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Research Article

Predictive Power of Hemorrhagic Transformation Scores in Real Life Stroke Patients Undergone to Urgent Reperfusion: A Brief Report

Running title: Hemorrhagic transformation in stroke patients

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Abstract

Introduction and aim: Hemorrhagic transformation (HT) is the most feared complication in acute phase of ischemic stroke. Predicting HT is of utmost importance in clinical practice. In the latest years a lot of HT prediction scores have been proposed, but their comparison in real life lack. Therefore, the aim of our study was to provide information about this topic. Materials and Methods: We retrospectively calculated THRIVE, SPAN-100, MSS score, SITS-ICH and GRASPS scores in patients consecutively admitted in our Stroke Unit along two years. To evaluate their predictive power, the area under the curve (AUC) of the Receiver Operating Characteristic (ROC) curve was calculated. Results: Study population was composed by ninety-one patients (51.6% females) with mean age 80.1 ± 11.3 years. Seventy-four (81.3%) patients undergone to systemic intravenous alteplase, seven (7.7%) to mechanical thrombectomy, ten (11%) to systemic intravenous alteplase plus mechanical thrombectomy. Eighteen patients (19.7%) presented HT. MSS score was the best prognosticator of HT, however the predictive power of the five analyzed score was low, ranging from and none of the score resulted significantly superior to the others. Conclusion: Our real-life study showed a low predictive power of a lot of HT prediction scores. Further prospective studies are warranted.

Key words: stroke; thrombolysis; mechanical thrombectomy; hemorrhagic transformation; outcome

Introduction

Predicting hemorrhagic transformation (HT) in stroke patients undergone to urgent reperfusion by intravenous thrombolysis and/or mechanical thrombectomy is of utmost importance in clinical practice. In 2017, a scientific statement for healthcare professionals from the American Heart Association/American Stroke Association identified seven validated scores for predicting HT in clinical practice [1-8]. All these seem to have a similar predictive power, C statistic ranging from about 0.50 to 0.86. National Institute of Health Stroke Scale (NIHSS) score is the only one variable present in all seven scores, while age is present in six of seven

scores. Other variables present in the majority of scores are high glucose levels and blood hypertension [1]. Literature lacks about comparison between these prediction score in real life patients, therefore the aim of our study was to compare the power of HT prediction scores.

Materials and Methods

We retrospectively analyzed clinical, instrumental and laboratory data of patients with acute ischemic stroke consecutively admitted to our Stroke Unit along two years, from November 1st 2017 to November 1st 2019, and undergone to sistemi thrombolysis and/or mechanical thrombectomy. For all patients we calculated five of the seven HT prediction scores proposed by ASA/AHA: THRIVE score [7], SPAN-100 score [8], MSS score [2], SITS-ICH score [5] and GRASPS score [6] (see Table 1 for characteristics of each score). To evaluate their predictive power, the area under the curve (AUC) of the Receiver Operating Characteristic (ROC) curve was calculated. All analyses were performed using MEDCALC statistical software (MedCalc Software Ltd, Acacialaan 22, B-8400 Ostend, Belgium).

Results

Study population was composed by ninety-one patients (51.6% females) with mean age 80.1 ± 11.3 years. Median NIHSS at hospital arrival was 3 (IQR 1-5). Twelve patients (13.2%) had NIHSS score ≥ 8 points. Seventy-four (81.3%) patients undergone to systemic intravenous alteplase, seven (7.7%) to mechanical thrombectomy, ten (11%) to systemic intravenous alteplase plus mechanical thrombectomy. At 24-hour brain CT-scan, eighteen patients (19.7%) presented HT, ten of them (55.5%) symptomatic according to the statement criteria (increase in NIHSS score of ≥4 points) (1). Median NIHSS score after 24 hours from urgent reperfusion was 9.5 (IQR 5-13.5) in patients with HT and 3 in patients without HT (IQR 2-8) ($p<0.001$). In-hospital mortality was 27.7% in patients with HT versus 2.7% in patients without HT ($p<0.001$). Median 90-day modified Rankin scale was 4 (IQR 3-4) in patients with HT versus 2 (IQR (0.5-3) in patients without HT ($p<0.001$). MSS score was the best prognosticator of HT (Figure 1), however the predictive power of the five analyzed score was low (Table 2) both for overall HT than for symptomatic HT and none of them resulted significantly superior to the others at pairwise comparison (Table 3).

	Variables												
Score	**Age**	**NIHSS score**	**Glucose**	**Platelets**	**Weight**	**Hypertension**	**Diabetes**	**Atrial fibrillation**	**Antiplatelets use**	**Systolic blood pressure**	**Onset to treatment time**	**Ethnicity**	**Range**
MSS	x	x	x	x									0-4
SISTS-SICH	x	x	x		x	x			x	x	x		0-12
GRASPS	x	x	x							x		x	0-101
THRIVE	x	x				x	x	x					0-9
SPAN-100	x	x											0-1

Table 1: *Characteristics of analyzed HT prediction scores*

	Overall HT			Only symptomatic HT (increase in NIHSS score of ≥4 points)		
Variable	**AUC**	**Standard error**	**95% CI**	**AUC**	**Standard error**	**95% CI**
SPAN 100 score	0,598	0,0607	0,490 to 0,700	0,570	0,0791	0,462 to 0,673
THRIVE score	0,583	0,0787	0,475 to 0,685	0,583	0,102	0,475 to 0,685
SISTS SICH score	0,547	0,0692	0,439 to 0,651	0,588	0,0785	0,480 to 0,690
MSS score	0,617	0,0662	0,509 to 0,717	0,512	0,0778	0,405 to 0,618
GRASPS score	0,537	0,0751	0,430 to 0,642	0,621	0,0963	0,513 to 0,721

Table 2: *Predictive power of analyzed HT scores*

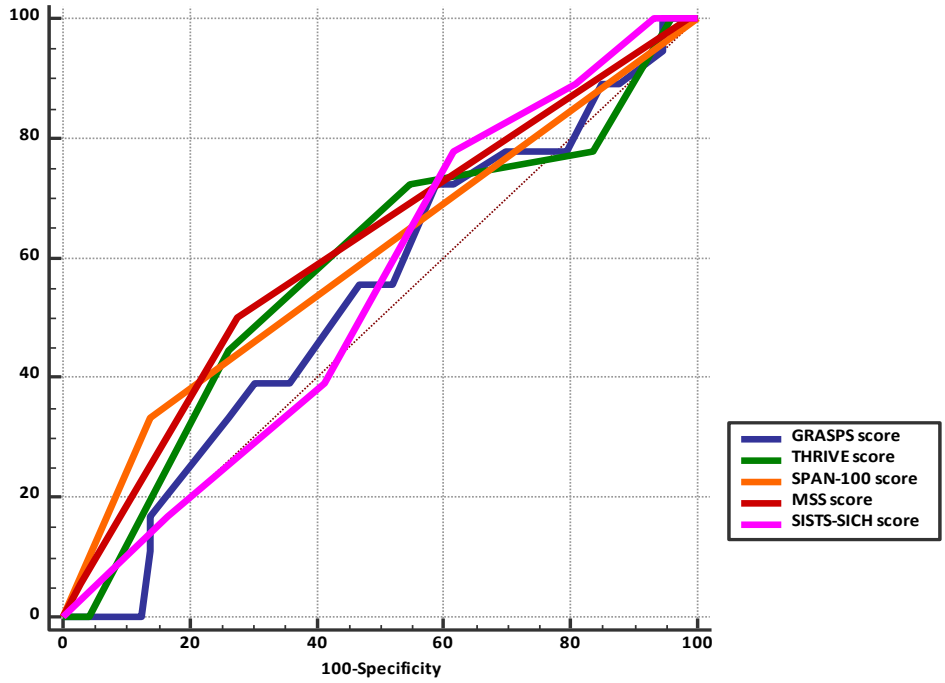

Figure 1: *Comparison of areas under the receiver operating curves of HT scores*

SPAN 100 score ~ THRIVE score	
Difference between areas (significante level)	0,0152, p=0.8419
SPAN score ~ SISTS-SICH score	
Difference between areas	0,0514, p=0.5752
SPAN-100 score ~ MSS score	
Difference between areas	0,0190, p=0.8176
SPAN-100 calc ~ GRASPS score	
Difference between areas	0,0609, p=0.5600
THRIVE score ~ SISTS-SICH score	
Difference between areas	0,0361, p=0.6873
THRIVE score ~ MSS s score	
Difference between areas	0,0342, p=0.7059
THRIVE score ~ GRASPS score	
Difference between areas	0,0457, p=0.6445
SISTS-SICH score ~ MSS score	
Difference between areas	0,0704, p=0.4808
SISTS-SICH score ~ GRASPS score	
Difference between areas	0,00951, p=0.9136
MSS score ~ GRASPS score	
Difference between areas	0,0799, p=0.3888

Table 3: *Pairwise comparison of score ROC curves*

Discussion

HT represents the most feared complication of urgent reperfusion in acute stroke patients and it is associated to reduced neurological improvement or deterioration [9]. Therefore, predict or prevent HT is fundamental. Despite the prediction scores are effective at estimating the HT risk, in clinical practice it's not justified withholding urgent reperfusion treatment in patients with high HT scoring. Many HT predictions scores have been proposed [2-8] in the past decade and others have been recently proposed [10-12]. These could help to select high HT risk patients requiring a closer monitoring. Despite limitations due to retrospective methodology, single center and limited sample size, our real-life study showed a low predictive power of a lot of HT prediction scores. Further prospective studies are warranted.

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