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EuroSCORE predicts postoperative mortality, certain morbidities, and recovery time.

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Abstract

EuroSCORE used for calculate the risk of the postoperative mortality rate for patients undergoing open-heart surgery may be able to predict of postoperative complications as well. Consecutive cases of isolated on-pump CABG (n=1552) performed between 1991 and 2006 at our hospital group were placed into a systematic database. Patients were stratified using additive EuroSCORE. Incidence of postoperative mortality, morbidity (bleeding, heart failure, mediastinitis, pneumonia, myocardial infarction, renal failure, and stroke), and recovery time (intubation time, ICU stay, and length of stay) was assessed in each EuroSCORE group. EuroSCORE was well correlated with mortality, total incidence of major complications, heart failure, renal failure, stroke, pneumonia and mediastinitis and three parameters of recovery time. Postoperative myocardial infarction and incidence of postoperative bleeding were not correlated with EuroSCORE. EuroSCORE can predict not only mortality but also postoperative complications and recovery time. (Word count : 138)

Introduction

EuroSCORE (European System for Cardiac Operative Risk Evaluation) is a risk calculation system for predicting perioperative mortality of patients undergoing cardiac surgery. EuroSCORE was developed in the late 1990s in Europe, [1] and was quickly accepted in the US, [2] Japan, [3] and other countries. [4] The mortality rate of coronary artery bypass grafting (CABG) is known to have a high correlation with EuroSCORE. [5, 6] Recently, EuroSCORE was also found to be correlated with postoperative complications and/or patient recovery, [6, 7] but it was not fully elucidated. Thus, we studied the outcomes of patients who had undergone CABG to evaluate the relationship between their postoperative complications and EuroSCORE.

Methods

Consecutive cases of isolated on-pump coronary artery bypass grafting performed between 1991 and 2006 at our hospital group (n=1552) were placed into the systematic database, which was approved for research by the internal review board. Patient demographics were presented as mean ± standard deviation or percentage as appropriate.

Additive EuroSCORE was calculated for each patient based on original EuroSCORE criteria. [2] Zero score was given for factors not used for isolated CABG, such as active endocarditis, other than isolated CABG, surgery on the thoracic aorta, or postinfarct septal rupture. The score for pulmonary hypertension was not incorporated into this study due to a lack of data on preoperative pulmonary artery pressure. EuroSCORE above 10 was found in a relatively small number of patients (30 patients) and the EuroSCORE range spread widely between 10 and 17; thus these patients were excluded from the analyses (however, it was marked as a reference point). All off-pump procedures (n=1395) were excluded from this study to

avoid selection biases for off-pump CBAG.

Postoperative mortality, morbidity (bleeding requiring reoperation, postoperative heart failure requiring inotropic support for more than 5 days, mediastinitis with deep sternal infection, pneumonia, postoperative new Q-wave myocardial infarction, renal failure newly required temporally or permanent dialysis, and postoperative stroke confirmed by CT scan) and postoperative recovery time (intubation time, ICU stay and postoperative length of stay) were analyzed in each EuroSCORE group (0-9). In addition to those cited above, major complications include, critical arrhythmia (ventricular fibrillation, recurrent ventricular tachycardia, bradycardia requiring a permanent pacemaker), pulmonary emboli, respiratory failure requiring prolonged ventilator support for more than 5 days, reintubation or tracheostomy, sepsis, and acute graft occlusion.

The adequacy of the correlation between the EuroSCORE and outcomes was accessed by the correlation coefficient (r). Correlations were considered adequate if r value was above 0.60 and p value was less than 0.05. Then, the receiver operating characteristics (ROC) curve was constructed and the area under the curve was calculated. Area under the ROC curve was used as an index indicating the appropriateness of the model in which EuroSCORE could predict a postoperative complication. The model was considered excellent if the area under ROC curve was higher than 0.80, very good if higher than 0.75 and good if higher than 0.70. All statistical analyses were performed using JMP software (SAS institute, Cary, NC).

Results

Baseline demographics of the study patients are shown in Table 1. EuroSCORE of the study group was 3.8 ± 2.8. Postoperative outcomes and EuroSCORE were shown in Table 2.

Results of correlation and ROC analyses are shown in Table 3. The incidence of postoperative mortality (Figure 1-a), major complications (Figure 1-b), heart failure (Figure 1-c), renal failure (Figure 2-a), postoperative pneumonia (Figure 2-b), stroke (Figure 2-c), and mediastinitis (Figure 2-d) were positively correlated with EuroSCORE. Intubation time (Figure 3-a), ICU stay (Figure 3-b), and postoperative length of stay (Figure 3-c) were also positively correlated with EuroSCORE. Postoperative bleeding or myocardial infarction was not correlated with EuroSCORE.

Comments

Additive EuroSCORE was chosen for our analysis because of the simplicity of calculation. Logistic EuroSCORE could more precisely estimate the postoperative mortality rate after cardiac surgery than the additive EuroSCORE; [8, 9] however, the calculation of logistic EuroSCORE is far more complex than additive EuroSCORE, and requires computer software. Similarly, the risk calculator presented by the Society of Thoracic Surgeons consists of many questions and requires an internet connection to calculate the patient's risk of mortality and morbidities (accessible from Society of Thoracic Surgeons' web site : http://www.sts.org/sections/stsnationaldatabase/riskcalculator). Compared to these processes, the additive EuroSCORE provides a quick bedside calculation and this result is well correlated with logistic EuroSCORE and thus considered an acceptable alternative. [10]

As expected, mortality rate and EuroSCORE were highly correlated with each other compared to other postoperative complications and EuroSCORE according to ROC analyses, since EuroSCORE was initially designed for the estimation of postoperative mortality. Complications other than bleeding or perioperative myocardial infarction were positively

correlated to EuroSCORE. According to ROC analyses, prediction of postoperative complications was excellent for death, heart failure, renal failure, and pneumonia, very good for stroke and mediastinitis, and good for overall major complications.

We used exponential transformation ($y=e^{ax+b}$) of the estimate curve to show better correlation between EuroSCORE and each complication. Each complication acted in a similar manner along with EuroSCORE, such that the complication rate remained relatively low between EuroSCORE 0 and 5; then it acutely increased after EuroSCORE 6 or above. To show this behavior, an exponential curve ($y=e^{ax+b}$) was more suitable than a straight line ($y=ax+b$). Previously, Sergeant found that EuroSCORE overestimated the risk from 0 to 8, was appropriate from 9 to 11, then underestimated the risk at 12 or higher, [11] which reflected our observation although our study was limited to EuroSCOREs between 0 and 10. Furthermore, EuroSCORE 6 has often been used as a cut off to identify high-risk patients. [9, 12, 13]

Postoperative complications independent from EuroSCORE such as perioperative myocardial infarction and bleeding were most likely related to technical issues or factors that were not picked up by EuroSCORE. For example, technical problems such as anastomosis of small target vessel that may be related to diabetes, or an intraoperative event such as the use of intraaortic balloon pump in patients who were unable to be weaned from cardiopulmonary bypass are not counted in EuroSCORE. Preoperative use of antiplatelet agents, which may be related to postoperative bleeding, [14] is not incorporated in EuroSCORE either.

Postoperative intubation time, ICU stay and postoperative hospital stay are positively related to EuroSCORE. These parameter may be simply related to the fact of the higher complication rate in the high risk group. EuroSCORE will identify the high risk patient easily. To avoid postoperative complication and prolonged stay, the surgical strategy and care for these

high risk patient should be individually tailored.

There are several limitation in this study. First, this is a retrospective, non-randomized, observational study, although the data was entered in a prospective manner. Second this study was performed at a single institution. Our institution did not have a back-up rehabilitation facility, which may have promoted prolonged hospital stay. Third, patients with high EuroSCORE above 10 comprised a relatively small percentage of out study population, although he majority of patients undergoing isolated CABG was included in this study.

In conclusion, EuroSCORE well predicts not only mortality, but also certain postoperative complications and recovery time. EuroSCORE can be a useful tool to predict prognosis after isolated CABG.

Tables

Table 1: Patient demographics

n	1552	
Patient factors		
Age (years ± std)	63.3 ± 9.3	
Female sex	340	21.9%
Chronic pulmonary disease	62	4.0%
Extracardiac arteriopathy	108	7.0%
Neurological dysfunction	153	9.9%
Previous cardiac surgery	50	3.2%
Serum creatinine >200 umol/L	61	3.9%
Critical preoperative state	16	1.0%
Cardiac factors		
Unstable angina	224	14.4%
LV dysfunction (EF 30-50%)	297	19.1%
LV dysfunction (EF<30)	38	2.4%
Recent myocardial infarction	65	4.2%
Surgical factors		
Emergent surgery	110	7.1%
EuroSCORE	2.9 ± 2.2	
Other factors		
Diabetes	642	41.4%
Distal anastomosis	3.3 ± 1.2	

Table 2: Outcome of each EuroSCORE. MI: myocardial infarction, n: number of patients, std: standard deviation.

EuroSCORE	0	1	2	3	4	5	6	7	8	9	>10
Patients	253	236	256	258	192	154	64	51	38	20	30
Mortality n (%)	0	0	1 (1.4%)	0	1 (0.5%)	1 (0.6%)	1 (1.1%)	7 (13.7%)	1 (2.6%)	2 (10.0%)	5 (16.7%)
Major complications n (%)	9 (3.6%)	25 (11%)	16 (7.0%)	33 (13%)	27 (14%)	33 (21%)	24 (26%)	17 (33%)	16 (47%)	13 (65%)	25 (85%)
Heart failure n (%)	0	2 (0.8%)	1 (0.4%)	1 (0.4%)	2 (1.0%)	4 (2.6%)	5 (5.3%)	9 (17.6%)	5 (13.2%)	4 (20%)	8 (26.5%)
Renal failure n (%)	0	0	0	2 (0.8%)	1 (0.5%)	0	3 (3.2%)	3 (5.9%)	2 (5.3%)	2 (10%)	7 (23.3%)
Pneumonia n (%)	1 (0.4%)	0	1 (0.4%)	4 (1.6%)	1 (0.5%)	3 (1.9%)	5 (5.3%)	1 (2.0%)	3 (7.9%)	2 (10%)	5 (16.7%)
Stroke n (%)	0	2 (0.8%)	1 (0.4%)	1 (0.4%)	7 (3.6%)	3 (1.9%)	5 (5.3%)	2 (3.9%)	3 (7.9%)	1 (5.0%)	2 (6.7%)
Sternal infection n (%)	0	0	1 (0.4%)	2 (0.8%)	0	0	1 (1.1%)	2 (3.9%)	0	1 (5.0%)	1 (3.3%)
Perioperative MI n (%)	2 (0.8%)	4 (1.7%)	3 (1.2%)	4 (1.6%)	2 (1.0%)	1 (0.6%)	2 (2.1%)	2 (3.9%)	0	0	0
Bleeding n (%)	0	1 (0.4%)	0	1 (0.4%)	1 (0.5%)	1 (0.6%)	1 (1.1%)	2 (3.9%)	1 (2.6%)	0	1 (3.3%)
Intubation time (mean ± std hours)	5.9±5.1	7.5±12.8	8.4±10.7	9.0±11.5	9.9±10.7	12.4±15.2	21.2±42.8	20.8±31.2	26.2±26.3	52.3±57.1	52.5±50.1
ICU stay (mean ± std days)	2.3±1.0	2.4±1.3	2.5±1.0	2.8±1.6	2.9±1.5	3.2±2.3	4.6±7.3	3.7±2.6	4.1±2.3	7.0±5.3	8.3±7.6
Postoperative stay (mean ± std days)	13.4±4.8	15.3±6.9	15.7±6.5	18.5±10.8	17.9±9.1	19.4±9.0	20.9±11.3	23.3±17.6	25.2±22.7	32.6±44.0	29.6±14.5

Table 3: Correlation score (r) between each complication and EuroSCORE. If there was an adequate correlation, the area under the receiver operating characteristics (ROC) curve was calculated for categorical variables.

	r	p	ROC
Death	0.672	0.0333	0.890
Major complications	0.928	0.0001	0.705
Congestive heart failure	0.870	0.0011	0.856
Renal failure	0.866	0.0012	0.873
Pneumonia	0.845	0.0021	0.813
Stroke	0.874	0.0010	0.771
Mediastinitis	0.641	0.0460	0.760
Bleeding	0.526	0.1185	
Perioperative myocardial infarction	0.033	0.9269	
Intubation time	0.847	0.0020	
ICU stay	0.837	0.0025	
Postop stay	0.937	0.0001	

Legends of Figures

Figure 1: 1-a) Mortality rate and EuroSCORE were well correlated ($y=e^{0.50x\ -7.00}$). 1-b) Major complications and EuroSCORE were well correlated ($y=e^{0.28x\ -3.02}$). 1-c) Postoperative heart failure and EuroSCORE were well correlated ($y=e^{\ 0.54x-6.32}$).

Figure 1-a

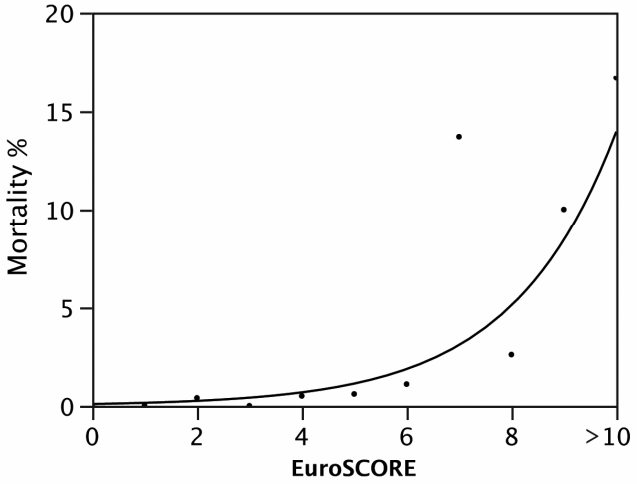


Figure 1-b

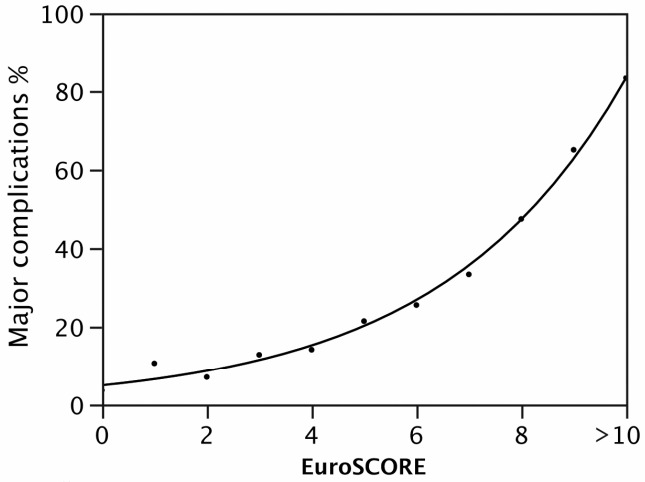


Figure 1-c

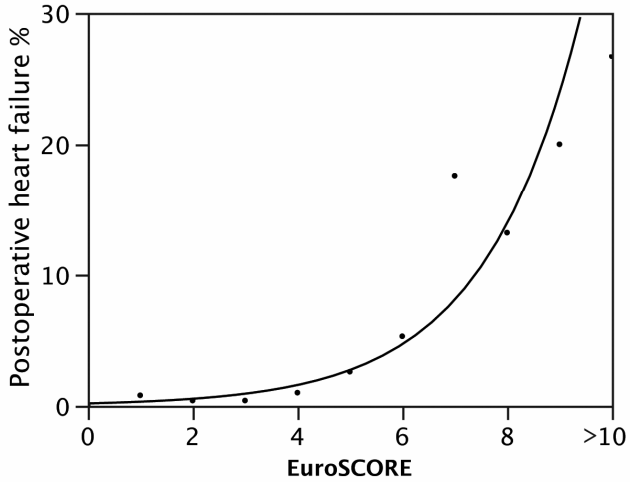


Figure 2: 2-a) Postoperative renal failure and EuroSCORE were well correlated ($y=e^{0.48x-6.61}$). 2-b) Postoperative pneumonia and EuroSCORE are well correlated ($y=e^{0.37x-1.23}$). 2-c) Postoperative stroke and EuroSCORE were well correlated ($y= e^{0.38x-5.85}$). 2-d) Postoperative mediastinitis and EuroSCORE were well correlated ($y=e^{0.35x-6.11}$).

Figure 2-a

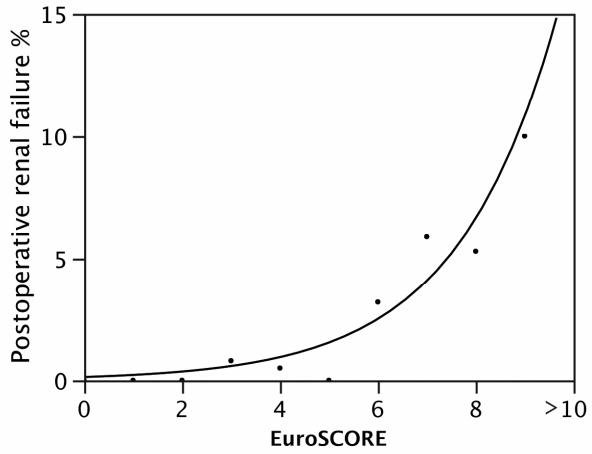


Figure 2-c

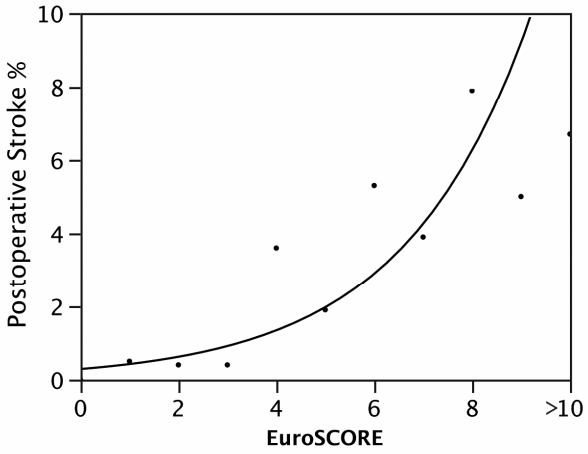


Figure 2-b

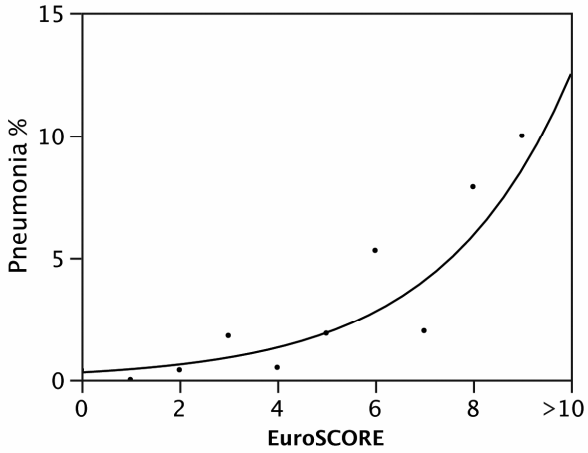


Figure 2-d

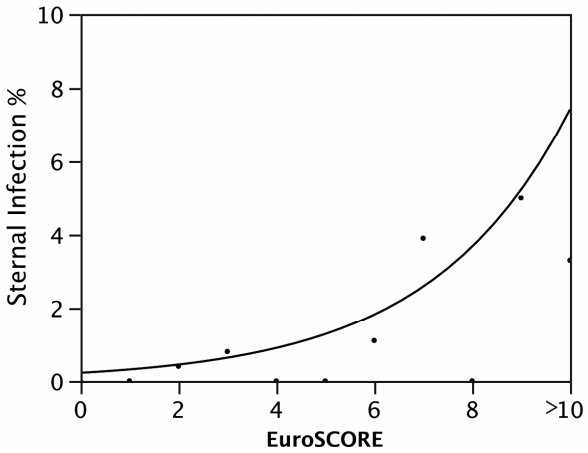


Figure 3: 3-a) Intubation time and EuroSCORE were well correlated ($y=e^{0.22x+1.65}$). 3-b) ICU stay and EuroSCORE were well correlated ($y=e^{0.11x+0.73}$). 3-c) Postoperative length of hospital stay and EuroSCORE were well correlated ($y=e^{0.08x+2.59}$).

Figure 3-a

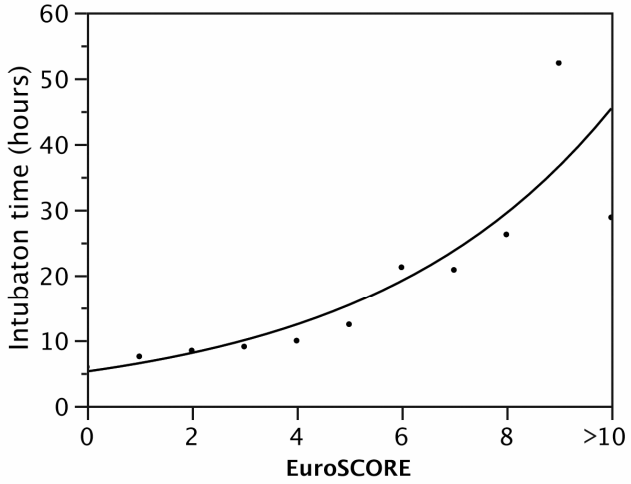


Figure 3-b

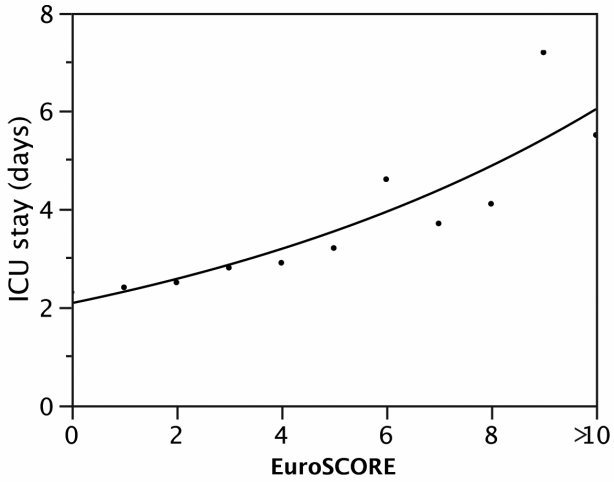
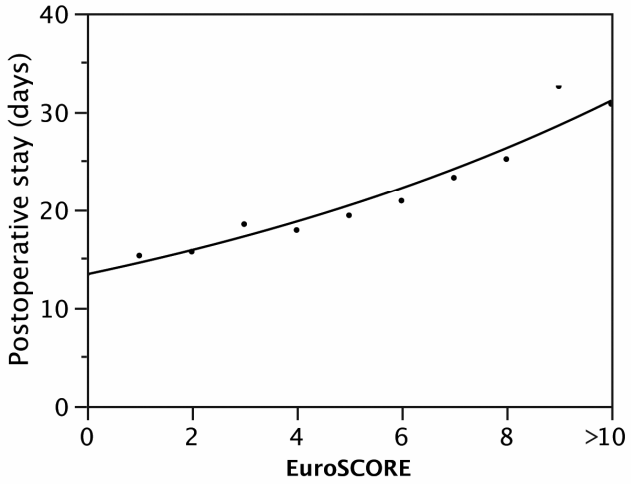


Figure 3-c



References

[1] Roques F, Nashef SA, Michel P, Gauducheau E, de Vincentiis C, Baudet E, Cortina J, David M, Faichney A, Gabrielle F, Gams E, Harjula A, Jones MT, Pintor PP, Salamon R, Thulin L. Risk factors and outcome in European cardiac surgery: analysis of the EuroSCORE multinational database of 19030 patients. Eur J Cardiothorac Surg 1999;15:816-822.

[2] Nashef SA, Roques F, Hammill BG, Peterson ED, Michel P, Grover FL, Wyse RK, Ferguson TB; EurpSCORE Project Group. Validation of European system for cardiac operative risk evaluation (EuroSCORE) in north American cardiac surgery. Eur J Cardiothorac Surg 2002;22:101-105.

[3] Kawachi Y, Nakashima A, Toshima Y, Arinaga K, Kawano H. Evaluation of the quality of cardiovascular surgery care using risk stratification analysis according to the EuroSCORE additive model. Circ J 2002;66:145-148.

[4] Yap CH, Reid C, Yii M, Rowland MA, Mohajeri M, Skillington PD, Seevanayagam S, Smith JA. Validation of the EuroSCORE model in Australia. Eur J Cardiothorac Surg 2006;29:441-446.

[5] Nashef SA, Roques F, Michel P, Cortina J, Faichney A, Gams E, Harjula A, Jones MT. Coronary surgery in Europe: comparison of the national subsets of the European system for cardiac operative risk evaluation database. Eur J Cardiothorac Surg 200;17:396-399.

[6] Biancari F, Kangasniemi OP, Luukkonen J, Vuorisalo S, Satta J, Pokela R, Juvonen T. EuroSCORE predicts immediate and late outcome after coronary artery bypass surgery. Ann Thorac Surg 2006;82:57-61.

[7] Toumpoulis IK, Anagnostopoulos CE, Swistel DG, DeRose JJ Jr. Does EuroSCORE predict length of stay and specific postoperative complications after cardiac surgery? Eur J Cardiothorac Surg 2005;27:128-133.

[8] Roques F, Michel P, Goldstone AR, Nashef SA. The logistic EuroSCORE. Eur Heart J 2003;24:882-883.

[9] Shanmugam G, West M, Berg G. Additive and logistic EuroSCORE performance in high risk patients. Interact Cardiovasc Thorac Surg 2005;4:299-303.

[10] Biancari F, Kangasniemi OP, Luukkonen J, Vuorisalo S, Satta J, Pokela R, Juvonen T. EuroSCORE predicts immediate and late outcome after coronary artery bypass surgery. Ann Thorac Surg 2006;82:57-61.

[11] Sergeant P, de Worm E, Meyns B. Single center, single domain validation of the EuroSCORE on a consecutive sample of primary and repeat CABG. Eur J Cardiothorac Surg 2001;20:1176–1182.

[12] Calafiore AM, Di Mauro M, Canosa C, Di Giammarco G, Iaco AL, Contini M. Early and late outcome of myocardial revascularization with and without cardiopulmonary bypass in high risk patients (EuroSCORE > or = 6). Eur J Cardiothorac Surg 2003;23:360-367.

[13] Riha M, Danzmayr M, Nagele G, Mueller L, Hoefer D, Ott H, Laufer G, Bonatti J. Off pump coronary artery bypass grafting in EuroSCORE high and low-risk patients. Eur J Cardiothorac Surg 2002;21:193-198.

[14] Berger JS, Frye CB, Harshaw Q, Edwards FH, Steinhubl SR, Becker RC. Impact of clopidogrel in patients with acute coronary syndromes requiring coronary artery bypass surgery: a multicenter analysis. J Am Coll Cardiol 2008 18;52:1693-1701.