Original Article

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Predictive Value of EuroSCORE II in a Nepalese Tertiary University Hospital – Prospective Observational Study

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Abstract

Background and Aims: The European System for Cardiac Operative Risk Evaluation (EuroSCORE) is an important tool for risk stratification in cardiac surgery. Updated EuroSCORE II (ESC II) is widely regarded as essential for risk stratification and several studies validate its efficacy, but these are fewer in Southern Asia and none in Nepal. Aim of this study was to compare the predicted versus observed early mortality in adults undergoing major cardiac surgeries in Nepalese population.

Methods: A prospective observational study was conducted from September 2019 to May 2021 at Manmohan Cardiothoracic Vascular and Transplant Center. Calibration and discrimination of scoring system were main parameters analyzed in total sample and subgroups. Discrimination were observed by plotting receiver operating characteristic (ROC) curves and calculating area under curve (AUC). Two sample t test, McNemar's test, Fisher's exact t test and Chi square test were used to derive P value.

Results: In this study, 249 patients were evaluated. Poor mortality prediction was shown by statistically significant p value <0.05 across all surgical groups. AUC for total cases, CABG and valve surgeries were 0.835, 0.766, 0.82 respectively.

Conclusion: The present study underpredicted mortality but displayed good discrimination for overall cardiac surgeries, with excellent discrimination in valve surgeries. As current sample is not entirely comparable to parent study, weak calibration could be attributed to it as etiology was mostly rheumatic with poorer cardiopulmonary reserve in this study versus degenerative etiology in original study.

Keywords: Cardiac surgery, risk assessment, Nepal

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Introduction

Risk stratification in cardiac surgery assumes substantial significance for preemptive optimization of resources in high-risk individuals, guide clinical decision making and benchmark clinical services. All-cause mortality in the perioperative period is a leading cause of death among patients undergoing cardiac surgery hence, it is desirable to have predictive tools to discriminate high risk and low risk patients.[1]

Wide array of multivariable risk models have been developed. The Society of Thoracic Surgeons (STS) score is effective in determining risk of short- and long-term mortality in cardiac surgery,[2] but restricted applicability in double valve replacement (DVR), maze procedure in atrial fibrillation (AF), surgery of thoracic aorta[3] gives EuroSCORE diverse employability for risk assessment. The age, creatinine, ejection fraction (EF) score (ACEF) introduced in 2009 is a parsimonious 30-day mortality risk score for elective adult cardiac surgery introduced by Ranucci in 2009. Its ease of calculation using only three variables makes ACEF score easier to apply. Although validated by study in Italy it can only be offered in elective surgeries with no role in urgent or emergency cases.[4]

ESC II was formulated in 2010 and is well calibrated with good discrimination. 22,380 patients in 43 countries in 154 units globally were evaluated to revise the original ESC. There are several studies that validate efficacy of this revised model but few in Nepal. This prospective observational study evaluates its efficacy in predicting mortality for patients meeting inclusion criteria

Methods

This is a prospective observational study conducted over 20 months (September 2019 – May 2021) at Manmohan Cardiothoracic Vascular and Transplant Center, Maharajgunj – Nepal. Sample size was 249, which was derived from expected proportion of

population based in previous studies with 95% confidence interval (CI). Sampling method was non-probability consecutive sampling. Ethical approval taken from Research Department – Institute of Medicine vide reference no. 378(6-11) E2/076/077 and patient consent taken prior inclusion in study.

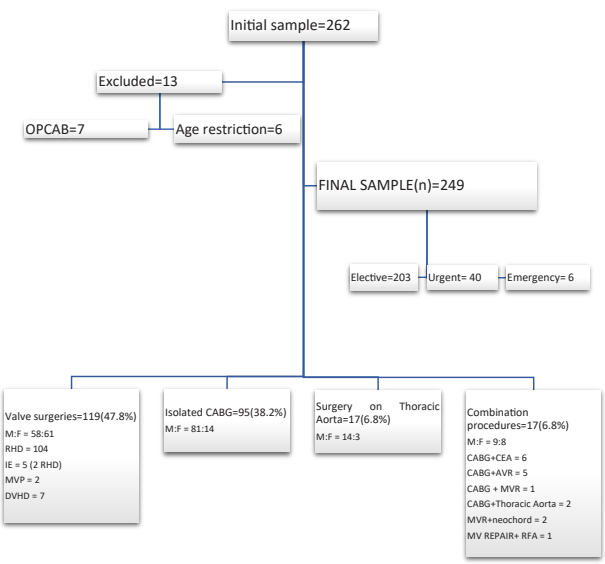
Inclusion criteria were age more than 18 years, isolated coronary artery bypass graft (CABG), valve surgery (repair/replacement), surgery on thoracic aorta, other major cardiac surgery or combination of any of above. Patients not meeting inclusion criteria, not giving consent were excluded. Qualitative variables were expressed as frequencies and percentages, quantitative variables as mean +/- standard deviation. Fischer's exact test, chi square test, Mc Nemar's test were used to obtain p value. Hosmer-Lemeshaw test was deployed for calibration which compares observed versus predicted mortality. Calibration was said to be poor if test was significant, non-significant result implied good calibration. Discrimination refers to capacity of a model to distinguish high and low risk patients. It was observed by plotting receiver operating characteristic (ROC) curves and calculating area under curve (AUC).

Data gathered in proforma of ESC II variables and score calculated by using official app of ESC. Data entered in Microsoft Excel sheet and analyzed with SPSS statistical software version 26.

Results

Total 262 patients initially evaluated and flowchart below shows how the final sample was obtained.

Figure 1



RHD – rheumatic heart disease; IE – infective endocarditis; MVP – mitral valve prolapse; DVHD – degenerative valvular heart disease; CABG – coronary artery bypass graft; CEA – carotid endarterectomy; AVR – aortic valve replacement; MVR – mitral valve replacement; RFA – radiofrequency ablation

Table 1: Patient characteristics

Variables	Frequency	Percentage (%)
Age (years), mean ± SD	48.9 ± 15.0	
Gender Male Female	 162 87	 65.1 34.9
Renal impairment CC-N CC-MOD CC-SEVERE On dialysis	 181 67 0 1	 72.7 26.9 0.4
ECA	14	5.6
Poor mobility	3	1.2
Previous cardiac surgery	17	6.8
CLD	23	9.2
Active IE	5	2.0
Critical pre-op state	7	2.8
DM on insulin	52	20.9
NYHA class Class I Class II Class III Class IV	 1 166 77 5	 0.4 66.7 30.9 2.0
CCS IV	6	2.4
LVEF (%) Good (>50) Moderate (31 – 50) Poor (21 – 30) Very poor (≤ 20)	 134 107 8 -	 53.8 43.0 3.2
Recent MI	30	12.0
PAH Moderate Severe	 68 18	 27.3 7.2
Urgency Elective Urgent Emergent Salvage	 203 40 6 -	 81.5 16.1 2.4

ECA- Extracardiac arteriopathy; CLD- Chronic Lung Disease; IE- Infective Endocarditis; DM- Diabetes Mellitus; NYHA- New York Heart Association; LVEF- Left Ventricular Ejection Fraction; MI- Myocardial Infarction; PAH- Pulmonary Artery Hypertension; CC – creatinine clearance

Table 2 Comparison of important variables of current study with original EuroSCORE II study

VARIABLE	CURRENT STUDY	EuroSCORE II	P value
Age	48.9 ± 15 years	64.6 ± 12.5 years	<0.001[a]
Female	87 (34.9%)	6919 (30.9)	0.14 [b]
DM on Insulin	52 (20.9%)	1705 (7.6%)	<0.001 [b]
Pulmonary disease	23 (9.2%)	2384 (10.7%)	0.19 [b]
Poor mobility	3 (1.2%)	713 (3.2%)	0.10 [b]
ECA	14 (5.6%)	2.26%	0.04 [b]
Active endocarditis	5 (2 %)	497 (2.2%)	0.89 [b]
Emergency surgery	6 (2.4%)	4135 (18.5%)	<0.001 [b]
Surgery on Thoracic Aorta	17 (6.8%)	1636 (7.3%)	0.11 [b]
Isolated CABG	95 (38.2%)	1 0 4 4 8 (46.7%)	0.09 [b]
Overall mortality/ Predicted	8.8 % / 1.98 ± 2.3 %	4.18% / 3.95 %	<0.001 [b]

a – 2 sample t test
b - chi square test

Table 3: Classification based on surgery type

Type of surgery	Frequency	Percentage (%)
Valve surgery	119	47.8
Isolated CABG	95	38.2
Surgery involving thoracic aorta only	17	6.8
Combination of procedures	17	6.8
Myxoma excision	1	0.4

The median duration of hospital stay was ten days with the Interquartile range (IQR) 6, (Q1-7, Q3-13). The highest stay was of 26 years old female who underwent DVR with left atrial appendage ligation. In the post-operative period, she developed cardiogenic shock with severe respiratory insufficiency and had high ionotropes requirement with prolonged mechanical ventilation support. She was discharged on her 74th post-operative day. She had a EuroSCORE II risk prediction of 1.34%. Subsequent highest stay was of two patients who underwent valve replacement surgeries and had a stay of 28 days each in the hospital with EuroSCORE II of 13.5% and 2.25 respectively.

17 patients (6.8%) underwent redo cardiac surgery. 15 of them had redo valve surgery and two of them had redo surgeries of the ascending Aorta. Most common previous surgery was a closed mitral commissurotomy (CMC). Two redo patients (11.7%) expired in early post-operative period

The predicted mortality by EuroSCORE II ranged from 0.1% to 15.06%, with a mean of 1.98%. Depending on the ESC II, patients were categorized as per mortality risk shown in Table 3.

Hosmer-Lemeshaw (HL) goodness-of-fit test was applied for calibration shown in Fig 2. and represented in Table 4.

Table 4 : Patient distribution as per EuroSCORE II

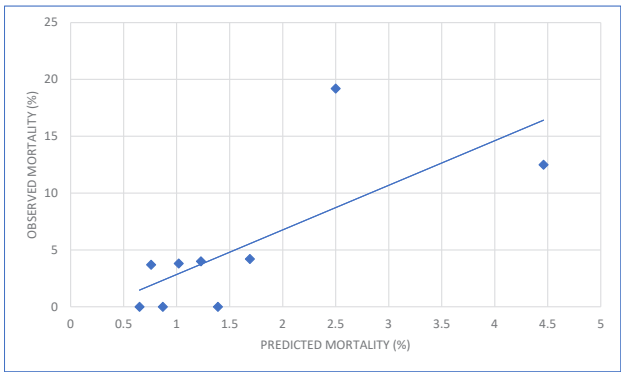
Risk category	EuroSCORE II	n
Very low risk	<1 %	96
Low risk	1 – 2.99 %	115
Moderate risk	3 – 4.99 %	18
High risk	> 5 %	20

Table 5: Observed & predicted mortality by surgery type

Type of surgery	Observed mortality n (%)	Predicted mortality (%)	P value
Valve surgery (n = 119)	7 (5.9)	1.9 ± 1.9	<0.001[a]
Isolated CABG (n = 95)	7 (7.4)	1.4 ± 1.3	
Surgery involving thoracic aorta only (n = 17)	6 (35.3)	5.4 ± 4.4	
Combination of procedures (n = 17)	2 (11.8)	2.6 ± 3.2	
Myxoma excision (n = 1)	0 (0.0)	2.23	0.09[b]
Overall	22 (8.8)	1.98 ± 2.3	<0.001[b]

a -McNemar's test, b- Chi square test

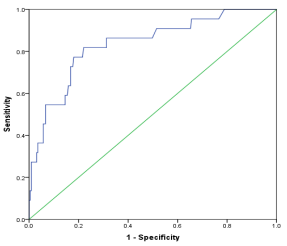
Figure 2: Calibration plot of observed and predicted mortality by EuroSCORE II



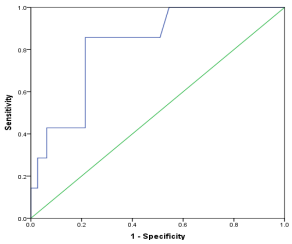
To determine the accuracy (discrimination) of ESC II area under ROC (AUC) was plotted. The AUC for overall surgeries, valve surgeries and CABG was 83.5%, 82% and 76.6% respectively (Fig

3). AUC for surgery on thoracic aorta and combined procedures although plotted cannot be considered valid owing to few numbers of cases. Table 5 highlights the discriminating capacity of this scoring system among various surgery groups. When considered as per surgery type it is observed that it performs well for valve surgeries with AUC 0.82 implying good discriminating capacity especially, if the EuroSCORE II was ≥ 2.15, it predicted mortality with 85.7% sensitivity and specificity of 78.6%.

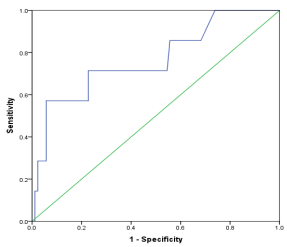
Figure 3 ROC curve as per surgery type



AUC for overall surgeries 0.835



AUC for valve surgeries 0.82



AUC for isolated CABG 0.76

Discussion

EuroSCORE has been widely used to predict in-hospital mortality in patients undergoing cardiac surgery.[5] ESC II is updated version of its previous model and has been proven in major studies to be better calibrated than its predecessor yet preserving good discriminatory capacity.[6] An important aspect while performing external validation of risk models is the type of population studied while developing the model and whether its results stand unanimous across all demographics and geography. Table 5 showed comparison of some important variables between the current study and original EuroSCORE II.

A notable observation here is that patients undergoing valve surgeries in our cohort are younger compared to parent study due difference in its etiology i.e., Rheumatic vs degenerative. Rheumatic heart disease (RHD) is the most critical form of acquired heart disease in children and young adults living in developing countries and accounts for about 15% - 20% of all patients with heart failure in endemic countries.[7] Valvular damage resulting from rheumatic carditis yield serious sequalae like valvular regurgitation, stenosis or combined lesions with heart failure (HF), arrhythmias, embolic phenomena, development of pulmonary arterial hypertension (PAH).[8] Prolonged hemodynamic load secondary to valve lesions may result in ventricular dysfunction and affect the post-operative period in such patients. Perioperative predictors of death include right HF, impaired left ventricular function and increased left ventricular filling pressures.[9,10] This crucial etiological prevalence can be said to negatively impact outcome of valve surgeries in our part of world compared to the west.

Casalino et al and Lisboa et al in their respective studies concluded that ESC II although accepted by developed nations its performance was not similar to developing nations due to polar epidemiological cohorts.[11,12] Both their studies displayed poor calibration but good discriminatory capacity which was similar to our observations in current study. In a similar study from India by Pillai et al the authors found the ESC II model unsuitable with reference to patients at their center. A statistically significant p value (<0.001) in predictive accuracy was displayed.[13]

In a recent publication by Parajuli et al comparing logistic EuroSCORE and ESC II at their center in Nepal for patients undergoing CABG, both the risk models had similar accuracy in predicting mortality although the ESC II slightly underpredicted mortality in their study.[14]

Limitations

This study also has some limitations. It is a single institution study with a relatively small sample size which might not be representative of the entire Nepalese population. Multiple types of procedures evaluated and a better result and description could have been obtained if spectrum of surgeries were narrowed for more thorough evaluation. Current study had a younger but sicker population due to rheumatic prevalence along with the difference in epidemiology with the parent study and hence population not entirely comparable.

Conclusion

The observed vs predicted mortality for this study was 8.8% v 1.98% (H-L p<0.05) which showed weak calibration but has good discrimination with AUC 0.835, With an optimal cutoff ESC II of 2.18 it can predict mortality with sensitivity of 77.3%. Discrimination was best for valve surgeries in which a score of 2.15 predicted mortality with 85.7% sensitivity. Surgery on thoracic aorta and combined surgeries needs further validation with higher cases being studied. The ESC II underpredicts mortality but has potential for discrimination in Nepalese adults undergoing cardiac surgery.

Conflict of interest: None

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