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Original Research Article

The stroke detections scales for emergency response workers: a comparison of FAST versus BEFAST

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ABSTRACT

Background: Eighty percent of strokes are ischemic, resulting from cerebral artery blockages. However, due to delays in taking patients to hospital, only around 3% of patients receive suitable treatment in time.
Methods: This research assessed the accuracy of diagnostic tests. Registry data concerning stroke patients were analyzed to compare the diagnoses made during the dispatching of suspected stroke patients with the final diagnoses made by hospital emergency departments in order to evaluate the validity of the initial tests.
Results: The study investigated a sample group of 317 patients. Over fifty percent lived in rural locations. The stroke patients tended to be of more advanced age, and presented significantly more underlying conditions than non-stroke patients ($p<0.05$). The data were collected over a period of one year, and the scale used was predominantly the BEFAST. Between stroke and non-stroke patients, significant differences were found only in terms of facial drooping and weakened arms ($p<0.05$). The accuracy levels of the BEFAST and FAST scales could be considered similar when comparing the area under the curve. BEFAST had AUC of 0.551 while for FAST the value was 0.706 ($p=0.059$).
Conclusions: It is possible to increase the sensitivity of BEFAST by including testing for coordination and diplopia, but the results in lowered PPV and specificity. Given that additional time is necessary in order to test coordination and diplopia, it would appear unlikely that this delay during dispatch will be beneficial even when improved sensitivity is taken into account.

Keywords: Stroke detection scale comparison, EMD, BEFAST scale, FAST scale, Diagnostic testing

INTRODUCTION

Globally, strokes are ranked second on the list of most common causes of disability and death, with 80% of stokes determined to be ischemic in type, whereby an obstruction caused by a blood clot prevents oxygen from reaching the brain.[1,2] When the symptoms of a stroke first appear, it is crucial to treat the patient as quickly as possible, ideally within 4.5 hours of the onset of the stroke.[3] However, very few cases can be addressed quickly enough to deliver thrombolytic therapy within a suitable time frame.[4] During the dispatching process, it is vital to recognize the signs of stroke, but accomplishing this can be highly variable, at 20-93%.[5] The Stroke Unit Trialists' Collaboration reported that treatment for strokes will be more successful if the stroke can be detected earlier, because every minute of delay results in the decline in as many as 1.9 million brain cells.[6,7] It can be challenging for EMDs to recognize strokes, and few truly accurate tools exist to offer support in this area. The first problem is that a patient suffering a stroke must first call for assistance before an expert can make a diagnosis, so it is essential that patients themselves can first recognized the signs of a stroke, and understand the urgency required in seeking emergency help. Many countries recommend that EMD staff use screening scales as guidelines for stroke identification. This is the norm in Europe, USA, Australia and New Zealand. Screening tools used prior to hospital admission typically focus on the most frequently-encountered symptoms of stroke. The Cincinnati Prehospital Stroke Scale (CPSS), which is today known more widely as the Face Arm Speech Test (FAST), was the first such scale to achieve widespread usage.7 The sensitivity of such tests, however, lies in the range of 44-97%, leading to questions about their accuracy, while the specificity ranges from 13-92%.[8] The greater difficulty lies in the fact that strokes also have a range of less common symptoms, including confusion, disturbed vision, and a loss of balance; a quarter of all stroke patients do not actually show any of the symptoms which are commonly investigated in the most frequently-used screening tests.[9] The FAST tends to have variable accuracy and around 30% of strokes might not be identified.[10] A figure of 18% was suggested by Berglund et al. for the proportion of strokes missed by emergency responders. An alternative to FAST is the BEFAST test (Balance, Eyes, Face, Arms, Speech, Time).[11] However, although this is a readily accessible test, studies have not shown it to be especially effective in stroke diagnosis. One study reported that for 159 stroke patients, the BEFAST approach produced an area under the operating characteristic curve of 0.70, and although FAST achieved 0.69, this was not a statistically significant difference.[12] A second study held that the FAST approach does not readily identify strokes affecting the posterior cerebral artery and those which affect the vision.[13]

The literature does not provide a broad account of those symptoms which are typically missed by EMD workers, and therefore it is not clear which further symptoms should additionally be the focus of modifications to the available scales in order to successfully identify a higher proportion of stroke incidences. In the absence of suitable screening tools and EMD training where rarer symptoms are concerned, as in the case of posterior stroke, such stroke patients will continue to experience worse outcomes due to the difficulty of timely diagnosis.[14] No studies have yet been carried out in Thailand to assess the comparative accuracy of the BEFAST and FAST scales for stroke screening in the field.

Objectives

This research sough to draw comparisons between the effectiveness of the FAST and BEFAST scales for identification of stroke cases when employed by EMDs.

METHODS

Design of the study

This research comprised a retrospective analysis of data registry data to determine the accuracy of the reported diagnoses. The data were gathered over a period of one year from July, 2020 to June, 2021.

Definitions

When an individual calls 1669, the EMD receiving the call will use the BEFAST or FAST approach to detect potential stroke cases by interviewing the caller. In cases where a suspected stroke case is detected, the dispatch sub-code IDC18 will be allocated. The closest suitable health center will then be notified, and the staff of the emergency medical services comprising nurses and paramedics will activate the IDC code whenever a positive FAST or BEFAST identification is made. Vital signs will then be measured and recorded, and the dispatch center will arrange the transportation of the patient to the appropriate health center. Upon arrival at the emergency department, those patients who presented stable hemodynamics could then undergo a computed tomography (CT) scan. Patients with stroke receive their diagnosis from the emergency physician on the basis of the CT scan results and the observed clinical symptoms. The treatment can then commence.

Population of the study

The population included all patients with suspected acute stroke who were over 18 years old and received an initial EMD diagnosis. These patients had no trauma history and were taken to hospitals in the Thai province of Mahasarakham under the instructions of the EMD staff. Exclusions were required in cases where the patient data records were incomplete or if the patient passed away prior to the arrival of the emergency medical staff.

Data collection

Data were gathered using EMS operation forms from one year of hospital records through the ITEMS database with IDC 18. Diagnoses of interest comprised acute ischemic stroke, intracerebral haemorrhage (ICH), transient ischemic attack (TIA), and also non-strokes which comprised non-cerebrovascular diagnoses (NVD).[15]

Data analysis

The descriptive data included median and inter-quartile range for numerical variables, while categorical data were presented in the form of percentages and frequencies, with comparisons made using the Chi-square test. The areas beneath the receiver operating characteristic (ROC) curves for the FAST and BEFAST scores were then calculated. The sensitivity and specificity of the EMDs' stroke diagnoses were used to assess accuracy using a 95% confidence interval (CI). Comparisons were drawn with the final hospital diagnoses which were held to be the correct diagnosis. Calculations of the PPV (positive predictive value) and NPV (negative predictive value) were then made using 95% CIs on the basis of the prevalence from hospital diagnoses. Independent t-testing was then carried out to determine the efficacy of EMD stroke diagnoses with statistical significance considered when p<0.05.

RESULTS

A total of 317 patients had their records analyzed (Table1). Of these, 48% were female and 52% were male, while 24.6% lived in urban areas and 75.4% lived in rural locations. The median age was 68 while the inter-quartile range was 98-23=75 for the stroke group. This group was significantly older than the non-stroke group. The risk groups were significantly different when comparing the stroke group and non-stroke group (Table 1). In Table 2, EMD stroke diagnosis are presented in the form of a cross-tabulation to compare with the standard hospital diagnosis of acute stroke. According to the data, BEFAST assessments were initially conducted for 88% of the patients, while 12% were given FAST assessments. In comparison to the non-stroke group, the most common symptoms observed were impaired speech and weakened arms. Significant differences were recorded for weakened arms in the BEFAST group (p<0.05) and for drooping face in the FAST group (p<0.01).

Figure 1 presents the ROC curves for the BEFAST scale (AUC=0.551) and the FAST scale (AUC=0.706) indicating the test characteristics for stroke identification (p=0.059). In the case of both the BEFAST and FAST scales, the optimal cut-off score for stroke prediction is ≥1. When this cut-off is used, the positive BEFAST score gave PPV of 0.73 and NPV of 0.12 (with sensitivity of 0.79 and specificity of 0.09). In comparison, the positive FAST score gave a PPV of 0.89 and NPV of 0.11 (with sensitivity of 0.76 and specificity of 0.33, as shown in Table 3.

Table 1: Basic data of the patients in the study.

Lists	N (%)	Stroke (N=246) (100)	Non-stroke (N=71) (100)	P value
Gender	317 (100)			
Male	164 (51.7)	125 (50.8)	39 (54,9)	0.957
Female	153 (48.3)	121 (49.2)	32 (45.1)	
Age (years), median (IQR)	67 (55, 75)	68 (23, 98)	64 (21, 89)	
<55	72 (23.0)	53 (21.5)	19 (26.8)	0.046
55-75	160 (51.1)	122 (49.6)	38 (53.5)	
>75	81 (25.9)	67 (27.2)	14 (19.7)	
Risk	313 (100)			
No underlying	146 (46.6)	115 (46.7)	31 (43.7)	0.021
DM	25 (7.9)	15 (6.1)	10 (14.1)	
HT	42 (13.4)	31 (12.6)	11 (15.5)	
Old CVA	15 (4.8)	12 (4.9)	3 (4.2)	
Others	5 (1.6)	4 (1.6)	1 (1.4)	
Underlying 2	69 (22.0)	57 (23.2)	12(16.9)	
Underlying 3	11 (3.5)	8 (3.3)	3 (4.2)	
Urban area	301 (100)			
Yes	74 (24.6)	61 (24.8)	13 (8.3)	0.251
No	227 (75.4)	172 (69.9)	55 (77.5)	
Scale	317 (100)			
BREAKFAST	280 (88.3)	212 (86.2)	68 (95.8)	0.059
FAST	37 (11.7)	34 (13.8)	3 (4.2)	

Table 2: Befast and fast frequency of symptoms by stroke designation.

Scale N (%)	Acronyms	Overall 317 (100)	Stroke 246 (100)	Non-stroke 71 (100)	P value
BEFAST 280 (88)	Balance	29 (9.1)	25 (10.2)	4 (5.6)	0.164
	Eyes	5 (1.6)	4 (1.6)	1 (0.4)	0.822
	Face	57 (17.9)	45 (18.3)	12 (16.9)	0.524
	Arm	159 (50.2)	112 (45.5)	47 (66.2)	0.018
	Speech	141 (44.5)	102 (41.5)	39 (54.9)	0.185
FAST 37 (12)	Face	9 (2.8)	6 (2.4)	3 (4.2)	0.001
	Arm	24 (7.6)	22 (8.9)	2 (2.8)	0.946
	Speech	10 (3.2)	10 (4.1)	0 (0)	0.272

Table 3: Accuracy comparison of the befast and fast scales for stroke detection.

Scale		N	Sensitivity	Specificity	PPV	NPV
BEFAST (N=280)	≥0	278	0.99	0.01	0.76	0.50
	≥1	230	0.79	0.09	0.73	0.12
	≥2	121	0.43	0.97	0.98	0.35
	≥3	27	0.12	0.91	0.81	0.25
	≥4	4	0.01	1	1	0.25
FAST (N=37)	≥0	36	0.97	0.33	0.89	0.50
	≥1	28	0.76	0.33	0.89	0.11
	≥2	12	0.29	0.33	0.83	0.50
	≥3	3	0.06	0.67	1	0.06

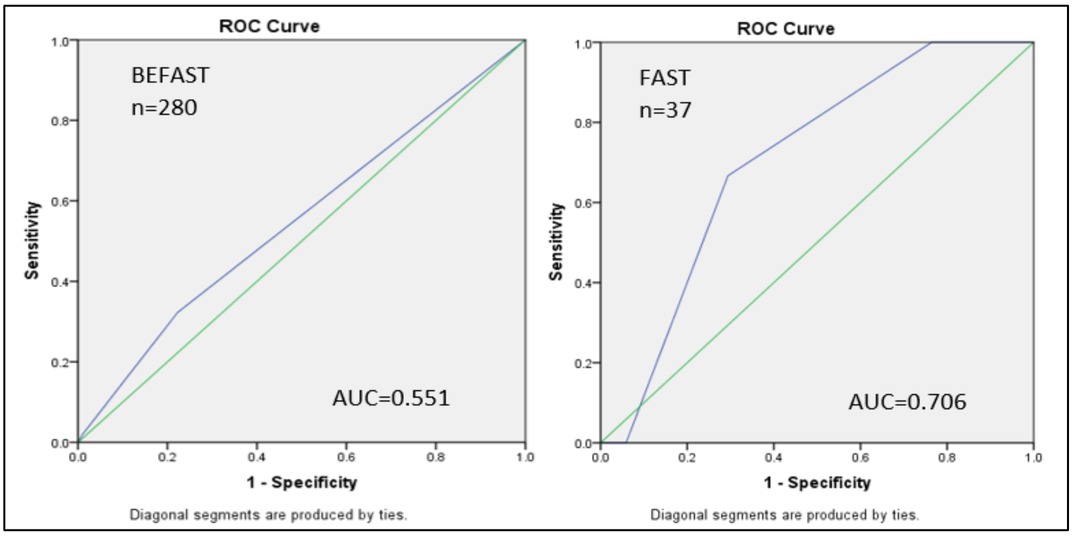

Figure 1: Receiver operating characteristic curves for the BEFAST (AUC=0.551) and FAST scale (AUC=0.706).

DISCUSSION

When the FAST scale is augmented by the addition of symptoms related to posterior circulation stroke, such as coordination and balance, or eyes and diplopia, the detection of strokes is not significantly enhanced, as we can observe from the relatively disappointing AUC values for BEFAST.

When using either scale, it was found that if any symptom was present, and hence the score was at least 1, stoke patients could be optimally identified in contrast to those suffering a similar non-stroke occurrence. When using that cut-off, the sensitivity of BEFAST exceeded that of FAST at 79% to 76%, but the BEFAST specificity was then lower, at 9% compared to 33%, while the PPV comparison was 73% to 89%. It has recently been broadly agreed that “no practical prehospital scale that accurately detects strokes outside of the middle cerebral artery distribution” currently exists.[16] The findings in this study are in general agreement with that statement, and find no evidence to support the addition of further criteria to the current scales prior to hospital assessment.

The current study showed that PPV was slightly lower for BEFAST than for FAST (73% versus 89%), supporting the finding that anomalies in the eyes and balance could not accurately identify stroke cases. Similarly, there was no significant difference for speech impairment as a predictor of stroke, since both stroke and non-stroke patients can be commonly affected. The most effective predictors of stroke were shown to be weakened arms and facial drooping, as earlier studies have also reported.[17] However, it is also noted that when using pre-hospital scales, stroke detection overall is increased.[11] Furthermore, outcomes for patients can be improved simply by ensuring that the patient is taken more quickly to a specialized stroke center, especially when the staff are given prenotification of an impending arrival. Treatment can then be given more frequently and quickly, leading to better results.[18] The findings in this study do indicate, however, that if the BEFAST system is used instead of FAST, then a further 5-6% of patients may be incorrectly identified as stroke patients by BEFAST, beyond the 29% who would already have been correctly diagnosed from just the use of FAST.

The are some notable limitations in this work. The stroke data from the IT-EMS system did not provide an equal number of patients for the two different scales, and the BEFAST assessment was used only with patients indicating neurological symptoms or complaints, and therefore these are the sole BEFAST inclusions in the study.

CONCLUSION

When used by EMD staff in pre-hospital situations, the overall performance levels of the BEFAST and FAST scales are not significantly different in detecting strokes. When coordination and diplopia are included through the use of BEFAST, sensitivity is increased at the cost of lowering both PPV and specificity. It is therefore argued that the additional time necessary to test for diplopia and coordination prior to hospitalization would not bring about sufficient to benefits to warrant the inclusion of these measures.

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