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Assessment of the EuroSCORE as a predictor for mortality in valve cardiac surgery at the Heart Institute of Pernambuco

Avaliação do EuroSCORE como preditor de mortalidade em cirurgia cardíaca valvar no Instituto do Coração de Pernambuco

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Abstract

Objective: **To assess the applicability of the European Risk System in Cardiac Operations (EuroSCORE) in patients undergoing cardiac valve surgery at the Heart Institute of Pernambuco.**

Methods: **840 patients operated between 2001 and 2009. Their medical records contained all the information necessary to calculate the EuroSCORE. Hospital death was the end-point of the study. In order to assess the applicability of the EuroSCORE it was used the non parametric test of Mann-Whitney. The calibration of the model was measured by comparing the morbidity observed with that expected, using the Hosmer-Lemeshow Test of Goodness of Fit. The accuracy of the model was evaluated by the ROC curve (receiver operating characteristic curve).**

Results: **The comparison of expected and observed mortality, by Hosmer-Lemershow test, showed good predictive capacity (*P*= 0.767) as well as when compared to each value of addictive EuroSCORE (p= 0.455). The area of ROC curve was 0.731 (IC 95%, 0.660 – 0.793) with *P*< 0.001. The global predicted mortality was practically identical to that observed (7.9%). The low-risk group (EuroSCORE 0-2) comprised 345 patients with a mortality of 3.19%. The medium-risk group (EuroSCORE 3-5) comprised 364 patients with a mortality of 7.69% and the high-risk group (EuroSCORE > 6) included 131 patients with a mortality of 20.6%. The regression logistic analyses allowed to identify the following risk-factors for death: age > 60 years, gender female, previous operation, active endocarditis, associated surgery of the thoracic aorta and extra-cardiac arteriopathy.**

Conclusion: **The EuroSCORE, a simple and objective method, proved to be a satisfactory predictor of operative mortality and risk factors for death in patients submitted to cardiac valve operations in the Heart Institute of Pernambuco.**

Descriptors: **Clinical Trial. Cardiac surgical procedures. Risk factors.**

Resumo

Objetivo: **Avaliar a aplicabilidade do Sistema Europeu de Risco em Operações Cardíacas (EuroSCORE) em pacientes submetidos à cirurgia valvar no Instituto do Coração de Pernambuco.**

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Métodos: **Foram incluídos no estudo 840 pacientes operados entre 2001 e 2009. Os prontuários desses doentes continham todas as informações que permitiram calcular o EuroSCORE. O desfecho de interesse foi óbito na internação. Com o objetivo de avaliar a aplicabilidade do EuroSCORE, foi usado o teste não paramétrico de Mann-Whitney. A calibração do modelo foi medida pela comparação da mortalidade observada com a esperada, usando-se o teste de bondade de ajuste de Hosmer-Lemershow. A acurácia do modelo foi avaliada pela curva ROC (*receiver operating characteristic curve*).**

Resultados: **A comparação entre a mortalidade prevista e a observada, por meio do teste de Hosmer-Lemershow, evidenciou boa capacidade preditiva (*P*=0,767), assim como quando comparada para cada valor do EuroSCORE Aditivo (*P*=0,455). Obteve-se uma área sob a curva de ROC de 0,731 (IC95% 0,660 - 0,793), com valor de *P*<0,001. A mortalidade global prevista foi praticamente idêntica à observada (7,9%). O grupo de baixo risco (EuroSCORE 0-2) era constituído por 345 pacientes, e a mortalidade foi de 3,19%. O grupo de médio risco (EuroSCORE 3-5) compreendeu 364 pacientes, com mortalidade de 7,69%, e o grupo de alto risco (EuroSCORE >6) incluiu 131 pacientes, com mortalidade foi 20,6%. A análise de regressão logística permitiu identificar os seguintes fatores de risco para o óbito: idade acima de 60 anos, sexo feminino, operação prévia, endocardite ativa, cirurgia associada da aorta torácica e arteriopatia extracardíaca.**

Conclusões: **O EuroSCORE, um método simples e objetivo, revelou-se um preditor satisfatório de mortalidade operatória e, por ele, foram identificados fatores de risco para o óbito em pacientes submetidos à cirurgia valvar no Instituto do Coração de Pernambuco.**

Descritores: **Valvas cardíacas/cirurgia. Ensaio clínico. Avaliação de resultado de intervenções terapêuticas. Medição de risco.**

INTRODUCTION

The European Risk System in Cardiac Operations (EuroSCORE) analyzed 68 preoperative risk factors and 29 operative risk factors, which could be related to hospital death, in a consecutive series of 19.030 adult patients submitted to heart surgery in Europe [1-4]. The relation between the several risk factors and the results was studied statistically by univaried analysis and regression logistic analyses, which allowed to identify 17 real risk-factors and, for each one of them, it was attributed a score. Therefore, it was built a model that permitted to divide the patients in three risk groups: low-risk (score 0-2), medium-risk (score 3-5) and high-risk (score >6).

This method has proven efficient and it has been used in the stratification of surgical risk, especially for having been validated when applied to non-European people [5-7]. Nevertheless, the majority of population studied for the establishment of the EuroSCORE consisted of patients submitted to myocardial revascularization. Less than 30% were cardiac valve patients and, although the score having been adequate, with a good predictor of mortality, there were observed in this group two different aspects of valve cardiac patients operated in developing countries: first, the European patients are older, and second, the predominance in them is degenerative disease, not rheumatic disease, the latter predominant amongst us. This has motivated some to develop specific risk scores for cardiac valve operations among us [8].

This study aims to evaluate the applicability of the EuroSCORE in patients submitted to cardiac valve surgery at the Heart Institute of Pernambuco. The EuroSCORE was chosen for it has already been part of a line of research of our group.

METHODS

The present work is an observational, transversal study, with data colleted in a retrospective and prospective way by analysis of the patient's report. The sample studied consisted of 840 patients submitted to cardiac valve surgery at the Heart Institute of Pernambuco between January, 2001 and June, 2009, and the reports from these patients contained all the necessary information for the calculation of the EuroSCORE. Hospital death was the end-point of the study. The calculation of the EuroSCORE was performed by the score formula available in the original article [1]. The scores were calculated in their Additive and Logistic forms [4]. In order to compare the EuroSCORE between the patients that died and those who survived, it was applied the non parametric test of Mann-Whitney. In order to evaluate the calibration of the EuroSCORE, it was used the Hosmer-Lemeshow Test of Goodness of Fit [9]. The accuracy of the model was evaluated by the ROC curve (*receiver operating characteristic curve*), built for sensibility (accurate death prediction) and specificificity (accurate prediction of survival), calculated for each value of each score studied [5].

The area below the ROC curve was used to represent the precision of the predictions. In order to identify, amongst the variables involved in the EuroSCORE calculation, those, which, in our sample, alter the risk of death, we performed a univariate analysis, using the Chi-Square test of Pearson and the Fisher's exact test, when

indicated. In order to acquire a global analysis, it was used the Regression Logistic technique. There were included in the regression all the variables that presented *P*-value < 0.20 in the univaried analysis. The selected variables had their eventual interactions examined in a correlation matrix, being incorporated in the model all the interactions with correlation coefficient ≥ 0.5. The statistical program employed was SPSS (*Statistical Package for the Social Sciences*) – version 12.0. The level of significance employed was 0.05.

The study was approved by the Ethical Committee of the Heart Institute of Pernambuco and sent to the Research Ethical Committee of the Federal University of Pernambuco, in order to be used as a Master's degree test for the Surgery Post-graduation program.

RESULTS

The distinction of the sample according to the variables studied is shown in Table 1, with its relative and absolute frequencies. Table 2 presents the comparison of the sample of the original study of establishment of the EuroSCORE with the sample of our study, in which are evidenced differences of the two populations. After calculation of the EuroSCORE, patients were classified in three risk-groups (low, medium and high), as presented in Table 3.

Table 1. Distribution of the qualitative variables studied in the sample, according their absolute and relative frequencies.

Variables	N	%
Death	66	7.9
Age > 60 years	235	28.0
Female Gender	456	54.3
Previous heart surgery (Reoperation)	215	25.6
Active endocarditis	22	2.6
Creatinine > 2.3mg/dl	7	0.8
EF < 30	13	1.5
EF 30 - 50	94	11.2
PHBP	188	22.4
Associate myocardial revascularization	88	10.5
Thoracic aorta surgery	19	2.3
Emergency surgery	6	0.7
Critical state	5	0.6
Unstable angina	0	0.0
Recent infarction	4	0.5
DPOC	4	0.5
Neurological dysfunction	14	1.5
Extracardiac arteriopathy	4	0.5
IVC after IAM	0	0.0

EF: ejection fraction, PHBP: pulmonary high blood pressure, COPD: chronical obstructive pulmonary disease, IVC: interventricular communication

Table 2. Prevalence of risk factors in the original study and in our study.

Risk factor	EuroSCORE (n: 19.030) (%)	Present study (n: 840) (%)
< 60 years	33.2	72
>60 years	66.8	28
Female gender	27.8	54.3
COPD	3.9	0.4
Extracardiac arteriopathy	11.3	0.4
Neurological dysfunction	1.4	1.5
Previous heart surgery	7.3	25.6
Creatinine > 2.3mg/dl	1.8	0.8
Active endocarditis	1.0	2.6
Preoperative critical state	4.1	0.6
Unstable angina	8.0	0,0
Ejection fraction 30-50%	25.6	11.2
Ejection fraction <30	5.8	1.5
Recent AMI	9.7	0.5
Pulmonary high blood pressure	2.0	22.4
Emergency surgery	4.9	0.7
Associate myocardial revascularization surgery	36.4	10.5
Thoracic aorta surgery	2.4	2.3
IVC after infarction	0.2	0.0

Table 3. Sample distribution according to the Risk Groups of the EuroSCORE.

Risk Group	N	%
Low-risk (0-2)	345	41.1
Medium-risk (3-5)	364	43.3
High-risk (> 6)	131	15.6
Total	840	100.0

The variance either in the Additive model as in the Logistic one was shown through their means, medians and standard deviation, according Table 4.

When comparing the means of the EuroSCORE between survivors and non survivors, it was detected that the score mean was higher for those who died, either in the Additive model as in the Logistic one, as shown in Tables 5 and 6.

The comparison between predicted mortality and observed mortality, by the Hosmer-Lemeshow Test of Goodness of Fit, for the three risk groups, evidenced a very good predictive capacity (*P*=0.767), as when compared to each value of the EuroSCORE Additive (*P*= 0.455), as observed in Tables 7 and 8.

It was obtained an area under the ROC curve of 0.731 (IC95% 0.669 – 0.793) with *P*-value < 0.001. The area under the ROC curve, presented in Figure 1, showed good discrimination between survivors and non survivors.

Table 4. Descriptive statistics of the EuroSCORE of analyzed patients: variance.

Variable	N	Mean	Median	Standard Deviation	Minimum	Maximum
Additive EuroSCORE	840	3.05	3.00	2.35	0	14
Logistic EuroSCORE l (LOG %)	840	3.29	2.37	4.31	0.88	53.75

Table 5. Comparison of the mean of the Additive EuroSCORE between survivors and non survivors.

Death	N	Mean	Median	Standard Deviation	Minimum	Maximum
No	774	2.86	3.00	2.19	0	14
Yes	66	5.18	5.00	3.05	0	14
Total	840	3.05	3.00	2.35	0	14

p-value < 0.001 (Mann-Whitney test)

Table 6. Comparison of the mean of the Logistic EuroSCORE between survivors and non survivors.

Death	N	Mean	Median	Std. Deviation	Minimum	Maximum
No	774	2.95	2.37	3.25	.88	53.75
Yes	66	7.24	3.77	9.89	.88	51.66
Total	840	3.29	2.37	4.32	.88	53.75

p-value < 0.001 (Mann-Whitney test)

Table 7. Comparison of the percentages of observed death and predicted death by the model in each one of the risk groups of the EuroSCORE.

Risk group	Patients	Observed death (%)	Predicted death (%)	*P value*
Low-risk (0-2)	345	3.19	2.99	
Medium-risk (3-5)	364	7.69	7.58	*0.767*
High-risk (>=6)	131	20.61	21.37	

Chi-Square Test

Table 8. Observed and predicted mortality using the EuroSCORE as predictive variable in the groups defined by the Hosmer-Lemeshow test.

	Survivors		Óbito		Number of
	Observed	Expected	Observed	Expected	patients
0	112	110,5	1	2,5	113
1	164	162,8	4	5,1	168
2	58	61,3	6	2,7	64
3	166	166,5	11	10,5	177
4	116	114,8	9	10,2	125
5	54	55,1	8	6,9	62
6	63	62,05	10	10,9	73
>= 7	41	40,9	17	17,1	58

Chi-square (6) = 5.729 (p-value = 0.455)

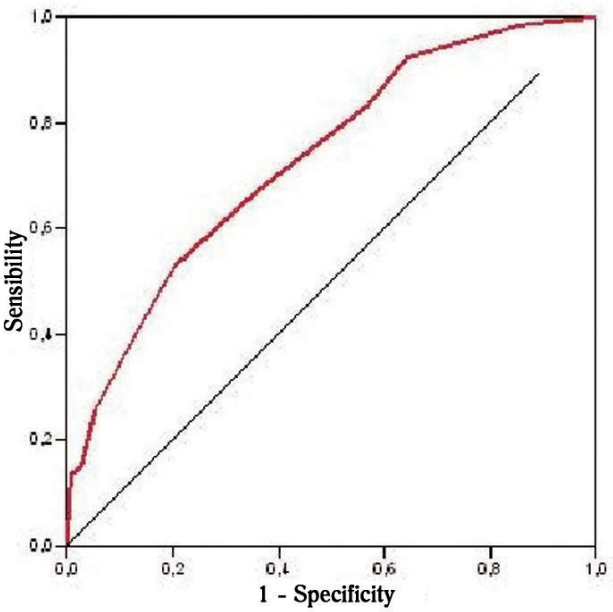

Fig. 1 – Graphic of the ROC curve. Result of the univariate analysis

Result of the univariate analysis

Aiming to identify amongst the variables involved in the calculation of the EuroSCORE, the main factors (variables) that alter the risk of death, we performed in our sample a univariate analysis. Table 9 reveals the results of this analysis for the variables studied, which consist of: number of patients in each category, the percentile of death in each subgroup, *odds ratio* and its respective certainty interval of 95%.

The variables: age over 60 years (OR= 4.9; 2.91-8.27), active endocarditis (OR=4.74; 179-12.55), serum creatinine > 2.3mg/dl (OR= 9.17; 2.01-41.86) thoracic aorta surgery (OR= 4,45; 1,55-12,76), emergency surgery (OR= 12.24; 2.42-61.89) and extracardiac arteriopathy (OR= 12.06; 1.67- 87.06), were statistically significant according to the increase in the risk of death.

Table 9. Factors associated with Hospital mortality.

Variables	N	Death	Univariate Analysis	
Age		n (%)	OR (I.C.95%)	*P*
<= 60 years	605	25 (4.1%)	1,0	
> 60 years	235	41 (17.4%)	4.90 (2.91 ; 8.27)	< 0.001*
Gender				
Male	384	25 (6.5%)	1.0	
Female	456	41 (9.0%)	1.42 (0.85 ; 2.38)	0.183
Previous surgery (reoperation)				
No	625	44 (7.0%)	1.0	
Yes	215	22 (10.2%)	1.51 (0.88 ; 2.57)	0.133
Active endocarditis				
No	818	60 (7.3%)	1.0	
Yes	22	6 (27.3%)	4.74 (1.79 ; 12,55)	0.005*
Creatinine > 2.3				
No	833	63 (7.6%)	1.0	
Yes	7	3 (42.9%)	9.17 (2.01 ; 41.86)	0.013*
EF				
< 30	13	2 (15.4%)	1.0	
30 - 50	94	12 (12.8%)	1.66 (0.19 ; 14.13)	
> 50	733	52 (7.1%)	0.77 (0.09 ; 6.09)	0.063
PHBP				
No	652	51 (7.8%)	1.0	
Yes	188	15 (8.0%)	1.02 (0.56 ; 1.86)	0.944
Associate Revascularization				
No	752	51 (6.8%)	1.0	
Yes	88	15 (17.0%)	2.82 (1.51 ; 5.27)	0.001*
Thoracic aorta surgery				
No	821	61 (7.4%)	1.0	
Yes	19	5 (26.3%)	4.45 (1.55 ; 12.76)	0.013*
Emergency surgery				
No	834	63 (7.6%)	1.0	
Yes	6	3 (50.0%)	12.24 (2.42 ; 61.89)	0.008*
Critical state				
No	835	64 (7.7%)	1.0	
Yes	5	2 (40.0%)	8.03 (1.32 ; 48.94)	0.052
Unstable angina				
No	840	66 (7.9%)	-	-
Yes	0	-	-	-
Previous infarction				
No	836	66 (7.9%)	-	
Yes	4	0 (0.0%)	-	>0.999
COPD				
No	836	65 (7.8%)	1.0	-
Yes	4	1 (25.0%)	3.95 (0.41 ; 38.55)	0.280
Neurological dysfunction				
No	827	66 (8.0%)	-	-
Yes	13	0 (0.0%)	-	0.614
Extracardiac arteriopathy				
No	836	64 (7.7%)	1.0	-
Yes	4	2 (50.0%)	12.06 (1.67 ; 87.06)	0.033*
IVC after infarction				
No	840	66 (7.9%)	-	-
Yes	0	-	-	-

*Base = 840 patients; IVC: interventricular communication, PHBP: pulmonary high blood pressure, EF: ejection fraction, COPD: chronical obstructive pulmonary disease, * statistically significant*

Table 10. Results of the Regression Logistic – Method Stepwise forward.

Independent variable	Odds Ratio	IC 95% OR	*P*-value
Age (> 60 years vs ≤ 60 years)	6.42	3.64 – 11.35	<0.001
Gender (Female vs Male)	2.00	1.13 – 3.55	0.018
Previous surgery (Reoperation) (yes vs no)	2.09	1.14 – 3.82	0.017
Active Endocarditis (yes vs no)	3.45	1.07 – 11.10	0.038
Thoracic aorta surgery (yes vs no)	8.54	2.56 – 28.54	<0.001
Emergency surgery (yes vs no)	7.05	1.14 – 43.48	0.035
Extracardiac arteriopathy (yes vs no)	13.03	3.85 – 63.25	0.001
Constant			<0.001

Result of the multivariate analysis

In order to obtain a global analysis, it was used the Regression Logistic technique. The selection of the variables was performed by the *stepwise forward* method establishing a level of significance of 0.05 for inclusion of variables and 0.10 for exclusion of variables. Therefore, the variables remained in the model as factors associated to a higher chance of death (Table 10): age over 60 years (OR= 6.42; 3.64-11.35); female gender (OR=2; 1.13-3.55); previous heart surgery (OR=2.09; 1.14-3.82); active endocarditis (OR=3.45; 1.07-11.10); thoracic aorta surgery (OR=8.54; 2.56-28.54); emergency surgery(OR=7.05; 1.14-43.48), and extracardiac arteriopathy (OR=13.03; 3.85-63.25).

DISCUSSION

The stratification of the surgical risk allows estimating the operative risk to be confronted by the patient and also to evaluate the results and, in the end, the quality of assistance of a certain institution [10]. Amongst a range of score systems developed, the EuroSCORE has had large acceptance worldwide. The EuroSCORE is an additive system which each one of the 17 risk factors receives a score, that, when summed up, supplies a score that allows classifying a certain patient in one of the three risk groups: low-risk (score 0-2), medium-risk (score 3-5) and high-risk (score >6). After publishing the original work [1], several centers started adopting the EuroSCORE [11-14], but some discrepant results appeared between the expected mortality and the observed mortality, especially in high-risk patients. In order to solve this problem, Nashef et al. [4] started conceding the value of a logarithmic function to each one of the variables, which made possible, at the end of the calculation, to attribute a value of death risk percentage. This procedure is known as logistic EuroSCORE.

In a previous publication [7], our group showed that the EuroSCORE was a simple and objective method, revealing to be a satisfactory predictor of surgical mortality in patients submitted to coronary artery bypass graft surgery. However, for obvious reasons, this finding could not be extended to patients submitted to cardiac valve surgery without a specific study on this group of patients, due to the prevalence of rheumatic disease. In fact, the group of 840 patients holding valvopathies that participated in this study differs largely from the population studied in the original research of the EuroSCORE, as it can be analyzed in Table 1: our patients were much younger, with higher number of previous surgeries and higher incidence of pulmonary hypertension and active endocarditis. On the other hand, as expected, there was lower prevalence of ventricular dysfunction and events related to coronary disease (recent infarction, unstable angina). Despite these differences, it was observed that the model adjusted well, with an area under the ROC curve of 0.731 (P<0.001) similar to the result of the evaluation of the EuroSCORE in America for patients holding valve lesions [5]. Also similar to the validation in patients submitted to myocardial revascularization [7] and the application of the very original study in patients holding valvopathies [3].

Differently from another study performed in our area [14] that aimed to validate the EuroSCORE in patients holding valvopathies, there was a higher prevalence, in our group, of medium and low-risk patients.

The mean of the EuroSCORE, either Additive or Logistic, among the patients that died, was higher than the mean of survivors, which confirms higher risk of death among the high-risk patients and lower probability of death in the groups of medium and low risk, as it had already been observed by others [13]. The global mortality rate in our series was 7.9%, similar to that related by others [8].

The model also presented a good predictive value for either predicted mortality and observed mortality in the three groups of risk (P=0.767) or for each value of the Additive EuroSCORE (P=0.455).

The multivariate analysis showed that age over 60 years is a risk factor, which is in agreement with the literature [15-

17], especially when the cardiac valve surgery is associated to myocardial revascularization [18,19] or is a case of reoperation [17,20].

The female gender also showed to be a risk factor. It has also been reported that this fact is true when it comes to cases of change of aortic valve. We have observed a sheer correlation between age and gender, as attested in our material, more than 50% of death occurred in female patients over 60 years.

Previous heart surgery has been related as a risk factor for cardiac valve surgery [22-24], which was confirmed in our study. A critic that could be formulated to the EuroSCORE is the fact that number of previous surgeries is not taken into account, which is widely known to have influence in the surgical risk [25].

In spite of the relatively low prevalence in our sample, it was also possible by means of multivariate analysis, to show that not only active endocarditis, either in native valve or prosthesis, but also surgery associated to thoracic aorta, emergency surgery and extratracardiac arteryopathy are factors of major surgical risk.

In conclusion, the EuroSCORE proved to be a simple and objective indicator, revealing to be a satisfactory surgical mortality predictor in patients submitted to cardiac valve surgery at the Heart Institute of Pernambuco. The variables involved in higher surgical risk include age over 60 years, female gender, previous heart surgery, active endocarditis, emergency surgery, surgery associated to the thoracic aorta and extracardiac arteryopathy.

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