Proposed Preoperative Risk Score for Patients Candidate to Cardiac Valve Surgery

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Abstract

Background: To establish a risk score for heart surgery allows the assessment of preoperative risk, informing the patient and defining care during the intervention.

Objective: To assess preoperative risk factors for death in cardiac valve surgery and construct a simple risk model (score) for in-hospital mortality of patients candidate to surgery at Hospital São Lucas of Pontifícia Universidade Católica do Rio Grande do Sul (HSL-PUCRS).

Methods: The study sample included 1,086 adult patients that underwent cardiac valve surgery between January 1996 and December 2007 at HSL-PUCRS. Logistic regression was used to identify risk and in-hospital mortality factors. The model was developed in 699 patients and its performance was tested in the remaining data (n = 387). The final model was created using the total study sample (n = 1,086).

Results: Global mortality was 11.8%: 8.8% of elective cases and 63.8% of emergency cases. At the multivariate analysis, 9 variables remained independent predictors for the outcome: advanced age, surgical priority, female sex, ejection fraction ≤ 45%, concomitant myocardial revascularization (CABG), pulmonary hypertension, NYHA functional class III or IV, creatinine levels (1.5 - 2.49 mg/dl and > 2.5 mg/dl or undergoing dialysis).The area under the ROC curve was 0.83 (95%CI: 0.78 - 0.86). The risk model showed good capacity for observed/predicted mortality: the Hosmer-Lemeshow test was x^2 = 5.61; p = 0.691 and r = 0.98 (Pearson's coefficient).

Conclusions: The variables predictive of in-hospital mortality allowed the construction of a simplified risk score for daily practice, which classifies the patient as having low, moderate, high, very high and extremely high preoperative risk. (Arq Bras Cardiol 2010; 94(4):507-514)

Key Words: Probability; risk; preoperative care; thoracic surgery; heart valves/surgery.

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]. In Brazil, at the analysis of more than 115,000 heart surgeries carried out between 2000 and 2003, the reported mortality was 8%. The main risk factors for death during valve replacement surgeries are: advanced age[4], female sex[5-7], chronic obstructive pulmonary disease (COPD)[8,9], New York Heart Association functional class (NYHA- FC), ventricular dysfunction, surgical priority (urgency/emergency), pulmonary arterial hypertension (PAH)[10], renal dysfunction[11], valvular disease associated with ischemic cardiopathy[12], reoperation[13-16] and infectious endocarditis[17-20].

The multivariate analysis of these risk factors, observed in a certain sample, enables the construction of a risk score, with the objective[21] of obtaining an actual surgical risk estimate, making some variables capable of undergoing intervention in the preoperative phase and monitoring the effect of technical alterations, assistential dynamics and failures in the treatment offered to patients.

Thus, the objective of the present study was to research preoperative factors that could be associated with the occurrence of death in cardiac valve surgery, as well as construct a risk score for in-hospital mortality for patients candidate to cardiac valve surgery in Hospital São Lucas of PUCRS.

Methods

Population and sample

Between Janeiro 1996 and December de 2007, 3,895 patients were submitted to heart surgery in Hospital São Lucas of PUC - RS. Of these, 1,086 underwent isolated cardiac valve surgery or CABG-associated surgery, which was the object of the present study.

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Study design

The present was a historical cohort observational study. The data were prospectively collected and inserted in the database of the Cardiac Surgery Postoperative Unit of Hospital São Lucas of PUCRS.

Inclusion criteria

Patients aged 18 or older submitted to cardiac valve replacement surgery (valve replacement or plasty), isolated or in combination with myocardial revascularization surgery (CAGB).

Exclusion criteria

Tricuspid and pulmonary valve surgeries, when isolated surgical procedures, were excluded from the analysis due to the small number of patients submitted to these procedures.

Study variables

The variables included in the analysis were:

• Sex (male/female)

• Age

• 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 NYHA criteria.

• Atrial fibrillation

• Previous cerebrovascular accident

• Previous heart surgery

• Diabetes

• COPD: diagnosed clinically and/or through a radiological study of the thorax and/or spirometry and/or current drug treatment (corticoids, bronchodilators)

• Systemic arterial hypertension (SAH)

• Endocarditis: current or recent history (≤ 60 days)

• Obesity: defined when the body mass index (BMI) ≥ 30 kg/m²

• Ejection fraction: measured by echocardiography

• Serum creatinine

• 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). However, for the construction of the score, there was no stratification regarding the degree of severity of the latter, only detection of its presence or absence.

Outcome

Death - Considered in the transoperative period and throughout the entire hospitalization period.

Procedures

Anesthesia, extracorporeal circulation (ECC) and cardioplegia were carried out according to the standard procedures of Hospital São Lucas of PUC-RS, as previously described[22]. After the surgery, all patients were transferred to the postoperative intensive care unit (ICU) and mechanically ventilated.

Statistical analysis

The continuous variables were described by means and standard deviations and compared by Student's *t* test. The categorical variables (or categorized continuous variables) were described by the Chi-square test. To construct the risk score, the database was randomly divided in two portions: 2/3 of the data were used for the modeling and 1/3 for validation.

Obtaining the preliminary risk model - The initial consideration of the variables followed a hierarchical model based on biological plausibility and external information (literature) regarding the relevance and power of the association between these potential risk factors and the occurrence of the outcome being analyzed (in-hospital death).

Once these variables were listed, multiple logistic regression was used in a backward selection process and all variables with a level of significance $p < 0.05$ were maintained in the model. After that, a weighted risk score was built, based on the magnitude of the *b* coefficients of the logistic equation. After they were transformed (exp [b]) into odds ratios, the values were rounded to the closest whole number to create the score.

Validation - The preliminary risk score was applied to the validation database and two performance statistics were obtained: c-statistics (area under the ROC curve), the Hosmer-Lemeshow (HL) Chi-square test of goodness-of-fit and the consequent Pearson's coefficient of correlation between the observed events and those predicted by the model. The values for the area under the ROC curve between 0.85 and 0.90 indicate an excellent discriminatory power. A non-significant HL Chi-square test ($P > 0.05$) shows good model calibration. A Pearson's coefficient of correlation value $r \geq 0.7$ indicates a strong correlation between the observed values and the predicted ones.

Obtaining the final risk score - Once an appropriate performance of the model was observed at the validation process, the databases (modeling and validation) were combined to obtain the final risk score. During this process, the variables that had been removed were not included, which simply resulted in the obtaining of more precise estimates for the coefficients that had been previously calculated. The same aforementioned performance statistics were also presented.

The resulting logistic model followed the formula presented below and, differently from the score, it presents direct estimates of outcome occurrence probability. This process is understood by some authors[109] as being more appropriate to obtain event estimates, although it presents a certain degree of mathematical complexity for its use in daily medical practice. The use of the logistic model is more adequate for the prognosis of individual risk, mainly in patients with a very high risk in the additive model[23].

Original Article

P(event) = $1 / 1 + \exp(-(\beta 0 + \beta 1x1 + ... + \beta k\ xk))$

The data were processed and analyzed with the help of the Statistical Package for the Social Sciences (SPSS), release 15.0.

Ethical considerations - The research project of the present study was submitted to the Ethics Committee in Research of FAMED PUCRS, registration # 06003478.

Results

Characteristics

Of the total sample (1,086) 128 patients died (11.8%). Considering only the elective surgeries, the mortality rate decreases to 8.8%. In cases where the surgical intervention was an emergency/urgency (5.3%), mortality was very high: 63.8%. These patients contributed with 29% of the total number of deaths. The mean age of the studied population was 55.5 years (± 15.8 years) and 45% of the patients were aged 60 years or older. Regarding gender, 56% of the patients were males. Combined myocardial revascularization (CABG) was necessary in 20% of the patients (Table 1).

Development of the risk model (modeling)

The multiple logistic regression of the predictors was carried out in 699 non-consecutive patients (random selection), which accounted for 2/3 of the total sample. The selected predictors, due to their statistical importance for the risk score construction, were: age (≥ 60 years), surgical priority, ejection fraction (≤ 45%), female sex, combined CABG, pulmonary hypertension, functional class III or IV (NYHA), creatinine ≥ 1.5 to 2.49 mg/dl and creatinine ≥ 2.5 mg/dl or dialysis (Table 2). The scoring system, according to what was described in the statistical analysis, is shown in Table 2. The area under the ROC curve of the obtained model was 0.82 (95%CI: 0.77 to 0.87).

Validation of the risk model

The external validation was carried out in 387 patients (1/3 of the total sample), chosen randomly. The risk model accuracy was measured by the area under the ROC curve of 0.84 (95%CI: 0.77 to 0.90) thus presenting good discriminatory capacity. There was also a good correlation between the predicted and the observed mortality: r = 0.93 with x^2 = 8.68 (p = 0.37) (Hosmer-Lemeshow test).

Risk model in the total sample: (n = 1,086)

The model was then reconstructed based on the integration of the score developed with data from 2/3 of the sample and the validation data. The multiple logistic regression was used with the listed variables, originating the recalibrated risk score based on the magnitude of the β coefficients of the logistic equation (Table 3 and Table 4). The factors associated with higher risk were: surgical priority (emergency/urgency), followed by high creatinine levels (≥ 2.5 mg/dl), age ≥ 60 years and combined CABG. The area under the ROC curve of the obtained model was 0.83 (95%CI: 0.78 - 0.86) (Figure 1). Table 6 shows the risk of death according to the score and the classification of this risk (additive score). To calculate the logistic score (evaluation of individual risk), the logistic equation inserted in Table 3 must be used. In the total sample, 70.5% of the patients submitted to surgery presented low and moderate risk, that is, mortality estimated by the score at 2% and 7.9%, respectively. The risk was considered extremely high in 6.7% of the patients. To test the calibration of the model, we compared the observed mortality with the predicted mortality among all patients in each of the five intervals of score classification, obtaining a predicted/observed coefficient of correlation of 0.98 with x^2 = 5.61 (p = 0.691) (Hosmer-Lemeshow test) (Figure 2).

Discussion

This study identified nine predictors for death at cardiac valve surgery, which according to their risk, formed the score: age ≥ 60 years, urgency/emergency surgery, ejection fraction ≤ 45%, female sex, concomitant myocardial revascularization surgery, pulmonary hypertension, functional class III or IV (NYHA) and renal failure (2 variables). A clinical usefulness tool was then developed, which is easy to apply to calculate the preoperative risk of death in patients candidate to cardiac valve surgery. The choice of variables was based on the experience of the postoperative cardiac surgery service of Hospital São Lucas of PUC-RS, as well as from the previous literature studies[3,12,13,24,25]. One must bear in mind, however, that when using a predictive model of risk at the bedside, we are evaluating the possibility of death of a population and not of that particular patient[26].

The mortality rate in the present study was 11.8%. When the urgency/emergency surgeries were not considered, the mortality rate was 8.8% (isolated cardiac valve surgery or with combined CABG). Although higher than the rates reported in most European and North-American centers, the mortality rate was similar to that reported in Brazil, according to data from the DATASUS, that is, 8.9% for valvular surgeries[27,28]. Considering that both the STS register and the UK Cardiac Surgical Register are voluntary, whereas DATASUS is administrative, the comparison between the obtained surgical results is inappropriate. Pons et al[29] from the Catalan Study Group on Open Surgery Heart developed a risk model for death based on the analysis of 1,309 cardiac surgeries, where 47% were valvular procedures. The mortality reported by the authors, global as well as for elective cases, was similar to ours: 10.9% and 8%, respectively. In the risk model developed by Ambler et al[3], the mortality for elective surgeries was 5%. Nowicki et al[12], from the Northern New England Cardiovascular Disease Study Group, reported 6.2% of deaths for aortic valve surgeries and 9.4% for mitral valve procedures. In Brazil, Brandao et al[30], in a study of double-leaflet mechanical prosthesis implant, reported a mitral mortality of 13.5% and an aortic mortality of 7.5%. De Bacco et al[15], also in our country, in a retrospective study of 703 patients that were submitted to surgery for the implant of bovine pericardial bioprosthesis, reported a mortality rate of 14.3% of in-hospital deaths and 12.1% when the surgery was elective. What literature demonstrates, therefore, is a broad oscillation in the mortality rate, which stimulates the search for factors that can contribute to in-hospital mortality.

Table 1 - **Characteristics of the studied groups and univariate analysis**

Variable	Total n = 1086 (%)	Occurrence of events				
		Death n = 128 (%)	Non-death n = 958 (%)	OR	95%CI	P
Age			n = 955			
≥ 60 years	488 (44.9)	92 (18.9)	395 (81.1)	3.6	2.4 - 5.4	<0.001
< 60 years	598 (55.1)	36 (6.0)	560 (94.0)	1		
Mean ± SD	55.5 ± 15.8	63.2 ± 14.2	54.5 ± 15.8	-		<0.001
Sex						
Male	612 (56.0)	60 (9.8)	552 (90.2)	0.6	0.5 - 0.9	<0.01
Female	474 (44.0)	68 (14.4)	406 (85.6)	1		
Ejection fraction						
≤ 45	133 (12.2)	34 (25.6)	99 (74.4)	3.1	2.0 - 4.9	<0.001
> 45	948 (87.8)	94 (9.8)	855 (90.2)	1		
Mean ± SD	60.5 ± 13.3	52.8 ± 14.9	62.0 ± 12.8	-		<0.001
Creatinine, mg/dl						
< 1,5	992 (91.3)	98 (9.9)	894 (90.1)	1		
1,5 a 2,49	71 (6.5)	19 (26.8)	52 (73.2)	3.3	1.8 - 6.1	<0.001
≥ 2,5 or dialysis	23 (2.2)	11 (47.8)	12 (52.2)	8.4	3.3 - 20.9	<0.001
Mean ± SD	1.11±0.78	1.38±1.04	1.08±0.73			<0.001
Surgery						
Isolated valve	872 (80.0)	74 (8.5)	798 (91.5)	1		
Combined CABG	214 (20.0)	54 (25.0)	160 (75.0)	3.6	2.5 - 5.4	0.001
Pulmonary hypertension						
Yes	274 (25.0)	45 (16.4)	229 (83.6)	1.7	1.2 - 2.6	0.005
No	812 (75.0)	83 (10.2)	729 (89.8)	1		
Chronic atrial fibrillation						
Yes	226 (21.0)	34 (15.0)	192 (85.0)	1.4	0.9 - 2.2	0.09
No	860 (79.0)	94 (10.9)	766 (89.1)	1		
Previous CVA						
Yes	42 (3.8)	7 (16.7)	35 (83.3)	1.5	0.7 - 3.5	0.32
No	1,044 (96.2)	121 (11.6)	923 (88.4)	1		
Previous heart surgery						
Yes	146 (13.4)	22 (15.1)	124 (84.9)	1.4	0.9 - 2.3	0.19
No	940 (96.2)	106 (11.3)	834 (88.7)	1		
Diabetes						
Yes	84 (7.7)	17 (20.2)	67 (79.8)	2.0	1.2 - 3.6	0.01
No	1,002 (92.3)	111 (11.1)	891 (88.9)	1		
NYHA III or IV						
III or IV	480 (44.0)	87 (18.1)	393 (81.9)	3.1	2.1 - 4.5	0.001
I or II	606 (56.0)	41 (6.8)	565 (93.2)	1		
COPD						
Yes	127 (11.7)	32 (25.2)	95 (74.8)	3.0	2.0 - 4.8	0.001
No	959 (87.3)	96 (10.0)	863 (90.0)	1		
Arterial hypertension						
Yes	427 (39.3)	54 (12.6)	373 (87.4)	1.1	0.8 - 1.7	0.48
No	659 (60.7)	74 (11.2)	585 (88.8)	1		
Emergency/urgency						
Yes	58 (5.3)	37 (63.8)	21 (36.2)	18.1	10.1 - 32.3	<0.001
No	1,028 (94.2)	91 (8.9)	937 (91.1)	1		
Obesity						
Yes	56 (14.3)	8 (14.3)	48 (85.7)	1.3	0.6 - 2.7	0.55
No	1,030 (85.7)	120 (11.7)	910 (88.3)	1		
Endocarditis						
Yes	64 (5.9)	14 (21.9)	50 (78.1)	2.2	1.2 - 4.2	0.01
No	1,022 (94.1)	114 (11.2)	908 (88.8)	1		

Table 2 - **Logistic regression and multivariable risk score (modeling - n = 699)**

Variables	B Coefficient	OR	95%CI	p	Points
Age ≥ 60 years	1.272	3.6	1.9 to 6.6	< 0.001	4
Emergency/urgency	2.577	13.1	5.2 to 33.5	< 0.001	13
Female sex	0.581	1.8	1.0 to 3.0	< 0.01	2
EF ≤ 45%	0.976	2.7	1.4 to 5.1	< 0.005	3
Combined CABG	1.006	2.7	1.5 to 5.0	0.001	3
Pulmonary hypertension (PAH)	0.575	1.8	1.0 to 3.2	< 0.01	2
Functional class III or IV (NYHA)	0.611	1.8	1.0 to 3.3	<0.01	2
Creatinine (mg/dl) 1.5 to 2.49	0.283	1.3	0.6 to 3.2	0.53	1
Creatinine ≥ 2.5 or dialysis	2.117	8.3	2.1 to 32.8	0.003	8
Constant	- 4.250				

EF - ejection fraction; CABG - myocardial revascularization surgery.

Table 3 - **Logistic regression - total sample data (n = 1,086)**

Variables	B Coefficient	OR	95%CI	p
Age ≥ 60 years	0.996	2.7	1.7 - 4.4	< 0.0001
Emergency/ urgency	2.804	16.5	8.3 - 3.3	< 0.0001
Female sex	0.655	1.5	1.1 - 2.2	< 0.01
EF ≤ 45%	0.761	2.1	1.2 - 3.7	0.007
Combined CABG	0.938	2.6	1.6 - 4.1	< 0.0001
Pulmonary hypertension (PAH)	0.705	2.0	1.3 - 3.2	0.003
Functional Class III or IV (NYHA)	0.495	1.6	1.0 - 2.6	0.03
Creatinine (mg/dl) 1.5 to 2.49	0.446	1.6	0.8 - 3.1	0.20
≥ 2.5 mg/dl (or dialysis)	1.793	6.0	2.1 - 17.0	0.001
Constant	- 4.186			

*EF - ejection fraction; CABG - myocardial revascularization surgery. Logistic equation: Prob(death) = 1/ (1 + exp (- (-4.186 + [0.996 * age ≥ 60] + [2.804 * emergency] + [0.655 * female sex] + [0.761 * FE ≤ 45%] + [0.938 * combined CABG] + [0.705 * PAH] + [0.495 * NYHA III or IV] + [0.446 * creatinine of 1.5 - 2.49 = 1] + [1.793 * creatinine ≥ 2.5 = 1]))).*

Table 4 - **Multivariate risk score of the total sample (n = 1,086)**

Preoperative characteristics	Points
Age ≥ 60 years	3
Emergency/urgency	17
Female sex	2
FE ≤ 45%	2
Combined CABG	3
Pulmonary hypertension (PAH)	2
Functional class III or IV (NYHA)	2
Creatinine (mg/dl) 1.5 - 2.49	2
Creatinine ≥ 2.5 mg/dl or dialysis	6

EF - ejection fraction; CABG - myocardial revascularization surgery.

Table 5 - **Risk and death according to the score (n = 1,086)**

Score	Sample n (1,086)	Mortality		Risk category
		nº	%	
0 to 3	398	8	2.0	Low
4 to 6	366	29	7.9	Medium
7 to 9	181	29	16.0	High
10 to 13	68	15	22.0	Very high
≥ 14	73	47	64.3	Extremely high

Age older than 60 years was an important predictor of death in the present study, worth 3 score points. Age, as a predictor of death, is a part of all risk scores found in the literature[3,12,13,24,25]. What is noteworthy in each score is the difference in the cutoff based on which the surgical risk is established. The study by Hannan et al[25] verified that patients submitted to surgery when they were at least 50 years of age presented higher in-hospital mortality, regardless of the performed valve intervention: aortic, mitral or multivalve replacement, with or without revascularization surgery. The EuroSCORE[24] was able to determine that after 60 years of age, there is an increase in the risk of death and adds a point to the score for every 5 years thereafter.

In the present study, the mortality was higher among women: 14.4% *vs* 9.8% among men, with the female sex being an independent risk factor for in-hospital death (OR; 1.9 95%CI: 1.2 - 3.0). It added 2 points to the risk score. However, it must be observed that the female patient in the absence of another risk factor has a low mortality, estimated at 2%, similar to the male patient in the same situation. The increased risk for women is a controversial issue in literature[3,12,24]. Patients

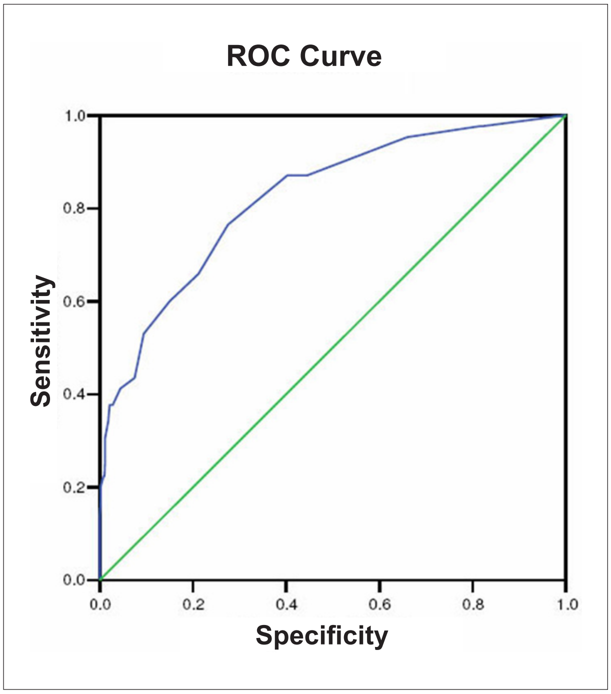

Figure 1 - Area under the ROC curve in the detection of the occurrence of death: h = 0.83 (95%CI; 0.78 - 0.86) at the final risk model (n = 1,086).

with NYHA-FC III or IV constitute 44% of the cases in our sample and presented an in-hospital mortality rate of 18.1% *vs* 6.8% in those with NYHA-FC I or II. That added 2 points to the score. This finding demonstrates that the surgery in patients with valvulopathies must be carried out before the development of symptoms that can significantly impair the physical capacity. Thus, the functional class, which is a strictly clinical parameter, is an important prognostic factor, which, in spite of its subjective nature, is easily registered at the bedside, taking the patient's symptom into account.

In the present study we verified that EF ≤ 45% was an important risk factor for death with an OR of 2.1; 95%CI: 1.2 - 3.7 at the logistic regression, adding 2 points to the score, which demonstrates the importance of ventricular dysfunction, even in the absence of symptoms.

Pulmonary hypertension, which was considered when PASP ≥ 30 mmHg obtained by echocardiogram, was present in 25% of the patients submitted to surgery and was an independent risk factor for death in our series: OR 2.0; 95%CI: 1.3 - 3.2, adding 2 points to the score. Although it was not evaluated in most studies[12,29,31], the presence of PAH showed to be an important predictor of death in some series[13,24].

The study demonstrated that patients candidate to valve replacement associated with myocardial revascularization present a 3-fold higher risk of death in the postoperative period, adding 3 points to the score. The high occurrence of death among these patients - 25.2% *vs* 8.5% for isolated valve replacement - demonstrates that other comorbidities are associated.

The presence of high creatinine levels is an important predictor of death risk in the present study. Patients with

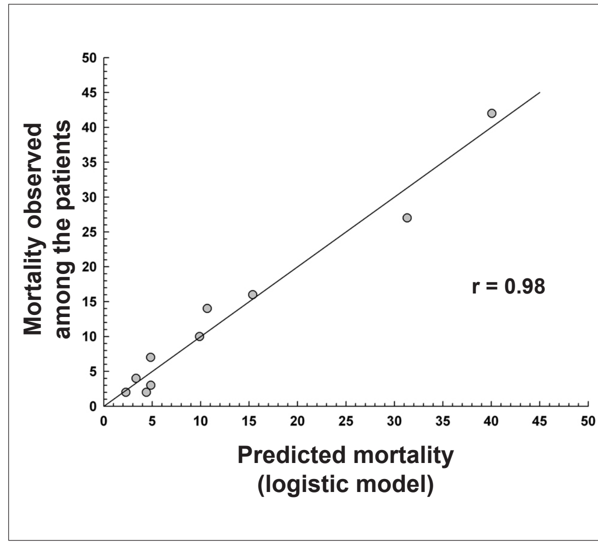

Figure 2 - Dispersion of points representing the predicted mortality (through the logistic model) and that observed among the patients (n = 1,086; events = 128 deaths). Pearson's coefficient was r = 0.98m with x² (Hosmer-Lemeshow) = 5.61 (p = 0.691), indicating good model performance.

creatinine levels ≥ 2.5 mg/dl (undergoing dialysis or not) present a six-fold higher risk (OR 6.00; 95%CI: 2.12 - 16.99). We included patients undergoing dialysis in this group, due to the small number of patients in the sample (only 9 patients).

The highest impact on the score developed in the present study was the performance of cardiac valve surgery in patients presenting imminent risk of death. This situation was observed in 5.3% of the cases in the sample and the rate of mortality was 64%, being responsible for 29% of the deaths. A study published by De Bacco showed a similar rate of mortality[4]. Recently, in our country, a new risk score for cardiac valve surgery (VMPC) was published, which was able to predict a longer period of hospitalization. However, the risk of death could not be predicted at the multivariate analysis[31].

Score accuracy

The discrimination of the model developed in the present study according to the ROC curve was 0.83 (95%CI: 0.78 - 0.86). The calibration of the present score, that is, the degree of concordance between the observed mortality and the predicted risk at the H-L test (Hosmer-Lemeshow test) was r = 0.98, x^2 = 5.61 (p = 0.691), which indicates a good model performance. In most mortality scores, the area under the ROC curve is between 0.70 and 0.86[32,33] (Table 6).

Limitations

Our risk model was constructed and validated in a single institution. Several studies have demonstrated that the scores present a lower performance when applied to groups of patients that are different from the ones for which the score was developed[26]. Therefore, the validation in an external population with new data from other institutions is important for the score to have broad clinical use.

Table 6 - **Score accuracy**

Score	ROC Curve	H-L Test
HSLPUC - RS	0.83	r = 0.98; p = 0.691
NOWICKI (NNE)[12]	0.79 mitral	r = 0.99; p = 0.704
AMBLER (UK)[3]	0.75 aortic	r = 0.98; p = 0.157
HANNAN (NY)[25]	0.79 C/CABG 0.75 S/CABG	p = 0.52 p = 0.04
EDWARDS (STS)[26]	0.74 C/CABG 0.77 S/CABG	p = 0.141 p = 0.225
ROQUES (EuroSCORE)[44]	0.75	
CARE[32]	0.75	
PARSONNET[13]		R = 0.85
JAMIESON (STS)[26]	0.75	

H-L Test - Hosmer-Lemeshow test; CABG - myocardial revascularization surgery.

As in all scores found in the literature, the present score does not present a perfect discrimination, although it is considered good (area under the ROC curve: 0.83; 95%CI: 0.78 - 0.86). It is probable that unknown mechanisms of physiopathological response to the surgery or of factors that can influence the individual reserve of each patient can contribute to the fact that the score does not have a high predictive value.

It is likely that the model will lose its calibration with the continuous improvement in medical care. This loss must be counterbalanced by recalibrating the risk index, using more recent data from new patient cohorts. The presence of PAH was not categorized in degrees of severity, which could aggregate a higher proportional risk to its increase. Perhaps this will be possible with a larger sample.

Implications

As the score is based on a clinical database, the system offers an estimate of surgical risk in the “real world”. The score can be used to monitor deficiencies of the hospital facility, the multidisciplinary team (surgeon, anesthesiologist, and postoperative team) and of the surgical indication. The model presents enough accuracy to be routinely employed at Hospital São Lucas of PUC - RS and to be tested with data from other institutions.

Conclusions

The risk factors associated with the occurrence of in-hospital death after cardiac valve surgery were: age > 60 years, surgical priority, female sex, ejection fraction (EF) ≤ 45%, concomitant cardiac revascularization surgery, pulmonary hypertension, NYHA functional class III or IV and high creatinine levels. Based on the identified variables that were predictors of in-hospital mortality, a risk score was constructed that classified the patients as presenting low, medium, high, very high and extremely high preoperative risk.

Potential Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study Association

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