



## Arterial Lactate Level Changes in First Day after Cardiac Operation

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### ABSTRACT

**Introduction:** Lactate level is an important index for predicting cardiac events. There are some debates about time and type of sampling for defining of its prognostic values.

**Methods:** To assess the prognostic importance of arterial lactate level in patients after cardiac surgery with regarding to operation factors serial arterial lactate levels during and after surgery was measured up to 24 hours, these data were processed by T-independent test and chi-square, P less than 0.01 was significant.

**Results:** 31 patients entered to study, high persistent arterial lactate level (1.5-4 mmol/L) can be seen in most patients (80%) during operation which returned to normal level (<1.5 mmol/L) up to 12<sup>th</sup> hours post operation in 75% of cases. Persistent high level (>4 mmol/L) will occur unusually at 24<sup>th</sup> hour but can be associated with poor prognosis.

**Conclusion:** Serial measurement of serum lactate level can be helpful for our management quality and very highly persistent arterial lactate level (>4 mmol/lit) up to 24 hours after operation will increase mortality rate in operated patients for congenital heart disease.

### Introduction

Lactic acid is a product of anaerobic glycolysis in favorable metabolic conditions can be changed to pyruvate. Although all tissues can consume or produce lactic acid, liver is principal tissue for consumption of lactic acid overproduced by other tissues.

Lactic acidosis is a common finding in critically ill patients. High initial blood level and persistently increasing high lactate levels have been correlated with poor outcome.<sup>1</sup> Mortality in groups whose lactate levels have not been normalized in 24, 48 and 72 hr was 10%, 24% and 67% in addition there is not any difference between arterial and venous level and mixed venous blood for evaluation in these circumstances<sup>2</sup> in other study serial lactate level monitoring has priority in compared to one sample for prognosis prediction.<sup>3</sup>

Normal lactate level in normal unstressed patient is 1±0.5 mmol/L<sup>4</sup> this concentration ratio in arterial level depends on both production and conversion in various organ and should be maintained below 2 mmol/L.<sup>5</sup>

In this study 31 patients under cardiac operation mainly by cardiopulmonary bypass assessed for complications and their arterial lactate changes in first day after operation to finding about the lactate level changes during and after a major heart operation and make impression on importance of these measures.

### Method and Material

31 patients with congenital malformation selected for heart surgery including of 18 males and 13 females, selected for correcting operations in Madani heart center. Their physical characters like as height, weight, and types of their cardiac anomalies. Our exclusion criteria were defined as hyper metabolism conditions like diabetes, sepsis, active infection and preexisting metabolic diseases can be cleared by examination and laboratory results.

They divided to simple malformation including of atrial septal defect (ASD), ventricular septal defect (VSD), patent ductus arteriosus (PDA), and complex type of multiple major cardiac structural defects including of cyanotic or acyanotic defects.

Laboratory findings before operation and during operation were collected and their vital signs mean arterial blood pressure and central venous pressure were recorded.

Arterial lactate level was measured regularly in 3 samples at first minutes of operation or before bypassing, at first hour and second hours or the ending of operation in cases with shorter operation time these samples were taken from arterial line and these sampling were repeated four times at defined intervals after operation up to 24 hours (3<sup>rd</sup>, 6, 12, 24<sup>th</sup> hour), levels lower than 1.5 mmol/lit considered normal and values between 1.5 to 4 mmol/L was high and above 4 mmol/L was considered as very high .

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Anesthesia was started with 5 mg/kg of intramuscular ketamine. The intravenous anesthesia was performed with 1 mg/kg of ketamine, 1.5 micr/kg of fentanyl and 0.1 mg/kg of pancuronium. Patients lung were ventilated with oxygen, air and isoflurane and ventilation was adjusted to maintain normocarbica. The maintenance of the general anesthesia was achieved with an infusion of 5 micro/kg/h of fentanyl and isoflurane in 0% to 1% inspiratory concentration.

Noninvasive monitoring consisting of electrocardiogram, pulse oximetry and measurement of inspiratory and expiratory gas concentrations were used as well as invasive monitoring of central venous and arterial pressure was performed.

The operation was performed under low-flow hypothermic cardiopulmonary bypass (CPB), a median sternotomy was made and after systemic heparinization (activated coagulation time > 480s)

Data were collected through forms were filled out by physician the results have been drawn and expressed to percent and mean and relations between quantity material extracted by T-independent test and non quantity data processed to chi-square in SPSS software version 11.5. P value less than 0.01 was considered significantly.

## Results

31 patients entered to this study mean age (Minimum, Maximum) 5.74 years (0.7-25 years), with different forms of congenital heart malformations.

Arterial lactate level was high in 2 out of 31 in first sample in operation room before bypassing the increased level of lactate in our cases occurred in 25 out of 30 patients (14 cases in very high and other 11 cases were in high level group) in first hour sampling after operation and 25 cases (6 cases very high and 19 cases had high lactate level) in second hour or near the ending of operating (Figure 1).

These arterial lactate measures increment during operation were changed in pattern after operation and number of cases with abnormal lactate level decreased slowly at 3<sup>rd</sup>, 6<sup>th</sup>, 12<sup>th</sup> and 24<sup>th</sup> hour after operation (Figure 2).

Arterial lactate level changes were compared between simple and complex repaired surgery. In simple form 6 out of 8 cases (75%) had high and very high lactate level at the end of operation while in complex cardiac repair this rate was 19 out of 23 cases (83%) (Figure 3). After operation serum lactate level by arterial line were measured at 3<sup>rd</sup> hour post operation 2 out of 8 cases (25%) with simple repaired cardiac malformation had abnormal serum lactate levels while this ratio in group with simple cardiac malformation was not changed up to 24<sup>th</sup> hour as the end point of our observation but very high serum lactate level (more than 4 mmol/l) was not seen in this group while in complex repaired group at 3<sup>rd</sup> and 6<sup>th</sup> hours after operation 10 out of 23 cases (43%) with complex repaired malformation had high and very high serum lactate level at 12<sup>th</sup> hour 6 out of 23 (26%) and at the 24<sup>th</sup> hour 3 out of

23 cases (13%) had abnormal serum lactate level (Figure 4). One patient out of 31 patients had persistent high serum lactate levels over than 4 mmol/l up to 24<sup>th</sup> hour after operation who passed away.

Bypass time is prolonged in complex cardiac defect repair significantly ( $P=0.03$ )  $133\pm 47$  vs  $90\pm 34$  minutes, clamp time was not differed significantly ( $P=0.08$ ) between complex and simple repair  $83\pm 33$  vs  $56\pm 33$  minutes.

In patients with simple cardiac defects after operation most patient have normal lactate level in 6<sup>th</sup> hours after operation (6 out of 8) and there is not any case with very high lactate level after 6<sup>th</sup> hours after operation in simple form repaired malformation.

## Discussion

Lactate elevation mechanism as cardinal finding of sepsis and septic shock is different in sepsis it backs to hyper metabolism while in septic shock it is due to tissue hypoxia. Normal lactate level in normal unstressed patient is  $1\pm 0.5$  mmol / L<sup>4</sup> Lactic acidosis is common in critically ill patients can effect on outcome. Persistently elevated is attributed with poor out come. High blood lactate levels may happen in critically patients due to shock and sepsis because of many reasons such as increased catecholamine and glucose flux from hypoperfusion or hypoxia.<sup>1</sup>

In one study high initial level and elevated 24-hour lactate level was associated with mortality but this is not true for

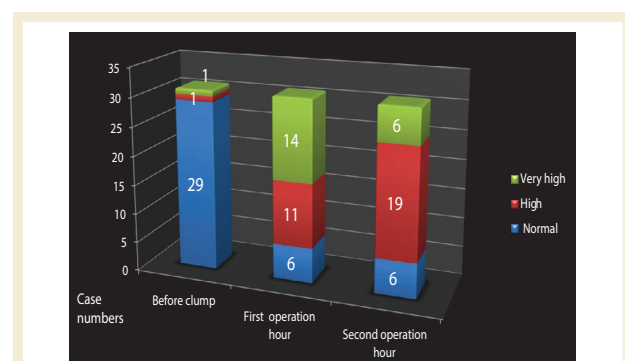


Figure 1. Arterial serum lactate level during cardiac operation.

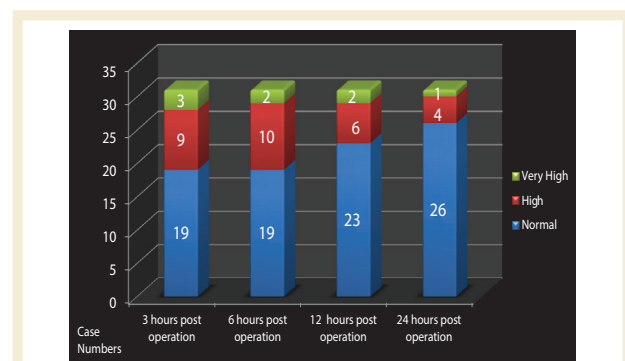
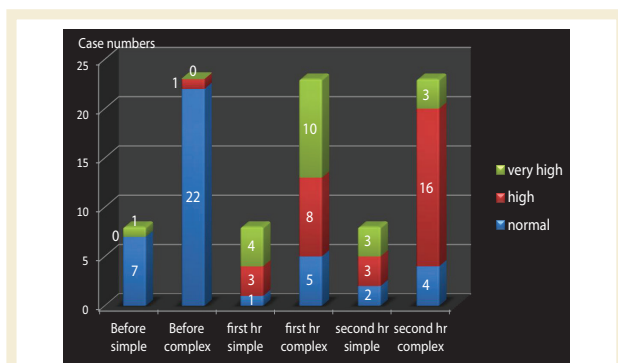
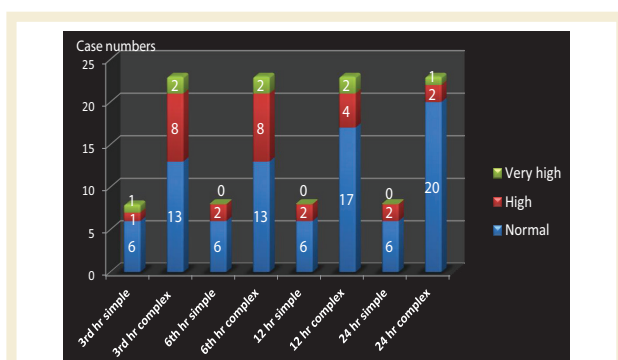


Figure 2. Arterial serum lactate levels at 3, 6, 12 and 24 hours after operation.



**Figure 3.** Arterial serum lactate level changes during operation in simple and complex cardiac malformations.



**Figure 4.** Arterial serum lactate level changes at 3<sup>rd</sup>, 6<sup>th</sup>, 12<sup>th</sup> and 24<sup>th</sup> after operation in both simple and complex cardiac malformations.

base excess level. Mortality in groups that have not been normalized in 24, 48 and 72 hr was 10%, 24% and 67% in another word, there is a good correlation between arterial and venous level and mixed venous blood as well as serially monitoring<sup>2,3</sup> in another study peak arterial quantity has prognostic value.<sup>6</sup> Lactate levels may prognostically decrease over time due to decreased production or increased clearance or both. Arterial lactate level depends on production and conversion in various organ and should be maintained below 2 mmol/L.<sup>5</sup> Lactate above 7.8 carried with prediction of mortality in 80%<sup>7</sup> in other study lactate in admission > 4.5 mmol was the best predictor of major adverse events.<sup>8</sup>

In our study arterial lactate level between 1.5 to 4 mmol/L was moderate and values above 4mmol/L considered as high. Arterial lactate level without regarding to operating time include of clamp time and bypass time usually

returns to normal at 12<sup>th</sup> hour after operation. Highly serial persistent arterial lactate level up to 24 hours was associated with mortality and prognosis during post operation period. Most patients had high arterial lactate level in mid operation but start to decrement in the end of operation and will be normalized in most up to 24 hours after operation. One patient with persistent high lactate level >4 mmol/L until 24 hours died, it means that high lactate level >4 mmol/L improve after operation in serial measurements if not increases mortality at 12<sup>th</sup> hour was associated with 50% mortality (1 out of 2), at 24<sup>th</sup> hours was associated with 100% mortality (1 out of 1).

In addition prolonged operation time that can be met in complex type repairing is associated with high incidence of prominent raised lactate level up to 12 hours post operation.

### Conclusion

In spite of persistent very high arterial lactate levels (above 4 mmol/L) up to 24 hours post operation is uncommon as low as one out of 31 cases but it is associated with high mortality rate. In fact it shows serial lactate measurement can be more predictable for our management efficacy.

**Ethical issues:** This study was reviewed and confirmed by the ethics committee of Tabriz University of Medical Sciences.

**Conflict of interests:** The authors declare no conflicts of interest.

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