ORIGINAL ARTICLE

MORTALITY SCORES IN SURGICAL CORRECTION OF ABDOMINAL AORTIC ANEURYSM IN RUPTURE

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This article was presented in SPCCTV 4Dvisions Congress (22/11/2019 – 24/11/2019)

Abstract

Introduction: *Ruptured abdominal aortic aneurysm's treatment relies on the emergent surgery, considering preoperative prognosis. There are several scores that estimate perioperative mortality of ruptured abdominal aortic aneurysm, however, the accuracy of such algorithms in some populations remains unknown.*

Objective*: Compare the prognostic validity of the Weingarten score with the Glasgow Aneurysm Score and the Vancouver Scoring System. Validation of three prognostic ruptured abdominal aortic aneurysms tools for the Portuguese population.*

Material and Methods: *A retrospective analysis of consecutive patients with ruptured abdominal aortic aneurysm surgically treated, in a peripheral and in a referral hospital between 2012 and 2016 was performed. The 30-day mortality discriminative power was analysed using each score.*

Results: *120 patients were included. The mean Glasgow Aneurysm Score was 98.53 ± 19.57, the Vancouver Scoring System was 3.64 ± 1.43. The Weingarten score classified 51 (43.2%) patients as stable and 67 (56.8%) as unstable. The three scores demonstrated some predictive value concerning mortality, although Glasgow Aneurysm Score demonstrated the highest area under the ROC curve (0.74) and the best discriminatory capacity for cut-off points with higher specificity. Neither of the scores demonstrated clinically useful predictive value.*

Conclusions: *The Weingarten score did not present as a superior prediction model of preoperative mortality in ruptured abdominal aortic aneurysm. None of the scores, even when optimized for a higher specificity, could select which patients will not benefit from surgical intervention. The Glasgow Aneurysm Score was validated for the Portuguese population.*

Keywords: *Ruptured Abdominal Aortic Aneurysm, Mortality, Scores.*

1.INTRODUCTION

Abdominal aortic aneurysm (AAA) estimated prevalence in men over 65 is 5% and rupture is considered a surgical emergency with an elevated mortality rate (80 to 90%), which makes this condition one of the ten most common causes of death.[1-4] In Portugal, an AAA prevalence of 2.4% was described[5], and the survival rate of ruptured abdominal aortic aneurysms (rAAA) who reach the hospital alive is less than 50%.[2] The *European Society for Vascular Surgery* recommends the screening of AAA in men over 65[6,7], notwithstanding, in Portugal, systematic screening has not yet been implemented.[5]

Due to the high surgical risk of correcting a ruptured AAA, some surgeons choose to select which patients should be treated.[4] In 1994, Samy et al demonstrated that mortality in ruptured abdominal aortic aneurysms was influenced by age, preoperative shock (defined as blood pressure less than 80 mmHg), and personal history of heart disease, renal disease, and cerebrovascular disease, thus developing the Glasgow Aneurysm Score (GAS).[8] However, another variables also have been proposed as predictors of mortality, such as sex, low hematocrit or hemoglobin values, syncope or cardiac arrest.[9-11] Thus, several new scores have been presented[12], nevertheless, GAS has frequently been shown to be a good predictor of mortality and the standard of comparison.[13-15] The Vancouver Scoring System (VSS) considers mainly preoperative variables that we can easily access, such us age, loss of consciousness and cardiac arrest.[16]

In April 2016, Weingarten et al proposed a new score based exclusively on the clinical presentation of the patient prior to surgery: hypotension (systolic arterial pressure <80 mmHg), loss of consciousness, cardiac failure and necessity of tracheal intubation.[17] Patients categorized as "unstable" presented higher mortality rates, correlating directly with higher GAS values.[17] Sutton *et al*[18] suggested that a risk assessment scoring system should be accurate, quick, easy to use bedside and should include a small number of variables, which were presented in these scores. Additionally, this scores consider preoperative characteristics, that turns it possible to use in immediately in admission, and is an advantage relatively to other scores.

In 2015, Abreu *et al* developed a study to evaluate the applicability of GAS in a Portuguese center.[14] They showed that it wasn't possible to identify a cut-off able to provide a guaranteed mortality so we could be refusing treatment to some patients, that could possibly survive.[14] However, to the extent of our knowledge, there are no further studies in Portugal or in other countries that try to prove the applicability of the Weingarten score.

The aim of this study was to compare the mortality predictive value of these scores. The secondary aim was to validate the scores to the Mediterranean population.

2. MATERIAL AND METHODS

All patients submitted to open or endovascular repair due to ruptured abdominal aortic aneurysm were evaluated. The sample was consecutively selected from the surgical database of two Portuguese hospitals, a peripheral (Hospital Senhora da Oliveira (HSO)) and a referral center (Centro Hospitalar Universitário de São João (CHUSJ)), between 2012 and 2016.

2.1. Procedure

The identification of patients submitted to ruptured abdominal aortic aneurysm repair by conventional or endovascular surgery was performed resorting to ICD 9 coding (HSO: Ruptured abdominal aorta aneurysm (441.3); Surgical correction of ruptured abdominal aortic aneurysm - 3952 | CHUSJ: ruptured abdominal aortic aneurysm - 441.3; graft endovascular implant in the abdominal aorta (3971); Aneurism repair, ncop (3952); aorto-iliac femoral bypass (3925). A table was created by matching the patient's number to a tabulated number, to create the database. Three patients were excluded due to lack of data.

The scores were calculated according to the formulas described in table 1.

2.2. Statistical analysis

The statistical analysis was performed using the Statistical Package for Social Sciences (SPSS) version 25 (IBM Corp., released 2017. IBM SPSS Statistics for Windows, version 25.0, Armonk, NY, USA).

For the continuous variables, the mean and standard deviation (SD) were presented in those with normal or median distribution and interquartile ranges (AIQ) in those with normal distribution deviation, as well as maximum (max) and minimum (min) values of it. The normality of the variables was tested using the Shapiro-Wilk test or the analysis of asymmetry and kurtosis values, considering values between -1 and 1 as presenting a normal distribution.[19]

The Student's t-test for independent samples and the Mann-Whitney test were used to verify the relationship between the quantitative variables and perioperative mortality, depending on whether or not the normality assumptions were met, respectively.[20] The Chi-square test and the Fisher's exact test were used, when appropriate, for the categorical variables.[21] To discriminate the power of each score in predicting the mortality of patients with ruptured AAA, the Receiver Operating Characteristics (ROC) analysis was used, obtaining the area under the ROC (AUROC) as an effective measure of the inherent validity of the scores, as well as the values of sensitivity and specificity for the different cut-off points.[22] The R^2 with the Nagelkerke method was also calculated for each score.

3. RESULTS

The final sample consisted of 120 patients, patients' characteristics were listed in table 2. Table 3 shows the preoperative presentation of patients with ruptured AAA. Regarding the calculation of mortality scores, mean GAS was 96.[30]

Table 1 **Formulas to Glasgow Aneurysm Score and Vancouver Scoring System calculation**

Glasgow Aneurysm Score [12,25]	Age (years) + 7 (if heart disease is present) + 10 (if cerebrovascular disease is present) + 17 (if shock is present) + 14 (if acute/chronic renal disease is present)
Vancouver Scoring System[12]	Mortality calculation predicted by Vancouver Score $\frac{e^x}{1+e^x}$ in which "e" is the basis of the natural logarithm x = -3.44 + 0.062 x age +: • loss of consciousness (yes "+ 1.14", no "- 1.14") • cardiac arrest (yes "+ 0.60", not "- 0.60")

Table 2 **Patients characteristics and personal history**

	HSO* n (%)	CHUSJ† n (%)	Total n (%)
Age (years) Mean ± SD‡ min - max	 74.00 ± 3.00 61.00 – 91.00	 73.00 ± 1.00 51.00 – 96.00	 72,51 ± 9.34 5.10 – 96.00
Gender Male n (%) Female n (%)	 11 (100.0) 0 (0.0)	 98 (89.9) 11 (10.1)	 109 (90.8) 11 (9.2)
Personal History Smokers n (%) Cardiac Disease n (%) Renal Disease n (%) Cerebrovascular Disease n (%)	 3 (75.0) 4 (36.4) 5 (45.5) 2 (22.2)	 55 (56.7) 34 (35.8) 57 (58.2) 14 (13.5)	 58 (57.4) 38 (35.8) 62 (56.9) 16 (14.2)

*HSO – Hospital Senhora da Oliveira; †CHUSJ – Centro Hospitalar Universitário de São João; ‡SD – standard deviation.

Table 3 **Preoperative clinical variables**

	HSO* n (%)	CHUSJ† n (%)	Total n (%)
Hypotension	7 (63.6)	50 (47.2)	57 (48.7)
Cardiac arrest	2 (20.0)	11 (10.7)	13 (11.5)
Loss of consciousness	4 (36.4)	32 (30.8)	36 (31.3)
Intubation necessity	1 (91.0)	56 (58.3)	57 (53.3)

*HSO – Hospital Senhora da Oliveira; †CHUSJ – Centro Hospitalar Universitário de São João

(SD ± 23.935, min 58 - max 184). The mean VSS was 3.64 (SD ± 1.43, min 1.48 - max 7.38). It was found that the Weingarten score ranked 51 patients (43.2%) as stable and 67 (56.8%) as unstable.

In the perioperative period (30 days), 6 patients died in HSO and 66 died in CHUSJ, corresponding to a mortality of 54.5% and 60.6%, respectively.

In the univariate analysis only renal disease (OR 2,78 95%; IC 1,26–6,14; p=0.011) and hypotension (OR 3,75; 95% IC 1,71–8,26; p=0.001) were considered statistically significant for 30 days mortality. Age was also considered significantly higher in the group of patients who died with a mean age of 74.97±9.4; min 51; max 96 (p <0.001).

The scores performance predicting mortality is described on Table IV.

Regarding the ROC analysis, it was found, for all three scores, a linear increase in the risk of death (figure 1). GAS Area Under ROC (AUROC=0.74 [0.641-0.826],

Table 4 **Univariate analysis of mortality scores (*GAS, †VSS and Weingarten)**

	Death	Survival	*p* Value
GAS* Mean ± SD[‖] min[‖] - max[¶]	 103.80 ± 17.653 58 - 141	 90.79 ± 19.640 59 - 184	 < 0.001[a ††]
VSS† Mean ± SD[‖] min[‖] - max[¶]	 3.83 ± 1,46 1.98 – 7.38	 3.36 ± 1.34 1.48 – 6.51	 0.060[b]
Weingarten Unstable n (%) Stable n (%)	 46 (68.7) 25 (49.0)	 21 (31.3) 26 (51.0)	OR** (95% CI[#]) 2.28 (1.07 – 4.84) 0.031[c††]

a - Man-Whitney test
b - T-student test
c – Chi-square test
†† Statistically significant p-value

*GAS - Glasgow Aneurysm Score; †VSS - Vancouver Scoring; §IQR – Interquartile range; ‖SD - Standard Deviation; ‖ minimum; ¶maximum; # CI – Confidence interval; **OR – Odds Ratio

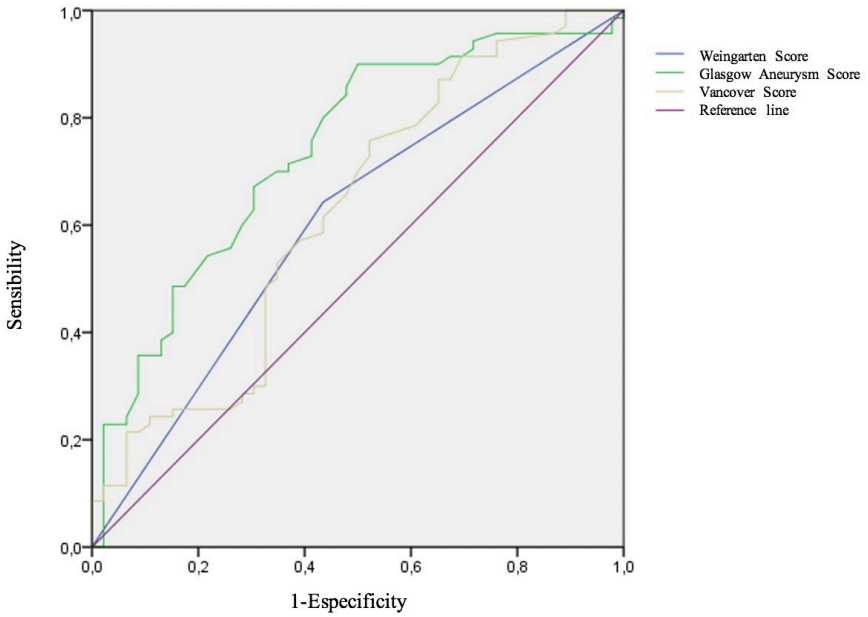

Figure 1 *ROC (Receiver Operating Characteristics) curve – comparison between Glasgow Aneurysm Score, Vancouver Scoring System and Weingarten Score.*

R^2 0.154) demonstrated the best performance, followed by the Vancouver Score (VSS) with AUC=0.62 [0.526 – 0.738], R^2 0.047. The Weingarten score had an AUROC of 0.60 [0.493 – 0.703], R^2 0.05. A cutoff value for GAS above 87.5 was established, which had a sensitivity of 90% and a specificity of 50%. For the Vancouver score, the cut-off value was 2.76, with a sensitivity of 76% and a specificity of 48%. Thus, patients with scores on GAS and VSS scores higher than the defined cut-off points, twenty--four and twenty-six survived, respectively.

The agreement between Weingarten Score and GAS (cut-off: 98) was 28,6% (± 8.7%), with p=0.02.

4. DISCUSSION

Because of the high mortality of surgical correction of a ruptured AAA, some surgical groups select which patients should be submitted to surgical intervention.[4] Death risk estimates may be useful as a point of reference for the surgeon when this options are contemplated.[10]

In this study the demographics (sex, smoking status and age) are in agreement with the bibliography. It was also found that age, renal disease and hypotension were the only variables in our study that were related to mortality. Nevertheless, these results resemble those of Abreu et al who verified this same relationship.[14] They only differed in what concerns age of those who died: in their study patients who died were significantly younger, unlike our study, where they were significantly older (74 *vs* 68, p <0.001).[14] Mortality in both centers was estimated at 60%, similar to those obtained in another study.[2]

Of the three scores studied, GAS obtained consistently better results regarding correlation with mortality, presenting a higher AUROC (0.74), although it was not able to predict the 95% probability cut off to 30 day death risk. The findings are consistent with those previously reported.[13,15,23] Relatively to VSS, a relation to mortality in the univariate analysis was not found, although presented an AUROC of 0.62. By 2015, Van Beek *et al* found an AUROC for this score of 0.72, but concluded that VSS overestimated death considerably.[13] Thus, this score is effective in identifying patients at high risk (> 90%), but it will not behave as well in patients with a lower mortality risk (>80%).[4,24] Despite the ease in obtaining the variables for the calculation of this score, the necessity of coefficients and mathematical calculations that are too complex make it impractical and, therefore, it has been seldom used.[4]

In spite of GAS and VSS were limited in their ability to identify patients at high risk and without survival benefit with surgical intervention[13], these scores may be of value in comparative studies between different hospitals and surgeons, by allowing stratification of the patient's prognosis.[4,13] However, the necessity to know the patient's clinical data limits the applicability of these scores.[25]

In their study, Weingarten *et al* classified 85 patients as "unstable", with a mortality rate of 41% in these patients. In those classified as "stable", mortality was 13.0%.[17] Although, patients classified as "unstable" actually had a higher mortality rate (68.7%, p<0.031), approximately half (49.0%) of those considered "stable" died. Therefore, it is safe to say that in our study, the Weingarten score did not behave as a better predictor of mortality, nor did have a good discriminative power. Although the ease and rapid application in the emergency context, this score did not appear to be superior to the two previously known scores, GAS and VSS.

There is an agreement of 28.6% (p=0.02) between Weingarten Score and GAS which means that the addition of both scores could have an additional predictive value, although adding complexity to the calculation.

The main limitation of this study is the retrospective data collection, especially those related to the preoperative presentation which, due to the emergency of the procedure, is sometimes conditioned. On the other hand, it becomes impossible to mimic the reality of urgency in the search for variables for the calculation of scores, which makes it hard to evaluate their real applicability in clinical practice.

In this study the three scores failed to predict mortality reliably, which is in accordance with the bibliography quoted.[4,10,13,14,17,23,24] Every recommendation is against the exclusive use of scores to select for surgery. Thus the score are effective as adjuvants for the surgical decision, and helping estimate the comparative balsa risks and results of each center.

5. CONCLUSION

GAS was found to be the best among the three scores studied, although it failed to discriminate the futility of surgery in patients at high risk. Nevertheless, the objective of validating the GAS score for the Portuguese population, represented by HSO and CHUSJ patients, was reached. The authors concluded that the Weingarten was not useful in clinical practice and that it did not supplant the GAS.

Nevertheless, this new score should not be set aside, but rather reformulated in future studies, so that, for each variable a quotation is attributed to increase the classification stratification and thus present a score that become more reliable in predicting mortality.

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