Practical Use of a Risk Assessment Model for Complications After Cardiac Surgery

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Summary

Background: The identification of risk factors for postoperative complications in cardiac patients with surgical indication may influence the therapeutic decision.

Objective: To describe the experience of a Cardiology hospital in the validation and practical use of a preoperative risk score.

Methods: To validate TUMAN's score, chosen by considering morbidity and mortality, 300 adult patients were prospectively evaluated before elective cardiac surgery with the use of extracorporeal circulation (ECC). Patients with a score of zero to five were considered as being low risk; from six to nine, as moderate risk and a score higher than 10 as high risk for cardiac, infectious, neurological, pulmonary and renal complications, as well as death.

Results: The TUMAN classification showed a statistically significant association with the occurrence of infectious complications (p = 0.010), with the other postoperative complications (p = 0.034) and death (p <0.001). Pulmonary infection was the most frequent infectious complication (15.3%) and Infected patients had a longer ICU stay duration (p = 0.001) and more prolonged hospitalization (p = 0001). After routine use, a new review of 154 patients operated in 2005, confirmed the validity of this score in the identification of those with the highest risk of postoperative infections.

Conclusion: TUMAN's score was chosen as it uses variables that can be promptly obtained, classifies in the same system the most frequently performed surgeries and predicts risk of postoperative complications, in addition to mortality. Its continued use in this hospital has been able to identify the group of patients with increased risk of complications, especially infectious ones, although it was not useful in the prediction of individual risk. (Arq Bras Cardiol 2008; 91(5) : 315-320)

Key words: Thoracic surgery; postoperative complications; risk; infection.

Introduction

In the last two decades, there has been a significant change in the profile of patients submitted to cardiac surgery, due to the improvement in diagnostic and therapeutic methods. The myocardium revascularization surgery, for instance, is being indicated at a later stage or for patients with more severe lesions, resulting in a higher incidence of risk situations, such as reoperations, associated diseases (diabetes, arterial hypertension, nephropathy) and elderly patients.

Due to the increasing costs of healthcare services and more treatment options for cardiopathies, the identification of the patient's risk factors for postoperative complications can influence the decision-making process on the most adequate conduct. Additionally, for the organizations that financially support the procedures, it is important to define the complication risk parameters to improve the planning of the necessary resources and the final cost of hospitalization.

Therefore, it is important to identify, in the preoperative period, the patients with the highest risk of preoperative complications. Among these, infection remains one of the most important causes of morbidity and mortality in surgical patients and thus, it is especially important to identify risk factors for its occurrence.

Many studies have been published to compare the several risk indices being used by institutions all over the world[1-4] and most of them used similar variables. Additionally, these data have been used to predict the duration of the hospital stay at the Intensive Care Unit (ICU), which allows the rationalization of the surgical program[5] and the implementation of the applicable prophylactic measures. However, there are few reports on the infectious complications.

We describe the experience of a university hospital of

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Cardiology in the validation and practical use of a risk score for postoperative complications, especially infectious ones, and death.

Methods

In order to validate the chosen score (Tuman[6]), a total of 300 adult inpatients were prospective and consecutively assessed; they had been admitted to undergo elective cardiac surgery with the use of extracorporeal circulation (ECC): myocardium revascularization surgery (MRS), combined left ventricular aneurysmectomy and/or valvular procedure (prosthesis implant or conservative surgery). This study was approved by the Ethics Committee and Research of Hospital das Clínicas of the University of São Paulo School of Medicine.

Table 1 shows the variables used in this score, according to the following definitions:

• acute myocardial infarction: patient presenting two or more of the following findings: elevation of the MB fraction of creatine phosphokinase (CK-MB); new Q-waves at the electrocardiogram; failure in the technetium pyrophosphate uptake at the myocardial scintigraphy.

• pulmonary hypertension: pulmonary artery pressure of 25 mmHg above the systemic arterial pressure, shown at the echocardiogram or during hemodynamic study.

• cerebrovascular disease: history of cerebrovascular accident and/or vascular alterations diagnosed during carotid angiography.

• congestive cardiac failure: radiological alterations compatible with pulmonary congestion or presence of third heart sound (S3).

• left ventricle dysfunction: ejection fraction (EF) <35% at the echocardiogram.

Table 1 – Clinical Risk Score System, According to Tuman et al[6]

Preoperative Factor	Score
Emergency surgery	4
Age	
65-74 years	1
> 75 years	2
Renal dysfunction	2
Previous myocardium infarction	
3-6 months	1
< 3 months	2
Female sex	2
Previous cardiac surgery	2
Pulmonary hypertension	2
Cerebrovascular disease	2
Multiple valvular change or MRS + valvular	2
Aortic or mitral valve change	1
Congestive heart failure	1
Left ventricular dysfunction	1

• renal dysfunction: serum creatinine > 1.4 mg/dl.

Concerning the classification of the risk of complications, patients with score zero to five were considered as being low risk; scores from six to nine, as moderate risk and scores > 10 as high risk.

As for the diagnosis of the underlying cardiopathy, the patients were subdivided in three groups: coronary heart failure (CHF); valvular cardiopathy (VAL) or the association of the two diagnoses (CHF + VAL).

Cefuroxime (IV) was administered as antibiotic prophylaxis (1.5 g started one hour before the surgery and repeated every 12 hours, totaling 5 doses).

The postoperative complications that occurred during the hospital stay were recorded according to the criteria described below:

Cardiac complications: perioperative acute myocardial infarction: patient presenting two or more of the following: CKMB elevation; new Q waves at the electrocardiogram; failure in the technetium pyrophosphate uptake at the myocardial scintigraphy; low cardiac output syndrome: cardiac index < 2 l/m/m^2, with need for inotropic drugs for more than 2 hours and/or use of intra-aortic balloon.

Pulmonary complications: tracheal intubation or mechanical ventilation for more than 48 hours after the surgery; need for tracheal reintubation associated to mechanical ventilation.

Renal complications: serum creatinine levels of 2 mg/dl above the preoperative level; need for dialysis at any moment of the postoperative period.

Neurological complications: alteration in the level of consciousness or coma in association with neurological lesion during the surgery; sensory, motor or reflex alteration at any moment of the postoperative period.

Infectious Complications: the infections were classified according to the definitions by the Center for Diseases Control[7], adapted by the Sub-Committee for Control of Hospital Infections of the Heart Institute (InCor). Pulmonary, urinary, surgical wound (chest and lower limbs) and bloodstream infections were recorded.

The response-variables that were evaluated included postoperative complications, infectious complications and death. The comparison of proportions of these variables between groups of patients established from the exposition or not to the studied preoperative factors was evaluated by the Chi-square test or Fisher's exact test. The relative risk of each response with the corresponding 95% confidence interval was estimated for each variable. The level of significance established for the analysis was 5%. The Statistical Analysis System (SAS) was used to perform the statistical calculations.

Results

At the validation study, four patients were excluded: one died before the surgery, two presented contraindications to the surgery and received clinical treatment and one patient was submitted only to the left ventricular aneurysmectomy. The preoperative data, thus, refer to 296 patients, aged 20

to 84 years (mean± SD: 58.93 ± 11.79 years), of whom 208 (70.3%) were males.

Two hundred and ten patients were in the CHF group, 59 in the VAL group and 27 in the CFH+VAL group. A total of 57 valvular change procedures were performed (31 aortic; 26 mitral; 7 associations), 17 plasties and 9 commissurotomies; 232 myocardial revascularizations and 23 left ventricular aneurysmectomies.

TUMAN[6] complication score showed a statistically significant association with the occurrence of infectious complications (p=0.010), with other postoperative complications (p=0.034) and with death (p<0.001) as shown in Table 2. The incidence of complications estimated by the authors would be 14.3 to 14.8% for low risk, 33.8 to 35% for moderate risk and 59.4 to 62.5% for high risk. Although the incidences observed were higher than the expected ones, there was a statistically significant association between the risk stratification and a higher occurrence of complications (p=0.034).

The incidence of each type of postoperative complication according to the same score is described in Table 3. Of the 296 patients, two were excluded from this analysis as they died during surgery, resulting in 294 studied patients.

A total of 112 patients (38.1%) presented at least one postoperative complication, with a predominance of cardiac (72 patients – 24.5%) and infectious (69 patients – 23.5%) complications, even after the stratification by underlying cardiopathy; they were followed by pulmonary (33 patients – 11.2%), neurologic (32 patients -10.5%) and renal complications (9 patients – 3.1%).

The relative risk of complications estimated in the CHF group was 1.5-fold higher than in the VAL group and in the CHF+VAL group, it was 1.8-fold higher than in the VAL group. At the detailed analysis of distribution of postoperative complications, the cardiac complication alone was the most frequent event (29 patients), followed by postoperative infection (22 patients) and associated cardiac and infectious complication (10 patients). Renal and pulmonary complications did not occur in isolation. Six patients presented neurologic complication only and none of them died.

Pulmonary infection was the most frequent among the infectious complications (15.3%), followed by bloodstream infection (3.1%), chest surgical wound infection (2.7%) and lower limb infection (2.7%) and urinary tract infection (2.4%). The distribution of the infections according to the underlying cardiopathy is shown in Table 4. The infected patients remained longer at the ICU (10.8±14.1 days x 3.0 ± 1.6 days - p = 0.001) and had a longer duration of hospital stay (40.7 ± 23.7 days x 22.7±8.5 days - p = 0.001).

Table 2 – Incidence of postoperative complications, infectious complications and death with Tuman et al6 score[6]

Variable	Tuman score	n	p	Relative Risk	95% Confidence interval
Postoperative Complications	0-5	89 (35.3)	0.034*	1.53	(1.19;2.13)
	6-9	21 (53.8)		1.89	(0.83;4.28)
	>=10	2 (66.7)			
Infectious complications	0-5	52 (20.6)	0.010		
	6-9	15 (38.5)		1.86	(1.17;2.97)
	>=10	2 (66.7)		3.23	(1.40;7.45)
Death	0-5	9 (3.5)	<0.001	0.05	(0.02; 0.15)
	6-9	12 (30.8)		8.68	(3.92; 19.25)
	>=10	2 (66.7)		18.82	(6.75; 52.47)

Table 3 – Association between Tuman et al[6] score and the occurrence of postoperative complications in the 294 assessed patients

Complications	Escore de Tuman						P
	0-5 252 patients		6-9 39 patients		≥ 10 3 patients		
	n	%	n	%	n	%	
Cardiac	53	(21.0)	17	(43.6)	2	(66.7)	0.002*
Pulmonary	20	(7.9)	11	(28.2)	2	(66.7)	<0.001*
Renal	3	(1.2)	4	(10.3)	2	(66.7)	<0.001*
Neurologic	23	(9.1)	7	(17.9)	2	(66.7)	0.002*
Infectious	52	(20.6)	15	(38.5)	2	(66.7)	0.010*

** statistically significant result.*

Table 4 – Incidence of postoperative infection in the 294 patients according to the underlying cardiopathy

Infection	Underlying cardiopathy							
	CHF		Val		CHF + Val		Total	
	n=208	%	N=59	%	n=27	%	n	%
Pulmony	32	(15.4)	9	(15.2)	4	(14.8)	45	(15.3)
Urinary	6	(2.9)	-	-	1	(3.7)	7	(2.4)
Surgical wound								
chest	7	(3.4)	-	-	1	(3.7)	8	(2.7)
lower limbs	6	(2.9)	-	-	2	(7.4)	8	(2.7)
Bloodstream	4	(1.9)	3	(5.1)	2	(7.4)	9	(3.1)

Twenty-three patients (16 males) died (7.8%), with two deaths occurring during the surgery. The death rate per group was 4.8% (10 patients) in the CHF group, 13.6% (8 patients) in the VAL group and 18.5% (5 patients) in the CHF + VAL group. Age ranged from 30 to 79 years (62.2±14.9 years). The patients who died presented a higher incidence of postoperative complications when compared to those who survived ($p<0.001$).

After the validation, this score was implemented in the routine preoperative assessment of adult patients submitted to cardiac surgery at InCor.

A new assessment of 154 patients that underwent surgery in 2005, confirmed the validity of this score in the identification of those with a higher risk of postoperative infections. As only two patients presented a score ≥10 (Table 5), we compared those with low and moderate risk of complications ($p=0.0013$; relative risk $=2.35$).

Discussion

The healthcare professionals that carry out the follow-up of cardiac surgery, whatever area they work in, at times face extremely severe clinical situations, long postoperative evolutions and, sometimes important sequelae that can impair the patient's quality of life.

The evaluation of the postoperative outcome is the first step to measure the healthcare service quality and for this measurement to be precise, it is essential to differentiate patients by degrees of severity[3]. The healthcare providers are also interested in learning these results in order to provide the hospital procedures with the lowest rates of complications, shortest duration of hospital stay and lowest mortality[8].

Table 5 – Incidence of postoperative infection in 154 patients that underwent surgery in 2005, according to Tuman et al[6] score

Tuman number	Number of patients	Infectious complications (%)	Death
0-5	97	16 (16.5%)	5 (5.2%)
6-9	55	24(43.6%)	9 (16.4%)
>10	2	1(50%)	1(50%)

On the other hand, to know the risk profile of the patient can help in the therapeutic decision-making and allows the implementation of individualized strategies to prevent complications[9]. These issues show the importance of assessing the data as precisely as possible and continuously.

The use of scores of classification to define the risk of postoperative complications in cardiac surgery started at the end of the 80s and to date, there is no consensus on the best method to assess risk of complications and death; such method must be chosen according to specific needs of the Service. No reference was found in the literature on the use of risk scores in Cardiac Surgery Services in Brazil.

The score created by TUMAN et al[6] was chosen because it uses variables that can be promptly obtained, classifies in the same system the most frequently performed surgeries (myocardium revascularization and/or valvular change) and also predicts risk of postoperative complications, in addition to mortality. These authors performed a univariate analysis of the preoperative risk factors in 3,156 surgeries and identified 11 variables that received different values. Therefore, they obtained postoperative complication risk categories. The increase in the risk score was also associated with a higher individual frequency of complications and with a prolonged duration of ICU stay.

The continuous use of the Tuman et al[6] score at our hospital allowed us to identify the group of patients with the highest risk of complications, but it was not accurate in predicting individual risk, as the rates of complications and death were higher than the estimated ones. The death rates at InCor have ranged, in the last three years, from 1.9 to 2.9% for myocardium revascularization, 4.2 to 5% for valvular procedures and from 5.6 to 13% for associated surgeries (MRS + valvular procedure), according to the data provided by the Surgical Patient Control Unit.

Regarding infectious complications, the literature is scarce. Some authors mention infection as only one of the postoperative complications[2,3,6,10], without using the classification of preoperative risk as a predictor of infection as we did in the present study. Infection was second in frequency only to cardiac complications in the postoperative period (Table 3) and Tuman score showed a statistically significant association with the occurrence of infectious complications. It can be used to identify patients who need a reinforcement of preventive measures, such as being operated on by the most experienced surgeon,

decrease the duration of preoperative hospital stay and/or receive individualized antimicrobial prophylaxis.

It is worth mentioning that the systems of risk classification do not consider the intraoperative evolution, which can be a decisive factor in the patient's evolution.

When analyzing the most recent publications on the risk score for cardiac surgeries, one concludes that there is no ideal model or one that is accepted worldwide. The Parsonnet et al[11] score, one of the scores most frequently cited in literature, was useful to identify patients who stayed for less than 24 hours at the ICU in the postoperative period, in an analysis of 5,591 patients from a hospital in London with few ICU beds[5]. However, when applied to 8,210 patients who underwent surgery in four hospitals of the northwestern region of England to identify the risk of death, the data were overestimated[12]. More recently, Marius Berman et al[13] used in Israel a simplified score of Bernstein-Parsonnet (BP) that includes variables easily obtained at bedside, compared to the EuroSCORE[14], which was developed in Europe. For this population, which is a very heterogeneous one in terms of origin, the BP score presented a higher power of discrimination to predict mortality.

Geissler et al[8] applied different scores to 1,999 patients submitted to cardiac surgery with ECC in a German hospital; however, only 504 patients were followed postoperatively, evaluating mortality, use of mechanic support devices, hemodialysis or hemofiltration, myocardial infarction, duration of mechanical ventilation and ICU stay. Considering the scores of Parsonnet, Cleveland Clinic, French, EuroSCORE, Pons and Ontario Province Risk (OPR), the EuroSCORE was the one that presented the best predictive values for morbidity and mortality. The predictive values for morbidity were significantly lower than those for mortality for all scores.

Based on the database of the Society of Thoracic Surgeons (STS) of the United States, a model was developed to predict mortality and morbidity in the first 30 days postoperatively, after myocardium revascularization surgery, by studying 503,478 individuals. Based on this analysis, 87% of the patients presented no complications during the postoperative period.

To evaluate the differences between the EuroSCORE and the STS regarding the capacity to predict mortality after myocardium revascularization, a total of 3,125 consecutive patients were evaluated retrospectively. The authors concluded that the two scores were good predictors of mortality, with a slight advantage for the STS[15].

In another study[1], five different scores were applied (Parsonnet, Canadian, Cleveland, New York and Northern New England) to 1,135 patients submitted to myocardium revascularization at an American community hospital to evaluate accuracy in predicting death. There was no significant difference among them, although they used distinct variables.

A comparative study among four scores of mortality risk after cardiac surgery (modified Parsonnet, TU, Tuman and APACHE II) was carried out in 331 Mexican patients[16]. The TU score was the only one that did not have good discrimination; however, the modified Parsonnet and the APACHE II scores had better calibration. The authors concluded that these two models can be used as predictors of mortality in cardiac surgery in Mexico.

These systems of risk stratification can be used for research, individual patient management or to rationalize the use of resources in hospitals. They must be revised periodically, as the patients' characteristics as well as the diagnostic and therapeutic resources can change throughout time.

It is important to mention that, although the probability of complication can be estimated for a patient, one cannot be absolutely sure about his or her evolution. On the other hand, many times the patients with higher risk are the ones who benefit the most from surgery[17].

These examples demonstrate the need to validate a score before initiating its use in daily practice and that, to choose a score, one must consider the characteristics of the population to be assessed, as we did in the present study.

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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