Standard and logistic EuroSCORE risk evaluation in isolated aortic and mitral valve surgery: Is it time for review?

Standardowa i logistyczna ocena ryzyka EuroSCORE w chirurgii izolowanej wady zastawki aortalnej i mitralnej – czas na modyfikacje?

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Abstract

Aim: To assess the accuracy of EuroSCORE in stratifying perioperative risk in isolated aortic and mitral valve surgery.

Material and methods: Between January 2000 and December 2006, 515 patients underwent aortic valve surgery (AVR group) and 228 patients underwent mitral valve surgery (MVR group). Data were prospectively collected. The association of perioperative risk factors with outcome was investigated in both groups. A comparison of EuroSCORE predicted vs. observed mortality was made.

Results: Patients in the AVR group were older than those in the MVR group; 65.3 years (SD 12.0) vs. 60.7 (SD 12.2) ($p < 0.001$); more frequently had extracardiac arteriopathy; 5.4% vs. 2.2% ($p = 0.024$), and poor preoperative ejection fraction; 9.5% vs. 4.4% ($p = 0.009$). There was no difference in additive EuroSCORE 5.9 (SD 2.9) vs. 6.2 (SD 3.3) and logistic EuroSCORE 9.1 (SD 10.1) vs. 9.1 (SD 13.3). Parsonnet score was higher in the AVR group, 13.2 (SD 7.2) vs. 11.2 (SD 5.8) ($p < 0.001$). The MVR group were more frequently females, 53.1% vs. 40.9% ($p = 0.001$); patients who underwent a redo operation, 16.7% vs. 8.5% ($p = 0.001$); had infective endocarditis, 9.6% vs. 5.2% ($p = 0.013$); and critical preoperative state, 7.9% vs. 1.9% ($p < 0.001$). 30-day mortality in the AVR group was 2.9% and 5.3% in the MVR group ($p = 0.057$).

Conclusions: In both groups, observed mortality was less than that predicted by both additive and logistic EuroSCORE, however it was more accurate in the MVR group.

Key words: Euroscore, aortic, mitral, isolated valve disease.

Streszczenie

Cel: Dokonanie oceny dokładności skali EuroSCORE w stratyfikacji ryzyka okołooperacyjnego w chirurgii izolowanej wady zastawki aortalnej i mitralnej.

Materiał i metody: Między styczniem 2000 r. a grudniem 2006 r. 515 pacjentów poddano operacji zastawki aortalnej (grupa AVR), a 228 operacji zastawki mitralnej (grupa MVR). Dane zebrano prospektywnie. W obydwu grupach dokonano oceny związku pomiędzy czynnikami ryzyka okołoperacyjnego a wynikami. Dokonano porównania pomiędzy spodziewaną śmiertelnością wg EuroSCORE a faktyczną.

Wyniki: Pacjenci w grupie AVR byli starsi aniżeli pacjenci z grupy MVR – 65,3 roku (SD 12,0) *vs* 60,7 (SD 12,2) ($p < 0,001$); częściej chorowali na arteriopatię pozasercową – 5,4% *vs* 2,2% ($p = 0,024$) oraz słabą przedoperacyjną frakcję wyrzutową – 9,5% *vs* 4,4% ($p = 0,009$). Nie odnotowano różnic w addytywnym EuroSCORE 5,9 (SD 2,9) *vs* 6,2 (SD 3,3) oraz logistycznym EuroSCORE 9,1 (SD 10,1) *vs* 9,1 (SD 13,3). Wyniki w skali Parsonneta były wyższe w grupie AVR – 13,2 (SD 7,2) *vs* 11,2 (SD 5,8) ($p < 0,001$). Grupę MVR częściej stanowiły kobiety – 53,1% *vs* 40,9% ($p = 0,001$), poddawani powtórnej operacji re-do – 16,7% *vs* 8,5% ($p = 0,001$), z infekcyjnym zapaleniem wsierdzia – 9,6% *vs* 5,2% ($p = 0,013$), oraz krytycznym stanem przedoperacyjnym – 7,9% *vs* 1,9% ($p < 0,001$). Śmiertelność 30-dniowa w grupie AVR wynosiła 2,9%, zaś w grupie MVR 5,3% ($p = 0,057$).

Wnioski: W obydwu grupach śmiertelność faktyczna była niższa aniżeli przewidywana zarówno przy użyciu adytywnej, jak i logistycznej skali EuroSCORE, jednakże wyniki były dokładniejsze w grupie MVR.

Słowa kluczowe: EuroSCORE, wada zastawki aortalnej, mitralnej, izolowana.

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Introduction

Recently the relevance of risk stratification to the practice of cardiac surgeons worldwide has increased. It influences clinical decision-making, informed patient consent, training and resource planning. Risk stratified outcomes are used to evaluate the performance of individual surgeons as well as cardiac centres. Mortality and morbidity have been the focus of many models based on preoperative and intraoperative factors or a combination of them [1, 2].

The European System for Cardiac Operative Risk Evaluation score (EuroSCORE) [3, 4] has been shown to be a valuable measure for prediction of immediate postoperative death after adult cardiac surgery [5-11]. This system was developed between 1995 and 1999 in 8 European countries. The simple, additive score system has been upgraded by a logistic risk model in the European adult cardiac surgery [3, 4, 7]. This is widely accepted in Europe and also around the world [7, 12-14]. More recent studies suggest that this risk evaluation system overpredicts mortality in modern cardiac surgery [15-18]. EuroSCORE was based on nearly 20 000 patients, with relatively small groups undergoing isolated aortic (AVR) (16.8%) and mitral (MVR) (8.5%) valve surgery [3, 4].

Over the last decade the population undergoing cardiac surgery has changed [15-18]. As cardiac surgery results improve and with cardiologists becoming more aggressive with cardiac interventions, the patients being referred for surgical intervention have a greater risk profile than ever before. This new population of patients with a higher preoperative risk frequently requires more complex surgery. Operative strategies and techniques like repair instead of replacement may also have some input on outcome in modern surgical treatment. This study was undertaken to assess the accuracy of additive and logistic EuroSCORE as a tool for analysing operative outcomes in isolated aortic and mitral valve surgery.

Material and methods

Patient population

From January 2000 until December 2006, 512 patients underwent isolated aortic valve surgery (AVR group) and 227 – mitral valve surgery (MVR group) in the University Hospital of Wales.

All procedures were performed using cardiopulmonary bypass with mild systemic hypothermia (30°C to 34°C). The selection of myocardial protection and the valve prosthesis type was at the discretion of the operating surgeon.

Patients' demographics, preoperative risk factors and operative information together with postoperative hospital course and 30-day mortality were prospectively collected and entered to a database, PATS (Patient Analysis & Tracking System - Dendrite Clinical). Additive and logistic EuroSCORE was calculated and applied to all patients. Definitions of all risk factors in our database were identical to the definitions described in the EuroSCORE [4].

Retrospective analyses of discrepancies in preoperative risk factors between both groups as well as between predicted and observed 30-day mortality were made.

Statistical analysis

Normally distributed continuous data are expressed as mean ± standard deviation throughout. Categorical data are expressed as counts and proportions. Unrelated two-group univariate comparisons were performed with paired and independent, two-tailed t tests for means of normally distributed continuous variables. The χ^2 or Fisher exact univariate tests were used to analyse differences in proportions in the categorical data. All values of p less than 0.05 were considered to be statistically significant. Factors found to trend towards significance by univariate testing ($p < 0.10$) were entered into a multivariate analysis. Binary logistic regression analysis of predictor variables for 30-day mortality was performed with estimate odds ratios (ORs) and 95% confidence intervals (CIs) for each of the independent variables in the model displayed. Model discrimination (statistical accuracy) and calibration (statistical precision) were analysed by determining the area under the receiver operating characteristic (ROC) curve. Data acquisition was performed using Microsoft Excel version 2003 (Microsoft Corporation, USA). Data analysis was performed using SPSS 11.5 statistical software package (SPSS Inc. Chicago, IL, USA).

Results

There were significant differences in preoperative characteristics between the AVR and MVR groups (Table I). There were no differences between both groups in observed mortality ($p = 0.057$), additive ($p = 0.16$) or logistic EuroSCORE ($p = 0.07$). Mortality in the AVR group was 2.9% (n = 15), mean additive EuroSCORE for the group was 6.0 (SD 2.9) ($p < 0.001$) and mean logistic 9.1 (SD 10.1) ($p < 0.001$). In the MVR group mortality was 5.3% (n = 12), mean additive EuroSCORE for that group was 6.2 (SD 3.3) (ns) and mean logistic 9.1 (SD 13.3) ($p = 0.014$). 77 (33.6%) patients undergoing mitral valve surgery had mitral valve repair. Figure 1 summarizes the observed and expected mortality in

Tab. I. Preoperative characteristics of AVR and MVR groups

	AVR Mean/n (SD/%)	MVR Mean/n (SD/%)	*p*
age	65.5 (11.8)	60.8 (12.2)	0.001
female gender	211 (41)	121 (53)	0.001
previous cardiac surgery	43 (8)	38 (17)	0.001
extracardiac arteriopathy	28 (5)	5 (2)	0.001
ejection Fraction < 30%	48 (10)	10 (4)	0.001
active endocarditis	27 (5)	22 (10)	0.001
critical preoperative state	10 (2)	18 (8)	0.001
parsonnet score	13.3 (7.3)	11.2 (5.8)	0.001
EuroSCORE	6.0 (2.9)	6.2 (3.3)	ns
logistic EuroSCORE	7.8 (10.1)	9.1 (13.3)	ns

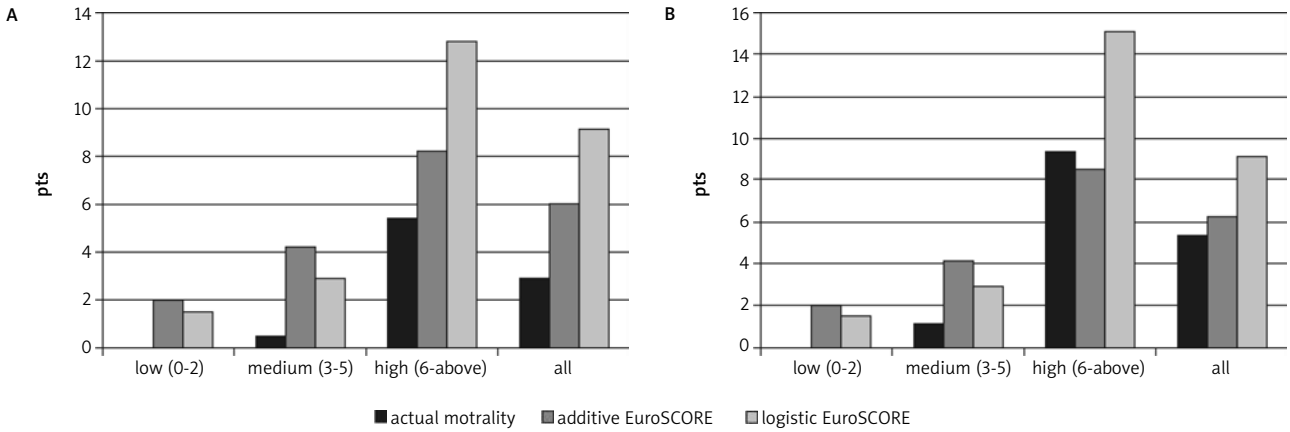

Fig. 1A-B. Observed and expected mortality (%) in 3 conventional EuroSCORE sub-groups (low, medium, high). A. AVR group. B. MVR group

3 conventional EuroSCORE sub-groups (low, medium, high – on the basis of additive EuroSCORE).

To further assess the discriminatory power of additive and logistic EuroSCORE, areas under the ROC curves were measured. Both systems showed good and very good discrimination ability. In the AVR group, the area under the ROC curve was 0.787 for additive and 0.795 for logistic EuroSCORE. In the MVR group, the area under the ROC curve was 0.84 for both additive and logistic EuroSCORE.

Preoperative risk factors including 17 variables from EuroSCORE in both groups were subjected to statistical analysis as predictors of 30-day mortality.

Univariate analysis identified: age above 75 years (p = 0.024), active endocarditis (p = 0.01), critical preoperative state (p = 0.008), preoperative serum creatinine level > 200 mmol/l (p = 0.002), poor left ventricle ejection fraction (EF < 30%) (p = 0.011), emergency operation (p = 0.001) and preoperative atrial fibrillation (p = 0.03) as preoperative predictors of mortality in the AVR group. In the MVR group: chronic pulmonary disease (p = 0.002), active endocarditis (p = 0.002), critical preoperative state (p < 0.001), preoperative serum creatinine level > 200umol/l (p < 0.001), poor left ventricle ejection fraction (EF < 30%) (p < 0.001), recent myocardial infarct less than 90 days before surgery (< 0.001), emergency operation (p < 0.001) and preoperative atrio-ventricular block (p = 0.002) were identified as preoperative risk factors of mortality (Table II).

Multivariate analysis confirmed only emergency operation (p = 0.04, 95% CI 1.1 – 66.9) in patients undergoing AVR as a preoperative predictor of death. In the MVR group: recent myocardial infarct less than 90 days before surgery (p = 0.01, 95% CI 3.2 – 75.4) and preoperative atrio-ventricular block (p = 0.01, 95% CI 1.8 – 86.6) (Table III) were found a negative predictive value.

In order to assess how risk was generated, the distribution of points within groups was examined (Fig. 2). In the AVR group, the total additive EuroSCORE score was 3006 pts (100%) vs. 1381 (100%) in the MVR group. A relatively large component of overall risk in both groups was age. Age above 60 years generated 1050 pts (35.2%) among patients with AVR vs. 325 (23.53%) with MVR.

Tab. II. Univariate analysis of predictors of 30-day mortality in isolated aortic (AVR group) and mitral (MVR group) valve surgery

		p	OR	95% CI	
				Lower	Upper
AVR	age above 75	0.024	5.6	1.4	19.3
	Active endocarditis	0.01	4.9	1.3	18.6
	critical preoperative state	0.008	9.4	1.8	48.6
	preoperative creatinine level > 200umol/l	0.002	8.6	2.2	34.01
	poor ejection fraction (EF)	0.011	1.7	1.1	2.5
	preoperative atrial fibrillation (AF)	0.03	3.6	1.1	11.9
	emergency operation	0.001	11.6	3.3	40.97
MVR	chronic pulmonary disease	0.01	4.9	1.4	16.8
	active endocarditis	0.01	5.4	1.5	19.95
	critical preoperative state	0.003	7.1	1.9	26.7
	preoperative creatinine level > 200 umol/l	0.04	5.9	1.1	32.4
	poor EF	0.003	9.9	2.1	44.7
	preoperative atrio-ventricular block	0.04	9.4	1.1	33.7
	recent MI < 90days	0.001	7.1	1.6	75.5
	emergency operation	0.001	10.9	3.1	37.4

Tab. III. Multivariate analysis of predictors of 30-day mortality in isolated aortic (AVR group) and mitral (MVR group) valve surgery

		p	OR	95% CI. for odds ratio	
				Lower	Upper
AVR group	age	0.025	1.07	1.011	1.170
	creatinine > 200 umol/l	0.046	1.94	1.082	2.435
	emergency	0.04	8.5	1.1	66.9
MVR group	MI < 90 d	0.01	5.6	3.2	75.4
	AV block	0.01	2.3	1.8	86.6

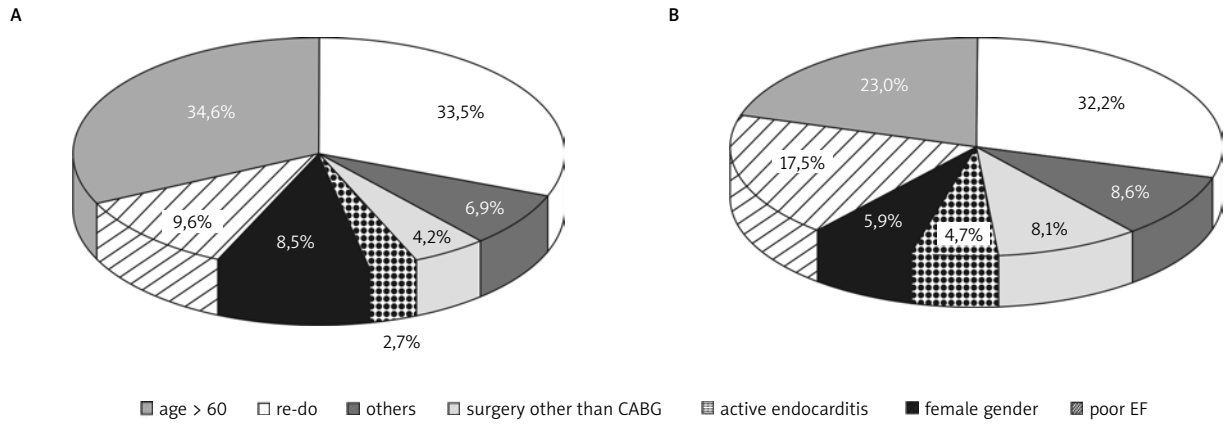

Fig. 2A-B. OWeighting of risk factors in the AVR and MVR groups: where does the risk come from? A. AVR group. B. MVR group

Discussion

Risk prediction models play an important role in current cardiac surgical practice. They allow meaningful comparison of outcomes to be performed between institutions and surgeons by adjusting for differing case-mix. Appropriate risk assessment is vital in surgical decision-making, preoperative patient education and obtaining informed consent [2, 16]. Hence, it is very important that the tools used for this should be as accurate as possible.

This study shows that both additive and logistic EuroSCORE models no longer can be relied upon to accurately predict outcomes in isolated aortic and mitral valve surgery. Both models

overpredict mortality. Furthermore, predicted high mortality for some individuals may change plans concerning surgical treatment. Both systems do not discriminate between mitral and aortic valve surgery giving the same points in additive and the same weight in the logistic system, moreover the same score for multi valve surgery or valve surgery with coronary artery bypass grafting.

Although the discrimination of both EuroSCORE systems, as measured by the ROC statistics, were good and very good, with the area under the ROC curve values of 0.78-0.84, as shown in our data, it appears to consistently overestimate the mortality risk, this happened also in other data [15-18]. When the discrimination is good but the calibration is not, the model could be made more accurate by recalibration. However, in our analysis some preoperative risk factors important for outcome, like atrial fibrillation or atrio-ventricular block, have not been included in original EuroSCORE. Similar findings were presented in other publications [1, 2]. The EuroSCORE model was based on 17 preoperative risk factors and does not take into consideration possible negative intraoperative events such as prolonged cross-clamp time, cardiopulmonary bypass time and requirement for mechanical support at the end of the procedure, which have been proved to be strong predictors for postoperative mortality and morbidity after cardiac surgery [1].

Both systems, additive and logistic, were developed on data of patients operated in 1995 and may not reflect the current cardiac surgical population. From 19 030 patients analysed in original EuroSCORE, only 29.4% had valve surgery, including aortic, mitral and combined procedures. Moreover, this original population was relatively young – only 5% of patients were 75 or older whereas in our study nearly 20%. The original population had also a relatively low preoperative risk with only 29% of people with additive EuroSCORE above 6 whereas in the presented data there was more than 51% of patients with a high preoperative risk [3]. For over more than a decade patients requiring cardiac surgery became older and fitter due to decreased prevalence of smoking, increased attention placed on healthy lifestyles and improved medical treatment of cardiovascular diseases [16, 19]. Hence, the significant weight placed on increasing age in the EuroSCORE model may no longer be appropriate. What is more, also modern cardiac surgery has changed.

There are several limitations to this study. Primarily, this is a retrospective investigation, although the data collection on pre, intra and postoperative factors was performed prospectively. Secondly, this study refers to a single centre regional database; therefore, the results require further evaluation prior to being applied across other institutions and countries.

EuroSCORE remains a useful instrument to identify patients at higher risk of an adverse outcome following cardiac surgery. The additive EuroSCORE is a simple, easily applied and universal system of risk assessment. Both additive and logistic EuroSCORE do not accurately predict outcome in both groups of patients and both overestimate mortality in our population. Moreover, some important factors for predicting outcome may not be taken into account when generating EuroSCORE. That is why we believe that the inaccuracies and overestimation of mortality in the current EuroSCORE system cannot be corrected by simple mathematical manipulation of the calculated score. A new analysis is needed.

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