GuaragnaSCORE satisfactorily predicts outcomes in heart valve surgery in a Brazilian hospital

GuaragnaSCORE prediz satisfatoriamente os desfechos em cirurgia cardíaca valvar em hospital brasileiro

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Abstract

Objective: The aim of this study is to evaluate the applicability of GuaragnaSCORE for predicting mortality in patients undergoing heart valve surgery in the Division of Cardiovascular Surgery of Pronto Socorro Cardiológico de Pernambuco - PROCAPE, Recife, PE, Brazil.

Methods: Retrospective study involving 491 consecutive patients operated between May/2007 and December/2010. The registers contained all the information used to calculate the score. The outcome of interest was death. Association of model factors with death (univariate analysis and multivariate logistic regression analysis), association of risk score classes with death and accuracy of the model by the area under the ROC (receiver operating characteristic) curve were calculated.

Results: The incidence of death was 15.1%. The nine variables of the score were predictive of perioperative death in both univariate and multivariate analysis. We observed that the higher the risk class of the patient (low, medium, high, very high, extremely high), the greater is the incidence of postoperative AF (0%; 7.2%; 25.5%; 38.5%; 52.4%), showing that the model seems to be a good predictor of risk of postoperative death, in a statistically significant association (*P* <0.001). The score presented a good accuracy, since the discrimination power of the model in this study according to the ROC curve was 78.1%.

Conclusions: The Brazilian score proved to be a simple and objective index, revealing a satisfactory predictor of perioperative mortality in patients undergoing heart valve surgery at our institution.

Descriptors: Risk. Heart valve diseases. Cardiovascular surgical procedures.

Resumo

Objetivo: O objetivo deste estudo é avaliar a aplicabilidade do GuaragnaSCORE na predição de mortalidade perioperatória em pacientes submetidos à cirurgia cardíaca valvar na Divisão de Cirurgia Cardiovascular do Pronto Socorro Cardiológico de Pernambuco - PROCAPE, Recife, PE, Brasil.

Métodos: Estudo retrospectivo envolvendo 491 pacientes consecutivos operados entre maio/2007 e dezembro/2010. Os registros continham todas as informações utilizadas para calcular a pontuação. O desfecho de interesse foi óbito. A associação de fatores do escore com óbito (análise univariada

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Abbreviations, acronyms & symbols	
CABG	coronary artery bypass graft
CI	confidence interval
CPB	cardiopulmonary bypass
EF	ejection fraction
NYHA	New York Heart Association criteria
OR	odds ratio
PAH	pulmonary arterial hypertension
ROC curve	receiver operating characteristic curve
SPSS	Statistical Package for Social Sciences

e análise de regressão logística multivariada), associação
de classes de risco do escore com óbito e acurácia do modelo
através da área sob a curva ROC (*receiver operating
characteristic*) foram calculados.

Resultados: **A incidência de óbito foi de 15,1%. As nove
variáveis do escore foram preditoras de morte em análise
univariada e multivariada. Observamos que, quanto maior
a classe de risco do paciente (baixa, média, alta, muito alta,
extremamente alta), maior é a incidência de óbito (0%;
7,2%; 25,5%; 38,5%; 52,4%), demonstrando que o modelo
parece ser um bom preditor de risco de óbito, em uma
associação estatisticamente significativa (*P*<0,001). O escore
apresentou boa acurácia, levando em consideração que a
área sob a curva ROC foi de 78,1%.**

Conclusões: **O escore brasileiro demonstrou-se um índice
simples e objetivo, revelando-se um preditor satisfatório de
óbito no período perioperatório em pacientes submetidos à
cirurgia cardíaca valvar em nossa instituição.**

Descritores: **Risco. Doenças das valvas cardíacas.
Procedimentos cirúrgicos cardiovasculares.**

INTRODUCTION

Currently, a total of 275.000 cardiac valve replacement
surgeries are carried out worldwide [1], with operative
mortality ranging from 1 to 15% [2,3]. The reported mortality
in Brazil is 8.9% for heart valve surgeries, according to
administrative register from DATASUS [4].

Guaragna et al. [5] recently proposed a Brazilian risk
score for prediction of surgical risk after heart valve surgery
– we baptized the model as GuaragnaSCORE. However,
several studies show that risk prediction scores tend to
have inferior performance when applied to different groups
of patients which have been used to development of the
original model [6]. So the external assessment in population
of patients with new data from other institutions is always
important for the score has wide clinical application [7-9].
Previously, we tested EuroSCORE in coronary artery bypass
graft (CABG) surgery at our institution, and this proved to
be a simple and objective index, revealing a discriminating
satisfactory postoperative outcome, so we showed the
importance of validating risk prediction models in local
institutions in order to verify its applicability [8].

The objective of this study is to evaluate the ability of
the score of Guaragna et al. [5] in predicting surgical risk in
our institution, specifically in the group undergoing heart
valve surgery.

METHODS

Source population

After approval by the ethics committee, in accordance
with Resolution 196/96 (National Board of Health – Ministry
of Health – Brazil) [10,11], we reviewed the records of
patients undergoing consecutive isolated heart valve
surgery (replacement or repair) or combined with CABG

surgery at the Division of Cardiovascular Surgery of Pronto
Socorro Cardiológico de Pernambuco (PROCAPE), Recife,
PE, Brazil, from May 2007 to December 2010. We excluded
the following: patients whose records did not contain the
necessary data concerning the variables to be studied;
patients undergoing surgery for tricuspid and/or pulmonary
valves (when isolated, due to small number of patients
undergoing these procedures); age < 18 years.

Study design

It was a retrospective study of exposed and nonexposed
to certain factors (independent variables) with outcome
(dependent variable) followed by assessment of a model
(the score of Guaragna et al. [5]).

The independent variables were: gender (male/female),
age (years), surgical priority (emergency/urgency surgery
considered as a single variable and defined as the need to
undergo surgical intervention in up to 48 hours, due to
imminent risk of death or unstable clinical-hemodynamic
condition), heart failure functional class according to New
York Heart Association criteria (NYHA I, II, III, IV), ejection
fraction (EF%, measured by echocardiography), serum
creatinine (mg/dL), pulmonary arterial hypertension (PAH,
detected at the echocardiogram, defined as systolic
pressure in pulmonary artery ≥ 30 mmHg according to the
Brazilian Guideline of Pulmonary Arterial Hypertension of
2005), combined CABG surgery.

The dependent variable was perioperative death
(considered in the transoperative period and throughout
the entire hospitalization period).

Each patient was evaluated for the presence or absence of
the nine risk factors established by Guaragna et al. [5],
respecting the definition of each of them and giving them the
correct score (Table 1). Depending on the final score, each
patient was placed in one of the five risk groups (Table 2).

Table 1. Factors associated with development of outcome (death) after heart valve surgery and appropriate score

Clinical profile	Score
Age ≥ 60 years	3
Emergency/urgency surgery	17
Female sex	2
Ejection fraction ≤ 45%	2
Combined CABG	3
Pulmonary arterial hypertension	2
NYHA class III or IV	2
Creatinine 1.5 - 2.49 mg/dL	2
Creatinine ≥ 2.5 mg/dL or dialysis	6

Table 2. Risk category according to the score

Risk category	Total score
Low	0 - 3
Medium	4 - 6
High	7 - 9
Very High	10 - 13
Extremely high	≥ 14

Statistical methods

Data were analyzed using percentage and descriptive statistics measures. The following tests were used: chi-square test or Fisher's exact test (as appropriate, for non-parametric variables). In the study of univariate association between categorical variables, the values of the odds ratio (OR) and a confidence interval (CI) for this parameter with a reliability of 95% were obtained.

Multivariate analysis was adjusted to a logistic regression model to explain the proportion of patients who died that were significantly associated to the level of 5% (*P* <0.05) by a backward elimination procedure. The calibration of multivariate model was evaluated by the Hosmer-Lemeshow goodness-of-fit test.

The accuracy (discrimination ability of the score) was calculated using the area under the ROC curve (receiver operating characteristic curve), built on correct prediction of death (among high, very high and extremely high risk categories) and correct prediction of survival (among low and medium risk categories).

The level of significance in the decision of the statistical tests was 5%. The program used for data entry and retrieval of statistical calculations was SPSS (Statistical Package for Social Sciences) version 15.0.

RESULTS

Incidence of death and population characteristics

Taking into account the inclusion and exclusion criteria, we analyzed 491 patients undergoing heart valve surgery

with a mean age of 44.6 ± 17.9 years, being 51.5% female. In-hospital death occurred in 15.1% (n=74) patients.

Univariate analysis

Analyzing the variables proposed in the score with the occurrence of death, we observed that all of them were significantly associated with this complication (Figure 1).
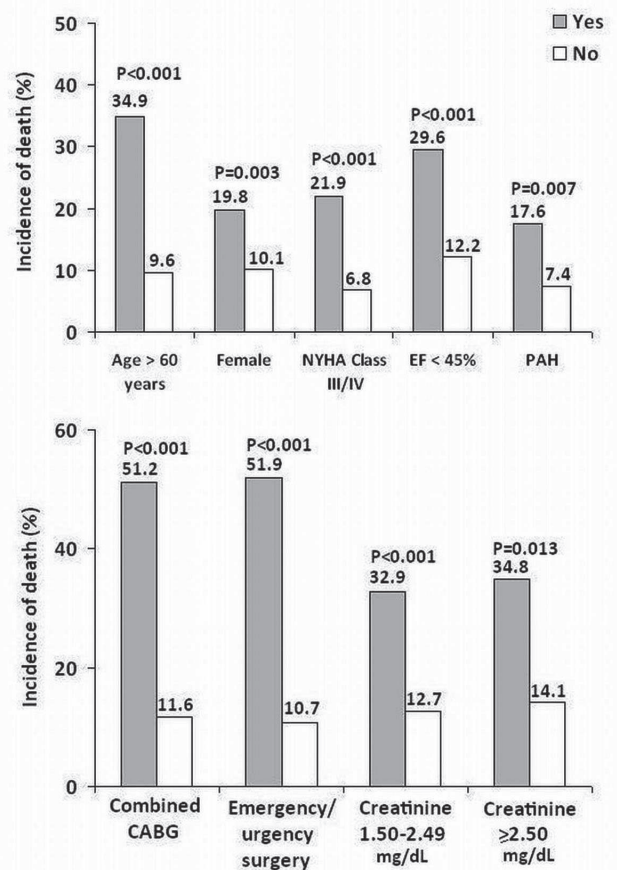

Fig. 1 - Association of clinical characteristics with the occurrence of death after heart valve surgery (univariate analysis). EF - ejection fraction; CABG - coronary artery bypass graft

Multivariate analysis

Applying a multivariate logistic regression model, associations of clinical variables of the score remained strongly associated with death (Table 3). The model was well accepted (*P*<0.001) and showed a degree of explanation of 88.4%. The Hosmer-Lemeshow goodness-of-fit was also well accepted (*P*=0.811), indicating a good model calibration.

Analysis of the score and prediction of death

The incidence of death according to the risk score

Table 3.   Multivariate logistic regression model

| | OR / 95%CI | | |
Variable	Univariate analysis	Multivariate analysis	*P* value
Age ≥ 60 years	5.04 (2.99 - 8.52)	3.33 (1.67 - 6.64)	0.001*
Female	2.20 (1.30 - 3.71)	2.40 (1.23 - 4.67)	0.010*
NYHA class III - IV	3.84 (2.11 - 6.99)	2.14 (1.04 - 4.43)	0.040*
Combined CABG	7.98 (4.11 - 15.50)	6.56 (2.71 - 15.89)	< 0.001*
Ejection fraction ≤ 45%	3.03 (1.73 - 5.31)	2.30 (1.09 - 4.87)	0.029*
Emergency/urgency surgery	9.01 (4.83 - 16.79)	7.48 (3.46 - 16.18)	< 0.001*
Pulmonary arterial hypertension	2.65 (1.28 - 5.50)	2.77 (1.13 - 6.78)	0.026*
Creatinine 1.50 - 2.49 mg/dL	3.35 (1.81 - 6.21)	2.20 (1.07 - 7.00)	0.048*
Creatinine ≥ 2.5 mg/dL	3.25 (1.33 - 7.96)	2.09 (1.03 - 8.00)	0.049*

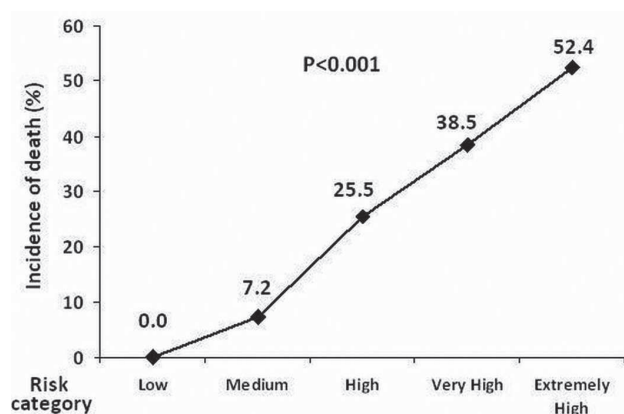*(*): Significative at 5% level. Constant P < 0.001*

Fig. 2 - Relationship between the risk group classification according to the score and incidence of death. Note the upward curve as it increases the risk class

Fig. 3 - Receiver operating characteristic (ROC) curve. The graphic shows the good accuracy of the model

classification is showed in Figure 2. We observed that the higher is the risk category, the higher is the incidence of death, in a statistically significant association (*P*<0.001).

Accuracy of the proposed risk score

According to the results presented in the area under the ROC curve (overall capacity of the measure used to discriminate individuals who died or survived), measured by 78.1%, the score shown a good measure to identify patients with risk of death (Figure 3).

DISCUSSION

The incidence of death in our study was 15.1%. This is 28% greater than that observed in the original study by Guaragna et al. [5], which was 11.8%. This is probably because our population has surplus of 17% of female, 25% of patients with NYHA class III/IV, 35.2% of left ventricular dysfunction, 301.6% of pulmonary arterial hypertension, 81.5% of creatinine 1.50-2.49 mg/dL and 213.6% of creatinine ≥ 2.5 mg/dL, which makes our population as higher risk.
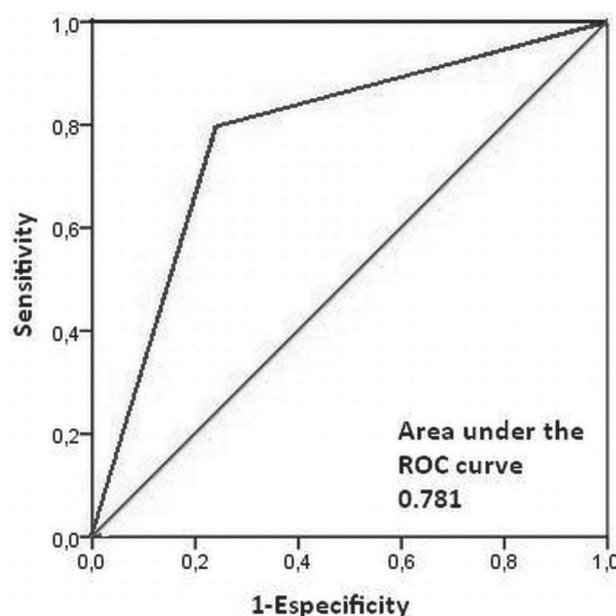
We observed that age ≥ 60 years is an independent predictor of death in patients undergoing heart valve surgery. Almeida et al. [12] already demonstrated that age is associated with the occurrence of death after heart valve surgery regardless of type of prosthesis (biological or mechanics).

We also observed that female is an independent predictor of death in patients undergoing heart valve surgery. Andrade et al. [13] demonstrated that female gender increases by 2 times the chance of death in patients undergoing heart valve surgery (independent association).

We also observed that ejection fraction ≤ 45% is an independent predictor of death in patients undergoing heart valve surgery. De Bacco et al. [14] showed that left ventricular dysfunction is associated with increased mortality in patients undergoing heart valve replacement.

We also observed that combined CABG is an independent predictor of death in patients undergoing heart valve surgery. We think it happens for two reasons. First, many studies show that combination of two or more concomitant cardiac surgeries increases the risk of death [5,8,9]. Second, the combination with CABG increases time of cardiopulmonary bypass (CPB). Many studies showed the impact of CPB in increased rates of morbidity and mortality in various situations related to cardiac surgery [15,16].

We also observed that pulmonary arterial hypertension is an independent predictor of death in patients undergoing heart valve surgery. Roques el al. [17] demonstrated the importance of pulmonary hypertension on outcomes during the development of EuroSCORE.

We also observed that NYHA class III/IV is an independent predictor of death in patients undergoing heart valve surgery. Despite this evidence, we must remember that it is precisely these patients (patients more symptomatic) who benefit from more aggressive strategies (surgical treatment) compared with medical therapy [18].

We also observed that high levels of creatinine is an independent predictor of death in patients undergoing heart valve surgery. Volkmann et al. [19] showed that, beyond patients with overt renal insufficiency, patients with hidden renal dysfunction (normal creatinine, but with decreased glomerular filtration rate) had a higher incidence of death after cardiac surgery, demonstrating the impact of renal disease in outcomes.

It is worth mentioning that other scores have been tested in cardiac surgery, although not specifically in heart valve surgery. Recently, Mejía et al. [9] tested the EuroSCORE and 2000 Parsonnet-Bernstein in Heart Institute of the University of São Paulo Clinics Hospital (InCor-USP). They showed that the similarity between both observed and expected mortality by the scores allows them to confirm that the values given by the scores to the various risk factors could be applied to their patients. Therefore, they concluded that both models were similar and adequate in predicting the mortality of patients undergoing CABG, heart valve, and associated surgeries at their institution. The GuaragnaSCORE stands out in the sense of having been created specifically for heart valve surgery.

The GuaragnaSCORE presented a good accuracy, since the discrimination power of the model in this study according to the ROC curve was 78.1%.

CONCLUSIONS

The risk score proposed by Guaragna et al. [5] seems to be a good model for prediction of death in patients undergoing heart valve surgery.

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