Validation of EuroSCORE for Coronary Artery Bypass Grafting at Siriraj Hospital

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Objective: *To access the performance of the EuroSCORE when applied to CABG patients at Siriraj hospital.*
Material and Method: *One thousand five hundred forty nine patients diagnosed with coronary artery disease (CAD) who underwent isolated CABG between January 2007 and December 2009 was prospectively studied.*
Results: *The patients included 1,102 men and 447 women and had a mean age of 67 years old. The mean additive score in expired and survived groups were 9.65 ± 5.14 and 3.87 ± 3.06. In logistic, score were 25.43 ± 26.31 and 4.88 ± 7.88 respectively ($p < 0.001$). The best cut-off value of EuroSCORE for prediction of a death rate was 6 for additive score and 10 for logistic score. Area under the curve was 0.831 for the additive score and 0.823 for the logistic score. The observed overall mortality rate was 2.0% while the predict mortality was 5.27%. The difference between observed and predicted deaths was significant with additive score and logistic score ($p < 0.001$).*
Conclusion: *Our results suggest that EuroSCORE is not valid for CABG in Thai patient due to over prediction.*

Keywords: *Cardiac surgery, CABG, Mortality, Logistic model, Additive model, EuroSCORE*

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The number of coronary artery disease patients in Thailand who undergo coronary bypass grafting has been increasing. Many predictive models have been created for CABG risk prediction.

The European System for Cardiac Operative Risk Evaluation (EuroSCORE) was developed between 1995 and 1999[14]. It was composed of two components, logistic and additive risk models. The objective was to predict early mortality rate in European adult cardiac surgery. Currently this model is also used to predict morbidity and mortality rate so it can help surgeons decide appropriate management and advise patients about their prognosis. Recently, a correlation was found between post-operative complication and patient recovery.

Nowadays, the EuroSCORE is widely used but its validation is still uncertain after it has been tested in many countries such as European countries, North America, Japan, Australia, Taiwan, and China[5,14,21,22].

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At Siriraj hospital, the authors also used EuroSCORE for risk prediction. However, the authors have never tested the performance of this model. For the present study, the authors concentrated on patients who underwent isolated CABG and used the EuroSCORE to predict morbidity and mortality outcome. The authors tested the validity of this model on Thai CABG patients in Siriraj hospital, and compared it to the previous study in other countries.

Material and Method

Patients population

Between January 2007 and December 2009, 1,549 patients who underwent isolated CABG were recruited to the present study. The data was collected prospectively by using the record from the cardiothoracic surgery division. The data collection included patient characteristics, pre-operative risk factors according to the EuroSCORE, peri-operative variables, morbidity, and mortality outcomes. In the present study, mortality was defined as any in-hospital death. Risk prediction in pre-operative period was performed by using the EuroSCORE, both additive and logistic models. Definitions of risk factors were the same as the EuroSCORE as shown in Table 1.

Table 1. Definitions of risk factors

Risk factors	EuroSCORE definitions
Age	In years at last birthday
Sex	Female
Chronic pulmonary disease	Long-term use of bronchodilators or steroids for lung disease
Extracardiac arteriopathy	Any one or more of: claudication, carotid occlusion or > 50% stenosis, previous or planned intervention on abdominal aorta, limb or carotids
Neurological disease	Disease severely affecting ambulation or day-to-day functioning
Previous cardiac Sx	Requiring opening of the pericardium
Serum creatinine	> 0.2 mmol/l preoperatively
Active endocarditis	Patient still under antibiotic treatment for endocarditis at the time of surgery
Critical preoperative state	Any one or more of the following: ventricular tachycardia or fibrillation or aborted sudden death, preoperative cardiac massage, preoperative ventilation before arrival in the anaesthetic room, preoperative inotropic support, intra-aortic balloon counterpropulsion or preoperative acute renal failure(anuria or oliguria <10 ml/h)
Unstable angina	Rest angina requiring i.v. nitrates until arrival in the anaesthetic room
LV dysfunction	Moderate or LVEF 30-50%
	Poor or LVEF < 30%
Recent MI	< 90 days
Pulmonary HT	Systolic PA pressure >60 mmHg
Emergency	Carried out on referral before the beginning of the next working day
Other than isolated CABG	Major cardiac procedure other than or in addition to CABG
Sx on thoracic aorta	For disorder of ascending, arch or descending aorta
Postinfarct VSD	Acquired ventricular septal defect

Ethical issues

The present study was approved by the Siriraj institutional research board. The conduct of the present study followed the declaration of Helsinki (2008).

Statistical methods

Statistical analyses were performed using SPSS version 13.0. Continuous variables were presented as mean ± SD (quantitative data) or percentage (qualitative data). Comparisons between them were performed using student's t-test or Mann-Whitney U test. A p-value less than 0.05 was considered significant. Performance of the EuroSCORE model assessed the model discrimination (statistical accuracy) by using the area under the receiver operating characteristics (ROC) curve. The discriminative power of the model is the best if the area under the receiver operating characteristic curve is greater than 0.80, and presented with diagnostic value (sensitivity, specificity, PPV, and NPV) and 95% CI (confidence interval). The Hosmer-Lemeshow Chi-square statistic measures differences between expected and observed outcomes. A well-calibrated model gives the corresponding p-value lesser than 0.05.

Results

Of the 1,549 patients, there were 447females (28.9%), 1,102 males (71.1%) and the mean age at time of surgery was 67 years old.

There were 31 deaths (2%). Mortality in male patients was 17 (1.1%) and in female was 14 (0.9%), p-value = 0.68 (Fig. 1).

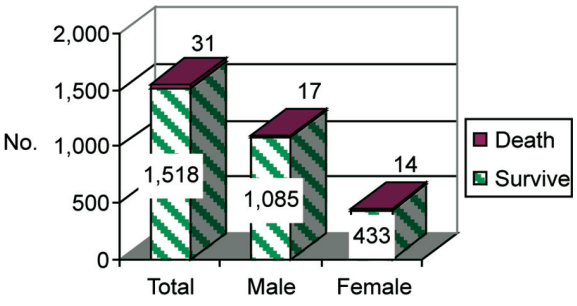

Fig. 1 Mortality rate compared between sex and overall

The mean of additive score was 9.65 ± 5.14 in the dead group and 3.87 ± 3.06 in survived group. The mean of logistic score was 25.43 ± 26.31 in the dead group and 4.88 ± 7.88 in survived group, p-value < 0.001 in both additive and logistic score groups (Table 2).

The discriminative power of both additive and logistic models was assessed by ROC curve analysis and was good. The area under the curve (AUC) was 0.831 for additive model and 0.823 for logistic model. The highest discriminative accuracy to predict mortality rate was obtained with 6 in additive model and 10 in logistic model (Fig. 2).

There were 31 deaths observed, giving an overall observed mortality rate of 2.0%. The additive EuroSCORE model predicted a mortality rate of 5.27% (p < 0.001 vs. observed) and the logistic EuroSCORE model predicted a mortality rate of 5.29% (p < 0.001 vs. observed). This represents an over prediction for the both additive and logistic models.

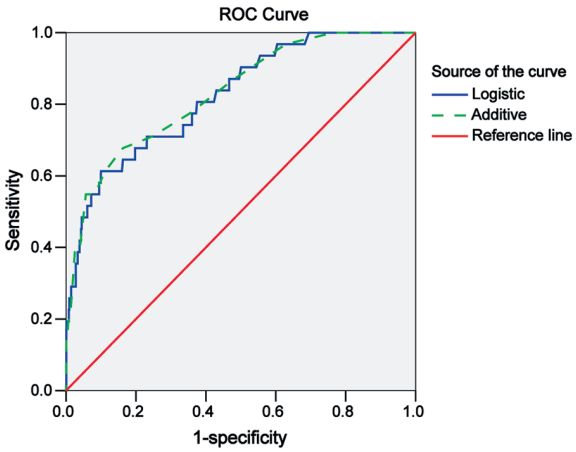

Fig. 2 Receiver operating characteristic (ROC) curves. Area under the curve is 0.831 for the additive and 0.823 for logistic EuroSCORE models

Table 2. Comparision of both additive and logistic scores between dead and survived groups

	No. of patients	Mean ± SD	p-value
Additive score			
Death	31	9.65 ± 5.14	<0.001
Survive	1,518	3.87 ± 3.06	
Logistic score			
Death	31	25.43 ± 26.31	<0.001
Survive	1,518	4.88 ± 7.88	

The authors classified the patients into subgroups according to the level of both additive and logistic EuroSCORE models. Predicted mortality rate of both models were higher than observed mortality in all subgroups (Table 3).

Table 3. Comparison of EuroSCORE-predicted mortality with the observed mortality

	Patients (deaths)	Observed mortality (%)	Predicted mortality (%)	O:E ratio
EuroSCORE additive				
0-3	793	4 (0.26)	12 (0.77)	0.33
4-6	489	6 (0.39)	20 (1.29)	0.30
7-10	197	9 (0.58)	22 (1.42)	0.41
> 10	70	12 (0.77)	26 (1.68)	0.46
Total	1,549	31 (2.00)	81 (5.23)	0.38
EuroSCORE logistic				
≤ 5	1,167	9 (0.58)	25 (1.61)	0.36
> 5-10	210	3 (0.19)	14 (0.90)	0.21
> 10-20	95	6 (0.39)	13 (0.84)	0.46
> 20-30	37	4 (0.26)	9 (0.58)	0.44
> 30-40	9	1 (0.06)	3 (0.19)	0.33
> 40-50	12	1 (0.06)	5 (0.32)	0.20
> 50-60	7	1 (0.06)	4 (0.26)	0.25
> 60	12	6 (0.39)	8 (0.52)	0.75
Total	1,549	31 (2.00)	81 (5.23)	0.38

The observed vs. expected ratio or O:E ratio were less than 1 in all level of scores or subgroups but the logistic model seems to be close to observe mortality when compared to additive models (Fig. 3, 4).

When Hosmer Lemeshow Chi-square goodness-of-fit was used to measure the difference between observed and predicted mortality, it was significantly different, p-values less than 0.05.

Discussion

The result from the present study showed that the EuroSCORE model did not accurately predict outcomes of CABG patients because both additive and logistic models were over predicted. However, the discriminatory of the EuroSCORE assessed by ROC statistic was good (AUC 0.83 for additive model and 0.823 for logistic model). Several factors influenced the outcome of the present study and made outcomes different from the previous study. However, the present results were similar to the studies from Asian countries. Factors that may influence outcomes included the difference in demographic characteristics between Asian and European populations. Moreover, the population in the present study was quite small and was collected from only a single center, so distribution of data was quite limited when compared to the other studies and may not reflect all population of the country. The difference in natural history of disease between European and Asian population also influenced the outcome. Risk factors in the EuroSCORE that were significant to predict outcome may not really be applied for Thai patients. Furthermore, improvement of medical care included pre-operative evaluation, peri-operative care, and surgical technique, has decreased the mortality rate when compared to the past. Lastly, because the present study focused only on isolated CABG, it did not include all cardiac surgical conditions. These many factors may contribute to inaccurate performance of the model and differ from other studies.

Conclusion

The EuroSCORE model does not accurately predict outcomes in Thai CABG patients at Siriraj hospital due to its over prediction. A multicenter study should be done to search for the outcome that represent data of the whole country. This will bring to a new standard model that can predict morbidity and mortality rate precisely for the Thai population.

Potential conflicts of interest

None.

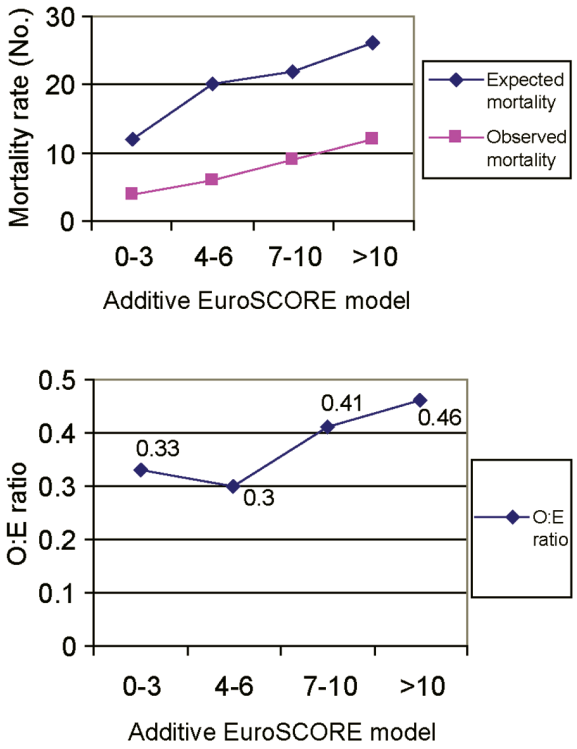

Fig. 3 The observed and expected additive EuroSCORE mortalities by 4 subgroups and the ratios of observed and expected mortality (O/E)

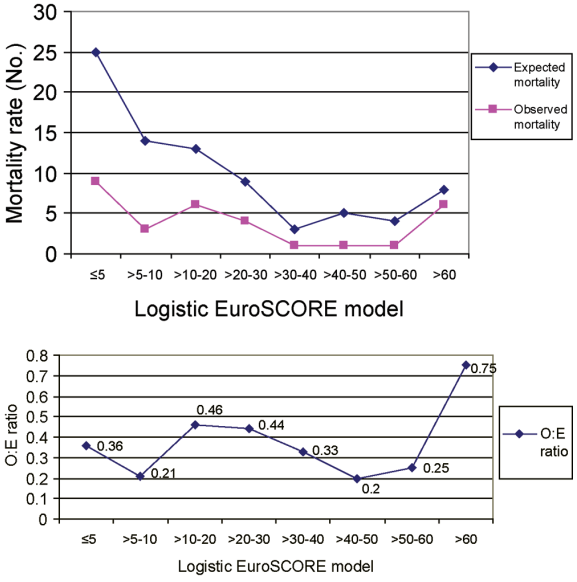

Fig. 4 The observed and expected logistic EuroSCORE mortalities by 8 subgroups and the ratios of observed and expected mortality (O/E)

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การประเมินความถูกต้องของ EuroSCORE ที่ใช้ในผู้ป่วยที่ผ่าตัดโรคหลอดเลือดหัวใจโคโรนารีตีบในโรงพยาบาลศิริราช

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วัตถุประสงค์: *เพื่อประเมินความถูกต้องของ EuroSCORE เมื่อนำมาใช้ในผู้ป่วยที่ผ่าตัดโรคหลอดเลือดหัวใจตีบในโรงพยาบาลศิริราช*

วัสดุและวิธีการ: *ทำการเก็บข้อมูลในผู้ป่วยจำนวน 1,549 คน ซึ่งได้รับการรักษาโดยวิธีการผ่าตัดโรคหลอดเลือดหัวใจตีบ (Coronary artery bypass graft) และได้รับการประเมินอัตราการเสียชีวิตก่อนผ่าตัดโดยใช้ EuroSCORE ตั้งแต่เดือนมกราคม พ.ศ. 2550 ถึงเดือนธันวาคม พ.ศ. 2552*

ผลการศึกษา: *จากผู้ป่วยทั้งหมดจำนวน 1,549 คน ที่ได้รับการวินิจฉัยว่าเป็นโรคหลอดเลือดหัวใจตีบ และได้รับการรักษาโดยวิธี coronary artery bypass graft เพียงอย่างเดียวนั้น เป็นผู้ป่วยเพศชาย 1,102 คน และเป็นเพศหญิง 447 คน โดยอายุเฉลี่ยของผู้ป่วยคือ 67 ปี ค่าเฉลี่ยของ additive score ในกลุ่มผู้ป่วยที่เสียชีวิตอยู่ที่ 9.65 ± 5.14 และกลุ่มที่รอดชีวิตมีค่าเท่ากับ 3.87 ± 3.06 ค่าเฉลี่ยของ logistic score ในผู้ป่วยทั้งสองกลุ่มคือ 25.43 ± 26.31 และ 4.88 ± 7.88 ตามลำดับ ($p < 0.001$) ค่าพื้นที่ใต้กราฟ (area under the curve) ของ additive score มีค่าเท่ากับ 0.831 และของ logistic score มีค่าเท่ากับ 0.823 อัตราการเสียชีวิตของผู้ป่วยตามความเป็นจริง มีค่าเท่ากับ 2.0% ในขณะที่การประเมินอัตราการเสียชีวิตที่ได้จาก EuroSCORE มีค่าเท่ากับ 5.27% โดยค่าที่ได้จากการสังเกตการณ์จริงและค่าที่ได้จากการคำนวณมีความแตกต่างกันอย่างมีนัยสำคัญทางสถิติ ($p < 0.001$)*

สรุป: *จากการศึกษาพบว่า EuroSCORE ไม่มีความแม่นยำพอในการประเมินอัตราการเสียชีวิตของผู้ป่วยที่ได้รับการรักษาโรคหลอดเลือดหัวใจตีบ โดยการผ่าตัด coronary artery bypass graft เนื่องจากมีการพยากรณ์อัตราการเสียชีวิตที่สูงกว่าความเป็นจริง*