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Original Article

Morbidity After cardiac surgery under cardiopulmonary bypass and associated factors: A retrospective observational study

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ABSTRACT

Background: The present study aimed to assess the morbidity after cardiac surgery and identify the preoperative and intraoperative factors associated with postoperative morbidity.
Methods: A retrospective observational study was conducted including 362 adult patients aged 18–75 years who underwent open-heart surgery under cardiopulmonary bypass at Sri Jayadeva Institute of Cardiovascular Sciences and Research, Bengaluru, India, during the period from June 2016 to May 2017. Using a structured schedule, preoperative and intraoperative data were collected from the hospital's cardiac surgery database, whereas the postoperative data were collected from the intensive care unit (ICU) database and the hospital's clinical information system database.
Results: Of 362 patients, 254 (70.2%) had at least one major complication, and the most frequently occurring complication was low cardiac output state (29.8%). The ICU length of stay (LOS) was for > 2 days in 23.2% of patients, and the hospital LOS was for > 7 days in almost 60% of the patients. Multivariate logistic regression analyses revealed that gender, type of surgery, body weight, blood lactate level at ICU admission, and 12-h blood lactate level were significant predictors of complications; gender and 24-h blood lactate level were significantly associated with the prolonged ICU LOS, whereas type of surgery and 24-h blood lactate level were significantly associated with prolonged hospital LOS.
Conclusion: The appropriate patient management strategy can be tailored based on the personal attributes, surgery type, and blood lactate level for individual patients undergoing cardiac surgery to reduce the likelihood of postoperative complications, ICU LOS, and hospital LOS.

1. Introduction

There is substantial improvement in the field of cardiac surgery due to advances in medical treatment and perioperative cardiac surgical critical care. On the other hand, the proportion of high-risk patients has risen owing to large numbers of elderly patients with increased numbers of comorbidities[1,2] presenting for cardiac surgery. Cardiopulmonary bypass (CPB) is a technique that is widely used during open-heart surgery, which helps in maintaining systemic perfusion and oxygenation.[3] After cardiac operations, it is important to analyze the outcomes such as postoperative morbidity and mortality because of the concerns about the quality of life of patients and cost of the surgical interventions. However, mortality alone is not an adequate marker of quality of care or cost-effectiveness as it does not correlate with complication rates and length of stay (LOS) in hospital.[4] Complications such as cardiac, pulmonary, renal, and neurological disorders and infections such as pneumonia or sepsis and prolonged stay in the intensive care unit (ICU) and hospital are indicators of not only quality of care but also quality of life after cardiac surgery.[4] Thus, it is important to identify the risk factors that predispose the patients to serious post-operative morbidity and prolonged length of hospital stay after operation. Various outcome prediction models are used for cardiac surgery such as the Cardiac Anaesthesia Risk Evaluation score,[5] Tuman score,[4] Tu score,[6] and European System for Cardiac Operative Risk Evaluation score,[7] which use the preoperative factors to predict the postoperative outcome. Intraoperative factors such as the duration of CPB, aortic cross-clamp time, surgical technique, and serum lactate levels are known to be associated with post-operative morbidity.[4,8–11]

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To our knowledge, information regarding postoperative morbidity and its risk factors is scarce in India. We have undertaken this study to assess the morbidity among patients undergoing cardiac surgery under CPB and identify the preoperative and intraoperative factors associated with postoperative morbidity in terms of complications, prolonged stay in the ICU, and prolonged hospital stay.

2. Methods

2.1. Study population, sample size determination, and data collection

This retrospective observational study was conducted on patients who underwent cardiac surgery at Sri Jayadeva Institute of Cardiovascular Sciences and Research, Bengaluru (Karnataka, India) during the period from June 2016 to May 2017. The inclusion criteria were as follows: adult patients aged 18–75 years admitted for elective open-heart surgery (coronary artery bypass grafting or valve surgery or both) under CPB, with an ejection fraction ≥ 40%. Patients who had off-pump surgery, who had preoperative serum creatinine >2.0 mg/dl, or with active congestive heart failure were excluded from the study. Patients with intraoperative cardiac arrest or who died were also excluded. Assuming the prevalence of postoperative morbidity as 29.5% based on the prevalence of most common postoperative complications in a previous study,[12] with acceptable margin of error 5% and 95% confidence interval (CI), the sample size was calculated as 319. However, in total, 362 eligible patients' data were collected using a structured schedule. Preoperative and intraoperative data including demographics such as age, gender, weight, type of surgical operation, and presence of comorbid illness and laboratory data such as hemoglobin, serum creatinine, CPB duration, aortic cross-clamp duration, pump flow rate, blood lactate level, and hemoglobin were obtained from the hospital's cardiac surgery database. Postoperative data were collected from the ICU database and the hospital's clinical information system database. For measuring lactate levels, arterial blood samples were collected at the following intervals: baseline sample, 10 min after institution of CPB, 10 min after release of the aortic cross-clamp, immediately on arrival to the ICU, 6 h later, 12 h later, and 24 h later. A standard arterial blood gas analyzer (GEM Premier 3000 Blood Gas Analyzer) was used to generate blood lactate values.

The postoperative morbidity was divided into 3 categories: presence of postoperative complication, LOS in the ICU, and LOS in the hospital. Postoperative complication is the presence of one or more of the following categories: cardiac—myocardial infarction (new Q wave on Electrocardiogram (ECG) or serum Creatine kinase - muscle/brain (CKMB) > 100 IU/L 24–48 h after surgery), atrial fibrillation, low cardiac output state as indicated with use of inotropic drugs for > 24 h or use of the intraaortic balloon pump; neurologic—stroke, focal neurologic deficits, seizures, or severely altered mental status; respiratory—mechanical ventilation for > 24 h or acute respiratory failure requiring reintubation; gastrointestinal—peritonitis, acute gastrointestinal bleed, and paralytic ileus; renal—postoperative renal insufficiency defined as an increase in serum creatinine concentration > 2 mg/dl or the need for hemodialysis or hemofiltration; infectious diseases—pneumonia, mediastinal infection, septicemia, or sepsis with positive culture. The patients were followed up postoperatively in the ICU/ward until the time of discharge. As per the institutional protocol, the LOS for >2 days in the ICU and >7 days in the hospital were considered as prolonged ICU stay and prolonged hospital stay, respectively.

2.2. Statistical methods

Statistical analyses were performed using SPSS 21.0 software. Data are reported as the percentage, mean, standard deviation, odds ratio, and 95% CI as appropriate. Univariate comparisons were computed using the chi-square test. The Fisher exact test was used for categorical variables, and the *t*-test, for continuous variables. All variables found to have p value < 0.15 in the univariate analyses were entered in the multivariate logistic regression analyses to determine their respective predictive powers on morbidity, ICU stay, and hospital stay. All tests were 2-tailed, and a *p* value less than 0.05 was considered significant.

2.3. Anesthesia and CPB

As per the institutional protocol, all the patients were administered general anesthesia. The patient was premedicated with tablets alprazolam 0.5 mg and pantoprazole 40 mg orally on the night before surgery. A balanced anesthetic technique with injections midazolam (0.05 mg/kg), fentanyl (5-10u/kg), Etomidate (0.1–0.3 mg/kg)/propofol (1 mg/kg), nondepolarizing muscle relaxants (rocuronium or vecuronium), and Sevoflurane (1–2%) was used for induction and maintenance of anesthesia. All patients underwent endotracheal intubation and were mechanically ventilated. The standard American Society of Anesthesiologist monitoring was followed. The monitoring also included five-lead ECG, measurement of systemic arterial blood pressure for which a radial or femoral artery catheter was used, and intermittent arterial blood gas sampling; a 7-french triple lumen central venous catheter was inserted in the right internal jugular vein for central venous pressure monitoring and inotrope/vasopressor administration; and a nasopharyngeal probe was used for temperature monitoring. Transesophageal echocardiography was used for the intraoperative assessment of all patients undergoing surgeries. Unfractionated heparin was administered intravenously in the dose of 400 IU/kg and only after achieving an activated clotting time (ACT) of >480 s, and cardiac cannulation was performed. Additional heparin boluses were given if required to maintain the ACT in this range before and during CPB.

The CPB circuit was primed with a mixture of ringer's lactate, mannitol, and sodium bicarbonate solution to make the priming volume to 1200 ml. The standard CPB techniques were used. Extracorporeal circulation with the pump flows from 2.0 to 2.4 L/min/m^2 of the body surface area; moderate systemic hypothermia (30–34 °C) and intermittent cold crystalloid cardioplegia were used. Mean arterial pressure was monitored continuously and maintained between 50 and 60 mmHg during CPB using phenylephrine boluses and noradrenaline infusion if required. Hemoglobin was measured intraoperatively and maintained between 6 and 8% gm during the bypass period. Intraoperative blood sugar was monitored and maintained between 100 and 140 mg/dl in all patients, and insulin infusion was started when blood sugar exceeded 180 mg/dl. Urine output was monitored throughout the procedure.

After the proposed surgical repair, the patients were weaned from CPB once they satisfied the weaning protocol. Heparin was reversed using protamine sulfate at a 1:1 ratio after completion of CPB and once the cannulas were removed. Adrenaline (0.01–0.2 μg/kg/min) was used as the primary inotrope, and noradrenaline was added to attain the desired hemodynamic stability. Patients with impaired left ventricular function or severe pulmonary hypertension were given a bolus dose of milrinone (50 μg/kg over 15 min) with or without an infusion of 0.3–0.5 μg/kg/min. Postoperatively, all the patients were shifted to the cardiac ICU without extubation. In the ICU, the patients were electively ventilated with continuous monitoring of the hemodynamic parameters, and arterial blood gas analyses were carried out at regular intervals.

3. Results

A total of 362 patients were included in the study; the mean age of the study participants was 52.2 ± 0.6 years, and the mean weight

Table 1
Postoperative morbidity in patients undergoing cardiac surgery (n = 362).

Variable	n (%)
Complication[a]	
Atrial fibrillation	53 (14.6)
Myocardial infarction	20 (5.5)
Low cardiac output state	108 (29.8)
Intraaortic ballon pump	05 (1.4)
Mechanical ventilation	57 (15.7)
Renal dysfunction	92 (25.4)
Gastrointestinal bleed	03 (0.8)
Neurological	06 (1.7)
Infection	09 (2.5)
Total	254 (70.2)
Length of stay in the ICU	
≤2 days	278 (76.8)
>2 days	84 (23.2)
Length of stay in the hospital	
≤7 days	146 (40.3)
>7 days	216 (59.7)

ICU: intensive care unit.
[a] Multiple responses.

of the patients was 61.1 ± 12.2 kg; the majority (219, 60.5%) of the patients were males. Of 362 patients, 171 (47.2%) had undergone isolated valve surgery, 155 (42.8%) had undergone isolated coronary artery bypass grafting (CABG), and 38 (10.5%) underwent combined surgery (CABG + valve). The mean age of patients who underwent isolated CABG was 59.5 ± 6.6 years, valve surgery was 48.0 ± 10.6 years, and combined surgery procedure was 41.4 ± 16.4 years. In total, 124 (34.3%) patients undergoing heart surgery had diabetes mellitus. Hypertension was prevalent in 108 (29.8%) patients. There were 163 (45.0%) patients who had ischemic heart disease, and 187 (51.3%) patients had valvular heart disease. Only 5 (1.4%) patients had asthma or chronic obstructive pulmonary disease, and 11 (3.0%) had chronic kidney disease.

Table 1 depicts the postoperative morbidity of the patients undergoing cardiac surgery. More than two-thirds (70.2%) of patients had at least one major complication. The most frequently occurring complication was low cardiac output state (29.8%), followed by renal dysfunction (25.4%), mechanical ventilation (15.7%), and atrial fibrillation (14.6%). Nearly one-fourth (23.2%) of the patients stayed in the ICU for > 2 days, and LOS in the hospital was for > 7 days for almost 60% of the patients. The mean duration of stay in the ICU and hospital was 2.3 ± 0.7 days and 7.9 ± 1.3 days, respectively. The study group used a total of 826 cardiac ICU patients days and 2879 hospital patient days.

Preoperative and intraoperative factors predicting the occurrence of postoperative complications are shown in Table 2. The multivariate logistic regression analysis identified five variables as independent predictors of the occurrence of one or more complications after cardiac surgery, which included male gender (adjusted odds ratio [aOR]: 1.79, 95% CI: 1.08–2.96), type of surgical procedure (isolated CABG: aOR, 0.25; 95% CI, 0.09–0.69; isolated valve surgery: aOR, 0.32; 95% CI, 0.12–0.85), body weight of the patient (aOR, 1.03; 95% CI, 1.01–1.05), blood lactate level at ICU admission (aOR, 1.19; 95% CI, 1.02–1.39), and 12-h blood lactate level (aOR, 1.21; 95% CI, 1.03–1.43).

Table 3 presents the preoperative and intraoperative factors associated with postoperative ICU LOS. Only two variables such as

Table 2
Predictive factors for postoperative complications after cardiac surgery ($n = 362$).

Variable	Complication					
	Absent	Present	Univariate		Multivariate	
	n (%)/mean (SD)	n (%)/mean (SD)	p value	aOR	95% CI	*P* value
Age (years)						
≤50	44 (28.6)	110 (71.4)	0.651	–		
>50	64 (30.8)	144 (69.2)				
Sex						
Male	58 (26.5)	161 (73.5)	0.085	1.79	1.08–2.96	0.024
Female	50 (35.0)	93 (65.0)	1			
Type of surgery						
CABG	52 (33.8)	102 (66.2)	0.094	0.25	0.09–0.69	0.008
Valve	50 (29.4)	120 (70.6)		0.32	0.12–0.85	0.023
Combined	06 (15.8)	32 (84.2)		1		
DM	43 (34.7)	81 (65.3)	0.146	1.29	0.77–2.15	0.338
Hypertension	31 (28.7)	77 (71.3)	0.759	–		
IHD	53 (32.5)	110 (67.5)	0.313	–		
VHD	54 (28.9)	133 (71.1)	0.681	–		
Asthma/COPD	02 (28.6)	05 (71.4)	0.651	–		
CKD	04 (36.4)	07 (63.6)	0.425	–		
Weight (kg)	58.4 (12.9)	62.2 (11.8)	0.008	1.03	1.01–1.05	0.010
LVEF	54.3 (3.5)	54.3 (3.4)	0.877			
Preop Hb	12.4 (1.7)	12.4 (1.7)	0.851			
Creatinine	1.19 (0.27)	1.18 (0.26)	0.593			
CPB time	89.1 (30.9)	87.3 (26.9)	0.579			
ACC time	50.9 (20.4)	52.2 (18.5)	0.571			
Pump flow rate	3.8 (0.6)	3.7 (0.6)	0.553			
CPB lactate	4.4 (2.3)	4.1 (0.6)	0.058	0.73	0.49–1.09	0.122
ACC lactate	4.0 (2.9)	3.9 (1.3)	0.763			
On-pump Hb	6.7 (1.2)	6.9 (1.3)	0.142	1.18	0.97–1.44	0.105
ICU lactate	4.1 (1.7)	4.6 (1.7)	0.004	1.19	1.02–1.39	0.031
6-hr lactate	4.2 (1.9)	4.5 (2.1)	0.287	–		
12-hr lactate	2.7 (1.4)	3.3 (1.8)	0.002	1.21	1.03–1.43	0.018
24-hr lactate	2.1 (1.0)	2.3 (1.4)	0.188			

ICU: intensive care unit, SD: standard deviation, aOR: adjusted odds ratio, CI: confidence interval, CABG: coronary artery bypass grafting, DM: diabetes mellitus, IHD: ischemic heart disease, VHD: valvular heart disease, COPD: chronic obstructive pulmonary disease, CKD: chronic kidney disease, LVEF: left ventricular ejection fraction, Preop Hb: preoperative hemoglobin, CPB: cardiopulmonary bypass, ACC: aortic cross-clamp.
Model $\chi^2 = 40.496$, $p < 0.001$ and Hosmer and Lemeshow $p = 0.809$ indicates that the model fits the data. The classification table reports that overall expected model performance is 71%, that is, 71% of the cases can be expected to be classified correctly by the model.

Table 3
Predictive factors for ICU stay after cardiac surgery (n = 362).

Variable	ICU stay		Univariate	Multivariate		
	≤2 days	>2 days				
	n (%)/mean (SD)	n (%)/mean (SD)	p value	aOR	95% CI	p value
Age (years)						
≤50	121 (78.6)	33 (21.4)	0.491			
>50	157 (75.5)	51 (24.5)				
Sex						
Male	160 (73.1)	59 (26.9)	0.037	1.73	1.01–2.96	0.045
Female	118 (82.5)	25 (17.5)		1		
Type of surgery						
CABG	120 (77.9)	34 (22.1)	0.194			
Valve	125 (73.5)	45 (26.5)				
Combined	33 (86.5)	05 (13.2)				
DM	93 (75.0)	31 (25.0)	0.559			
Hypertension	88 (81.5)	20 (18.5)	0.168			
IHD	127 (77.9)	36 (22.1)	0.648			
VHD	143 (76.5)	44 (23.5)	0.880			
Asthma/COPD	04 (57.1)	03 (42.9)	0.206			
CKD	09 (81.8)	02 (18.2)	0.689			
Weight (kg)	61.3 (11.9)	60.2 (13.3)	0.480			
LVEF	54.4 (3.4)	54.1 (3.5)	0.534			
Preop Hb	12.4 (1.7)	12.4 (1.7)	0.891			
Creatinine	1.19 (0.27)	1.18 (0.25)	0.711			
CPB time	87.9 (28.7)	87.7 (26.1)	0.938			
ACC time	52.0 (19.8)	51.2 (16.2)	0.714			
Pump flow rate	3.7 (0.6)	3.8 (0.5)	0.553			
CPB lactate	4.1 (0.6)	4.3 (2.6)	0.413			
ACC lactate	3.9 (2.1)	4.0 (1.4)	0.785			
On-pump Hb	6.9 (1.3)	6.8 (1.2)	0.421			
ICU lactate	4.5 (1.7)	4.3 (1.8)	0.277			
6-hr lactate	4.4 (2.0)	4.5 (2.2)	0.691			
12-hr lactate	3.0 (1.6)	3.5 (1.9)	0.021	1.09	0.95–1.27	0.215
24-hr lactate	2.1 (1.1)	2.6 (1.7)	0.000	1.32	1.09–1.59	0.004

ICU: intensive care unit, SD: standard deviation, aOR: adjusted odds ratio, CI: confidence interval, CABG: coronary artery bypass grafting, DM: diabetes mellitus, IHD: ischemic heart disease, VHD: valvular heart disease, COPD: chronic obstructive pulmonary disease, CKD: chronic kidney disease, LVEF: left ventricular ejection fraction, Preop Hb: preoperative hemoglobin, CPB: cardiopulmonary bypass, ACC: aortic cross-clamp.
Model $\chi^2 = 17.404$, $p = 0.001$ and Hosmer and Lemeshow $p = 0.398$ indicates that the model fits the data. The classification table reports that overall expected model performance is 78.5%, that is, 78.5% of the cases can be expected to be classified correctly by the model.

male gender (aOR, 1.73; 95% CI, 1.01–2.96) and 24-h blood lactate level (aOR, 1.32; 95% CI, 1.09–1.59) were found to be significantly associated with the prolonged ICU LOS as revealed by multivariate analysis. Postoperative prolonged hospital LOS was significantly associated with the type of surgery especially isolated valvular surgery (aOR, 2.44; 95% CI, 1.11–5.35) and 24-h blood lactate level (aOR, 1.23; 95% CI, 1.01–1.50), as shown in Table 4.

4. Discussion

The present study revealed that low cardiac output state (29.8%), renal dysfunction (25.4%), prolonged mechanical ventilation (15.7%), and atrial fibrillation (14.6%) were the most common complications seen in patients undergoing cardiac surgery under CPB. Previous studies have shown that the incidence of low cardiac output state after cardiac surgery varies in the range of 13.5–42.5%.[13–15] Incidence of atrial fibrillation in our study was low compared with the results of previous studies, which ranges from 29.7% to 47%.[16–19] Studies have reported that prolonged mechanical ventilation occurs in 2–22% of patients[20] and renal dysfunction occurs in 7–30% of patients undergoing cardiac surgery.[21,22] The differences might be due to the variation in patient characteristics and methodologies followed in different studies. We observed that more than two-thirds of patients had one or more postoperative complications which are much higher than those reported in a previous study.[10]

In this study, the duration of stay in the ICU was more than 2 days in almost one-fourth of patients, and this is consistent with the findings of other studies.[23,24] Naik et al[12] showed in their study that 24.1% of patients had stayed in the ICU for ≥3 days, whereas in another study, 26% of patients had prolonged ICU stay for >3 days.[25] Nearly 60% of patients in our study had stayed in the hospital for >7 days, which is higher compared with the results of other studies.[12,26]

Five variables such as gender, type of surgery, patient's body weight, blood lactate level immediately after ICU admission, and 12-h blood lactate level were found to be independent predictors of postoperative complications. The odds of developing one or more complications after cardiac surgery are 1.8 times more in male patients than their female counterparts. This is in contrast to the findings of previous studies,[27–29] which showed that female gender was an independent predictor of early morbidity with higher risk of postoperative complications than males. This could be due to the reason that data regarding risk factors such as smoking history, alcohol consumption, and lifestyle habits were not included in the analysis as these were not available. Furthermore, the risk profiles of males and females who undergo cardiac surgery vary, and a given risk factor can impact the surgical outcome in a gender-specific fashion. The occurrence of complications after cardiac surgery was less likely among patients who had undergone CABG surgery alone or valve surgery alone compared with those who had combined surgery or other type of surgery. Hajjar et al[10] reported the reverse of our finding that complications were more likely associated with isolated CABG surgery or isolated valve surgery. It was observed in this study that there is a 3% rise in risk of developing complications after cardiac surgery with every unit increase

Table 4
Predictive factors for hospital stay after cardiac surgery (n = 362).

Variable	Hospital stay					
	≤7 days	>7 days	Univariate		Multivariate	
	n (%)/mean (SD)	n (%)/mean (SD)	p value	aOR	95% CI	p value
Age (years)						
≤50	64 (41.6)	90 (58.4)	0.682			
>50	82 (39.4)	126 (60.6)				
Sex						
Male	80 (36.5)	139 (63.5)	0.068	1.39	0.87–2.24	0.171
Female	66 (46.2)	77 (53.8)		1		
Type of surgery						
CABG	68 (44.2)	86 (55.8)	0.008	1.79	0.84–3.96	0.150
Valve	56 (32.9)	114 (67.1)		2.44	1.11–5.35	0.026
Combined	22 (57.9)	16 (42.1)		1		
DM	53 (42.7)	71 (57.3)	0.500			
Hypertension	45 (41.7)	63 (58.3)	0.736			
IHD	72 (44.2)	91 (55.8)	0.178			
VHD	65 (34.8)	122 (65.2)	0.025	0.73	0.37–1.43	0.364
Asthma/COPD	03 (42.9)	04 (57.1)	0.891			
CKD	04 (36.4)	07 (63.6)	0.785			
Weight (kg)	59.9 (11.4)	61.8 (12.8)	0.162			
LVEF	54.4 (3.5)	54.2 (3.4)	0.574			
Preop Hb	12.2 (1.9)	12.5 (1.6)	0.141	1.11	0.97–1.27	0.117
Creatinine	1.16 (0.24)	1.20 (0.28)	0.146	1.47	0.62–3.49	0.380
CPB time	87.2 (26.4)	88.4 (29.3)	0.694			
ACC time	51.2 (18.2)	52.2 (19.6)	0.614			
Pump flow rate	3.7 (0.5)	3.8 (0.6)	0.666			
CPB lactate	4.1 (0.6)	4.2 (1.7)	0.188			
ACC lactate	3.9 (1.3)	4.0 (2.3)	0.596			
On-pump Hb	6.8 (1.2)	6.9 (1.3)	0.274			
ICU lactate	4.4 (1.6)	4.5 (1.8)	0.630			
6-hr lactate	4.2 (2.1)	4.5 (2.1)	0.141	1.04	0.93–1.16	0.537
12-hr lactate	3.1 (1.8)	3.2 (1.7)	0.343			
24-hr lactate	2.0 (1.0)	2.3 (1.4)	0.015	1.23	1.01–1.50	0.036

ICU: intensive care unit, SD: standard deviation, aOR: adjusted odds ratio, CI: confidence interval, CABG: coronary artery bypass grafting, DM: diabetes mellitus, IHD: ischemic heart disease, VHD: valvular heart disease, COPD: chronic obstructive pulmonary disease, CKD: chronic kidney disease, LVEF: left ventricular ejection fraction, Preop Hb: preoperative hemoglobin, CPB: cardiopulmonary bypass, ACC: aortic cross-clamp.
Model $\chi^2 = 24.269$, $p = 0.002$ and Hosmer and Lemeshow $p = 0.686$ indicates that the model fits the data. The classification table reports that overall expected model performance is 64.3%, that is, 64.3% of the cases can be expected to be classified correctly by the model.

in the patient's body weight. However, many studies did not find any significant association of obesity with development of postoperative complications.[10,30,31] In addition, the odds of having one or more complications increase about 1.2 times for every unit rise in the blood lactate level at ICU admission and also with the 12-h blood lactate level in the patients. Similar finding was reported in the previous studies.[9,10,12] It suggests that in clinical settings, monitoring the blood lactate level can be a valuable tool, which can help physicians in identifying patients at risk of developing complications after cardiac surgery.

We observed that male patients were more likely to have prolonged ICU stay than female patients. This is contrasted by the findings of previous studies which have shown that duration of ICU stay was of longer duration in women than men.[32,33] It might be due to the reason that a higher proportion of male patients had preoperative morbidities in the present study. The odds of prolonged ICU stay among the patients increase 1.3 times with one unit rise in the 24-h blood lactate level. This is supported by the result of another study.[12]

Our study revealed that patients who underwent valve surgery alone had 2.4 times higher risk of prolonged hospital stay than those who had combined surgery. Almashrafi et al[26] also observed prolonged postoperative LOS in the hospital among patients who had undergone isolated valvular surgery. In addition, the odds of prolonged hospital stay increase 1.2 times with every unit rise in the 24-h blood lactate level. Naik et al[12] also found significant association of hyperlactemia with prolonged hospital LOS.

The study has the limitation of being performed in a single center and retrospective in nature, which could restrict the generalization of our findings. In addition, owing to the retrospective nature of the study, several variables could not be taken into consideration for analysis and thus were not adjusted in the multivariate analysis.

5. Conclusion

In conclusion, the incidence of postoperative morbidity including complications, prolonged ICU stay, and hospital stay is high among patients undergoing cardiac surgery under CPB. The study revealed that using variables such as gender, body weight, and type of surgery and blood lactate level at ICU admission, 12-h blood lactate level, and 24-h blood lactate level may be useful for screening of postoperative morbidity in patients undergoing cardiac surgery under CPB and thereby in taking timely appropriate clinical decision. Further multicenter prospective studies are necessary to test the predictor and outcome variables observed in this study.

Author contributions

Dr. Chitralekha Patra was involved in concept/design of the study, data collection, drafting the article, critical revision of the article, and final approval of the version to be published. Dr. Prabhushankar Chamaiah Gatti was involved in concept/design of the study, drafting the article, critical revision of the article, and final approval of the version to be published. Dr. Ansuman Panigrahi was involved in concept/design, data analysis and interpretation, drafting the article, critical revision of the article, and final approval of the version to be published.

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Conflicts of interest

The authors declare that there is no conflict of interest.

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