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Research Article

Frequency of Morbidity and Mortality with Increased Lactate Level After Open Heart Surgery at Tertiary Care Hospital

Vikram Kumar[1], Zubair Ahmed[1], Ali Raza Brohi[2]*, Hafeezullah[1], Asmat Achakzai[1] and Suhayb Ahmed Khushk[1]

[1]*National Institute of Cardiovascular Diseases, Karachi, Pakistan*

[2]*People's University of Medical and Health Sciences, Nawabshah, Pakistan*

***Corresponding Author:** Ali Raza Brohi, Professor and Chairman, Department of Paediatric Surgery, People's University of Medical and Health Sciences, Nawabshah, Pakistan.

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Abstract

Introduction: 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 (CPB). Morbidity and mortality are related directly to the preoperative status of the patient, as well as to specific anesthetic, surgical and postoperative factors in the cardiac surgery. The maintenance of appropriate hemodynamic goals is essential to improve outcomes after cardiac surgery.

Objective: The objective of the study was to determine the frequency of mortality and morbidity among patients with increased lactate levels after open heart surgery at tertiary care hospital.

Materials and Methods: A Case series study was conducted in Surgical ICU, Department of Cardiac Surgery, National Institute of Cardiovascular Diseases (NICVD), Karachi. The duration of study was 6 months after the approval of the synopsis. This study includes 143 hyperlactatemic patients who underwent open heart surgery at National Institute of Cardiovascular Diseases, Karachi. All the patients who fulfilled the inclusion criteria were included in the study. Detailed medical history of patients was collected after obtaining informed consent from patients including demographic characteristics (gender and age), history of myocardial infarction, hypertension, congestive heart failure and diabetes. All patients ABG sample was collected at 6, 12 and 18 hours to measure the lactate levels. All collected information was recorded in proforma for evaluation of results.

Results: In present study, 143 patients were selected out of which 83 (58.0%) patients were male and 60 (42.0%) were female with mean age of 61.24 ± 11.720 years. Patients underwent for open heart surgery developed hyperlactatemia during CPB that causes; increased surgery time (3.5 ± 0.93 hours), increased serum lactate at 6 hours (3.69 ± 1.97), at 12 hours (3.39 ± 1.81) and at 18 hours (3.12 ± 1.35) mmol/L, increased ICU stay (51.31 ± 11.78 hours) and hospital stay (12.79 ± 4.31 days). Hyperlactatemia also increases the morbidity and mortality rate (13.3%) in open heart surgery patients.

Conclusion: It was concluded from the study that patients underwent open heart surgery are at a higher risk of development of hyperlactatemia (≥ 4.0 mmol/L) that increases the post-operative morbidity and mortality.

Keywords: Hyperlactatemia; Cardiac Surgery; Drug Therapy; Cardiopulmonary Bypass

Introduction

Increased lactate levels are commonly seen in patients during and after cardiac surgery and causes includes tissue hypoxia as well as non-hypoxic causes such as drug therapy, cardioplegia, hypothermia and cardiopulmonary bypass (CPB) [1,2].

Lactic acidosis in patients after cardiac surgery is a manifestation of systemic inflammation and excess pro-inflammatory cytokine production [3]. Blood carrying capacity and transferring oxygen to tissues in stored blood also accompanied with an increase in lactate level [4]. In states like sepsis and shock, hyperlactatemia has been associated with poor outcomes, including mortality [5,6].

After cardiac surgery, morbidity and mortality are related directly to the pre-operative status of the patient, as well as to specific anesthetic, surgical and postoperative factors. Hemodynamic stability is essential to improve outcomes after cardiac surgery [1]. Central venous pressure, lactate levels and oxygen saturation are important markers for managing these patients [7].

Study conducted by Mak NT., *et al*. hyperlactatemia (blood lactate ≥ 3.0 mmol/L) was observed in 144 patients out of 469 post-cardiac surgery patients enrolled in the study and mortality rate amongst hyperlactatemic patients was found to be 10.4% [8]. In another study conducted by Naik R., *et al*. reported postoperative morbidity in hyperlactatemia patients, atrial fibrillation in 19.9% of the patients, 34.0% of the patients required more inotropic supports, renal dysfunction was observed in 7.5% of the patients, GI bleeding was observed in 0.7% of the patients, ICU stay of more than or equal to 3 days was observed in 88.8% and hospital stay of more than equal to 7 days was 49% [9]. Similarly, a study reported higher lactate level in the group with complications at the end of surgery [10].

The predictive role of hyperlactatemia as a prognostic factor in patients who underwent open heart surgery has not been studied extensively in Pakistan. Therefore, study is designed with aim to evaluate whether high lactate levels after cardiac surgery are predictors of morbidity and mortality in our region. The findings of this study will guide the clinicians in identifying and early detection of patients at higher risk of morbidity and mortality, which will be helpful in the better management ultimately outcomes and counseling of patients.

Materials and Methods

A case series study was conducted for six months in Surgical ICU, Department of Cardiac Surgery, National institute of Cardiovascular Diseases (NICVD), Karachi. Sample size was calculated on the basis of the mortality rate among hyperlactatemic patients was (P) = 10.4% [8], Confidence level = 95%, Bond on error (d) = 5%. The calculated sample size of the study is (n) = 143 hyperlactatemic patients undergoing open heart surgery. Sample size was calculated using WHO sample size calculator version 2.0:

$$n = \frac{1.96^2\, p(1-p)}{d^2} = \frac{(1.96)^2 \times 0.104 \times (1-0.104)}{(0.05)^2} = 143$$

Sample selection

Inclusion criteria:

1. Patients between 40 years to 80 years of age including female and male.
2. Patients undergoing open heart surgery as per operational definition.
3. Signed informed consent.
4. Postoperative peak lactate levels ≥ 3 mmol/L.

Exclusion criteria:

1. Patients in cardiac arrest, assessed by history, clinical examination and ECG changes.
2. Patients with atrial fibrillation, assessed by history, clinically and ECG (irregular rhythm and absent P wave).
3. Not given informed consent.

Data collection and analysis

Data was collected on pre-designed structured questionnaire (provided in annexure A). SPSS version 21 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp) used for data analysis.

Results

In present study 143 patients were included who fulfill the inclusion criteria.

Table 1 shows descriptive statistics of continuous variable of age (in years) was done, where mean and standard deviation of age was 61.24 ± 11.720 (42 - 80). Shapiro-Wilk test was applied that accept the null hypothesis i.e. data was normally distributed.

Variables	N	Minimum	Maximum	Mean	Standard Deviation
Age	143	42	80	61.24	11.720

Table 1: Descriptive statistics of continuous variable (Age).

Shapiro-Wilk test statistic = 0.943.

P-value = 0.001 (Significant).

Null hypothesis is accepted that the data is normally distributed.

Table 2 descriptive statistics of continuous variable of surgery time (in hour) was done, where mean and standard deviation of surgery time was 3.5 ± 0.93 (1.5 - 5.0) hour. Shapiro-Wilk test was applied that accept the null hypothesis i.e. data was normally distributed.

Variables	N	Minimum	Maximum	Mean	Standard Deviation
Surgery Time (Hour)	143	1.5	5.0	3.5	0.93

Table 2: Descriptive statistics of continuous variable (Surgery time).

Shapiro-Wilk test statistic = 0.949.

P-value = 0.001 (Significant).

Null hypothesis is accepted that the data is normally distributed.

Table 3 descriptive statistics of continuous variable of serum lactate (mmol/L) was done at 6, 12 and 18 hours, where mean and standard deviation of serum lactate at 6 hours was 3.69 ± 1.97 (3.0 - 4.13) mmol/L, at 12 hours 3.39 ± 1.81 (3.3 - 3.95) mmol/L and at 18 hours 3.12 ± 1.35 (3.1 - 3.43) 3.39 ± 1.81 (3.3 - 3.95) mmol/L. Shapiro-Wilk test was applied that accept the null hypothesis i.e., data was normally distributed.

Table 4 descriptive statistics of continuous variable of ICU stay (in hour) was done, where mean and standard deviation of ICU stay was 51.31 ± 11.78 (24 - 72) hour. Shapiro-Wilk test was applied that accept the null hypothesis i.e., data was normally distributed.

Table 5 descriptive statistics of continuous variable of hospital stay (in days) was done, where mean and standard deviation of hospital stay was 12.79 ± 4.31 (5 - 15) days. Shapiro-Wilk test was applied that accept the null hypothesis i.e. data was normally distributed.

Variables	N	Minimum	Maximum	Mean	Std. Deviation
Serum Lactate (mmol/L)					
At 6 Hour	143	3.0	4.13	3.69	1.97
At 12 Hour	143	3.3	3.95	3.39	1.81
At 18 Hour	143	3.1	3.43	3.12	1.35

Table 3: Descriptive statistics of continuous variable (Serum lactate).

Shapiro-Wilk test statistic = 0.945.

P-value = 0.001 (Significant).

Null hypothesis is accepted that the data is normally distributed.

Variables	N	Minimum	Maximum	Mean	Standard Deviation
ICU Stay (Hour)	143	24	72	51.31	11.78

Table 4: Descriptive statistics of continuous variable (ICU stay).

Shapiro-Wilk test statistic = 0.941.

P-value = 0.001 (Significant).

Null hypothesis is accepted that the data is normally distributed.

Variables	N	Minimum	Maximum	Mean	Standard Deviation
Hospital Stay (Days)	143	5	15	12.79	4.31

Table 5: Descriptive statistics of continuous variable (Hospital stay).

Shapiro-Wilk test statistic = 0.901.

P-value = 0.001 (Significant).

Null hypothesis is accepted that the data is normally distributed.

Table 6 distribution of gender was done in this study 83 (58.0%) patients were male and 60 (42.0%) were female. Male patients were more affected with disease as compare to female patients.

Gender	Frequency	Percent
Male	83	58.0
Female	60	42.0
Total	143	100.0

Table 6: Distribution of gender (n = 143).

Table 7 distribution of age was done, in this study enrolled patients were grouped as: in 41 - 50 years 36 (25.2%) patients, in 51 - 60 years 27 (18.9%) patients, in 61 - 70 years 49 (34.3%) patients and in 71 - 80 years 31 (21.7%) patients.

Age groups (Years)	Frequency	Percent
41 - 50	36	25.2
51 - 60	27	18.9
61 - 70	49	34.3
71 - 80	31	21.7
Total	143	100.0

Table 7: Distribution of age (n = 143).

Table 8 distribution of diabetes mellitus was done, in this study 51 (35.7%) patients were diabetic and 92 (64.3%) patients were non-diabetic.

Diabetes Mellitus	Frequency	Percent
Yes	51	35.7
No	92	64.3
Total	143	100.0

Table 8: Distribution of diabetes mellitus (n = 143).

Table 9 distribution of hypertension was done, in this study 117 (81.8%) patients were hypertensive and 26 (18.2%) patients were non-hypertensive.

Table 10 distribution of smoking was done, in this study 47 (32.9%) patients were smoker and 96 (67.1%) patients were non-smoker.

Hypertension	Frequency	Percent
Yes	117	81.8
No	26	18.2
Total	143	100.0

Table 9: Distribution of Hypertension (n = 143)

Smoking	Frequency	Percent
Yes	47	32.9
No	96	67.1
Total	143	100.0

Table 10: Distribution of smoking (n = 143).

Table 11 distribution of myocardial infarction was done, in this study 44 (30.8%) patients were having myocardial infarction and 99 (69.2%) patients were not.

Myocardial Infarction	Frequency	Percent
Yes	44	30.8
No	99	69.2
Total	143	100.0

Table 11: Distribution of myocardial infarction (n = 143).

Table 12 distribution of congestive cardiac failure was done, in this study 49 (34.3%) patients were having congestive cardiac failure and 94 (65.7%) patients were not.

CCF	Frequency	Percent
Yes	49	34.3
No	94	65.7
Total	143	100.0

Table 12: Distribution of congestive cardiac failure (CCF) (n = 143).

Table 13 distribution of morbidity in patients after open heart surgery was done, in this study enrolled patients were suffering from; atrial fibrillation in 39 (27.3%) patients, requires more ino-

tropic support in 63 (44.1%) patients, extended mechanical ventilation in 19 (13.3%) patients, renal dysfunction in 15 (10.5%) patients and GI bleeding in 7 (4.9%) patients.

Morbidity	Frequency	Percent
Atrial Fibrillation	39	27.3
Required More Inotropic Supports	63	44.1
Extended Mechanical Ventilation	19	13.3
Renal Dysfunction	15	10.5
GI Bleeding	7	4.9
Total	143	100.0

Table 13: Distribution of morbidity.

Table 14 distribution of mortality in patients after open heart surgery was done, in this study 19 (13.3%) enrolled patients were died and 124 (86.7%) were alive.

Mortality	Frequency	Percent
Yes	19	13.3
No	124	86.7
Total	143	100.0

Table 14: Distribution of mortality (n = 143).

Table 15-22 stratification of mortality with respect to gender, age, diabetes mellitus, hypertension, smoking, myocardial infarction, congestive cardiac failure and morbidity was done. Smoking, hypertension, myocardial infarction, congestive cardiac failure and morbidity shows highly significant relation with mortality whereas gender, age and diabetes mellitus show non-significant relation with mortality.

Gender	Mortality		Total
	Yes	No	
Male	11	72	83
Female	8	52	60
Total	19	124	143

Table 15: Stratification of mortality with respect to gender (n = 143).

Chi-square value = 0.001.

P-value = 0.989 (Non-significant).

Age (Years)	Mortality		Total
	Yes	No	
41 - 50	4	32	36
51 - 60	3	24	27
61 - 70	7	42	49
71 - 80	5	26	31
Total	19	124	143

Table 16: Stratification of mortality with respect to age (n = 143).

Chi- square value = 0.519.

P-value = 0.915 (Non-significant).

DM	Mortality		Total
	Yes	No	
Yes	10	41	51
No	9	83	92
Total	19	124	143

Table 17: Stratification of mortality with respect to diabetes mellitus (n = 143).

Chi- square value = 2.749.

P-value = 0.097 (Non-significant).

HTN	Mortality		Total
	Yes	No	
Yes	12	105	117
No	7	19	26
Total	19	124	143

Table 18: Stratification of mortality with respect to hypertension (n = 143).

Chi- square value = 5.125.

P-value = 0.024 (Significant).

Smoking	Mortality		Total
	Yes	No	
Yes	12	35	47
No	7	89	96
Total	19	124	143

Table 19: Stratification of mortality with respect to smoking (n = 143).

Chi- square value = 9.112.

P-value = 0.003 (Significant).

MI	Mortality		Total
	Yes	No	
Yes	11	33	44
No	8	91	99
Total	19	124	143

Table 20: Stratification of mortality with respect to myocardial infarction (n = 143).

Chi- square value = 7.568.

P-value = 0.006 (Significant).

CCF	Mortality		Total
	Yes	No	
Yes	12	42	49
No	7	82	94
Total	19	124	143

Table 21: Stratification of mortality with respect to congestive cardiac failure (n = 143).

Chi- square value = 6.013.

P-value = 0.014 (Significant).

Morbidity	Mortality		Total
	Yes	No	
Atrial Fibrillation	3	36	39
Required More Inotropic Supports	6	57	63
Extended Mechanical Ventilation	3	16	19
Renal Dysfunction	4	11	15
GI Bleeding	3	4	7
Total	19	124	143

Table 22: Stratification of mortality with respect to morbidity (n = 143).

Chi- square value = 9.580.

P-value = 0.048 (Significant).

Discussion

Cardiopulmonary bypass (CPB) provides a bloodless field for cardiac surgery. CPB provides the extracorporeal circulation whose function is circulatory and respiratory support along with temperature management to facilitate cardiovascular surgery. The basic function of CPB is to maintain systemic perfusion and oxygenation during open heart surgeries, which is performed by maintaining required flow rate, temperature, gas flow and hemoglobin to maintain oxygen delivery. Sometime tissue hypo-perfusion occurs due to low flow CPB, hypothermia, extreme hemodilution and excessive neurohormonal activation, which causes an anaerobic condition, which blocks the oxidative phosphorylation and adenosine triphosphate (ATP) is produced from pyruvate, the latter being metabolized into lactate [11]. Hyperlactatemia in open heart surgery may be occur due to tissue hypo-perfusion, less oxygen supply, decreased oxygen extraction and decreased hepatic lactate clearance [12].

In current research male patients were more affected with disease i.e. 83 (58.0%) as compared to female patients i.e. 60 (42.0%). Mean age of patients was 61.24 ± 11.720 years. A similar study was conducted by Joudi M., *et al*. on serum lactate after cardiac surgery and reports the high prevalence in male (57.89%) and less in female (42.11%) similar to our study. Mean age of selected patients was higher (65.196 ± 11.027) years then current study [13]. Similar results were reported by Muhammad Sadeghi M., *et al*. that high prevalence of male (65.7%) and mean age 60.33 ± 9.07 years [14]. Hajjar LA, reports the high male prevalence 62% and mean age 60 ± 12 years [15]. Mak NT., *et al*. report the similar high male prevalence 64.6% and mean age 70 years [16]. All studies reveal that male patients underwent for open heart surgery are at higher risk of development of hyperlactatemia that ultimately increases the morbidity and mortality.

In current research most, affected age group was 61 - 70 years in which 49 (34.3%) patients were fallen followed by 41 - 50 years having 36 (25.2%) patients, 71 - 80 years having 31 (21.7%) patients and 51 - 60 years having 27 (18.9%) patients.

In current research previous disease history of patients were taken to compare the increasing risk factors responsible for mortality in patients underwent for open heart surgery, such as diabetes mellitus (DM) was present in 51 (35.7%) patients, hypertension in 117 (81.8%) patients, myocardial infarction (MI) in 44 (30.8%) patients, congestive cardiac failure in 49 (34.3%) patients and 47 (32.9%) patients were smokers. A study by Mir Muhammad

Sadeghi M., *et al*. reports the history of DM in 35.9%, MI in 32.0% and neurological dysfunction 1.1% in selected patients [14]. Hajjar LA, reports the history of hypertension in 78%, DM in 33%, renal diseases in 11%, MI in 35% and unstable angina in 35% [15]. Mak NT., *et al*. report the DM in 26.4%, renal failure in 15.3% and cardiogenic shock in 3.5% [16]. All risk factors show highly significant relation with mortality and indicates that hypertension is the most common risk factor in patients who developed hyperlactatemia followed by DM, MI, CCF and smoking.

In current research patients underwent for open heart surgery having hyperlactatemia were suffering from different problems and requires management such as: atrial fibrillation in 39 (27.3%) patients, requires more inotropic support in 63 (44.1%) patients, extended mechanical ventilation in 19 (13.3%) patients, renal dysfunction in 15 (10.5%) patients and GI bleeding in 7 (4.9%) patients. A study by Demers P., *et al*. reports the neurological problem in 9.3%, MI in 17.2%, hemodynamic problem in 29.5%, pulmonary problem in 8.8%, digestive problem in 7.5%, renal problem in 9.3% and infectious problem in 7.1% [11]. Morbid conditions show highly significant relation with mortality, whereas hyperlactatemia is responsible for increasing the frequency of morbidity in patients who underwent for open heart surgery.

In current research surgery time was 3.5 ± 0.93 hours, serum lactate at 6 hours was 3.69 ± 1.97, at 12 hours 3.39 ± 1.81 and at 18 hours 3.12 ± 1.35 mmol/L, ICU stay 51.31 ± 11.78 hours and hospital stay 12.79 ± 4.31 days. A study by Muhammad Sadeghi M., *et al*. reports the ICU stay 47.27 ± 14.38 hours, hospital stay 8.88 ± 2.66 days and mean lactate after operation was 3.08 ± 1.01 mmol/L [14]. Hajjar LA, reports the mean lactate after 6 hours was 4.4 mmol/L and at 12 hours 2.3 mmol/L [15]. Mak NT., *et al*. report the peak lactate after operation 4.6 mmol/L [16]. Oğuz S., *et al*. reports the surgery time 91.91 minutes and average ICU admission 3 days [17]. All studies reveal that the patients underwent for open heart surgery are at a higher risk of hyperlactatemia that increases the ICU stay and hospital stay that causes the morbidity and mortality.

In current research patients 19 (13.3%) underwent for open heart surgery having hyperlactatemia were died due to different complications, whereas remaining 124 (86.7%) were alive but suffering from different complications. Demers P., *et al*. reports the mortality rate in 11.0% patients having hyperlactatemia [11]. A study by Muhammad Sadeghi M., *et al*. reports the lower mortality rate 3.3% [14]. Hajjar LA, reports the lower mortality rate of 5.2% [15]. Mak NT., *et al*. report the high similar prevalence 10.4% [16]. In our study mortality rate was high due to different reasons such as increasing age, history of chronic illnesses like DM, HTN, MI and CCF, increased post-operative complications due to hyperlactatemia and history of smoking.

Conclusion

It was concluded from the study that patients underwent open heart surgery are at a higher risk of development of hyperlactatemia (≥ 4.0 mmol/L) that increases the post-operative morbidity and mortality.

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