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Original article

Evaluation of accuracy of EuroSCORE II in prediction of in-hospital mortality in patients underwent mitral valve replacement in Egypt

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Abstract

Objective: To evaluate the performance of the updated version of European System for Cardiac Operative Risk Evaluation (EuroSCORE II) for prediction of in-hospital mortality after mitral valve replacement.

Patients and methods: Medical records of 580 Egyptian patients underwent mitral valve replacement in Nasser institute, Suez Canal University, and Minia University hospitals were evaluated in six-year period. Data on demographics, comorbidities, risk factors, operative outcome and postoperative complications were collected with in-hospital mortality as primary end-point. Statistical analysis assessed discriminative power and calibration of EuroSCORE II.

Results: The study population had younger age, more prevalence of female gender and higher body mass index (BMI) than EuroSCORE II population. The observed in-hospital mortality rate was 2.6% and average of the predicted mortality by EuroSCORE II was 1.60%. EuroSCORE II had low discriminative power (area under the curve 0.52, 95% CI: 0.38–0.66), and poor calibration as determined by Hosmer–Lemeshow (HL) test (P-value = 0.02). On multivariate analysis, other factors not involved in EuroSCORE II were significant predictors for in-hospital mortality including redo-operation, previous valvuloplasty, hypercholesterolemia and chronic liver disease.

Conclusion: Differences in clinical profile and presence of other local risk factors may explain the reduced discriminative and predictive power of EuroSCORE II in Egyptian patients underwent mitral valve replacement. Other larger prospective studies in this concern are recommended.

Keywords: Cardiac surgery; Risk factors; Hospital mortality

1. Introduction

During preoperative evaluation of patients undergoing cardiac surgery, risk stratification is helpful to determine outcome associated with such operations and to identify the treatable conditions that may help to reduce the risk of morbidity and mortality [1].

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The European System for Cardiac Operative Risk Evaluation (EuroSCORE) is the most prevalent risk predicting model that was established during 1995–1999 to present a risk model in adult European patients undergoing cardiac surgery [2].

Changing epidemiology of cardiac surgery and improvement of surgical techniques affected the calibration of EuroSCORE. To overcome this problem, EuroSCORE II is available since October 2011, in order to maintain and optimize its role in contemporary cardiac surgical practice [3].

Nowadays, EuroSCORE II is well accepted and routinely used in clinical practice in many countries [4]. However, limitations in the inter-observer reliability of a risk-predicting model raise the need for external validation of EuroSCORE II in larger populations and in other geographic regions [5,6].

The aim of this study was to assess the role of EuroSCORE II risk model in predicting in-hospital mortality of Egyptian patients undergoing mitral valve replacement.

2. Patients and methods

2.1. Study population

This retrospective study evaluated the medical records of 580 adult patients who underwent mitral valve replacement in departments of cardiac surgery at the Nasser Institute, Suez Canal University Hospital and Minia University Hospital in Egypt, between January 2010 and December 2015.

The collected data included preoperative risk factors of EuroSCORE II: age, female gender, creatinine clearance, extracardiac arteriopathy, poor mobility due to musculoskeletal or neurological dysfunction, previous cardiac surgery, chronic pulmonary disease, active endocarditis, critical state, diabetes on insulin, New York Heart Association (NYHA) functional classification, Canadian Cardiovascular Society (CCS) grade IV of angina, left ventricular ejection fraction (LVEF), recent myocardial infarction (MI), systolic pulmonary artery pressure (sPAP), urgency of operation, weight of the intervention and surgery on thoracic aorta [3]. Medical records with lacking of data were excluded from analysis (17 out of 597 records). EuroSCORE II was calculated using online interactive calculator (http://www.euroscore.org/calc.html).

The primary end point was in-hospital all-cause mortality that was defined as death occurring at any time after surgery during in-hospital period. Additional data on other preoperative risk factors or comorbidities, operative data, major operative and postoperative complications was collected if available.

2.2. Statistical analysis

Statistical analysis was performed with the SPSS 18.0 software (SPSS, Inc., Chicago, IL, USA). The quantitative data were presented as mean and standard deviation or median (interquartile range) and compared using t-student test while qualitative data were expressed by number and percentage and compared using Chi-square test.

The discriminative power of EuroSCORE II model was estimated by the area under the receiver operating characteristic (ROC) curve which was calculated as an index to discriminate between lived and died patients after cardiac surgery. The results were presented with 95% confidence interval (CI) and P-value < 0.05 was considered significant. The discriminative power of the model was considered good if area under the curve (AUC) was >0.70.

To estimate EuroSCORE II model calibration, the Hosmer–Lemeshow goodness of fit test and calibration plots were used to compare observed to predicted values by decile of predicted probability. A well-calibrated model for the study population was considered when Hosmer–Lemeshow p-value > 0.05.

To identify, other independent predictors of mortality, multivariate logistic regression was performed with calculation of odds ratio (OR), 95% confidence interval (CI) and significance level (P-value) for risk factors of mortality that had a statistical significance on univariate analysis.

3. Results

3.1. Patients' characteristics

The study included 580 patients underwent isolated mitral valve replacement (MVR). The age ranged from 18 to 67 years with mean of 41.3 ± 11.2 years and 48.2% of the included patients were female. The preoperative and

Table 1
Preoperative and intraoperative characteristics of the study cohort.

Variables	Patients underwent MVR (n = 580)
Age (years); mean ± SD (range)	40 ± 13 (18–67)
Female gender; n (%)	280 (48.2%)
EuroSCORE II; median (range)	1.60 (0.50–27.2)
Renal function:	
- Normal	546 (94.13%)
- Moderate impairment	24 (4.13%)
- Severe impairment	10 (1.72%)
Extracardiac arteriopathy	9 (1.55%)
Previous cardiac surgery	14 (2.41%)
Chronic pulmonary disease	10 (1.72%)
Active endocarditis	15 (2.6%)
Critical preoperative state	15 (2.6%)
Diabetes on insulin therapy	10 (1.72%)
NYHA functional class:	
- NYHA I	5 (0.86%)
- NYHA II	235 (40.51%)
- NYHA III	285 (49.13%)
- NYHA IV	35 (6.03%)
CCS class 4 angina	10 (1.72%)
LV function:	
- Fair (30–49%)	18 (3.10%)
- Good (>50%)	562 (96.89%)
Pulmonary hypertension	29 (5%)
Other than isolated CABG	580 (100%)
Redo-operation	18 (3.10%)
Diabetes mellitus	15 (2.6%)
Hypertension	9 (1.55%)
Previous valvuloplasty	10 (1.72%)
Hypercholesterolemia	6 (1.03%)
Smoking (Ex-smoker or still-smoking)	92 (15.86%)
Chronic liver disease	19 (3.27%)
Cardioplegia method:	
- Cold cardioplegia	525 (90.51%)
- Warm cardioplegia	55 (9.48%)
Coming off bypass:	
- High inotropic support	1 (0.17%)
- Minimal inotropic support	399 (68.79%)
- No inotropic support	180 (31.03%)
Bypass time (min); median (range)	75 (38–255)
Cross-clamp time (min); median (range)	55 (21–213)

intraoperative characteristics of the study patients are shown in Table 1. Most of patients had normal renal function (94.13%), good left ventricular (LV) function (96.89%), NYHA functional class III (49.13%), and most of them underwent elective MVR (93.96%) for first time (96.89%). Most of operations were done using cold cardioplegia (90.51%), with minimal need for inotropic support (68.79%).

Comparison of preoperative risk factors and demographics between Egyptian patients cohort who underwent mitral valve replacement (MVR) and EuroSCORE II population (Table 2), revealed presence of significant differences in the clinical profiles as Egyptian surgical population had younger age, more prevalence of female gender and higher body mass index (BMI).

3.2. Immediate postoperative outcome

Regarding the immediate postoperative results (Table 3), median length of ICU stay was 24 h (range: 18–340 h), and median total hospital stay was 9 days (range: 5–44 days), with 18.10% of patients had total hospital stay for more than 15 days. Low incidences of postoperative complications were reported, including neurological

Table 2
Comparison of preoperative risk factors and demographics between Egyptian patients cohort underwent mitral valve replacement (MVR) and EuroSCORE II population.

Variables	Egyptian population underwent MVR (n = 580)	EuroSCORE II population (n = 22,381)	P-value
Age (years); mean ± SD (range)	41.3 ± 11.2 (18–67)	64.6 ± 12.5 (18–95)	<0.001[a]
Female gender; n (%)	280 (48.2%)	6919 (30.9%)	<0.001[a]
Body mass index (kg/m^2)	29.08 ± 8.9	27.4 ± 4.8	<0.001[a]
Diabetes on insulin therapy	10 (1.7%)	1705 (7.6%)	<0.001[a]
Pulmonary disease	10 (1.7%)	2384 (10.7%)	<0.001[a]
Neurological dysfunction with poor mobility	0 (0%)	713 (3.2%)	<0.001[a]
Creatinine clearance (ml/min)	87.75 ± 15.14	83.6 ± 50.9	0.04[a]
Active endocarditis	15 (2.6%)	497 (2.2%)	0.55
Critical preoperative state	15 (2.6%)	924 (4.1%)	0.06
Emergency operation	20 (3.44%)	4135 (18.5%)	<0.001[a]
Surgery on thoracic aorta	0 (0%)	1636 (7.3%)	<0.001[a]

[a] Significant difference.

Table 3
Immediate postoperative results.

Variables	Patients underwent MVR (n = 580)
Stay on ICU (hours); median (range)	24 (18–340)
Total hospital stay (days); median (range)	9 (5–44)
Long hospital stay > 15 days; n (%)	105 (18.10%)
Neurological complications	1 (0.17%)
Prolonged ventilation	5 (0.86%)
DSW infection	3 (0.51%)
Renal complications	0 (0%)
Reoperation	6 (1.03%)
Low cardiac output	4 (0.68%)
Arrhythmias	1 (0.17%)
Pulmonary complications	1 (0.17%)
Readmitted to ICU	1 (0.17%)
Mortality	15 (2.6%)

ICU: Intensive care unit, DSW: Deep sternal wound.

complications in 0.17%, prolonged ventilation in 0.86%, deep sternal wound (DSW) infection in 0.51%, reoperation in 1.03%, low cardiac output in 0.68%, arrhythmias in 0.17%, pulmonary complications in 0.17% and readmission to ICU in 0.17%.

3.3. Observed and predicted mortalities

The observed rate of in-hospital mortality was 2.6% (n = 15 patients). The predicted mortality by EuroSCORE II ranged from 0.50 to 27.2% with mean of 1.60%. The expected 1st quartile of EuroSCORE II was 0.67% in 145 patients, while 2nd was 0.80% in another 145 patients, 3rd quartile was 1.13% in 150 patients and 4th quartile was >1.13% in 140 patients. Table 4 distributes observed in-hospital mortality in relation to expected quartiles

Table 4
Observed in-hospital mortality in relation to expected quartiles of mortality estimated by EuroSCORE II.

Outcome	Quartiles of EuroSCORE II			
	0–0.67%	0.68–0.80%	0.81–1.13%	>1.13%
Alive	142 (97.9%)	139 (95.9%)	148 (98.7%)	136 (97.1%)
Died	3 (2.1%)	6 (4.1%)	2 (1.3%)	4 (2.9%)
Total	145	145	150	140

estimated by EuroSCORE II. The real observed mortality rate was 2.1% of patients in 1st quartile, 4.1% in 2nd quartile, 1.3% of 3rd quartile and 2.9% in 4th quartile, with non-significant difference (P = 0.47). Fig. 1 represents a histogram of real observed mortality in relation to predicted quartiles of EuroSCORE II, indicating non-parametric distribution of died patients as most of them were in 1st and 2nd quartiles of EuroSCORE II.

3.4. Accuracy (discriminative power)

As shown in (Fig. 2), the area under the ROC curve (AUC) for the EuroSCORE II was 0.52 (95% CI, 0.38–0.66) with no statistical significance (P = 0.77), indicating that EuroSCORE II had low discriminative power to distinguish between incidences of died and alive patients.

3.5. Calibration (predictive power)

The Hosmer–Lemeshow (HL) goodness-of-fit test showed a significant difference between expected and observed mortality according to EuroSCORE II model (Chi-square = 16.2, P = 0.02), indicating poor calibration of this model in predicting the overall in-hospital mortality (Fig. 3).

3.6. Other predictors of in-hospital mortality

On multivariate logistic regression (Table 5), other factors not involved in EuroSCORE II were significant predictors for in-hospital mortality in our study cohort which included redo-operation (Odds ratio: 57.67; 95% CI: 10.51–316.34; P = 0.0001), previous valvuloplasty (Odds ratio: 50.32; 95% CI: 5.50–459.74; P = 0.001), hypercholesterolemia (Odds ratio: 34.64; 95% CI: 1.11–1073.91; P = 0.043) and chronic liver disease (Odds ratio: 17.82; 95% CI: 2.20–143.96; P = 0.007).

4. Discussion

The rheumatic etiology is the leading reason of valve surgery in Egypt while the degenerative etiology is the leading reason of valve surgery in western countries. The rheumatic fever in Egypt has an aggressive course because of the reluctance to give proper prophylactic courses of long acting penicillin. Accordingly more patients require surgery in younger age compared with the western population. Other common and endemic liver diseases in Egypt like

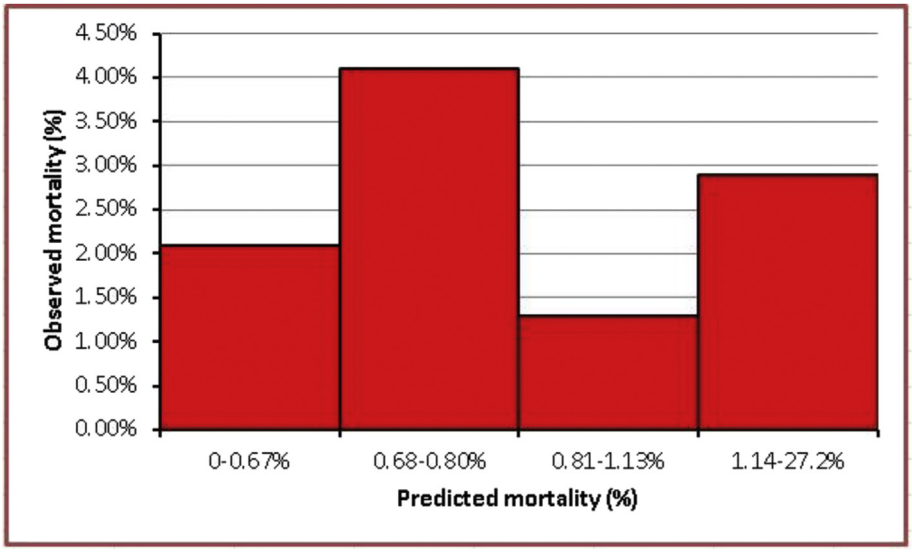

Fig. 1. Histogram of real observed mortality in relation to predicted quartiles of EuroSCORE II.

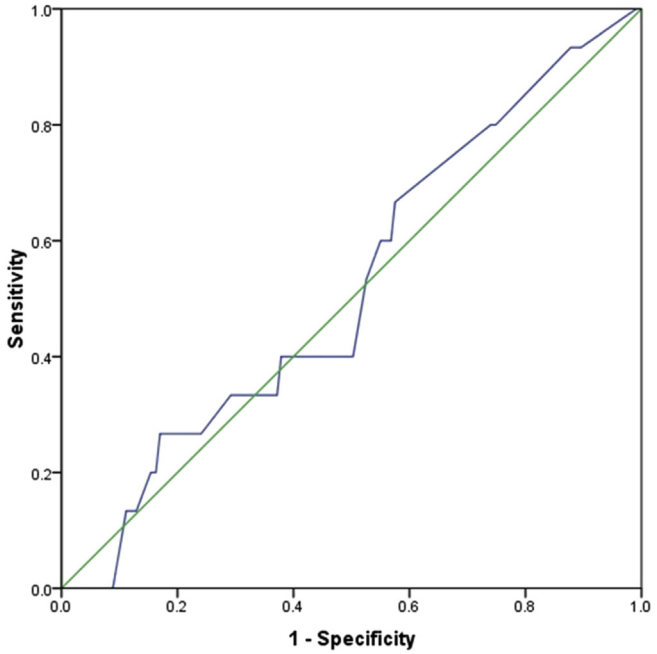

Fig. 2. The receiver operating characteristic (ROC) curve for EuroSCORE II. The area under curve (AUC) was 0.52.

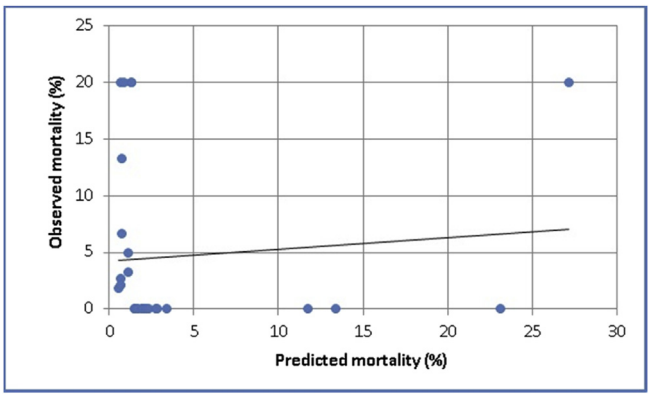

Fig. 3. Calibration plot of observed and predicted mortality by EuroSCORE II.

Table 5
Results of multivariate logistic regression of other risk factors for in-hospital mortality not involved in EuroSCORE II.

Risk factors	Odds ratio	95.0% CI for odds ratio		P-value
		Lower	Upper	
Redo-operation	57.67	10.51	316.34	<0.001[a]
Previous valvuloplasty	50.32	5.50	459.74	0.001[a]
Hypertension	8.28	0.43	158.09	0.160
Hypercholesterolemia	34.64	1.11	1073.91	0.04[a]
Smoking	3.08	0.63	14.95	0.162
Chronic liver disease	17.82	2.20	143.96	0.007[a]

CI: Confidence interval.
[a] Significant independent predictors.

Bilharziasis and hepatitis make the incidence of mortalities and morbidities higher than western countries. Also late presentation makes the patients arrive to surgery in more advanced state of valve fibrosis and calcification than in western countries and that made more patients require replacement of their valves rather than repair [7,8]. In addition, lack of sticking to proper oral anticoagulant therapy by patients, especially those coming from far rural areas and oases, made redo valve surgery for valve related complications a common practice in major cardiac centers in Egypt.

Risk-predicting models have an important role in perioperative care for patients undergoing cardiac surgery. Since its development and validation in 1999, EuroSCORE has been widely used to predict in-hospital mortality in patients undergoing cardiac surgery [9]. The updated version, EuroSCORE II, was proved in some studies to be better calibrated than the original model yet preserves powerful discrimination [3]. However, in respect to differences in the clinical profile of the reference population and the testing sample, external validation studies were performed outside the boundaries of the population EuroSCORE II was built upon, to verify its quality as a risk-predicting reference [10,11]. Some clinical differences have emerged in external validation cohorts [6,12,13].

Scant data are available regarding external validation of EuroSCORE II in heart valve surgery, with controversy in results. The studies performed in Chinese patients showed good discriminative power and calibration of EuroSCORE II in single-valve surgery [14–16]. In a study on Pakistani patients by Rabbani et al. [17], EuroSCORE II was an accurate predictor for individual operative risk in isolated valve surgery. In contrast to these findings, a study from Brazil by Lisboa et al. [18], concluded poor calibration of EuroSCORE II to predict mortality in patients undergoing valve surgery.

In the present study, we evaluated discriminative power and calibration of EuroSCORE II in Egyptian patients undergoing isolated mitral valve surgery. The discrimination performance is important to determine how the model distinguishes between alive and died patients during in-hospital period. Calibration is also important to determine the agreement between the real observed and the predicted mortality.

EuroSCORE II has poor calibration and low discriminative power in our surgical population, with significant differences in preoperative demographics and risk factors when compared to European population on whom EuroSCORE II was developed and validated. In addition, other significant predictors of in-hospital mortality which not involved in EuroSCORE II were determined in our study including redo-operation, previous valvuloplasty, hypercholesterolemia and chronic liver disease.

These findings may be explained by the differences in the clinical base of two different surgical populations. In countries where EuroSCORE was developed and validated, more patients underwent heart valve surgery for degenerative causes; however this profile is different from developing countries where valve surgery is more frequent mainly for rheumatic causes [15].

We should be cautious in utilization of this risk stratification model outside the countries of origins. The differences in demographic characteristics and comorbid conditions between Egyptian and European population should be respected. Young age of patients at operation, obesity and prevalence of female gender reflect specific criteria of Egyptian patients. Also, endemic chronic comorbid conditions such as chronic liver disease in Egypt must be considered.

In conclusion, other risk factors affecting outcome after cardiac surgery should be re-evaluated to increase the accuracy and predictive power of EuroSCORE II, particularly in populations outside the boundaries where it was initially validated. The differences in preoperative comorbidity between Egyptian and European patients raise the need for larger studies, to establish new specific risk stratification model or to renew the currently used scoring system.

Conflict of Interest

No conflict of interest.

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