Prognostic Value of BEFAST vs. FAST to Identify Stroke in a Prehospital Setting

David Pickham, André Valdez, Jelle Demeestere, Robin Lemmens, Linda Diaz, Sherril Hopper, Karen de la Cuesta, Fannie Rackover, Kenneth Miller & Maarten G. Lansberg

To cite this article: David Pickham, André Valdez, Jelle Demeestere, Robin Lemmens, Linda Diaz, Sherril Hopper, Karen de la Cuesta, Fannie Rackover, Kenneth Miller & Maarten G. Lansberg (2018): Prognostic Value of BEFAST vs. FAST to Identify Stroke in a Prehospital Setting, Prehospital Emergency Care, DOI: 10.1080/10903127.2018.1490837

To link to this article: https://doi.org/10.1080/10903127.2018.1490837

Accepted author version posted online: 17 Aug 2018.
Published online: 23 Aug 2018.

Submit your article to this journal

Article views: 82

View Crossmark data
**Prognostic Value of BEFAST vs. FAST to Identify Stroke in a Prehospital Setting**

David Pickham, PhD, RN, André Valdez, PhD, Jelle Demeestere, MD, Robin Lemmens, MD, PhD, Linda Diaz, BSN, RN, Sherril Hopper, MSN, RN, Karen de la Cuesta, FNP-C, Fannie Rackover, MS, Kenneth Miller, MD, PhD, Maarten G. Lansberg, MD, PhD

**ABSTRACT**

**Background:** Use of prehospital stroke scales may enhance stroke detection and improve treatment rates and delays. Current scales, however, may lack detection accuracy. As such, we examined whether adding coordination (Balance) and diplopia (Eyes) assessments increase the accuracy of the Face-Arms-Speech-Time (FAST) scale in a multisite prospective study of emergency response activations for presumed stroke. **Methods:** This was a prospective study of emergency response activations for presumed stroke in Santa Clara County, California. Emergency medical responders were trained in the Balance-Eyes-Face-Arms-Speech-Time (BEFAST) scale and administered the scale on scene to all patients who were within 6 hours of onset of neurological symptoms. Each patient’s final diagnosis (stroke vs. no stroke) was based on review of hospital records. We compared the performance of the BEFAST and FAST scales for stroke detection. **Results:** Three hundred fifty-nine patients were included in our analysis. Compared to nonstroke patients (n = 200), stroke patients (n = 159) more often scored positive on each of the five elements of the BEFAST scale (p < 0.05 for each). In multivariable analysis, only facial droop and arm weakness were independent predictors of stroke (p < 0.05). BEFAST and FAST scale accuracy for stroke identification was comparable (area under the curve [AUC] = 0.70 vs. AUC = 0.69, p = 0.36). Optimal cutoff for stroke detection was ≥1 for both scales. At this threshold, the positive predictive value (PPV) was 0.49 for the BEFAST and 0.53 for the FAST scale, and the negative predictive value (NPV) was 0.93 for BEFAST and 0.86 for FAST. **Conclusion:** Adding coordination and diplopia assessments to face, arm, and speech assessment does not improve stroke detection in the prehospital setting. **Key words:** prehospital; acute stroke; stroke; assessment

**INTRODUCTION**

Stroke is the third leading cause of disability and accounts for more than 10% of all deaths globally (1). Intravenous thrombolysis and endovascular reperfusion techniques have been shown to significantly reduce ischemic stroke-related disability (2–4). However, the effect of these treatments rapidly declines when treatment is delayed (2,5–8). For hemorrhagic stroke, time-dependent treatment effects have also been suggested, with reduced hematoma growth and better clinical outcomes among patients who receive earlier treatment for hypertension or coagulopathy (9–11). Further, early neurosurgical intervention may be lifesaving for hemorrhagic stroke patients with impending herniation (12).

Earlier and improved stroke detection by emergency medical services (EMS) may reduce treatment delays through pproximation of the accepting hospital and bypassing of hospitals unable to provide acute stroke treatment (13–15). Several scales to aid stroke detection are currently in use by EMS, ranging from simple 3-item scales, such as the Face-Arms-Speech-Time (FAST) or Cincinnati Prehospital Stroke scale, to more complex scales like the National Institutes of Health Stroke Scale (NIHSS) (16–27). A benefit of the simple FAST scale is that it requires little training and can be administered quickly. As with most prehospital stroke scales, the FAST scale lacks sensitivity, and more than one-fifth of stroke patients are missed (20).

Posterior circulation stroke, which represents 20–25% of ischemic stroke patients, involves greater risk of disability and death compared to anterior circulation strokes (24) but is more difficult to diagnose using traditional scales, due to the presence of atypical signs such as balance, coordination, and visual...
symptoms. In one study, screening with the FAST score failed to detect 38% of posterior cerebral circulation strokes (28). To address this, two additional items (Balance/coordination and Eyes/diplopia) have been added to the FAST scale (BEFAST). We examined whether the addition of these two elements improves stroke detection in the prehospital setting.

### METHOD

#### Study Design and Data Collection

This was a multisite prospective study of consecutive 9-1-1 emergency response activations for individuals experiencing stroke-like symptoms within the Santa Clara County (California) EMS system. Santa Clara County includes approximately 2 million residents across 15 municipalities. Each year the public/private EMS partnership responds to more than 100,000 requests for assistance.

All consecutive adult patients assessed by EMS in the field and transported to one of 5 participating stroke-receiving centers in Santa Clara County between April 2015 and September 2016 were screened. Institutional review board approval was obtained by each center before study participation. Patients with sudden onset of neurological symptoms less than 6 hours from EMS arrival were assessed with BEFAST in the field. All patients who underwent a complete BEFAST assessment by paramedics were included. Patients presenting directly to the emergency department (ED) were not included in this study. Prior to facility transfer, BEFAST data were entered into the county electronic record by EMS personnel during field assessment. The patient’s final diagnosis (stroke vs. no stroke) was based on chart review by experienced stroke nurses at each participating hospital. Patients with a transient ischemic attack, defined as transient neurological symptoms attributable to a neurovascular cause and lasting less than 24 hours and/or no confirmed lesion on follow-up brain imaging, were considered nonstroke cases. All patient data were deidentified, input in a secure database (REDCap, UL1 TR001085 from NIH/NCRR), and stored on a central server at Stanford University (29).

#### BEFAST and NIHSS Scoring

Training was developed by the County EMS Medical Director. All EMS personnel received 1 hour of education via training video and were provided an opportunity to ask clarifying questions. A formal assessment of knowledge acquisition or task performance was not performed by the research team.

The Face, Arms, and Speech components of BEFAST were scored conventionally (30). EMS scored facial droop by evaluating facial asymmetry at rest and upon smiling, arm weakness by assessing drift, and speech quality and content by asking patients to repeat a standard sentence (e.g., “The sky is blue”). The Balance component of the BEFAST scale was scored by finger-to-nose testing and the Eyes component by assessing for diplopia during a finger-tracking maneuver. A certified
registered nurse or physician scored the NIHSS at the receiving stroke center upon patient arrival.

**Statistical Analysis**

We analyzed the data using R version 3.3.1 (31). The BEFAST score was analyzed as a 6-point scale ranging from “no observed symptoms” (a score of 0) to “abnormal” on all five items (a score of 5), and the FAST score was analyzed as a 4-point scale. We compared median BEFAST and NIH stroke scores between groups with the Wilcoxon rank-sum test, compared percentages with the chi-squared test, and assessed independent predictors of a stroke diagnosis with multiple logistic regression. We calculated the area under the receiver operating characteristic (ROC) curves for BEFAST and FAST scores and used the Youden index to determine optimum BEFAST and FAST cutoff scores. The sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) for stroke detection were determined at these cutoffs. All inferential tests had a significance criterion of 0.05.

**Results**

Of the 495 patients that EMS assessed, 359 (72.5%) received a full BEFAST evaluation and were included in the analysis (Table 1). Fifty percent of the included patients were male, and most were white (70%). Forty-four percent had a final diagnosis of stroke. NIHSS score, determined in the ED, was significantly higher in stroke versus nonstroke patients (median 7 vs. 2, \( p < 0.001 \)). Clinically confirmed stroke patients also had higher median BEFAST (3 vs. 1, \( p < 0.001 \)) and FAST scores (2 vs. 1, \( p < 0.001 \)) than patients with nonstroke etiologies. Higher NIHSS scores correlated with higher BEFAST (\( r_s = 0.38, p < 0.001 \)) and FAST (\( r_s = 0.32, p < 0.001 \)) scores (Figure 1).

Compared with nonstroke patients, stroke patients had a higher percentage of facial droop (52% vs. 24%, \( p < 0.001 \)), arm weakness (55% vs. 20%, \( p < 0.001 \)), and abnormal speech (63% vs. 42%, \( p < 0.001 \)). The two additional features captured by the BEFAST scale also differed between stroke and nonstroke patients (balance/coordination: 55% vs. 40%, \( p = 0.003 \); eyes/diplopia 31% vs. 22%, \( p = 0.04 \); Table 2). In multivariable analysis, the only independent predictors of stroke were facial droop (OR = 1.95, 95% CI [1.13, 3.36], \( p = 0.01 \)) and arm weakness (OR = 3.20, 95% CI [1.90, 5.43], \( p < 0.001 \)). The variance inflation factor for each predictor (Balance = 1.09; Eyes = 1.05; Face = 1.30; Arms = 1.20; Speech = 1.25) indicated a low likelihood of multicollinearity.

Both the BEFAST scale (AUC = 0.70) and the FAST scale (AUC = 0.69) had moderate (32) test characteristics for identifying stroke and performed similarly (\( p = 0.36; \) Figure 2). The BEFAST model did not provide a better fit over the FAST model (\( \chi^2 = 4.64, p = 0.09 \)). The optimal cutoff score for predicting stroke was \( \geq 1 \) for both the BEFAST scale and the FAST scale (Youden’s \( J = 0.47 \) and 0.44, respectively; Table 3). At this cutoff, a positive BEFAST score had a PPV of 0.49 and NPV of 0.93 (sensitivity 0.91 and specificity 0.56), while a positive FAST score had a PPV of 0.53 and NPV of 0.86 (sensitivity 0.76 and specificity 0.68; Table 3).

**Discussion**

Adding symptoms more specific to posterior circulation stroke (Balance/coordination and Eyes/diplopia) to the FAST scale does not improve prehospital stroke detection, as evidenced by the similar AUCs for BEFAST and FAST. For both scales, presence of any symptom (a score of at least 1) optimally distinguished stroke patients from patients suffering a stroke mimic. At that cutoff, BEFAST was more sensitive (91% vs. 76%), but this was at the cost of lower specificity (56% vs. 68%) and PPV (49% vs. 53%). A recent consensus statement finds that currently there is “no practical prehospital scale that accurately detects strokes outside of the middle cerebral artery distribution” (33). This study’s evidence is concordant, finding no additional benefit of the inclusion of these parameters within the prehospital assessment.

Prior studies have reported higher PPV for a positive FAST (62–73%) than the PPV observed in our study (53%) (20,34). In these studies, NPV for FAST was lower (59–71%) compared to our results (86%) (20,34). In our study, a positive BEFAST had a slightly lower PPV than a positive FAST (49% vs. 53%). This is consistent with our finding that balance and eye symptoms were not predictive of stroke in multivariable analysis. Speech abnormality was also not an independent predictor of stroke in multivariate analysis, as this symptom is prevalent.
in stroke as well as nonstroke patients. Consistent with prior studies, we found that only facial droop and arm weakness independently predicted stroke (20,34).

The use of prehospital stroke scales by EMS may increase stroke detection (20). Diversion to a primary or comprehensive stroke center and prenotification of the receiving center may result in earlier and more frequent stroke treatment, which would improve patient outcomes (2,3). However, the transfer of a large number of patients with mild symptoms and stroke mimics would increase the logistic burden on the receiving center. Our results demonstrate that for every 100 patients assessed with the BEFAST criteria, an additional 4 stroke-mimic patients are falsely identified, above and beyond the 47 stroke-mimic patients that would have been identified using the FAST criteria alone. The optimal threshold of \( \geq 1 \) BEFAST symptoms may thus depend on the goal and loco-regional stroke network organization. For that reason, recently published scales have focused on detection of ischemic stroke patients with a large vessel occlusion, as these patients may benefit from direct transfer to a comprehensive stroke center for endovascular treatment (35). Because we did not document vessel occlusion status in our study population, we cannot comment on the usefulness of the BEFAST and FAST scales for detection of patients with a target for endovascular treatment.

This study has several other limitations. First, stroke diagnosis was based on all available clinical and radiological data at the time of hospital discharge but did not require imaging confirmation. Therefore, some patients may have been misclassified. Second, only patients with neurological symptoms or complaint underwent BEFAST assessment and were included in the study. Thus, we do not have data on stroke patients who did not have neurological symptoms or who had neurological symptoms that were not recognized as such by EMS. Third, final stroke diagnosis was not categorized by vascular distribution. We could therefore not assess the test characteristics of the FAST and BEFAST scales separately for posterior and anterior circulation. Finally, we could not assess whether assessment of alternative posterior circulation symptoms (e.g., hemianopia) improved stroke detection.

**CONCLUSION**

In the prehospital setting, the BEFAST and FAST scales have similar overall performance for stroke detection. Testing for coordination and diplopia as
part of BEFAST increases sensitivity, but this is countered by reduced specificity and PPV. Consequently, the added time required for the assessment of coordination and diplopia in the field is likely not warranted.

References


