The mortality ratio and the validity of the original EuroSCORE in patients over the age of 70 undergoing cardiovascular surgery

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Summary

Introduction: The aim of our study was to evaluate the performance of the European Cardiac Operative Risk Assessment System (EuroSCORE) in predicting mortality in elderly patients aged 70 years and older undergoing elective cardiovascular surgery.

Material and methods: The hospital data of 112 patients aged 70 years and older who underwent elective cardiovascular surgery procedures at a state hospital clinic in Turkey were scanned retrospectively. The demographic, medical, surgical, and postoperative information and risk factors for the patients were recorded and evaluated. The patients were divided into 3 groups according to the EuroSCORE system. In-hospital death was defined as the end-point of the study.

Results: The overall mortality was 5.35%. 28.57% of the patients were in the low-risk group, whereas the rates in the medium- and high-risk groups were 61.60% and 9.83%, respectively. The mean EuroSCORE was 5.33 ± 2.50 in the deceased group and 3.17 ± 1.90 in the surviving patient group ($p = 0.0093$). The number of observed predicted deceased cases did not differ between different risk groups ($p = 0.23$). The area under curve (AUC) for the EuroSCORE was 0.932 ± 0.019; $p < 0.0001$, with a 95% CI of 0.8950–0.9704.

Conclusions: The AUC for the EuroSCORE in our cases was higher than the reported articles with a similar age group. We suggest that the EuroSCORE assessed operative risk in octogenarians with significantly high efficiency.

Key words: EuroSCORE, mortality cardiac surgery, geriatrics.

Introduction

The progressive elevation in the ratio of aging population and improvement in the surgical management tools resulted in the increased proportion of cardiac procedures being performed in patients aged 70 years and older [1]. Recent data reports an increased incidence of octogenarians among the cardiovascular surgery patients in developing countries. In a recent study, the early death rate was 2%, and a high rate of complications has been reported for cardiac surgery. Common complications reported in the elderly include mediastinal bleeding, tamponade, bleedings requiring transfusions, heart rhythm disorders, low cardiac output, prolonged mechanical ventilation, and pneumonia [2]. With a higher life expectancy, this newly introduced specific population requires alterations of some surgical indications due to their higher risk of major complications or mortality. The biological status of the patient should be taken into account for risk stratification alongside the chronological age to identify the surgical risk and adverse outcomes.

The gradual ageing of the world's population presents significant challenges to social, economic, and public health. Advances in surgical procedures and perioperative treatment have, on the other hand, made it possible to treat elderly patients with an acceptable degree of risk. Thus, the age of patients undergoing cardiac surgery has substantially risen in recent years [3].

The literature shows that elderly patients who underwent cardiac surgery experienced postoperative haemodynamic instability. Preoperative training by nurses has been reported to reduce postoperative complications [4].

Although the European Cardiac Operative Risk Assessment System (EuroSCORE) was reported to overestimate mortality at a score level of ≤6, it is still a widely used tool for cardiac operative risk evaluation [5].

The aim of the current study was to evaluate the performance of the EuroSCORE in predicting mortality in patients aged 70 years and older undergoing elective cardiovascular surgery procedures at our institution, and to present the data on deceased patients and their specifications.

Material and methods

We retrospectively reviewed 112 patients aged 70 years and older who underwent elective surgery for isolated coronary artery bypass graft (CABG), isolated aortic valve replacement (AVR), isolated mitral valve surgery, combined AVR and CABG, combined carotid endarterectomy and CABG, and other procedures (Bentall, abdominal aortic aneurysm) at a state hospital clinic in Turkey. We evaluated the hospital data of 112 patients who underwent elective surgery procedures in our cardiovascular clinic between April 2018 and September 2019. The demographics and diagnosis and treatment schemes of the patients were reviewed from retrospective records. All the patients were informed about the procedure in detail and provided written informed consent at enrolment. The study protocol was reviewed and approved by the institutional Ethics Committee (E-58230125-000-383, Düzce State Hospital).

The inclusion criteria were all patients over 70 years of age, coronary bypass, valve surgery, combined surgery, and aortic surgery. All patients over the age of 70 years who had endocarditis, thoracic aortic surgery, and prosthetic dysfunction but who entered the pump with extracorporeal circulation support were also included in the study. Those under 70 years of age and emergency cases were not included in the evaluation. Patients under the age of 70 years who entered the pump with extracorporeal circulation support were also excluded.

Standard coronary and valvular surgery procedures were applied to all patients. A combined antegrade/retrograde cardioplegia was used for myocardial protection. Etomidate, fentanyl, and vecuronium or rocuronium were used in patients with low ejection fraction, instead of propofol for procedural sedation and anaesthesia.

The demographic, medical, surgical, and postoperative information and risk factors for the patients were recorded and evaluated.

We used the EuroSCORE risk score as a risk assessment tool to estimate intra- and postoperative outcomes in elderly patients before and after cardiac surgery. The calculation of the EuroSCORE II was performed by the formula available on the original website [6]. The patients were divided into 3 groups according to the EuroSCORE system as follows: low-risk group (score 0–2); median-risk group (score 3–5), and high-risk group (score ≥ 6). Written permissions were obtained from the patients or their closest kin. In-hospital death was defined as the end-point of the study.

Data analysis

Statistical analyses were performed using GraphPad Prism version 8.0 (GraphPad Software, CA, USA). Continuous variables were expressed as mean and standard deviation or median and minimum and maximum values. Qualitative variables were expressed as absolute numbers and percentages. The comparison of variables was performed using Student's t-test for continuous variables and the χ^2 or Fisher's exact test for qualitative variables. Hosmer-Lemeshow Test of Goodness of Fit test was used for the determination of risk groups and evaluate the calibration of the EuroSCORE. The performance of the EuroSCORE system was evaluated by constructing a receiver operating characteristic curve and calculating the area under the curve (AUC) with 95% confidence interval (CI). A *p*-value of less than 0.05 was considered significant.

Results

Of the 112 patients, 27 (24.10%) were females. Of the 112 patients who had undergone cardiac surgery the mean age was 73.53 ± 2.63 years, BMI was 26.87 ± 4.02, congestive heart failure was seen in 13 (11.60%), obesity in 24 (21.42%), hypertension in 68 (60.71%), diabetes mellitus in 35 (31.25%, chronic kidney disease in 4 (3.57%), chronic obstructive pulmonary disease in 11 (9.82%), and cerebral vascular disease in 5 (4.46%). Duration to postoperative extubation was 15.99 ± 15.06 hours, the mean hospitalisation duration in the intensive-care unit (ICU) was 1.55 ± 1.25 days, and the duration of postoperative hospital stay was 11.79 ± 4.36 days. The overall mortality was 5.35%. 28.57% of the patients were in the low-risk group, whereas the ratios in the medium- and high-risk groups were 61.60% and 9.83%, respectively (Tab. 1). Although only 1 patient in the deceased community had a cross-clamping time of more than 90 minutes, the by-pass duration was less than 120 minutes.

Duration of cross-clamping and by-pass did not differ between the deceased and surviving patients (Tab. 2). The mean EuroSCORE was 5.33 ± 2.50 in the deceased group and 3.17 ± 1.90 in the surviving patient group ($p = 0.0093$) (Tab. 3). The number of observed predicted deceased cases did not differ between different risk groups ($p = 0.23$) (Tab. 4). Table 5 demonstrates the survival proportions according to different EuroSCORE groups. The EuroSCORE results did not surprise us with the high risk, as expected.

The receiver operator characteristic for the deceased patient group is shown in Figure 1. The area under curve for the EuroSCORE was 0.932 ± 0.019; $p < 0.0001$, with a 95% CI of 0.8950–0.9704. The comorbidities and detailed intra- and postoperative specifications of the 6 deceased

Table 1. Demographic data and specifications of the study group

Age (years) Mean ± SD	**73.53 ± 2.63**
Female	27 (24.10%)
BMI	26.87 ± 4.02
Comorbidities	
Congestive heart failure	13 (11.60%)
Obesity	24 (21.42%)
Hypertension	68 (60.71%)
Diabetes mellitus	35 (31.25%)
Chronic kidney disease	4 (3.57%)
COPD	11 (9.82%)
Cerebral vascular disease	5 (4.46%)
Type of Surgery	
CABG x 1	14 (12.5%)
CABG x 2	26 (25.0%)
CABG x 3	34 (30.35%)
CABG x 4	17 (15.16%)
CABG x 5	1 (0.89%)
MVR	2 (1.79%)
AVR	13 (12.35%)
CABG + AVR	2 (1.79%)
CABG+CEA	1 (0.89%)
Bentall	1 (0.89%)
AAA	1 (0.89%)
Duration of postoperative extubation (hours)	15.99 ± 15.06
Duration of postoperative ICU stay (days)	1.55 ± 1.25
Duration to postoperative hospital stay (days)	11.79 ± 4.36
Risk group	
Low risk (0–2)	32 (28.57%)
Medium risk (3–5)	69 (61.60%)
High risk (≥ 6)	11 (9.83%)

BMI – body mass index, CABG– coronary artery by-pass grafting, MVR – mitral valve replacement, AVR – aortic valve repair, CEA – carotid endarterectomy, AAA – abdominal aortic aneurysm, ICU – intensive care unit

Table 2. The comparison of intraoperative variables between the deceased and surviving patients

	Outcome		***p*-value**
	Death	**Survival**	
Duration of cross-clamping (minutes)	71.99 ± 29.19 (Median: 67.50; Min: 20; Max: 150)		
≤ 90 min	4 (5.71%)	66 (94.29%)	0.82
> 90 min	2 (4.76%)	40 (95.24%)	
Duration of by-pass (minutes)	99.49 ± 30.79 (Median: 102; Min: 35; Max: 180)		
< 120 min	5 (6.49%)	72 (93.51%)	0.42
≥ 120 min	1 (2.86%)	34 (97.14%)	

patients are presented in Table 6. We noticed that the mortality and morbidity variables in our patient population are comparable to those in the literature.

Discussion

Recent advancements in surgical techniques and critical care allow better postoperative clinical outcomes in the elderly, with increased life expectancy. Recently, postoperative survival is not the sole parameter to measure the success of the surgery; thus, an improved survival rate and, if possible, resolution of the comorbidities are expected. Furthermore, some complications, such as stroke, arrythmia, and congestive heart failure worsen the life quality of the patient after cardiovascular surgery [7].

It is estimated that the population of those who live to 65 years and more will grow to 2 billion by the year 2050 [8]. Thus, identifying elderly patients who may benefit from cardiac surgery is of utmost importance in patient selection and postoperative care. EuroSCORE, one of the variables for estimating the survival after cardiovascular surgery, is a widely used tool to predict early mortality. However, the final decision is made by the surgeon her/himself due to data reporting overestimated scores calculated using these systems. Thus,

Table 3. The comparison of European Cardiac Operative Risk Assessment System values between the deceased and surviving patients

Death	***n***	**Mean**	**SD**	**Median**	**Lowest**	**Highest**	***p*-value**
No	106	3.17	1.90	3	0	8	0.0093
Yes	6	5.33	2.50	4	3	9	–
Total	112	3.29	1.98	3	0	9	–

Table 4. The comparison of observed and predicted mortality depending on the risk severity

Risk group	**Number of cases**	**Observed deaths (*N*)**	**Predicted deaths (*N*)**	***p*-value**
Low risk (0–2)	32	0	1.66	0.23
Medium risk (3–5)	69	4	6.33	–
High risk (≥ 6)	11	2	2.78	–

we aimed to evaluate the efficacy of EuroSCORE in our patients over the age 70 years and report the surviving and deceased patient ratios in a state hospital cardiovascular surgery clinic.

The overall mortality in our study group was 5.35%, with a mean EuroSCORE of 5.33 ± 2.50. Although female gender is a risk factor for cardiovascular surgery, none of the female patients died in our study group. In an observational, retrospective, multicentre study of a large group of cardiac surgery patients older than 75 years, mortality was found to be 1.1%, 12%, and 15.1% during surgery, in the intensive care unit, and within 30-days, respectively [9].

The mean EuroSCORE value of a global cohort of 7161 cases was 8.5 ± 11.0 for patients over the age of 80 years, with a 9.38% mortality rate [10].

According to a report published by the Society for Cardiothoracic Surgery in Great Britain and Ireland, less than 50% of patients receive 3 bypass grafts, while under 5% of patients receive only 1 bypass graft [11]. In our study, the ratio of patients who received 3 or more grafts was 46.4%, whereas the proportion of patients who received 1 graft was 12.5% of the study group. The relatively higher ratio of patients operated for 1 graft CABG might be due to our patient selection criteria and the higher age of the patient population.

Although combined surgery is an additional risk factor for the elderly, only 3 out of 112 patients in our series underwent combined valvular surgery with CABG, and all of them survived. The 6 deceased patients were lost to various complications, mainly arrythmia and cardiopulmonary collapse, and half of them died in the ICU. All patients in the deceased group were below the age of 75 years and were operated on for CABG of 1 or 2 grafts. While the duration of cross-clamping was more than 90 minutes in only 1 patient in the deceased group, the by-pass duration was less than 120 minutes.

Although the original EuroSCORE was developed in a patient population with a mean age of 62.5 years, the AUC for the EuroSCORE in our cases was higher than the reported articles with a similar age group [12]. On the other hand, the number of high-risk patients in our study group was 11 (9.83%), and the high predictive capacity of this scoring system might regress if the risk groups had similar numbers of cases. In a similar group of patients, Affilalo ***et al***. found the AUC for EuroSCORE to be 0.65 (0.55–0.75), which is significantly lower than our finding, which might be a result of different char-

Table 5. Survival proportions depending on the European Cardiac Operative Risk Assessment System values

	Total (N)	Death (N)	Survival proportion (%)
0	14	0	100
1	6	0	100
2	12	0	100
3	32	1	98.75
4	21	3	92.57
5	16	0	92.57
6	3	0	92.57
7	4	0	92.57
8	3	1	69.43
9	1	1	0

Table 6. Demographic data and specifications of the deceased patients

	Patient #1	Patient #2	Patient #3	Patient #4	Patient #5	Patient #6
Age	72	73	74	71	70	73
Gender	M	M	M	M	M	M
BMI	30.07	28.08	25.60	23.14	25.39	26.12
Type of Surgery	CABG x 1	CABG x 1	CABG x 1	CABG x 2	CABG x 1	CABG x 2
Duration of cross-clamping (minutes)	46	80	80	39	103	BEATING
Duration of by-pass (minutes)	73	110	110	115	118	BEATING
EuroSCORE	9	4	4	3	8	4
Preoperative hypertension	–	+	–	–	+	+
Preoperative diabetes mellitus	+	+	+	–	–	–
Pre-operative arrhythmia	–	–	–	+	–	–
Usage of inotropic drugs	+	+	+	+	+	–
Duration to postoperative extubation (hours)	Not extubated	Not extubated	Not extubated	18	72	120
Duration of postoperative ICU stay (days)	14	11	11	1	3	5
Duration of postoperative hospital stay (days)	14	11	11	3	11	8

CABG – coronary artery by-pass grafting, ICU – intensive care unit

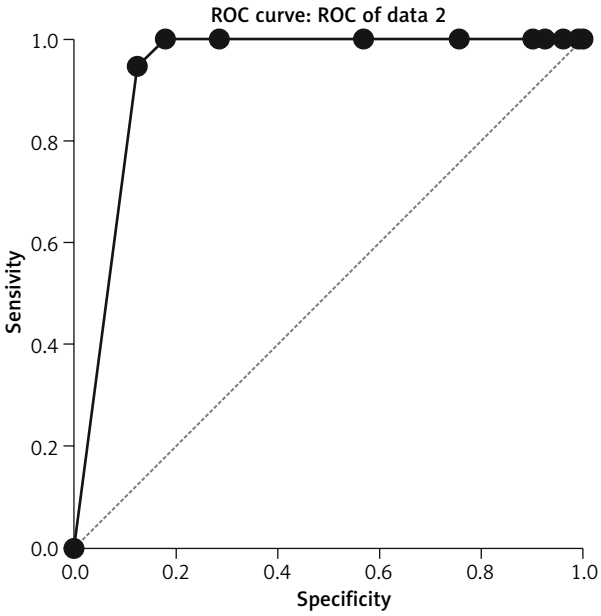

Fig. 1. Receiver operating characteristics curve for the European Cardiac Operative Risk Assessment System [AUC: 0.93 ± 0.019 (0.895–0.970) $p < 0.0001$]

acteristics in the patient selection, operative variables, and postoperative care between the 2 groups [13].

It was reported that the proportion of patients in the higher risk EuroSCORE groups has increased over time, and EuroSCORE significantly and consistently over-predicted the observed mortality in the highest risk patients [11]. With the improvements in surgical outcomes over time, it is challenging to establish a risk score system to predict observed mortality with raised sensitivity and specificity. It was also suggested that other common conditions in the elderly, such as aortic calcification and diffuse coronary disease, should be among the risk factors used to calculate the EuroSCORE, to increase the efficacy of the tool in predicting postoperative outcomes [12].

There are reports mentioning that heart failure patients receiving inotropes were more likely to have complications including ventricular tachycardia, prolonged hospital stay, cardiac arrest, and in-hospital mortality [14]. It is worth mentioning that 5 out of the 6 deceased patients received inotropic drugs to improve haemodynamic function. However, we do not have the data to show whether these agents played an additional role in the mortality of our patients.

There are several limitations to this study. First, this is a report of a single institution in a developing country; thus, the presented results may not apply to those from other institutions and countries. Second, the present study included patients undergoing a heterogeneous pool of cardiovascular procedures, and it is obvious that the predictive capability of the scoring systems would vary among different study set-ups. Lastly, the European Association for Cardio-Thoracic Surgery reported the establishment of the EuroSCORE II with novel risk factor variables in 2012 [15]. However, it was not possible draw a calculation and calibration for our patient group for this scoring system because data on newly introduced variables such as mobility were not recorded in our database. Furthermore, there are recent studies of large cohorts reporting that both models are sensitive, specific, and have similar predictive power.

Conclusions

Our results show that EuroSCORE assessed operative risk in octogenarians with significantly high efficiency, and the EuroSCORE was an objective indicator of postoperative mortality in elderly patients who underwent cardiovascular procedures in a state hospital.

The authors declare no conflict of interest.

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