EuroSCORE Predicts Short- and Mid-Term Mortality in Combined Aortic Valve Replacement and Coronary Artery Bypass Patients

Kimiyoshi J. Kobayashi, B.S., Jason A. Williams, M.D., Lois U. Nwakanma, M.D., Eric S. Weiss, M.D., Vincent L. Gott, M.D., William A. Baumgartner, M.D., and John V. Conte, M.D.

Division of Cardiac Surgery, Johns Hopkins Medical Institutions, Baltimore, Maryland

ABSTRACT ***Background and Aim of the Study:*** **European system for cardiac operative risk evaluation (EuroSCORE) has been studied for its effectiveness in predicting operative mortality, and more recently, long-term mortality in a wide variety of cardiac surgical procedures. Combined coronary artery bypass and aortic valve replacement (AVR-CABG) carries increased perioperative risk, and tends to have higher-risk patients. Performance of the EuroSCORE system in patients undergoing concomitant AVR-CABG has not been well established. Thus, we aimed to analyze the accuracy of both additive and logistic EuroSCOREs in predicting operative and mid-term mortality.** ***Methods:*** **We retrospectively reviewed and calculated EuroSCOREs for all patients who underwent AVR-CABG between January 2000 and December 2004. Patients who had previous cardiac surgery and those undergoing any concomitant procedures were excluded. Areas under the receiver operator curves (ROC) were determined to assess EuroSCORE's accuracy in predicting operative mortality. Kaplan-Meier analysis and Cox regression were used to determine mid-term survival, freedom from repeat revascularization, and predictors of these outcomes.** ***Results:*** **There were 233 patients who met study criteria. Mean follow-up period was 2.2 ± 1.7 years with one patient lost to follow-up. Mean additive and logistic EuroSCOREs were 8.77 and 16.1, respectively, with an observed mortality of 9.44%. The area under the ROC curves for additive EuroSCORE was 0.76 and for logistic EuroSCORE was 0.75. Regression analysis revealed additive EuroSCORE, but not logistic EuroSCORE, to be predictive of mid-term mortality.** ***Conclusions:*** **Both additive and logistic EuroSCOREs were accurate in predicting operative morality. Only additive EuroSCORE was predictive of mid-term mortality in AVR-CABG patients. EuroSCORE remains a good and well-validated risk stratification model applicable to patients who undergo concomitant AVR-CABG.** doi: 10.1111/j.1540-8191.2009.00906.x *(J Card Surg 2009;24:637-643)*

Developed in the late 1990s from a large multi-institution database, the European system for cardiac operative risk evaluation (EuroSCORE) was initially designed to predict operative mortality in cardiac surgical patients using preoperative clinical characteristics.[1] Since its inception, it has been the subject of extensive validation. When compared to other operative mortality score systems such as the Parsonnet, Cleveland Clinic, and CABDEAL, EuroSCORE has been proven to be superior for all cardiac procedures, including coronary artery bypass grafting (CABG).[2,3] The literature has further demonstrated the model's applicability to patient populations outside of the United Kingdom, where it was originally developed.[4,5] Recent literature suggests that EuroSCORE's application can be extended as a predictor of long-term mortality and outcome in various cardiac surgical procedures.[6-14] EuroSCORE—because of its widespread validation and acceptance—is particularly suited for preoperatively quantifying risk and for risk adjustment when comparing institutional and individual surgeon performance.[15]

Patients undergoing combined bypass and valvular procedures tend to be older and carry multiple preoperative comorbidities, thus putting them at higher operative risk. Despite this risk, 2006 witnessed combined CABG and aortic valve replacement (AVR-CABG) to be the third most frequently performed procedure behind isolated CABG and AVR.[16] The above facts underscore the importance of effective preoperative risk stratification for AVR-CABG patients. Numerous publications have validated the use of EuroSCORE for predicting operative and long-term mortality for CABG and AVR as separate procedures.[8-12] It has been shown that both the additive and the logistic EuroSCORE were predictive of long-term mortality in CABG patients.[8-9] Similarly, both EuroSCORE systems

Address for correspondence: John V. Conte, M.D., Professor of Surgery, Surgical Director, Heart Transplantation, Division of Cardiac Surgery, Department of Surgery, Blalock 618, Johns Hopkins Hospital, 600 North Wolfe Street, Baltimore, MD 21287-4618. Fax: 410-955-3809; e-mail: jconte@csurg.jhmi.jhu.edu

were predictors of long-term mortality in valvular surgical patients.[12] Dedicated studies on the predictive value of EuroSCORE for combined bypass and valvular procedures are limited.[13,17] Thus, the purpose of our study was to evaluate the accuracy of the additive and the logistic EuroSCORE for predicting operative mortality and to determine whether they were predictors of mid-term mortality in combined AVR-CABG patients. We further extended our analysis to determine whether EuroSCORE could be used as a predictor of major postoperative morbidities.

MATERIAL AND METHODS

Patient selection

Patients were selected from the 378 patients who underwent AVR-CABG in the 5-year period between January 2000 and December 2004 at our institution. To exclude possible confounders from our analysis, patients with a history of prior cardiac surgery or those undergoing any additional procedures other than AVR-CABG were excluded. Only those patients who had a concomitant placement of an intraaortic balloon pump or aortic root enlargement were included in this study.

Retrospective data collection consisted of review of patient medical records. Additional follow-up data were collected by reviewing outpatient records and contacting patients through letter mailings and telephone interviews. This study's methods and Health Insurance Portability and Accountability Act (HIPAA) waiver for individual patient consent was approved by our Institutional Review Board.

Variable definitions and EuroSCORE calculation

Preoperative hemodynamic characteristics were collected for each patient using both echocardiography and cardiac catheterization reports. Any coronary narrowing greater than 70% was considered stenosed. Diagnoses of aortic stenosis and aortic insufficiency were based on preoperative echocardiography as well as intraoperative findings.

Variables for all patients were collected to calculate both the additive and the logistic EuroSCOREs. Throughout the manuscript, where not specified, "EuroSCORE" will refer to the additive rather than the logistic EuroSCORE. Variable definitions were in accordance with the definitions listed on the EuroSCORE website (http://euroscore.org/index.htm). Neurological dysfunctional disease was defined as any patient who had a preoperative history of transient ischemic attacks or stroke. In addition to the EuroSCORE definition of systolic pulmonary artery pressure greater than 60 mmHg, patients were categorized as having pulmonary hypertension if they had a mean pulmonary artery pressure greater than 25 mmHg. Emergent operation was defined in our study as any operation that was performed within 24 hours of referral. Due to the patient selection in this study, no patient had previous cardiac surgery, isolated CABG, or surgery on the thoracic aorta. Both the additive and the logistic EuroSCOREs were calculated for each patient using the formulas available on the EuroSCORE website. Patients were separated into groups of high, moderate, or low risk, according to their EuroSCORE for further statistical analyses. The EuroSCORE cutoffs were chosen arbitrarily to give three groups of equal size: patients with an additive risk score below 7 were considered low risk, those with scores between 8 and 10 were considered moderate risk, and those with a risk score above 11 were considered high risk.

Our primary endpoints were operative and mid-term mortality. Operative morality was defined as any death prior to discharge or within 30 days of operation. Mid-term mortality refers to any death after hospital discharge, but within a 6-year postoperative period.

Secondary morbidity endpoints used in the study were postoperative repeat revascularization and postoperative cardiac rehospitalization. Postoperative repeat revascularization was defined as any postoperative repeat surgical bypass, as well as any percutaneous coronary interventions. Postoperative cardiac rehospitalization was defined as any subsequent hospital admission following initial operative discharge where the primary indication for admission was a cardiac issue.

Statistical analysis

All statistical analyses were performed using SPSS 13.0 software (SPSS Inc., Chicago, IL, USA). Means were compared using one-sample Student's *t*-tests. Pearson chi-square and Fisher's exact test were used to analyze differences in categorical variables. To determine whether operative mortality is predicted by the additive or logistic EuroSCORE, univariate logistic regression was used. For the regression, the study sample was divided along placeholder values into three groups of risk using both additive and logistic scores. The receiver operating characteristics (ROC) curves were plotted to assess the ability of the additive and logistic EuroSCOREs to predict operative mortality.[18] The ROC curves were generated based on the results of logistical regression analysis. After excluding those patients considered to be operative mortalities, the Kaplan-Meier method was used to calculate late survival for the patient group. Similar to previous studies,[9,12] univariate Cox proportional hazards model was used to analyze whether additive or logistic EuroSCORE predicted mid-term mortality. In addition, multivariate Cox regression was used to determine whether variables other than those used to calculate EuroSCORE were predictors of mid-term mortality.

Finally, analysis of the relationship between EuroSCORE (both additive and logistic) and postoperative morbidities (repeat revascularization and cardiac rehospitalization) followed similar analytical methods as those used for operative and mid-term mortality. The Kaplan-Meier method was used to calculate freedom from postoperative morbidities at the one, two, and 5-year mark, after excluding those patients considered to be postoperative mortalities. Next, univariate and then multivariate Cox regression was used to determine whether EuroSCORE or any other preoperative variables were predictors of the postoperative morbidities. Following convention, a p value less than 0.05 was considered statistically significant.

RESULTS

There were 233 patients who met the study criteria over the 5-year study period. The major clinical characteristics for the entire study group are summarized in Table 1. Of note, our study's patient sample was a relatively high-risk group with an advanced mean age, poor preoperative New York Heart Association functional status, and extensive coronary disease (Table 1). Accordingly, over the entire patient sample the mean additive and logistic EuroSCOREs were 8.77 ± 3.16 and 16.1 ± 13.9, respectively. The observed operative mortality was 9.44% (n = 22). Both the additive and logistic EuroSCOREs did not differ significantly from the observed mortality (Table 2). When separated by additive EuroSCORE, the logistic EuroSCORE predicted a higher operative mortality than was observed in almost every group (Fig. 1). Further, for lower-risk patients with a EuroSCORE below 8, both the additive and logistic EuroSCORE predicted higher mortality than was observed (Fig. 1).

TABLE 1
Preoperative Clinical Data

Variable	No. (%)
Mean age (years)	73.6 ± 10.6
Females	78 (33.5)
Chronic obstructive pulmonary disease	21 (9.0)
Emergent procedure	3 (1.3)
Extracardiac arteriopathy	55 (23.6)
Neurologic dysfunction	16 (6.9)
Serum creatinine (>200 μmol/L)	14 (6.0)
Active endocarditis	0 (0)
Critical preoperative state	5 (2.1)
Preoperative NYHA class III/IV	173 (74.2)
Hypertension	181 (77.7)
Hypercholesterolemia	124 (53.2)
Diabetes	70 (30.0)
Unstable angina	71 (30.5)
Left ventricular dysfunction	
Moderate (30% to 50%)	58 (24.9)
Poor (<30%)	17 (7.3)
Recent history of MI (<90 days)	28 (12.0)
Pulmonary hypertension	93 (39.9)
Smoking history	116 (49.8)
Atrial fibrillation	21 (9.0)
Aortic stenosis	220 (94.4)
Aortic insufficiency	45 (19.3)
Mean number of stenosed vessels	2.06 ± 0.80
CAD*	
1 territory	67 (28.8)
2 territories	84 (36.1)
3 territories	82 (35.2)
IMA graft	187 (80.3)
IMA-LAD	167 (89.3)†

NYHA = New York Heart Association; MI = myocardial infarction; CAD = coronary artery disease; IMA = internal mammary artery; LAD = left anterior descending.
*For CAD, the three territories used were left anterior descending coronary artery, left circumflex coronary artery, and right coronary artery. Left main disease was considered two-territory disease.
†This represents the number of patients who specifically received an IMA graft to the LAD. Percentages are presented as a percentage of the number of IMA grafts (one row above).

Patients were stratified according to the risk predicted by their additive EuroSCORE into low, moderate, or high risk using arbitrary threshold values. Table 2 shows the mean additive and logistic EuroSCOREs along with the observed operative mortality for each patient group. Further, univariate logistic regression was used to determine whether additive or logistic EuroSCOREs (as both a continuous score and in categorical risk groups) predicted observed mortality. Both the additive and logistic EuroSCORE's predicted mortality overall (Table 2). When stratified by risk, this effect was confined to the highest risk patients (Table 2).

To better assess EuroSCORE's accuracy as a model in predicting operative mortality, ROC curves were plotted (Fig. 2). For the entire study sample, the areas under the ROC curves for the additive and the logistic EuroSCORE models were 0.76 (95% confidence interval [CI] 0.66 to 0.87) and 0.75 (95% CI 0.64 to 0.86), respectively (Fig. 2). Analysis of the areas under the ROC curves was not stratified by risk group as we felt that the sample sizes in the subgroups were too small to yield statistically robust information.

The mean follow-up period for our study was 2.2 ± 1.7 years with only one patient lost to follow-up. Using the Kaplan-Meier method, mid-term survival was determined for those patients who survived the perioperative period. The survival at 1, 2, and 5 years for the entire patient cohort was 88.1%, 83.3%, and 66.3%, respectively. When stratified by predicted risk, the low-risk patients had a significantly higher 5-year survival when compared to moderate- and low-risk patients: 5-year survival for low-, moderate-, and high-risk patients were 82.2%, 58.1%, and 53.4%, respectively (Fig. 3, p = 0.019).

The results of the univariate Cox regression analysis revealed the additive EuroSCORE (hazard ratio [HR] = 1.29, 95% CI 1.03 to 1.63, p = 0.030), but not the logistic EuroSCORE (HR = 0.98, 95% CI 0.93 to 1.04, p = 0.59), to be predictive of mid-term mortality. Further, in addition to the additive EuroSCORE, multivariate Cox regression analysis using variables not used in the EuroSCORE calculation revealed preoperative New York Heart Association (NYHA) class III/IV (HR = 4.17, 95% CI1.65 to 10.6, p = 0.003) and preoperative atrial fibrillation (HR = 2.36, 95% CI 1.18 to 4.69, p = 0.02) as two other variables predictive of mid-term mortality. Within each risk group, neither the additive nor the logistic EuroSCORE were predictive of mid-term mortality. Only atrial fibrillation in the low-risk group was predictive (HR = 26.1, 95% CI 1.80 to 378.5, p = 0.017). Finally, hazard ratios were calculated using Cox regression for the predicted risk stratified groups and are listed in Table 3.

Postoperative repeat revascularization and cardiac rehospitalization are both major postoperative outcomes for AVR-CABG patients. Overall, there were

TABLE 2
Observed and Predicted Operative Mortality Stratified by EuroSCORE Risk

Risk	Observed Mortality (%)	Additive EuroSCORE (p Value)	Odds Ratio (95% CI), p Value*	Logistic EuroSCORE (p Value)*	Odds Ratio (95% CI), p Value*
All patients (n = 233)	9.44 (n = 22)	8.77 ± 3.16 (0.13)	1.39 (1.19 to 1.63), $p < 0.001$†	16.1 ± 13.9 (0.74)	258.3 (19.0 to 3508.3), $p < 0.001$†
Low (ref) (EuroSCORE 0 to 7, n = 84)	2.38 (n = 2)	5.49 ± 1.48	Reference	4.79 ± 2.00	Reference
Moderate (EuroSCORE 8 to 10, n = 86)	6.98 (n = 6)	9.07 ± 0.82	3.1 (0.6 to 15.7), p = 0.17	13.5 ± 3.60 (0.15)	1.72 (0.37 to 8.0), p = 0.5
High (EuroSCORE 11 to 17, n = 63)	23.0 (n = 14)	12.7 ± 1.70 (0.55)	11.7 (2.6 to 53.7), p = 0.002	34.7 ± 12.9 (0.91)	6.77 (1.9 to 24.4), $p < 0.001$

EuroSCORE = European system for cardiac operative risk evaluation.
Both additive and logistic EuroSCORE shown with mean ± standard deviation.
*p value based on univariate logistic regression comparing additive and logistic EuroSCORE to operative mortality.
†OR based on additive and logistic EuroSCOREs as continuous variables for the entire study sample. When stratified, the cutoff values used for the logistic EuroSCORE to produce three risk groups were 2% to 8%, 9% to 17%, and 18% to 69% for low-, moderate-, and high-risk groups. Those used for the additive EuroSCORE are indicated in the table.

six patients (2.6%) who underwent postoperative repeat revascularization. At 1, 2, and 5 years, the freedom from repeat revascularization was 98.8%, 96.8%, and 96.8%, respectively. There was no significant difference when stratified by risk group; the 5-year freedom from repeat revascularization was 94.4%, 98.5%, and 97.9%, respectively, for low-, moderate-, and high-risk groups (p = 0.80). Both univariate and multivariate Cox regressions were used to further determine whether any preoperative variable was predictive of repeat revascularization. No preoperative variable—including the additive and the logistic EuroSCORE—was a significant predictor. No difference was observed even after stratification by risk group.

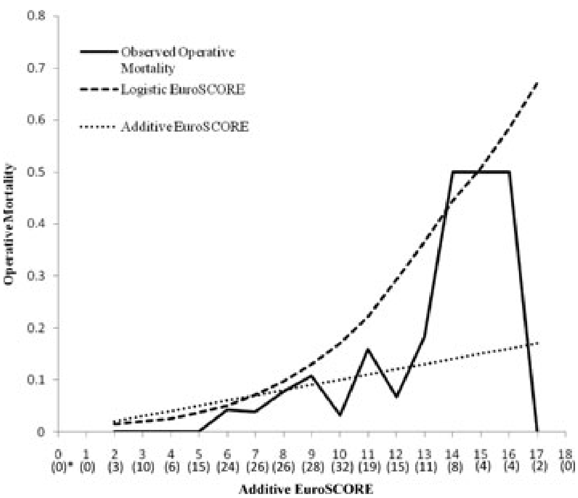


Figure 1. *Comparison of observed and predicted operative mortality using logistic and additive EuroSCORE. EuroSCORE = European system for cardiac operative risk evaluation. *Number in parentheses represents number of patients with the respective EuroSCORE.*

Next, we analyzed the ability of EuroSCORE to predict cardiac rehospitalization. In the study sample of 233 patients, there were 30 patients who had one or more hospital admissions for a cardiac issue. The 1-, 2-, and 5-year freedom from cardiac rehospitalization was 95.8%, 93.0%, and 66.1%, respectively. When stratified by additive EuroSCORE, the difference in 5-year freedom from rehospitalization approached statistical significance: 79.2%, 60.9%, and 50.6% for the low-, moderate-, and high-risk groups, respectively (p = 0.053). Univariate Cox regressions revealed neither additive nor logistic EuroSCORE to be predictive

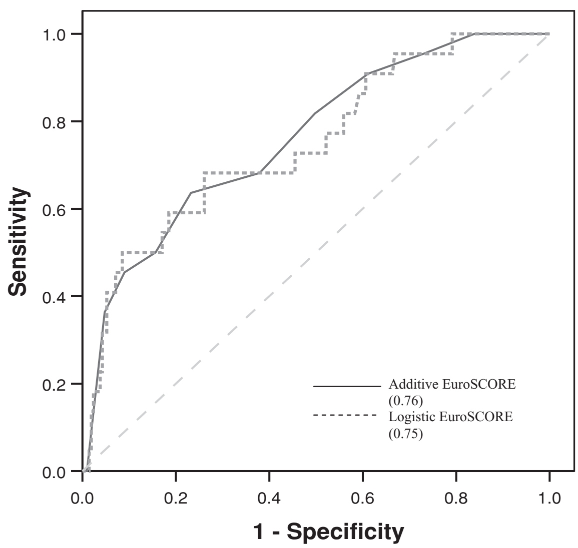
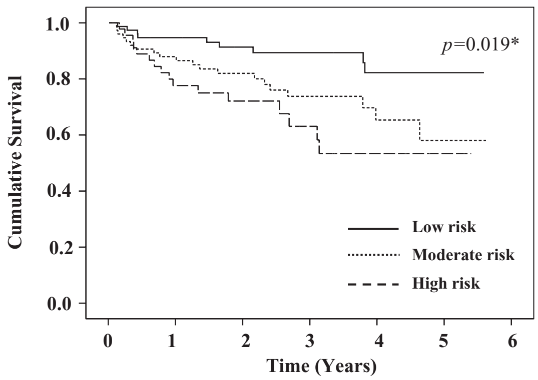


Figure 2. *Receiver operator characteristics (ROC) curves were plotted to determine the accuracy of additive and logistic EuroSCORE at predicting operative mortality for patients undergoing AVR-CABG. The areas underneath the corresponding curves are indicated in parentheses. EuroSCORE = European system for cardiac operative risk evaluation.*



		Time (years) 0	1	2	3	4	5
Number at risk	Low risk	82	67	48	36	20	9
	Moderate risk	80	63	47	30	15	5
	High risk	49	34	24	13	7	2

Figure 3. *Kaplan-Meier survival stratified by predicted risk for those patients who survived the initial perioperative period. *p value compared the difference between the cumulative survival of the three risk groups over the 5-year study period, excluding those patients who were considered operative mortalities.*

of rehospitalization ($p = 0.057$ and $p = 0.136$, respectively). Further multivariate Cox regression analysis revealed the presence of preoperative chronic obstructive pulmonary disease (COPD) to be the only variable predictive of rehospitalization (HR = 7.45, 95% CI1.83 to 30.4, $p = 0.005$).

DISCUSSION

Accurate risk stratification models are a critical part of improving care and allocation of resources. Being able to differentiate accurately between a low- and high-risk patient allows for better informed consent, choice of intervention, and delivery of postoperative care. In addition, quality monitoring and outcomes results of individual surgeons, institutions, or national healthcare systems must be adjusted for the patient's preoperative risk in order to be fair and informative. Increasingly, preoperative risk score models are being used to triage high-risk patients between open versus less invasive interventions, especially in patients requiring aortic valve procedures.[19] Thus, EuroSCORE and other risk stratification models can potentially make a huge impact and must be validated and studied for its accuracy and precision in a wide variety of patient populations and procedures. To this end, EuroSCORE has been applied successfully to a large number of procedures including revascularization and valvular interventions at different institutions in both the United Kingdom and abroad.[4-13] EuroSCORE's ability to predict longer-term mortality, in addition to operative mortality, for certain procedures increases its potential impact and utility. Although EuroSCORE has been extensively verified in CABG and valvular procedures, its applicability in combined AVR-CABG has not been extensively documented. Previous studies on combined bypass and valvular procedures did not use the logistic EuroSCORE[13] or analyzed only operative mortality.[17] There is some controversy as to whether the logistic EuroSCORE may overestimate operative mortality in high-risk patients.[19,20,21] This study sought to comprehensively analyze the accuracy of both the additive and the logistic EuroSCOREs and their ability to predict both operative and mid-term mortality in AVR-CABG patients.

The results of our retrospective analysis of 233 AVR-CABG patients revealed that both the additive and the logistic models were very good at predicting operative mortality and that the additive, but not the logistic, scores were predictive of mid-term mortality. Overall, our study population consisted of higher-risk patients than those in the previous literature,[17] as can be seen by the higher mean additive and logistic EuroSCOREs (8.77 and 16.1 vs. 6.7 and 9.4, $p < 0.05$ for both). At the same time, however, our observed mortality was not significantly different from the study sample from Karthik and colleagues (9.44% vs. 8.7%, Reference 17, p = NS).

One important limitation of previous studies on EuroSCORE in bypass and valvular procedures is that they have not included a truly rigorous assessment of scores' predictive ability using ROC curves. For our study sample, the areas under the ROC curves for the additive and logistic EuroSCORE were 0.76 and 0.75 for operative mortality, respectively, indicating that both EuroSCOREs had good accuracy at predicting operative mortality. The study sample was divided into three risk groups of similar size to verify whether the logistic EuroSCORE was a better predictor of operative mortality in high-risk patients. Similar to previously published results,[17,20,21] the mortality tended to be overestimated and underestimated by the logistic and the additive EuroSCOREs, respectively, though the difference between the mean EuroSCORE and the observed mortality of the entire study sample was not significantly different. In addition, the additive EuroSCORE tended to overestimate mortality in lower-risk patients while underestimating risk in high-risk patients, similar to previously published results.[4] The logistic model is a more accurate estimation of mortality because patients with many preoperative risk factors should have a mortality that is compounding instead of simply being additive. Small sample size contributed to our inability to calculate ROC curves with ample statistical

TABLE 3
Hazard Ratios Stratified by Predicted Risk

Risk	Hazard Ratio	95% Confidence Interval	p Value
Low (EuroSCORE 0 to 7, n = 84)	1.00	Reference	–
Moderate (EuroSCORE 8 to 10, n = 86)	2.53	1.25 to 5.12	0.010
High (EuroSCORE 11 to 17, n = 63)	4.98	2.49 to 9.96	<0.001

EuroSCORE = European system for cardiac operative risk evaluation.

robustness; however, data presented in Figure 1 and Table 2 suggest that the logistic EuroSCORE overestimates risk in high-risk groups. These results are consistent with recently published literature.[19,20] This suggests that perhaps in these higher-risk patient groups, different predictive models such Society of Thoracic Surgeons Predicted Risk of Mortality (STS-PROM) should be used in addition to EuroSCORE to predict a patient's operative risk profile.

What accounts for this overestimation? Aside from small sample size, another possibility is that the discrepancy between observed and predicted mortality is a reflection of a single institution and not the inaccuracy of the EuroSCORE model. Second, due to reconciliation of some preoperative variables that factor into the calculation of the EuroSCORE, some patients may have been characterized as having a risk factor they did not truly have, which would translate into an inflated predicted mortality. Alternatively, the difference may be a reflection of overall improvement in the care of cardiac surgery patients. According to the Society of Thoracic Surgeons, the operative mortality of all AVR-CABG patients has decreased since 1999 when EuroSCORE was developed[16]; thus, we would expect EuroSCORE to overpredict mortality. The possibility of type II error within these small patient subgroups is considerable, and reflects an important limitation of this study. A larger study would need to be undertaken before reaching any further conclusions on the apparent overestimation of mortality.

Next, we sought to determine whether the additive or the logistic EuroSCORE could predict mid-term mortality. Our regression analysis revealed that only the additive EuroSCORE was predictive of mid-term mortality. Other than the EuroSCORE, both poor preoperative NYHA class and atrial fibrillation were also important risk factors for mid-term mortality. One expectation is that if the study sample were divided by risk, then the logistic EuroSCORE may be more predictive of mid-term mortality within the high-risk subgroup. However, this was not the case. In fact, neither the additive nor the logistic EuroSCORE were predictive of mid-term mortality in any of the subgroups. Here again, our suspicion is that the small sample size of the subgroups limited the power of our analysis to appreciate smaller differences. Over the entire study sample, however, additive EuroSCORE was an independent predictor of mid-term morality, and thus remains the bedside "gold standard" for calculation of a patient's EuroSCORE[21] as it has important implications for predicting both short- and mid-term mortality.

In this study, we plotted ROC curves to examine the predictive ability of EuroSCORE in the logistic regression for operative mortality. One extension that could be performed in the future would be to plot ROC curves for the Cox regression to determine the predictive ability of EuroSCORE with respect to mid-term survival. These extended analytical methods would be an informative addition to this and other EuroSCORE studies in the literature.

Several previous studies have extended their analysis to determine whether EuroSCORE is a predictor of postoperative morbidity.[2,3] For our AVR-CABG patients, postoperative repeat revascularization was a major morbidity; however, neither the additive nor the logistic EuroSCORE were predictive of this outcome. EuroSCORE was developed initially as a model for operative mortality and thus we did not expect it to be predictive of repeat revascularization. This is most likely a reflection that the risk factors for repeat revascularization are not the same as those that are important in surviving the immediate operative period.

In contrast, patients with higher preoperative risk profiles may be more susceptible to subsequent cardiac rehospitalization following their initial procedure. Although neither the additive nor logistic EuroSCORE were predictive of cardiac rehospitalization, the analysis of additive EuroSCORE approached statistical significance. Further, when the study sample was stratified into risk groups, the higher-risk patients had a lower freedom from rehospitalization compared to lower-risk patients. This observed difference approached statistical significance, and perhaps would have been significant had the study sample been slightly larger. Only the preoperative presence of COPD was found to be a statistically significant predictor of cardiac rehospitalization. Our analysis suggests that EuroSCORE may be a better predictor of postoperative cardiac rehospitalization rather than revascularization.

In conclusion, though this study was limited by its retrospective nature and somewhat limited sample size, we were able to undertake a detailed study of EuroSCORE in AVR-CABG patients. Most studies on the subject have focused on the procedures separately. Our results suggest that both the additive and the logistic EuroSCORE are good at predicting operative mortality, and that the additive EuroSCORE can be used to predict mid-term survival. AVR-CABG is often considered to be a higher risk operation with patients who tend to be elderly and have multiple comorbidities. An important conclusion supported by this study and others is that logistic EuroSCORE may overstate the risk of the open AVR-CABG procedure in high-risk patients. We support the conclusion of Dewey and colleagues[20] that the best approach may be to use multiple predictive models to assess a patient's true preoperative risk profile. However, we believe that surgical intervention should remain a strong option even for high-risk patients.

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