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Original Article

Predictive Power and Implication of EuroSCORE, EuroSCORE II and STS Score for Isolated Repeated Aortic Valve Replacement

Sebastian Holinski, MD, PhD,[1] Sören Jessen, MD,[1] Konrad Neumann, PhD,[2] and Wolfgang Konertz, MD, PhD[1]

Objective: We evaluated the predictive power of the EuroSCORE, EuroSCORE II and Society of Thoracic Surgeons (STS) score for isolated redo aortic valve replacement.
Materials and Methods: 78 consecutive patients underwent the aforementioned procedure mainly with a stentless valve prosthesis at our institution. Observed mortality was compared to the predicted mortality, Receiver Operating Characteristics (ROC) curves were calculated and the area under the curve (AUC) analyzed.
Result: Observed mortality was 11.5%. EuroSCORE and EuroScore II predicted a mortality of 28.2 ± 21.6% (p <0.001) and 10.2 ± 11.8% (p = 0.75), respectively. AUC of the EuroSCORE was 0.74 (95% CI: 0.62–0.83), p = 0.009 and of the EuroSCORE II 0.86 (95% CI: 0.76–0.93), p <0.0001. Optimal Youden index of the EuroSCORE II was 0.59 refering to a predicted mortality of 9.9% (sensitivity: 77.8% and specificity: 81.2%). Predicted mortality of STS score was 17.8 ± 10.6% (p = 0.08) and AUC was 0.64 (95% CI: 0.53–0.75), p = 0.06.
Conclusion: EuroSCORE II calculation was not only superior to EuroSCORE and STS score but led to a very realistic mortality prediction for this special procedure at our institution. A EuroSCORE II greater 10 should encourage to consider an alternative treatment.

Keywords: Euroscore, STS score, operative risk models, aortic valve reoperation

Introduction

Repeated aortic valve replacement has a considerably higher morbidity and mortality than the initial procedure particularly in patients undergoing emergency reoperation.[1)] Several surgical risk models exist to calculate the specific risk of a patient that needs repeated aortic valve replacement.[2–4)] Their predictive value for this special procedure needs to be evaluated since they based mainly on coronary patients and primary procedures. However, a precise risk algorithm is required to decide when to perform standard redo-operation or an alternative treatment like valve-in-valve TAVI which is an option at least in patients without active endocarditis.[5)] Therefore we compared our institutional results with the predictions of the EuroSCORE, EuroSCORE II and Society of Thoracic Surgeons (STS) score.

[1]*Department of Cardiovascular Surgery, Charité Hospital, Medical University, Berlin, Germany*
[2]*Department of Biometry, Charité Hospital, Medical University, Berlin, Germany*

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Corresponding author: Sebastian Holinski, MD, PhD. Department of Cardiovascular Surgery, Charité Hospital, Medical University, Berlin, Germany Schumannstr. 20/21, 10117 Berlin, Germany
Email: sebastian.holinski@charite.de

Methods

Patients and Operation

Between January 2004 and September 2011, 78 Patients with a mean age of 66 ± 11 years underwent isolated repeated aortic valve replacement at the Charité University

Table 1 Patient characteristics

Characteristics	number	mean ± SD (%)
Patients	78	100%
Age, yrs	66 ± 11	
Female gender	17	22%
Height, cm	174 ± 9	
Weight, kg	77 ± 14	
Extracardiac arteriopathy	9	12%
Chronic obstructive pulmonary disease	8	10%
Neurologic dysfunction	13	17%
Critical preoperative state	8	10%
Renal dysfunction		
Dialysis	6	8%
Creatinin clearance <50 ml/min	24	31%
Creatinin clearance 50 ml–85 ml	27	35%
Insulin dependent diabetes mellitus	8	10%
Arterial hypertension	72	92%
Immunosupression	5	6%
Impaired mobility	13	17%
Left ventricular ejection fraction		
>50%	45	58%
31%–50%	29	37%
21%–30%	2	3%
≤20%	1	1%
Systolic pulmonary artery pressure		
31 mmHg–55 mmHg	2	3%
≥55 mmHg	8	10%
CCS class 4 angina	0	0%
Recent myocardial infarction	2	3%
Arrhytmia	14	18%
Active prosthetic valve endocarditis	38	49%
Emergency	2	3%

SD: standard deviation; CCS: Canadian Cardiovascular Society

Hospital Berlin. Main indication was severe regurgitation with or without stenosis. Active prosthetic valve endocarditis was present in 49% of the patients. Further characterization of this cohort is provided in **Table 1**. Operation was performed with median resternotomy, ascending aortic and right atrial cannulation, normothermic cardiopulmonary bypass, direct aortic clamping as well as intermittent, antegrade warm blood cardioplegia. A biological prosthesis was implanted in 92% of the patients. 97% of the biological prostheses were stentless. An overview of implanted prostheses provides **Table 2**. Standard transthoracic echocardiography was performed at discharge with a HP Sonos 5500 (Hewlett-Packard, Palo Alto, California, USA) or a GE Vivid 7 Dimension (General Electric, Fairfield, Connecticut, USA) to check function of implanted prostheses.

Statistics

EuroSCORE, EuroSCORE II and STS score were calculated according to their definition. Observed mortality was compared to the predicted mortality using a version of the binomial-test based on the parametric bootstrap method. Receiver Operating Characteristics (ROC) curves were calculated and the area under the curve (AUC) analyzed. Moreover, Youden's index (= Sensitivity + Specificity − 1) was calculated which captures the performance of a diagnostic test. Statistical calculations were performed using MedCalc version 12.4.06 (MedCalc Software, Ostend Belgium) and SPSS 19 (IBM, Armonk, New York, USA). Level of significance was 0.05.

Results

Mean Aortic Cross Clamp time and duration of cardiopulmonary bypass was 95 and 125 minutes respectively. There was a median blood loss including serous drainage of 830 ml. 65% of the patients were extubated within 24 h. Median of ICU and hospital stay were 3 and 13 days. Maximum and mean pressure gradients of the aortic valve prostheses at discharge were 24/14 mmHg.

Table 2 Implanted valve prostheses

Type	genesis	No
Biological		
stentless		
Elan Root (AorTech, Bellshill, Scotland, UK)	porcine	21
3F Aortic Bioprothesis (Medtronic, Minneapolis, Minnesota, USA)	equine, pericardial	18
Pericarbon Freedom (Sorin Biomedica, Saluggia, Italy)	bovine, pericardial	16
Freedom Solo (Sorin Biomedica, Saluggia, Italy)	bovine, pericardial	6
Toronto SPV (St. Jude Medical, St. Paul, Minnesota, USA)	porcine	5
Edwards Prima Plus (Edwards Lifesciences LLC, Irvine, California, USA)	porcine	2
NR2000 + (Shelhigh, Millburn, New Jersey, USA)	porcine	2
stented		
TLPB (Labcor, Belo Horizonte, Brazil)	porcine	2
Mechanical		
ATS 500FA (Medtronic, Minneapolis, Minnesota, USA)		5
Medtronic ADVANTAGE (Medtronic, Minneapolis, Minnesota, USA)		1

Table 3 Frequency of postoperative complications

Complications	Patients	No (%)
Renal Failure (STS definition)	15	19%
Pneumonia	15	19%
Sepsis	13	17%
Re-exploration for Bleeding/tamponade	8	10%
Low Cardiac Output		
IABP	5	6%
VAD	1	1%
Stroke	1	1%
Mediastinitis (STS definition)	1	1%
AV-block III requiring PM implant	11	14%
Myocardial infarction	0	0%
Gastrointestinal complication	1	1%
Reoperation for valve dysfunction	3	4%

STS: Society of Thoracic Surgeons

CVA occurred in one patient (1.3%) and a permanent pace maker was required in 11 patients (14.1%). No patient suffered from myocardial infarction. Three patients had to be reoperated during the same hospital stay. Recurrent rapid prosthetic endocarditis was the indication for reoperation in two cases. Another stentless bioprosthesis (Sorin Solo) had to be replaced because of symptomatic valvular stenosis due to oversizing. All complications are listed in **Table 3**.

No patient died during the operation. 30-day mortality was 6.5%. Another 5% died after the 30th postoperative day but within the same hospital admission. Thus, the actual combined mortality due to the EuroSCORE mortality definition was 11.5%. Causes of death were septic, therapy-resistant prosthetic valve endocarditis in six patients, pneumonia in two patients and intractable hemorrhagic shock in one patient. The predicted combined mortality according to the mean logistic EuroSCORE of

Table 4 Observed and predicted non-pure mortality endpoints of the STS score

Criteria	Observed (%)	Predicted (%)	p
Morbidity and mortality	39.7	66.8	0.000
Long length of stay	44.9	41.8	0.64
Short length of stay	7.7	7.6	1.00
Permanent stroke	1.3	7.6	0.03
Prolonged ventilation	32.8	52.1	0.001
Deep sternal wound infection	1.3	0.3	0.19
Renal failure	15.3	47.3	0.000
Reoperation	19.2	23.5	0.000

STS: Society of Thoracic Surgeons

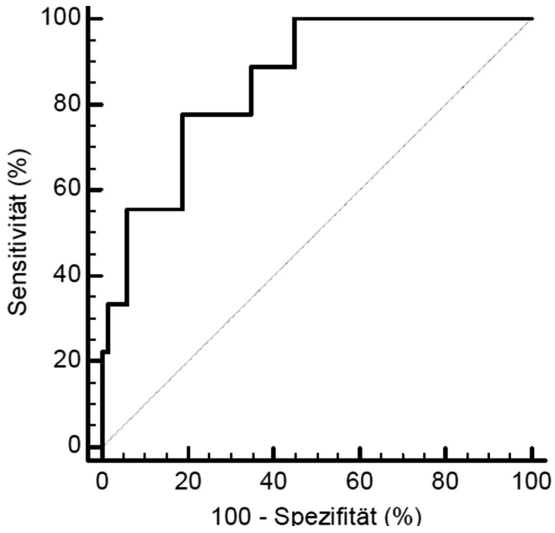

Fig.1 ROC curve of EuroSCORE II. ROC: Receiver Operating Characteristics.

the cohort was 28.2 ± 21.6% which was significantly different from the observed mortality (p <0.001). AUC of the EuroSCORE was 0.74 (95% CI: 0.62–0.83), which was significantly different from the random resembling diagonal line (p = 0.009). Youden index is 0.42 for a mortality of 63.5% with a sensitivity of 44.4% and a specifity of 97.1%.

The logistic EuroSCORE II predicted a mortality of 10.2 ± 11.8% which was not significantly different from the observed mortality (p = 0.75). AUC (**Fig.1**) of the EuroSCORE II was 0.86 (95% CI: 0.76–0.93), p <0.0001. Youden index is 0.59 for a mortality of 9.9% with a sensitivity of 77.8% and a specifity of 81.2 %.

Predicted mortality of STS score was 17.8 ± 10.6% (p = 0.08) and AUC was 0.64 (95% CI: 0.53–0.75), p = 0.06. Youden index is 0.37 for a mortality of 16.8% with a sensitivity of 77.8% and a specifity of 59.4%. Comparison of observed and predicted morbidities according to the STS score criteria are provided in **Table 4**.

Discussion

Statistical models to estimate the operative risk for a specific procedure and patient can be very helpful to decide if to operate and which procedure should be performed. This study investigated the risks of patients undergoing standard isolated repeated aortic valve replacement. Several risk models exist to predict operative mortality for cardiac surgical patients. The most commonly used EuroSCORE,[2] EuroSCORE II[3] and STS score[4] were chosen and their predictive power evaluated for our redo AVR patients. As previously described the EuroSCORE significantly overestimated the risk of patients undergoing aortic valve surgery.[6,7] These rough predictions especially for valve procedures[8,9] can be explained by the fact that the data base of the EuroSCORE consists mainly of coronary patients. Only 17% were aortic valve procedures with probably a much smaller but not reported percentage of patients undergoing redo AVR operation.[10] Another reason is that the data base was completed almost two decades ago with improvements of surgical techniques and intensive care in between. In order to overcome these problems the EuroSCORE II was developed based on data of more than 22.000 patients operated in 43 countries all over the world in 2010.[3] Moreover, the rate of aortic valve patients in the EuroSCORE II database was twice as high compared to the predecessor. In fact, the EuroSCORE II predicted the mortality of our patients quite precise and much better than the EuroSCORE. Moreover it was also superior over the STS Score although the STS score is based on much more patients (67.000) and parameters.[4] However, only centers in the USA provided data and patients were operated before 2007. Predicted non-pure mortality endpoints of the STS score apart from deep sternal wound infections and length of stay did also not match well with our results. Either this special patient subgroup is not well represented in

the STS database or our results are not representative. This leads to one limitation of our study which is the relative small number of patients included in the study referring to a rather infrequent complication like mortality. Since there were only nine deaths a larger study population would be desirable.

Nevertheless, we conclude that EuroSCORE II calculation was not only superior to EuroSCORE and STS score but led to a very realistic mortality prediction for our patients undergoing isolated, repeated aortic valve replacement.

Disclosure Statement

The authors have no conflict of interest.

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