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ARTICLE

Performance of four ischemic stroke prognostic scores in a Brazilian population

Desempenho de quatro escalas de prognóstico de AVCI em uma população brasileira

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ABSTRACT

Objective: Ischemic stroke (IS) prognostic scales may help clinicians in their clinical decisions. This study aimed to assess the performance of four IS prognostic scales in a Brazilian population. **Method:** We evaluated data of IS patients admitted at Hospital Paulistano, a Joint Commission International certified primary stroke center. In-hospital mortality and modified Rankin score at discharge were defined as the outcome measures. The performance of National Institutes of Health Stroke Scale (NIHSS), Stroke Prognostication Using Age and NIHSS (SPAN-100), Acute Stroke Registry and Analysis of Lausanne (ASTRAL), and Totaled Health Risks in Vascular Events (THRIVE) were compared. **Results:** Two hundred six patients with a mean ± SD age of 67.58 ± 15.5 years, being 55.3% male, were included. The four scales were significantly and independently associated functional outcome. Only THRIVE was associated with in-hospital mortality. With area under the curve THRIVE and NIHSS were the scales with better performance for functional outcome and THRIVE had the best performance for mortality. **Conclusion:** THRIVE showed the best performance among the four scales, being the only associated with in-hospital mortality.

Keywords: ischemic stroke, prognostic scales, NIHSS, THRIVE, Brazil.

RESUMO

Objetivo: Escalas de avaliação prognóstica do acidente vascular cerebral isquêmico (AVCI) podem ajudar decisões clinicas. O objetivo deste estudo foi avaliar o desempenho de quatro escalas prognósticas em uma população brasileira. **Método:** Foram avaliados os dados de pacientes admitidos com AVCI no Hospital Paulistano, um hospital acreditado pela "Joint Commission International". A mortalidade intra-hospitalar e a escala de Rankin foram definidos como desfechos de evolução clínica. O desempenho de quatro escalas: National Institutes of Health Stroke Scale (NIHSS), Stroke Prognostication Using Age and NIHSS (SPAN-100), Acute Stroke Registry and Analysis of Lausanne (ASTRAL) e Totaled Health Risks in Vascular Events (THRIVE) foi comparado. **Resultados:** Foram incluídos duzentos e seis pacientes, com uma idade média de 67,58 ± 15,5 anos, sendo 55,3% dos sexo masculino. Todas as quatro escalas associaram-se de forma independente com prognóstico funcional. Apenas o THRIVE correlacionou-se com a mortalidade hospitalar. O THRIVE e o NIHSS tiveram melhor desempenho para prognóstico funcional e o THRIVE teve o melhor desempenho para mortalidade pela área sob a curva. **Conclusão:** O THRIVE mostrou-se a escala com melhor performance, sendo a única correlacionada com a mortalidade hospitalar.

Palavras-chave: acidente vascular cerebral isquêmico, escalas de prognóstico, NIHSS, THRIVE, Brasil.

The prediction of ischemic stroke outcome may help physicians in their acute treatment decisions. Some scores have been developed for predicting prognosis after ischemic stroke (IS). The National Institutes of Health Stroke Scale (NIHSS) strongly predicts stroke prognosis, is well validated, and is routinely used, both in clinical and research settings[1]. The Stroke Prognostication Using Age and NIHSS (SPAN-100) index, which combines age and NIH Stroke Scale, was shown to be a simple method for estimating the clinical response and risk of hemorrhagic complications after tissue-type plasminogen activator (tPA) for acute IS[2]. The Acute Stroke Registry and Analysis of Lausanne (ASTRAL) score (age, severity, time delay between stroke onset and admission, range of visual deficit, acute glucose, and levels of consciousness)

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is a six items score, at hospital admission, that showed to be potentially useful for clinical practice[3]. Totaled Health Risks in Vascular Events (THRIVE) score (totaled health risks in vascular events) is calculated with age, NIHSS, and the presence of hypertension, diabetes mellitus, and atrial fibrillation and was validated to predicting clinical outcome and hemorrhagic transformation in patients receiving tPA and showed to be a simple score to help clinicians to estimate outcome and death after acute IS[4]. These four scores were not yet compared and their reproducibility has been tested only in Europe, North America, and Asia.

Stroke is the leading cause of death and disability in Brazil[5]. IS accounts for more than 80% of all stroke types in Brazil[6]. In recent years, a growing number of stroke centers have been settled in this country[7]. Consequently, an increasing number of patients with acute IS have benefited from validated therapies, including the use of tPA[8]. However, only few studies have evaluated IS outcome in Brazil[9] and none of them have assessed the utility of prognostic scores in a Brazilian population. The aim of the present study was to compare the performance of NIHSS, SP-100, ASTRAL, and THRIVE scores to predict in-hospital mortality and functional outcome in an acute IS Brazilian population.

METHOD

Charts of patients assisted at Hospital Paulistano, a Joint Commission International certified stroke center located in the central region of São Paulo, between 2012 and 2014, were reviewed. This study protocol was approved by the Ethics Committee on Research of Hospital Paulistano (Amil Stroke Network).

Patients and procedures

We retrospectively evaluated the clinical records of all patients admitted with suspected or confirmed stroke. The diagnoses were made by neurologists with expertise in cerebrovascular disease through clinical and radiological evaluation. All patients underwent at least one computed tomography scan of the brain (CT scan) to confirm the diagnosis. Only patients diagnosed as having IS were included in the analysis.

Age, gender, stroke risk factors (hypertension, smoking, familial history of vascular diseases, diabetes, previous stroke or transient ischemic attack) were compiled. Data on clinical presentation, NIHSS, capillary glucose level, and vital signs on admission were also recorded.

Prognostic scores

The prognostic scales as well as their cut-offs were used as described in previous studies. According to NIHSS patients were allocated into three subgroups (0 to 5, 6 to 15, and ≥ 16)[1]. SPAN-100 was calculated by the sum of the age in years and the NIHSS. The adopted cut off for SPAN-100 was 100 and patients were divided into two groups, one with SPAN-100 < 100 and other with SPAN-100 ≥ 100[2]. ASTRAL score was calculated by the sum of age (1 point for every 5 years), NIHSS, time delay from onset to admission (0 points when onset to admission was < 3 hours, 2 points when it was more than 3 hours), range of visual deficit (0 points in the absence of visual field defect, 2 points for any stroke-related visual field defect), acute glucose < 3.7 mmol/L or > 7.3 mmol/L (1 point), and decreased level of consciousness (3 points). An ASTRAL score ≥ 31 was adopted as an indicator of unfavourable outcome[3]. THRIVE score was calculated by the sum of age (1 point for age of 60 to 79 years, 2 points for an age ≥ 80 years), 2 points for a NIHSS of 11 to 20, 4 points for a NIH ≥ 21, and 1 point for each hypertension, diabetes mellitus, and fibrillation. The THRIVE ranged from 0 to 9 and the patients were divided in three subgroups (0 to 2, 3 to 5, and 6 to 9)[4].

Data analysis

Statistical analysis was performed using SPSS version 15.0 for Windows. The confidence interval was of 95% and the significance level was set at $p < 0.05$. Normality was assessed using the Kolmogorov-Smirnov test. In-hospital mortality and modified Rankin score (mRs) at discharge, whereby the patients were divided in two groups, one with mRS ≤ 2 and other with mRs > 2, were defined as outcomes measures. Univariate analysis was carried out with Mann-Whitney test for continuous variables and chi-square for categorical variables. A binary logistic regression analysis was performed with mRS and in-hospital mortality as dependent variables. A sensitivity analysis was conducted to compare the three scores. Area under the receiver operator curves (AUROC) and 95% CIs were calculated as a measure of predictive ability. According to the AUROC result the predictive ability was considered excellent (0.9 to 0.99), good (0.8 to 0.89), fair (0.7 to 0.79), poor (0.6 to 0.69), and failure (0.5 to 0.59).

RESULTS

Three hundred fifty one patients were admitted with stroke or suspected stroke in the period of the study. Among them, two hundred six patients (58.7%) had the diagnosis of IS and were included in the analysis. The mean ± standard deviation (SD) age was 67.58 ± 15.5 years and 55.3% of patients were male. Table 1 shows the comparisons of the characteristics of patients who had favorable functional outcome (mRs ≥ 2) with those of patients with poor functional outcome (mRs > 2). By univariate analysis, patients with mRs > 2 had higher age ($p = 0.002$), higher percentage of NIHSS ≥ 16 at admission ($p < 0.001$), higher percentage of SPAN-100 ≥ 100 ($p < 0.001$), higher percentage of ASTRAL ≥ 31 ($p < 0.001$), and higher percentages of THRIVE 3 to 5 and THRIVE > 5 ($p < 0.001$). After adjusted analysis, none of these variables were independently associated with mRs > 2. Table 2 shows the comparisons of baseline characteristics of survivors and

patients who died during hospitalization. No significant differences were found between these two groups.

NIHSS subgroups were fairly predictive of mRs > 2 (AUROC 0.754; 0.644 to 0.810, p < 0.001) and were not predictive of in-hospital mortality (AUROC 0.546; 0.409 to 0.683, p = 0.495). SPAN-100 ≥ 100 was poorly predictive of poor functional outcome (AUROC 0.591; 0.5 to 0.683, p = 0.041) and was not predictive of in-hospital mortality (AUROC 0.520; 0.386 to 0.654, p = 0.766). ASTRAL ≥ 31 was poorly predictive of mRs > 2 (AUROC 0.668; 0.577 to 0.758, p < 0.001) and not predictive of in-hospital mortality (AUROC 0.556; 0.428 to 0.705, p = 0.321). THRIVE subgroups were fairly predictive of mRs > 2 (AUROC 0.720; 0.641 to 0.800, p < 0.001) and were poorly predictive of in-hospital mortality (AUROC 0.636; 0.513 to 0.758, p = 0.042) (Figure).

DISCUSSION

In the present study none of the scores demonstrated good or excellent ability to predict in-hospital mortality and functional outcome in the studied population. THRIVE score was the only score to predict death but the accuracy was poor. THRIVE and NIHSS were fairly accurate to predict worse functional outcome at hospital discharge. In previous studies THRIVE was shown to be a good predictor of clinical outcome, hemorrhagic transformation, and outcome after endovascular[10] and intravenous stroke treatment[11,12]. This score has been previously tested in North American, European, and Asian populations; however, to the best of our knowledge, this was the first study to evaluate this score in a South American population. The THRIVE score can be easily calculated and can be quickly performed with data routinely obtained during the initial clinical evaluation, such as age, NIHSS, and risk factors (hypertension, diabetes, and atrial fibrillation), without the need of neuroimaging and laboratory testing[4]. Despite the fact THRIVE was the score with better performance, it had not an AUROC above the threshold of 0.8, which is required for clinical use. These results should be interpreted cautiously since our study was small and was carried out in a single institution. Future studies are needed to better assess and validate the use of THRIVE in the Brazilian population.

SPAN-100 did not predict well in-hospital mortality and functional outcome. This finding is in line with a previous study also demonstrating poor performance of SPAN-100 to predict outcomes at 3 and 12 months in

Table 1. Clinical characteristics of patients according to the mRs at hospital discharge.

	mRs ≤ 2	mRs > 2	p	p*
Age	68 (18-93)	76.5 (23-95)	0.002	0.080
Gender				
Male	42.2%	13.1%		
Female	29.6%	15.0%	0.122	0.994
Hypertension	66.9%	74.1%	0.403	0.309
Diabetes	34.5%	37.9%	0.632	0.542
Smoking	16.3%	13.8%	0.831	0.357
Family history of stroke	8.1%	6.9%	1.000	0.291
Previous stroke or TIA	27.7%	31%	0.732	0.624
Atrial fibrillation	31.6%	40.8%	0.283	0.832
Time of symptoms	36 (30-17280)	575 (60-7200)	0.072	0.996
Wake-up stroke	22.97%	36.2%	0.079	0.796
Glucose at admission	113 (76-321)	115 (60-271)	0.336	0.774
SPAN-100 ≥ 100	0.67%	18.96%	< 0.001	0.774
ASTRAL ≥ 31	2.7%	36.2%	< 0.001	0.999
NIHSS				
0 to 5	83.24%	38.46%		
6 to 15	10.86%	26.92%	< 0.001	0.999
≥ 16	2.9%	34.62%		
THRIVE				
0 to 2	62.16%	24.14%		
3 to 5	37.17%	58.62%	< 0.001	0.228
6 to 9	0.67%	17.24%		

mRs: modified Rankin score; TIA: transient ischemic accident; SPAN-100: stroke prognostication using age and NIH stroke scale; NIHSS: National Institutes of Health stroke scale; ASTRAL: Acute Stroke Registry and Analysis of Lausanne; THRIVE: totaled health risks in vascular events; p: Mann-Whitney test; p*: Binary Logistic Regression.

Table 2. Clinical characteristics of patients according to the in-hospital death.

	Survivors	In hospital death	p	p*
Age	68 (24-93)	4 (0-21)	0.827	0.253
Gender				
Male	50.2%	6%	1.000	0.862
Female	39.3%	4.5%		
Hypertension	66.7%	81%	0.223	0.615
Diabetes	36.7%	33.3%	0.816	0.824
Smoking	16.2%	14.3%	1.000	0.516
Family history	7.8%	4.8%	1.000	0.787
Previous stroke or TIA	27.2%	38.1%	0.312	0.313
Atrial fibrillation	33.1%	41.2%	0.590	0.299
Time of symptoms	455 (30-17280)	430 (30-4320)	0.793	0.519
Wake-up stroke	28.9%	14.3%	0.200	0.463
Glucose at admission	114.5 (76-321)	111 (60-147)	0.669	0.392
SPAN-100 > 100	5.56%	9.52%	0.363	0.999
ASTRAL > 31	10.56%	23.8%	0.145	0.971
NIHSS				
0 to 5	10.37%	66.66%		
6 to 15	15.24%	14.29%	0.497	0.649
≥ 16	74.39%	19.05%		
THRIVE				
0-2	55%	28.6%		
3-5	40%	61.9%	0.069	0.148
6-9	5%	9.5%		

mRs: modified Rankin score; TIA: transient ischemic accident; SPAN-100: stroke prognostication using age and NIH stroke scale; NIHSS: National Institutes of Health stroke scale; ASTRAL: Acute Stroke Registry and Analysis of Lausanne; THRIVE: totaled health risks in vascular events; p: Mann-Whitney test; p*: Binary Logistic Regression.

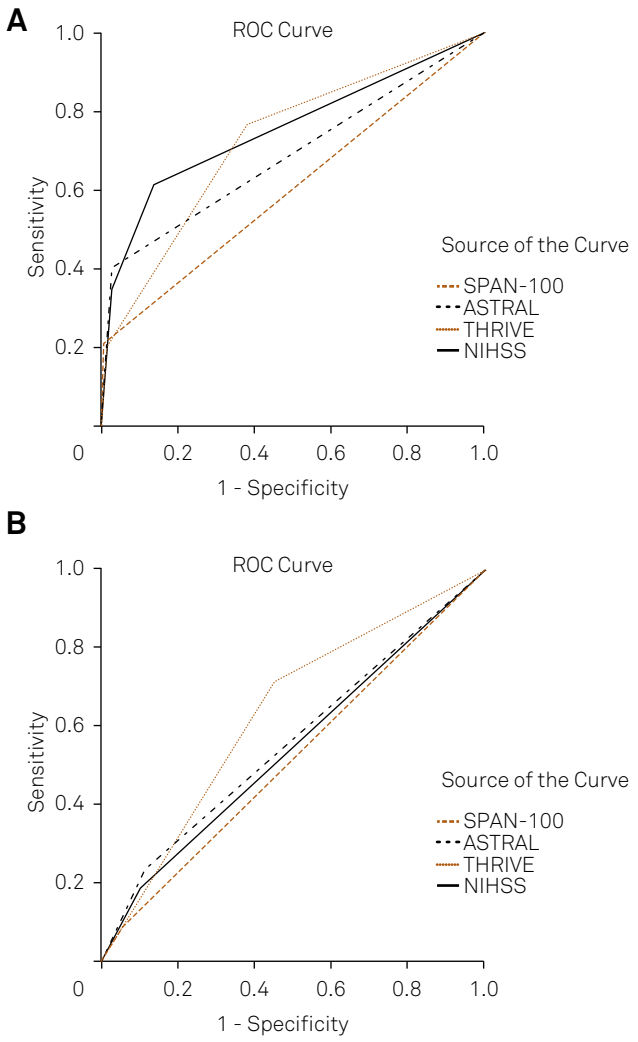

Figure. Comparison of National Institutes of Health Stroke Scale (NIHSS), Stroke Prognostication Using Age and NIHSS (SPAN-100), Acute Stroke Registry and Analysis of Lausanne (ASTRAL), and Totaled Health Risks in Vascular Events (THRIVE) ability to predict (A) mRS at hospital discharge and (B) in-hospital death.

Chinese population[12]. ASTRAL score was previously shown to be a reliable predictor of 5-year functional outcome and mortality[13] and a good predictor of unfavorable outcome at 3 and 12 months in Chinese population[14,15]. In the present study ASTRAL poorly predicted functional outcome and did not predict in-hospital mortality. The difference between our findings and the previous studies evaluating ASTRAL performance must be viewed with caution. In the present study we evaluated in-hospital outcomes, ie, functional status at discharge and in-hospital mortality, while the previous studies evaluated prognosis at 3 months or more. It is possible that these differences explain why none of the tested variables were independently associated with functional outcome and in-hospital mortality.

Our study has limitations that deserve comment. First, the number of included patients was small. Consequently, these results need confirmation in larger stroke registries or in prospective studies. Also, we did not follow the patients after discharge, so there are not data concerning 3- and 12-month outcomes. As strengthens of the study it must be mentioned the homogeneity of the sample, since all the patients were from a single institution and the same stroke team evaluated all patients.

The use of prognostic scores may help clinicians, since the clinical evaluation alone is inaccurate[16]. To contribute to clinicians, the score must be highly effective in prognostic evaluation and easily applied during the first clinical evaluation. The use of such scales, in this context, can help better target the use of therapeutic resources, especially in countries where limited resources to treat stroke patients are available, such as the low to medium income countries. The present results do not allow, to date, the recommendation of these scores for clinical use in Brazilian population. Future and larger studies are still necessary to reassess the accuracy of these scales, specially THRIVE which showed to be the most promising of the four evaluated scales.

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