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ORIGINAL ARTICLE

Cardiac operative risk evaluation: The EuroSCORE II, does it make a real difference?

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Abstract
Background The EuroSCORE, worldwide used as a model for prediction of mortality after cardiac surgery, has recently been renewed. Since October 2011, the EuroSCORE II calculator is available at the EuroSCORE website and recommended for clinical use. The intention of this paper is to compare the use of the initial EuroSCORE and EuroSCORE II as a risk evaluation tool.
Methods 100 consecutive patients who underwent combined mitral valve and coronary bypass surgery (MVR+CABG) and 100 consecutive patients undergoing combined aortic valve surgery and coronary bypass surgery (AVR+CABG) at the Radboud University Nijmegen Medical Center before 10 October 2011 were included. For both groups the initial EuroSCORE and the EuroSCORE II model were used for risk calculation and based on the calculated risks, cumulative sum charts (CUSUM) were constructed to evaluate the impact on performance monitoring.
Results For the MVR+CABG group the calculated risk using the initial logistic EuroSCORE was 9.95±8.47 (1.51–45.37) versus 5.08±4.03 (0.67–19.76) for the EuroSCORE II. For the AVR+CABG group 9.50±8.6 (1.51–69.5) versus 4.77±6.6 (0.96–64.24), respectively. For both groups the calculated risk by the EuroSCORE II was statistically lower compared with the initial EuroSCORE ($p<0.001$). This lower expected risk has influence on performance monitoring, using risk-adjusted CUSUM analysis.
Conclusion The EuroSCORE II, based on a recently updated database, reduces the overestimation of the calculated risk by the initial EuroSCORE. This difference is statistically significant and the EuroSCORE II may also reflect better current surgical performance.

Keywords EuroSCORE · EuroSCORE II · Operative risk · Mitral valve surgery · Aortic valve surgery · Myocardial revascularization

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Introduction

Progress in preoperative screening, surgical techniques, and intensive care has decreased the risk of mortality and morbidity of cardiac surgery over the years. The EuroSCORE to assess operative risk no longer seemed to be appropriate for currently performed adult cardiac surgery. On 3 October 2011, the EuroSCORE II was launched at the 2011 EACTS (European Association for Cardiothoracic Surgery) meeting in Lisbon and the online calculator (www.euroscore.org) has been updated to use this new risk stratification model [1]. It was known that the initial EuroSCORE overestimates the risk of cardiac surgery procedures and has a low discrimination ability [2], especially for valve surgery [3, 4]. The EuroSCORE, however, is not only used for preoperative risk calculation but also for risk-adjusted evaluation of the postoperative mortality using Cumulative Sum Control Chart (CUSUM) analysis [5]. The aim of this report is to compare the use of the initial EuroSCORE and EuroSCORE II as risk model for patients undergoing combined mitral or aortic valve surgery and coronary artery bypass grafting (CABG), whether or not in combination with other major cardiac surgery.

Patients and methods

Patients

With the aid of our database, the Coronary Surgery Database Radboud Hospital (CORRAD), we identified the last 100 consecutive patients who underwent combined mitral valve and coronary bypass surgery (MVR+CABG), whether or not in combination with other major cardiac surgery, and the last 100 consecutive patients who underwent combined aortic valve surgery and coronary bypass surgery (AVR+CABG) operated on before 10 October 2011. The MVR+CABG group consisted of 70 men and 30 women, with a mean age of 69.2±8.3 (45–84) years. Sixty-nine patients had three-vessel disease, 18 patients two-vessel and 13 patients one-vessel disease in combination with significant mitral valve regurgitation. In four patients the combined mitral valve and coronary bypass operation was combined with rhythm surgery, in one patient with the resection of a left ventricular aneurysm and in five patients with tricuspid valve surgery. The AVR+CABG group consisted of 70 men and 30 women, with a mean age of 73.6±7.8 (54–87) years. Forty patients had three-vessel disease, 35 two-vessel and 25 one-vessel disease. In two patients the AVR+CABG was combined with rhythm surgery.

Hospital mortality, defined as death at the Radboud University Nijmegen Medical Center before discharge, was 3 % (3 patients) for the MVR+CABG group and 0 % for the AVR+CABG group.

EuroSCORE and EuroSCORE II: Risk variables

The calculation of the initial EuroSCORE, additive and logistic, is incorporated in our CORRAD database system. For the EuroSCORE II, we calculated the risk using the online calculator (www.euroscore.org). Because the variables preoperative serum creatinine, height, weight, pulmonary artery pressure, and left ventricular ejection fraction are registered in the CORRAD database as the real numeric values, it was possible to use these data for both the initial EuroSCORE and for the EuroSCORE II. Of the new risk variables used in the EuroSCORE II, the variables New York Heart Association (NYHA) status, elective, urgent, emergency, or salvage surgery, preoperative dialysis and insulin-dependent diabetes were already registered routinely in our database. The variables reduced mobility due to musculosketal dysfunction and the CCS angina class 4 were retrieved retrospectively from the patients records.

Surgical technique

Standard cardiopulmonary bypass techniques were used for all patients. Myocardial protection was achieved with ischaemic arrest with cold crystalloid cardioplegia. Table 1 shows the operative data.

Statistical analysis

Variables are presented as percentages (or as numbers, because the total number is 100) for ordinal variables and for numeric values as mean±standard deviation, minimum and maximum. For the EuroSCORE values the median and 25 % and 75 % interquartile range (IQR) are also presented. CUSUM charts are constructed as described [5]. Differences between calculated expected risk by the initial EuroSCORE and EuroSCORE II were tested using the paired *t*-test. Statistical significance was assumed at a p value of ≤0.05.

Results

The calculated risk

Table 1 presents the distribution of preoperative risk variables as identified by the initial EuroSCORE and EuroSCORE II for both groups. For the definition of the described risk variables we refer to the website (www.euroscore.org) and the original publications [1, 2]. For the MVR+CABG group the initial logistic EuroSCORE was 9.95±8.47 (1.51–45.37) with a median of 7.59, IQR 3.87–12.48. The EuroSCORE II was 5.08±4.03 (0.67–19.76) with a median of 3.7, IQR 2.35–6.64. For the AVR+CABG group the initial logistic EuroSCORE was 9.50±8.6 (1.51–69.5) with a median of 6.93, IQR 4.47–12.39. The EuroSCORE II was 4.77±6.6 (0.96–64.24) with a median of 3.2, IQR 2.09–5.75. The difference between the calculated risk by the initial EuroSCORE and EuroSCORE II is statistically significant ($P<0.001$) for both the MVR+CABG and the AVR+CABG group.

Table 1 Operative data

Variable	MVR+CABG group N=100	AVR+CABG group N=100
Valve replacement		
• Mechanical	4	9
• Biological	22	91
Valve reconstruction	74	
Number of grafts	1.7±0.48 (1–3)	1.4±0.56 (1–3)
Number of distal anastomosis	3.3±1.3 (1–6)	2.3±1.7 (1–6)
Minimaal 1 arterial graft	78	62
ECC time (minutes)	169.4±52.9 (75–431)	149.8±39.1 (70–246)
AOX time (minutes)	112±33.5 (50–264)	102±29.6 (52–197)

AOX aortic cross-clamping

ECC extracorporeal circulation

In eight patients of the MVR+CABG group the EuroSCORE II risk was higher than for the initial EuroSCORE risk; however the mean difference in these patients was 1.80±2.38 (0.09–5.55) For 92 other patients the EuroSCORE II risk was lower than for the risk calculated with the initial EuroSCORE. The mean decrease of risk was 5.44±5.7 (0.4–27.43). In the AVR+CABG group the EuroSCORE II was higher in only three patients, 2.8±3.8 (0.52–7.3); for the other 97 patients the EuroSCORE II was lower than the initial EuroSCORE, 4.9±4.9 (0.06–26.9)

CUSUM analysis

Figure 1 presents the risk-adjusted CUSUM analysis for hospital mortality for both groups using the initial EuroSCORE and the EuroSCORE II risk stratification model. The upwards slope of the CUSUM curves constructed using the EuroSCORE is less than when the initial EuroSCORE is used for both groups.

Discussion

The intention of this study is to evaluate both risk models in clinical use. For this evaluation we selected the last 100 patients undergoing combined mitral valve surgery and CABG and the last 100 patients undergoing combined aortic valve surgery and CABG.

The EuroSCORE II is based on data of more than 22,000 patients undergoing cardiac surgery during the months May to July 2010 and were collected in 154 hospitals in 43 countries. New risk coefficients were calculated on these new data. Also, some risk variables were changed or new variables were identified and included in the EuroSCORE II (Table 2). In the patient-related variables, insulin-dependent diabetes was added. Neurological dysfunction was changed into reduced mobility due to neurological or to musculoskeletal dysfunction. Renal insufficiency defined in the initial EuroSCORE as a serum creatinine of 200 μmol/l preoperatively was replaced by creatinine clearance and subdivided into two groups at increased risk, and patients preoperatively on dialysis are also identified as a separate risk group. In the cardiac-related variables, unstable angina, defined as rest angina requiring intravenous nitrates until arrival in the anaesthetic room, was replaced by NYHA class II, III and IV and angina CCS class 4. The variables left ventricular dysfunction and pulmonary hypertension were divided into new categories. Concerning the operation-related variables, emergency surgery, defined as carried out on referral before the beginning of the next working day, in the initial EuroSCORE has been redefined in

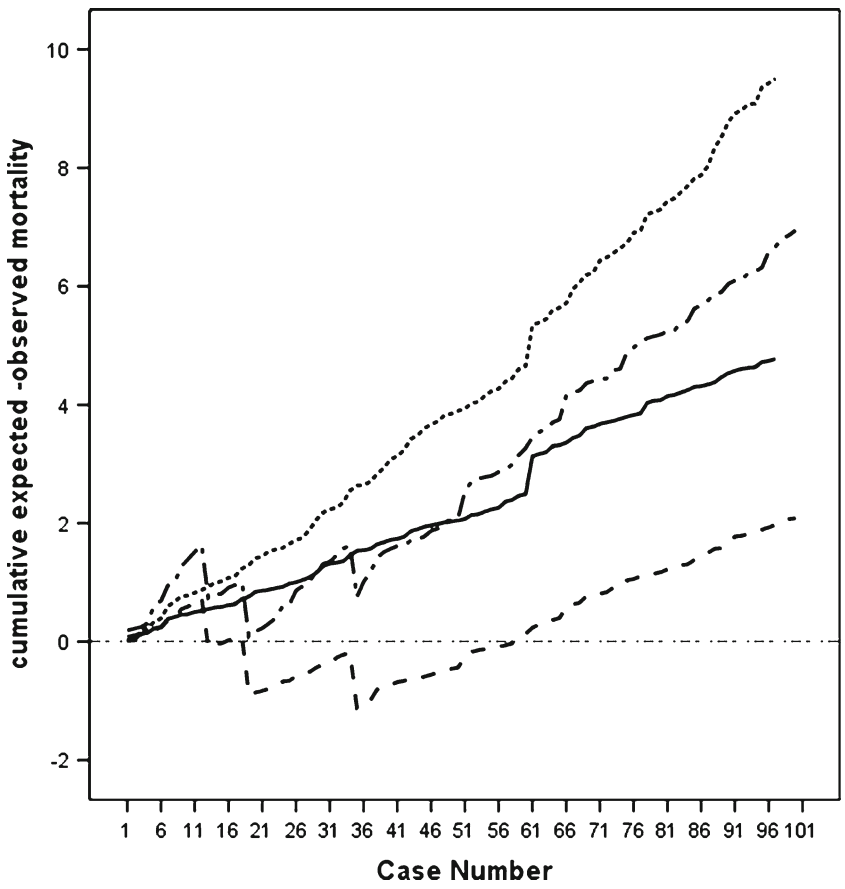

Fig. 1 Risk-adjusted CUSUM chart for hospital mortality. AVR+CABG group: *dotted line* based on the initial EuroSCORE, full line based on the EuroSCORE II. MVR+CABG group: *dash-dot-dash line* based on the initial EuroSCORE, *dashed line* based on the EuroSCORE II

Table 2 Incidence of patients with a risk variable

Initial EuroSCORE			EuroSCORE II		
Variable	MVR+CABG *N*=100	AVR+CABG *N*=100	Variable	MVR+CABG *N*=100	AVR+CABG *N*=100
Patient-related variables					
Age (years)[a]	69.2	73.6	Age (years)[a]	69.2	73.6
Female	30	30	Female	30	30
ECA	15	41	ECA	15	41
CPD	13	8	CPD	13	8
N dysfunction	1	2	N/M dysfunction	1	2
Redo	2	5	Redo	2	5
Renal dysfunction			Renal dysfunction		
Creat≥200 μmol/l	4	0	CC≤50	14	12
			CC>50 to 85	45	47
			On dialysis	1	
AE	2	3	AE	2	3
Critical preop state	7	1	Critical preop state	7	1
			IDD	7	12
Cardiac-related variables					
Unstable angina	0	0	NYHA class II	15	14
			NYHA class III	62	72
			NYHA class IV	19	5
			CSS angina class IV	6	0
LV function			LV function		
30–50 %	29	25	31–50 %	29	18
<30 %	12	2	21–30 %	9	1
			≤20 %	3	1
Unknown[b]	49	58	Unknown[b]	49	58
SPAP			SPAP		
>60 mmHg	7	2	31–55 mmHg	23	13
			>55 mmHg	8	2
Unknown[b]	62	77	Unknown[b]	62	77
Recent MI	18	2	Recent MI	18	2
Operation-related variables					
Emergency	3	0	Urgent	7	1
			Emergency	3	
			Salvage		
Other than ICABG	100	100	Non-ICABG, single		
			Two MCP	91	98
			Three or more MCP	9	2
Thoracic aortic surgery	0	0	Thoracic aortic surgery	0	0
Postinfarct VSR	0	0			

[a] age: mean age is presented, [b] unknown: no measured values are available

ECA extracardiac arteriopathy; *CPD* chronic pulmonary disease; *N-dysfunction* neurological dysfunction; *N/M dysfunction*: neurological or musculoskeletal dysfunction; *Redo* previous cardiac surgery; *creat* serum creatinine; *CC* creatinine clearance; *AE* active endocarditis; *IDD* insulin-dependent diabetes; *NYHA* Hew YORK Heart Association; *CSS* Canadian Cardiovascular Society; *LV* left ventricular; *SPAP* systolic pulmonary artery pressure; *MI* myocardial infarction; *ICABG* isolated CABG; *MCP* major cardiac procedure; *VSR* ventricular septal rupture.

three different risk groups namely urgent, emergency and salvage. Also the variable 'other than isolated CABG' is divided into several risk categories. Of note: postinfarct septal rupture as mentioned in the initial EuroSCORE is not

identified in the EuroSCORE II; this is due to the low number of patients with a postinfarct septal rupture included in the database.

The calculated risk by the EuroSCORE II is statistically significantly lower than the risk calculated by the initial EuroSCORE, with a reduction in risk of about 50 %. This decreased calculated risk for a surgical procedure will certainly have clinical consequences for the decision to perform an operation in 'high-risk' patients. As a few patients will have a lower predicted risk with the EuroSCORE II risk stratification, it may also have consequences in the selection of patients for a transcatheter aortic valve implantation [6].

As a logical consequence of the lower calculated expected risk of the procedure the EuroSCORE II will also have an important influence on the evaluation of the results, using the risk-adjusted CUSUM analysis. The upwards slope of the curves constructed with the EuroSCORE II is less than with the initial EuroSCORE. Despite our results (no mortality in the AVR+CABG group and 3 % mortality in the MVR+CABG group) our CUSUM curves based on the EuroSCORE II risks are nearer to the null line indicating that our performance is better than expected. However, it may be assumed that these curves are more realistic and the curves using the initial EuroSCORE may overestimate our performance.

A limitation of this paper is that the analysis was done in a relatively small number of patients in this study. This also applies to the presented CUSUM analysis. However, one of the strengths of CUSUM analysis is that it can identify subtle differences in a process, even for small numbers. We only included patients undergoing combined valve surgery because it is known that it is especially in these patients that the initial EuroSCORE overestimates the predicted risk.[3, 4] However, there are also some critical notes concerning the EuroSCORE II model itself. What is important is that the EuroSCORE II is based on, and thus predicts hospital mortality, defined as death in the hospital where the operation took place. All participating units were able to provide data on status at discharge but not all units were able to provide data on 30-day status. In the collected dataset, data at 30 days post-surgery were only available in 56.6 % of the patients. The problem with a systematic follow-up of patients undergoing cardiac surgery is well known, however not the focus of this study [7]. Another point is that this EuroSCORE model is built on the same statistical base as the initial EuroSCORE. It would probably have been better to use dynamic modelling techniques as presented by Steyerberg et al [8]. However, also this discussion is beyond the scope of this paper.

An additional, but important, drawback is the number of unknown values for left ventricular function and systolic pulmonary artery pressure (Table 2). These two variables are clearly defined and therefore estimation or estimated values are not acceptable and cannot be used for risk assessment. When a risk variable is unknown, there is no contribution to the calculated expected EuroSCORE risk. That several 'risk' variables are not available, despite their importance, is regrettable because this results in an inferior risk stratification. The same applies for the calculated risks that are used for evaluation of the performed surgery using risk-adjusted CUSUM analysis, or as an indication for transcatheter valve procedures [9, 10]. At this point cardiologists referring their patients for cardiac surgery should be aware of the need for these important risk variables and they should always assess these variables before a patient is presented to the heart team for cardiac intervention.

Conclusion

The initial EuroSCORE no longer seems to be appropriate for risk stratification of currently performed adult cardiac surgery. Progress in preoperative screening, surgical techniques and intensive care has decreased the risk of mortality and morbidity in cardiac surgery. The EuroSCORE II, based on a recently updated database, seems to reduce the overestimation of the calculated risk. The EuroSCORE II may also reflect a better current surgical performance.

References

1. Nashef SA, Roques F, Sharples LD, et al. EuroSCORE II. Eur J Cardiothorac Surg. 2012;41:734–45.
2. Nashef SAM, Roques F, Michel P, et al. European system for cardiac preoperative risk evaluation (EuroSCORE). Eur J Cardiothorac Surg. 1999;16:9–13.
3. Parolari A, Pesce LL, Trezzi M, et al. EuroSCORE performance in valve surgery: a meta-analysis. Ann Thorac Surg. 2010;89(3):787–93.
4. Basraon J, Chandrashekhar YS, John R, et al. Comparison of risk scores to estimate periopertive mortality in aortic valve replacement surgery. Ann Thorac Surg. 2011;92(2):535–40.
5. Noyez L. Control charts, CUSUM techniques and funnel plots. A review of methods for monitoring performance in healthcare. Interact Cardiovasc Thorac Surg. 2009;9:494–9.
6. Vahanian A, Alfieri O, Al-Attor N, et al. Transcather valve implantation for patients with aortic stenosis: a position statement from the European Association of Cardio-Thoracic Surgery (EACTS) and the European Society of Cardiology (ESC), in collaboration with the European Association of Percutaneous Cardiovascular Interventions (EAPCI). Eur Heart J. 2008;29:1463–70.
7. Wouters CW, Noyez L. Is no news good news? Organized follow-up, an absolute necessity for the evaluation of myocardial revascularization. Eur J Cardiothorac Surg. 2004;26:667–70.
8. Steyerberg EW, Eijkemans MJ, Harrel FE, et al. Prognostic modeling with logistic regression analysis: a comparison of selection and estimation methods in small data sets. Stat Med. 2000;19:1059–79.
9. Noyez L, Kievit PC, Verkroost MWA, et al. Evaluation of quality in adult cardiac surgery: let us speak the same language. Neth Heart J. 2010;18:365–9.
10. Baan J, Yong ZY, Koch KT, et al. Percutaneous implantation of the CoreValve aortic valve prosthesis in patients at high risk or rejected for surgical valve replacement. Neth Heart J. 2010;18:16–24.