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Accuracy of prehospital ambulance stroke test in terms of diagnosis of patients with acute ischemic stroke: A multi-center study

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Data Accuracy; Decision Support Techniques; Emergency Medical Services; Stroke

Abstract

Background: Andsberg et al. have recently introduced a novel scoring system entitled "PreHospital Ambulance Stroke Test (PreHAST)", which helps to early identification of patients with acute ischemic stroke (AIS) even in prehospital setting. Its validity has not been assessed in a study yet, and the purpose of this study was to assess this scoring system on a larger scale to provide further evidence in this regard.

Methods: This was a cross-sectional multi-center accuracy study, in which, sampling was performed prospectively. All patients over 18 years of age admitted to the emergency department (ED) and suspected as AIS cases were included. All required data were recorded in a form consisting of 3 parts: baseline characteristics, neurological examination findings required for calculating PreHAST score, and the ultimate diagnosis made from interpretation of their brain magnetic resonance imaging (MRI).

Results: Data from 805 patients (57.5% men) with the mean age of 67.1 ± 13.6 years were analyzed. Of all the patients presenting with suspected AIS, 562 (69.8%) had AIS based on their MRI findings. At the suggested cut-off point (score ≥ 1), PreHAST had a specificity of 46.5% [95% confidence interval (CI): 40.1%-53.0%) and a sensitivity of 93.2% (95% CI: 90.8%-95.2%).

Conclusion: According to the findings of our study, at the suggested cut-off point (score ≥ 1), PreHAST had 93.2% sensitivity and 46.5% specificity in detection of patients with AIS, which were somewhat different from those reported in the original study, where

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100% sensitivity and 40% specificity were reported for this scoring system.

Introduction

Early identification of patients with acute ischemic stroke (AIS) in the prehospital settings has been reported to be associated with better outcome.[1-3] Accordingly, some prehospital stroke scales were developed in this regard, which demonstrated a wide variability in their capability of identifying patients with stroke, with considerable false negative diagnoses.[4] In 2017, Andsberg et al. developed a novel scoring system named PreHospital Ambulance Stroke Test (PreHAST). It is an 8-item scale whose score ranges from 0 to 19 points, and was adapted from the National Institutes of Health Stroke Scale (NIHSS).[5] To the best of our knowledge, there are few studies that have evaluated the validity of PreHAST.[6,7] Therefore, this study was performed to test PreHAST on a larger scale to provide more solid evidence about its accuracy in identifying patients with AIS.

Materials and Methods

This was a cross-sectional multi-center accuracy study, in which, sampling was performed prospectively in 3 foremost referral hospitals in Tehran and Isfahan, Iran. The required permission was received from the Ethics Committee of Tehran University of Medical Sciences, Tehran (IR.TUMS.MEDICINE.REC.1397.755). All patients over the age of 18 years, presenting to the emergency department (ED) with suspicion of AIS, were included. The considered exclusion criteria were as follows: history of stroke, neurological surgery, or head trauma, known neurological disease, and leaving the hospital against medical advice before a brain magnetic resonance imaging (MRI) was performed. Assuming 87% sensitivity for PreHAST, 35% stroke prevalence in suspected AIS cases, 5% type-1 error, and 4% absolute precision on either side of the sensitivity (ε), the minimum required sample size was calculated to be 776. All required data were recorded in a form containing 3 parts: baseline characteristics, neurological examination findings required for calculating PreHAST score, and the ultimate diagnosis made from the findings of brain MRI that was considered as the gold standard in current study. SPSS software (version 24, IBM Corporation, Armonk, NY, USA) and Stata software (version 14, Stata Corporation, College Station, TX, USA) were used for the statistical analyses, using appropriate tests for each performed comparison and the P-value of less than 0.05 was considered statistically significant. Receiver operating characteristic (ROC) curve analysis was conducted to assess the accuracy of PreHAST in identifying patients with AIS. We used the area under the ROC curve (AUC) to compare PreHAST scores of the two diagnostic groups (with and without AIS). We also used Youden's index and maximized the vertical distance from line of equality to the point [x, y] in ROC to choose the best cut-offs for the diagnosis of AIS.

Results

Data of 805 patients (57.5% men) were analyzed. Participants' mean age was 67.1 ± 13.6 years and their age range was between 26 and 95 years. Of all suspected patients, 562 patients (69.8%) were ultimately diagnosed with AIS. Prevalence of AIS in men was higher than women (73.9% vs. 64.3%, P = 0.004). Presence of ischemic heart disease (IHD), as an underline disease, was more common among patients with AIS than the others (74.9% vs. 67.1%, P = 0.021); also, patients with AIS diagnosis were older than others (P < 0.001).

The median of PreHAST score in patients with AIS was significantly higher than that in patients without AIS (6.0 vs. 1.0, P < 0.001). PreHAST score in all patients ranged from zero to 16. Among patients with PreHAST scores of zero, one, and two, 25.2%, 46.3%, and 62.8%, respectively, had the ultimate diagnosis of AIS (Figure 1).

Analysis of the ROC curve showed an AUC of 0.824 [95% confidence interval (CI): 0.80-0.85]. In the suggested cut-off point (score ≥ 1), there were 130 (16.1%) false positive and 38 (4.7%) false negative cases and thus, the scoring system had a sensitivity of 93.2% (95% CI: 90.8%-95.2%) and a specificity of 46.5% (95% CI: 40.1%-53.0%). The score of ≥ 4, with a sensitivity of 75.4% (95% CI: 71.7%-79.0%) and a specificity of 77.4% (95% CI: 71.6%-82.5%) was the best cut-off point, correctly classifying 76.1% of patients [55 (6.8%) false positive and 138 (17.1%) false negative cases]. The cut-off point of ≥ 2 had the highest accuracy with a sensitivity of 87.7% (95% CI: 84.7%-90.3%) and a specificity of 61.3% (95% CI: 54.9%-67.5%) (Table 1).

Discussion

In this study, we found a sensitivity of 93.2% (95% CI: 90.8%-95.2%) and a specificity of 46.5% (95% CI: 40.1%-53.0%) for PreHAST, at the suggested cut-off point (score ≥ 1).

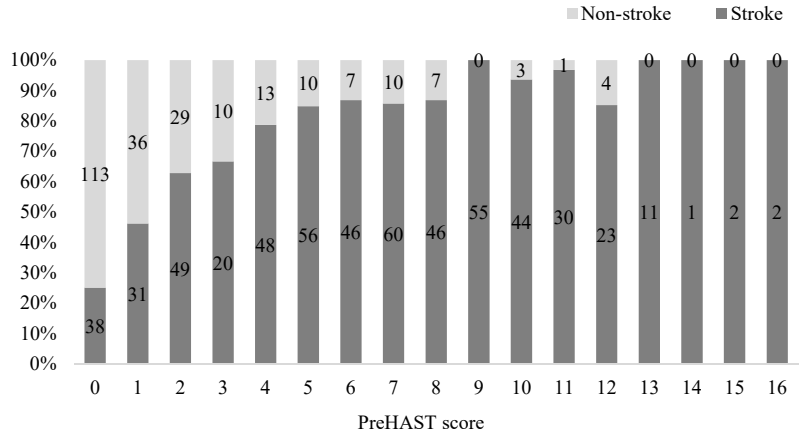

Figure 1. Distribution of acute ischemic stroke (AIS) diagnosis in suspected patients based on their PreHospital Ambulance Stroke Test (PreHAST) score

Table 1. Accuracy indices for acute ischemic stroke (AIS) diagnosis using PreHospital Ambulance Stroke Test (PreHAST) in various cut-off points

Cut-off	Sensitivity (95% CI)	Specificity (95% CI)	+LR (95% CI)	-LR (95% CI)	PPV (95% CI)	NPV (95% CI)	Correctly classified (%)
≥ 1	93.2 (90.8-95.2)	46.5 (40.1-53.0)	1.7 (1.5-2.0)	0.1 (0.1-0.2)	80.1 (76.9-83.1)	74.8 (67.1-81.5)	79.1
≥ 2	87.7 (84.7-90.3)	61.3 (54.9-67.5)	2.3 (1.9-2.7)	0.2 (0.2-0.3)	84.0 (80.8-86.9)	68.3 (61.7-74.5)	79.7
≥ 3	79.0 (75.4-82.3)	72.2 (67.2-78.7)	2.9 (2.4-3.7)	0.2 (0.2-0.3)	87.2 (84.0-90.0)	60.1 (54.3-65.8)	77.3
≥ 4*	75.4 (71.7-79.0)	77.4 (71.6-82.5)	3.3 (2.6-4.2)	0.3 (0.3-0.4)	88.5 (85.3-91.2)	57.7 (52.1-63.1)	76.1
≥ 5	66.9 (62.8-70.8)	82.7 (77.4-87.3)	3.9 (2.9-5.1)	0.4 (0.4-0.5)	90.0 (86.7-92.7)	51.9 (46.8-57.0)	71.7
≥ 6	56.9 (52.7-61.1)	86.8 (81.9-90.8)	4.3 (3.1-6.0)	0.5 (0.4-0.6)	90.9 (87.4-93.7)	46.6 (41.9-51.3)	66.0
≥ 7	48.7 (44.5-53.0)	89.7 (85.2-93.2)	4.7 (3.2-6.9)	0.5 (0.5-0.6)	91.6 (87.9-94.5)	43.1 (38.7-47.5)	61.1

CI: Confidence interval; LR: Likelihood ratio; PPV: Positive predictive value; NPV: Negative predictive value
*Best cut-off point

However, in the original study conducted by Andsberg et al., the results were somewhat different, and a sensitivity of 100% (95% CI: 87%-100%) and a specificity of 40% (95% CI: 25%-56%) were reported.[5] There were some important dissimilarities in the current study in comparison with the original pilot study, which must be taken into consideration when discussing the results. The original pilot study was conducted on 69 patients in a single-center manner, but the current multi-center study included 805 patients; this typically makes the results more reliable. The final diagnosis has been made by a neurologist in the original pilot study. However, we have used brain MRI in this regard, which seems to be more definitive. Nevertheless, PreHAST by Andsberg et al. describes the accuracy for stroke (both hemorrhagic and ischemic) and transient ischemic attack (TIA), not only for AIS as we did; thus, our sensitivity/specificity could be different due to this point. When it comes to prehospital stroke screening tools, apparently most investigators focus on their sensitivity, but their specificity is also very important; therefore, appropriate facilities can be considered for the selected patients and over-triage and wasting of resources can be avoided. This may not be a major issue in a country such as Sweden, in which PreHAST was developed, but the importance of this issue is especially crucial in countries with overcrowded EDs and limited facilities such as Iran. However, PreHAST, even in its best cut-off point (score ≥ 4), has a specificity of 77.4% (95% CI: 71.6%-82.5%), which is not perfect in this regard.

PreHAST, unlike some other scales, does not exclude young, seizing, or syncope patients. However, it cannot evaluate unconscious or comatose patients, and also does not assess the blood glucose level, which is definitely important. There are also some ambiguities regarding the use of PreHAST when dealing with patients with a history of previous stroke and those with general weakness in which both sides have decreased force, as although they may not have a stroke, they can still be given four points on this scale. So, we suggest to exclude patients with hypoglycemia, bilateral weakness, and previous stroke before using this scale.

Conclusion

Based on the findings of our study, at the suggested cut-off point (score ≥ 1), PreHAST has a sensitivity of 93.2% and a specificity of 46.5% in terms of diagnosis of patients with AIS. Yet, the results were somewhat different in the original study, where 100% sensitivity and 40% specificity were reported. In its best cut-off point (score ≥ 4), PreHAST had a specificity of 77.4%, which is not perfect for preventing over-triage.

Limitations: We did not report the final diagnosis of non-AIS cases that were introduced as false positive cases in the predictions made using PreHAST. Also, the efficacy of PreHAST in recognizing AIS cases with large vessel occlusion (LVO), who may benefit from thrombectomy instead of thrombolytic therapy, could have been assessed.

Conflict of Interests

The authors declare no conflict of interest in this study.

Acknowledgments

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