DOI: https://doi.org/10.53350/pjmhs22164263
DOI:

ORIGINAL ARTICLE

Base Excess or Hyperlactatemia: Identifying the Superior Risk Factor for Increased Morbidity and Mortality in Cardiac Surgery

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ABSTRACT

Objective: Cardiopulmonary bypass in cardiac surgery is often associated with metabolic changes. So, we conducted this study in order to find the supremacy between two risk factors base excess and hyperlactatemia in early prediction of morbidity and mortality in ICU after cardiac surgery.

Material and Methods: Intraoperative data of total of 100 patients who had cardiac surgery was recorded. Intraoperative and postoperative data of base excess and lactate levels were recorded at 1st, 6th, 12th and 24th hour in ICU. Two perioperative groups for B.E(Group 1 B.E < +/-2.5 mmol: Group 2 B.E >+/- 2.5 mmol) and lactate (Group 1 Lactate < 3 mmol: Group 2 Lactate>mmol) were created, Two post-operative groups for B.E(Group 1 B.E < +/-5.0 mmol: Group 2 B.E >+/- 5.0 mmol) and lactate(Group 1 Lactate <5mmol: Group 2 Lactate>5mmol)were created to find their correlation with early postoperative complications.

Results: In our study ICU morbidity and mortality was more related to the lactate and base excess values in the early 24 hours. Progressive Hyperlactatemia and constant negative base excess values were both significantly associated with ICU complications. In the CPB period subgroup negative base excess was more superior in predicting ICU prognosis than Lactate. (P-value 0.001) similarly patients divided in subgroup BE >+/- 5mmol/l had demonstrated superiority in making such prediction. Both CPB (0.013) and X.C (0.036) time were associated independently with ICU prognosis. .Longer ventilation times were also associated with bad ICU prognosis.

Conclusion: Our study found negative base excess values in the early postoperative period to be superior in predicting ICU morbidity and mortality when studied at subgroup level both peri-operatively and postoperatively.

INTRODUCTION

Cardiopulmonary bypass in cardiac surgery results in distinct metabolic abnormalities thus inflicting various hemodynamic and metabolic changes. Hyperlactatemia is often inevitable and base deficit often seems to worsen the situation during ICU stay and is considered to relate to longer length of Hospital stay.

Tissue hypoxia during cardiac surgery is often inevitable due to insufficient micro or macro hemodynamic changes, pulmonary diseases or due to reduction in oxygen carrying capacity because of bleeding resulting in anaerobic glycolysis leading to Hyperlactatemia. (Type A hyperlactatemia). Hyperlactatemia due to non-hypoxic sources is termed as (Type B Hyperlactatemia)[1-5] Various drugs, Hypothermia, Hemodilution and low pump blood flows with metabolic acidosis during CPB also result in hyperlactatemia.[6-8] In order to ensure proper oxygen delivery to prevent perioperative and postoperative tissue hypoxia because of low hematocrit packed red blood cells are often transfused but in addition to increasing patient hematocrit storage duration of transfused blood also result changes in potassium, pH and serum lactate levels. A blood stored for more than two weeks was found to be associated with increase mortality.

Hyperlactatemia in the early postoperative period is an indicator of impaired hemodynamics and is associated with increased morbidity and mortality. It is more common in cardiac surgery with longer bypass and cross clamp time. In the late onset hyperlactatemia often starting 6 to 24 hours after cardiac surgery is associated with preserved cardiac output. [09]

The risk factors associated can be hyperglycemia, epinephrine use, longer bypass time and cross clamp time, and longer ventilation duration and ICU stay. Higher lactate levels along with reduced lactate clearance are known to increase morbidity and mortality in ICU patients. However, high negative base deficit values after cardiac surgery and their association with increased ventilation time, longer ICU stays and other complications need further investigation. As it is predicted that high early postoperative base deficit values not high lactate values are more involved in complications.

The Purpose of this study is to study the supremacy of base deficit over hyperlactatemia in predicting mortality and morbidity in ICU after cardiac surgery.

MATERIAL AND METHODS

This prospective randomized study was conducted in cardiac surgery department of Bahawalpur Victoria Hospital Bahawalpur from 1st January 2021 to 31st December 2021. All the patients of age group 20 to 81 years undergoing simple coronary artery bypass grafting (CABG), single vale replacement or double valve replacement (DVR) were included. Patients undergoing simple adult congenital cardiac surgical procedures i.e., Atrial septal defect (ASD) were also incorporated. All patients with re do surgery, emergency surgeries, patients having BMI >30Kg / m^2, end stage liver or kidney dysfunction, very low EF (<25%), having recent MI or complication of MI were excluded.

Informed consent was taken from patients. Approval letter from Ethical Review Committee, Quaid e Azam medical collage was obtained. Two perioperative groups for B.E(Group 1 B.E < +/- 2.5 mmol: Group 2 B.E >+/- 2.5 mmol) and lactate(Group 1 Lactate < 3 mmol: Group 2 Lactate>3 mmol) were created. And Two post operative groups for B.E(Group 1 B.E < +/-5.0 mmol: Group 2 B.E >+/- 5.0 mmol) and lactate(Group 1 Lactate <5mmol: Group 2 Lactate>5mmol) were created to find their correlation with early postoperative complications.

All patients were anesthetized by same anesthetist following the same technique. Patients were operated through median sternotomy and routine cardiopulmonary bypass (CPB) technique was used. Intermittent cardioplegia was given to arrest the heart. On completion of procedure patients were weaned off from CPB successfully. Inotropic support initially started was Dobutamine, Nor adrenaline/adrenaline was added as double support and Milrinone was added as triple support.

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Patient was shifted in ICU as intubated, sedated and extubated when patients were stable on mild to moderate pressure support and PEEP, at paO2>60mmHg and FiO2<0.4 as well as the ability of patients sufficiently protect their airway and follow commands. Patients were discharged from the ICU on assurance of hemodynamic stabilization after weaning of vasoactive medication, stable respiratory and neurological conditions.

Complications on the ICU were defined as: cardiopulmonary resuscitation, surgical revision with/without CPB, secondary cardiac failure, postoperative coronary angiography for suspected cardiac ischemia, postoperative infectious complication, postoperative respiratory failure (re-intubation, non-invasive Ventilation), delirium, multiple organ failure, acute kidney, injury with/without need for continuous renal replacement therapy (CRRT) and/or others. Moreover, requirement of blood products transfusion (red packed blood cells, FFP, and platelets) within the early postoperative phase (first 12 hours) were noted. All preoperative, demographic, intraoperative parameters and perioperative mean pressures were studied.

Postoperative CKMB was recorded. Blood transfusions and ICU stay were also recorded. Lactate and base deficits values were recorded preoperatively, peri-operatively and postoperatively at 1st, 6th, 12th and 24th hour. All measurements were recorded on preformed Performa.

Statistical Analysis: By using SPSS version-26, values were displayed in term of combination of mean and standard deviation for quantitative values and percentages for qualitative values. The continuous variables were analyzed by using Student t test in both the groups and chi-square test for categorical variables for both groups. Statistically significance was denoted by value of p≤0.05.

Table 1: Demographic and Preoperative data

		No Complication	Reinttubation	Renal Injury	Post Surgery Angiography	Death	P-Value
Age		47± 14	44±11	57±-9	57±0	59±-3	0.532
Gender		59M/33F	2M/0F	2M/0F	1M/0F	2M/1F	0.361
Hypertension	Yes	25	0	0	1	1	0.621
	No	68	2	2	0	2	
DIABETES	Yes	17	0	1	0	0	0.663
	No	75	2	1	1	3	
Hepatitis	Yes	5	0	0	0	0	0.504
	No	87	2	2	1	3	
Smoker	Yes	8	1	0	0	0	0.780
	No	84	1	2	1	3	
EF	30-45%	11	1	0	1	0	0.137
	46-60%	48	1	1	0	3	
	61-75%	33	0	1	0	0	
Urea	34+/-8	40± 7	43± -5	49± 2	54	48± 9	0.343
Creatinine	1.1+/-0.3	1.4± 0.5	1.7± 0.6	2.2± 3	1.8	2.4± 0.3	0.221

Table 2: Peri-operative Data

		No complication	Reinttubation	Renal injury	Post Surgery Angiography	Death	P-value
CPB(min)		105± 37	156± 18	113± 7	194	136± 53	0.013
X.C(min)		69± 27	97± 16	61± 2	125	107± 50	0.036
CPB Hb(gm/dl)		9.8± 1.5	11± 0	13± 2.2	11.5	9.3± 1.2	0.117
BT	Yes	4	2	0	0	3	0.056
	No	88	0	2	1	0	
Hem filtration	Yes	23	0	0	0	1	0.458
	No	69	2	2	1	2	
Urine Output	< 4ml/kg/hr	21	1	2	0	1	0.090
	> 4ml/kg/hr	71	1	0	1	2	
MAP		64± 6	70± 5	54± 12	60	70± 5	0.100
Lactate	<3mmol/l	59	2	1	0	0	0.113
	>3mmol/l	33	0	1	1	3	
Base Excess	<± 2.5mmol	72	0	0	0	1	0.001
	> ± 2.5mmol	20	2	2	1	2	

Table 3: Post-operative Data

		No complication	Re-intubation	Renal injury	Post Surgery Angiography	Death	P-value
V.T		159± 54	1030± 70	250+/-99	554	613± 434	0.001
H.S		7	9	11	7	2	0.594
Lactate	1st h	4.5± 0.9	4± 1.4	5± 2.8	5.3	5.8± 1.4	0.314
	6th h	3.0± 08	5.8± 1.1	5.1± 2.4	3.6	6.2± 2.4	0.001
	12th h	2.4± 0.9	4.9± 2.6	5.7± 2.4	6.7	5.9± 3.1	0.045
	24th h	1.7± 6	5± 3.5	5.9± 1.6	5.5	5.0± 2.4	0.000
B.E	1st h	1.0± 2.5	-5.7± 3.25	-3.9± 1.1	-2.9	-4.5± 1.8	0.021
	6th h	0.7± 2.1	-4.9± 1.2	-3.6± 8.9	-3.4	-3.4± 1.4	0.032
	12th h	1.1± 1.9	-4.2± 2.4	-4.0± 4.1	-6.7	-4.3± 5.7	0.001
	24th h	1.2± 1.2	-3.8± 1.1	-1.9± 4.1	-6.7	-4.3± 4.6	0.000
Lactate	<5mmol	74	2	1	0	2	0.09
	>5mmol	26	0	1	1	1	
B.E	<+/-5	88	1	1	1	2	0.049
	>+/-5	12	1	1	0	1	

RESULTS

Out of 110 patients 100 patients included in the study. Demographic factors were found not significantly associated with ICU complications. Mean age in patients with nil complication was 47± 14 years, Reintubation 44± 11years, Renal injury 57± 9 years, Re-angiography to check graft patency 57± 0 years and 59± 3 years of patient who expired in ICU.(P-value 0.532) . Most of the patients who had complications were male 7(7%) and only 1(1%) patient was female. In our study complications were not dependent

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on patient gender (P-value0.361).Hypertension was not related to the complications in our study out of 100 patients 27(27%) patients were hypertensive and only 2(2%) had Postoperative complications, 1 patient had postoperative Angiography and 1 patient died. (P-value 0.621). Only 18 out of 100 patients were diabetic and only 1(1%) diabetic patient had developed acute renal injury. (P-value 0.663). Hepatitis (5%) was not found to be associated with postoperative complication. (P-value 0.504). In our study smoking was not associated significantly with postoperative morbidity and mortality, 9(9%) patients were smoker and only 1(1%) patient was re-intubated. (0.780).

Our patients were divided into three groups based upon there Ejection fraction. Those patients in the second group 46-60% EF were more associated with postoperative complications and death. Preoperative Urea and Serum Creatinine also didn't show any significance relation with post- operative ICU morbidity and mortality (P-value 0.343) and (P-value 0.221) respectively.

Cardiopulmonary bypass time and cross clamp time was independently associated with post-operative complications, greater the CPB and X.C duration, greater was the possibility of complication. Mean CPB time in re-intubated patients was 156± 18, in renal injury 113± 7, Reangiography194 and 136± 53 in expired patients. (P-value 0.013). Mean X.C time in re-intubated patients was 97± 16, in renal injury 61± 2, Re-angiography 125 and 107± 50 in expired patients. (P-value 0.036). Perioperative Hemoglobin levels showed no significant association with any complication (P-value 0.117). Blood transfusion and hemofiltration were also insignificantly associated with post-operative morbidity and complication with P-value 0.056 and P-value 0.458 respectively.

Patients were divided into two groups. Group 1(U.O< 4ml/kg/hr) and Group 2 (U.O> 4ml/kg/hr) both groups were insignificant in predicting any complication.(P-value 0.09). Mean Arterial Pressure was found to be similar and nonsignificant in predicting any ICU complication. Patients were also divided on the basis of lactate levels during cardiopulmonary bypass. Group 1(<3mmol/l) and Group 2(>3mmol/l), both groups were insignificantly associated with postoperative ICU complications. (P-value 0.113). On the basis of perioperative Base Excess value patients were divided into groups. Group 1(<+/-2.5mmol/l) and Group 2(>+/-2.5mmol/l). Patients in the second group were independently associated with post-operative complication. (P-value0.001)

Patients lactate and base excess values were recorded in the post-operative period for consecutive 1st, 6th, 12th and 24th hour and were correlated with postoperative complications. Lactate values at immediate 1st hour were not significantly related to the postoperative complication (P-value0.314). Lactate value a 6th, 12th and 24th hour were significantly associated with postoperative morbidity and mortality. P-value 0.001, P-value0.045 and P-value 0.000 respectively. Our study showed patients with increased lactate values at 6th, 12th and 24th hour were more prone to complications. We further classified patients into two groups based upon lactate levels in 1st 24-hour Group 1 Lactate < 5mmol/l and Group 2 Lactate >5mmol/l, current study found no significant difference between both groups related to predicting ICU complications (P-value 0.09).

Base Excess values at immediate 1st h, 6th, 12th and 24th hour were significantly associated with postoperative morbidity and mortality. P-value 0.021 P-value 0.032, P-value0.001 and P-value 0.000 respectively. Our study showed patients with increased base excess values at 1st, 6th, 12th and 24th h were more prone to complications. We further classified patients into two groups based upon base excess values in 1st 24 hours Group 1 B.E < +/-5mmol/l and Group 2 B.E >+/-5mmol/l, our study found significant difference between both groups related to predicting ICU complications. Group 2 showed significant relation with postoperative complications (P-value 0.49). Mean ventilation time showed prominent association with postoperative complication, those patients who had postoperative complication had relatively longer ventilation time.(P-value0.001) and mean hospital stay of patients was insignificant. (0.549).

DISCUSSION

The aim of this study was to identify the significance of two key metabolic factors in predicting prognosis after cardiac surgery in patients undergoing cardiac surgery with cardiopulmonary bypass admitted in the ICU. Our study showed that Patients who had greater values of lactate and negative base excess during 1st 24 hours were related in prediction of ICU mortality and morbidity. On further evaluation patients with higher perioperative lactate group > 4mmol/l and Greater negative postoperative Base excess > ± 5mmol/l were more significant in prediction of ICU mortality and morbidity in cardiac surgery patients.

Only handful researches had been done so far on assessing comparative role between base excess and lactate in postoperative mortality due to the lack of multivariate analysis involving relevant coexisting factors.

In our study we focused early key metabolic factors to predict ICU morbidity and mortality.

We found that severe lactate and negative base excess values during early ICU hours after cardiac surgery were crucial in predicting ICU mortality and morbidity. Except lactate values during 1st ICU hour. Negative Base Excess values during CPB were found to be more related to ICU mortality and morbidity. This may be helpful for physicians in early predicting of patients at high risk.

In one study high negative BE value was linked with reduced tissue perfusion. Decreased BE and higher lactate has potential possibility in predicting various complications. In trauma patients BE was found superior than lactate in predicting mortality while in another no such difference was found.[10,11]

In our study highest mortality was more prominent in higher negative base excess group when compared with patients in higher lactate group found to be in accordance with few previous studies as well. And similarly during CPB greater negative base excess values were more prominent in making such predictions in our study.

Hospital laboratories provide normal ranges of various metabolic factors which are crucial in predicting adverse critical outcomes. Which further depend upon specificity and sensitivity of the target population. Different studies considered different cut off Base excess and hyper lactate values as in one such research values >2 mmol/l were considered to predict hyperlactatemia, in our study we considered >5 mmol/l as prognostic value in cardiac surgery as compared to 4 mmol/l value of a previous study.

CONCLUSION

Our study demonstrated both hyperlactatemia and Negative base excess values major metabolic factors in predicting post cardiac surgery ICU morbidity and mortality. In Subgroup study we found negative Base Excess value to be superior in making such prediction as compared to the lactate values.

Limitations: Our study was related to a single center and of small population and also few factors like total fluid intakes, use of inotropic drugs, no of grafts etc. were also not included.

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