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The Use of Arterial Lactate Level as a predictor of Major Complications after Cardiac Surgery

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Abstract: Coronary artery bypass graft surgery (CABG) remains the most common operation performed by cardiac surgeons today. Improvements in intraoperative technique and perioperative care have led to CABG being offered to a more broad patient profile with less complications and adverse events. Nevertheless, many complications of CABG are reported. Previous studies reported mortality rates after isolated CABG ranging from 2.6% to 12.2%. Determining predictive factors for mortality and morbidity is very important in the management of patients with cardiac surgery. Elevated Lactate levels have been associated with increased morbidity and mortality in a diverse patient population including: trauma, sepsis, multiple organ failure and elderly patients. However, few studies have looked at lactate's role as an independent predictor of mortality in patients undergoing CABG. Therefore, we conducted the present prospective cohort study to evaluate the role of blood lactate level as a predictor of major complications after cardiac surgery including mortality. The present prospective study was conducted at Ain Shams university hospital and Mahalla Cardiac Center. Seventy adult patients who underwent elective CABG with cardiopulmonary bypass were included. Then, patients were divided into two groups of thirty-five in each. Group (1) with low lactate level (lactic acid blood level<2 mmol/l). Group (2) with high lactate level (lactic acid blood level >2mmol). In the present study, the mean age of the included patients was 58.2 ±6.4years and the majority of patients were males (68.8%). In our cohort, more than 50% of the patients had diabetes or hypertension. The results showed that the rate of in-hospital mortality was 14%; while the rate of morbidity was 34%. The most commonly encountered morbidities in high group were pneumonia (11.4%) and low cardiac output syndrome (LCOS) (8.6%). In the present study, we assessed the associations between blood lactate levels and postoperative mortality. We found that there were significant changes in serum lactate level in studied groups over the first 48 hours of ICU admission (p <0.05). Our analysis indicated that patients with high lactate levels had significantly higher rates of mortality than patients with low lactate levels (p <0.001). On the other hand, our analysis showed that patients with high lactate levels had significantly longer ICU stay than patients with low lactate levels (p =0.019). In contrary, there were no significant differences between both groups in terms of duration of MV (p =0.62) and ward stay (p =0.205).

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1. Introduction

Cardiac surgery is an important procedure for many patients with heart diseases. Identification of predictors of morbidity and mortality is an important issue for the optimal management of cardiac surgical patients **(Rashkin et al, 1985).**

The maintenance of appropriate hemodynamic goals is essential to improve outcomes after cardiac surgery (**Maillet et al, 2003).**

Cardiopulmonary bypass is used during cardiac operation to allow adequate systemic oxygenation and perfusion during the surgical procedure (**Alston et al, 1989).**

The outcome after any cardiac surgery is determined by the preoperative characteristics of the patient as well as intraoperative factors such as surgical technique, strategies of myocardial protection, hemodynamic management of the patient, and duration of CPB (cardiopulmonary bypass), which play an important role in determining the postoperative course of the patient **(Toraman et al, 2004).**

Perfusion markers such as central venous oxygen saturation and blood lactate may, therefore, represent important tools for the management of these patients (**Lobo et al, 2006).**

In cardiac surgery, increased serum lactate levels both during operation and after transferring the patient to the ICU may associated with postoperative morbidity and mortality **(Mak et al, 2016).**

Hyperlactatemia is frequently encountered during and after cardiac surgery and has many causes that include tissue hypoxia as well as nonhypoxic causes such as drug therapy cardioplegia, hypothermia, and cardiopulmonary bypass (**O'Connor et al, 2010).**

Aim of the Work

This prospective study is designed to evaluate the role of blood lactate level as a predictor of major complications after cardiac surgery including mortality.

2. Patients and Methods

Study design:

The present prospective study was conducted at Ain Shams university hospital and Mahalla Cardiac Center. Seventy adult patients who underwent elective CABG with cardiopulmonary bypass were included during the period from June 2018 to March 2019.

Studied populations were divided into 2 groups:

- Group (1) with low lactate level (lactic acid blood level<2 mmol/l)
- Group (2) with high lactate level (lactic acid blood level >2mmol).

Ethical Statement:

We confirm that the present study run in concordance with international ethical standards and applicable local regulatory guidelines. A written informed consent was obtained from the patients enrolled in this study. Patients were informed about the study objectives, methodology, risk, and benefit. The study's protocol was reviewed and approved by institutional review board (IRB), ethics committee or audit department of Faculty of Medicine, Ain-Shams University.

Inclusion criteria:

All patients enrolled in the study period if they were:

- ❖ Patients age >45 and <70years old.
- ❖ Patients underwent elective CABG.

Exclusion criteria:

- ❖ Patients underwent emergent surgery (defined as life threatening or unstable condition requiring surgery on the same day of the surgical consultation).
- ❖ Patients with renal failure.
- ❖ Patients with liver cell failure.
- ❖ Patients on chemotherapy and/or radiotherapy.
- ❖ Recent trauma.
- ❖ Pregnancy.
- ❖ Diabetic patients on treatment with biguanides (Ex: metformin).
- ❖ Poor cardiac Function (EF< 35%).

Sample Size and Sampling:

We utilized non-probability consecutive sampling Technique. Using STATA program v-11, setting alpha over at 5% and power at 80% result from previous study (**Maillet et al, 2003**) showed that among low lactate level, the incidence of complications was 19% compared to 50.9% among cases with high lactate. Based on this, the needed sample is 35 cases per group (total 70).

These patients underwent the following:

1. **Full history**: We collected name, age, sex, and history of any comorbidity.
2. **Clinical examination**: which include the following;
   - General examination.
   - Neurological examination.
   - Cardiac examination.
   - Chest examination.
3. **Investigations:** which include the following;
   - Complete blood picture (CBC) profile.
   - Prothrombin time and partial thromboplastin time.
   - Liver function tests (Alanine aminotransferase (ALT) and aspartate aminotransferase (AST).
   - Renal function tests (serum creatinine and urea levels).
   - Echocardiogram and Electrocardiogram (ECG).
   - Chest x-ray.

Anesthetic and Operative Techniques:

All patients were treated according to the cardiac anesthesia protocol, with the standard preoperative medication and a routine ventilation protocol. in brief, anesthesia was induced with fentanyl, midazolam, and pancuronium and maintained with continuous administration of isoflurane and incremental doses of pancuronium. All patients received a central venous catheter and a radial artery catheter. Depth of anesthesia was monitored with a bispectral index monitor (Philips Medical System, Best, The Netherlands). Ventilation parameters were set to achieve tidal volumes between 6 and 10mL/kg, positive end-expiratory pressure of 5 cmH2O and end-tidal CO2 levels between 35-45 mmHg.

After institution of cardiopulmonary bypass (CPB) using normothermic non-pulsatile flow, cardiac arrest was induced with cold antegrade crystalloid cardioplegia (St Thomas solution), according to the surgeon's preference. Patients were weaned from CPB only when the pharyngeal temperature was≤37.0°C. If necessary, dobutamine, epinephrine was used for hemodynamic support to facilitate weaning. The operative mean aortic pressure was maintained at ≥60 mmHg during CPB.

Measurements of Lactate Levels:

Lactate levels were measured in arterial blood using point-of-care blood gas analyzers (GEM Premier 3500, Instrumentation Laboratory, Bedford, Massachusetts, USA; upper normal limit 2.2 mmol/L).

Lactate levels were measured immediately on arrival into the ICU, hour zero (H0, initial blood lactate level) using the arterial blood gases analysis. According to this Patients were divided into two groups of thirty-five in each. Group (1) with low lactate level (lactic acid blood level<2 mmol/l) and group (2) with high lactate level (lactic acid blood level >2mmol).

Lactate levels were measured immediately on arrival into the ICU (H0, initial blood lactate level), 24 h later (H24), and 48 h later (H48) (in mmol/l) using the arterial blood gases analysis.

Study's Outcomes:

The primary outcome in the present study was the correlation between lactate levels after admission to ICU and the outcomes of ICU in terms of mechanical ventilation, duration of ICU stay, morbidity rates, and mortality rates.

Statistical Analysis

An Excel spreadsheet was established for the entry of data. We used validation checks on numerical variables and option-based data entry method for categorical variables to reduce potential errors. The analyses were carried with SPSS software (Statistical Package for the Social Sciences, version 24, SSPS Inc, Chicago, IL, USA). The normality of the data was assessed using Shapiro-Wilk Test. Numerical data were described as mean ±SD if normally distributed; or median and interquartile range [IQR] if not normally distributed. Frequency tables with percentages were used for categorical variables. Independent Student t-test and paired t-test were used to compare parametric quantitative variables; while Mann-Whitney tests and Wilcoxon matched pairs test were used to compare non-parametric quantitative variables. Chi-square test or McNemar-Bowker tests were used to analyze categorical variables. Multilinear logistic regression was undertaken to assess the predictors of mortality. A p-value < 0.05 is considered statistically significant.

3. Results

The mean age of the included patients was 58.2 ±6.4years in low group and 56.9 ±6.1 in high group (p =0.399). The majority of patients were males in both groups (p =0.99). There were no significant differences between both groups in terms of diabetes mellitus (p =0.41) and hypertension (p =0.5) (Table 1).

Table 2 shows that there were no significant differences between both groups in terms of preoperative WBCs (p =0.74), hemoglobin (p =0.24), PT (= 0.68), and PTT (p =0.14). In contrary, there were significant differences between both groups in terms of platelet count (p =0.02). Patients with low lactate levels had significantly higher platelet count.

Table 1: The baseline demographic characteristics of the included patients

Variables	Low group (N =35)	High group (N =35)	P-value
Age in years			
- Mean ±SD - Median (Range)	58.2 ±6.4 59 (48 – 68)	56.9 ±6.1 57 (45 – 69)	0.399
Gender			
- Male	24 (68.8%)	22 (62.8%)	0.99
- Female	11 (31.2%)	13 (37.2%)	
DM, No (%)			
- Yes	20 (57.1%)	18 (51.4%)	0.41
- No	15 (42.9%)	17 (48.6%)	
HTN, No (%)			
- Yes	19 (54.3%)	18 (51.4%)	0.5
- No	16 (45.7%)	17 (48.6%)	

*Data are presented as mean ±SD, median (IQR), or number (%). DM: Diabetes mellitus; HTN: Hypertension.

Table 2: Association between Studied groups and Preoperative Hematological profile

Variables	Low group (N =35)	High group (N =35)	P –value
Hemoglobin (g/dL)			
- Mean ±SD	13.46 ±0.96	13.32 ±0.84	0.249
- Median (Range)	13.4 (11.9 – 15.4)	13.3 (11.5 – 14.9)	
WBCs x10^3 (cell/mm^2)			
- Mean ±SD	7.6 ±1.3	7.6 ±1.7	0.74
- Median (range)	7 (4 -12.5)	7.6 (4.3 -11)	
Platelet count x10^6			
- Mean ±SD	335 ±56.6	302.1 ±60.7	0.022
- Median (range)	340 (226-454)	298 (194 - 415)	
PT (seconds)			
- Mean ±SD	12.6 ±0.88	12.7 ±1.1	0.68
- Median (range)	12.6 (11.2 -14.3)	12.7 (10.6 -15.8)	
PTT (seconds)			
- Mean ±SD	33.13 ±3.6	31.9 ±4.8	0.14
- Median (range)	32.4 (28-39)	30 (28 - 38)	

*Data are presented as mean ±SD or median (range). WBCs: white blood cell; PT: prothrombin time; PTT: partial thromboplastin time.

Table 3 shows that there were no significant differences between both groups in terms of preoperative serum AST (p =0.25), ALT (= 0.12), urea (p =0.57), and creatinine (p =0.75).

Table 3: Association between Studied groups and preoperative kidney/liver functions

Variables	Low group (N =35)	High group (N =35)	P –value
Serum ALT (IU/L)			
- Mean ±SD	29.7 ±4.5	26.9 ±5.6	0.25
- Median (range)	29.6 (19 -39)	27.6 (15.4 -40.7)	
Serum AST (IU/L)			
- Mean ±SD	32.8 ±5.3	29.7 ±5.9	0.12
- Median (range)	32.7 (22.5 -42.7)	31 (20.5 -39.7)	
Serum Urea (mg/dL)			
- Mean ±SD	28.9 ±6.8	28.1 ±5.6	0.57
- Median (range)	29.6 (19 -44)	27.5 (17.2 -37.6)	
Serum creatinine (mg/dL)			
- Mean ±SD	0.97 ±0.28	0.95 ±0.21	0.75
- Median (range)	1.03 (0.5 -1.4)	0.9 (0.5 -1.3)	

*Data are presented as mean ±SD or median (range)

Table 4 shows that there were no significant differences between both groups in terms of ejection fraction (p =0.67).

Table 4: Association between Studied groups and Ejection fraction

Variables	Low group (N =35)	High group (N =35)	P –value
EF (%)			
- Mean ±SD	50.14 ±4.2	50.6 ±4.8	0.67
- Median (range)	50 (42 -57)	51 (42 – 59)	

*Data are presented as mean ±SD or median (range) EF: Ejection Fraction

Table 5 shows that there were significant differences between both groups in lactate level over 48 hours; at H0 patients in low group had lactate level 1.78±.12 while in high group had 6.17± 1.46 (p>0.001). at H24 patients in low group had lactate level 1.51+ 0.45 while in high group had 4.89± 1.43 (P> 0.001). at H48 patients in low group had lactate level 1.33± 0.57 while in high group had 2.99± 1.61 (P> 0.001).

Table 5: The changes in lactate levels of the included patients

Variables	Patients (N =70)				P-value
	Pre	H0	H24	H48	
Lactate level low group (mg/dL)					<0.001
- Mean±SD	0.99 ±0.26	1.78±.12	1.51+0.45	1.33±0.57	
- Median (range)	0.9 (0.8 – 1.3)	1.8 (1.7 – 1.9)	1.4 (1.3 – 1.6)	1.1 (0.9 – 1.5)	
Lactate level high group (mg/dL)					<0.001
- Mean ±SD	1.03 ±0.27	6.17±1.46	4.89±1.43	2.99±1.61	
- Median (range)	0.9 (0.8 – 1.3)	6.2 (5.0 – 7.4)	5.0 (3.9 – 5.5)	2.3 (1.7 – 4.3)	
P-value	0.55	<0.001	<0.001	<0.001	

*Data are presented as median (IQR)

Table 6 shows that there was significant difference between both groups in terms of ICU stay; patients in high group had significantly longer ICU stay (p =0.019). In contrary, there were nosignificant differences between both groups in terms of duration of mechanical ventilation (p =0.62) and ward stay (p =0.205).

Table 6: Association between Studied groups and clinical outcomes

Variables	Low group (N =35)	High group (N =35)	P –value
Duration of MV in hours			
- Mean ±SD	10.7±19.1	16.5 ±29.1	0.62
- Median (range)	7 (6– 72)	8 (6– 96)	
ICU stay in days			
- Mean ±SD	2.74 ±0.88	3.25 ±0.98	0.019
- Median (range)	3 (2 – 5)	3 (2 – 6)	
Ward stay in days			
- Mean ±SD	4.7 ±0.9	4.7 ±1.8	0.205
- Median (range)	5 (0 – 6)	5 (0 –7)	

*Data are presented as mean ±SD, median (IQR), or number (%). MV: Mechanical ventilation

Table 7 shows that there was significant difference between both groups in terms of morbidity and mortality rates; patients in high group had significantly higher rates of mortality (p <0.001) and morbidity (p <0.001). The most commonly encountered morbidities in high group were pneumonia (11.4%) and low cardiac output (8.6%).

Table 7: Association between Studied groups and clinical outcomes

Variables	Low group (N =35)	High group (N =35)	P –value
Morbidity rate, No (%)			
- Yes	6 (17.1%)	18 (51.4%)	<0.001
- No	29 (72.9%)	17 (48.6%)	
Type of Morbidity, No (%)			<0.001
- Adult respiratory distress syndrome (ARDS)	1 (2.9%)	2 (5.8%)	
- Pneumonia	0	4 (11.4%)	
- Acute Kidney Injury (AKI)	1 (2.9%)	2 (5.8%)	
- Renal Impairment	1 (2.9%)	2 (5.8%)	
- Stroke	1 (2.9%)	2 (5.8%)	
- Low cardiac output syndrome (LCOS)	1 (2.9%)	3 (8.6%)	
- Myocardial infarction	1 (2.9%)	2 (5.8%)	
- Renal Impairment & Myocardial infarction	0	1 (2.9%)	
Mortality rate, No (%)			
- Dead	1 (2.9%)	9 (25.7%)	<0.001
- Alive	34 (97.1%)	24 (74.3%)	

*Data are presented as mean ±SD, median (IQR), or number (%).

Table 8shows the results of multivariate analysis of factors associated with mortality. The regression analysis showed that only ICU stay was the independent predictor of mortality (OR 40.189, 95% CI [1.462 – 1105.107], p =0.029).

Table 8: Multivariate analysis of factors associated with mortality.

	Odds ratio	95% confidence interval	P- Value
Age in years	0.984	0.796 – 1.216	0.880
ICU stay in days	40.189	1.462 – 1105.107	0.029
Lactate at admission	1.447	0.778 – 2.689	0.243

*Data are presented as odds ratio and 95% confidence interval.

4. Discussion

Coronary artery disease (CAD) is the leading cause of death globally. The development of the heart-lung machine ushered in the era of modern cardiac surgery. Coronary artery bypass graft surgery (CABG) remains the most common operation performed by cardiac surgeons today. From its infancy in the 1950s till today, CABG has undergone many developments both technically and clinically. Improvements in intraoperative technique and perioperative care have led to CABG being offered to a more broad patient profile with less complications and adverse events (**Malakar et al.**, **2019**).

Nevertheless, many complications of CABG are reported which include stroke, wound infection, graft failure, renal failure, atrial fibrillation, and death. Previous studies reported mortality rates after isolated CABG ranging from 2.6% to 12.2%. Determining predictive factors for mortality and morbidity is very important in the management of patients with cardiac surgery. Therefore, various postoperative variables -as length of stay in intensive care unit, atrial fibrillation, acute kidney injury, neurological damage type I and dialysis- were evaluated as predictors of postoperative mortality (**Ibrahim et al.**, **2017**).

Lactate is the end product of pyruvate metabolism via the enzyme lactate dehydrogenase. Elevated Lactate levels have been associated with increased morbidity and mortality in a diverse patient population including: trauma, sepsis, multiple organ failure and elderly patients. Additionally, lactate levels have been used to risk stratify septic patients to determine their disposition and intensity of treatment (**Bou Chebl et al.**, **2017**).

However, few studies have looked at lactate's role as an independent predictor of mortality in patients undergoing CABG. Therefore, we conducted the present prospective cohort study to evaluate the role of blood lactate level as a predictor of major complications after cardiac surgery including mortality.

CAD is markedly more common in men than in women. In both sexes, CHD risk increases with age (**Genders and Hunink**, **2012**). In the present study, the mean age of the included patients was 58.2 ±6.4years and the majority of patients were males (68.8%).

In line with our findings, **Shahwan and colleagues** (**2019**) performed across-sectional study to determine the prevalence of cardiovascular disease and associated risk factors in the population of Gaza strip in Palestine. A sample of 2240 participant (1121 males and 1119 females) aged ≥25 years participated in the study. It was noted that males reported a higher prevalence (10.1%) than females (6.4%); while the majority of the patients lies between 50-65 years old.

Traditional risk factors for CAD include hypertension, hypercholesteremia, smoking, diabetes, overweight or obesity, lack of physical activity, Those risk factors are major contributors for the development of CAD and negatively affect its prognosis (**Wilson**, **1994**). In our cohort, more than 50% of the patients had diabetes or hypertension.

In agreement with our findings, **Najib et al,** (**2015**)**, for example**, conducted a retrospective analysis on 1,822 patients with CAD who attended university hospital from 2010 to 2013. They found that 76% of the CAD patients had hypertension, 88% had hypercholesteremia, and 46% had diabetes (**Najib et al.**, **2015**). Another study reported that hypertension was noted in 78.0% of the patients with CAD, while hypercholesteremia was noted by 65.1% of the patients and 23.5% of the patients were diabetic (**Banasiak et al.**, **2007**).

Although CABG is a safe procedure performed worldwide with low rates of mortality and morbidity in the general population; the rates of postoperative mortality and morbidity still represent major concerns in developing countries (**Piegas et al.**, **2009**). In the present study, the rate of in-hospital mortality was 14%; while the rate of morbidity was 34%. The most commonly encountered morbidities in high group were pneumonia (11.4%) and low cardiac output syndrome (LCOS) (8.6%).

In agreement with our findings, **Kamal and colleagues** (**2017**) aimed to determine adverse outcome and its specific perioperative predictors after CABG. This study included 100 patients who underwent CABG at departments of Cardiothoracic

Surgery in Assiut and Minia University Hospitals, between November 2014 and October 2016. The overall mortality rates were 12%.

Similarly, in the study by **Hamad and colleagues** (**2009**), the mortality rates among patients undergoing CABG was 12.1%.

However, it should be noted that other reports showed much lower mortality rates after CABG. For example, **Piegas and colleagues** (**2009**) aimed to assess myocardial revascularization surgery results when not associated to other procedures. A retrospective study was conducted on a total of 63,529 surgeries which were performed in the period between 2005 and 2007 at 191 hospitals. The in-hospital mortality rate after CABG was 6.22%.

Hannan and colleagues (**2003**) examined both hospital and surgeon volume-mortality relations for CABG surgery through the use of a population-based clinical data set. Data from New York's clinical CABG surgery registry from 1997 to 1999 (total number of procedures, 57 150) were used. The risk-adjusted mortality rate for patients undergoing CABG was 1.89%.

The exact causes of such higher mortality rates in our cohort are unknown. However, this discrepancy is probably due to the high prevalence of cardiovascular risk factors among Egyptians who underwent CABG. Currently, there is a higher prevalence of poor cardiac conditions and associated comorbidities (**Reda et al.**, **2018**). Another explanation is related to the design of our study half of our patients had high lactate levels which may donate poor general condition. It was reported that a lactate excess of > 4 mmol/L was associated with poor outcomes in ICU (**Andersen et al.**, **2013**).

In the present study, we assessed the associations between blood lactate levels and postoperative mortality. We found that their significant changes in serum lactate level in studied groups over the first 48 hours of ICU admission ($p < 0.05$). Our analysis indicated that patients with high lactate levels had significantly higher rates of mortality than patients with low lactate levels ($p < 0.001$).

In concordance with our findings, **Yılmaz and colleagues** (**2011**) aimed to determine the risk factors for hyperlactatemia developing after coronary artery CABG surgery and to analyze its effect on mortality and the morbidity. Four-hundred and eighty-two consecutive patients who had undergone elective CABG were prospectively included in the study and divided into two groups: high blood lactate levels and normal blood lactate levels. The blood lactate levels were found significantly higher in dead patients. There was a significant correlation between blood lactate levels and mortality and morbidity ($p<0.01$).

Similarly, **Demers and colleagues** (**2000**) performed a retrospective study to determine an association between blood lactate levels and perioperative morbidity and mortality. The study reviewed 1,376 patients who underwent CABG. Peak blood lactate levels of 4.0 mmol/L or higher were present in 227 patients (18.0%). Postoperative mortality was higher in this group than in the patients who had peak blood lactate levels of less than 4.0 mmol/L. Logistic regression analysis revealed that peak blood lactate levels of 4.0 mmol/L or higher were strongly associated with postoperative mortality ($p = 0.0001$) and morbidity ($p = 0.013$).

In addition, **Hajjar and colleagues** (**2013**) assessed whether high lactate levels after cardiac surgery are predictors of major complications including mortality. This was a sub-study of TRACS (Transfusion Requirements After Cardiac Surgery), which was designed as a prospective, randomized, controlled trial evaluating the effects of a transfusion strategy on morbidity and mortality. Of the 502 patients enrolled, 52 (10%) had at least 1 major complication. Lactate levels were higher in the group with complications. In a multivariate model, high lactate levels 6 hours after ICU admission was a predictor of major complications.

Toraman and colleagues (**2004**) investigated the effect of increased serum lactate on outcome after on-pump CABG. Serum lactate level was measured in 776 patients within half an hour after surgery. Lactate level was less than or equal to 2 mmol/L in 534 patients (low lactate group) and more than 2 mmol/L in 242 patients (high lactate group). Significant rise in postoperative lactate levels was associated with higher mortality rates (OR, 5.6, $P =.04$).

Similarly, **Ozgoz and colleagues** (**2017**) evaluated the relationship between serum lactate levels and postoperative outcomes in patients who underwent on-pump CABG. A prospective analysis was performed on 40 adult patients who underwent isolated first-time on-pump CABG between December 2014 and March 2015. In high lactate group, the mortality rates and postoperative complications were significantly higher.

On the other hand, our analysis showed that patients with high lactate levels had significantly longer ICU stay than patients with low lactate levels ($p =0.019$). In contrary, there were no significant differences between both groups in terms of duration of MV ($p =0.62$) and ward stay ($p =0.205$).

In line with these findings, **Naik and colleagues** (**2016**) aimed to identify the factors causing high lactate levels in patients undergoing CABG under cardiopulmonary bypass (CPB) and to assess the association between high blood lactate levels and postoperative morbidity and mortality. Aretrospective observational study including 370 patients who underwent cardiac surgeries under cardiopulmonary bypass. The patients were divided into 2 groups based on serum lactate levels; those with serum lactate levels greater than or equal to 4 mmol/L considered as hyperlactatemia and those with serum lactate levels less than 4 mmol/L. Patients with hyperlactatemia had significantly higher rate of postoperative morbidity like atrial fibrillation, longer stay in the ICU, and hospital stay.

Study's Limitations:

We acknowledge that the present study has a number of limitations. The sample size of our cohort was relatively small which may affect the generalizability of our findings. Moreover, long-term patient centered outcomes were not utilized in our study.

Conclusion

In conclusion, postoperative blood lactate level is an independent predictor of poor postoperative outcomes. In the present study, patients with high lactate levels exhibited higher rates of mortality, morbidity, and longer ICU stay than patients with normal lactate levels. so Prevention of hyperlactatemia is very important and we have to provide hemodynamic stabilization during ICU stay. Nevertheless, further large-scale studies are still needed to confirm our findings.

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