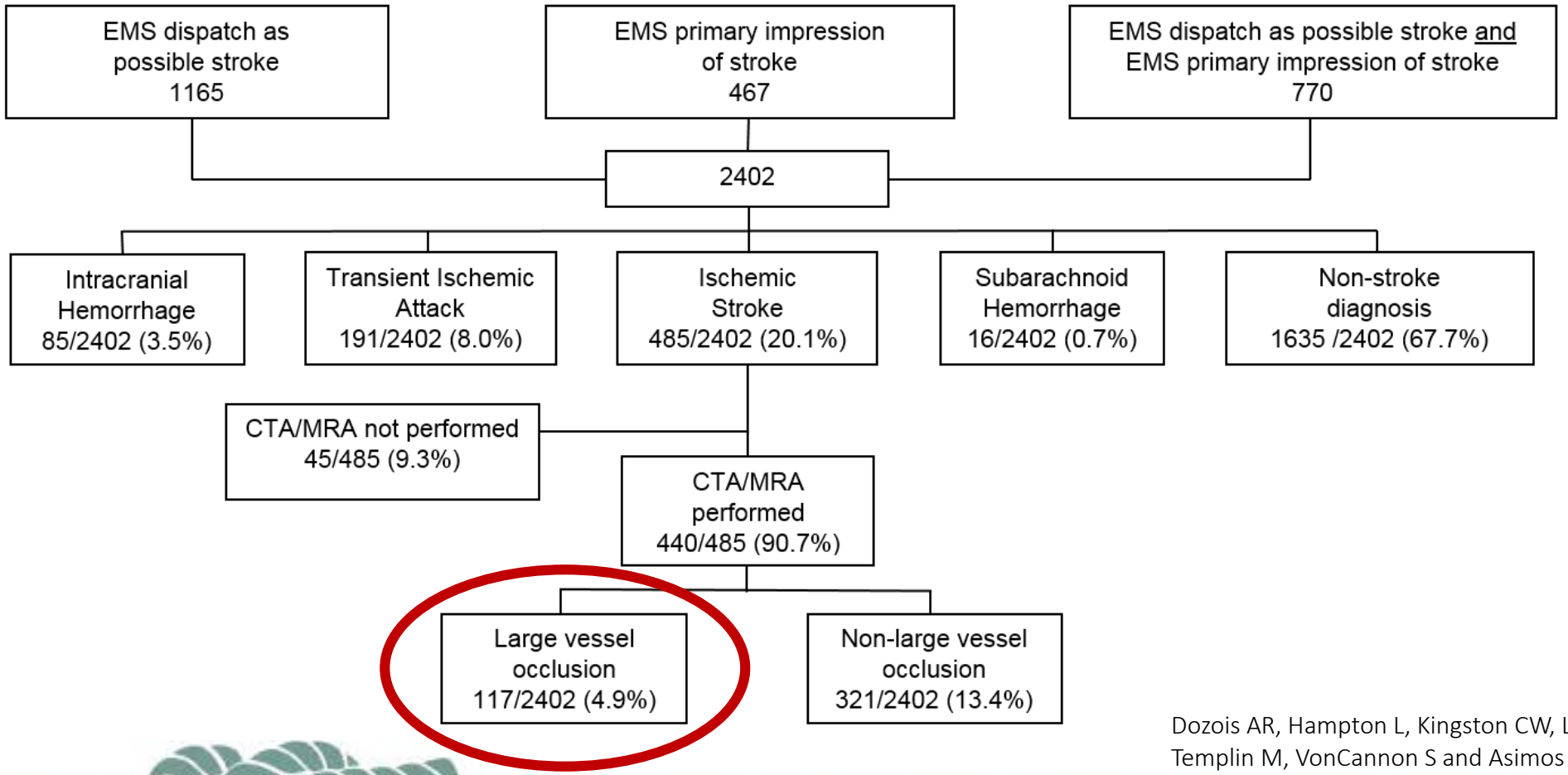
The NorthEast Cerebrovascular Consortium
EST 2006
NECC

- Cross sectional study of all patients transported by the Mecklenburg county EMS agency who were either
  - Dispatched as a possible stroke and/or
  - Primary impression of stroke recorded by prehospital providers



Dozois AR, Hampton L, Kingston CW, Lambert G, Porcelli TJ, Sorenson D, Templin M, VonCannon S and Asimos AW. *Stroke* 2017;48: *in press*

LVO Prevalence in PLUMBER



Dozois AR, Hampton L, Kingston CW, Lambert G, Porcelli TJ, Sorenson D, Templin M, VonCannon S and Asimos AW. *Stroke* 2017;48: *in press*

Poor accuracy of stroke identification by EMS Dispatch

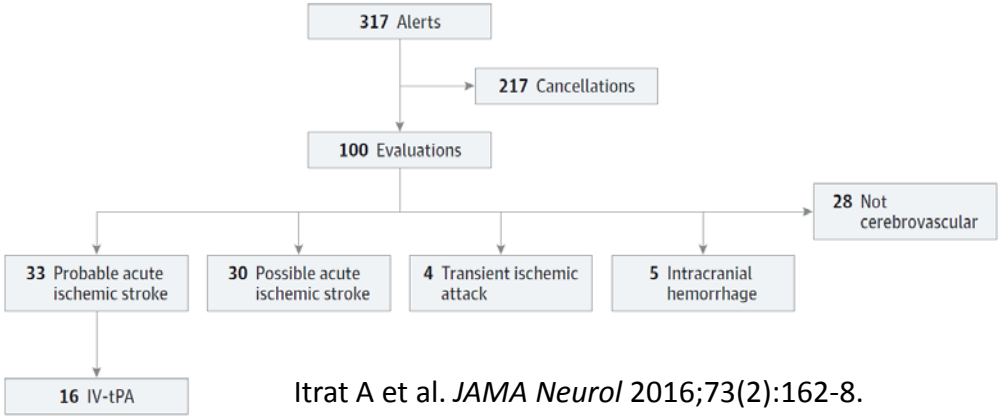
- Sensitivity of 35-53%

  Caceres JA et al. *J Stroke and Cerebrovasc Dis* **2013;**22(8):e610-e614.
  Krebes S et al. *Stroke* 2012;43:776-781.

- Specificity of 15-18%

  Viereck S et al. *Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine* 2016;24:89 DOI 10.1186/s13049-016-0277-5
  Ramanujam P et al. *Prehosp Emer Care* 2008;12(3)307-313.

Flowchart Showing the Triage and Initial Diagnoses of the Cleveland Clinic MSU

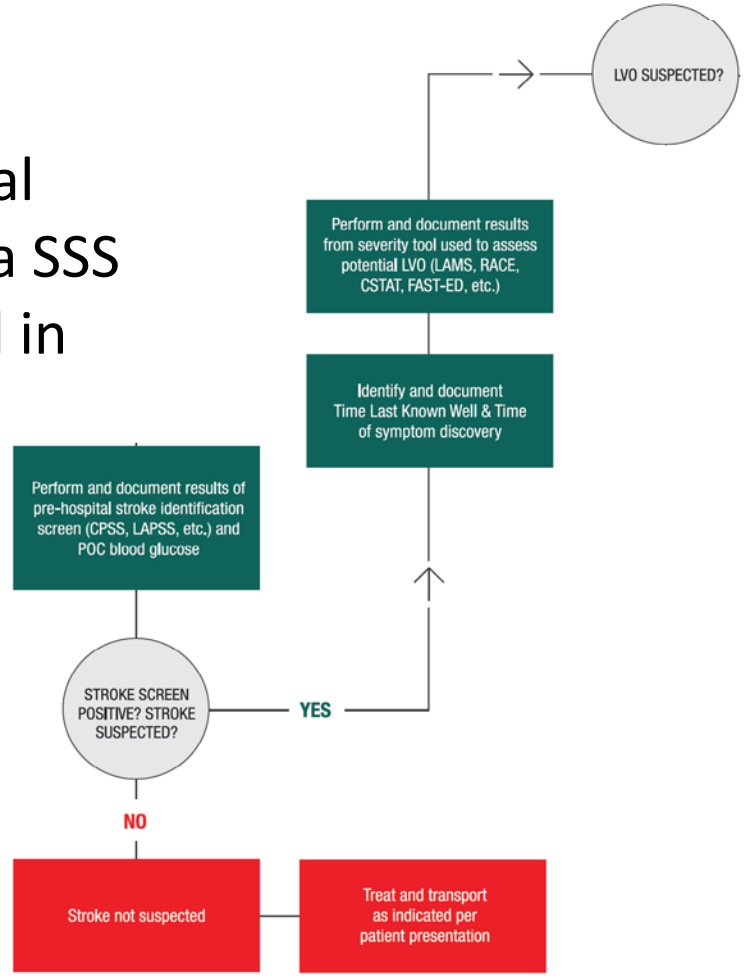


Itrat A et al. *JAMA Neurol* 2016;73(2):162-8.

Serial Use of Stroke Screens

Stroke Identification Screen (SIS) followed by a Stroke Severity Screen (SSS)

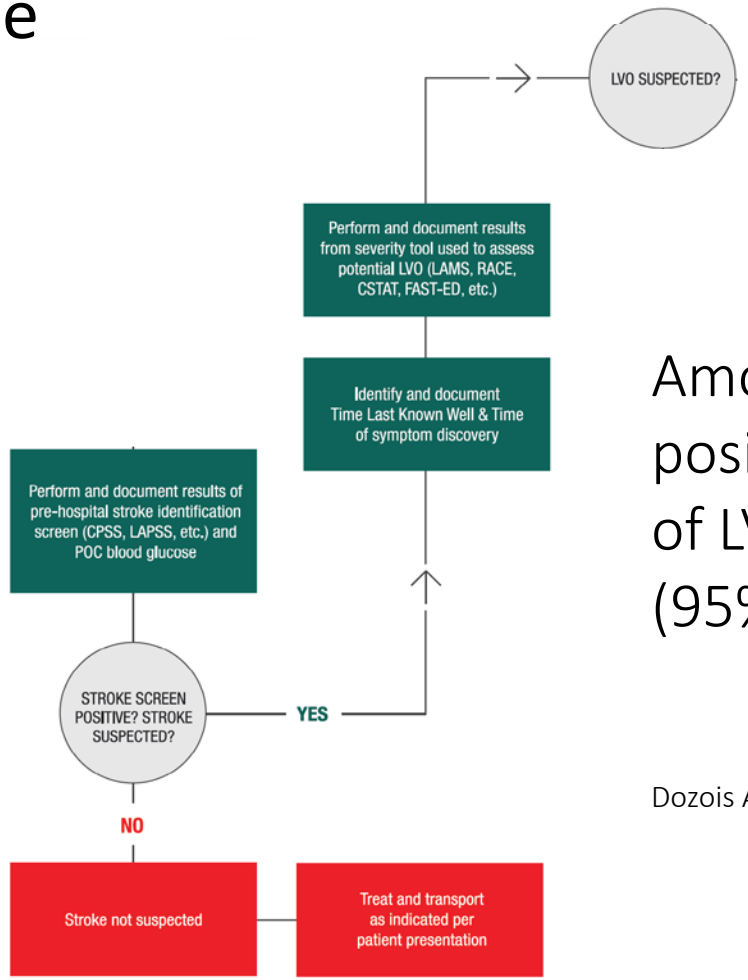
Experience with the serial use of a SIS followed by a SSS has never been reported in the medical literature



Serial Use of Stroke Screens

PLUMBER experience

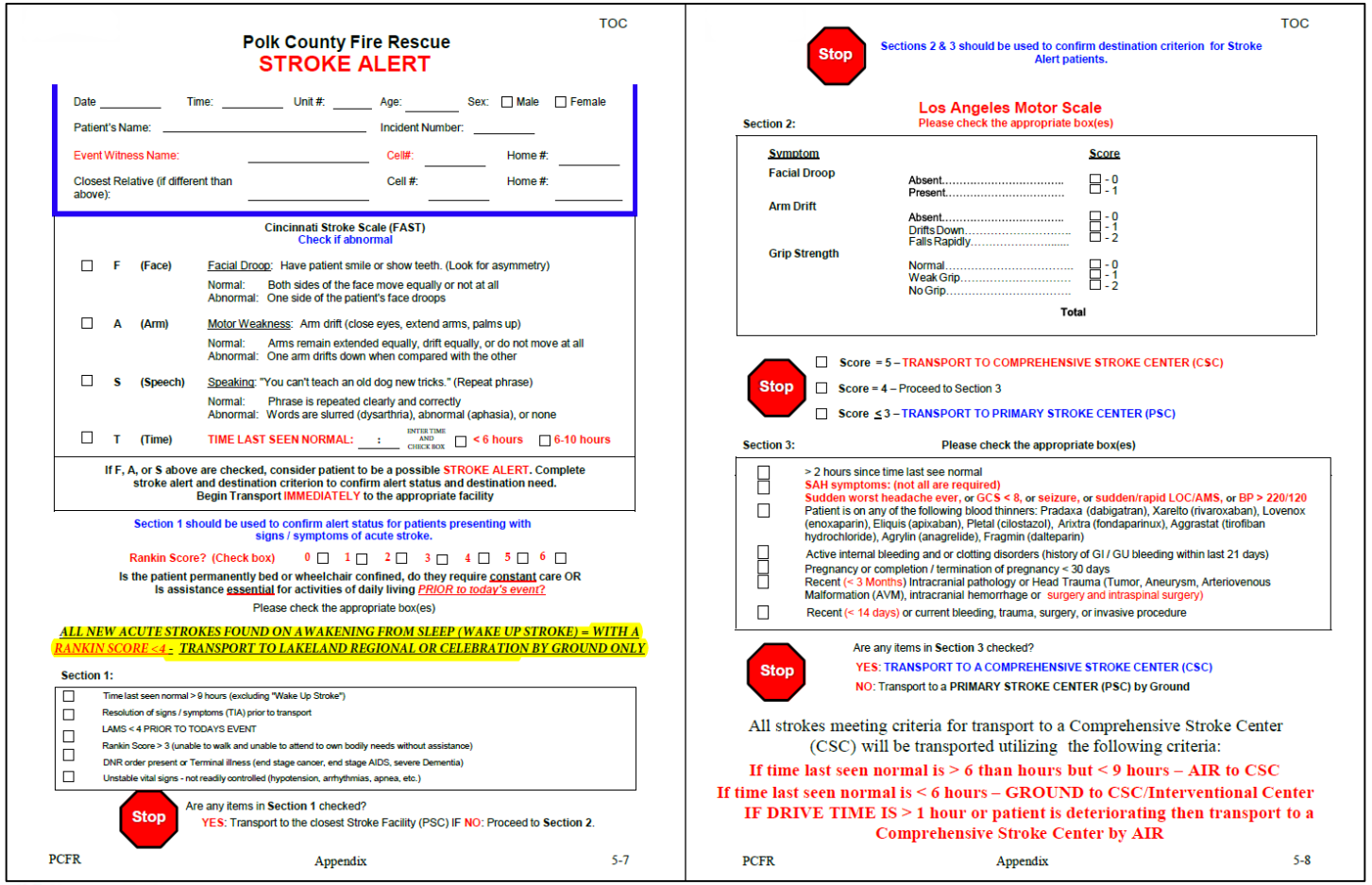
2.7% of patients with an LVO had a normal CPSS (n=3/113), including occlusions of the ICA, M1, and the basilar artery



Among patients with a positive CPSS, the prevalence of LVO increased to 11.2% (95% CI 9.3%-13.3%)

Dozois AR. May18, 2017, *SAEM Annual Meeting,* Orlando, FL

Serial Use of Stroke Screens



TOC

Polk County Fire Rescue
STROKE ALERT

Date _____ Time: _____ Unit #: _____ Age: _____ Sex: ☐ Male ☐ Female

Patient's Name: _____ Incident Number: _____

Event Witness Name: _____ Cell#: _____ Home #: _____

Closest Relative (if different than above): _____ Cell #: _____ Home #: _____

Cincinnati Stroke Scale (FAST)
Check if abnormal

☐ F (Face) Facial Droop: Have patient smile or show teeth. (Look for asymmetry)
Normal: Both sides of the face move equally or not at all
Abnormal: One side of the patient's face droops

☐ A (Arm) Motor Weakness: Arm drift (close eyes, extend arms, palms up)
Normal: Arms remain extended equally, drift equally, or do not move at all
Abnormal: One arm drifts down when compared with the other

☐ S (Speech) Speaking: "You can't teach an old dog new tricks." (Repeat phrase)
Normal: Phrase is repeated clearly and correctly
Abnormal: Words are slurred (dysarthria), abnormal (aphasia), or none

☐ T (Time) TIME LAST SEEN NORMAL: ___ : ___ (ENTER TIME AND CHECK BOX) ☐ < 6 hours ☐ 6-10 hours

If F, A, or S above are checked, consider patient to be a possible STROKE ALERT. Complete stroke alert and destination criterion to confirm alert status and destination need. Begin Transport IMMEDIATELY to the appropriate facility

Section 1 should be used to confirm alert status for patients presenting with signs / symptoms of acute stroke.

Rankin Score? (Check box) 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐

Is the patient permanently bed or wheelchair confined, do they require constant care OR Is assistance essential for activities of daily living *PRIOR to today's event?*

Please check the appropriate box(es)

ALL NEW ACUTE STROKES FOUND ON AWAKENING FROM SLEEP (WAKE UP STROKE) = WITH A RANKIN SCORE ≤4 - TRANSPORT TO LAKELAND REGIONAL OR CELEBRATION BY GROUND ONLY

Section 1:

- ☐ Time last seen normal > 9 hours (excluding "Wake Up Stroke")
- ☐ Resolution of signs / symptoms (TIA) prior to transport
- ☐ LAMS < 4 PRIOR TO TODAYS EVENT
- ☐ Rankin Score > 3 (unable to walk and unable to attend to own bodily needs without assistance)
- ☐ DNR order present or Terminal illness (end stage cancer, end stage AIDS, severe Dementia)
- ☐ Unstable vital signs - not readily controlled (hypotension, arrhythmias, apnea, etc.)

Stop

Are any items in **Section 1** checked?
YES: Transport to the closest Stroke Facility (PSC) IF **NO**: Proceed to **Section 2**.

PCFR Appendix 5-7

TOC

Stop **Sections 2 & 3 should be used to confirm destination criterion for Stroke Alert patients.**

Los Angeles Motor Scale
Please check the appropriate box(es)

Section 2:

Symptom		Score
Facial Droop	Absent.....	☐ - 0
	Present.....	☐ - 1
Arm Drift	Absent.....	☐ - 0
	Drifts Down.....	☐ - 1
	Falls Rapidly.....	☐ - 2
Grip Strength	Normal.....	☐ - 0
	Weak Grip.....	☐ - 1
	No Grip.....	☐ - 2
	Total	

Stop

☐ **Score = 5 – TRANSPORT TO COMPREHENSIVE STROKE CENTER (CSC)**
☐ **Score = 4 – Proceed to Section 3**
☐ **Score ≤ 3 – TRANSPORT TO PRIMARY STROKE CENTER (PSC)**

Section 3: **Please check the appropriate box(es)**

- ☐ > 2 hours since time last see normal
- ☐ **SAH symptoms: (not all are required)**
- ☐ **Sudden worst headache ever, or GCS < 8, or seizure, or sudden/rapid LOC/AMS, or BP > 220/120**
- ☐ Patient is on any of the following blood thinners: Pradaxa (dabigatran), Xarelto (rivaroxaban), Lovenox (enoxaparin), Eliquis (apixaban), Pletal (cilostazol), Arixtra (fondaparinux), Aggrastat (tirofiban hydrochloride), Agrylin (anagrelide), Fragmin (dalteparin)
- ☐ Active internal bleeding and or clotting disorders (history of GI / GU bleeding within last 21 days)
- ☐ Pregnancy or completion / termination of pregnancy < 30 days
- ☐ Recent (< 3 Months) Intracranial pathology or Head Trauma (Tumor, Aneurysm, Arteriovenous Malformation (AVM), intracranial hemorrhage or surgery and intraspinal surgery)
- ☐ Recent (< 14 days) or current bleeding, trauma, surgery, or invasive procedure

Stop

Are any items in **Section 3** checked?
YES: TRANSPORT TO A COMPREHENSIVE STROKE CENTER (CSC)
NO: Transport to a **PRIMARY STROKE CENTER (PSC) by Ground**

All strokes meeting criteria for transport to a Comprehensive Stroke Center (CSC) will be transported utilizing the following criteria:

If time last seen normal is > 6 than hours but < 9 hours – AIR to CSC
If time last seen normal is < 6 hours – GROUND to CSC/Interventional Center
IF DRIVE TIME IS > 1 hour or patient is deteriorating then transport to a Comprehensive Stroke Center by AIR

PCFR Appendix 5-8

Stroke Severity Screens

Perform and document results from severity tool used to assess potential LVO (LAMS, RACE, CSTAT, FAST-ED, etc.)

Stroke Severity Screens

Screen	Score Range	Vision	Facial Palsy	Grip Strength	Arm Weakness	Leg Weakness	Gaze	Aphasia	Neglect	Level of Arousal	Cut Point	Sensitivity for LVO	Specificity for LVO
LAMS[1]	0-5		Y	Y (1, 2)	Y (1, 2)						≥4	81	89
RACE[2]	0-9		Y (1, 2)	Y	Y (1, 2)		Y	Y (1, 2)	Y (1, 2)		≥4 or 5	85-89	55-65
C-STAT[3]	0-4				Y		Y			Y	≥2	83	40
3ISS[4]	0-6				Y (1, 2)	Y (1, 2)	Y (1, 2)			Y (1, 2)	≥4	67	92
VAN[5]	Y/N	Y			Y		Y	Y	Y			100	90
PASS[6]	Y/N				Y		Y			Y		66	83
FAST-ED[7]	0-9		Y		Y (1, 2)		Y (1, 2)	Y (1, 2)	Y (1, 2)		≥4	60	89
FANG-D[8]	Y/N	Y			Y	Y	Y	Y	Y				

[1]Nazliel B et al. *Stroke* 2008:39;2264-2267.
[2]De la Ossa MP et al. *Stroke* 2014;45:87-91.
[3]Katz BS et al. *Stroke* 2015;46:1508-1512.
[4]Singer OC et al. *Stroke* 2005;36(4):773-6.
[5]Teleb MS et al. *J Intervent Surg* 2017;9(2):122-126.
[6]Hastrup S et al. *Stroke* 2016;47:1772-1776.
[7]Lima FO et al. *Stroke* 2016;47:1997-2002.
[8]Martin C et al. *Stroke* 2016;48:ATP28.

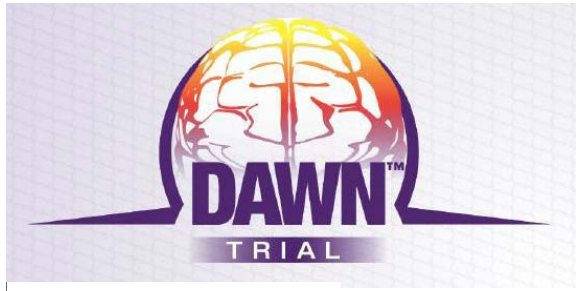
Predictive Values of Stroke Severity Screens

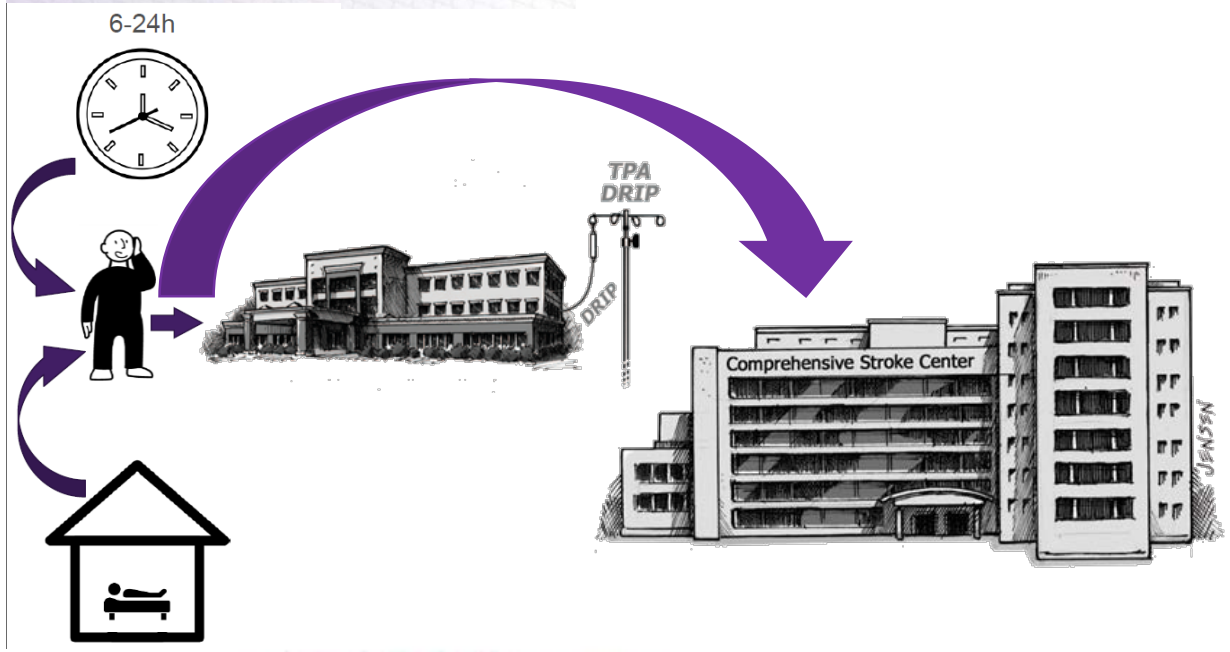
Based on a 5% and 10% Prevalence of LVO

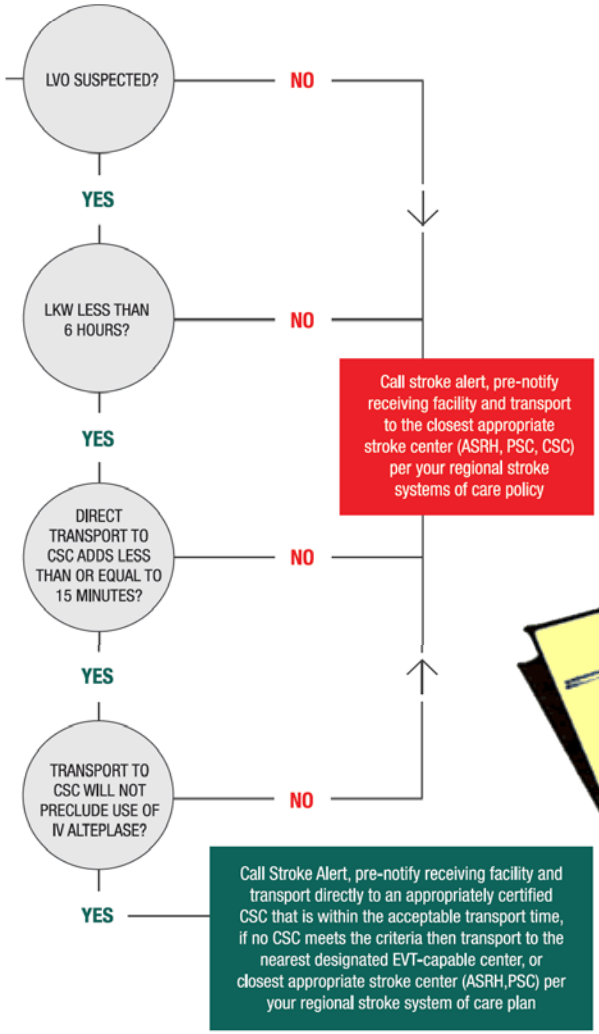
	5% Prevalence				10% Prevalence			
	Predictive Values		Likelihood Ratios*		Predictive Values		Likelihood Ratios*	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
LAMS[1] Score ≥4 81% Sensitivity, 89% Specificity	28%	99%	0.38	0.01	45%	98%	0.82	0.02
LAMS[2] Score ≥4 74% Sensitivity, 59% Specificity	9%	98%	0.09	0.02	17%	95%	0.2	0.05
RACE[3] Scale ≥5 85% Sensitivity, 68% Specificity	12%	99%	0.14	0.01	23%	98%	0.30	0.02
RACE[4] Scale ≥4 89% Sensitivity, 55% Specificity	9%	99%	0.10	0.01	18%	98%	0.22	0.02
C-STAT[5] Score ≥2 83% Sensitivity, 40% Specificity	7%	98%	0.07	0.02	13%	95%	0.15	0.05
3ISS[6] ≥ 4 67% Sensitivity, 92% Specificity	31%	98%	0.44	0.01	48%	96%	0.93	0.04
VAN[7] 100% Sensitivity, 90% Specificity	34%	100%	0.52	0.00	53%	100%	1.11	0.00
PASS[8] 66% Sensitivity, 83% Specificity	17%	98%	0.20	0.02	30%	96%	0.43	0.05
FAST-ED[9] ≥ 4 60% Sensitivity, 89% Specificity	22%	98%	0.28	0.02	38%	95%	0.61	0.05

[1]Nazliel B et al. *Stroke* 2008:39;2264-2267.
[2]De la Ossa MP et al. *Stroke* 2014;45:87-91.
[3]Katz BS et al. *Stroke* 2015;46:1508-1512.
[4]Singer OC et al. *Stroke* 2005;36(4):773-6.
[5]Teleb MS et al. *J Intervent Surg* 2017;9(2):122-126.
[6]Hastrup S et al. *Stroke* 2016;47:1772-1776.
[7]Lima FO et al. *Stroke* 2016;47:1997-2002.
[8]Martin C et al. *Stroke* 2016;48:ATP28.

Recommended Time Stipulations







Rebuttal

- Agree that inefficient transfer systems of care are a huge issue

- Agree that CSCs and PSCs should work together to improve stroke care for everyone
  - Rhode Island PSC ELVO protocol work is promising

McTaggart RA et al. *JAMA Neurol* 2017;74(7):793-800.

Los Angeles Motor Scale (LAMS)

PURE MOTOR

	LAMS	Definition
Facial Droop		
Absent	0	NIHSS 0-1
Present	1	NIHSS 2-3
Arm Drift		
Absent	0	NIHSS 0
Drift down	1	NIHSS 1
Falls Rapidly	2	NIHSS 2-4
Grip Strength		
Normal	0	Admission Exam 5/5
Weak	1	Admission Exam 2-4/5
No Grip	2	Admission Exam 0-1

Positive LAMS: ≥ 4

Nazliel B et al. *Stroke* 2008;39:2264-2267.

Field Validation of the Los Angeles Motor Scale as a Tool for Paramedic Assessment of Stroke Severity

Joon-Tae Kim, MD; Pil-Wook Chung, MD; Sidney Starkman, MD; Nerses Sanossian, MD; Samuel J. Stratton, MD; Marc Eckstein, MD, MPH; Frank D. Pratt, MD, MPHTM; Robin Conwit, MD; David S. Liebeskind, MD; Latisha Sharma, MD; Lucas Restrepo, MD; May-Kim Tenser, MD; Miguel Valdes-Sueiras, MD; Jeffrey Gornbein, PhD; Scott Hamilton, PhD; Jeffrey L. Saver, MD; on behalf of the FAST-MAG Trial (Field Administration of Stroke Therapy–Magnesium) Nurse-Coordinators and Investigators

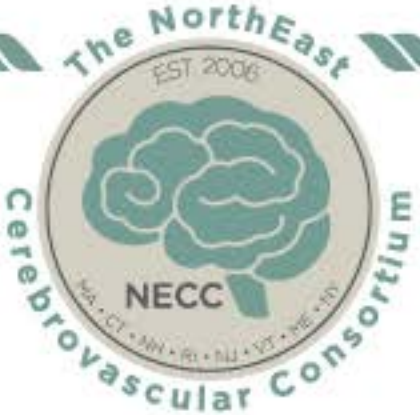
Background and Purpose—The Los Angeles Motor Scale (LAMS) is a 3-item, 0- to 10-point motor stroke-deficit scale developed for prehospital use. We assessed the convergent, divergent, and predictive validity of the LAMS when performed by paramedics in the field at multiple sites in a large and diverse geographic region.

Methods—We analyzed early assessment and outcome data prospectively gathered in the FAST-MAG trial (Field Administration of Stroke Therapy–Magnesium phase 3) among patients with acute cerebrovascular disease (cerebral ischemia and intracranial hemorrhage) within 2 hours of onset, transported by 315 ambulances to 60 receiving hospitals.

Results—Among 1632 acute cerebrovascular disease patients (age 70±13 years, male 57.5%), time from onset to prehospital LAMS was median 30 minutes (interquartile range 20–50), onset to early postarrival (EPA) LAMS was 145 minutes (interquartile range 119–180), and onset to EPA National Institutes of Health Stroke Scale was 150 minutes (interquartile range 120–180). Between the prehospital and EPA assessments, LAMS scores were stable in 40.5%, improved in 37.6%, and worsened in 21.9%. In tests of convergent validity, against the EPA National Institutes of Health Stroke Scale, correlations were r=0.49 for the prehospital LAMS and r=0.89 for the EPA LAMS. Prehospital LAMS scores did diverge from the prehospital Glasgow Coma Scale, r=–0.22. Predictive accuracy (adjusted C statistics) for nondisabled 3-month outcome was as follows: prehospital LAMS, 0.76 (95% confidence interval 0.74–0.78); EPA LAMS, 0.85 (95% confidence interval 0.83–0.87); and EPA National Institutes of Health Stroke Scale, 0.87 (95% confidence interval 0.85–0.88).

Conclusions—In this multicenter, prospective, prehospital study, the LAMS showed good to excellent convergent, divergent, and predictive validity, further establishing it as a validated instrument to characterize stroke severity in the field.

(*Stroke*. 2017;48:298-306. DOI: 10.1161/STROKEAHA.116.015247.)



This study does have several limitations. The study was performed among patients enrolled in a randomized clinical trial. Though the trial entry criteria were broad, the results may not be generalizable to patients who did not meet study entry criteria, such as patients with severe preexisting disability before onset of the current stroke. The EPA NIHSS examination analyzed in this study was performed a median of 83 minutes after ED arrival, when study personnel arrived at each performance site; in clinical practice, initial postarrival NIHSS exams may be performed earlier after arrival by immediately available clinical personnel and, given greater subsequent course fluctuation, would be expected to correlate with 3-month outcomes mildly less well than the exams here reported. Early vessel imaging after hospital arrival was not obtained routinely in studied patients, so that analysis of using the LAMS to identify patients with or without large vessel occlusions could not be conducted in the overall data set. A subsequent analysis is planned using data from a participating receiving hospital where early vessel imaging was acquired in consecutive patients.

Field Validation of Prehospital LAMS Score to Identify Large Vessel Occlusion Ischemic Stroke Patients for Direct Routing to Emergency Neuroendovascular Centers

Ali Reza Noorian, Nerses Sanossian, David S Liebeskind, Sidney Starkman, Marc Eckstein, Samuel Stratton, Graham G Woolf, Fiona Chatfield, Robin Conwit, Jeffrey L Saver for the FAST-MAG Investigators and Coordinators

Prehospital LAMS for Identifying LVO

- Sensitivity 74%
- Specificity 59%

Derivation

81%

89%

Noorian A, Sanossian N, Liebeskind DS, et al. Abstract 83: Field Validation of Prehospital LAMS Score to Identify Large Vessel Occlusion Ischemic Stroke Patients for Direct Routing to Emergency Neuroendovascular Centers. *Stroke*. 2016;47(Suppl 1):A83 LP-A83. http://stroke.ahajournals.org/content/47/Suppl_1/A83.abstract.

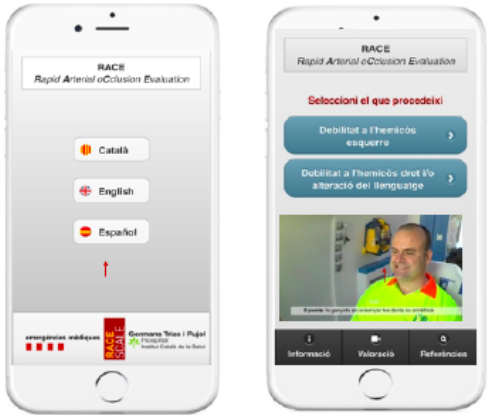
RACE Scale

Stroke
JOURNAL OF THE AMERICAN HEART ASSOCIATION

Stroke 2014; 45: 87-9

Design and Validation of a Prehospital Stroke Scale to Predict Large Arterial Occlusion: The Rapid Arterial oCclusion Evaluation Scale

Natalia Pérez de la Ossa, David Carrera, Montse Gorchs, Marisol Querol, Mònica Millán, Meritxell Gomis, Laura Dorado, Elena López-Cancio, María Hernández-Pérez, Vicente Chicharro, Xavier Escalada, Xavier Jiménez and Antoni Dávalos



RACE SCALE	www.racescale.org
Facial palsy	0-2
Arm motor	0-2
Leg motor	0-2
Head-gaze deviation	0-1
Aphasia - Agnosia	0-2
TOTAL	**0-9**

Perez de la Ossa N, Abilleira S, Ribó M, et al. Abstract 18: External Validation of the RACE Scale After Its Implementation in the Stroke Code Protocol in Catalonia. *Stroke*. 2017;48(Suppl 1):A18 LP-A18. http://stroke.ahajournals.org/content/48/Suppl_1/A18.abstract.

RACE ≥5:
Sensitivity 85%, Specificity 68% for LVO

External Validation of the RACE Scale After its Implementation in the Stroke Code Protocol in Catalonia

Pérez de la Ossa N, Abilleira S, Ribó M, Millan M, Cardona P, Urra X, Rodríguez-Campello A, Martí-Fábregas J, Purroy F, Serena J, Cánovas D, Garcés M, Krupinski J, Ustrell X, Saura J, Gorchs M, Carrera D, Jiménez X, Dávalos A , on behalf of the Catalan Stroke Code and Reperfusion Consortium (Cat-SCR)

emergències mèdiques

Germans Trias i Pujol Hospital
Institut Català de la Salut

Pla director de la malaltia vascular cerebral

Perez de la Ossa N, Abilleira S, Ribó M, et al. Abstract 18: External Validation of the RACE Scale After Its Implementation in the Stroke Code Protocol in Catalonia. *Stroke*. 2017;48(Suppl 1):A18 LP-A18. http://stroke.ahajournals.org/content/48/Suppl_1/A18.abstract.

Results

Identification of LVO

	RACE ≥ 5
Sensitivity	81%
Specificity	63%
PPV	43%
NPV	90%

Large Vessel Occlusion Scales Increase Delivery to Endovascular Centers Without Excessive Harm From Misclassifications

Henry Zhao, MBBS; Skye Coote, MN; Lauren Pesavento, BN; Leonid Churilov, PhD; Helen M. Dewey, PhD; Stephen M. Davis, MD; Bruce C.V. Campbell, PhD

Background and Purpose—Clinical large vessel occlusion (LVO) triage scales were developed to identify and bypass LVO to endovascular centers. However, there are concerns that scale misclassification of patients may cause excessive harm. We studied the settings where misclassifications were likely to occur and the consequences of these misclassifications in a representative stroke population.

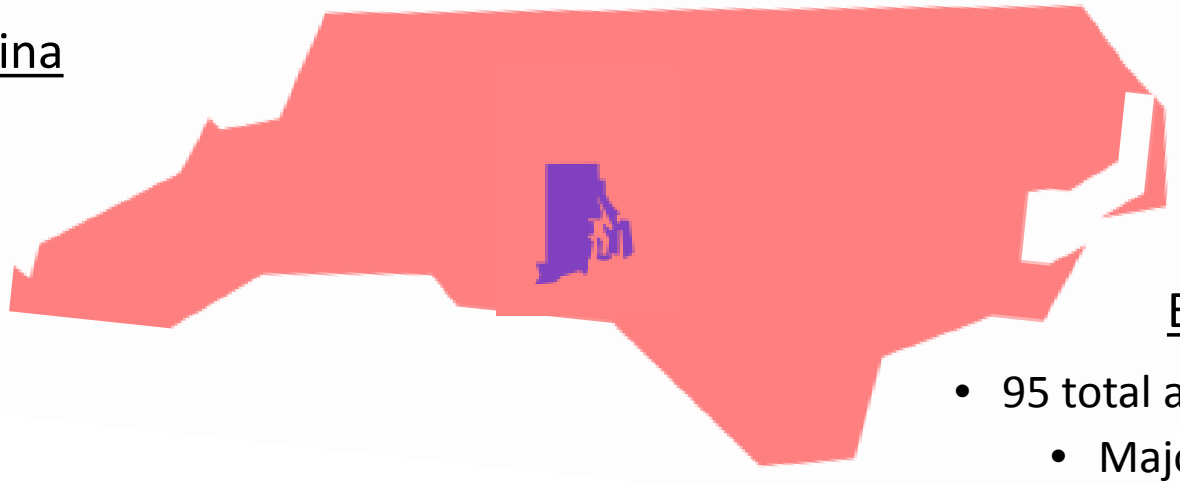
Methods—Prospective data were collected from consecutive ambulance-initiated stroke alerts at 2 stroke centers, with patients stratified into typical (LVO with predefined severe syndrome and non-LVO without) or atypical presentations (opposite situations). Five scales (Rapid Arterial Occlusion Evaluation [RACE], Los Angeles Motor Scale [LAMS], Field Assessment Stroke Triage for Emergency Destination [FAST-ED], Prehospital Acute Stroke Severity scale [PASS], and Cincinnati Prehospital Stroke Severity Scale [CPSSS]) were derived from the baseline National Institutes of Health Stroke Scale scored by doctors and analyzed for diagnostic performance compared with imaging.

Results—Of a total of 565 patients, atypical presentations occurred in 31 LVO (38% of LVO) and 50 non-LVO cases (10%). Most scales correctly identified >95% of typical presentations but <20% of atypical presentations. Misclassification attributable to atypical presentations would have resulted in 4 M1/internal carotid artery occlusions, with National Institutes of Health Stroke Scale score ≥6 (5% of LVO) being missed and 9 non-LVO infarcts (5%) bypassing the nearest thrombolysis center.

Conclusions—Atypical presentations accounted for the bulk of scale misclassifications, but the majority of these misclassifications were not detrimental, and use of LVO scales would significantly increase timely delivery to endovascular centers, with only a small proportion of non-LVO infarcts bypassing the nearest thrombolysis center. Our findings, however, would require paramedics to score as accurately as doctors, and this translation is made difficult by weaknesses in current scales that need to be addressed before widespread adoption. (***Stroke*. 2017;48:568-573. DOI: 10.1161/STROKEAHA.116.016056.)**

North Carolina versus Rhode Island

North Carolina (US) (139,509 km²) is **44** times as big as Rhode Island (US) (3,140 km²).



EMS in North Carolina

- 1,290 total agencies
  - 410 EMS agencies
  - 620 fire based
- 40,767 credentialed EMS professionals
  - May not be affiliated

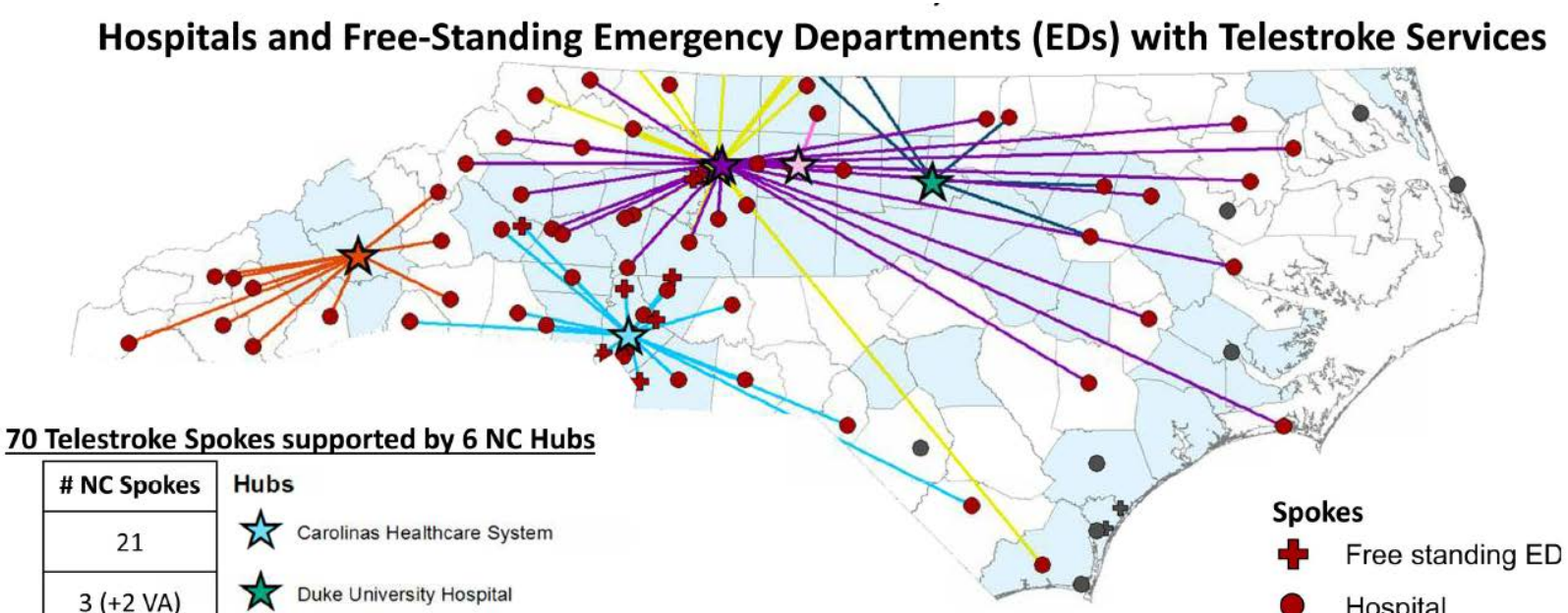
Source: NC OEMS, Division of Health Service Regulation
North Carolina Department of Health and Human Services

EMS in Rhode Island

- 95 total agencies
  - Majority are fire based (52) or third service (16) municipal departments
- 4,200 licensed providers

Jayaraman MV et al. *J NeuroIntervent Surg* 2017;9(3):330-332.

North Carolina Telestroke Map: 2017

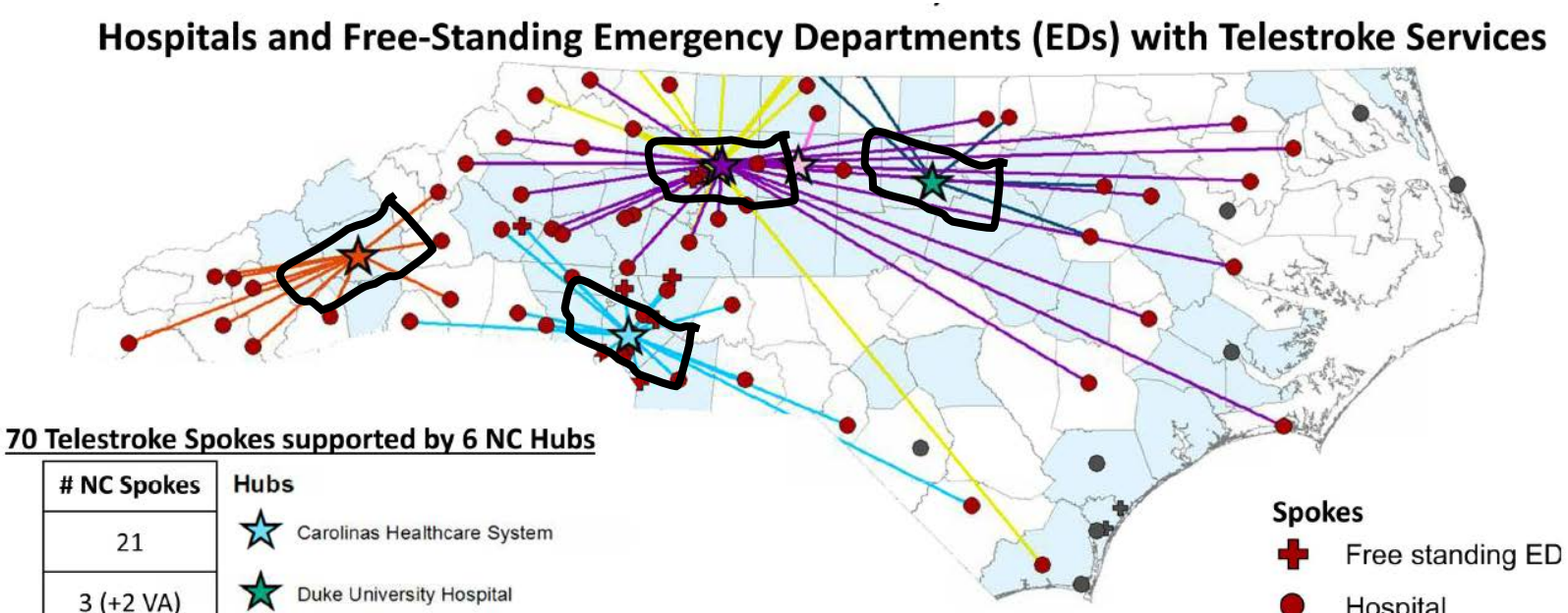


70 Telestroke Spokes supported by 6 NC Hubs

# NC Spokes	Hubs
21	Carolinas Healthcare System
3 (+2 VA)	Duke University Hospital
12	Mission Memorial Campus
10 (+4 VA)	Novant Forsyth Medical Center
3	The Moses H Cone Memorial Hospital
21	Wake Forest Baptist Medical Center

Created by: Brittany Bogle, bbogle@email.unc.edu
Sources:
Hub/Spokes: Previous Telestroke Maps and web search & list compiled by Anna Bess Brown, NC DHHS
Metro/non-Metro County Designation: obtained from The US Office of Management and Budget, 2016.
*Distributed spokes are facilities that receive Telestroke services from an independent contract

North Carolina Telestroke Map: 2017



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*Distributed spokes are facilities that receive Telestroke services from an independent contract

10 minute policy

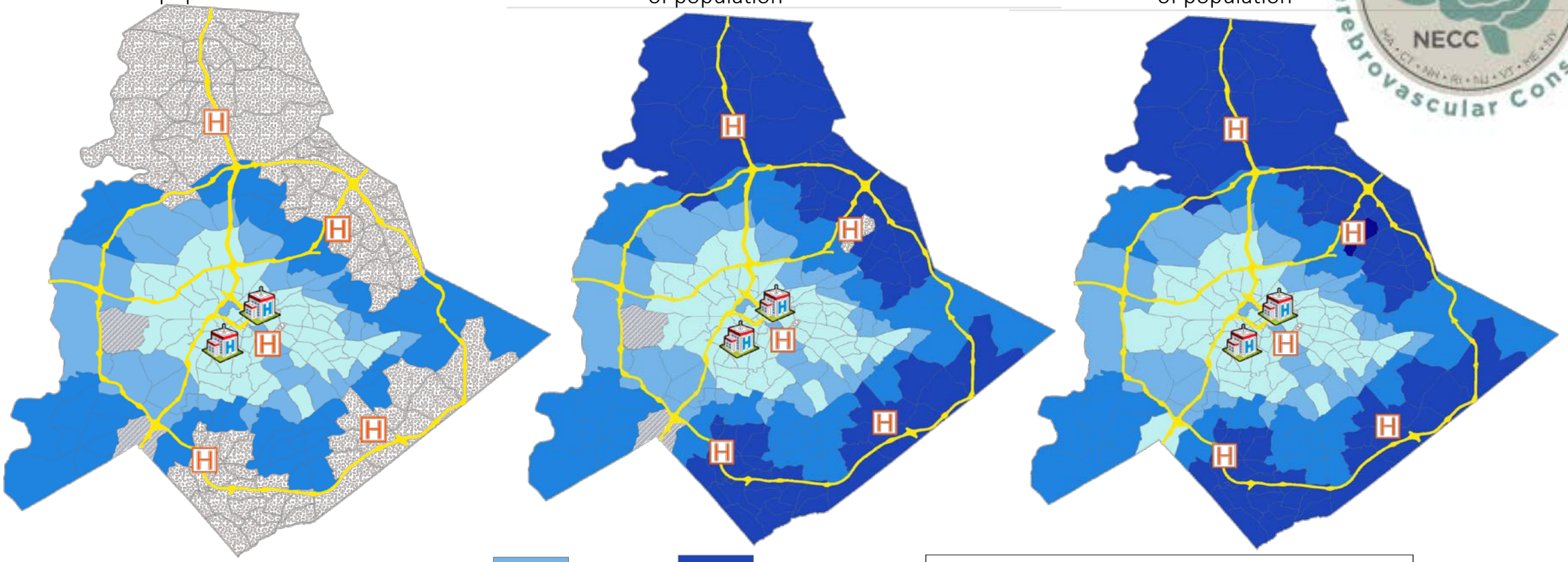
Covers 68%
of population

20 minute policy

Covers 99%
of population

30 minute policy

Covers 100%
of population



Average minutes added to transport

0

< 5

6 - 10

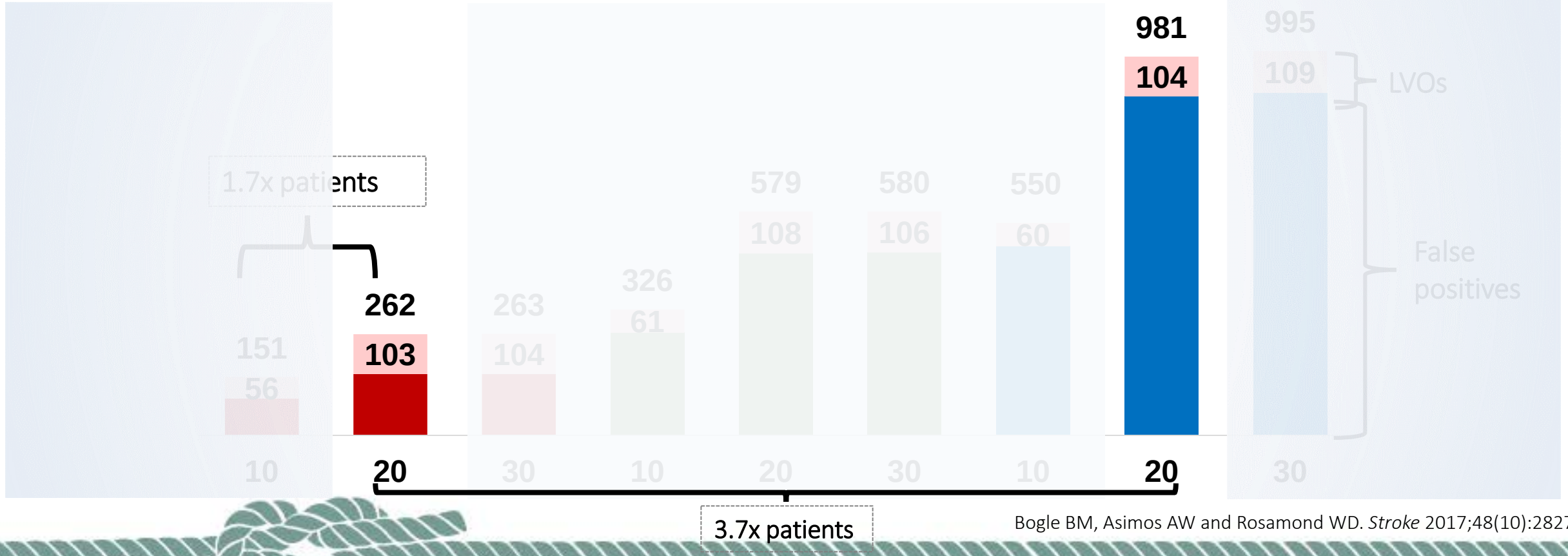
11 - 20

21 - 30

Bogle BM, Asimos AW and Rosamond WD. *Stroke* 2017;48(10):2827-2835.

Number of Patients transported to an Endovascular Center instead of closer hospital

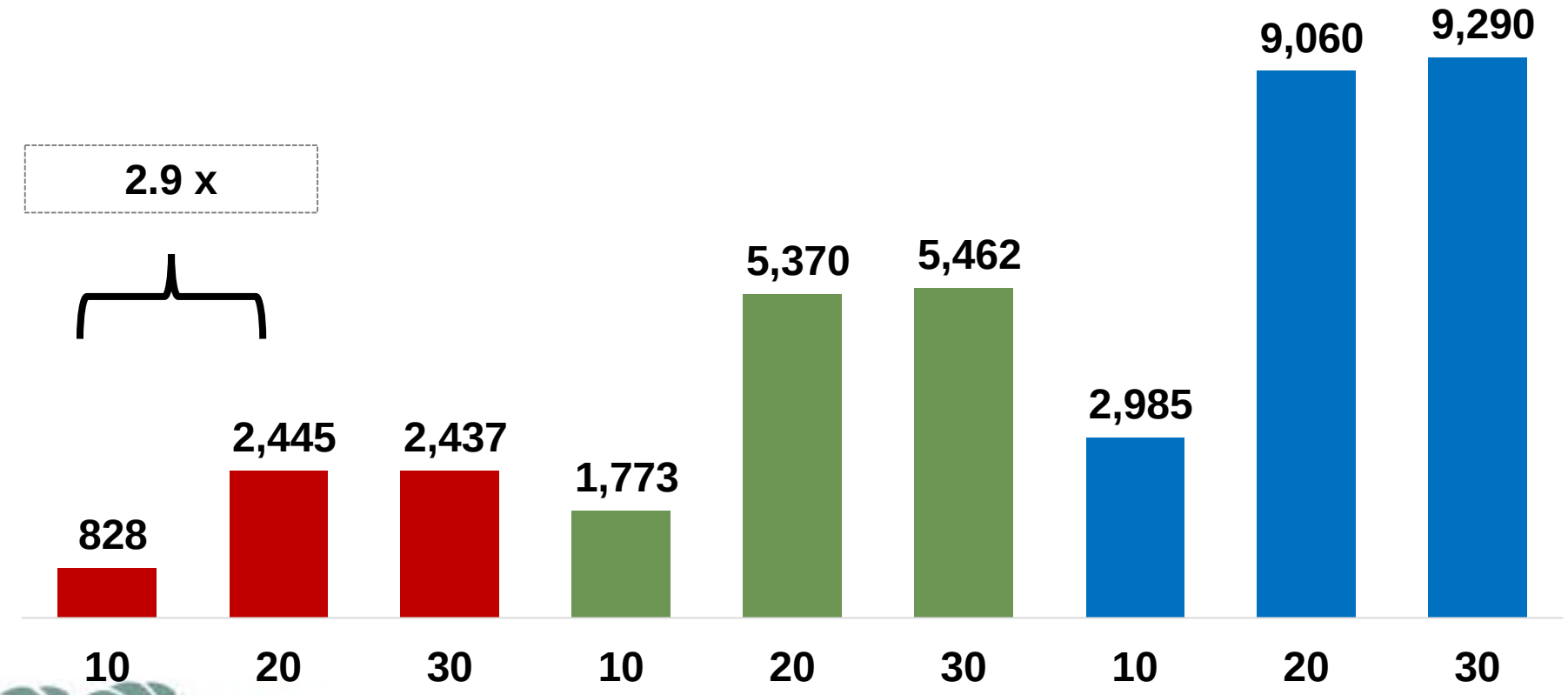
	LAMS≥4	RACE≥5	C-STAT≥2
Sens/Spec:	0.81/0.89	0.85/0.68	0.83/0.40



Bogle BM, Asimos AW and Rosamond WD. *Stroke* 2017;48(10):2827-2835.

Minutes per year of additional transport time

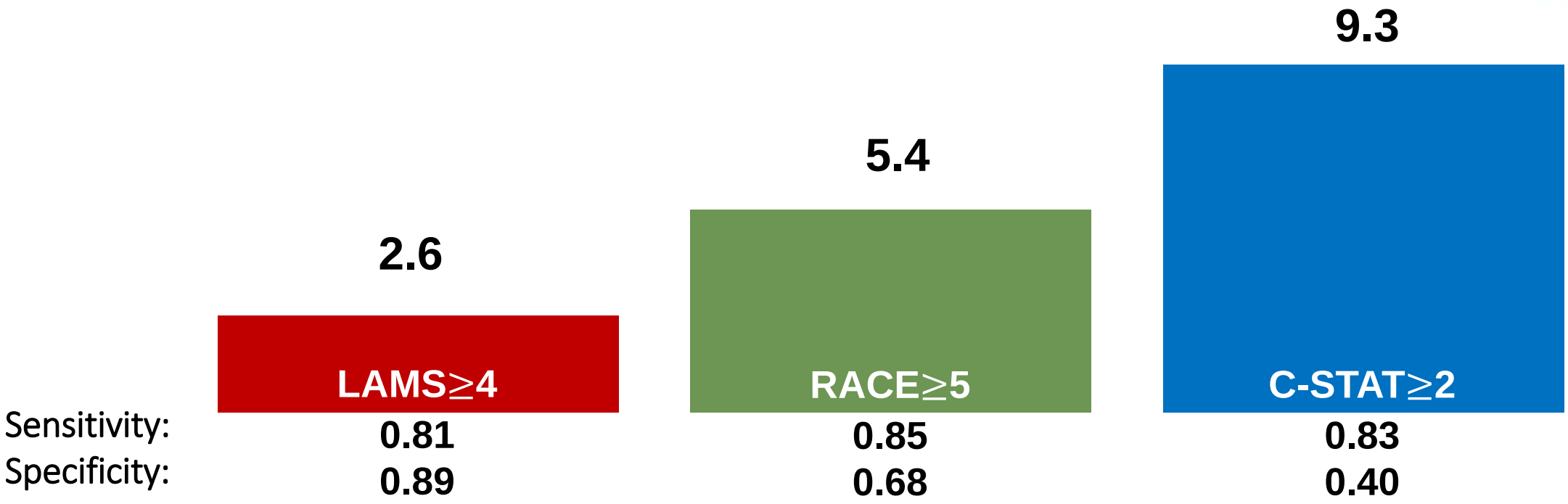
	LAMS≥4	RACE≥5	C-STAT≥2
Sens/Spec:	0.81/0.89	0.85/0.68	0.83/0.40



Bogle BM, Asimos AW and Rosamond WD. *Stroke* 2017;48(10):2827-2835.

Number Needed to Route (NNR)

Number of patients enduring additional transport time to route one LVO patient to an endovascular center



Bogle BM, Asimos AW and Rosamond WD. *Stroke* 2017;48(10):2827-2835.

"The specific scale chosen may be less important than the paradigm that some field severity assessment should be done to screen for possible ELVO."

-MV Jayaraman et al. *J Neurointervent Surg* 2017;9(3):330-332.

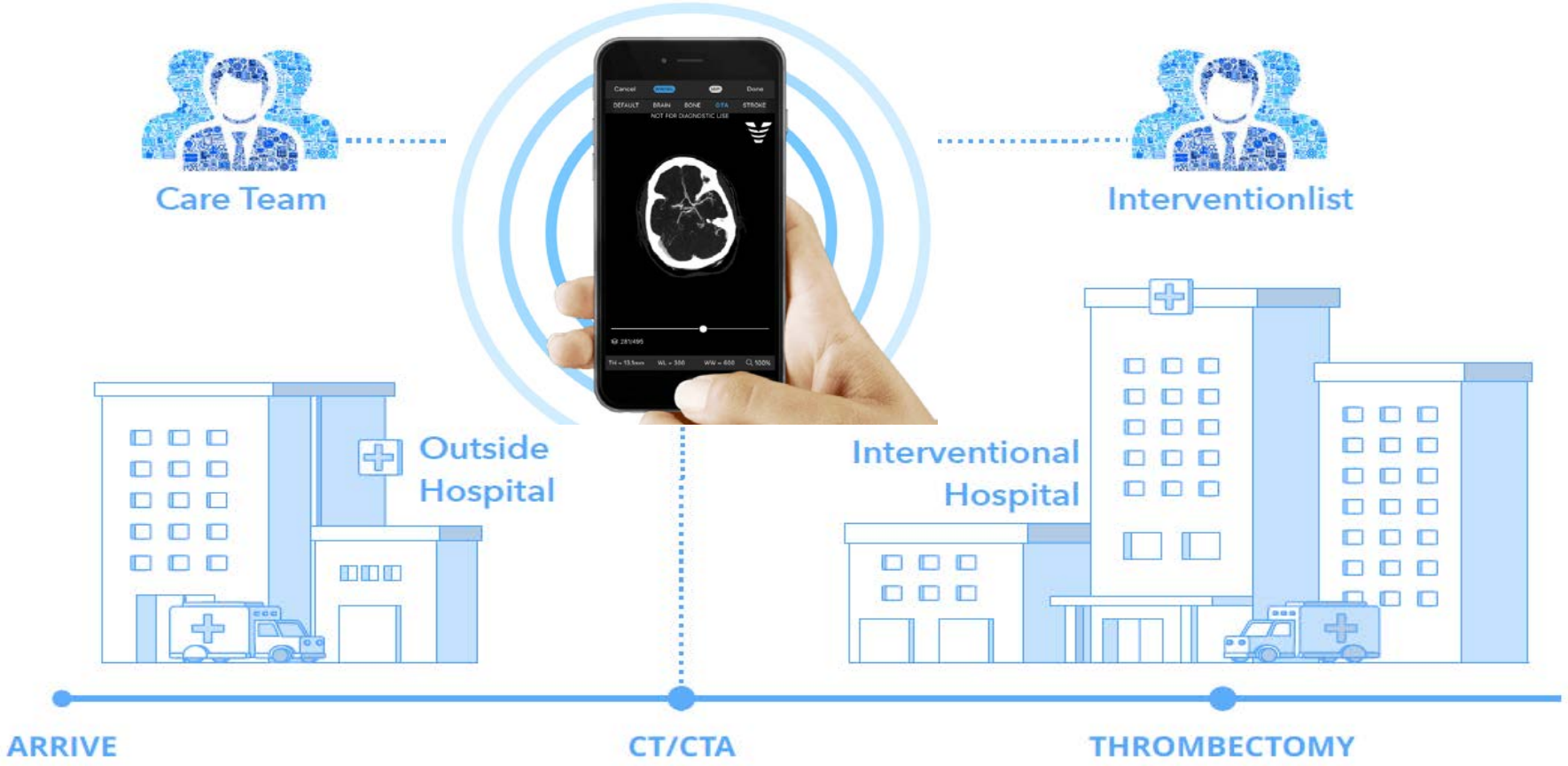
Summary

- Premature to widely implement the Mission Lifeline Severity based triage algorithm

- Regions should continue to explore innovative approaches to regionalization of acute stroke care
  - Prehospital telemedicine to triage
  - Stroke Tank studies
  - Novel “Pull” versus “Push”protocols

CATALIZE ALADIN

Carolinas Accelerated Transfer Algorithm UtiLIZing Expedited Automated Large Artery Occlusion Detection IN Stroke



Transport of Suspected Large Vessel Occlusion: What's the Right Protocol for Bypass?

Matthew S. Siket, MD, MS, FACEP
Co-Director, The Stroke Centers at Rhode Island Hospital & The Miriam Hospital
Assistant Professor of Emergency Medicine
The Warren Alpert Medical School of Brown University
Providence, RI

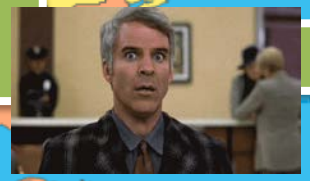
Disclosures

- None

I’m a Local Yokel

ESCAPE

SWIFT-PRIME



REVASCAT

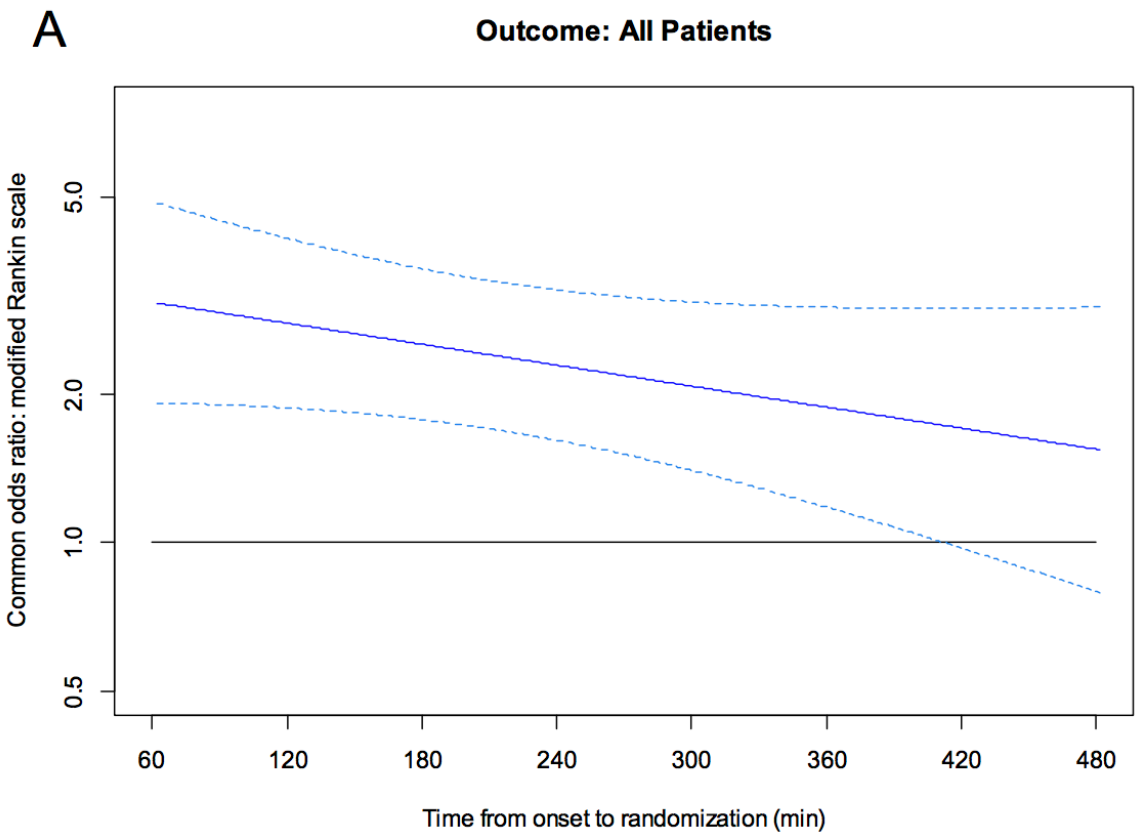
MR CLEAN

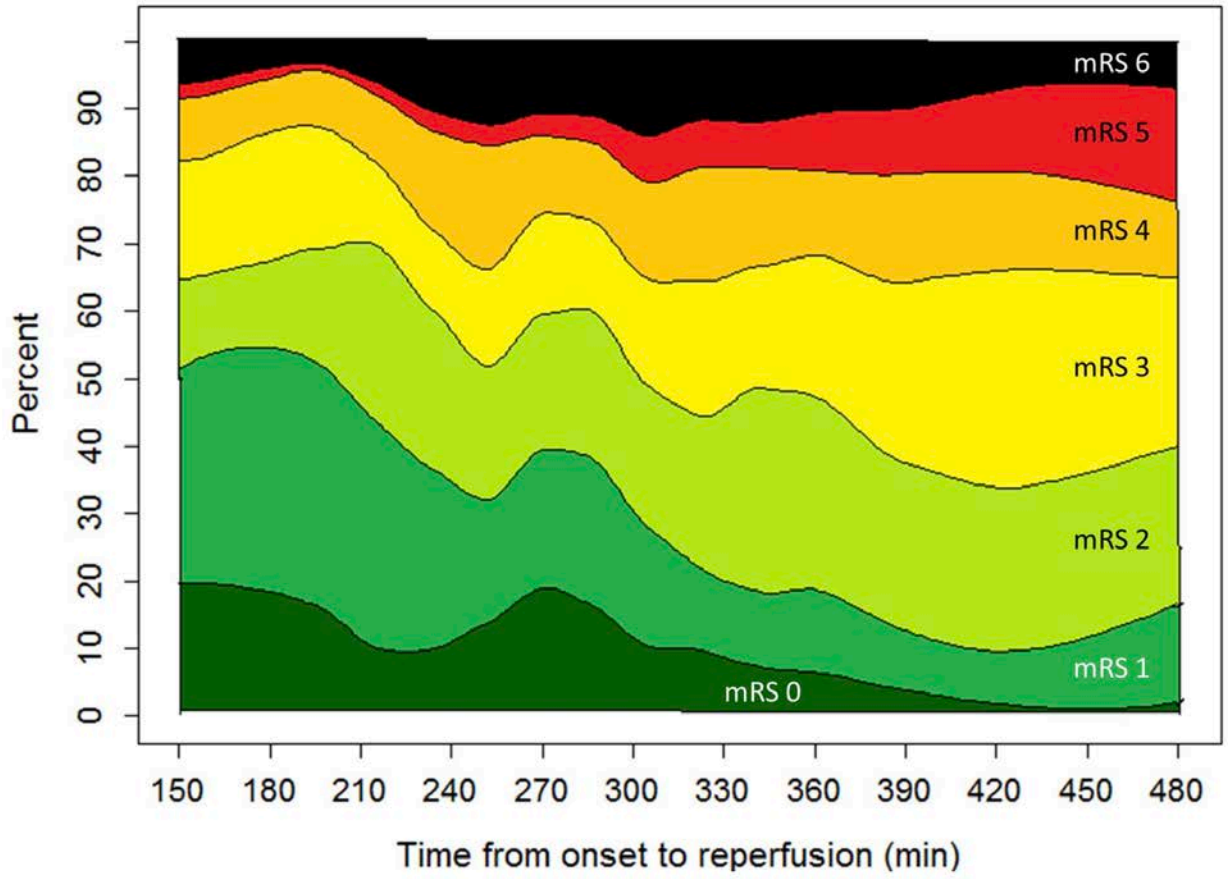
EXTEND-IA

NNT for a good outcome ranged from 3 to 7

Courtesy of Jayaraman MV

Time Dependent Effect





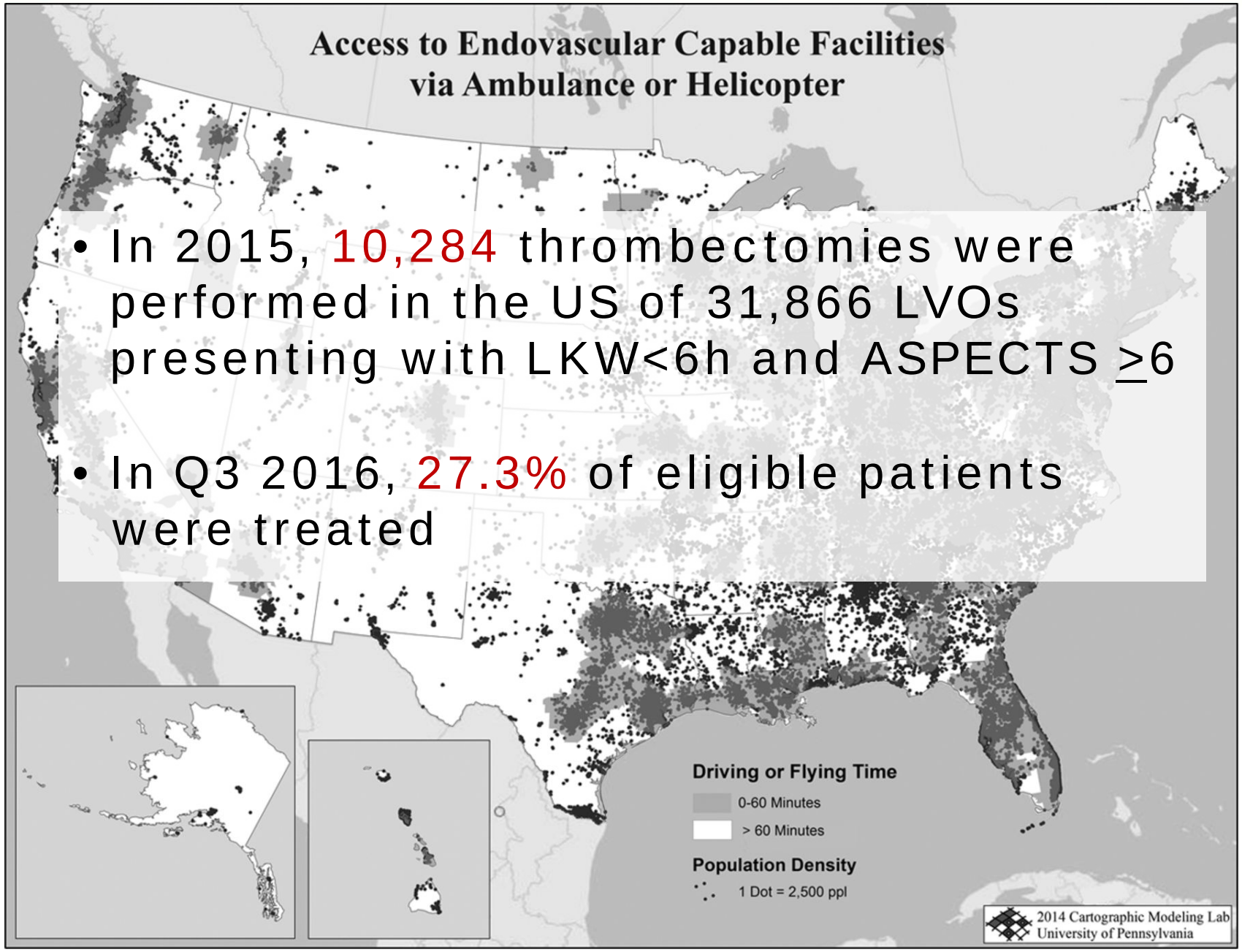
Saver Jl et al. JAMA 2016

"A drop of brain, a day of life…" **– Kawano et al. Brain 2017 & Saver JL. Brain 2017**

"Save a minute, save a week…" **– Meretoja A et al. Neurology 2017**

"…for every 15 minute faster ED door-to-reperfusion time, an estimated 39 patients would be less disabled at 3 months, including 25 more who would achieve functional independence." [out of every 1000 achieving reperfusion]

- **Saver JL et al. JAMA 2016**



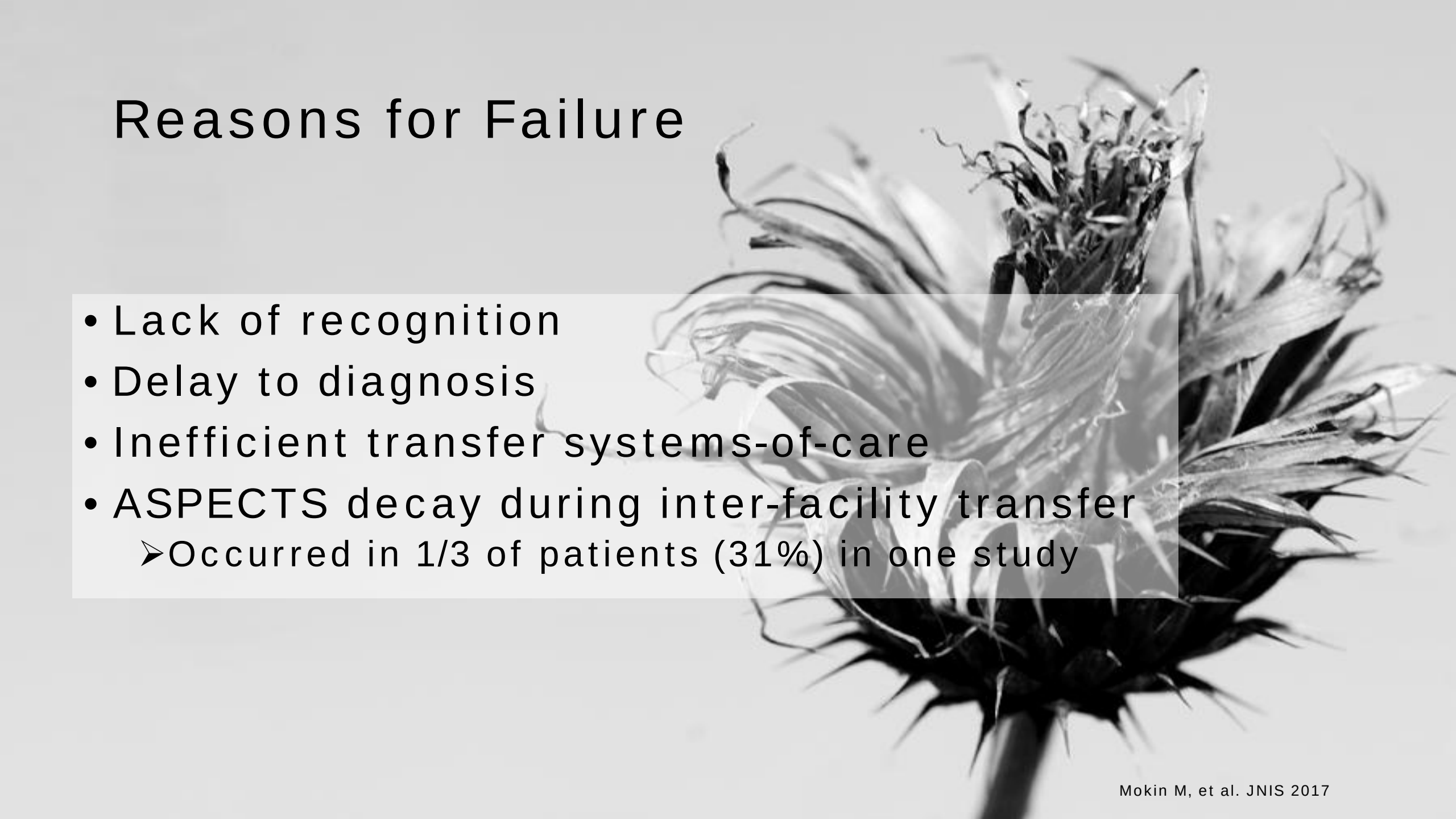
- In 2015, 10,284 thrombectomies were performed in the US of 31,866 LVOs presenting with LKW<6h and ASPECTS ≥6
- In Q3 2016, 27.3% of eligible patients were treated

Table. Percentage of Americans With 60-Minute Access to r-tPA–Capable Hospitals, Endovascular-Capable Hospitals, and Primary Stroke Centers by Ground and Air Ambulance, Allowing for Crossing State Lines

	60-min Ground Access			60-min Air Access		
	r-tPA Capable, %	Endovascular Capable, %	PSC, %	r-tPA Capable, %	Endovascular Capable, %	PSC, %
Northeast						
New England						
CT	95.6	63.8	89.4	100.0	100.0	100.0
ME	54.5	21.3	31.7	90.0	60.5	88.7
MA	96.3	63.4	9.3	100.0	97.6	96.9
NH	77.1	0.0	0.0	99.6	81.9	74.7
RI	97.5	83.7	96.5	100.0	100.0	100.0
VT	37.1	25.1	25.1	90.7	66.4	66.3
Middle Atlantic						
NJ	98.4	87.0	95.1	100.0	100.0	100.0
NY	91.9	77.4	72.3	99.8	96.0	94.2
PA	85.5	57.8	73.5	100.0	97.5	99.7

Rai AT et al. BMJ 2016
Smith EE et al. Circulation 2017
Adeoye O et al. Stroke 2014

Reasons for Failure



- Lack of recognition
- Delay to diagnosis
- Inefficient transfer systems-of-care
- ASPECTS decay during inter-facility transfer
  - Occurred in 1/3 of patients (31%) in one study

Mokin M, et al. JNIS 2017


Georgiaville
Esmond
N. Providence
Twin River Rec. Area
Slater Mill
HOSPITAL
EMERGENCY
Paw
eenville
Centredale
Snake Den S.P. (undev.)
R.I. College
Brown Stad.
HOSPITAL
EMERGENCY ROOM
Johnst
Providence Place Mall
R. Williams Natl. Mem.
Brown Univ.
Johnson & Wales Univ.
Hughesdale
Providence
Perf. Arts Ctr.
John Brown House
Thornton
Gov. Sprague Mansion
Randall Pond
Mus. of Natural Hist.
Ferry to Newport
Cranston
Pomham Rock Lighthouse
Roger Williams
PLAINFIELD PIKE
SCITUATE AV
PARK AV
BROAD ST
295
95

Field Triage

- Mobile Stroke Units
- Centralized & Coordinated Dispatch
- Mobile Endovascular Teams
- Prehospital Stroke Severity Scales (accuracy range 0.75-0.80)

	3ISS	LAMS	CPSSS	VAN	PASS	FAST-ED	RACE
LOC	*		*		*		
Gaze	*		*	*	*	*	*
Face		*				*	*
Arm	*	*	*	*	*	*	*
Grip		*					
Leg							*
Aphasia				*		*	*
Neglect				*		*	*

Perez de la Ossa N et al. Stroke 2016

Large Vessel Occlusion Scales Increase Delivery to Endovascular Centers Without Excessive Harm From Misclassifications

Table 1. Overall Agreement of LVO Scales With CT Imaging

Scale	Accuracy	Kappa (95% CI)	Sens	Spec	PPV	NPV	AUC	DOR
RACE ≥5	0.86	0.51 (0.41–0.60)	0.66	0.90	0.48	0.93	0.78	17.50
LAMS ≥4	0.83	0.43 (0.34–0.52)	0.66	0.86	0.48	0.93	0.76	11.80
FAST-ED ≥4	0.85	0.49 (0.40–0.58)	0.70	0.88	0.48	0.92	0.79	16.40
PASS ≥2	0.81	0.43 (0.34–0.52)	0.71	0.84	0.45	0.93	0.77	12.40
CPSSS ≥2	0.81	0.35 (0.26–0.45)	0.56	0.86	0.42	0.91	0.71	7.54

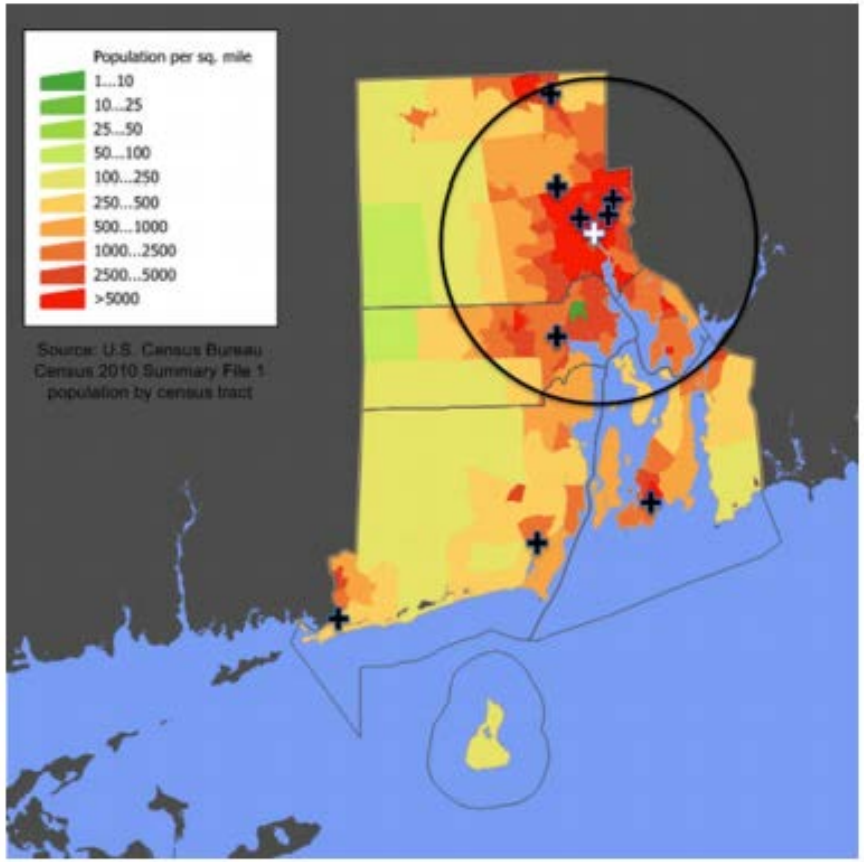
Prevalence =14.5%. AUC indicates area under receiver-operator curve value; CI, confidence interval; CPSSS, Cincinnati Prehospital Stroke Severity Scale; CT, computed tomography; DOR, diagnostic odds ratio; FAST-ED, Field Assessment Stroke Triage for Emergency Destination; LAMS, Los Angeles Motor Scale; LVO, large vessel occlusion; NPV, negative predictive value; PASS, Prehospital Acute Stroke Severity scale; PPV, positive predictive value; RACE, Rapid Arterial Occlusion Evaluation; Sens, sensitivity; and Spec, specificity.

Zhao H et al. Stroke 2017

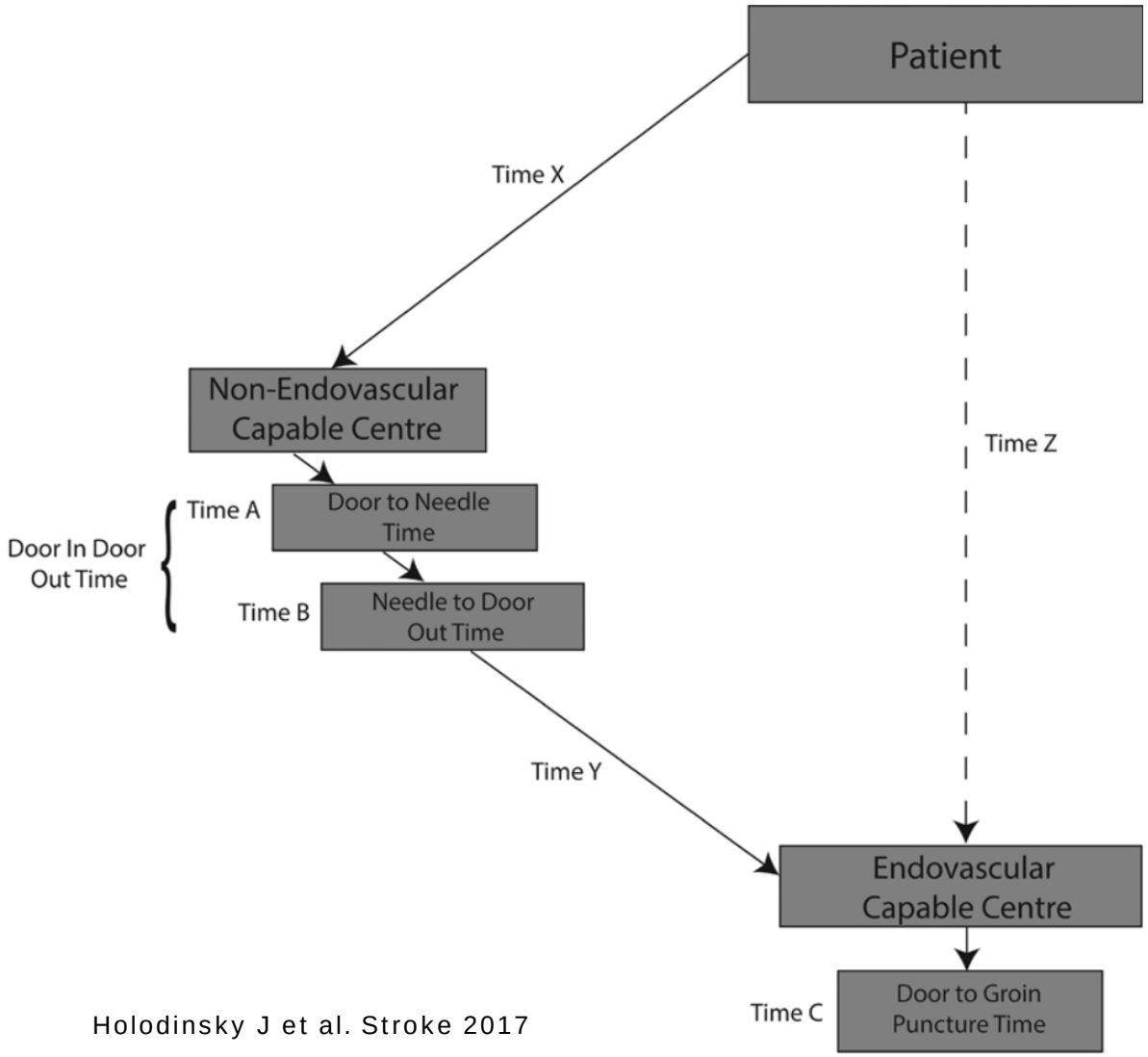
Developing a statewide protocol to ensure patients with suspected emergent large vessel occlusion are directly triaged in the field to a comprehensive stroke center: how we did it

Mahesh V Jayaraman,[1,2,3] Arshad Iqbal,[4] Brian Silver,[2] Matthew S Siket,[5] Caryn Amedee,[2] Ryan A McTaggart,[1] Gino Paolucci,[5] Jason Rhodes,[6] John Potvin,[7] Megan Tucker,[8] Nicole Alexander-Scott[6]

- RISTF convened and agreed to LAMS 4-5 field triage to CSC if within a 30 minute drive time (JNIS 2016)
- LAMS is the right choice for RI
  - Demonstrated convergent, divergent and predictive validity (Kim JT et al. Stroke 2017)
  - 25% of EMS-transported stroke patients will have LAMS 4-5, of which >70% will be CSC appropriate (unpublished, ISC abstract 2017)



Drip n' Ship or Mothership?



- <u>Modelling dependent on:</u>
  - D2N and DIDO times at PSC
  - D2N and D2G times at CSC
  - Reperfusion rates at CSC

Holodinsky J et al. Stroke 2017

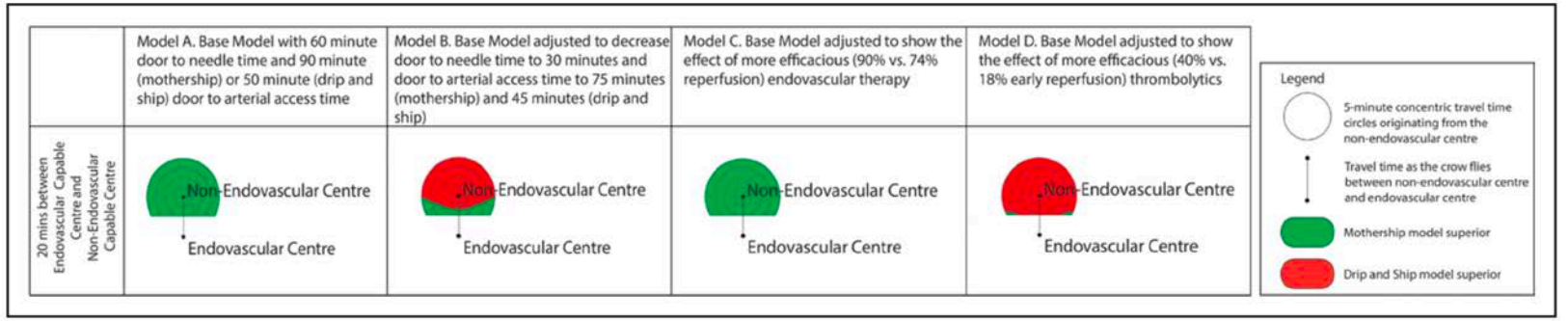
Model Favors Mothership when recanalization rates ~90%

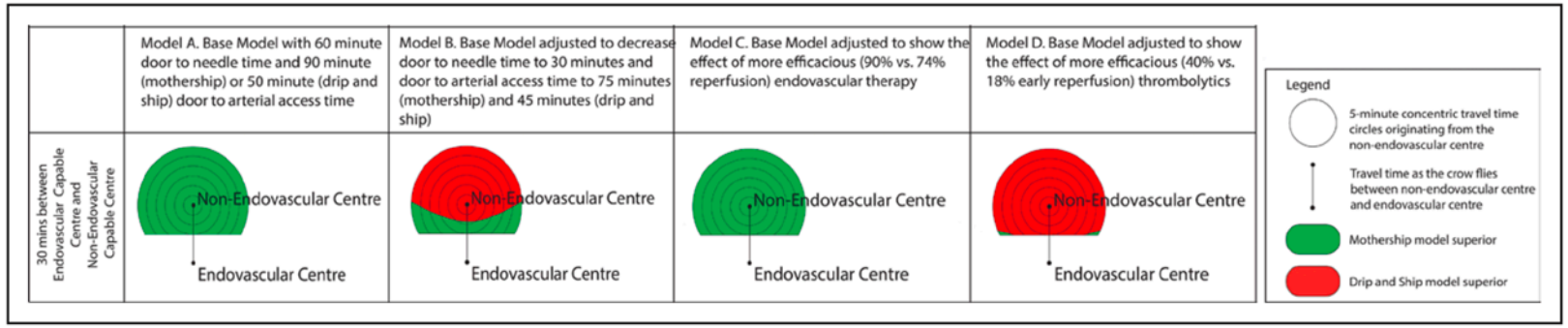
20min

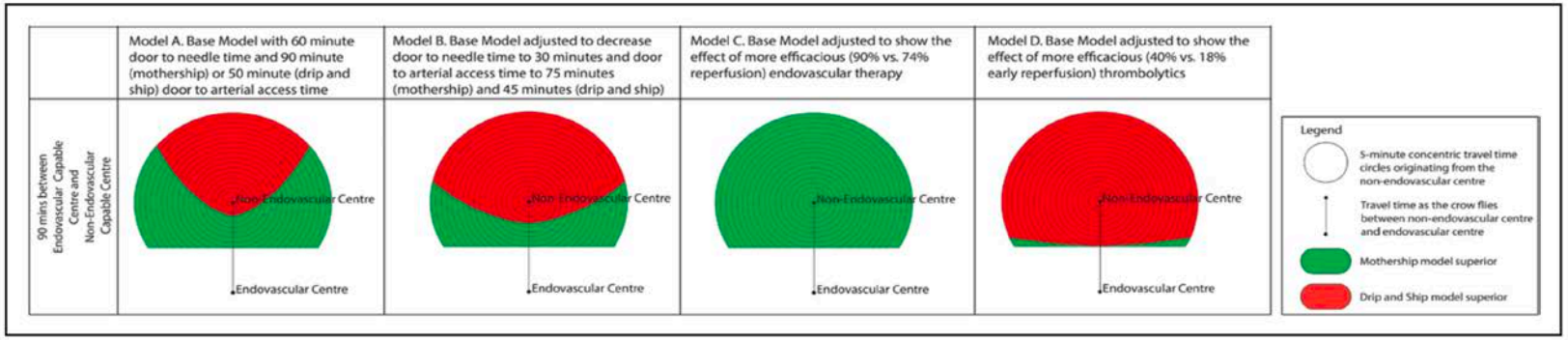
30min

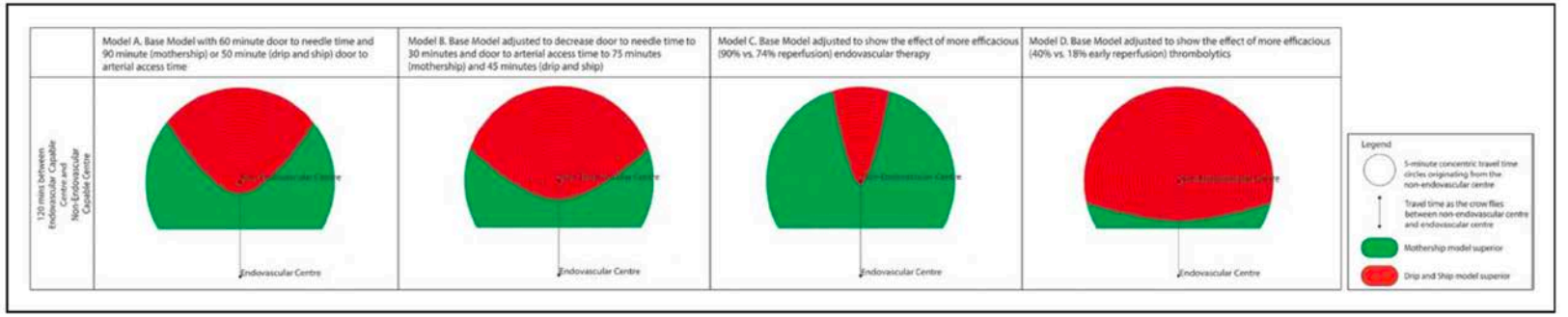
90min

120min





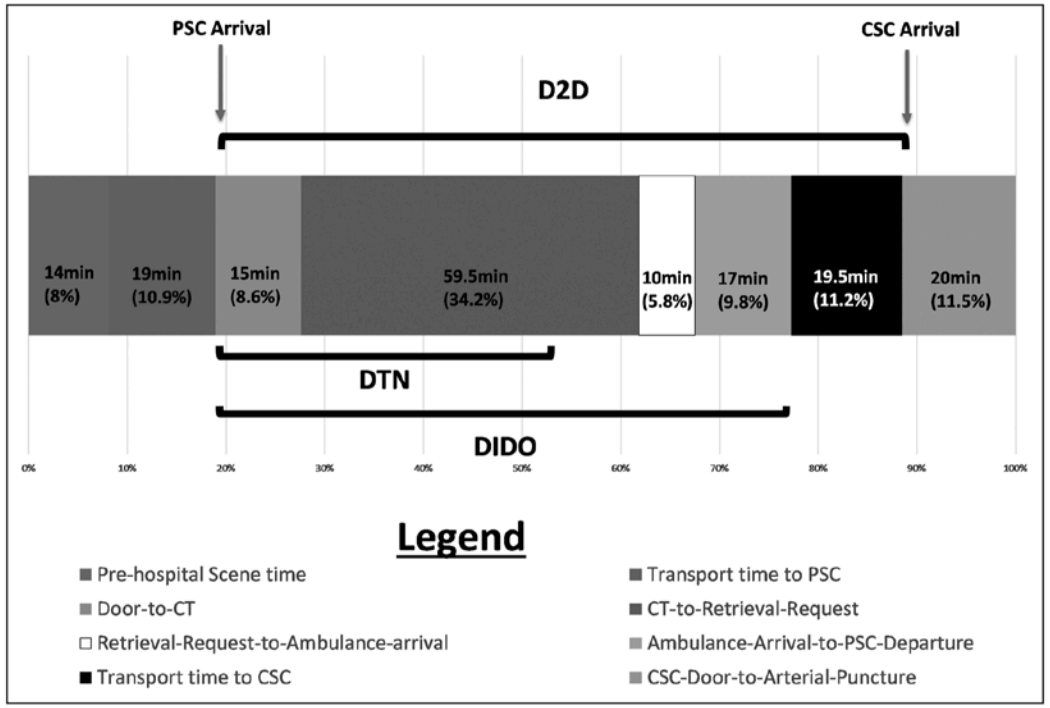




Holodinsky J et al. Stroke 2017

“No Brainer”

- Conditions required for drip n’ ship to be preferred:
  - ✓Longer onset-to-first medical response
  - ✓PSC D2N times < 30 min
  - ✓PSC DIDO times < 50 min
  - ✓CSC D2N times >60 min
  - ✓CSC Door-to-reperfusion time >200 min
  - ✓Transport time > 45 min



Milne SW et al. Stroke 2017

Ng FC et al. Stroke 2017

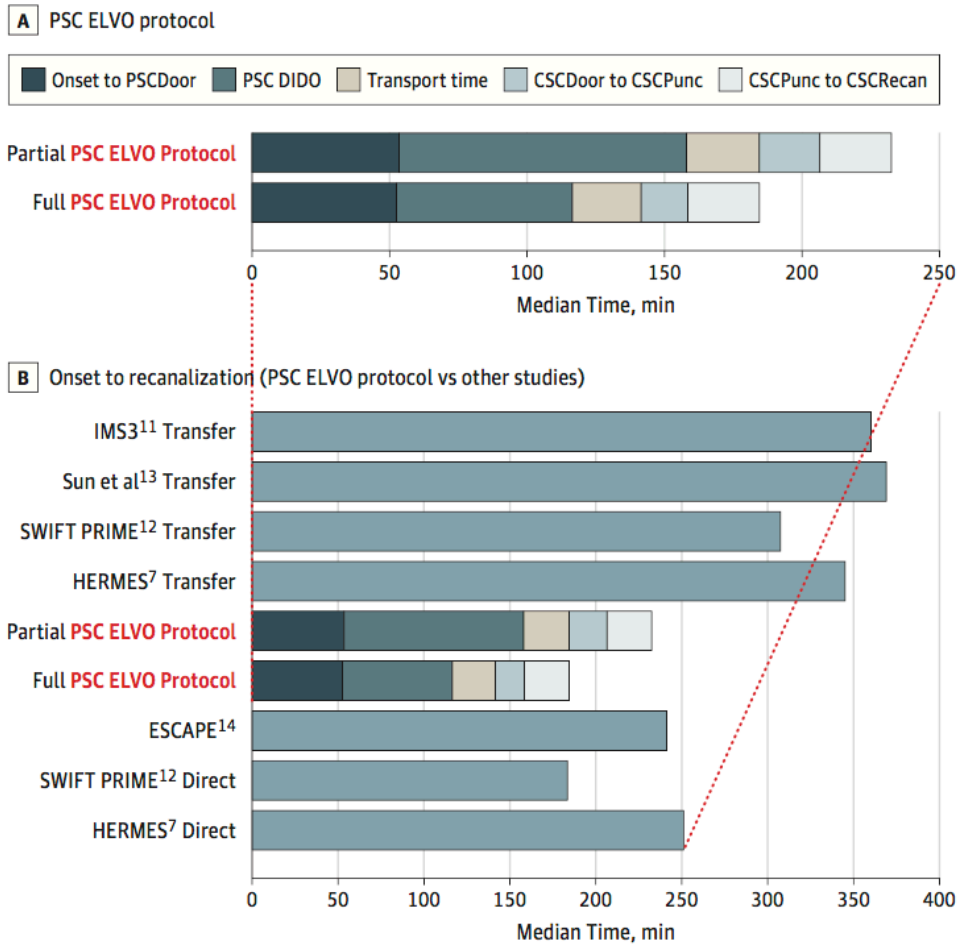
Unfortunate Interpretation

CSCs and PSCs should work together to improve stroke care for everyone

Association of a Primary Stroke Center Protocol for Suspected Stroke by Large-Vessel Occlusion With Efficiency of Care and Patient Outcomes

Ryan A. McTaggart, MD; Shadi Yaghi, MD; Shawna M. Cutting, MD, MS; Morgan Hemendinger; Grayson L. Baird, PhD; Richard A. Haas, MD; Karen L. Furie, MD, MPH; Mahesh V. Jayaraman, MD

Figure 3. Primary Stroke Center (PSC) Emergent Large-Vessel Occlusion (ELVO) Protocol Care Efficiency Metrics



RI Initiative:

1. Notify CSC on arrival
2. Immediate CT/CTA
3. Image sharing to cloud-based platform

RESULTS:

- ✓ 40 minute reduction in DIDO time (p<.001)
- ✓ Twice as likely to have a favorable outcome (50% vs. 25%, P<.04)

JAMA Neurol 2017

We've been down this road before…

25% reduction in death for severely injured patients who went to a Level I trauma center

Sasser SM et al. MMWR 2012

- Current national field triage guidelines for identifying seriously injured persons use 4 criteria (anatomic, physiologic, MOI and special considerations)
- Collectively, 80.1% sensitive and 87.3% specific for early critical resource use
- 37.3% overtriage rate
- Studied in over 1.5 million patients

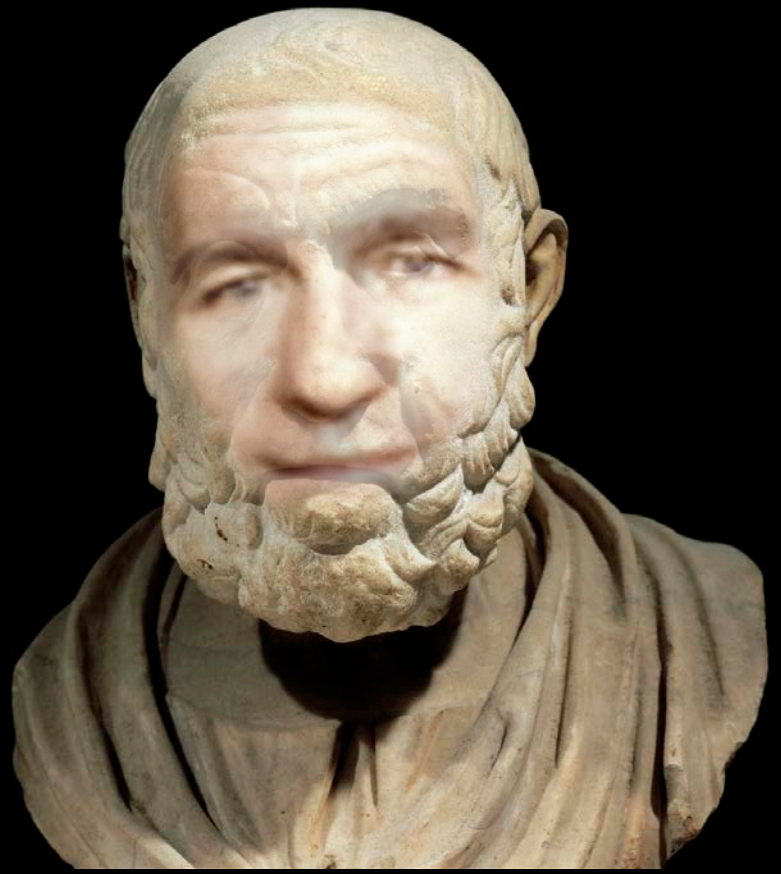
Newgard CD et al. J Am Coll Surg 2016

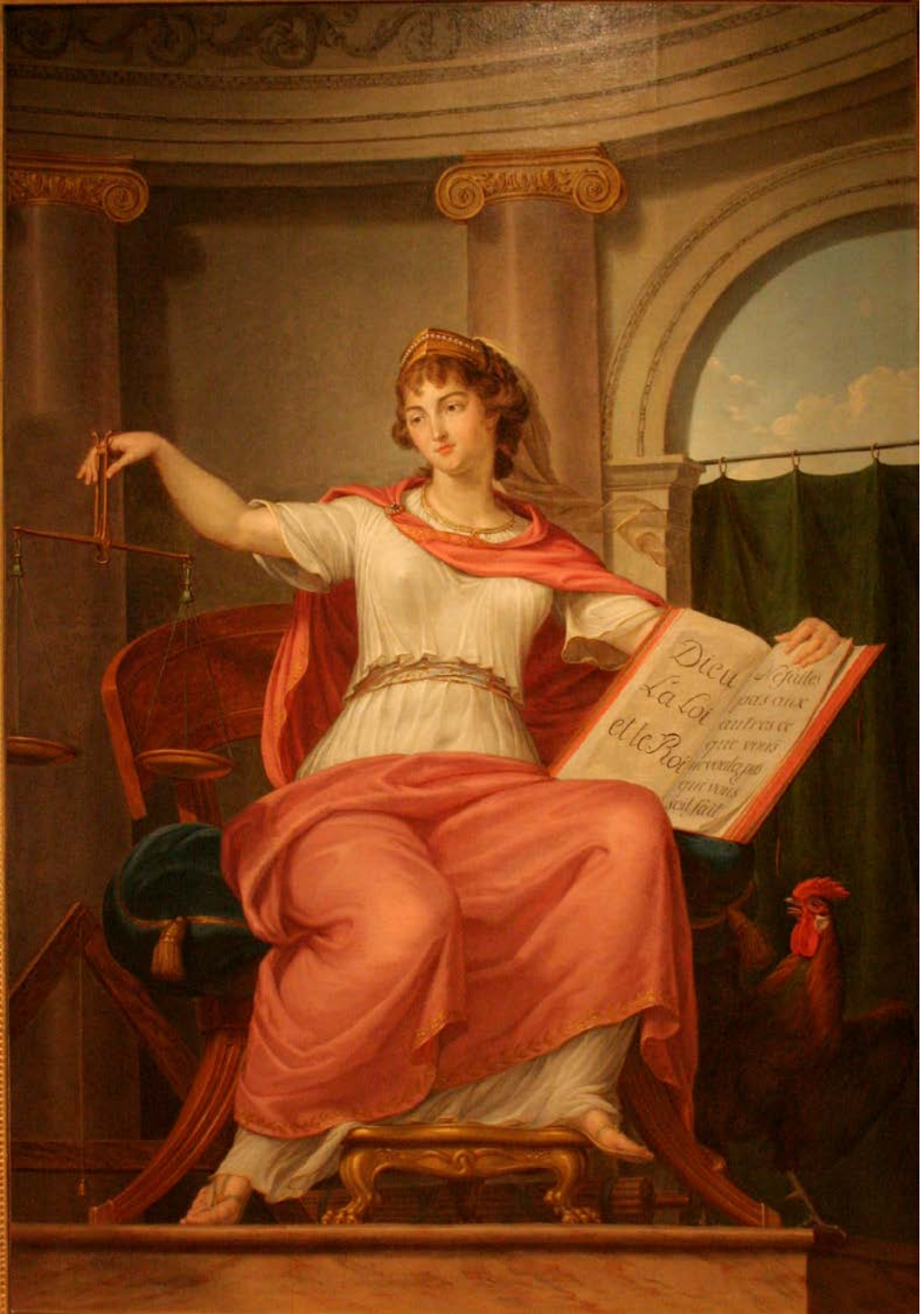
At the end of the day, this is really an ethical debate, not a data duel...

Visionary Mission: Lifeline Stroke Co-Chairs

Lee Schwamm-istotle

Peter Panagos-ocrates





- We know severity-based triage offers the most benefit to patients with LVO
- It obviates the harm caused by stroke progression while awaiting definitive care
- Creates a just and fair system wherein all patients have the same access to specialized care

THANK YOU

Matthew_Siket@brown.edu
@SiketMD

Rebuttal

“The severity scales are poor tools”

- They have demonstrated accuracy and predict CSC need (ELVO & ICH)
- It is estimated that ~25% of suspected stroke patients will have a LAMS 4-5
- Overtriage with LAMS appears to be <30%, which is better than current trauma triage criteria

“This will hurt low-volume centers”

- Not if implemented correctly. At TMH, we have seen a rise in the number of stroke patients and an improvement in D2N times in 2017, despite administering half as much tPA as 2016
- Working with CSCs will help ensure efficient transfer of appropriate patients and retention of non-indicated transfers

“Patient volume will overwhelm CSCs”

- LVO and ICH account for a minority of acute stroke patients
- Providing EMS and referring facilities with feedback, education and monitoring will help ensure protocol compliance
- Transparent system-wide data review is important for continued engagement and process refinement

“It is taking patients out of their communities for an unlikely diagnosis”

- LVO likely accounts for 10-25% of AIS and the appropriateness criteria for intervention is continually expanding
- These patients are the most likely to suffer long-term disability and death from their stroke
- Expediting a process by which they can receive definitive care, if needed, is the best thing we can do for them

In Summary

- The Mission: Lifeline EMS Stroke Triage Algorithm is an appropriate first step in the right direction
- It should be implemented across the country and individualized to meet each region's needs
- We in RI are a successful model of how this can be implemented and are proud of the what's being done


Thank you for this opportunity. Enjoy
beautiful Newport and the NECC