

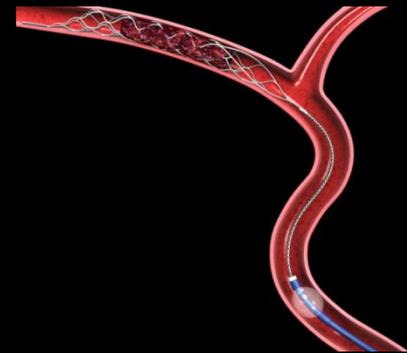
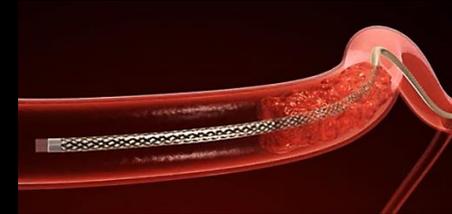
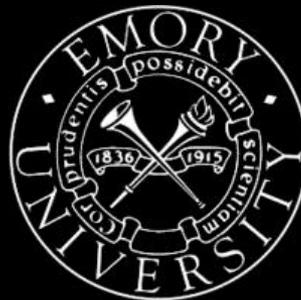
Pre-Hospital Stroke Care: How Can We Improve?

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**MARCUS STROKE &
NEUROSCIENCE CENTER**



Disclosures:

Stryker Neurovascular (unpaid)

- Trevo-2 Trial PI
- DAWN Trial PI

Medtronic

- SWIFT and SWIFT-PRIME Trial Steering Committee (unpaid)
- STAR Trial Core Lab

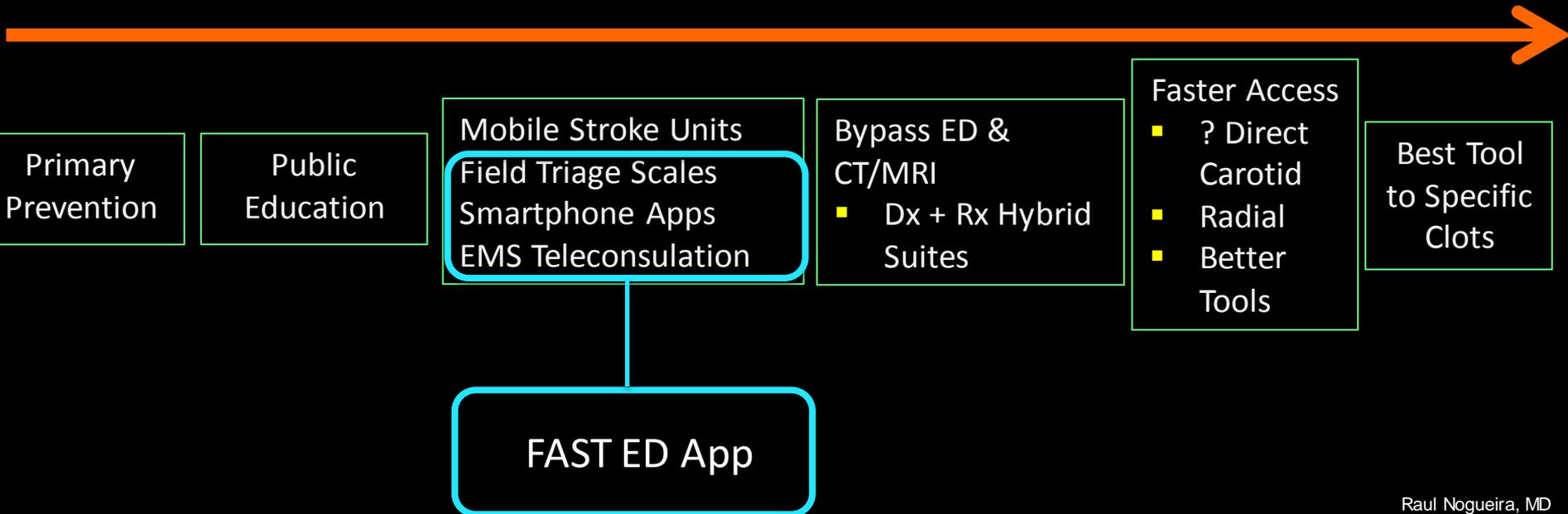
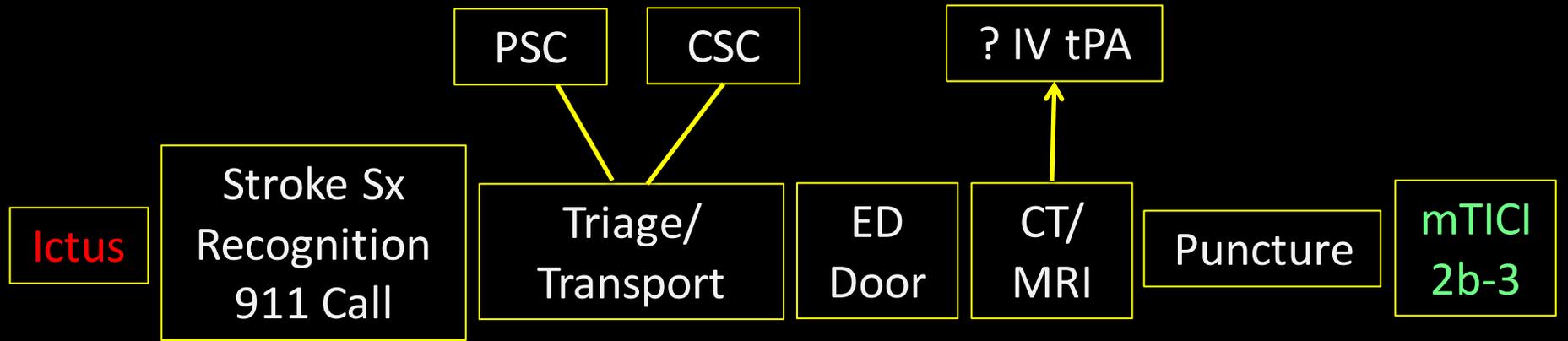
Penumbra (unpaid)

- 3-D Separator Trial Executive Committee

Interventional Neurology Journal (unpaid)

- Editor-In-Chief

Shortening Ictus to Reperfusion Times:



Shortening Ictus to Door Times: Better Triage and More Effective Transport

Mobile Stroke Units

Better and faster field selection and treatment



Field Stroke Triage Scales

RACE: The Rapid Arterial Occlusion Evaluation Scale

CPSS: The Cincinnati Prehospital Stroke Severity Scale

VAN: Vision, Aphasia, Neglect

LAMS: Los Angeles Motor Scale

FAST-ED: Field Assessment Stroke Triage for Emergency
Destination

Design and Validation of a Prehospital Stroke Scale to Predict Large Arterial Occlusion

The Rapid Arterial Occlusion Evaluation Scale

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

ESCALA RACE

PARESIA HEMICUERPO IZQUIERDO		PARESIA HEMICUERPO DERECHO / AFASIA	
Paresia facial izquierda:		Paresia facial derecha:	
Ausente	0	Ausente	0
Ligera	1	Ligera	1
Moderada/Severa	2	Moderada/Severa	2
Paresia del brazo izquierdo:		Paresia del brazo derecho:	
Ausente/Ligera (>10seg)	0	Ausente/Ligera (>10seg)	0
Moderada (<10seg)	1	Moderada (<10seg)	1
Severa (no levanta)	2	Severa (no levanta)	2
Paresia de la pierna izquierda:		Paresia de la pierna derecha:	
Ausente/Ligera (>5seg)	0	Ausente/Ligera (>5seg)	0
Moderada (<5seg)	1	Moderada (<5seg)	1
Severa (no levanta)	2	Severa (no levanta)	2
Desviación oculo-cefálica a la derecha		Desviación oculo-cefálica a la izquierda	
Ausente	0	Ausente	0
Presente	1	Presente	1
Agnosia		Afasia	
Ausente	0	Obedece 2 órdenes	0
Asomatognosia o anosognosia	1	Obedece 1 orden	1
Asomatognosia y anosognosia	2	No obedece ninguna orden	2
TOTAL		TOTAL	

Puntuación de 0 – 9

A mayor puntuación, mayor gravedad del ictus

Pacientes con RACE ≥ 5 tienen una alta probabilidad de tener una oclusión de un gran vaso cerebral

El SEM evaluará la escala RACE durante el traslado del paciente y transmitirá la información al centro receptor de ictus en el momento de hacer el pre-aviso

Motor Sx = not good discriminators of non-LVOS vs LVOS = subcortical or lacunar strokes
 6 pts in RACE vs 3 pts in FAST-ED

Gaze Deviation = powerful predictor of LVOS
 1 pts in RACE vs 2 pts in FAST-ED

Aphasia = powerful predictor of LVOS

Race only test for receptive

FAST-ED tests for both receptive and expressive

RACE does not test aphasia if left hemiplegia

RACE validated using **TCD** (prospective)

FAST-ED validated using **CTA** (retrospective)



Stroke vision, aphasia, neglect (VAN) assessment—a novel emergent large vessel occlusion screening tool: pilot study and comparison with current clinical severity indices

Table 1 Vision, aphasia, neglect emergent large vessel occlusion screening tool

Stroke VAN	
How weak is the patient? Raise both arms up	<input type="checkbox"/> Mild (minor drift) <input type="checkbox"/> Moderate (severe drift—touches or nearly touches ground) <input type="checkbox"/> Severe (flaccid or no antigravity) <input type="checkbox"/> Patient shows no weakness. Patient is VAN negative
(exceptions are confused or comatose patients with dizziness, focal findings, or no reason for their altered mental status then basilar artery thrombus must be considered; CTA is warranted)	
Visual disturbance	<input type="checkbox"/> Field cut (which side) (4 quadrants) <input type="checkbox"/> Double vision (ask patient to look to right then left; evaluate for uneven eyes) <input type="checkbox"/> Blind new onset <input type="checkbox"/> None
Aphasia	<input type="checkbox"/> Expressive (inability to speak or paraphasic errors); do not count slurring of words (repeat and name 2 objects) <input type="checkbox"/> Receptive (not understanding or following commands) (close eyes, make fist) <input type="checkbox"/> Mixed <input type="checkbox"/> None
Neglect	<input type="checkbox"/> Forced gaze or inability to track to one side <input type="checkbox"/> Unable to feel both sides at the same time, or unable to identify own arm <input type="checkbox"/> Ignoring one side <input type="checkbox"/> None

Patient must have weakness plus one or all of the V, A, or N to be VAN positive. VAN positive patients had 100% sensitivity, 90% specificity, positive predictive value 74%, and negative predictive value 100% for detecting large vessel occlusion. CTA, CT angiography; VAN, vision, aphasia, and neglect.

VAN tests too many items

(e.g. weakness, field cut, double vision, visual loss, expressive aphasia, receptive aphasia, gaze deviation, sensory extinction, asomatognosia, and visual spatial neglect) might be too complex to be used by EMS personnel

Studied for **NIHSS certified ED triage nurses**

Field Assessment Stroke Triage for Emergency Destination: FAST-ED

Does the patient have facial weakness?

Ask the patient to smile or show teeth. Watch for weakness on one side of the face



- Normal: both sides of the face move equally or not at all = 0 points
- Abnormal: one side of face droops (or is clearly asymmetric) = 1 point

Tip: Aphasic patients may respond better if you mimic so try that. If clearly asymmetric at baseline score as abnormal.

Does the patient have arm weakness?

Ask the patient to hold both arms out with palms up and eyes closed for 10 seconds. If patient cannot understand hold his/her arms up and then let them go



- Normal: both arms remain up > 10 seconds or slowly drift down equally = 0 points*
- Mild weakness: one arm drifts down in < 10 seconds but has antigravity strength = 1 point
- Moderate/severe weakness: one or both arms fall rapidly, have no movement against gravity, or no movement at all = 2 points

If patient is not weak = skip the questions “Are you weak anywhere?” and “Whose arm is this?”

Check speech content + Ask the patient to name 3 common items:

- Speech content normal AND names 2-3 items correctly = 0 points
- Speech content clearly abnormal OR names only 0-1 items correctly = 1 point

Tip: If speech is slurred but makes sense and naming is correct score as normal!

Ask the patient: “Show me two fingers”

Do not show the patient what to do!
Only verbal command with NO visual cues!

- Patient shows two fingers = 0 points
- Patient does not understand e.g. does not show two fingers = 1 point*

If patient cannot show two fingers on command = skip the questions
“Are you weak anywhere?” and “Whose arm is this?”

Does the patient have gaze deviation to either side?

Ask the patient to follow your finger as you move it from right to left and back from left to right



- Normal: no deviation, eyes move to both sides equally = 0 points
- Gaze preference: patient has clear difficulty when looking to one side (left or right) = 1 point
- Forced deviation: eyes are deviated to one side and do not move (e.g. cannot follow finger) = 2 points

Tip: Some patients will follow your face better than your finger so can try that instead

Ask the patient: “Are you weak anywhere?”

Ask the “Are you weak anywhere?” and check if the patient recognizes his/her weakness

- Normal: patient is weak and recognizes it = 0 points
- Abnormal: patient is weak but does NOT recognize it = 1 point

Ask the patient: “Whose arm is this?”

Show the patient his/her weak arm and ask “Whose arm it this?”. Check if the patient recognizes his/her weak arm as his/her own

- Normal: patient recognizes his/her weak arm = 0 points
- Abnormal: patient does NOT recognizes his/her weak arm = 1 point

Does the patient take any anticoagulants?

Ask the patient or family about the use of “anticoagulants” or “blood thinners”.
Do NOT score for antiplatelets meds (e.g. aspirin etc.)

No

(Aspirin, Plavix/Clopidogrel, Brilinta/Ticagrelor, Effient/Prasugrel, Aggrenox, Pletal/Cilostazol are NOT anticoagulants)

Yes

(Coumadin/Warfarin, Pradaxa/Dabigatran, Eliquis/Apixaban, Xarelto/Rivaroxaban, Savaysa/Edoxaban/Heparin/ Enoxaparin)

Unknown

How Old is the Patient?

Enter Date of Birth: __/__/____

or check

- Age \leq 80 years old
- Age $>$ 80 years old

“Did anyone see when the symptoms started?”

Ask patient or witnesses.

Yes = enter time: __ __ : __ __ (format 24:00)*

No = go to the next question e.g. ask “What time was the patient last seen well by anyone?”

If time of symptoms start is known = skip the questions “What time was the patient last seen well by anyone?”

“What time was the patient last seen well by anyone?”

Ask any witnesses!

Patient was seen by someone over the last 24 hours = **enter time:**
_ _ : _ _ (format 24:00)

Patient was NOT seen by anyone over the last 24 hours = **check unknown**

Family Contact:

Phone Number:

Contact Name:

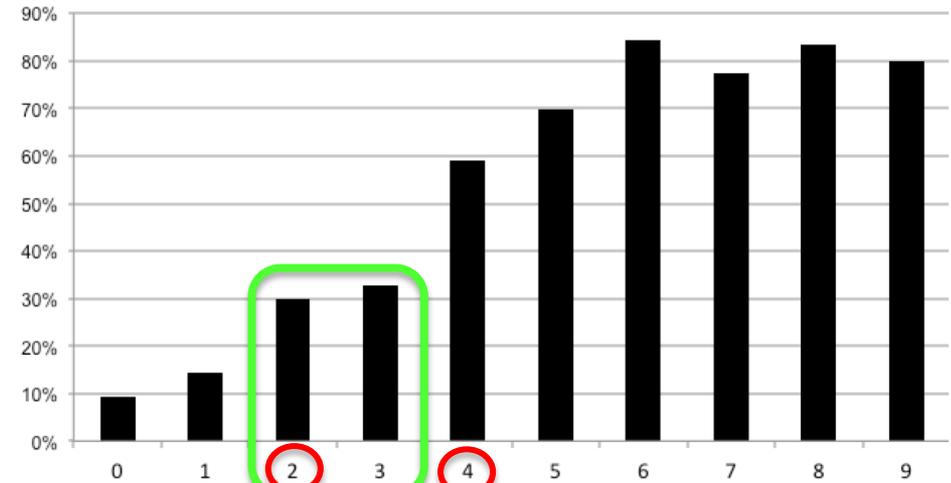
FAST ED: Field Stroke Triage Scale

Field Assessment Stroke Triage for Emergency Destination FAST-ED

The FAST-ED scale and its equivalence to the NIHSS.

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
Denial / 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

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



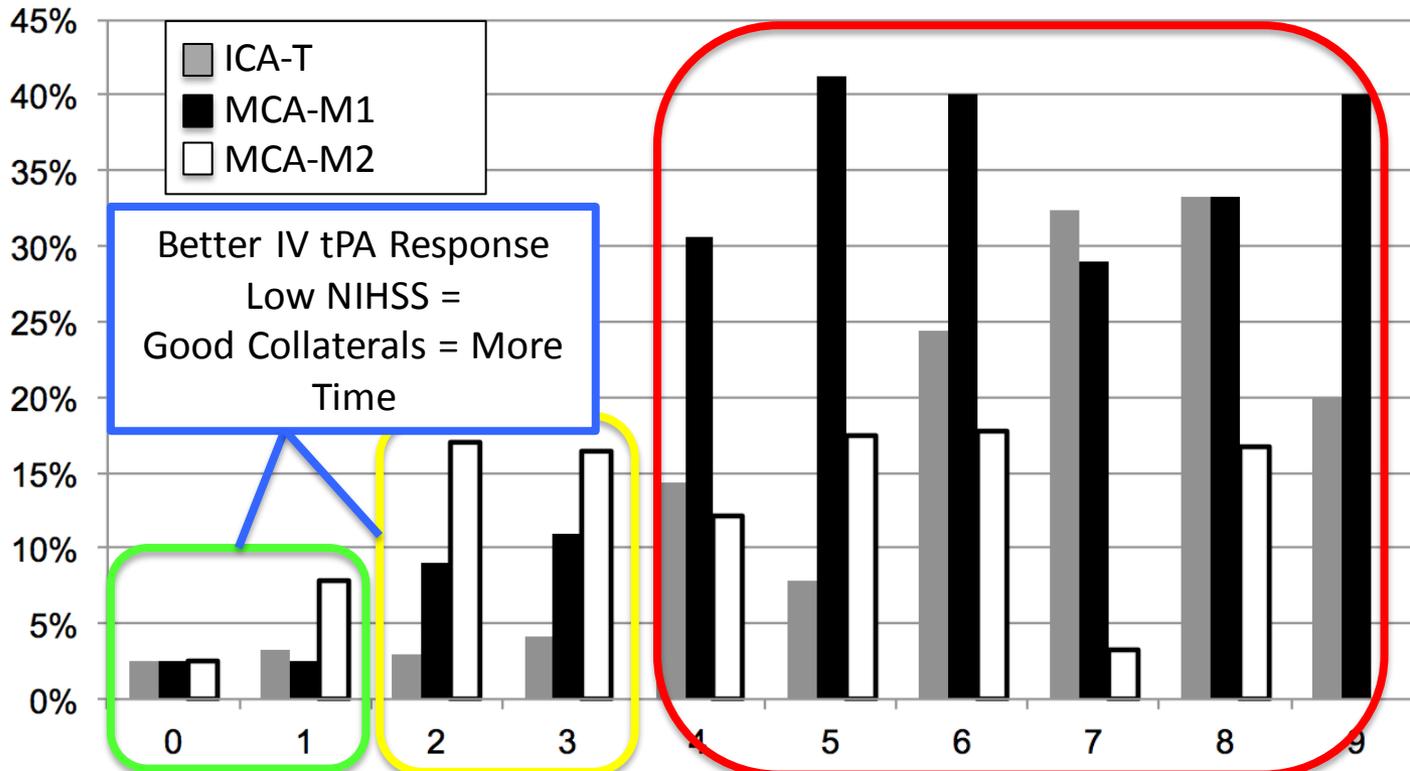
Hosmer and Lemeshow test: 0.62

- Only 1-point for face and no leg points to minimize redundancy of motor exam – does not discriminate subcortical vs. cortical
- More points for pure cortical findings e.g. 2-points gaze deviation and better tests aphasia (expressive)

FAST ED: Field Stroke Triage Scale

Field Assessment Stroke Triage for Emergency Destination FAST-ED

Proportion of patients with LVOS according to the FAST-ED scale and most proximal site of occlusion.



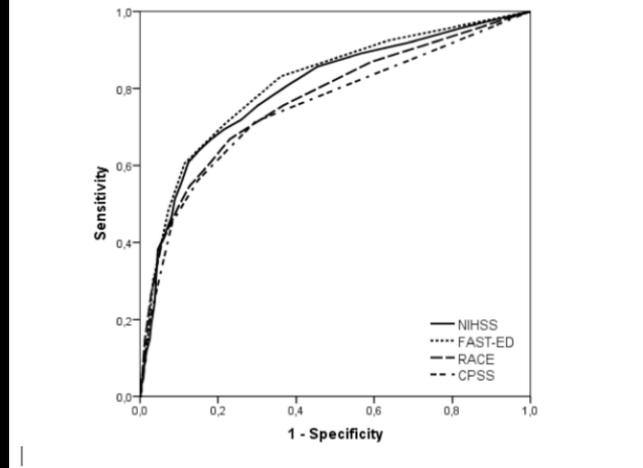
FAST ED: Field Stroke Triage Scale

Field Assessment Stroke Triage for Emergency Destination

STOPStroke cohort:

- 727 AIS + CTA 0-24h
- 240 LVOS (33%)
 - ICA: 53 (7.3%)
 - MCA-M1: 98 (13.5%)
 - MCA-M2: 74 (10.2%)
 - Basilar: 15 (2.1%)

ROC curves comparing the accuracy of FAST-ED, NIHSS, RACE and CPSS scales for the detection of LVOS



p=0.02

p=0.002

	FAST-ED ≥3	FAST-ED ≥4	RACE ≥5	CPSS ≥2
Sensitivity	0.71	0.60	0.55	0.56
Specificity	0.78	0.89	0.87	0.85
PPV	0.62	0.72	0.68	0.65
NPV	0.84	0.82	0.79	0.78
AUC - ROC	0.84	0.84	0.77	0.75

The Assessment and Assumptions

The 4 steps assessment:

A. Face/Arm Weakness:

- 0 = None
- 2 = Mild/Moderate
- 3 = Severe

B. Aphasia:

- 0 = None
- 1 = Expressive or Receptive Aphasia
- 2 = Combination

C. Eye Deviation:

- 0 = No
- 1 = Mild/Preference
- 2 = Forced

D. Neglect:

- 0 = None
- 1 = Anosognosia or Asomatognosia
- 2 = Combination

Determine the SCORE

Is he/she using anticoagulant ?

- NO
- YES (Pradaxa, Eliquis or Xarelto)

Determine the ANTICOAGULANT

What is the patient age?

Determine the AGE

LKWT = What's the Last known well time?

Time = minutes from LKWT + 90 min (*)

Determine the TIME

Score <2: low likelihood of Large Vessel Occlusion Stroke (LVOS)

Score >=4: high likelihood of Large Vessel Occlusion Stroke (LVOS)

Algorithm for the Destination Guidelines:
based on:

- (1) IV tPA Eligibility
- (2) Likelihood of LVOS
- (3) Time/Distance to Primary (PSC) vs. Comprehensive Stroke Center (CSC)

IV tPA Eligibility guideline:

NINDS t-PA Trial 0-3h:

Assumption: 30 min from site until arriving ED Door

Assumption: 60 min ED Door to Needle
Total time Field to needle: 0-90 min
- Excludes Anticoagulants

ECASS-III Trial 0-4.5h:

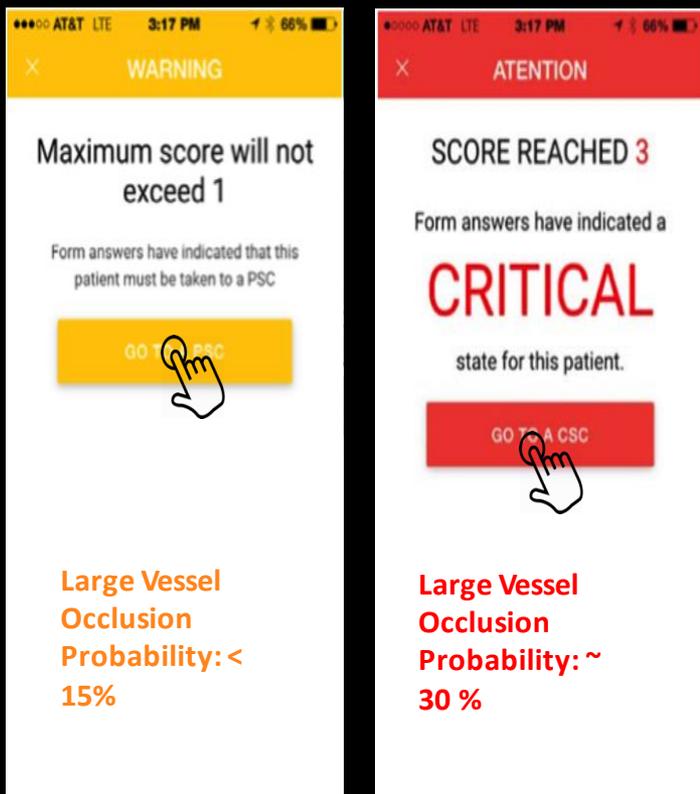
Assumption: 30 min from site until arriving ED Door

Assumption: 60 min ED Door to Needle
Total time Field to needle: 0-180 min
- Excludes >80, NIHSS >25 (~ED-FAST=7),
Anticoagulants

(*) Assumption: 30 min from site until arriving ED Door
Assumption: 60 min ED Door to Needle
Total = +90 min

FAST ED Smartphone App

Triage App -> Scoring and assessment



Anticoagulant use:

Can't justify a delay >30 min to CSC because risk of ICH requiring emergent reversal. CSC is faster at doing this and has better neurosurgical back-up so we can justify a 30 min delay even if ICH

Large Vessel Occlusion

Probability:

0-1 <15%

2-3 = 30%

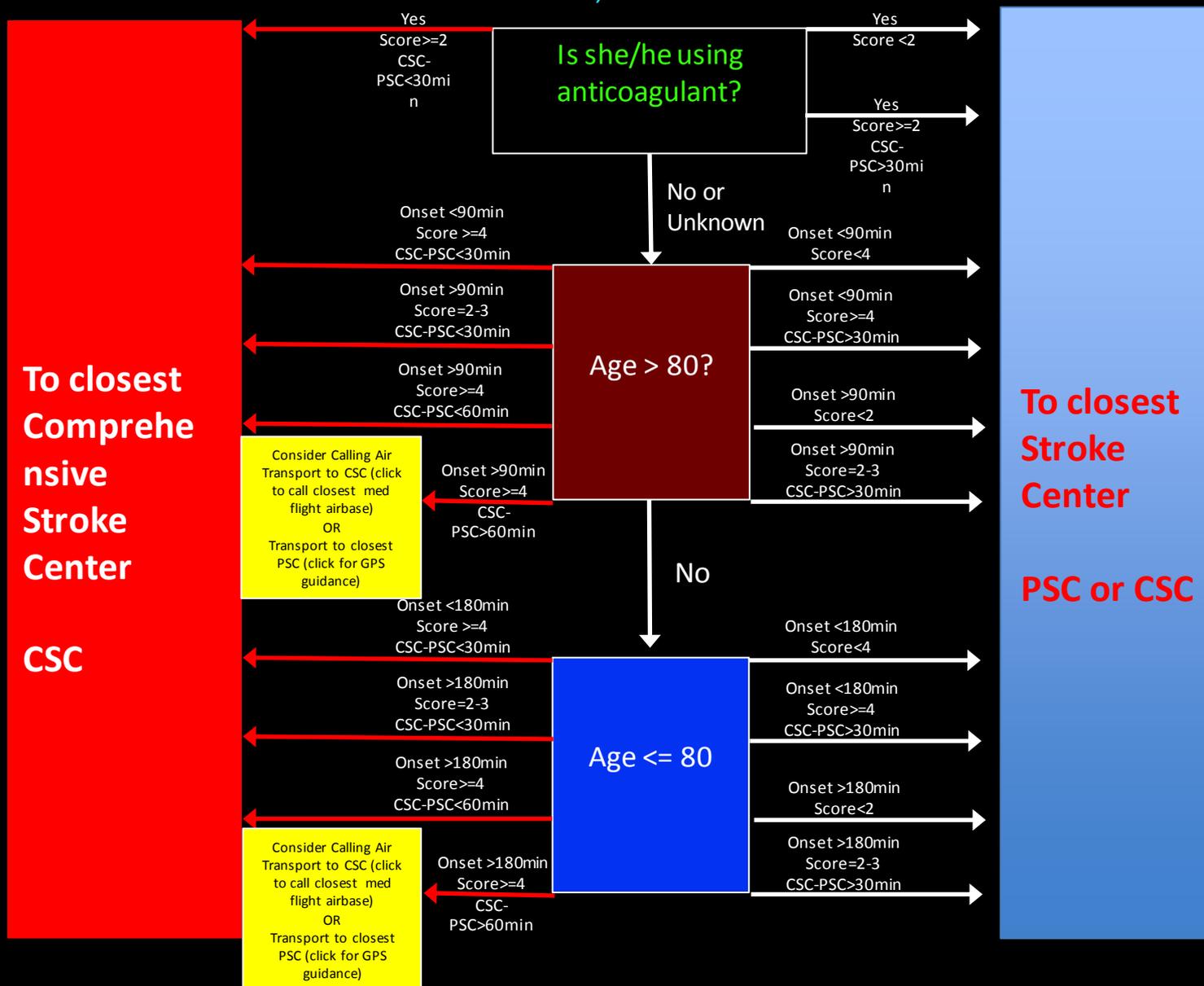
>=4 = 60-85%

Transport to CSC vs any closest SC depends of the chances of getting IV tPA and % of LVO

Once press "GO TO..." , it will bring the list of PSC and/or CSC

The Algorithm

Based on: Distance between PSC & CSC, ANTICOAGULANT, SCORE, AGE and TIME



Question workflow

App makes over 50 decisions
like this!

App Prototype

Smartphone Apps

Field Assessment Stroke Triage for Emergency Destination FAST-ED App

AT&T LTE 3:14 PM 67%

< Face Weakness

☹️

Does the patient have face weakness?

NO

YES

[More info about this step](#)

Ask the patient to smile or show teeth. Watch for weakness on one side of the face, as observed below.



▶ Normal: Both sides of the face move equally or not at all

▶ One side of face droops

☹️ 🧑 🧠 🧐 📷 🧑

AT&T LTE 3:15 PM 67%

< Arm Weakness

☒ Arm Weakness

🧑

Ask the patient to hold both arms out with palms up and eyes closed for 10 seconds. Does the patient have a drift of one side?

NO

YES, ONE ARM DRIFTS DOWN

YES, ONE ARM FALLS RAPIDLY

[More info about this step](#)

Ask the patient to hold both arms out with palms up and eyes closed for 10 seconds. Watch for a drift of one side, as observed below.



▶ Normal: both arms remain extended equally or drifts equally or do not move at all

▶ One arm drifts down

▶ One arm falls rapidly or no movement at all

☹️ 🧑 🧠 🧐 📷 🧑

Smartphone Apps

Field Assessment Stroke Triage for Emergency Destination FAST-ED App

AT&T LTE 3:15 PM 67%

< Speech Changes



Does the patient show speech changes?

NO

YES

[More info about this step](#)

Ask the patient to repeat the phrase: "You can't teach an old dog new tricks". What is his/her reaction?

- ▶ Normal: Phrase is repeated clearly and correctly
- ▶ Abnormal: Words are slurred (dysarthria) or abnormal (aphasia) or none

Ask the patient "Show me two fingers" (do not show the patient what to do! Only verbal command with no visual cues). What happens?

- ▶ Normal: Patient shows two fingers
- ▶ Abnormal: Patient cannot understand e.g. does not show two fingers



AT&T LTE 3:16 PM 67%

< Eye Deviation



Does the patient have gaze deviation to any side?

NO

YES, MILD DEVIATION / GAZE PREFERENCE

YES, FORCED GAZE DEVIATION

[More info about this step](#)

Check the patient's eyes to see if he/ she has a gaze deviation to one side or the other, as observed below.



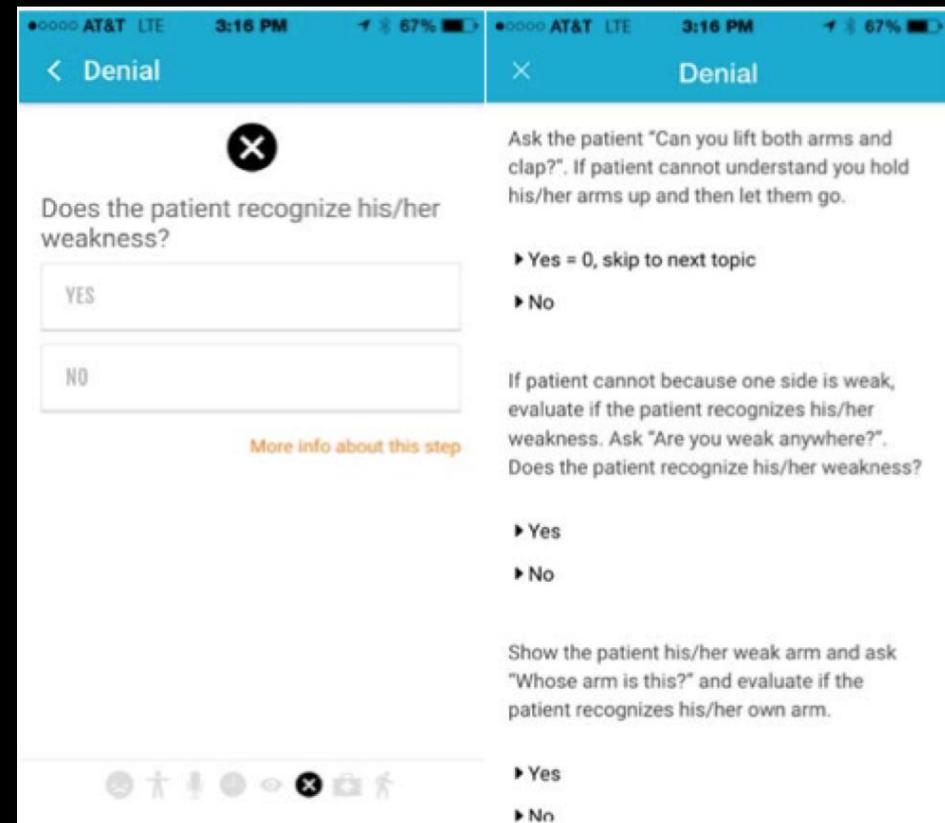
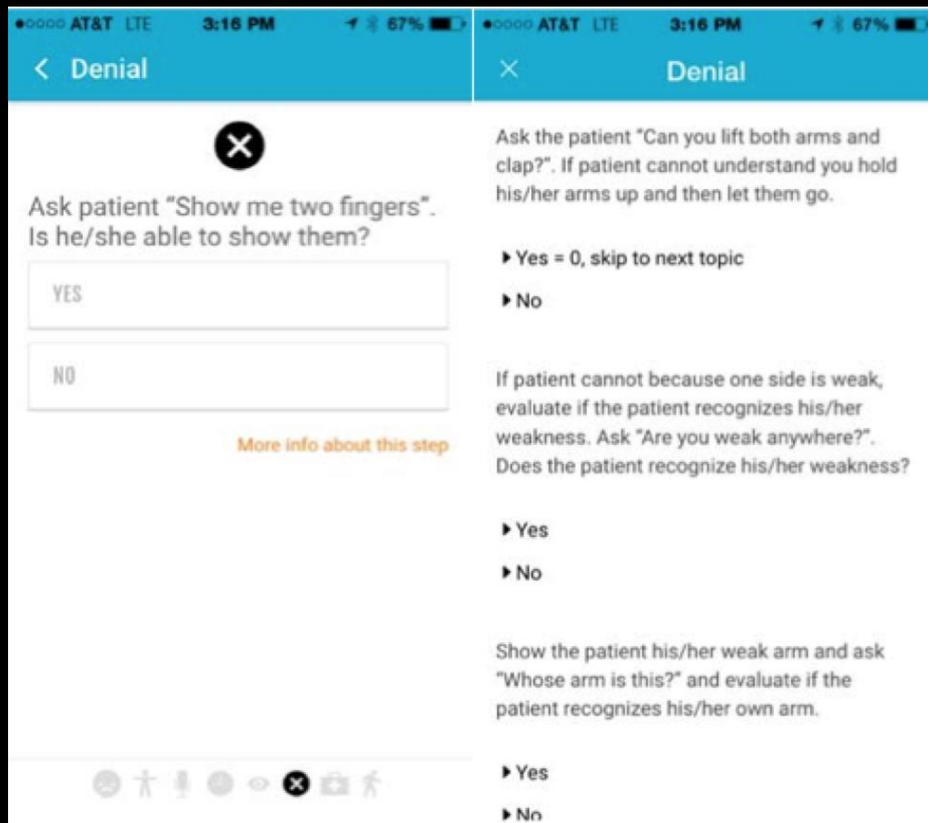
Ask the patient to follow your finger as you move it from right to left and back from left to right.

- ▶ Normal Gaze: No deviation, i.e., eyes move to both sides equally
- ▶ Mild Deviation/ Gaze Preference: Eyes are preferentially moved to the right or left but patient is able to follow finger to the other side
- ▶ Forced Gaze Deviation: Eyes are deviated to one side and do not move to the other side e.g. cannot follow finger



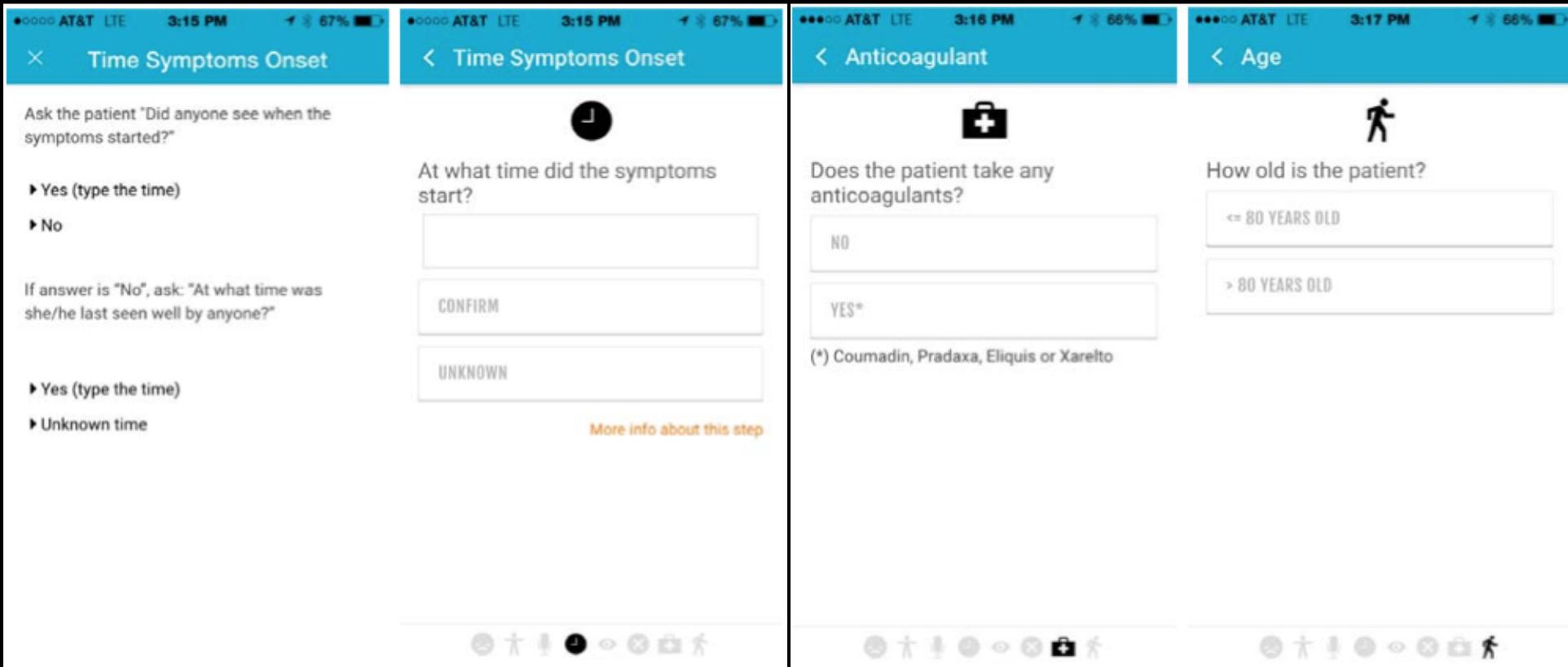
Smartphone Apps

Field Assessment Stroke Triage for Emergency Destination FAST-ED App



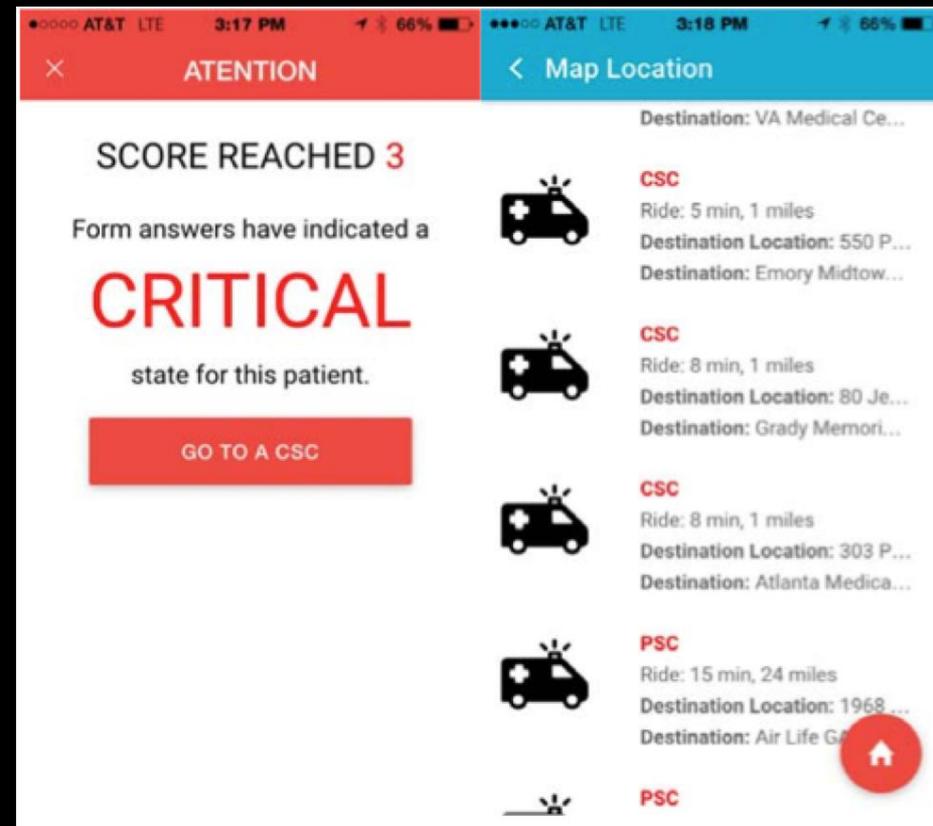
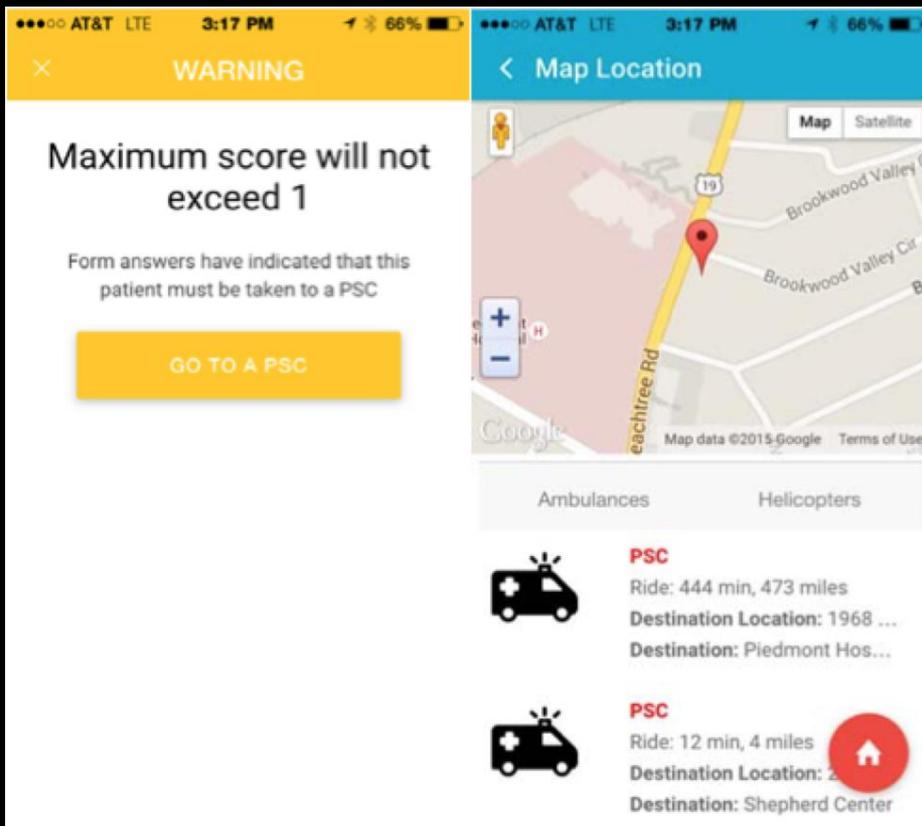
Smartphone Apps

Field Assessment Stroke Triage for Emergency Destination FAST-ED App



Smartphone Apps

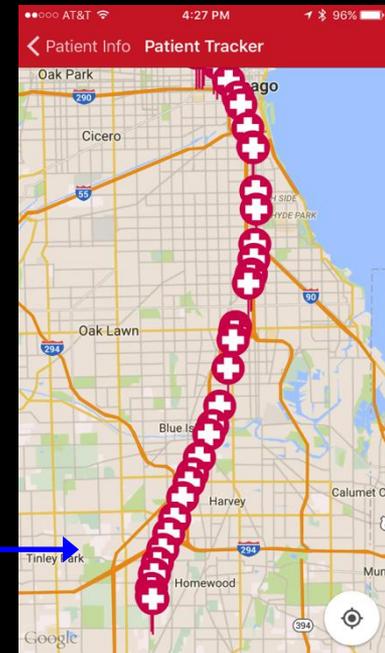
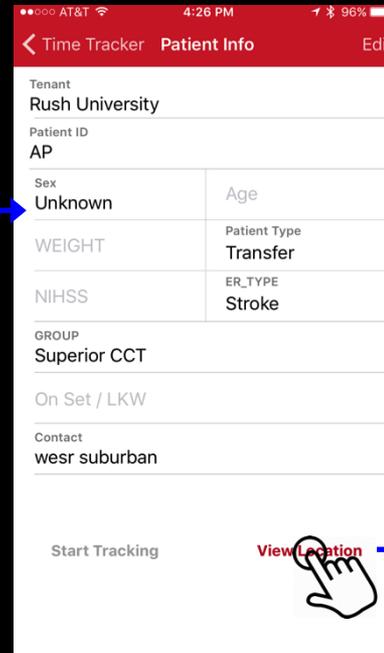
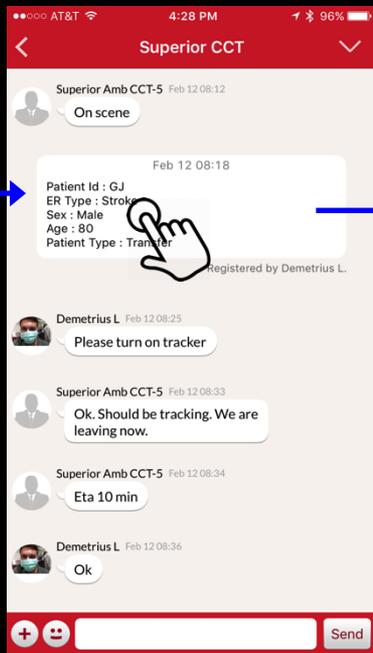
Field Assessment Stroke Triage for Emergency Destination FAST-ED App



Next Steps: Helicopter vs. Ground
EMS – Closest CSC Teleconsultation

FAST ED Smartphone App

From Triage App -> JOIN



Smartphone Apps

From Field Triage to Hospital Work Flow

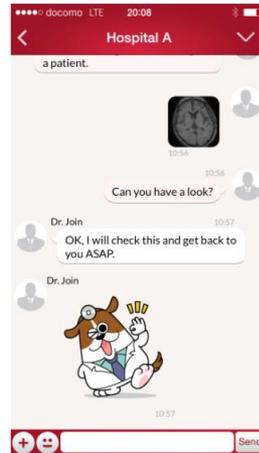
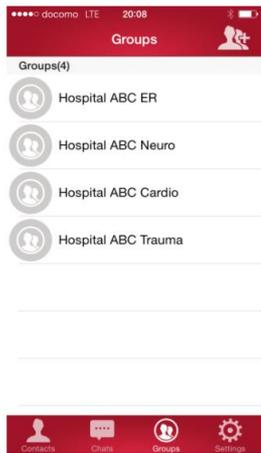
The image displays four smartphone app screens for the Pulsara system, illustrating the workflow from field triage to hospital work flow.

- EMS Screen:** Shows the user Bill Richardson. It lists the ED Physician John Carter, Neurologist Ben Casey, and Radiologist Ethan Boyd. It also displays the Emergency Department status, Door Time, NIHSS score, and a 1:45 timer for the 1st Contact.
- CHARGE RN Screen:** Shows the patient Bill Richardson - 85M. It displays the Last Known Well time (04:17 PM), EMS (Pulsara EMS), and ETA (05:40 PM). It includes options for Details, Team, Images, and Contacts.
- RAD TECH Screen:** Shows a notification for a New STROKE Patient with an ETA of 05-19 17:40. It features a large red circular gauge and a white dialog box with 'Cancel' and 'Go' buttons.
- NEUROLOGIST Screen:** Shows a large red circular gauge with four quadrants: NEW, INBOUND, ACTIVE, and TRANSFER. Each quadrant has a '0' indicator.

Smartphone Apps

From Field Triage to Hospital Work Flow

main functionality



Outside Hospitals: Collaboration is Crucial!

Who to Call/Transfer to CSC?

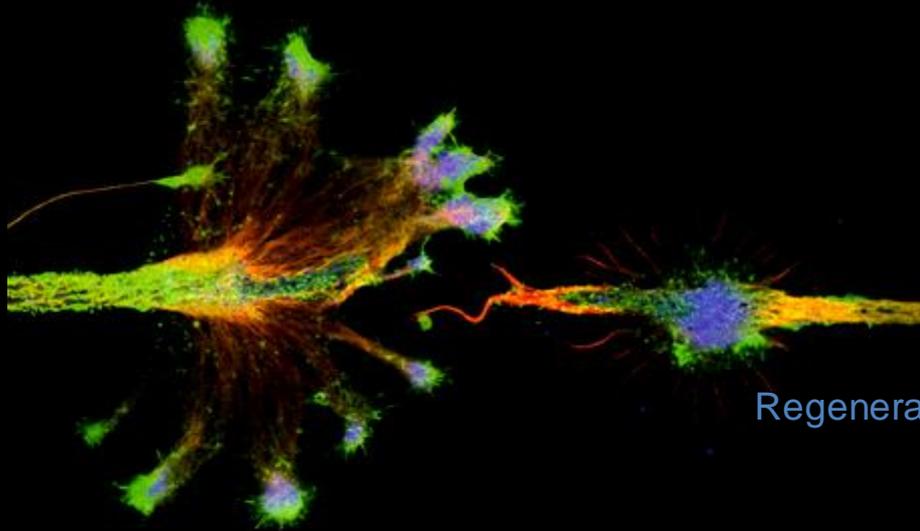
- **FAST-ED!**
- Any combo of **F**ace/**A**rm Weakness \pm **S**peech Changes (Aphasia) \pm **E**ye Deviation \pm **D**enial/Neglect = **T**imely Transfer!
- Any patient with severe weakness/hemiplegia
- Imaging: Dense MCA sign without Large Hypodensity
 - * $>8\text{mm}$ = high chances of IV tPA Failure

Bad Looking Patient + Good Looking CT = Please Call Us!

Conclusions:

- Level 1A Evidence (5 RCTs) of *Overwhelming Treatment Effect (NNT 3-7)* on the #1 Cause of Long-Term Severe Disability in U.S.
- The main opportunity for greater impact currently resides on the pre-hospital setting.
- Need to foster closer partnership with EMS personnel.
- Partnership with PCSs will be important – CSCs currently don't have enough capability to care for ALL strokes...

It's a beautiful day
Skeptics fall, you feel like
It's a beautiful day
Don't let that clot get away



Regeneracion, Pasajes Neuronales, 2006

Thank you for your
attention!