

Predicting Immediate and Late Outcome after Surgery for Mitral Valve Regurgitation with EuroSCORE

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Background and aim of the study: The European system for cardiac operative risk evaluation score (EuroSCORE) has been shown to be a valid tool for predicting immediate and late outcome after coronary artery bypass surgery. As evidence also suggests its value in heart valve surgery, this issue was investigated in a series of patients who underwent surgery for mitral valve regurgitation.

Methods: Data obtained from 180 patients who underwent mitral valve repair (MVRep) or mitral valve replacement (MVR) were reviewed, and the patients' additive and logistic EuroSCOREs calculated.

Results: The 30-day postoperative mortality rate was 10.0% (n = 18); rates were 7.1% after MVRep and 20.5% after MVR (p = 0.013). The additive EuroSCORE (p <0.0001, area under the ROC curve: 0.804, 95% CI 0.689-0.919, SE 0.059), as well as logistic EuroSCORE (p <0.0001, area under the ROC curve: 0.806, 95% CI 0.695-0.918, SE 0.057) were predictors of 30-day postoperative death. The 10-year overall sur-

vival rate from any cause of death was 74.7%. Additive and logistic EuroSCOREs were significantly higher in the MVR group compared to the MVRep group (p <0.0001 in both cases), and also among operative survivors. Patients who underwent MVR had a significantly poorer long-term survival than those with MVRep (p = 0.01). Both the additive EuroSCORE (p <0.0001) and logistic EuroSCORE (p = 0.003) were predictors of late, all-cause mortality. Both scores remained significant predictors of late outcome also when adjusted for type of surgery (MVRep versus MVR). Survival was particularly dismal in patients with an additive EuroSCORE ≥ 6 (at 10 years, 54.4% versus 86.6%, p <0.00001) or a logistic EuroSCORE ≥ 4 (at 10 years, 58.7% versus 86.6%, p <0.00001).

Conclusion: EuroSCORE is an important predictor of immediate and late outcome after surgery for mitral valve regurgitation.

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Mitral valve surgery is associated with relevant immediate postoperative mortality rates (1) which seem to be significantly higher after mitral valve replacement (MVR) compared with mitral valve repair (MVRep) (1-4). In particular, early postoperative mortality after MVR can approach 15% (1,3,4). The European system for cardiac operative risk evaluation score (EuroSCORE) (5) has been used and shown worldwide to be a valid tool for predicting immediate postoperative outcome after adult cardiac surgery (6-17). Some evidence also exists that this risk-scoring

method is a good predictor of late outcome after coronary artery bypass surgery (14-16), as well as heart valve surgery (16-18). This issue was further investigated in a series of patients who underwent surgery for mitral valve regurgitation.

Clinical material and methods

Patients

Between 1993 and 2000, a total of 207 patients underwent MVR or MVRep for mitral valve regurgitation at the authors' institution. Patients with mitral valve stenosis or combined mitral valve regurgitation and stenosis were excluded from the present analysis. Data on preoperative, intraoperative and postoperative variables were collected retrospectively from patients' records by a single surgeon (J.H.). Data for 180 patients were available for the retrospective calculation of additive and logistic EuroSCOREs (5,19).

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Data acquisition

The postoperative outcome after discharge following cardiac surgery was obtained by reviewing the hospital records, inclusive of data from all wards of the authors' hospital. If the patient was discharged to

another hospital for medical treatment or rehabilitation, the outcome data were retrieved from the discharge records of the latter institutions. In addition, patients were contacted by mail, while causes of late death were obtained from a national registry

Table I: Preoperative risk factors for patients undergoing mitral valve repair (MVRep) and mitral valve replacement (MVR).

Parameter	Overall	MVRep	MVR	p-value ⁺
Age (years)*	63.3 (53.8-69.2)	63.1 (53.3-68.8)	65.2 (56.6-73.1)	0.22
Females	56 (31.1)	38 (27.0)	18 (46.2)	0.022
Asthma/COPD	14 (7.8)	10 (7.1)	4 (10.3)	0.51
Extracardiac arteriopathy	7 (3.9)	5 (3.5)	2 (5.1)	0.64
Neurological dysfunction	9 (5.0)	6 (4.3)	3 (7.7)	0.41
Prior cardiac operation	14 (7.8)	11 (7.8)	3 (7.7)	1.00
CABG surgery	4 (2.2)	4 (2.8)	0	-
Aortic valve replacement	1 (0.6)	0	1 (2.6)	-
Atrial septal defect repair	4 (2.2)	4 (2.8)	0	-
Mitral valve repair	3 (1.7)	1 (0.7)	2 (5.1)	-
Aortic coarctation	1 (0.6)	1 (0.7)	0	-
Pentalogy of Fallot		1 (0.7)	0	-
Serum creatinine >200 µmol/l	3 (1.7)	1 (0.7)	2 (5.1)	0.12
Active endocarditis	3 (1.7)	0	3 (7.7)	0.010
Congestive heart failure	16 (8.9)	9 (6.4)	7 (17.9)	0.025
Critical preoperative state	10 (5.6)	2 (1.4)	8 (20.5)	<0.0001
Diabetes	17 (9.4)	12 (8.5)	5 (12.8)	0.53
Coronary artery disease	68 (37.8)	52 (36.9)	16 (41.0)	0.64
Previous MI	28 (15.6)	17 (12.1)	11 (28.2)	0.014
MI <3 months	14 (7.8)	4 (2.8)	10 (25.6)	<0.0001
Unstable angina pectoris	9 (5.0)	4 (2.8)	5 (12.8)	0.024
Regurgitation grade (n = 173)				0.005
1	1 (0.6)	0	1 (2.8)	-
2	13 (7.2)	8 (5.8)	5 (13.9)	-
3	106 (58.9)	92 (67.2)	14 (38.9)	-
4	53 (29.4)	37 (27.0)	16 (44.4)	-
NYHA class III-IV	112 (62.6)	77 (54.6)	35 (92.1)	<0.0001
Atrial fibrillation (n = 174)	39 (21.7)	32 (23.0)	7 (20.0)	0.018
Systolic PAP >60 mmHg	46 (25.6)	26 (18.4)	20 (51.3)	<0.0001
Type of operation				<0.0001
Elective	126 (70.0)	114 (80.9)	12 (30.8)	-
Urgent	39 (21.7)	23 (16.3)	16 (41.0)	-
Emergent	15 (8.3)	4 (2.8)	11 (28.2)	-
Etiology				0.09
Myxomatous degeneration	149 (82.8)	119 (84.4)	30 (76.9)	-
Rheumatic	4 (2.2)	3 (2.1)	1 (2.6)	-
Ischemic	10 (5.6)	5 (3.5)	5 (12.8)	-
Endocarditis	7 (3.9)	4 (2.8)	3 (7.7)	-
Trauma	2 (1.1)	2 (1.4)	0	-
No evident cause	8 (4.4)	8 (5.7)	0	-
LVEF <50%	32 (17.8)	20 (14.2)	12 (30.8)	0.017
Additive EuroSCORE*	5 (3-7)	4 (3-6)	8 (5-11)	<0.0001
Logistic EuroSCORE (%)*	3.7 (2.1-7.6)	3.2 (1.9-5.8)	10.0 (4.0-26.8)	<0.0001

Values in parentheses are percentages.

Continuous variables are reported as the median plus 25th and 75th interquartile range.

*Values are mean ± SD (range).

+MVRep group versus MVR group.

CABG: Coronary artery bypass grafting surgery; COPD: Chronic obstructive pulmonary disease; LVEF: Left ventricular ejection fraction; MI: Myocardial infarction; PAP: Pulmonary artery pressure.

(Tilastokeskus).

Preoperative clinical data and operative data for the overall series, as well for the MVR and MVRep groups, are listed in Tables I and II, respectively. Coronary angiography was routinely performed before surgery in order to assess the status of the coronary arteries and, in patients who previously have undergone coronary artery bypass surgery, of the bypass grafts.

Surgical procedure

Surgery was performed through a median sternotomy, employing moderate systemic hypothermia and antegrade/retrograde cold blood cardioplegia. St. Jude Medical mechanical prostheses (median size 29 mm; interquartile range (IQR) 27-31 mm) were inserted in all patients undergoing MVR. Low-molecular-weight heparin was administered postoperatively, and followed by warfarin for about three months, unless a patient had received a prosthetic valve or had chronic atrial fibrillation which indicated an indefinite need for permanent anticoagulation.

Statistical analysis

Statistical analysis was performed using SPSS statistical software (SPSS v. 10.0.5; SPSS Inc., Chicago, IL,

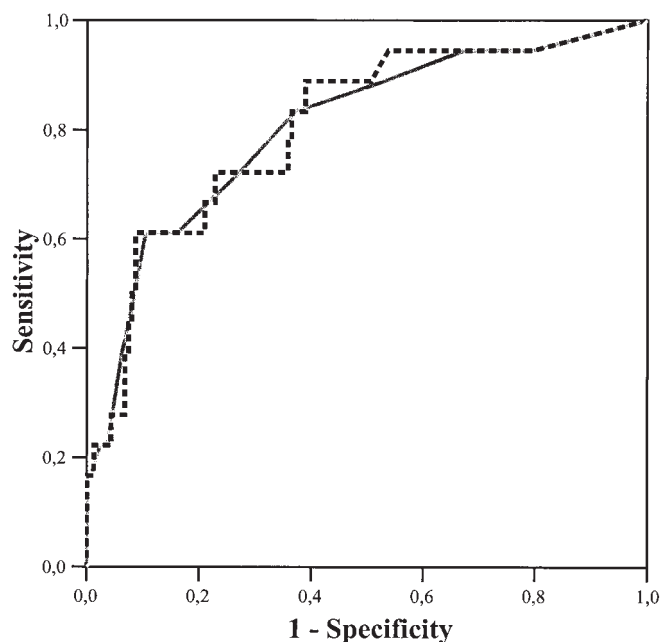


Figure 1: Area under the receiver operating characteristics curve of additive EuroSCORE (solid line) and logistic EuroSCORE in predicting 30-day postoperative death after surgery for mitral valve regurgitation.

Table II: Operative details for patients undergoing mitral valve repair (MVRep) and mitral valve replacement (MVR).

Parameter	Overall	MVRep	MVR	p-value ⁺
Findings at operation				
Annulus dilatation	24 (13.3)	19 (13.5)	5 (12.8)	0.91
Anterior leaflet disease	34 (18.9)	25 (17.7)	9 (23.1)	0.49
Posterior leaflet disease	77 (42.8)	67 (47.5)	10 (25.6)	0.015
Anterior + posterior leaflet involved	30 (16.7)	27 (19.1)	3 (7.7)	0.14
Ruptured chordae	89 (49.4)	75 (53.2)	14 (35.9)	0.056
Ruptured papillary muscle	5 (2.8)	4 (2.8)	1 (2.6)	1.00
Calcified valve	7 (48.9)	1 (0.7)	6 (15.4)	<0.0001
Annuloplasty				
Ring annuloplasty	88 (48.9)	-	-	-
Other	44 (24.4)	-	-	-
Leaflet resection and reconstruction				
Shortening of the chordae	12 (6.7)	-	-	-
Chordae reconstruction with PTFE thread	31 (17.2)	-	-	-
Associated procedures				
Coronary artery bypass surgery	67 (37.2)	50 (35.5)	22 (56.4)	0.35
Aortic valve replacement	10 (5.6)	1 (0.7)	9 (23.1)	<0.0001
Tricuspid valve repair	18 (10.0)	16 (11.3)	2 (5.1)	0.37
Atrial septal defect closure	10 (5.6)	8 (5.7)	2 (5.1)	1.00
Maze	7 (3.9)	7 (5.0)	0	0.15
Aortic cross-clamp time (min) [*]	139 (114-182)	134 (113-179)	156 (118-203)	0.090
CPB duration (min) [*]	189 (155-242)	183 (154-234)	224 (170-260)	0.049
Duration of surgery (min) [*]	285 (240-360)	275 (240-349)	345 (265-380)	0.018

Values in parentheses are percentages.

^{*}Values are mean \pm SD (range).

⁺MVRep group versus MVR group.

CPB: Cardiopulmonary bypass; PTFE: Polytetrafluoroethylene

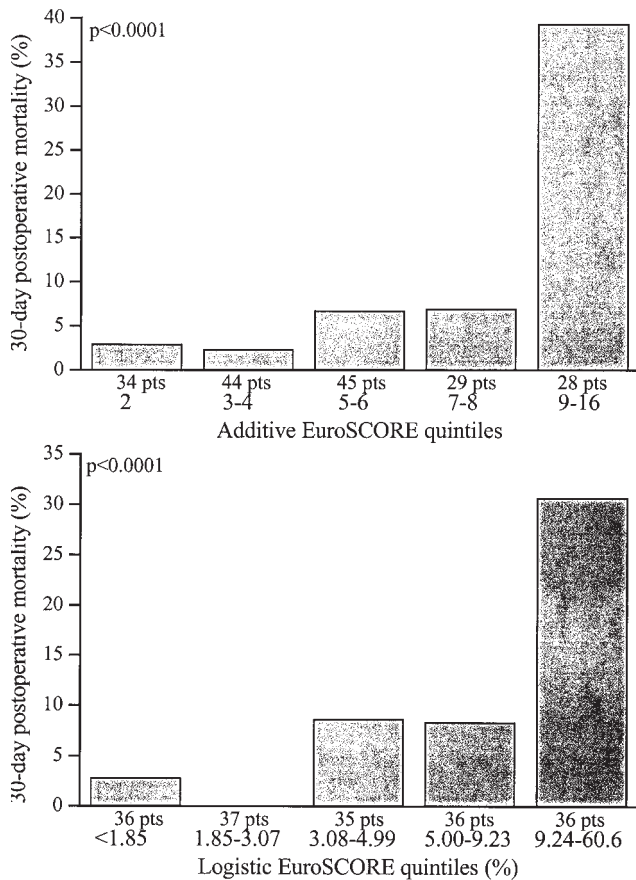


Figure 2: Thirty-day postoperative mortality rates according to different quintiles of additive and logistic EuroSCOREs. Numbers of patients per quintile are shown below each column.

USA). Continuous variables were reported as the median with 25th and 75th IQR. A chi-square test, Fisher's exact test and the Mann-Whitney test were used to evaluate any differences between the study groups. A receiver operating characteristics (ROC) curve was used to evaluate the impact of additive and logistic EuroSCOREs on the immediate postoperative mortality. The Kaplan-Meier method was used to estimate the long-term outcome. The Kaplan-Meier method and the Cox regression were used to evaluate the impact of EuroSCOREs on long-term survival. A p-value <0.05 was considered to be statistically significant.

Results

Thirty-day postoperative outcome

The 30-day postoperative mortality rate was 10.0% (n = 18); rates were 7.1% (n = 10) in the MVRep group and 20.5% (n = 8) in the MVR group (p = 0.013). Both additive and logistic EuroSCOREs were significantly higher in the MVR group compared to the MVRep

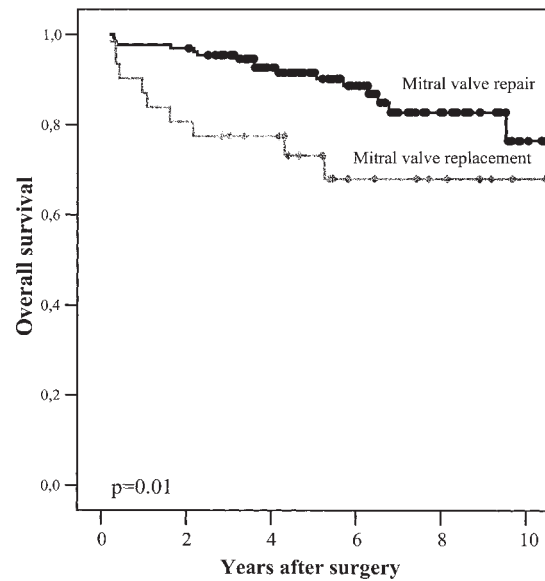


Figure 3: Overall long-term outcome of operative survivors after mitral valve repair compared with mitral valve replacement.

group (Table I). The additive EuroSCORE (p <0.0001, area under the ROC curve: 0.804, 95% CI 0.689-0.919, SE 0.059) as well as the logistic EuroSCORE (p <0.0001, area under the ROC curve: 0.806, 95% CI 0.695-0.918, SE 0.057) were significantly associated with 30-day postoperative death (Fig. 1). The 30-day postoperative mortality rates, according to different quintiles of additive and logistic EuroSCOREs, are shown graphically in Figure 2.

According to the ROC curve analysis, the best cut-off values for additive and logistic EuroSCOREs were 6% and 4.0%, respectively. The 30-day postoperative mortality rate was 20.0% in patients with an additive EuroSCORE ≥ 6 , but only 2.9% in those with an additive EuroSCORE <6 (p <0.0001, sensitivity 83.3%, specificity 62.9%, accuracy 65.0%). The 30-day postoperative mortality rate was 18.8% in patients with a logistic EuroSCORE ≥ 4 , but only 2.1% in those with an additive EuroSCORE <4 (p <0.0001, sensitivity 88.8%, specificity 57.4%, accuracy 60.5%).

Late outcome

Among operative survivors, 25 patients died during a median follow-up period of 5.1 years (IQR 3.5-7.3 years). The 10-year overall survival rate from any cause of death was 74.7%. Patients who underwent MVR had a significantly poorer long-term survival

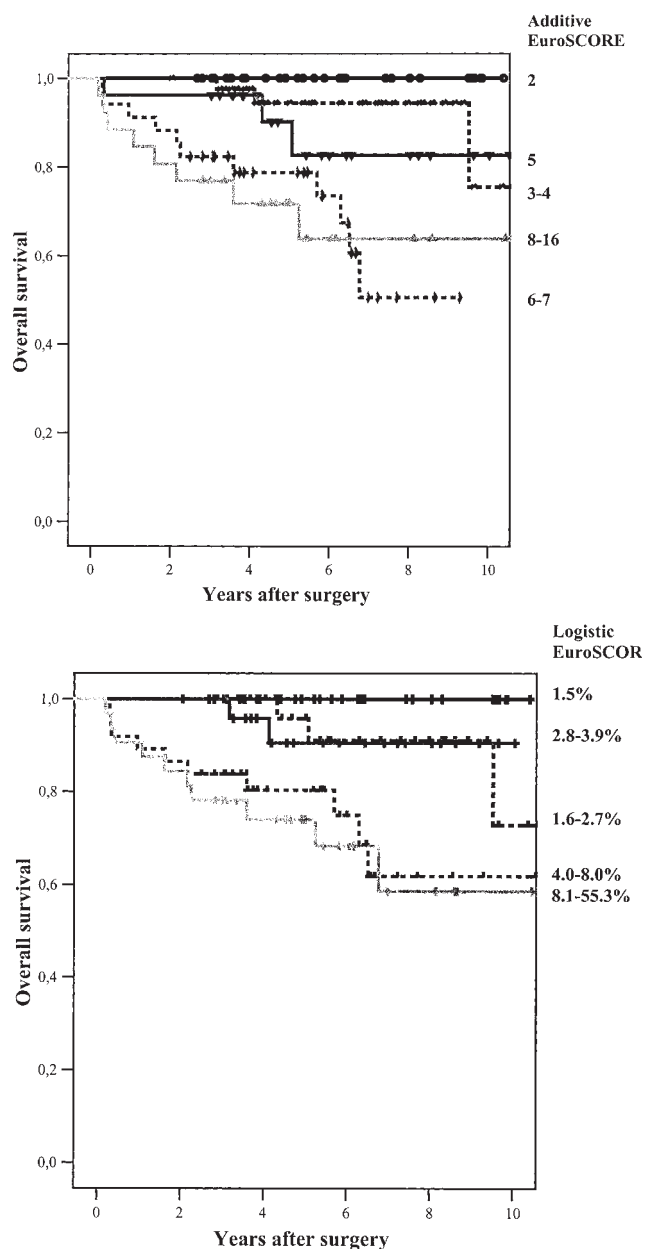


Figure 4: Kaplan-Meier estimate of overall long-term survival after surgery for mitral valve regurgitation. a) According to different additive EuroSCORE quintiles among operative survivors ($p < 0.0001$); b) according to different logistic EuroSCORE quintiles among operative survivors ($p < 0.0001$).

than those who had MVRep ($p = 0.01$; Fig. 3). The additive EuroSCORE (median: 8 versus 4, $p < 0.0001$) and logistic EuroSCORE (median: 9.6 versus 3.1, $p < 0.0001$) were also significantly higher in the MVR group compared to the MVRep group among operative survivors. Both additive ($p < 0.0001$) and logistic ($p = 0.003$) EuroSCOREs were predictors of late all-cause mortality. These scores remained significant predictors of late outcome also when adjusted for type of surgery

(MVRep versus MVR). The Kaplan-Meier estimates according to different quintiles of additive and logistic EuroSCOREs among operative survivors are shown in Figure 4. Ten-year survival was particularly dismal in patients with an additive EuroSCORE ≥ 6 (54.4% versus 86.6%, $p < 0.00001$) or a logistic EuroSCORE $\geq 4\%$ (58.7% versus 86.6%, $p < 0.00001$).

Discussion

The results of the present study showed that EuroSCORE is an important tool in predicting both the immediate and late outcome after mitral valve surgery. This observation confirms the validity of the EuroSCORE and previous observations on its value in predicting late outcome after isolated coronary artery bypass surgery, as well as adult heart valve surgery. To the best of the present authors' knowledge, this is the first series to include only those patients who underwent surgery for mitral valve regurgitation. This finding is of major relevance, as this risk-scoring method is simple and, today, is used worldwide, thus making it an optimal tool for risk stratification and a valid means for the comparison of results.

From the clinical point of view, it is worth noting that an additive EuroSCORE ≥ 9 was associated, in the present authors' experience, with a prohibitive operative risk that, along with the observed poor late survival in operative survivors within the subgroup of patients with an additive EuroSCORE ≥ 6 , clearly distinguishes low-risk patients from high-risk patients. This provides a good estimate of the operative risk and life expectancy after mitral valve surgery, which may be relevant in the decision-making process. In fact, as reported previously, MVRep is a durable procedure and is associated with satisfactory late survival (20) and a good quality of life (21). However, according to the present findings, patients undergoing MVR are not expected to experience the same benefits, as the latter procedure is associated with rather poor immediate postoperative and late survival.

These considerations should be viewed along with the limitations of the small size of the present series. However, these findings seem to indicate that, today, MVR is indicated only in patients with mitral valve regurgitation not amenable to repair, and that their operative risk is significantly higher than those in whom valve repair is technically feasible. Thus, the EuroSCORE herein indicated that the results of MVRep are not comparable to those of MVR, and further comparative analyses between these two procedures may benefit from including this risk-scoring method.

Finally, the present results indicate that prompt referral to mitral valve surgery can be of the utmost

benefit for these patients, as conservative management may in some cases dramatically increase the operative risk as well as shorten the patient's life expectancy. This is especially true in the case of patients who underwent MVR, where the prevalence of a critical preoperative state and raised pulmonary artery pressure, along with grade 4 mitral valve regurgitation, were extremely high.

In conclusion, the results of the present study highlighted the validity of both additive and logistic EuroSCOREs in predicting immediate postoperative outcome and, importantly, also the late survival of patients undergoing mitral valve surgery.

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