Pre-Hospital Stroke Care: How Can We Improve?

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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:

Ictus

Stroke Sx Recognition 911 Call

Triage/Transport

PSC CSC

ED Door CT/MRI

? IV tPA

Puncture

mTICI 2b-3

Primary Prevention

Public Education

Mobile Stroke Units

Field Triage Scales

Smartphone Apps

EMS Teleconsulation

Bypass ED & CT/MRI

Dx + Rx Hybrid Suites

Faster Access

? Direct Carotid

Radial

Better Tools

Best Tool to Specific Clots

FAST ED App

Raul Nogueira, MD
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
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

<table>
<thead>
<tr>
<th>Stroke VAN</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>How weak is the patient?</strong></td>
</tr>
<tr>
<td>Raise both arms up</td>
</tr>
<tr>
<td>□ Mild (minor drift)</td>
</tr>
<tr>
<td>□ Moderate (severe drift—.touches or nearly touches ground)</td>
</tr>
<tr>
<td>□ Severe (flaccid or no antigravity)</td>
</tr>
<tr>
<td>□ Patient shows no weakness. Patient is VAN negative</td>
</tr>
<tr>
<td>(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)</td>
</tr>
<tr>
<td><strong>Visual disturbance</strong></td>
</tr>
<tr>
<td>□ Field cut (which side) (4 quadrants)</td>
</tr>
<tr>
<td>□ Double vision (ask patient to look to right then left; evaluate for uneven eyes)</td>
</tr>
<tr>
<td>□ Blind new onset</td>
</tr>
<tr>
<td>□ None</td>
</tr>
<tr>
<td><strong>Aphasia</strong></td>
</tr>
<tr>
<td>□ Expressive (inability to speak or paraphasic errors); do not count slurring of words (repeat and name 2 objects)</td>
</tr>
<tr>
<td>□ Receptive (not understanding or following commands) (close eyes, make fist)</td>
</tr>
<tr>
<td>□ Mixed</td>
</tr>
<tr>
<td>□ None</td>
</tr>
<tr>
<td><strong>Neglect</strong></td>
</tr>
<tr>
<td>□ Forced gaze or inability to track to one side</td>
</tr>
<tr>
<td>□ Unable to feel both sides at the same time, or unable to identify own arm</td>
</tr>
<tr>
<td>□ Ignoring one side</td>
</tr>
<tr>
<td>□ None</td>
</tr>
</tbody>
</table>

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 the 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!

Expressive Aphasia
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 <= 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.

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

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

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

- ICA-T
- MCA-M1
- MCA-M2

Better IV tPA Response
Low NIHSS =
Good Collaterals = More Time

0 1 2 3 4 5 6 7 8 9

0% 5% 10% 15% 20% 25% 30% 35% 40% 45%
FAST ED: Field Stroke Triage Scale

Field Assessment Stroke Triage for Emergency Destination

STOP Stroke 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%)

<table>
<thead>
<tr>
<th></th>
<th>FAST-ED ≥3</th>
<th>FAST-ED ≥4</th>
<th>RACE ≥5</th>
<th>CPSS ≥2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>0.71</td>
<td>0.60</td>
<td>0.55</td>
<td>0.56</td>
</tr>
<tr>
<td>Specificity</td>
<td>0.78</td>
<td>0.89</td>
<td>0.87</td>
<td>0.85</td>
</tr>
<tr>
<td>PPV</td>
<td>0.62</td>
<td>0.72</td>
<td>0.68</td>
<td>0.65</td>
</tr>
<tr>
<td>NPV</td>
<td>0.84</td>
<td>0.82</td>
<td>0.79</td>
<td>0.78</td>
</tr>
<tr>
<td>AUC - ROC</td>
<td>0.84</td>
<td>0.84</td>
<td>0.77</td>
<td>0.75</td>
</tr>
</tbody>
</table>

p=0.02  p=0.002
**The Assessment and Assumptions**

**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

**The 4 steps assessment:**

1. **Determine the SCORE**
2. **Determine the ANTICOAGULANT**
3. **Determine the AGE**
4. **Determine the TIME**

**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

**Is he/she using anticoagulant?**
- NO
- YES (Pradaxa, Eliquis or Xarelto)

**What is the patient age?**

**LKWT = What’s the Last known well time?**

Time = minutes from LKWT + 90 min (*)

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

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

Is she/he using anticoagulant?

Yes
Score \( \geq 2 \)
CSC-PSC < 30 min

Onset < 90 min
Score \( \geq 4 \)
CSC-PSC < 30 min

Consider Calling Air
Transport to CSC (click to call closest med flight airbase)
OR
Transport to closest PSC (click for GPS guidance)

Yes
Score < 2

Onset < 90 min
Score > 2
CSC-PSC > 30 min

Yes
Score \( \geq 2 \)
CSC-PSC > 30 min

Onset > 90 min
Score > 2
CSC-PSC < 30 min

Onset > 90 min
Score >= 4
CSC-PSC < 60 min

Onset > 90 min
Score >= 4
CSC-PSC < 30 min

Onset > 90 min
Score = 2 - 3
CSC-PSC < 30 min

Onset > 90 min
Score >= 4
CSC-PSC < 60 min

Consider Calling Air
Transport to CSC (click to call closest med flight airbase)
OR
Transport to closest PSC (click for GPS guidance)

No or Unknown

Age > 80?

Yes

Onset < 90 min
Score > 4
CSC-PSC < 30 min

Onset > 90 min
Score = 2 - 3
CSC-PSC < 30 min

Onset > 90 min
Score >= 4
CSC-PSC < 60 min

Onset > 90 min
Score >= 4
CSC-PSC > 60 min

Onset > 180 min
Score < 2

Consider Calling Air
Transport to CSC (click to call closest med flight airbase)
OR
Transport to closest PSC (click for GPS guidance)

No

Age <= 80

Onset < 180 min
Score > 4
CSC-PSC < 30 min

Onset > 180 min
Score = 2 - 3
CSC-PSC < 30 min

Onset > 180 min
Score >= 4
CSC-PSC < 60 min

Onset > 180 min
Score >= 4
CSC-PSC > 60 min

Onset > 180 min
Score < 2

To closest Comprehensive Stroke Center
CSC

To closest Stroke Center
PSC or CSC

Raul Nogueira, MD
App makes over 50 decisions like this!
App Prototype
Smartphone Apps

Field Assessment Stroke Triage for Emergency Destination

FAST-ED App

- **Face Weakness**
  - Does the patient have face weakness?
    - NO
    - YES

- **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

- Normal: Both arms remain extended 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

Speech Changes

Does the patient show speech changes?

- NO
- YES

More info about this step

Speech Changes

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

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

Eye Deviation

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

Ask patient “Show me two fingers”. Is he/she able to show them?

- **YES**
- **NO**

If patient cannot because one side is weak, evaluate if the patient recognizes his/her weakness. Ask “Are you weak anywhere?”. Does the patient recognize his/her weakness?

- **Yes**
- **No**

Show the patient his/her weak arm and ask “Whose arm is this?” and evaluate if the patient recognizes his/her own arm.

- **Yes**
- **No**

Ask the patient “Can you lift both arms and clap?”. If patient cannot understand you hold his/her arms up and then let them go.

- **Yes = 0, skip to next topic**
- **No**

If patient cannot because one side is weak, evaluate if the patient recognizes his/her weakness. Ask “Are you weak anywhere?”. Does the patient recognize his/her weakness?

- **Yes**
- **No**

Show the patient his/her weak arm and ask “Whose arm is this?” and evaluate if the patient recognizes his/her own arm.

- **Yes**
- **No**
Smartphone Apps

Field Assessment Stroke Triage for Emergency Destination

FAST-ED App

- Time Symptoms Onset
  - Ask the patient “Did anyone see when the symptoms started?”
  - Yes (type the time)
  - No
  - If answer is “No”, ask: “At what time was she/he last seen well by anyone?”
  - Yes (type the time)
  - Unknown

- Anticoagulant
  - Does the patient take any anticoagulants?
  - NO
  - YES*
  - CONFIRM
  - UNKNOWN

- Age
  - How old is the patient?
  - <= 80 YEARS OLD
  - > 80 YEARS OLD

(*) Coumadin, Pradaxa, Eliquis or Xarelto
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
Smartphone Apps

From Field Triage to Hospital Work Flow

Join

Main functionality
Outside Hospitals: Collaboration is Crucial!

Who to Call/Transfer to CSC?

- FAST-ED!
- Any combo of Face/Arm Weakness $\pm$ Speech Changes (Aphasia) $\pm$ Eye Deviation $\pm$ Denial/Neglect = Timely 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

Thank you for your attention!