Comparison of some parameters in estimating in-hospital mortality risk in patients undergoing open-heart surgery

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Abstract. – OBJECTIVE: Despite accumulating evidence showing the importance of various scoring systems in predicting preoperative mortality rates among patients who are undergoing open cardiac surgery, the prediction of in-hospital mortality is still limited. This study aimed to investigate the contributing factors associated with in-hospital mortality in patients who undergo cardiac surgery.

PATIENTS AND METHODS: All patients, aged 19 to 80 years, who underwent cardiac surgery between February 2019 and November 2020 at our tertiary healthcare institute were analyzed retrospectively. Demographic details, transthoracic echocardiography data, operation-related details, cardiopulmonary bypass time and laboratory measurement results were retrieved from the institutional digital database.

RESULTS: Data was available for a total of 311 subjects whose median age was 59 (52-67) years, and 65% of which were male. Among these 311 subjects, 296 (95%) were successfully discharged; however, in-hospital mortality was observed in 15 (5%) patients. Multiple logistic regression analysis revealed that low ejection fraction (p=0.049 and p=0.018), emergency surgery (p=0.022), low postoperative platelet (p=0.002) and high postoperative creatinine (p=0.007) were the most significant risk factors of mortality.

CONCLUSIONS: In conclusion, in a population of subjects undergoing cardiac and thoracic surgery, the in-hospital mortality rate was 4.8%. Left ventricular ejection fraction (LVEF) <40%, emergency surgery, postoperative platelet count and postoperative creatinine were significant risk factors for mortality.

Key Words:

Cardiac surgery, Left ventricular function, Platelet, Creatinine, Mortality.

Introduction

Cardiac surgeries are among the most frequent and complex surgeries, especially when performed in elderly subjects[1,2]. Having an understanding of and being able to predict the risks may provide important clues to identify the focus points and improve postoperative care. Several risks scoring systems, including the European System for cardiac operative risk evaluation (EuroSCORE), Parsonnet score, and the Society of Thoracic Surgeons (STS) score, are widely utilized to assess perioperative risk in patients that will undergo cardiac surgery.

The EuroSCORE system was developed to predict postoperative mortality in patients undergoing coronary artery bypass grafting surgery (CABG) and is based on several clinical factors including age, sex, serum creatinine, ventricular arrhythmias, concomitant peripheral, carotid artery disease, chronic lung disease, neurological dysfunction, left ventricular systolic function, pulmonary artery pressure, unstable angina, recent myocardial infarction, emergency surgery, and additional heart procedure simultaneous with CABG, surgery for disorders of the aorta (ascending, arch or descending), and post-infarct ventricular septal defect (VSD)[3].

The Parsonnet score was developed to predict mortality in adults undergoing cardiac surgery[4]. Variables included in this scoring system are age, sex, body mass index (BMI), the presence of diabetes and hypertension, left ventricular systolic function, re-do surgery, preoperative intra-aortic balloon pump (IABP), left ventricular aneurysm, emergency surgery, renal impairment, presence of catastrophic clinical conditions including cardiogenic shock, acute structural defect, acute renal failure, lung disease, as well as the type of the cardiac surgery.

The STS risk scoring system is another system for adults undergoing cardiac surgery. This scoring system takes into account age, sex, comorbidities (hypertension, peripheral arterial disease, cerebrovascular disease, diabetes, and lung disease), and the presence of cardiogenic shock or underlying heart failure[5].

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Despite evidence from the literature demonstrating the value of these scoring systems in predicting mortality preoperatively among patients undergoing open cardiac surgery, there is still limited data regarding the prediction of in-hospital mortality among these patients. Therefore, this study aimed to investigate factors that are independently associated with in-hospital mortality among patients who underwent cardiac surgery.

Patients and Methods

All patients aged 19 to 80 years who underwent cardiac surgery between February 2019 and November 2020 at our tertiary healthcare institute were retrospectively analyzed in this study. This study received approval from the local Ethics Committee (15/04/2022, number: 2022/04-04).

All surgical procedures were carried out by the same surgical team, who were experienced in CABG, valvular surgery, correction of congenital heart defects, and aortic surgery. Blood types were identified (ABO). Venous blood samples were obtained from all subjects upon admission, and complete blood count and biochemistry analyses were done. Calculation of inflammation-related indices was performed from the complete blood count values, including platelet-to-mean platelet volume (MPV), neutrophil-to-lymphocyte, lymphocyte-to-monocyte, platelet-to-lymphocyte, and eosinophil-to-lymphocyte ratios. In addition, the monocyte-to-high-density lipoprotein (HDL) ratio was calculated. Transthoracic echocardiography was performed in all subjects prior to surgery. The left ventricular ejection fraction was calculated using the modified Simpson's method (biplane method of discs)[6]. The systolic pulmonary artery pressure was calculated using the modified Bernoulli equation ($4v^2$ + estimated right atrial pressure, v indicates maximum velocity of the tricuspid valve regurgitant jet). The demographic characteristics of each subject, including age, sex, BMI, comorbid diseases, smoking history, laboratory test results, COVID-19 polymerase chain reaction (PCR) positivity, type of cardiac surgery, aortic cross-clamp, the cardiopulmonary bypass times, transfusion rate, duration of intubation, length of ICU stay, and in-hospital mortality rate were retrieved from the institutional digital database and from patient charts.

Subjects were divided into two groups according to in-hospital mortality, and the deceased subjects were compared to the survivors with respect to their demographic, clinical, surgical characteristics, and laboratory test results. The difference between the two groups with respect to the aforementioned variables was the primary outcome measure of this study. Determining factors independently associated with in-hospital mortality following cardiac surgery was the secondary outcome measure.

Statistical Analysis

All analyses were performed on IBM SPSS Statistics Version 25.0 (IBM Corp., Armonk, NY, USA) for Windows, and were assessed with respect to a significance threshold of $p<0.05$. For the normality check, histogram and Q-Q plots were used. Mean±standard deviation or median (1st quartile - 3rd quartile) values were used to describe continuous variables, with and without normal distribution, respectively. Frequency, which was expressed in percentages, values were used to describe categorical variables. Normally distributed variables were analyzed with the independent samples *t*-test. Non-normally distributed variables were analyzed with the Mann-Whitney U test. Categorical variable distributions were analyzed with Chi-square tests, Fisher's exact test, or the Fisher-Freeman-Halton test. Normally distributed repeated measurements were analyzed with the two-way repeated measures analysis of variances (ANOVA). Non-normally distributed repeated measurements were analyzed with the Wilcoxon signed ranks test. The mortality prediction performance of variables was evaluated *via* Receiver Operating Characteristic (ROC) analysis. Cut-off points were determined using the Youden index. Measurements of performance (sensitivity, specificity, accuracy, positive predictive value, negative predictive value) were calculated. Multiple logistic regression analysis (forward conditional method) was performed to determine risk factors that are independently associated with mortality.

Results

Data were available for a total of 311 subjects with a median age of 59 (52-67) years, of which 65% were male. Among these 311 subjects, 296 (95%) were successfully discharged; however, in-hospital mortality was observed in 15 (5%) patients. The two groups were similar with regard to their age, sex, BMI values, frequency of hyperlipidemia, diabetes, chronic obstructive pulmonary disease, and chronic renal failure. Hypertension was more frequent among deceased subjects compared to survivors (100% to 69.3%, $p=0.007$). Pulmonary artery pressure was similar in the two groups; however, the number of subjects with an LVEF of <40% was more frequent among the deceased subjects compared to those who survived (26.7% *vs*. 7.1%, p=0.002). Emergency cardiac surgery was more frequent among the deceased subjects compared to surviving subjects (66.7% *vs*. 11.1%, p<0.001). Thoracic aorta surgery was more frequent among the deceased subjects compared to the survivors (46.7% *vs*. 5.7%, p=0.001). The median duration of the cardiopulmonary bypass was 96 minutes (min: 85-Max: 130) for deceased subjects *vs*. 81.5 minutes (min: 64-Max: 97) for subjects that survived, p=0.004 and the duration of intubation was 2 days (min: 1-Max: 5) for deceased subjects *vs*. 1 day (min: 1-Max: 1), p<0.001 for subjects that survived. Moreover, subjects that had COVID-19 in the past were more frequent among the deceased compared to the survivors (33.3% *vs*. 7.4%, p=0.006) (Table I).

Comparisons of pre- and postoperative laboratory measurements of the two groups are presented in Table II. Subjects with mortality demonstrated a significant decline in platelet count [209 (157-240) x 10^3 *vs*. 95.5 (80-171) x10^3, p=0.004], hemoglobin (13.70±2.75 g/dl *vs*. 8.61±1.33 g/dl, p<0.001), lymphocyte count (2.30±1.22 x 10^3 *vs*. 1.52±0.71 x 10^3, p=0.001), platelet-to-MPV ratio [20.64 (15.57-27.27) x 10^3 *vs*. 9.83 (7.45-15.98) x 10^3, p=0.003], lymphocyte-to-monocyte ratio [3.34 (1.75-5.29) *vs*. 2.04 (1.66-3.00), p=0.019] and a significant increase in MPV (10.22±1.15 *vs*. 9.29±1.00, p<0.001) and creatinine [2.80 (1.30-3.70) mg/dl *vs*. 0.80 (0.76-1.22) mg/dl, p=0.002] values in postoperative measurements compared to preoperative measurements.

The cut-off values to predict in-hospital mortality were calculated for LVEF, platelet count, hemoglobin, MPV, neutrophil count, creatinine, platelet-to-MPV ratio, neutrophil-to-lymphocyte ratio, and platelet-to-lymphocyte ratio have been presented in Table III.

Multiple logistic regression analysis revealed that low ejection fraction (40-50%, p=0.049 and <40%, p=0.018), emergency surgery (p=0.022), low postoperative platelet count (p=0.002), and high postoperative creatinine (p=0.007) were found to be independent risk factors associated with mortality (Table IV). Other variables included in the analysis were age (p=0.288), sex (p=0.460), hypertension (p=0.127), blood ABO group (p=0.681), surgical procedure (p=0.973), duration of cardiopulmonary bypass (p=0.458), COVID-19 positivity (p=0.096), postoperative hemoglobin (p=0.344), postoperative MPV (p=0.743), postoperative neutrophil (p=0.051), postoperative platelet-to-MPV ratio (p=0.538), postoperative neutrophil-to-lymphocyte ratio (p=0.250) and postoperative platelet-to-lymphocyte ratio (p=0.649) which were found to be non-significant (Figures 1-4).

Discussion

Our findings indicate a 4.8% rate of in-hospital mortality in the study group consisting of patients who underwent various types of cardiac surgery. Hypertension, emergency surgery, left ventricular systolic dysfunction, and COVID-19 positivity were more frequent among deceased subjects compared to survivors. Moreover, a comparison of preoperative and postoperative values showed that subjects with mortality demonstrated a significant decline in hemoglobin, platelet count, lymphocyte count, platelet-to-MPV ratio and lymphocyte-to-monocyte ratio, while they showed a significant increase in MPV and creatinine values. Multiple logistic regression analysis revealed that having a lower LVEF (40-50% and <40%), undergoing emergency surgery, and postoperative levels of platelet and creatinine were determined to be risk factors that were independently associated with mortality.

Open heart surgery, particularly CABG has been widely used for revascularization in patients with extensive coronary artery disease. Mitral valve surgery is reserved most commonly for patients with rheumatic valve disease, mitral valve prolapses, and ischemic mitral insufficiency; whereas aortic valve surgery is unusually performed for degenerative aortic stenosis. The Society for Thoracic Surgeons (STS) database demonstrates a 2.3% 30-day mortality rate following CABG[7]. Other large cardiac surgery datasets report 30-day mortalities varying from 1% to 4%[8]. In-hospital mortality from isolated valvular surgery has been reported to be 3.4% in a large dataset which included 67,292 patients who underwent isolated aortic valve replacement, 21,229 patients who underwent isolated mitral valve replacement, and 21,238 patients who underwent isolated mitral valve repair[9]. Over the past decades, the profile of patients who undergo cardiac surgery has changed considerably. More patients with older age, comorbid diseases, cardiac damage, and requiring re-do surgery are referred for cardiac surgery[10]. Furthermore, various center-specific and country-specific factors can also influence in-hospital mortality following cardiac surgery.

Table I. Summary of patient characteristics with regard to mortality.

		Final status		
	Total (n=311)	Discharged (n=296)	Exitus (n=15)	p
Age	59 (52-67)	59 (51.5-66)	64 (60-70)	0.067
Sex				
Male	202 (65.0%)	193 (65.2%)	9 (60.0%)	0.893
Female	109 (35.0%)	103 (34.8%)	6 (40.0%)	
Height, m	1.65±0.09	1.65±0.09	1.67±0.09	0.473
Weight, kg	76.07±13.06	76.19±12.74	73.67±18.71	0.466
Body mass index	27.40 (24.69-30.85)	27.51 (24.94-30.85)	24.69 (22.60-29.38)	0.086
Comorbidities				
Hypertension	220 (70.7%)	205 (69.3%)	15 (100.0%)	**0.007**
Hyperlipidemia	143 (46.0%)	139 (47.0%)	4 (26.7%)	0.203
Diabetes mellitus	110 (35.4%)	106 (35.8%)	4 (26.7%)	0.656
COPD	29 (9.3%)	28 (9.5%)	1 (6.7%)	1.000
Carotid disease	51 (16.4%)	48 (16.2%)	3 (20.0%)	0.720
Chronic renal failure	19 (6.1%)	16 (5.4%)	3 (20.0%)	0.055
Smoking	199 (64.0%)	191 (64.5%)	8 (53.3%)	0.545
Ejection fraction				
>50	223 (71.7%)	218 (73.6%)	5 (33.3%)	**0.002**
40-50	63 (20.3%)	57 (19.3%)	6 (40.0%)	
<40	25 (8.0%)	21 (7.1%)	4 (26.7%)	
Pulmonary artery pressure				
>25	128 (41.2%)	123 (41.6%)	5 (33.3%)	0.717
<25	183 (58.8%)	173 (58.4%)	10 (66.7%)	
Blood ABO group				
A	159 (51.1%)	151 (51.0%)	8 (53.3%)	**0.041**
B	51 (16.4%)	50 (16.9%)	1 (6.7%)	
O	79 (25.4%)	77 (26.0%)	2 (13.3%)	
AB	22 (7.1%)	18 (6.1%)	4 (26.7%)	
Blood Rh group				
Negative	34 (10.9%)	32 (10.8%)	2 (13.3%)	0.673
Positive	277 (89.1%)	264 (89.2%)	13 (86.7%)	
Surgery type				
Elective	268 (86.2%)	263 (88.9%)	5 (33.3%)	**<0.001**
Emergency	43 (13.8%)	33 (11.1%)	10 (66.7%)	
Surgery procedure				
CABG	207 (66.6%)	200 (67.6%)	7 (46.7%)	**0.001**
Aortic valve surgery	17 (5.5%)	17 (5.7%)	0 (0.0%)	
Mitral valve surgery	37 (11.9%)	37 (12.5%)	0 (0.0%)	
Tricuspid valve surgery	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Thoracic aorta surgery	24 (7.7%)	17 (5.7%)	7 (46.7%)	
Cardiac tumor	3 (1.0%)	3 (1.0%)	0 (0.0%)	
Atrial septal defect	11 (3.5%)	11 (3.7%)	0 (0.0%)	
CABG + AVR	5 (1.6%)	5 (1.7%)	0 (0.0%)	
CABG + MVR	4 (1.3%)	3 (1.0%)	1 (6.7%)	
MVR + AVR	3 (1.0%)	3 (1.0%)	0 (0.0%)	
Number of arteries bypassed	2 (0-3)	3 (0-3)	2 (0-3)	0.320
Duration of CPB, min	83 (65-98)	81.5 (64-97)	96 (85-130)	**0.004**
Duration of ACC, min	50 (37-63)	50 (37-63)	51 (45-66)	0.223
Transfusion				
None	104 (33.4%)	101 (34.1%)	3 (20.0%)	0.225
FFP	84 (27.0%)	81 (27.4%)	3 (20.0%)	
Blood	51 (16.4%)	49 (16.6%)	2 (13.3%)	
Blood + FFP	72 (23.2%)	65 (22.0%)	7 (46.7%)	
Duration of intubation, day	1 (1-1)	1 (1-1)	2 (1-5)	**<0.001**
Length of stay in ICU	4 (3-5)	4 (3-5)	4 (2-8)	0.722
COVID-19 positivity	27 (8.7%)	22 (7.4%)	5 (33.3%)	**0.006**

COPD: Chronic obstructive pulmonary disease, CABG: Coronary artery bypass graft, AVR: Aortic valve replacement, MVR: Mitral valve replacement, CPB: Cardiopulmonary bypass, ACC: Aortic cross-clamp, FFP: Fresh frozen plasma, ICU: Intensive care unit. Data are summarized as mean±standard deviation or median (1st quartile-3rd quartile) for continuous variables according to normality of distribution and as frequency (percentage) for categorical variables.

Table II. Summary of laboratory measurements with regard to mortality.

	Final status			
	Total (n=311)	**Discharged (n=296)**	**Exitus (n=15)**	***p* (between groups)**
HDL				
Preoperative	38 (32-45)	38 (32-45)	35 (32-45)	0.745
Postoperative	43 (35-47)	43 (35-47.65)	38 (33-44)	0.116
p (within groups)	**<0.001**	**<0.001**	0.968	
Hemoglobin				
Preoperative	14.39±1.91	14.43±1.86	13.70±2.75	0.512
Postoperative	10.54±1.50	10.63±1.45	8.61±1.33	**<0.001**
p (within groups)	**<0.001**	**<0.001**	**<0.001**	
Platelet (x10^3)				
Preoperative	240 (204-276)	243 (205-279)	209 (157-240)	**0.003**
Postoperative	324.5 (235-420)	331.5 (242.5-425.5)	95.5 (80-171)	**<0.001**
p (within groups)	**<0.001**	**<0.001**	**0.004**	
MPV				
Preoperative	9.38±1.13	9.39±1.14	9.29±1.00	0.828
Postoperative	9.01±1.13	8.95±1.10	10.22±1.15	**<0.001**
p (within groups)	**0.027**	**<0.001**	**<0.001**	
Neutrophil (x10^3)				
Preoperative	5.20 (3.96-7.14)	5.16 (3.92-7.00)	7.58 (5.00-11.86)	**0.003**
Postoperative	6.00 (4.68-7.64)	5.90 (4.64-7.53)	8.86 (7.30-11.70)	**<0.001**
p (within groups)	**<0.001**	**<0.001**	0.245	
Lymphocyte (x10^3)				
Preoperative	2.14±0.83	2.13±0.80	2.30±1.22	0.419
Postoperative	1.83±0.65	1.85±0.64	1.52±0.71	0.066
p (within groups)	**<0.001**	**<0.001**	**0.001**	
Eosinophil (x10^3)				
Preoperative	0.14 (0.07-0.21)	0.14 (0.07-0.22)	0.13 (0.07-0.16)	0.311
Postoperative	0.26 (0.15-0.42)	0.26 (0.15-0.40)	0.23 (0.02-0.60)	0.599
p (within groups)	**<0.001**	**<0.001**	0.124	
Monocyte (x10^3)				
Preoperative	0.62±0.27	0.62±0.26	0.70±0.27	0.342
Postoperative	0.75±0.29	0.76±0.29	0.74±0.30	0.899
p (within groups)	**0.023**	**<0.001**	0.482	
Creatinine				
Preoperative	0.85 (0.76-1.00)	0.85 (0.75-1.00)	0.80 (0.76-1.22)	0.394
Postoperative	0.80 (0.70-0.98)	0.80 (0.70-0.97)	2.80 (1.30-3.70)	**<0.001**
p (within groups)	**0.001**	**<0.001**	**0.002**	
Monocyte-to-HDL ratio				
Preoperative	15.00 (10.32-21.67)	14.88 (10.31-21.60)	19.11 (13.11-24.86)	0.253
Postoperative	17.33 (13.02-22.05)	17.33 (13.02-22.00)	19.71 (14.35-27.08)	0.544
p (within groups)	**<0.001**	**<0.001**	0.701	
Platelet-to-MPV ratio (x10^3)				
Preoperative	25.78 (21.05-30.56)	25.90 (21.10-30.60)	20.64 (15.57-27.27)	**0.003**
Postoperative	36.87 (25.64-48.78)	37.83 (27.09-50.41)	9.83 (7.45-15.98)	**<0.001**
p (within groups)	**<0.001**	**<0.001**	**0.003**	
Neutrophil-to-lymphocyte ratio				
Preoperative	2.44 (1.75-3.88)	2.40 (1.72-3.72)	3.88 (1.76-7.23)	0.087
Postoperative	3.39 (2.50-4.66)	3.34 (2.46-4.51)	5.96 (4.42-11.57)	<0.001
p (within groups)	**<0.001**	**<0.001**	0.084	
Lymphocyte-to-monocyte ratio				
Preoperative	3.49 (2.55-4.88)	3.50 (2.55-4.88)	3.34 (1.75-5.29)	0.616
Postoperative	2.50 (1.89-3.22)	2.50 (1.91-3.23)	2.04 (1.66-3.00)	0.211
p (within groups)	**<0.001**	**<0.001**	**0.019**	
Platelet-to-lymphocyte ratio				
Preoperative	116.09 (90.00-158.52)	116.76 (90.00-159.00)	102.13 (52.77-134.94)	0.186
Postoperative	174.05 (129.29-263.84)	181.85 (131.18-265.22)	97.38 (38.08-131.75)	**<0.001**
p (within groups)	**<0.001**	**<0.001**	0.875	
Eosinophil-to-monocyte ratio				
Preoperative	0.26 (0.13-0.43)	0.26 (0.14-0.43)	0.17 (0.08-0.33)	0.195
Postoperative	0.37 (0.21-0.59)	0.36 (0.22-0.59)	0.43 (0.02-0.60)	0.804
p (within groups)	**<0.001**	**<0.001**	0.363	

Data are summarized as mean±standard deviation or median (1st quartile - 3rd quartile) for continuous variables according to normality of distribution and as frequency (percentage) for categorical variables.

Table III. Performance of the variables to predict mortality.

	Cut-off	Sensitivity	Specificity	Accuracy	PPV	NPV	AUC (95.0% CI)	*p*
Ejection fraction	≤50	66.7%	73.6%	73.3%	11.4%	97.8%	0.713 (0.568-0.858)	0.005
Hemoglobin	≤8.9	71.4%	92.6%	91.6%	31.3%	98.6%	0.856 (0.744-0.969)	<0.001
Platelet ($x10^3$)	≤211	92.9%	86.5%	86.8%	24.5%	99.6%	0.947 (0.894-1.000)	<0.001
MPV	>9.9	64.3%	79.1%	78.4%	12.7%	97.9%	0.791 (0.680-0.902)	<0.001
Neutrophil ($x10^3$)	>6.97	92.9%	68.7%	69.8%	12.4%	99.5%	0.852 (0.779-0.924)	<0.001
Creatinine	>1.2	85.7%	92.9%	92.6%	36.4%	99.3%	0.902 (0.799-1.000)	<0.001
Platelet-to-MPV ratio	≤21.1	92.9%	88.5%	88.7%	27.7%	99.6%	0.948 (0.888-1.000)	<0.001
Neutrophil-to-lymphocyte ratio	>4.09	85.7%	70.4%	71.1%	12.1%	99.0%	0.806 (0.680-0.932)	<0.001
Platelet-to-lymphocyte ratio	≤132	78.6%	74.8%	75.0%	12.9%	98.7%	0.848 (0.756-0.940)	<0.001

PPV: Positive predictive value, NPV: Negative predictive value, AUC: Area under ROC curve, CI: Confidence intervals.

Table IV. Significant risk factors of the mortality, multiple logistic regression analysis.

	β coefficient	Standard error	*p*	Exp (β)	95.0% CI for Exp (β)	
Ejection fraction (1)						
40-50	3.059	1.556	0.049	21.315	1.010	449.924
<40	5.063	2.132	0.018	158.039	2.423	10,309.388
Emergency surgery	2.621	1.144	0.022	13.751	1.460	129.557
Postoperative platelet count ($x10^3$)	-0.031	0.010	0.002	0.969	0.950	0.989
Postoperative creatinine	1.455	0.541	0.007	4.285	1.484	12.368
Constant	-1.586	1.699	0.351	0.205		

Nagelkerke R^2=0.814, CI: Confidence Interval, (1) Reference category: >50.

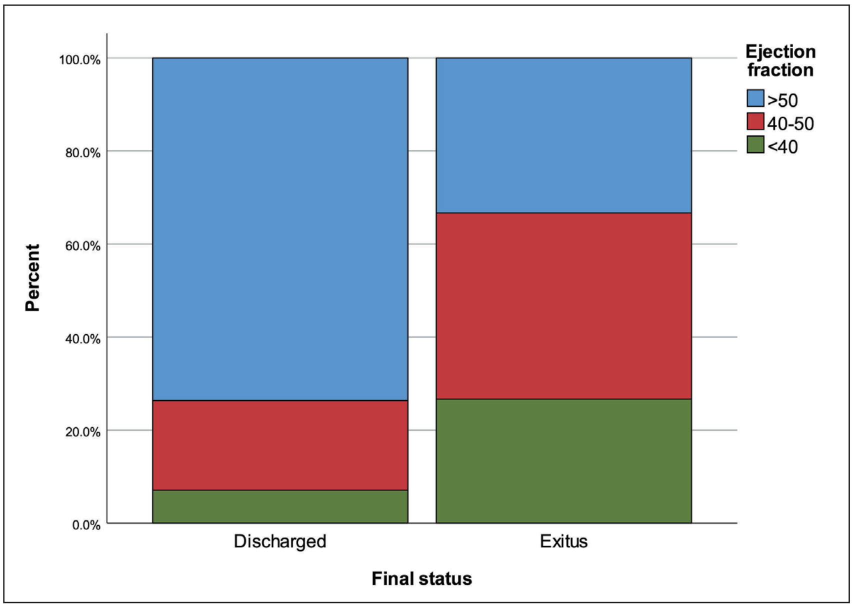

Figure 1. Ejection fraction with regard to mortality.

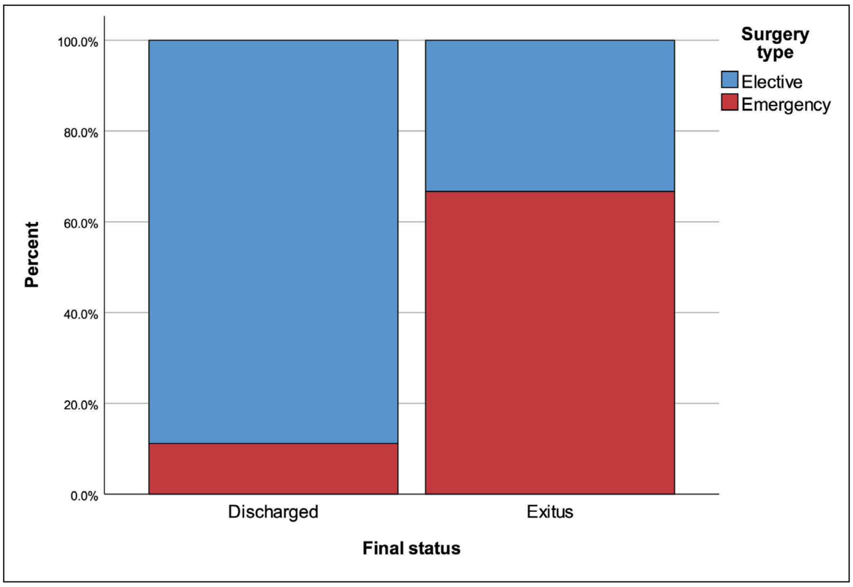

Figure 2. Surgery type with regard to mortality.

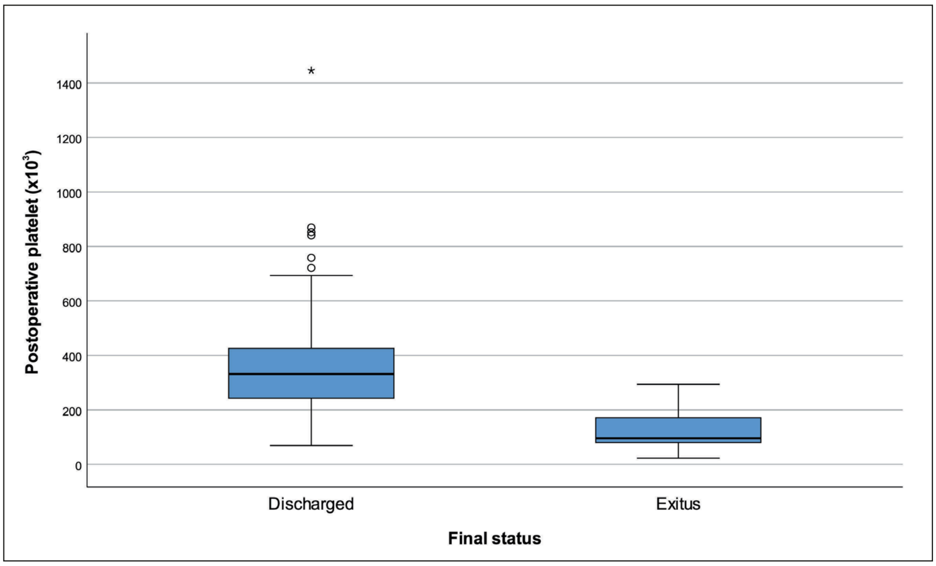

Figure 3. Postoperative platelet with regard to mortality.

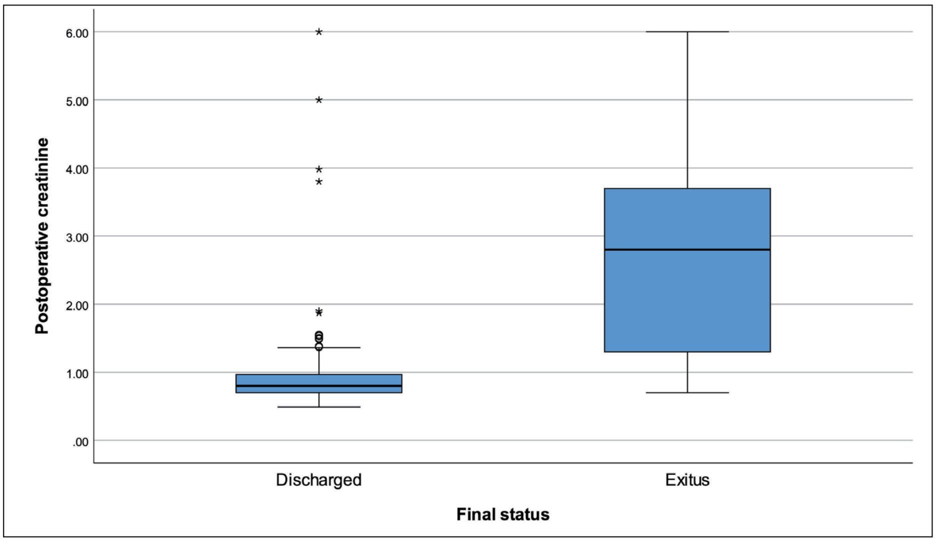

Figure 4. Postoperative creatinine with regard to mortality.

Several preoperative factors have been reported to increase early mortality after cardiac surgery. Old age, female sex, excessive weight, presence of diabetes, hypertension, chronic obstructive pulmonary disease, additional peripheral vascular disease including carotid artery disease, having neurological dysfunction, acute or chronic renal failure, left main disease, and extensive coronary artery involvement, the presence of left ventricular systolic dysfunction, and emergency surgery have been reported to increase mortality after CABG[11].

In our study, we found that the presence of left ventricular dysfunction was an independent predictor for in-hospital mortality following cardiac surgery. Previous evidence[12] indicates that mortality rates in patients with reduced LVEF reaches 7%, whereas mortality rate in subjects with normal left ventricular function varies between 1-3%. As reported by Carr et al[13] mortality rates following CABG may reach as high as 11% in subjects with low LVEF. Similarly, an early study by Christakis et al[14] reported a 9.8% operative mortality in subjects undergoing CABG with an LVEF value of <20%, while those with an LVEF of >40% had an operative mortality rate of 2.3%. In a recent study, Hamad et al[15] reported a mortality rate of 10.5% immediately following CABG in patients with an LVEF of <35%. Given strong evidence concerning the impact of left ventricular function on early mortality following CABG, LVEF is currently included in almost all scoring systems developed to predict mortality following cardiac surgery. Supporting the accumulated evidence, our findings indicate an excessively increased mortality in subjects with a relatively low LVEF (40-50% and worsens <40%).

Urgency of cardiac surgery was found to be another critical predictor of in-hospital mortality in our study. Although a small proportion of cardiac surgeries are performed in emergency situations, emergency CABG is not only associated with increased adverse events but also constitutes an important predictor of early mortality. All the causes associated with mortality following CABG have been reported to vary between 7% to 12% in different studies. Khaladj et al[16] reported a 30-day mortality rate of 6% in patients presenting with acute myocardial infarction and who underwent emergency CABG. Sezai et al[17] reported an operative mortality rate of 11.4% in 105 patients with acute myocardial infarction who underwent emergency CABG. In support of previous data, our findings showed that subjects who underwent emergency cardiac surgery demonstrated a 13-fold increase in mortality rates.

Another significant independent predictor of in-hospital mortality in our study was low postoperative platelet counts. A low platelet count following cardiac surgery is multifactorial, but inflammatory response induced by cardiac surgery is reported to be the leading cause of postoperative thrombocytopenia[18]. A recent study conducted by Nammas et al[19] reported that 30-day mortality rates following CABG was 3.2% in subjects with thrombocytopenia compared to the mortality rate of 1.9% in subjects with a normal platelet count. In contrast to the findings reported by Nammas et al[19], Li et al[18] reported that postoperative thrombocytopenia was not associated with increased operative mortality, although the ICU and hospital stay was prolonged in subjects with thrombocytopenia. Supporting the results of the study by Nammas et al[19], our study showed that low postoperative platelet count was an independent predictor for in-hospital mortality after cardiac surgery.

Our findings also showed that higher postoperative creatinine was an independent predictor of in-hospital mortality following cardiac surgery. Renal dysfunction is a well-known prognostic factor for subjects undergoing cardiac surgery. In a registry that included 36,284 patients[20], postoperative acute renal dysfunction was associated with all the independent causes of mortality during the first 3 months after CABG.

Another earlier study has shown that the mortality rate in subjects who developed ≥30% reduction in postoperative glomerular filtration rate (GFR) had an in-hospital mortality rate of 5.9%, which is significantly higher compared to the mortality rate of 2.2% among patients without postoperative renal failure[21]. Moreover, the study by Loef et al[22] reported that a 25% increase in creatinine during the first week post-operatively was associated with long-term mortality following CABG. From this point of view, our findings support previous data indicating that postoperative creatinine is a prognostic tool following cardiac surgery.

Our experience indicates a 4.8% mortality rate in a population who underwent cardiac and aortic surgery. The mortality rate was 3.5% in isolated CABG patients; however, the in-hospital mortality rate increased to 29% in subjects who underwent aortic surgery. Left ventricular systolic dysfunction, emergency surgery, postoperative platelet count, and high postoperative creatinine were independent predictors for in-hospital mortality.

The retrospective nature of the study is a drawback. Nevertheless, we believe that this study provides important indicators regarding the factors that should be carefully followed in patients undergoing cardiac surgery.

Conclusions

In conclusion, in a population of subjects who underwent open-heart surgery, the in-hospital mortality rate was determined to be 4.8%. The significant risk factors that are independently associated with in-hospital mortality are having relatively low LVEF, undergoing emergency surgery, having low postoperative platelet count, and having a high postoperative creatinine. Focusing on the factors associated with in-hospital mortality, particularly in complicated cases, may prevent both morbidity and mortality associated with cardiac surgery.

Ethics Approval

The study was approved by the Ethics Committee of the Medical Faculty of the Van Yüzüncü Yıl University and was performed in accordance with the Helsinki Declaration (Approval date and number: 15.04.2022/2022/04-04).

Informed Consent

Written informed consent was obtained from all patients before inclusion in the study.

Availability of Data and Materials

The data generated and analyzed during the study are available from the corresponding author. They are not available publicly.

Conflict of Interests

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Authors' Contributions

RDA: Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; drafting the work or revising it critically for important intellectual content.
ŞŞ: Agreement to be accountable for all aspects of the work in ensuring that issues related to the accuracy or integrity of any part of the work are appropriately investigated and resolved; final approval of the version to be published.

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