Original Article

Performance of the EuroSCORE II and the Society of Thoracic Surgeons score in patients undergoing aortic valve replacement for aortic stenosis

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Background: The aim of the study was to assess the predictive ability of risk calculators of the EuroSCORE II and the Society of Thoracic Surgeons (STS) score in patients undergoing aortic valve replacement (AVR) due to severe aortic valve stenosis (AS) during a 30-day and 1-year follow-up.

Methods: A prospective study was conducted on a group of consecutive patients with hemodynamically significant aortic valve stenosis that underwent elective valve replacement surgery. The risk of surgery using EuroSCORE II and STS was calculated for each patient. The primary and secondary endpoints were 30-day and 1-year mortality.

Results: The study group included 428 consecutive patients who underwent replacement of the aortic valve. Thirteen patients died during the 30-day follow-up and 25 patients died during 1-year follow-up. Actual mortality in 30-day observation was 3.0% compared to the predicted 2.9% using EuroSCORE II and 2.1% for STS. The discriminations of ES II and STS score were above 0.8 for mortality prediction during the 30-day and 1-year observation period.

Conclusions: The EuroSCORE II and STS score showed satisfactory discrimination and calibration for predicting 30-day and 1-year mortality in patients undergoing AVR.

Keywords: Aortic stenosis; EuroSCORE II; Society of Thoracic Surgeons (STS); risk stratification

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Introduction

The heart valve surgery is often the only way to improve the long-term survival of a patient with severe valvular heart disease. However, it is associated with the risk of serious post-operative complications, including death. In the risk assessment of cardiac surgery, risk calculators are used—in European conditions, EuroSCORE II is most often used (1). The reliability of risk calculators is relatively high in surgical revascularization of the myocardium, however, in patients qualified for cardiac valve surgery, there are significant discrepancies between the risk of surgery predicted by risk calculators and actual mortality (2-5). The presented study investigated the utility of commonly used risk calculators in the group of polish patients undergoing aortic valve replacement (AVR) because of aortic stenosis.

Methods

This was a prospective study of consecutive patients with hemodynamically significant aortic stenosis (a valve area

below 1 cm^2 and/or a mean pressure gradient ≥40 mmHg) undergoing AVR. The exclusion criteria were: a lack of consent to participate in the study and age under 18 years. Once a patient gave his/her consent to participate, the risk of surgery using EuroSCORE II and STS (from 2008) was calculated for each patient. The day before surgery a blood sample for biomarkers was collected from each patient. Complete blood count was performed with K2-EDTA samples, using a Cobas 6000 electronic counter (Roche, Mannheim, Germany). The primary end-point was death from all causes in 30-day follow-up. The secondary end-point was death from all causes in 1-year follow-up. All procedures were performed through a midline sternotomy incision under general anaesthesia in a normothermia. Patients were followed by direct observation during hospitalization, clinic visits, or telephone interviews for 30 days and 1 year after the surgery. The study was conducted at the Institute of Cardiology, Warsaw, between 2014 and 2018. The protocol was approved by the Institutional Ethics Committee of Institute of Cardiology, Warsaw, Poland (number 1705). All participants they gave their informed consent before taking part in the study.

Statistical analysis

A statistical analysis was performed using SAS version 9.2. Data are presented as the mean ± SD and the frequency (%). Logistic regression was used to assess relationships between variables. The following preoperative covariates: age, left ventricular ejection fraction, NYHA classes, creatinine, EuroSCORE II, STS score, high-sensitivity C-reactive protein (hs-CRP), high-sensitivity troponin T (hs-TnT), hematocrit, hemoglobin, N-terminal of the prohormone brain natriuretic peptide (NT-proBNP), platelets, red cell distribution width (RDW), red blood cell count (RBC) and white blood cell count were investigated for association with the 1-year mortality in univariate analysis. Significant determinants (P<0.05) identified from univariate analysis were subsequently entered into multivariate models. The Hosmer-Lemeshow test was performed to evaluate goodness of fit within equally sized subgroups in increasing order of patient risk. For calibration analysis, a P value of >0.05 indicated a well-calibrated model. Area under the receiver operative characteristics curves (c-statistics) with 95% confidence intervals (95% CI) were used to assess the discriminative ability of risk scores EuroSCORE II and STS for 30-day and 1-year survival following aortic valve surgery. The cut-off value and the log-rank test to compare the curves were employed. All tests were two-tailed and P<0.05 considered statistically significant.

Results

The study included 428 patients who underwent aortic valve. The mean age in the study group was 68.3 (±10.8) and 60% (n=256) patients were men. Baseline characteristics of the patients are presented in *Table 1*. In 278 patients, a biological aortic valve prosthesis was implanted, and in 150 a mechanical valve. Thirteen patients died during the 30-day follow-up period as a result of gradually increasing multi-organ failure and 25 patients died during 1-year follow-up. Statistically significant predictors of 1-year mortality at univariate analysis are presented in *Table 2*. At multivariate analysis RDW (OR 2.185; 95% CI: 1.315–3.630; P=0.002) and RBC (OR 0.118; 95% CI: 0.014–0.987; P=0.04) remained independent predictors of the 1-year mortality. The actual 30-day and annual mortality was 3.0% and 5.8% respectively *vs.* mortality 2.9% predicted by the EuroSCORE II and 2.1% by the STS model. *Table 3* shows the discrimination of 30-day and 1-year mortality by scores. The EuroSCORE II and STS risk calculators did not differ in their predictive ability both for 30-day mortality prediction (P=0.499) and 1-year mortality (P=0.765). *Figure 1* shows the areas under receiver operator characteristic curves of EuroSCORE II and STS score for 30-day survival following AVR surgery. The Hosmer-Lemeshow testing revealed good calibration of the EuroSCORE II and the STS score for 30-day and 1-year mortality in patients undergoing aortic valve surgery (*Table 4*).

Discussion

This is the first prospective study evaluating the utility of EuroSCORE II and STS risk calculators in polish population of patients with severe aortic stenosis undergoing classical AVR surgery for predicting 30-day and 1-year mortality.

The risk calculators are used to assess the surgical risk of heart valve surgery. In European conditions they are EuroSCORE II and less often American STS (1-8). EuroSCORE—European System for Cardiac Operative Risk Evaluation, was a first European tool for calculating the risk of death in the early postoperative period. The EuroSCORE was published in 1999 (9). Gradually accepted, it has become a commonly used tool for risk

Table 1 Baseline characteristics of the study population

Patient characteristics and preoperative variables (n=428)	Values
Age, years*	68.3±10.8
Male: men, n [%]	256 [60]
Previous myocardial infarction, n [%]	38 [9]
Stroke in history, n [%]	21 [5]
Atrial fibrillation, n [%]	102 [24]
Peripheral atherosclerosis, n [%]	34 [8]
Diabetes mellitus, n [%]	81 [19]
Hypertension, n [%]	286 [67]
Current smoker, n [%]	124 [29]
Hyperlipidaemia, n [%]	163 [38]
Body mass index, kg/m^2*	27.8±4.9
Chronic obstructive airways disease, n [%]	30 [7]
Chronic kidney disease (GFR <60 mL/min/1.73 m^2), n [%]	94 [22]
LVEF, n [%]	
>50%	299 [70]
50–36%, n [%]	90 [21]
≤35%	39 [9]
Pulmonary blood pressure, mmHg*	38.8±10.6
CCS (classes)*	2±1
NYHA classes*, n [%]	2.4±0.5
I	3 [1]
II	229 [54]
III	189 [44]
IV	7 [2]
GFR (mL/min/1.73 m^2)*	69±16
Hs-TnT (ng/L)	25±22
Hs-CRP (mg/dL)	0.39±0.3
Hemoglobin (g/dL)*	13.6±1.4
Red cell distribution width (%)*	13.9±1.2
Red blood cell count (min/μL)	4.4±0.5
EuroSCORE II*	2.9±2.6
STS*	2.1±1.5
Cardiopulmonary bypass time (min)*	101±38
Aortic cross-clamp time (min)*	78±33
Days at the ICU (n)*	4±3
Days in the hospital (n)*	11±6
Drainage after 24 h (mL)*	760±350
Myocardial infarction, n [%]	13 [3]
Reoperation during the same hospital stay, n [%]	39 [9]
Renal replacement therapy, n [%]	22 [5]
Stroke, n [%]	14 [3]
In-hospital mortality	18 [4]

Values are represented by the mean * and a measure of the variation of the internal standard deviation. AVR, aortic valve replacement; CCS, Canadian Cardiovascular Society; GFR, Glomerular filtration rate; Hs-TnT, high-sensitivity troponin T; LVEF, left ventricle ejection fraction; NT-proBNP, N-terminal of the prohormone brain natriuretic peptide; NYHA, New York Heart Association.

Table 2 Univariate analysis of predictive factors for the occurrence of the 1-year mortality

Variable	Odds ratio	95% CI	P
EuroSCORE II, %	1.370	1.173–1.600	<0.0001
NT-proBNP,	1.084	1.046–1.126	0.02
RBC, min/μL	0.103	0.026–0.371	0.0002
RDW, %	1.907	1.303–2.771	0.0002
STS score, %	1.983	1.451–2.710	<0.0001

NT-proBNP, N-terminal of the prohormone brain natriuretic peptide; RBC, red blood cell count; RDW, red cell distribution width.

Table 3 Discrimination analyses for 30-day mortality, 1-year mortality and risk scores

Statistical analysis	EuroSCORE II	STS
Mean risk ± SD	2.9±2.6	2.1±1.5
30-day mortality AUC*	0.859 (0.812–0.899)	0.845 (0.796–0.886)
1-year mortality AUC*	0.865 (0.818–0.903)	0.814 (0.763–0.859)

*, c-statistic (95% CI). AUC, area under the curve; STS, Society of Thoracic Surgeons.

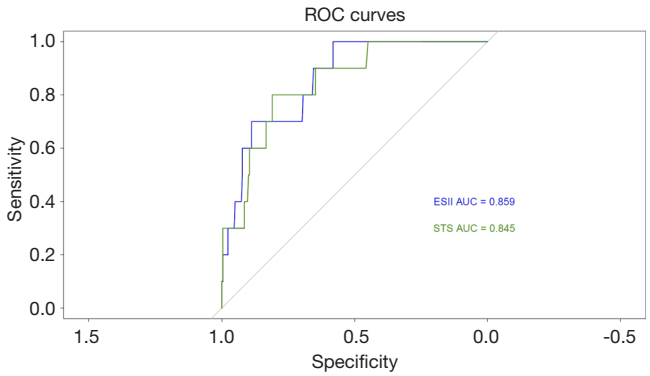

Figure 1 Areas under ROC curves of EuroSCORE II (ESII) and STS for 30-day survival following AVR surgery. AUC, area under the curve; AVR, aortic valve replacement; ROC, receiver operator characteristic; STS, Society of Thoracic Surgeons.

Table 4 The ratio between observed and expected 30-day and 1-year mortality for the EuroSCORE II and STS

Statistical analysis	EuroSCORE II	STS
30-day mortality O/E ratio	1.03	1.42
P	0.37	0.56
1-year mortality O/E ratio	1.93	2.66
P	0.86	0.64

O/E ratio, observed to expected; STS, Society of Thoracic Surgeons.

assessment in patients treated with cardiac surgery. Its use in everyday practice significantly contributed to the improvement of the results of heart surgery at the beginning of the new millennium. However, due to the discrepancy between the predicted and the actual mortality, at the 25th meeting of the European Association of Cardio Thoracic Surgery (EACTS) in Lisbon in October 2011 a new revised EuroSCORE II model was published and next available in the form of an electronic calculator in April 2012. The first reports on the use of EuroSCORE II indicated a significant improvement in risk calibration compared to older model, however, in the subsequent articles appearing there were also discrepancies between the predicted and the actual perioperative mortality (1,5,10,11).

Available literature indicates significant limitations on both the EuroSCORE calculator, the revised version—EuroSCORE II and the American STS (2-5,12). There is a tendency to overestimate the risk of death in patients undergoing heart valve surgery using EuroSCORE and for low risk patients using STS. In turn, the calculation of death risk with using EuroSCORE II reduces the risk especially in patients with numerous additional diseases (2,10). There have been reports that the EuroSCORE II scale did not improve the risk assessment in patients undergoing isolated AVR surgery. In the Chalmers *et al.*'s study on a group of 814 patients undergoing AVR surgery, the actual 30-day mortality was 2.3% *vs.* 7.1% predicted by the EuroSCORE and 2.1% by the EuroSCORE II calculator. In spite of similar actual mortality to the EuroSCORE II calculation result, the EuroSCORE II calculator did not improve the predictive ability of mortality as compared to EuroSCORE (C-statistic values: 0.69 *vs.* 0.67) (5).

In the presented study, the EuroSCORE II and STS calculators showed a significantly better discrimination ability to predict both 30-day mortality as well as 1-year compared to the EuroSCORE calculator. On the other hand, discriminatory abilities of EuroSCORE II calculators and STS did not differ significantly between themselves. The calibration capacity, i.e., the correspondence between the predicted and observed mortality, was the closest when using the EuroSCORE II calculator (3.0% *vs.* 2.9%), compared to the STS (2.1%) model. Thus, the results of the presented study indicate satisfactory discrimination and calibration of the EuroSCORE II and STS calculator in the group of patients with aortic stenosis undergoing valve replacement by the classical method. It seems that in Polish conditions, the EuroSCORE II or STS calculator should be the tool of choice for assessing the risk of death in patients with severe aortic stenosis qualified for AVR. However, it is worth noting that the available risk calculators do not allow accurate estimation of perioperative mortality due to insufficient calibration and discrimination (10). Accurate qualification for surgical treatment of valvular heart disease seems to be important also due to the development of new alternative treatments for heart disease, such as TAVI, for patients with medium or high risk of surgery (13). Therefore, it seems reasonable to put forward the thesis that our knowledge about predictors requires supplementation and, therefore, further research, in order to better calibrate and discriminate against the anticipated risk. Based on the research carried out so far, it seems that biomarkers such as RDW, RBC, Troponin T or frailty may be useful in improving discrimination against the EuroSCORE II calculator (14-19). Moreover, it is worth noting that when qualifying a patient for cardiac surgery, it is necessary to

assess the therapeutic resources of a given center (including staff training), the results of postoperative treatment and the results of percutaneous intervention (6,20). The decision to treat cardiac surgery should be made after a detailed analysis of experts (hearteam), in consultation with the patient and his family, in order to choose the most optimal type of therapy (21,22).

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None.

Footnote

Conflicts of Interest: The authors have no conflicts of interest to declare.

Ethical Statement: The protocol was approved by the Institutional Ethics Committee of Institute of Cardiology, Warsaw, Poland (number 1705) and written informed consent was obtained from all patients.

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