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Validation of a stratification system of surgical risk for valve surgery: VMCP score

Validación de un sistema de estratificación de riesgo quirúrgico para cirugía valvular: Escala VMCP

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ABSTRACT. Introduction: One of the various instruments that can be used to evaluate the impact of risk factors on the survival of patients undergoing valve surgery is the VMCP score. This work evaluates the performance of this tool. **Objective:** To validate the surgical risk score for heart valve surgery (VMCP score) in our hospital unit. **Material and method:** A prospective cohort study was conducted on 239 patients undergoing heart valve surgery, estimating the risk with the VMCP score. The sample was divided into two groups at a cut-off point of 8. The discriminating power of the score was analyzed based on the area under the ROC curve. A value of $p < 0.05$ was considered significant. The data were processed using SPSS v.25.0. **Results:** The score stratified the samples as follows: 40.6% of patients were without risk and 59.4% were at risk. The evaluation of the calibration component showed that the score was not appropriate for our sample (Cronbach's alpha coefficient: 0.59). The discrimination component of the score showed a poor capacity to distinguish between the population at risk of mortality (0.630) and/or morbidity (0.655). **Conclusion:** It is not valid to use the surgical risk score for heart valve surgery (VMCP score) in our hospital unit.

RESUMEN. Introducción: *Existen diversos instrumentos para evaluar el impacto de los factores de riesgo sobre la supervivencia del paciente sometido a cirugía valvular, entre los que encontramos la escala VMCP, por lo que conminaremos a una evaluación del desempeño.* ***Objetivo:*** *Validar la escala de riesgo quirúrgico para cirugía valvular: Escala VMCP en nuestra unidad hospitalaria.* ***Material y métodos:*** *Se realizó un estudio de cohortes prospectivo en 239 pacientes sometidos a cirugía valvular y se les estimó el riesgo mediante la escala VMCP. La muestra se dividió en dos grupos de acuerdo con un punto de corte de 8. La capacidad de discriminación se analizó mediante el área bajo la curva ROC. Una $p < 0.05$ fue significativa. Los datos se procesaron con SPSS v-25.0.* ***Resultados:*** *La estratificación de la escala mostró: 40.6% de pacientes sin riesgo y 59.4% con riesgo. La evaluación del componente de calibración mostró que la escala no se ajusta a nuestra muestra (Coeficiente Alfa de Cronbach 0.59). La evaluación del componente de discriminación mostró que no puede distinguir la población con riesgo de mortalidad (0.630) y/o morbilidad (0.655).* ***Conclusión:*** *No es válido el uso del sistema de estratificación de riesgo quirúrgico para cirugía valvular, la escala VMCP, en nuestra unidad hospitalaria.*

Keywords: Heart surgery, predictive models, risk measurement, hospital mortality.

Palabras clave: *Cirugía cardiaca, modelos predictivos, medición de riesgo, mortalidad hospitalaria.*

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INTRODUCTION

Cardiovascular surgical teams are accustomed to use various risk adjustment models (scores) to predict perioperative morbidity and mortality with the purpose of establishing management plans for each patient. The clinical practice guidelines of the American Heart Association/American College of Cardiology consider it reasonable to use such models for two purposes: to control surgical and institutional quality and to estimate the risk of death from specific causes[1].

Surgical risk is an extremely complex subject, particularly in cardiac surgery, as there are many different factors that can lead to an adverse result. Statistical predictions about the possibility of an eventuality during cardiac surgery are based on general trends or descriptive data, not on individual patients, and so it has been suggested that perioperative risk should be interpreted as the intersection of multiple components, including: the physical characteristics

of the patient, the clinical context of the disease and the aggressiveness of the planned surgical intervention[2]. The complexity of the problem is such that various instruments have been developed to assess the influence of these factors on patient survival[3].

One of these instruments is the surgical risk score for heart valve surgery (VMCP).

The VMCP score is a simplified score, created and validated in the Cardiology Institute of the Faculty of Medicine of the University of Sao Paulo, in Sao Paulo, Brazil, based on a study of 764 patients. This score is based on four fundamental parameters that characterize heart valve diseases: V [valvular lesion]; M [myocardial function]; C [coronary artery disease]; P [pulmonary artery pressure]. These are classified into four categories, and the sum of the score of the four parameters make up the VMCP score. In the institution in which it was developed, this score has been used to identify patients with a severe preoperative disease, and to assess the correlation between postoperative mortality and morbidity in valve surgery[4].

Since the score was developed for a population that is different from the population of our hospital, we evaluated the performance of the score in our population.

If validated, the VMCP would facilitate the identification of at-risk patients and the development of management guides that could help minimize hospital costs and unnecessary risks. We would be able to use a simple score based on straightforward clinical parameters that would help improve the postoperative prognosis of our patients.

SUBJECTS AND METHODS

With the approval of the Hospital Scientific Research Commission in order to determine the validity of the VMCP score, a prospective cohort study was carried out.

All patients, of any age and gender, who underwent elective or urgent heart valve surgery in our hospital unit during the period from January 1 to December 31, 2019, were identified using the surgical schedule, and the VMCP score was applied using data obtained with an easy-to-fill form, with questions designed for that purpose. A previous evaluation of surgical risk was performed by the resident of cardiothoracic surgery.

Surgical mortality and morbidity, as well as the presence of comorbidities and intrahospital parameters, were evaluated 30 days after surgery by reviewing the clinical record.

The internal consistency and discriminatory power of the model were analyzed to assess its validity. The internal consistency was evaluated using Cronbach's Alpha Coefficient. A value greater than or equal to 0.7 indicated that the model predicted well the probability of postoperative morbidity and mortality in the patients. The discriminatory power was analyzed by calculating the area under the ROC curve. A value less than or equal to 0.5 indicated that the model did not discriminate better than chance, while values close to 1 indicated an excellent discriminatory power. The sample was divided into two groups at a cut-off point of 8, which was previously established by Grinberg et al[4]. Morbidity and mortality in the two groups were compared using the χ^2 test. The continuous variables were expressed as mean ± standard deviation; the categorical variables were expressed as percentages. The analysis was performed using SPSS v.25.0 (SPSS, Inc., Chicago, IL, USA).

RESULTS

The data used to validate the VMCP score were obtained from a clinical series of 239 patients. The estimated morbidity was 35.98% while the mortality was 2.09%, since eighty-six patients presented perioperative complications, and five of them died. These findings suggest the need for studying the predictive capacity of risk stratification models for patients with heart valve disease.

Table 1: Demographic data of the population. N = 239.

Variable	
Age, years	59.85 ± 13.74
Gender (n)	
Male	129
Female	110
Valvulopathy, %	
Tricuspid	4.6
Mitral	20.9
Aortic	46.4
Pulmonary	0.4
Multiple	13.0
Valvular + ischemic heart disease	14.6
Type of surgery (E/U)	237/2
NYHA (I/II/III/IV)	23/136/78/2
CARE (I/II/III/IV/V/VI)	38/178/19/2/0/2
Cardiovascular risk factors, %	
Smoking	53.1
Hypertension	79.9
Diabetes mellitus	40.6
Time spent in the surgical anesthetic state, min	
Anesthetic time	272.62 ± 77.65
Surgical time	235.48 ± 71.05
Extracorporeal circulation time	120.42 ± 62.1
Aortic Impingement Time	102.30 ± 74.26
Type of valve prosthesis, %	
Mechanical	68.2
Biological	30.5
Mixed	1.3

BMI = Body mass index, NYHA = New York Heart Association. CARE = Cardiac anesthetic risk.

Table 2: Distribution of patients according to the VMCP score.

	Serious complications		Death		
VMCP score	Yes	No	Yes	No	Total
High risk	63	79	4	138	142
Low risk	23	74	1	96	97
Total	86	153	5	234	239

Patients between 22 and 92 years old were included, most of them male. The clinical and demographic data of the patients are summarized in *Table 1*.

The internal consistency of the model was poor (Alpha Cronbach's coefficient = 0.59), which indicated that the parameters considered were very weakly correlated. This made us conclude that the score does not fit the population of our hospital.

Calibration and discrimination tests were used to assess the predictive capacity of the system.

The VMCP score was applied to all patients; based on the score values, the study population was divided into 2 groups: low risk and high risk.

Sixty-three high-risk patients presented serious complications; among those who did not, 79 patients were at high risk. Four deceased patients had been previously classified in the high-risk group; of the patients at low risk, only one suffered perioperative death *(Table 2)*.

The median score of low-risk patients was 7 (5-7); the median score of high-risk patients was 9 (8-14). Regarding the prediction of morbidity and mortality, the sensitivity, the negative predictive value and the positive likelihood ratio of the score were high. *Table 3* shows the quality indices of the score.

The ROC curve was created by plotting the true positives (sensitivity) and true negatives (1-specificity) at the cut-off point. The area under the curve indicated the discriminating power of the model, that is, its ability to distinguish between those patients who were predicted to have serious complications and/or perioperative death, and those who were not. It is important to note that the area under the curve for complications was 0.630 *(Figure 1)*, and for the perioperative death 0.655 *(Figure 2)*, indicating that the predictive ability of the model is poor.

DISCUSSION

For several years, different models derived from mathematics, statistics and other sciences have helped predict the future evolution of patients through quantitative methods, and, although with certain restrictions, to make, in many cases, more accurate decisions[5,6]. This is the purpose of risk scores, which could be defined as an algorithm or clinical prediction rule that can help physicians to interpret the information obtained about the patient[5,7,8].

At present there are multiple risk scores that can be used to categorize patients. In this study, we evaluated the VMCP risk model/score. Although the main purpose of this score is adapt the surgical treatment of heart valve diseases to the individual risk of each patient, it did not produce an adequate classification of our patient population, as evidenced by the poor predictive capacity of the model according to the results regarding the predictive capacity of this score were not those expected at the time the ROC curve was plotted.

This result could be explained because when a validation is carried out, by a different group of researchers or in a group of patients with different clinical settings. Since it is difficult to fully reproduce the clinical settings present in another study, since there are always natural variations that do not appear in the initial study[9,10].

Heart valve pathologies are increasingly common, and so valve replacement has become an increasingly common intervention. The most prevalent preoperative diagnosis in our study was aortic valvulopathy followed by mitral valve disease, which coincides with the results reported by other authors[11,12].

Paylo-Hernández and colleagues have pointed out that patients with aortic valve disease are more likely to present morbidity and mortality than those with other valve diseases due to their greater longevity, their low preoperative functional class, moderate to severe reduction of left ventricular function, and increased incidence of coronary disease and

Table 3: Quality indices of the VMCP score.

Quality indices	VMCP score
Morbidity	
Prevalence*	35.98
Sensitivity*	73.25
Specificity*	48.36
Positive predictive value*	44.36
Negative predictive value*	76.28
Positive likelihood ratio	1.41
Negative probability ratio	0.55
Mortality	
Prevalence*	2.09
Sensitivity*	80.00
Specificity*	41.02
Positive predictive value*	2.81
Negative predictive value*	98.96
Positive likelihood ratio	1.35
Negative probability ratio	0.48

* = percentage.

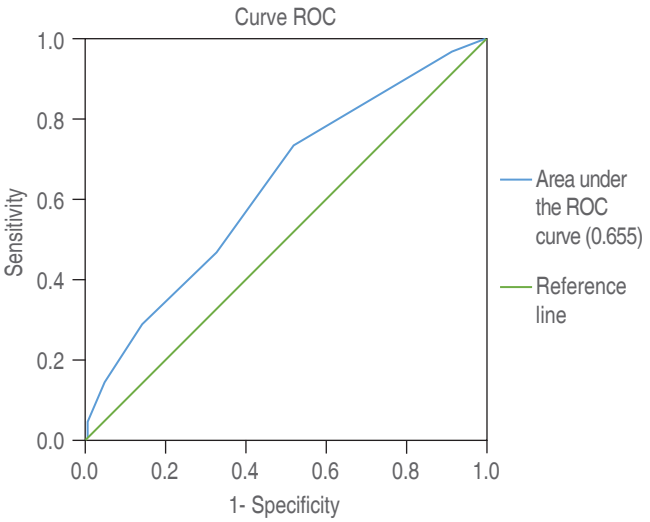

Figure 1. Area under the ROC curve of the VMCP score as a predictor of morbidity.

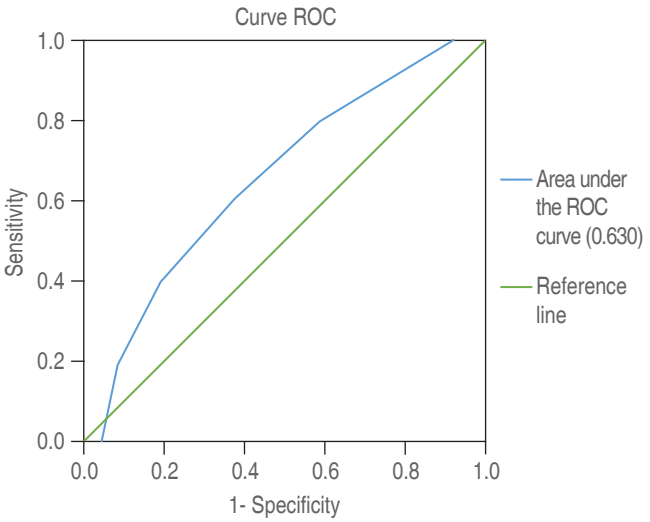

Figure 2: Area under the ROC curve of the VMCP score as a predictor of mortality.

degenerative pathologies, as well as increased association with perioperative bleeding, which can led to reoperation and death[13]. In our population, 25.2% of patients with aortic valve disease suffered major complications, while 0.9% died. These outcomes differ from those reported by other authors in which the morbimortality of aortic valve disease did not surpass that of other valve diseases. Another independent risk factor for morbidity and mortality is the presence of multiple valve pathologies. In our study, the mortality of bivalvular procedures was 0.

Current guidelines indicate valve replacement for patients with ventricular dysfunction (LVEF < 55%) and increased ventricular size (end-systolic diameter [ESD] ≥ 45 mm)[14-20]. In our study, 83.3% of the patients who suffered serious complications and/or death showed ventricular ejection fractions equal to or greater than 50%.This may be due to the fact that contractility indexes (LVEF), although useful, often do not represent the true contractile state of the left ventricle.

The American Heart Association (AHA) considers ischemic heart disease as an important predictor of death in patients with heart valve disease, as there is a positive relation between it and mortality rates. Likewise, combined surgery implies a variable increase in the risk of mortality, ranging from 1.5 to 18% (depending on the type of valve), compared to isolated valve replacement surgery[13].

In our population, 14.6% of patients with heart valve disease had concomitant coronary disease, in contrast with the proportion reported by Sodian et al[21] of up to 40%. Morbidity and mortality did not show differences between patients with heart valve disease and concomitant coronary disease, and those who underwent isolated valve replacement surgery.

In valve replacement procedures, mortality is influenced by a fourth factor, pulmonary artery pressure. Pulmonary hypertension is a pathology of low prevalence but with a very significant influence on morbidity and mortality, as shown by Ramakrishna et al., among other authors, who found that this variable was a significant risk factor for mortality after surgery[22,23]. In our study, pulmonary hypertension was present in 96.5% of the patients who suffered serious complications and/or death, and in 94.1% of those who did not.

CONCLUSION

It is not valid to use the surgical risk score for heart valve surgery (VMCP score) in our hospital unit.

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