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Accuracy of Field Assessment Stroke Triage for Emergency Destination for Diagnosis of Acute Ischemic Stroke Patients

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Abstract

Aim: Acute stroke is one of the most common and debilitating diseases. Rapid diagnostic measures undertaken upon hospital admission and reduction of the treatment duration will increase access to treatment. The purpose of this study is to examine the accuracy of Field Assessment Stroke Triage for Emergency Destination (FAST-ED) in terms of stroke diagnosis.

Materials and Methods: This prospective diagnostic accuracy study was conducted between March 2019 and January 2020. All adult patients transferred to the ED and suspected of having an acute ischemic stroke who had undergone brain magnetic resonance imaging (MRI) were eligible for inclusion. After data collection, receiver operating characteristic curve analysis was performed, and sensitivity, specificity, positive predictive value, and negative predictive value of FAST-ED were calculated and compared with those of the National Institute of Health Stroke Scale (NIHSS) scale.

Results: A total of 314 patients who had received MRI within the first 24 hours of symptom onset were included in this study. The mean age was 67.95±13.11 years, and 184 patients (58.60%) were male. Of all patients with suspicion of ischemic stroke, 274 (87.26%) were diagnosed on the basis of the gold standard. The best predictor of stroke in FAST-ED, with a sensitivity of 0.880 and specificity of 0.575, was a cut-off point of 2 (area under the curve: 0.836). The distribution of all FAST-ED symptoms was significant in the stroke and non-stroke groups, with the exception of "Eye deviation."

Conclusion: The FAST-ED scale is relatively simple and has a comparable ability to recognize AIS to that of the more complex NIHSS.

Keywords: Stroke, triage, acute cerebral ischemia, clinical prediction rules, emergency care

Introduction

Acute stroke is one of the most common and debilitating diseases (1). Despite major advances in recent years, however, stroke has become one of the leading causes of death worldwide. Stroke was the cause of one in 15 deaths in the United States, and 50% of these deaths occurred outside the hospital (2).

Previous studies have reported an incorrect stroke diagnosis (false positives) of 30-40% and a misdiagnosis of stroke (false negatives) of 2-26% (3). The post-ictal phase of seizures, hypoglycemia, etc., is the differential diagnosis of strokes and taking a complete history, careful physical examination, and the use of diagnostic tools can help differentiate them (3,4).

The main predictor of recovery in cases of acute ischemic stroke is the time elapsed between the onset of symptoms and reperfusion therapy. Rapid triage and rapid transport are critical for patients with acute stroke in a pre-hospital setting. Rapid diagnostic measures after entering the hospital and shortening the duration of treatment will increase the chances of access to treatment

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(5,6). Rapid treatment with intravenous treatment is effective for patients with an ischemic stroke of <4.5 hours after onset (5-7).

The National Institute of Health Stroke Scale (NIHSS) can comprehensively assess the degree of neurological impairment in stroke patients. However, NIHSS is complex and time-consuming (8).

Some existing simplified stroke screens, such as Melbourne Ambulance Stroke Screen, the Face Arm Speech Test (FAST), Cincinnati Prehospital Stroke Severity Scale (CPSSS) and its modification and Recognition of Stroke in the Emergency Room (ROSIER) were designed to detect strokes (1,8,9). The accuracy of these clinical scales varies between 0.75 and 0.80 and differs slightly from each other (8-10). Other prehospital stroke scales have been proposed to identify patients experiencing an acute stroke. Choosing a scale depends on both its accuracy and ease of use. An increasing number of studies assessing the diagnostic performance of clinical assessment tools have been seen in recent years. The accuracy and effectiveness of a new criterion that is comparable in sensitivity, specificity, etc. to other pre-hospital scales is important and plays an important role in the rapid and accurate diagnosis of acute stroke and thus increasing the patient's chances of successful treatment.

Therefore, we conducted a prospective cohort study to examined the Field Assessment Stroke Triage for Emergency Destination (FAST-ED) score and compared it to NIHSS for detecting acute stroke.

Materials and Methods

This prospective diagnostic accuracy study had been conducted between March 2019 to January 2020 at at Al-Zahra and Kashani Hospitals, two university hospitals in Isfahan, Iran. The study protocol has been approved by the Ethics Committee of Isfahan University of Medical Sciences (Code: IR.MUI.MED.REC.1397.336)

The FAST-ED Scale [facial palsy (scored 0-1), arm weakness (0-2), speech changes (0-2), time [documentation for decision making but no points], eye deviation (0-2), and denial/neglect (0-2)] was designed based on items of the NIHSS (Table 1).

We enrolled consecutive patients transferred to the emergency department (ED) and suspected of having an acute ischemic stroke. Those who did not receive magnetic resonance imaging (MRI) in the first 24 hours of symptom onset before intravenous thrombolysis or endovascular therapy were excluded.

Patients were excluded if there was evidence of head trauma, previous stroke, known neurological disease, or previous neurological surgery.

A checklist will be used to collect information. For this purpose, a checklist consisting of three sections will be prepared. The first part of the checklist is related to basic information and demographics data of patients, including age, gender, past medical history (hypertension, diabetes, dyslipidemia, ischemic heart disease, seizure, coagulopathy, cerebral infarction, and TIA), NIHSS Score, and time from onset of symptoms, the second part includes five items related to FAST-ED Criteria based on physical examination, and the third part includes the final diagnosis of patients. It was based on the results of the MRI, which was considered the gold standard in this study. The brain MRI was reported by radiologists.

In the present study, all patients transferred to the emergency department who have symptoms of stroke, or are suspected of having a stroke, will be evaluated by an emergency physician (emergency medicine resident, or specialist) and the FAST-ED Criteria and five items will be completed and registered in the checklist.

Statistical Analysis

SPSS v.22 software was used for statistical analysis. Continuous variables are presented as mean ± standard deviation. Categorical variables were reported as number and percentage.

Comparisons of variables between two groups (with and without stroke) were conducted by the chi-square test for categorical variables and the independent t-test for continuous variables. We used the Mann-Whitney U test to compare of median ± Interquartile Range Score of FAST-ED in patients with and without stroke.

Sensitivity and specificity with 95% confidence interval (CI), positive and negative predictive value, positive and negative likelihood ratio were calculated using several different thresholds of the FAST-ED. The discriminatory performances of FAST-ED were assessed by analysing the Receiver Operating Characteristic (ROC) curve. We calculated the area under the ROC curve (AUC) to distinguish between FAST-ED and NIHHS between two groups (with and without stroke). The Youden Index was used to evaluate the optimal threshold of the FAST-ED scale. A cut-off of 6, 7, and 10 points in the NIHSS was used for comparison.

P-value <0.05 was considered as statistically significant.

Results

A total of 363 patients suspected stroke were collected and 49 patients were excluded according to the exclusion criteria. Finally, 314 patients who receive MRI in the first 24 hours of symptom onset and before reperfusion therapy were included.

The mean age was 67.95±13.11 years (between 11 to 93 old years) and 184 patients (58.60%) were males. Of all suspected patients, 274 patients (87.26%) had ischemic stroke based-on gold standard diagnosis. The mean age in the stroke group was higher than the non-stroke group (69.05±13.62 vs 60.78±13.63; p<0.001). There was no significant difference in the past medical history (hypertension, diabetes, dyslipidemia, ischemic heart disease, seizure, coagulopathy, cerebral infarction, and TIA) between the two groups (Table 2).

The median of FAST-ED in with stroke group was significantly higher than the non-stroke group (4.0 vs 2.0; p=0.001). Of FAST-ED symptoms, "arm weakness" was highest (82.8%), and "eye deviation" was the lowest (22.6%) positive symptoms in the stroke group, respectively.

Except for "eye deviation", other FAST-ED criteria were present in more than half of the stroke patients.

Distribution of all FAST-ED symptoms was significant in stroke and non-stroke group except "eye deviation" (p<0.05) (Table 3).

The sensitivity, specificity, positive predictive value, negative predictive value, negative likelihood ratio, and positive likelihood ratio for different cut-off values of the FAST-ED scale for prediction of acute ischemic stroke (AIS) are shown in Figure 1. Better performance of FAST-ED could be shown at two distinct thresholds of ≥2 and ≥3 (Table 3). A FAST-ED scale ≥2 and ≥3 showed sensitivity of 0.88 and 0.77, specificity of 0.58 and 0.68, positive predictive value (PPV) of 0.88 and 0.89, and negative predictive value (NPV) of 0.58 and 0.45 in predicting AIS versus NIHSS ≥6 0.80, 0.60, 0.88, and 0.46 and NIHSS ≥10 0.78, 0.58, 0.88, and 0.38, respectively (Tables 4 and 5)

ROC curves of the FAST-ED scale with the NIHSS are shown in Figure 1.

Discussion

It is generally accepted that any patient with clinical signs of stroke needs to be an assessment at a stroke center with advanced imaging to make the best treatment decision for the patient. Rapid triage and rapid transport are very important for patients with acute stroke in a pre-hospital setting. Rapid diagnostic measures after entering the hospital and shortening the duration of treatment will increase the chances of access to treatment.

Most items included in FAST-ED scales except "eye deviation" had a strong correlation with AIS and were easy to assess.

Table 1. The FAST-ED Scale and its correspondence to the NIHSS

Item	FAST-ED Score	NIHSS Score Source
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 1 sensory modality	1	1
Does not recognize own hand or orients only to one side of the body	2	2

FAST-ED: Field Assessment Stroke Triage for Emergency Destination, NIHSS: National Institute of Health Stroke Scale

Table 2. Demographic characteristics and history of disease and risk factors in patients with and without stroke diagnosis			
	Stroke (n=274)	**Non-stroke (n=40)**	**p-value**
Age; mean (SD), year	69.05 (13.6)	60.78 (13.6)	<0.001
BS; glucometer, mean (SD)	151.60 (65.8)	160.43 (100.3)	0.981
Onset to ED mean (SD), hour	6.68 (19.88)	3.66 (4.75)	0.942
History of hypertension, n (%)			
Negative	102 (87.9)	14(12.1)	0.785
Positive	172 (86.9)	26 (13.1)	
History of IHD, n (%)			
Negative	175 (86.2)	28(13.8)	0.449
Positive	99 (89.2)	12(10.8)	
History of smoking, n (%)			
Non-smoker	246 (87.9)	34 (12.1)	0.363
Smoker	28 (82.4)	6 (17.6)	
DM, n (%)			
Negative	182 (87.9)	25 (12.1)	0.625
Positive	92 (86.0)	15 (14.0)	
Coagulopathy, n (%)			
Negative	273 (87.2)	40 (12.8)	0.999
Positive	1 (100.0)	0 (0.0)	
History of stroke, n (%)			
Negative	236 (86.1)	38 (13.9)	0.134
Positive	38 (95.0)	2 (5.0)	
HLP, n (%)			
Negative	234 (86.7)	36 (13.3)	0.434
Positive	40 (90.9)	4 (9.1)	
Seizure, n (%)			
Negative	270(87.4)	39 (12.6)	0.496
Positive	4 (80.0)	1 (20.0)	

BG: Blood glucose, SD: Standard deviation, DM: Diabetes mellitus, HLP: Hyperkeratosis lenticularis perstans, IHD: Ischemic heart disease, ED: Emergency department, n: Number

In analysing the strength of the FAST-ED scale for our patient population, FAST-ED scale ≥2 and ≥3 showed a sensitivity of 0.88 and 0.77, a specificity of 0.58 and 0.68, PPV of 0.88 and 0.89, and NPV of 0.58 and 0.45 in predicting AIS. This analysis compares with Lima et al.'s (11) and Carr et al.'s (12) study.

Lima et al. (11) assessed that FAST-ED ≥4 had a sensitivity of 0.60, the specificity of 0.89, the positive predictive value of 0.72, and a negative predictive value of 0.82.

Carr et al. (12) assessed the sensitivity for FAST-ED greater than or equal to 4 as 0.80, specificity 0.68, PPV 0.40, and NPV 0.93.

Our results were slightly different in which a positive predictive value of 88% and a negative predictive value of 57.5% were reported.

In our study, FAST-ED had a high PPV for acute stroke and appeared to be effective for identifying patients who required triage to a stroke center.

FAST-ED scales have also been developed to predict AIS in the prehospital setting and demonstrated good sensitivity and acceptable specificity, it has a sensitivity of 88.0% [95% Confidence interval (CI); 81.5%-92.9%] and a specificity of 57.5% (95% CI; 40.9%-72.9%) in its best cut-off point (score ≥2). It demonstrated a comparable ability when compared with the more complex NIHSS score and other similar scales.

Several scales have been developed to be used in pre-hospital and hospital settings to screen stroke patients. There is a significant difference in the diagnostic accuracy of the scales

Table 3. Distribution of FAST-ED symptoms and signs and score in patients with and without stroke diagnosis

	Total number (n=314); %	Final diagnosis		p-value
		Stroke (n=274); %	Non-stroke (n=40); %	
Facial palsy 0: Normal or minor paralysis 1: Partial or complete paralysis	 143 (45.5) 171 (54.5)	 117 (42.7) 157 (57.3)	 26 (65.0) 14 (35.0)	0.008
Arm weakness 0: No drift 1: Drift or some effort against gravit 2: No effort against gravity or no movement	 68 (21.7) 104 (33.1) 142 (45.2)	 47 (17.2) 92 (33.6) 135 (49.3)	 21 (52.5) 12(30.0) 7 (17.5)	0.001
Speech changes 0: Absent 1: Mild to moderate 2: Severe, global aphasia, or mute	 75 (23.9) 150 (47.8) 89 (28.3)	 57 (20.8) 136 (49.6) 81(29.6)	 18 (45.0) 14 (35.0) 8(20.0)	0.004
Eye deviation 0: Absent 1: Partial 2: Forced deviation	 247 (78.7) 49 (15.6) 18 (5.7)	 212 (77.4) 44 (16.1) 18 (6.6)	 35 (87.5) 5 (12.5) 0 (0.0)	0.206
Denial/neglect 0: Absent 1: Extinction to bilateral simultaneous stimulation in only 1 sensory modality 2: Does not recognize own hand or orients only to one side of the body	 68 (21.7) 150 (47.8) 96 (30.6)	 52 (19.0) 132 (48.2) 90 (32.8)	 16 (40.0) 18(45.0) 6(15.0)	0.004
FAST-ED score, median (IQR)	4.0 (3)	4.0 (3)	2.0 (3.75)	0.001

FAST-ED: Field Assessment Stroke Triage for Emergency Destination, IQR: Interquartile range, n: Number

Table 4. Sensitivity, specificity, PPV, NPV, -LR and +LR of the FAST-ED Scale

FAST-ED	Sensitivity (95% CI)	Specificity (95% CI)	LR+	LR-	PPV	NPV	Youden index
≥1	97.2 (92.9-99.2)	35.0 (20.6-51.7)	1.50	0.08	84.1	77.8	0.322
≥2*	88.0 (81.5-92.9)	57.5 (40.9-72.9)	2.07	0.21	88.0	57.5	0.455
≥3	76.8 (68.9-83.4)	67.5 (50.9-81.4)	2.36	0.34	89.3	45.0	0.443
≥4	57.0 (48.5-65.3)	75.0 (58.8-87.3)	2.28	0.57	89.0	33.0	0.320
≥5	39.4 (31.3-48.0)	90.0 (76.3-97.1)	3.94	0.67	93.3	29.5	0.294
≥6	16.9 (11.1- 24.1)	95.0 (83.0-99.2)	3.38	0.87	92.3	24.4	0.119
≥7	6.3 (2.9-11.7)	100.0 (91.1-100.0)	-	0.94	100.0	23.1	0.060
≥8	0.7 (0.1-3.9)	100.0 (91.1-100.0)	-	0.99	100.0	22.1	0.070
≥9	0.0 (0.0-2.6)	100.0 (91.1-100.0)	-	1.00	22.0	-	0.000

FAST-ED: Field Assessment Stroke Triage for Emergency Destination, CI: Confidence interval, LR+: positive likelihood ratio, LR-: Negative likelihood ratio, PPV: Positive predictive value, NPV: Negative predictive value
*: Best cut-off point

designed to diagnose AIS. Sensitivity values varied from 44% [Los Angeles Pre-Hospital Stroke Screen (LAPSS) 1998] to 91% (NIHSS-EMS). Specificity ranged from 27% [Medical Priority Dispatch System (MPDS)] to 98% (LAPSS 1998). FABS showed the best diagnostic accuracy values. The FABS tool which was designed specifically for detecting stroke mimics and included additional clinical information, such as atrial fibrillation compared to other well-established tools, for example, ROSIER, demonstrated high sensitivity and specificity rates of about 90% (PPV: 87%, NPV: 93%) (9).

Table 5. Comparison of threshold of the FAST-ED and NIHSS according to sensitivity, specificity, PPV and NPV						
	FAST-ED ≥2*	FAST-ED ≥3	FAST-ED ≥4	NIHSS ≥6	NIHSS ≥7*	NIHSS ≥10
Sensitivity	88.0	76.8	57.0	80.3	84.1	77.8
Specificity	57.5	67.5	75.0	60.0	88.0	57.5
PPV	88.0	89.3	89.0	87.7	89.1	88.3
NPV	57.5	45.0	33.0	46.2	42.9	38.0

FAST-ED: Field Assessment Stroke Triage for Emergency Destination, NIHSS: National Institute of Health Stroke Scale, PPV: Positive predictive value, NPV: Negative predictive value
*: Best cut-off point

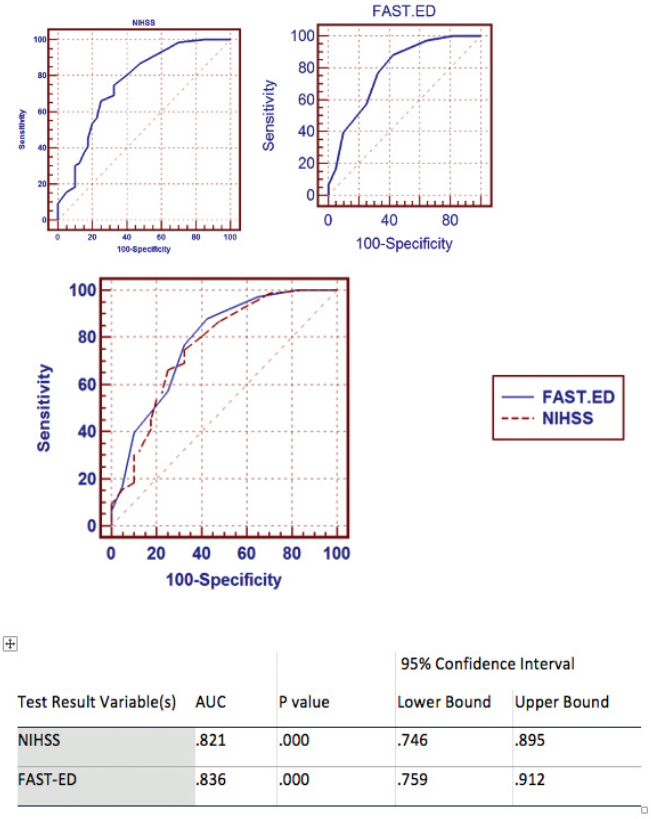

Figure 1. The sensitivity, specificity, positive predictive value, negative predictive value, negative likelihood ratio, and positive likelihood ratio for different cut-off values of the FAST-ED scale for prediction of acute ischemic stroke

Smith et al. (5) suggest that the NIHSS is the optimal large vessel occlusion (LVO) prediction instrument in the hospital emergency department, whereas in the prehospital setting, a variety of scales, including the CPSSS, FAST-ED, Los Angeles Motor Scale, and Rapid Arterial Occulsion Evaluation Scale (RACE), could be used without clear evidence for the superiority of 1 scale over the others.

FAST-ED are already familiar with the CPSS and just have added two items to it. Indeed, the FAST-ED scale is simpler than the RACE scale (six items), which has been validated in the prehospital setting.

In summary, the FAST-ED was designed to be user-friendly and applicable for pre-hospital and hospital settings. FAST-ED ≥2 has promising characteristics in predicting AIS and should be prospectively evaluated to demonstrate clinical use.

Study Limitations

This study has limitations. First, we did not report the final diagnosis of non-stroke cases. Secondly, we have not compared FAST-ED with all existing prehospital scales.

Conclusion

FAST-ED scale is relatively simple and has a comparable ability for recognizing AIS to more complex NIHSS. Assessment of both cortical and motor function using FAST-ED or NIHSS demonstrated the good diagnostic accuracy values for selecting subjects with LVO.

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Ethics

Ethics Committee Approval: The study protocol was approved by the Ethics Committee of Isfahan University of Medical Sciences (IR.MUI.MED.REC.1397.336).

Informed Consent: Before the study, written informed consent was obtained from all parents, before enrolment into the study.

Peer-review: Externally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: F.H., M.N.E., E.I.D., A.F.G., Concept: M.N.E., F.H., E.I.D., A.F.G., P.N., Design: M.N.E., F.H., Data Collection or Processing: M.N.E., F.H., E.I.D., A.F.G., Analysis or Interpretation: F.H., P.N., Literature Search: M.N.E., F.H., E.I.D., A.F.G., P.N., Writing: M.N.E., F.H., E.I.D., A.F.G., P.N.

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