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A score proposal to evaluate surgical risk in patients submitted to myocardial revascularization surgery

Proposição de um escore de risco cirúrgico em pacientes submetidos à cirurgia de revascularização miocárdica

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Abstract

Introduction: **Scores to predict surgical risk in patients submitted to myocardial revascularization surgery are broadly used.**

Objective: To develop a score capable to predict mortality in patients submitted to myocardial revascularization surgery.

Methods: **From January 1996 to December 2007, data were collected from 2809 patients submitted to myocardial revascularization surgery at PUC-RS Sao Lucas Hospital. In 2/3 of the sample (n=1875), the score was developed, after uni and mutivariated analyses. In the remaining 1/3 (n =934) the score was validated. The final score was developed with the total sample, using the same variables (n=2809). The accuracy of the model was tested using the area under the ROC curve.**

Results: **The median age was 61.3 ±10.1 years and 34% were women. The risk factors identified as independent predictors of surgical mortality and used for score development (parentheses) were: age > 60 years (2), female (2), extracardiac vasculopathy (2), heart failure functional class III and IV (3), ejection fraction<45% (2), atrial fibrillation (2), chronic obstructive pulmonary disease (3), aortic stenosis (3), creatinine 1.5-2.4 (2), creatinina > 2.5 or dialysis (4), emergency/urgency surgery (16). The area obtained under the ROC curve was 0.86 (CI 0.81-0.9).**

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Conclusion: **The score developed, using clinical variables easy to obtain (age, sex, extracardiac vasculopathy, functional class, ejection fraction, atrial fibrillation, chronic obstructive pulmonary disease, aortic stenosis, creatinine and emergency/urgency surgery) showed capability to predict mortality in patients submitted to myocardial revascularization surgery in our Hospital.**

Descriptors: **Myocardial revascularization. Risk factors. Mortality. Risk assessment/methods.**

Resumo

Introdução: **Escores para avaliação de risco cirúrgico em pacientes submetidos à cirurgia de revascularização miocárdica são amplamente utilizados.**

Objetivo: **Construir um escore capaz de predizer mortalidade em pacientes submetidos à cirurgia de revascularização miocárdica.**

Métodos: **No período entre janeiro de 1996 e dezembro de 2007, foram coletados dados de 2809 pacientes submetidos à cirurgia de revascularização miocárdica no Hospital São Lucas da PUC-RS. Em cerca de 2/3 da amostra (n=1875), foi construído o escore, após análises uni e multivariada. No restante (n=934), o escore foi validado. O escore final foi construído com a amostra total, utilizando as mesmas variáveis (n=2809). A acurácia do modelo foi testada utilizando-se a área sob a curva ROC.**

Resultados: **A idade média foi 61,3 ± 10,1 anos (desvio padrão) e 34% eram mulheres. Os fatores de risco identificados como preditores independentes de mortalidade cirúrgica e utilizados para montagem do escore (parênteses) foram: idade ≥ 60 anos (2), sexo feminino (2), vasculopatia extracardíaca (2), insuficiência cardíaca classe funcional III e IV (3), fração de ejeção ≤ 45% (2), fibrilação atrial (2), doença pulmonar obstrutiva crônica (3), estenose aórtica (3), creatinina 1,5-2,4 (2), creatinina ≥ 2,5 ou diálise (4) e cirurgia de emergência/urgência (16). A área sob a curva ROC obtida foi de 0,86 (IC 0,81-0,9).**

Conclusão: **O escore desenvolvido por meio de variáveis clínicas de fácil obtenção (idade, sexo, vasculopatia extracardíaca, classe funcional, fração de ejeção, fibrilação atrial, doença pulmonar obstrutiva crônica, estenose aórtica, creatinina e cirurgia de emergência/urgência) mostrou-se capaz de predizer mortalidade em pacientes submetidos à cirurgia de revascularização miocárdica no nosso Hospital.**

Descritores: **Revascularização miocárdica. Fatores de risco. Mortalidade. Medição de risco/métodos.**

INTRODUCTION

In medical decisions related to interventions, whether medical or surgical, benefits must be weighed against its risks. In order to estimate this risk, many variables must be taken into consideration, including characteristics of patient and disease. Risk stratification allows a better prognosis of operative risk for certain individuals and has great importance in retrospective analysis of surgical outcomes, allowing comparison not only among institutions, but also among individual surgeons, enabling a quality control in daily clinical practice [1,2]. Classically, a plenty of bias can help to predict the probability of an event [3].

The patients' profile undergoing coronary artery bypass grafting (CABG) has changed, compared with patients of the 70's. This surgical population is currently consisted of a higher percentage of elderly and women, higher prevalence of poor cardiac conditions and associated comorbidities [4].

There are some scores to estimate the death risk in patients undergoing CABG [5-13]. Among them, the most pervasive one is the EuroSCORE [10-12]. In Brazil, there is already a score developed to predict the risk for patients undergoing CABG [14]. The profile of patients undergoing CABG in Brazil differs significantly from those in Europe, as demonstrated in a study [15], which compared the risk factors of patients included in the EuroSCORE, with risk factors more prevalent in patients undergoing CABG in four hospitals. In this study, there was a greater proportion of young patients, women, hypertensive and diabetic people. Moreover, all risk factors analyzed were significantly different between the two populations. Thus, the factors associated with mortality may also differ.

This study was conducted with the aim of defining the risk factors associated with surgical mortality in patients undergoing CABG in our service, building a risk score and validating it in a subsequent sample.

METHODS

Population and sample

Between January 1996 and December 2007, 3,895 patients underwent cardiac surgery at Sao Lucas Hospital, PUC - RS. Among them, 2809 underwent isolated or combined CABG with valve replacement (VR), being the reason for this study.

Study design

Historical cohort observational study. Data were prospectively collected and entered into the postoperative unit of cardiac surgery database at Sao Lucas Hospital, PUCRS. The research project of this study was approved by the Research Ethics Committee at FAMED, PUCRS, under the registration number 06003478.

Inclusion criteria

Patients aged 18 years or over undergoing isolated or combined CABG with VR.

Exclusion criteria

The isolated VR surgeries were excluded from the analysis.

Variables in study

The variables included in the analysis were:

- Gender (male/female);
- Age;
- Surgical priority: emergency/urgent surgery considered as a single variable and defined as need for intervention within 48 hours due to risk of imminent death or unstable clinical-hemodynamic status;
- Functional classification for congestive heart failure (CHF) according to criteria of the New York Heart Association;
- Prior atrial fibrillation;
- Chronic obstructive pulmonary disease (COPD) clinically diagnosed and / or through a study of chest radiology and / or spirometry and / or with drug therapy (corticosteroids or bronchodilators);
- Ejection fraction: measured by echocardiography, ventriculography or Radiocardiography;
- Serum creatinine;
- Extracardiac vasculopathy clinically defined by the presence of significant carotid or peripheral artery diseases;
- Presence of aortic stenosis;
- Need to use intra-aortic balloon (IAB);
- Lesion of left main coronary artery (LMCA) $\geq$ 50%;
- Diabetes mellitus (DM);
- Obesity defined by body mass index (BMI) $\geq$ 35 kg / m²;
- Prior Cerebrovascular accident (CVA);
- Systemic arterial hypertension (SAH);
- Prior Acute Myocardial Infarction (AMI);
- Prior Heart surgery (HS);
- Functional classification of angina following the criteria of the Canadian Cardiovascular Society;
- Unstable angina.

The variables were chosen taking into account previous studies [5.10] and biological plausibility. The ejection fraction, renal failure, extracardiac vasculopathy and the need for emergency revascularization are the most important variables that may increase the perioperative risk. The determination of ejection fraction has unquestionable importance in patients undergoing CABG. Those with lower ejection fraction have more difficulty in weaning from extracorporeal circulation, and develop low output syndrome postoperatively more often. Extracardiac vasculopathy aggregates greater morbimortality because it increases the chance of CVA or peripheral embolism. COPD patients have higher incidence of arrhythmias, more difficulty in weaning from mechanical ventilation and higher risk of pneumonia. In patients with renal failure, there is a higher rate of bleeding due to platelet dysfunction, which also increases morbidity. Diabetic patients have higher incidence of infections, renal and cerebral complications. Patients in unstable preoperative status (angina, arrhythmias) also have higher death risk.

The aortic valve replacement must be considered as a variable, as it is currently performed more frequently, adding greater surgical risk. Moreover, the percentage of older patients who undergo CABG has increased along with the prevalence of aortic stenosis calcification.

Concomitant major procedures with CABG, such as implantation of a valved tube or aneurysmectomy, were not included in the analysis due to its infrequency, as well as the presence of active endocarditis.

Outcome

Death, considered during transoperatory and throughout the hospitalization period.

Procedures

Anesthesia, the extracorporeal circulation and cardioplegia techniques were performed according to the standardization of Sao Lucas Hospital at PUC-RS, as previously described [16]. After surgery, all patients were transferred to the Postoperative Intensive Care Unit in cardiac surgery, with mechanical ventilation.

Statistical analysis

Continuous variables were described by an average, standard deviation and compared by Student's t test.

Categorical or continuous categorized variables were described by counts and percentages and compared by chi-square test. The database was randomly divided into two parts for the process of building risk score: 2/3 of the data were used for modeling and 1/3 for validation.

Obtaining the preliminary risk model

The variables initial consideration followed a hierarchical model based on biological plausibility and external information (literature) about the relevance and strength of the associations of these potential risk factors with the outcome being studied (in-hospital death). Once these variables are listed, multiple logistic regression was step-by-step used in the backward selection process, keeping all variables with significance level P <0,05 in the model. It was then constructed a weighted risk score, in which each variable was given a score according to the magnitude of its coefficient b of the logistic equation. When they were being transformed (Exp [b]) into odds ratios (OR), this score was established. The values were rounded up to the nearest whole number to compose the score.

Validation

The preliminary risk score was applied to the database validation obtaining two performance statistics: c statistic (area under the ROC curve), Hosmer-Lemeshow test (HLT) and, consequently, Pearson's correlation coefficient between observed and predicated events by the model. The values for the area under the ROC curve between 0.85 and 0.90 indicate excellent discriminatory power. A Hosmer-Lemeshow chi-square was not significant (*P*> 0.05), which indicates a good model calibration. A value of Pearson correlation coefficient $r \geq 0.7$ indicates a very strong correlation between observed and predicted vales.

Obtaining the final risk model

Once an appropriate role model was observed in the validation process, the databases (modeling and validation) were combined to obtain the final score. The variables were neither included nor excluded in this process, which simply resulted in obtaining more precise estimates for the coefficients previously calculated. The same performance statistics described above were also shown.

The resulting logistic model followed the formula below, and unlike the score, presents direct estimates of the occurrence probability of the outcome. This process is understood by some authors [17] as being more suitable for obtaining event estimates, despite a certain degree of mathematical complexity for its use in daily medical practice. The application of the logistic model is more suitable for prognosis in individual risk, particularly in patients with high risk in the additive model.

$$P\ (\text{event}) = 1 / 1 + \text{Exp}\ (-\ (\beta 0\ \beta 1x1 + +. . . + \beta k\ xk))$$

The data were processed and analyzed with the aid of the Statistical Package for the Social Sciences (SPSS) version 15.0.

RESULTS

Characteristics

In the total sample (2809), 280 patients died (10%). Considering only the elective surgeries, the death rate drops to 6.3%. In cases where there was emergency/urgent surgery (7%), mortality was very high: 54%. These patients represented 42% of total deaths. The average age of the population was 61.3 years (± 10.1 years) and 58% of patients were aged 60 years or younger. Regarding gender, 34% were women. Combined valve replacement surgery was necessary in 4.4% of patients (Table 1).

Risk Model Development (Modeling)

In randomly selected patients (2 / 3 of the total sample) was performed the multiple logistic regression of predictors in 1895, which were selected according to their statistical significance for the score construction (Table 2). The area under the ROC curve of the model was 0.84 (95% CI 0.67 to 0.87). Pearson correlation coefficient obtained was 0.99 with *P* <0.001.

Risk Model Validation

External validation was performed in 934 patients (one third of the total sample) randomly selected. The risk model accuracy was measured by area under the ROC curve of 0.85 (95% CI 0.68 to 0.89). Pearson correlation coefficient obtained in the validation sample was 0.99 with *P* <0.001. There was also good correlation between predicted and observed deaths and obtained a Pearson correlation coefficient of 0.95 with *P* = 0.0012.

Risk Model in total sample

The model was then reconstructed from the score combination, developed with data of 2/3 of the sample with the validation data. Multiple logistic regression was used with the listed variables resulting in the recalibrated risk score, based on the magnitude of the coefficients β of the logistic equation (Table 3 and Table 4). The area under the ROC curve of the model was 0.86 (95% CI 0.81 to 0.9) (Figure 1). Table 5 shows the death risk according to the score and this risk classification (additive score). In order to calculate the logistic score (individual risk assessment) the logistic equation inserted in Table 3 should be used. To test the model calibration, the observed mortality was compared with the predicted one in all patients in each of the five interval classification of the score, obtaining a expected/observed correlation coefficient of 0.99, *P* <0.001 and H-L test equal to 0.617 (Tables 3-5 and Figures 1 and 2).

Table 1. Characteristic of study groups and univariate analysis.

Variable	Total n = 2809 (%)	Death n = 280 (%)	Events occurrence Non-deaths n = 2529 (%)	OR	95% IC	*P*
Age						
≥ 60 years	1632 (58)	219 (13)	1413 (87)	2.92	2.16-3.95	<0.001
< 60 years	1153 (41)	58 (5)	1095 (95)	1		
mean ± SD	61.3±10.13	65.59+9.24	60,87+10,11	–		<0.001
Gender						
Male	1852 (66)	166 (9)	1686 (91)	1		0.013
Female	955 (34)	114 (12)	841 (88)	1.22	1.05-1.42	
Ejection fraction						
≤ 45	810 (29)	142 (18)	668 (82)	2.88	2.24-3.7	<0.001
>45	1996 (71)	137 (7)	1859 (93)	1		
mean ± SD	60.5±13.3	47.07±15.5	54,6+14,95	–		<0.001
Creatinine, mg / dL						
<1,5	2519 (90)	223 (9)	2295 (91)	1		
1.5 to 2.49	147 (5)	28 (19)	119 (81)	2.78	1.94-3.99	<0.001
≥ 2,5 or dialysis	66 (2)	20 (30)	46 (70)	4.65	2.7-8.01	<0.001
mean ± SD	1.17±094	1.45±1.22	1,15±0,9			<0.001
Surgery						
Isolated CABG	2595 (92)	226 (9)	2369 (91)	1		
CABG + aortic VR	214 (8)	54 (25)	160 (75)	3.5	2.52-4.95	<0.001
Use of IABP						
Yes	272 (10)	53 (19)	219 (81)	2.46	1.77-3.42	<0.001
No	2537 (90)	227 (9)	2310 (91)	1		
Prior atrial fibrillation						
Yes	98 (4)	23 (23)	75 (77)	2.92	1.8-4.75	<0.001
No	2711 (96)	257 (9)	2454 (91)	1		
Prior CVA (%)						
Yes	179 (4)	27 (15)	152 (85)	1.66	1.08-2.56	0.018
No	2630 (96)	253 (9)	2377 (91)	1		
Prior CS						
Yes	101 (3)	16 (16)	85 (84)	1.74	1.00 – 3.01	0.045
No	2708 (97)	264 (10)	2444 (90)	1		
Diabetes						
Yes	828 (29)	92 (11)	736 (89)	1.19	0.91-1.55	0.191
No	1981 (71)	188 (10)	1793 (90)	1		
NYHA III or IV						
III or IV	424 (15)	124 (29)	300 (71)	5.9	4.53-7.69	<0.001
I or II	2385 (85)	156 (7)	2229 (93)	1		
COPD						
Yes	551 (20)	109 (20)	442 (80)	3.01	2.31 – 3.90	<0.001
No	2258 (80)	171 (8)	2087 (92)	1		
Arterial hypertension						
Yes	2005 (71)	196 (10)	1809 (90)	0.92	0.70 - 1.21	0.59
No	804 (29)	84 (10)	720 (90)	1		
Emergency/Urgency						
Yes	217 (8)	118 (54)	99 (46)	17.87	13.10-24.39	<0.001
No	2592 (92)	162 (6)	2430 (94)	1		
Obesity						
Yes	325 (12)	34 (11)	291 (89)	1.06	0.72-1.55	0.75
No	2484 (88)	246 (10)	2238 (90)	1		
Stable angina CF CCS IV + Unstable angina						
Yes	1083(6)	142 (13)	941 (87)	1.73	1.35 – 2.22	<0.001
No	1726 (94)	138 (8)	1588 (92)	1		
Extracardiac vasculopathy						
Yes	304 (11)	63 (21)	241 (79)	2.75	2.02-3.75	<0.001
No	2505 (89)	217 (9)	2288 (91)	1		
Prior AMI						
Yes	1151 (41)	106 (9)	1045 (91)	0.86	0.67-1.11	0.263
No	1658 (59)	174 (11)	1484 (89)	1		
Lesion of the LMC						
Yes	588 (21)	65 (11)	523 (89)	1.16	0.86-1.55	0.323
No	2221 (79)	215 (10)	2006 (90)	1		

Rev Bras Cir Cardiovasc 2010; 25(4): 447-456

Table 2. Logistic Regression and Multivariate risk score (Modeling n = 1875).

Variables	Coefficient B	OR	95% CI	*P*	Points
Age ≥ 60 years	0.525	1.69	1.11-2.55	0.013	2
Emergency/Urgency	2.642	14.03	9.1-21.62	< 0.001	14
Female gender	0.376	1.45	0.99-2.12	0.051	1
Ef ≤ 45%	0.461	1.58	1.07-2.34	0.021	2
Combined aortic valve replacement	1.35	3.86	2.06-7.24	<0.001	4
Arteriopathy	0.927	2.52	1.55-4.12	< 0.001	3
Functional class III or IV (NYHA)	1.035	2.81	1.88-4.2	<0.001	3
Creatinine (mg / dl) 1.5 to 2.49	0.58	1.78	1.00-3.15	0.046	2
Creatinine ≥ 2.5 or dialysis	1.66	5.27	2.2-12.61	<0.001	5
COPD	0.981	2.66	1.8-3.94	<0.001	3
Atrial fibrillation	1.055	2.87	1.42-5.78	0.003	3
Constant	- 4.267				

Ef: Ejection fraction; CABG: Coronary artery bypass grafting

Table 3. Logistic regression from total sample (n=2809).

Variables	Coefficient B	OR	95% CI	*P*
Age ≥ 60 years	0.695	2.00	1.41-2.83	<0.0001
Emergency/Urgency	2.797	16.39	11.4-23.57	<0.0001
Female gender	0.438	1.55	1.13-2.11	0.006
Ef ≤ 45%	0.45	1.56	1.13-2.16	0.006
Combined valve replacement	1.08	2.95	1.71-5.1	<0.0001
Atrial fibrillation	0.794	2.21	1.21-4.02	0.009
Functional class III or IV (NYHA)	1.177	3.24	2.32-4.53	<0.0001
Creatinine (mg / dl) 1.5 to 2.49	0.637	1.89	1.18-3.02	0.008
≥ 2,5 mg/dl (or dialysis)	1.398	4.04	1.96-8.35	<0.0001
COPD	1.097	2.99	2.16-4.14	<0.0001
Extracardiac vasculopathy	0.810	2.24	1.51-3.33	<0.0001
Constant	-4.439			

Logistic equation:
Prob(death) =1/(1+Exp (-(-4,439 +[0,695*age≥60] + [2,797*emergency]+[0,438*female gender] + [0,45*Ef≤45%] + [1,08*combined aortic valve replacement] + [0,794*FA]+[1,177*NYHA III or IV] + [0,637*creatinine leves of 1,5 – 2,49=1] + [1,398*creatinine≥2,5 = 1] + [1,097*COPD] + [0,81*vasculopathy])))

Table 4. Multivariable risk score from the total sample (n = 2809).

Preoperative characteristics	Points
Age ≥ 60 years	2
Emergency/Urgency	16
Female gender	2
Ef ≤ 45%	2
Combined aortic valve replacement	3
Atrial fibrillation	2
Functional class III or IV (NYHA)	3
Creatinine (mg / dl) 1.5 to 2.49	2
Creatinina ≥ 2,5 or dialysis	4
Extracardiac vasculopathy	2
COPD	3

Table 5. Risk and deaths according to the Score (n = 2809).

Score	Sample	Mortality		Risk Category
	n (2809)	nº	%	
0 a 2	1051	17	1.6	Low
3 a 4	596	22	3.7	Medium
5 a 8	737	60	8.1	High
9 a 14	214	59	27.5	Very high
≥ 15	211	122	>35	Extremely high

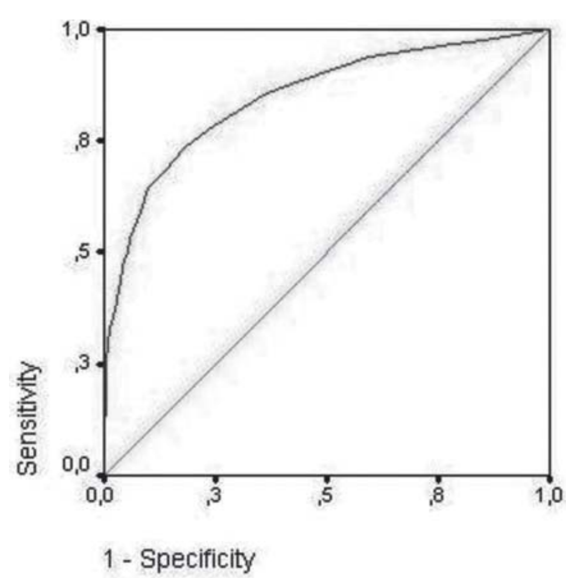

Fig. 1 - Area under the ROC curve detecting the occurrence of death h = 0.86 (95% CI: 0.81 to 0.9) in the Final Risk Model (n = 2809)

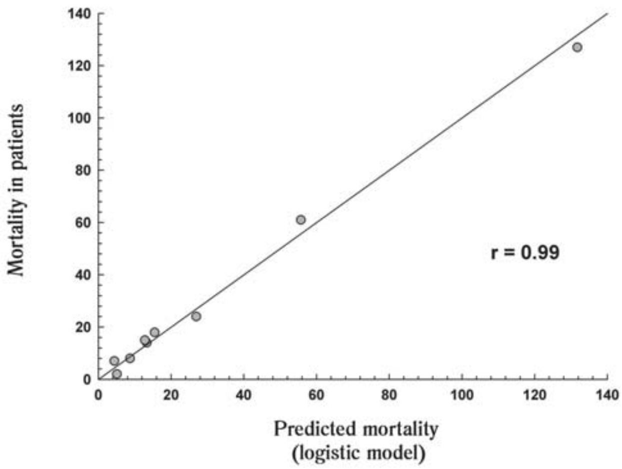

Fig. 2 - Dispersion points representing the predicted mortalities (logistic model) and observed mortalities (n=2089; events = 280 deaths) Pearson coefficient was r = 0.99 and Hosmer-Lemeshow test = 0.617, indicating good model performance

DISCUSSION

This study identified eleven predictors of death in coronary artery bypass surgery which formed the score: age $\geq$ 60 years, emergency/urgent surgery, ejection fraction $\leq$ 45%, surgery in women, concomitant aortic surgery, concomitant aortic valve replacement surgery, COPD, atrial fibrillation , extracardiac vasculopathy, functional class III or IV (NYHA) for congestive heart failure (CHF) and renal failure (two variables). Thus, it was developed a useful tool for easy clinical application to calculate the risk in patient undergoing CABG. The choice of variables was based on the postoperative sector's experience in CS at Sao Lucas Hospital, PUC-RS, as in previous studies in the literature [5.10]. We have to bear in mind that, by using predictive models of risk at the bedside, we evaluate the probability of death of a population and not of a particular patient [18].

The death rate in this study was 10%. The observed total mortality in the EuroSCORE was 4.7%. When not considering the emergency/urgency surgeries, mortality was 6.3% (isolated or associated CABG with aortic VR). Despite of the fact of being higher than most centers in Europe and U.S., the observed mortality in our study is similar to that one reported in Brazil according to the DATASUS, representing 7% of CABG [19]. Since both the registration of the Society of Thoracic Surgeons (STS) as the UK Cardiac Surgical Register are volunteers, while DATASUS is administrative, the comparison between the surgical results obtained is inappropriate. Pons et al. [20], the Catalan Study Group on Open Heart Surgery, developed a risk model of death from an analysis of 1309 cardiac surgery, where 46.4% were CRM. The global mortality reported by the authors related to CABG was 8.1%, and 4.2% for elective cases.

In the current study, the mean age of individuals was 61.3 years, similar to the EuroSCORE population, in which it was 62.5 years. Patients aged 60 years or over accounted for 58% of the study population, and in the EuroSCORE, 66%. Still, 34% were women, and in the EuroSCORE 28%.

The EuroSCORE is the most common and important risk prediction model among the existing ones. [10]. Studies evaluating the EuroSCORE in certain populations show conflicting results regarding its accuracy [21-26]. Campagnucci et al. [27] in our service, 100 patients undergoing CABG were evaluated and compared the expected mortality rates according to EuroSCORE with the observed mortality rate. There was not a good correlation between the expected and the observed mortality rate, indicating poor calibration of the model for the number of patients in the study sample. The authors concluded that, for the validation of logistic regression analysis, a hundreds of individuals are necessary, which limits the applicability of the EuroSCORE.

It is known that these scores may have limited applicability in populations with different profiles from those in which the score was developed. The patients' population in our hospital may differ from the national population, so in order to further validation it should be tested in other Brazilian institutions, in the same way as the score of Gomes et al. [14].

Age above 60 years was an important death predictor in this study, resulting in two points in the score. The EuroSCORE has determined that, after 60 years, there is increased death risk and it adds one point for every 5 years thereafter.

In this study, mortality was higher in women: 11.9% against 9% in men, being an independent risk factor for hospital death (OR: 95% CI 1.55 1.13 to 2.11). It resulted 2 points in the risk score, while it counts 1 point in the EuroSCORE.

Patients in functional class III or IV are 15% of cases in our sample and had hospital mortality of 29% versus 6.5% in those with functional class I or II. It contributed 3 points in the scores. The CHF classified by the NYHA evaluates patients' functional limitations caused by heart failure, disregarding the presence of left ventricular systolic dysfunction. Therefore, diastolic dysfunction is included in the evaluation. This variable do not score in the EuroSCORE.

The concomitant presence of COPD was also a contributing factor to the increase death rate, obtaining an OR of 2.99 and 2.16 to 4.14 CI. it originated 3 points in the score. This variable is also part of the EuroSCORE. It is believed that the pulmonary dysfunction caused by COPD gives the appearance of deleterious ventricular arrhythmias in the postoperative period [28].

Atrial fibrillation was associated with the occurrence of death in this study. An OR of 2.21 and 1.21 to 4.02 CI were obtained, contributing two points in the score. This variable was significant for STS scores [29], but not in the EuroSCORE.

The presence of extracardiac vascular disease reached statistical significance. It was obtained an OR of 2.24 and 1.51 to 3.33 CI. The scores from the study group of Northern New England (NNE), hospital mortality was 2.4 times higher in patients with peripheral vascular disease [30].

In this study, we found that EF d" 45% was a risk factor for death with OR 1.56, 95% CI 1.13 to 2.56 in logistic regression, adding two points in the risk model. This demonstrates the importance of ventricular dysfunction, even in the absence of symptoms. In EuroSCORE, EF <30% adds 2 points to the risk and between 30-50%, 1 point.

The study showed that patients who are candidates for CABG and presenting aortic stenosis in need of VR are at risk of death three times higher. 3 points in the score were added. The EuroSCORE does not include any valve disease in the risk quantification. However, in its sample, 30% of patients have valve diseases. In the EuroSCORE, the need for concomitant valve replacement can be included in the item "other surgeries besides the coronary artery bypass grafing." The risk of patients who are undergoing valve replacement differs from those patients undergoing CABG. The work of Guaragna et al. [31] brings a score developed especially in patients undergoing valve replacement.

The presence of high creatinine level was an important risk predictor for death in this study. In patients with creatinine e" 2.5 mg / dl, the risk is four times higher (OR 4.04, 95% CI 1.96 to 8.35). Dialysis patients were included in this group due to the small sample number.

The biggest impact on the score rating developed in our study was to perform CABG in patients with imminent risk of death. This situation was present in 7% of cases in the sample and the death rate was 54%, accounting for 42% of deaths. In Parsonnet score et al. [5], developed 20 years ago and it is still being used in some institutions, the surgical priority added significant death risk, but it was excluded from the weighted tabulation because according to the authors, "in practice it is impossible to achieve a uniform definition of terms. "

Among the variables present in the EuroSCORE that were not significant in our study, are the trunk lesions and the prior cardiac surgery. These two variables were not significant in univariate analysis. The history of CVA, which also scores the EuroSCORE, although it increases the chance of stroke in the perioperative period [32] it was not significant in multivariate analysis in our study. Similar to the STS score, atrial fibrillation was significant in our study, increasing at twice the risk of surgery, and was not a risk predictor in the EuroSCORE. The NYHA functional class also scored in the current score and it did not in EuroSCORE. The other variables that have built our scores were also significant in EuroSCORE.

It is interesting to compare our study with EuroSCORE, for patients with similar risk, which may be an aid in the surgical quality evaluation. For instance, a female patient under 60 years old, having peripheral vascular disease will obtain 3 points in the EuroSCORE and will be considered as a medium risk, with mortality estimated at 3%. In the current score, 4 points will be obtained and will also be considered a medium risk patient, with similar mortality, estimated at 3.7%. In contravention, a 65 year-old man with atrial fibrillation, chronic renal failure with creatinine of 2 mg / dl or COPD, will obtain 4 points in EuroSCORE, which is also considered a medium risk, with mortality estimated at 3%. In the present score, this patient would obtain 9 points and be considered at high risk, with mortality estimated at 27.5%.

Score Accuracy

The model discrimination developed in this study according to the ROC curve was 0.86 (95% CI 0.81 to 0.90). The score calibration, in other words, the degree of agreement between the observed mortality and predicted risk obtained a Pearson correlation coefficient of 0.99, P <0.001 and 0.617 for HL test, which indicates a good model performance. Most of the mortality scores, the area under the ROC curve is between 0.79 and 0.86 [6,7,9-11] (Table 6).

Our risk model was constructed and validated in a single institution. Several studies show that the scores have lower performance when applied to different groups of patients [14]. Therefore, the external validation population with new data from other institutions is important for the score to have a wide clinical application. As all the scores from the literature, the current one does not have perfect discrimination, although it is considered good (area under ROC curve 0.86, 95% CI 0.81 to 0.9). Some mechanisms of pathophysiological response to surgery or factors that influence the individual response of each patient may

Table 6. Score Accuracy.

Score	ROC curve	H-L test
Sao Lucas Hospital, PUC-RS.	0.86	*P*=0.61
Hannan et al.[6]	0.79	*P*=0.16
Turner et al.[7]	0.87	*P*=0.73
Nashef et al.[9]	0.79	*P*=0.4
Magovern et al.[11]	0.86	*P*=0.97

contribute to the predictive value whose values are not so high.

The model may lose calibration due to the continuous improvement of medical care. This loss should be compensated by recalibrating the risk with the use of more recent data from new cohorts of patients.

As the score comes from clinical database, the system provides an estimate of surgical risk from the "real world". The score has the function to monitor hospital, multidisciplinary team (surgeon, anesthesiologist and team of post-surgery) and surgical indication inefficiency. The model has sufficient accuracy to be used in the daily routine of Sao Lucas Hospital at PUC - RS and to be tested with data from another institution.

CONCLUSION

Through the identification of preoperative factors that are associated with the occurrence of hospital death after CABG, it was possible to develop a score based on variables that are easily obtained in every candidate for surgery, which would certainly facilitate the risk stratification of our patients, being a vital part for better management in the postoperative period. This score can be tested in other Brazilian institutions.

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