Original Research Article

Serum lactate level as a potent biomarker in acute myocardial infarction

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ABSTRACT

A well-known metabolite that is released under stress conditions, lactate can be easily assessed as a diagnostic tool for patients under critical illness. The effect of elevated lactate level has been well studied but due to the lack of a standard cut-off value of this metabolite it has not been decided to be used as a biomarker for further care and hemodynamic management of patients suffering from Acute myocardial infarction or any other cardiogenic shock/stress condition. The mechanism(s) associated with disturbed lactate levels under hypothemic conditions ranges from various side effects of reduced temperatures to the hemodynamic effects of hypothermia (i.e., reduced need of vasopressor agents). The present article is focused on the estimation of plasma lactate level in AMI patients along with their cardiac Troponin-I levels to study the correlation between the two and to look into the possibility of dual marker approach to deal wit h complications associated with acute myocardial infarction. Serial measurement of serum lactate with proper time management is recommended for clinically reliability in acute cardiac patients.

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1. Introduction

Patients visiting the emergency departments across the world with various cardiological issues and related complaints ranges to millions but only few are recognized with acute myocardial infarction (AMI). Although several biomarkers and techniques have been evolved and discovered to deal with the issues of these patients yet the early diagnosis of AMI in the patients suffering from acute chest pain continues to be a problem till date. The informations collected from these patients based on their clinical history, baseline vital signs and initial electrocardiogram (ECG) readings prove to be unreliable as well as the rapid assays of AMI like creatine phosphokinase (CK), CK-MB subforms, troponin T, troponin I may /may not rise for almost six to twelve hours after presentation.[1–3] Under such conditions frequent detection of serum lactate with proper time management, could be a well established marker of inadequate systemic perfusion and tissue hypoxia because it represents up to 60% of cardiac oxid ative substrate. Lactate is the most important fuel of the heart under stress/ shock conditions.[4]

Since lactate is a widely produced metabolite in majority of the energy-related pathways, the source of Hyperlactatemia remains unclear even under critically ill conditions. Lactate levels tend to increase severely under stress condition leading to elevated metabolic rates, activation of sympathetic nervous systems, higher glycolysis and gluconeogenesis levels.[5] Elevated levels of serum lactate produced under aerobic condition during stress sometimes get cleared from the system[6] but most of the times it remains intact into the metabolic systems and leads to hyperlactatemia condition which somehow leads to adrenergic stimulations leading to a chain of further destructions involved in the emergency conditions of AMI.[7,8] Due to its easily detectable condition, lactate could serve as a potent biomarker under critical illnesses and septic shock in patients admitted to intensive care unit.[9–11] Various studies related to research on cardiological diseases have shown that in patients presented with AMI and cardiogenic shock lactate could serve as a potent marker if properly managed with time and frequency[12,13] because elevated blood lactate has been found to be associated with increased mortality in patients who remain unrecognized

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with acute decompensated heart failure. [14]

2. Materials and Methods

The present study was conducted in Department of Biochemistry, Dr. Ram Manohar Lohia Institute of Medical Sciences, Lucknow, Uttar Pradesh, India. Total 50 subjects diagnosed with acute myocardial infarction (AMI) were enrolled for this study. These patients were detected with their cardiac Troponin-I level > 0.200 n g/ml and other MI related symptoms as explained by the cardiologists. Samples collected from the patients was centrifuged at 3000 rpm and subjected to analyses using commercial kits. Cardiac Troponin–I and Lactatate levels were analyzed by chemiluminescence method on AU-480 Beckmann Coulter. All samples were treated in accordance with the Helsinki Declaration.

3. Results and Discussion

In table 1 of our study we found higher levels of Troponin-I and plasma lactate in both the men and women categories which were diagnosed with AMI, indicating that these markers are associated with the etiology of cardiovascular disorders.   Several studies related to cardiovascular disorders have proved that blood lactate plays a significant role in risk stratification in the patients who need intensive care under cardiogenic shock/stress, sepsis and other critical conditions that need immediate disease management and specifically in patients suffering of sepsis. [7,8,11]

Lazzeri and colleagues in 2010[13] have shown that early mortality in patients presented with STEMI was associated with an increased lactate. Gjesdal et al. in 2018 found that short-term mortality in patients with myocardial infarction blood lactate was a pre dictor and these patients had complicated conditions with heart failure but without cardiogenic shock. [15]

Observations in Tables 1 and 2 of the study indicate a significant correlation between Troponin I and plasma lactate levels in the patient group. As it is well known that Troponin-I is an indicator of myocardial infarction hence its positive correlation with plasma lactate shows that the later is also a clear indicator of CVD and AMI.

Table 1: Levels of Cardiac Troponin-I and Plasma Lactate in the AMI patients

	Male (n=30)	Female (n=20)	Mean ± SD
Age (yrs)	35-75	35-70	53.75 ± 14.1
Troponin-I (ng/ml)	0.264 – 173	0.31-82.3	21.15 ± 47.18
Plasma lactate (mg/dl)	20.0 – 102.4	24.2 – 72.1	46.64 ± 28.35

Schmiechen NJ et al., (1997) published an article in American Family Physician[16] where they showed that serum lactate level rises rapidly in AMI patients due to poor systemic perfusion and a course of cardiac ischemia. They propose that the level of lactate only may not be used as a decisive concept because it has been noticed that the serum lactate level increase in critical illnesses and stress conditions such as renal insufficiency, smoke inhalation, seizures and alcohol intoxication. However, the CK-MB and other in use markers along with the patients medical history and ECG findings could also be considered for the better management of AMI. At the same time serum lactate level can be used to " rule out " the possibilities of AMI as this test is quick, simple, inexpensive. [17]

Lactate level when goes undetected and deviates drastically from its normal level under stress conditions that includes increased metabolic rate, activation of the sympathetic nervous system, accelerated glycolysis level and bioenergetics supply is known as hyperlactetemia that could be a severe condition to unregulated and overlooked patients. [18,19] A study conducted by Chioléro et al in 2000, where they infused labeled lactate solution in healthy subjects and AMI patients, shows that 50% of this lactate was oxidized and 20% used for glucose synthesis, without any significant difference between the use of lactate by the metabolic system in these two subgroups. [20] All these studies strongly correlate with the concept that lactate is a source of energy under stress conditions but could be equally dangerous in critically ill patients if remains uncleared from their system and leads to the accumulation of this metabolite resulting into the exaggeration in their disease.   This observation suggests that under stress condition, lactate is the source of energy but needs to be properly managed in AMI patients as these patients suffers from oxygen insult during the disease which becomes even more life threatening due to the imbalance of pro-oxidants due to oxidative stress.

Table 2: Comparison of plasma lactate values between cases and controls

	Controls (n =30) Median (IQR)	Cases (n =30) Median (IQR)	p value
Plasma lactate (mg/dl)	14.4 (4.9)	34.4 (33.25)	< 0.001

** The Troponin I was correlated significantly with plasma lactate levels (r = 0.654; p <0.001 on Spearman's correlation).

Our findings in the study are in line with these observations, but due to limited number of subjects involved in the study we recommend the research to be more elaborate with more number of AMI patients to get a transparent picture of the critical conditions related to AMI condition.

4. Conclusion

Our study suggests that serum lactate levels along with cTn-I can be used as dual marker approach to identify the complications related to AMI. Though the measurement of serum lactate is reported to be more reliable in detecting the risks to acute myocardial infarction in CVD patients, elaborate investigations are required to identify the cut-off value of lactate for better clinical management of the AMI patients.

5. Source of funding

None.

6. Conflict of interest

None.

References

1. Khosravani H, Shahpori R, Stelfox HT, Kirkpatrick AW, Laupland KB. Occurrence and adverse effect on outcome of hyperlactatemia in the critically ill. *Crit Care*. 2009;13:90–90.
2. Cerovi O, Golubovi V, Spec-Marn A, Kremzar B, Vidmar G. Relationship between injury severity and lactate levels in severely injured patients. *Intensive Care Med*. 2003;29:1300–1305.
3. Nguyen HB, Rivers EP, Knoblich BP, Jacobsen G, Muzzin A, et al. Early lactate clearance is associated with improved outcome in severe sepsis and septic shock. *Crit Care Med*. 2004;32:1637–1642.
4. Garcia-Alvarez M, Marik P, Bellomo R. Stress hyperlactataemia: present understanding and controversy. *Lancet Diabetes Endocrinol*. 2014;2:339–347.
5. Beadle RM, Frenneaux M. Modification of myocardial substrate utilisation: a new therapeutic paradigm in cardiovascular disease. *Heart*. 2010;96:824–830.
6. Attan P, Lazzeri C, Picariello C, Dini CS, Gensini GF, Valente S. Lactate and lactate clearance in acute cardiac care patients. *Eur Heart J Acute Cardiovasc Care*. 2012;1:115–121.
7. Shapiro NI, Howell MD, Talmor D, Nathanson LA, Lisbon A, et al. Serum lactate as a predictor of mortality in emergency department patients with infection. *Ann Emerg Med*. 2005;45(5):524–528.
8. Rimachi R, Carvahlo BD, Orellano-Jimenez F, Cotton F, Vincent JL, D DB. Lactate/pyruvate ratio as a marker of tissue hypoxia in circulatory and septic shock. *Anaesth Intensive Care*. 2012;40(3):427–432.
9. Jansen TC, Bommel JV, Bakker J. Blood lactate monitoring in critically ill patients: a systematic health technology assessment. *Crit Care Med*. 2009;37(10):2827–2839.
10. Khosravani H, Shahpori R, Stelfox HT, Kirkpatrick AW, Laupland KB. Occurrence and adverse effect on outcome of hyperlactatemia in the critically ill. *Critical Care*. 2009;13(3):90–90.
11. Musikatavorn K, Thepnimitra S, Komindr A, Puttaphaisan P, Rojanasarntikul D. Venous lactate in predicting the need for intensive care unit and mortality among nonelderly sepsis patients with stable hemodynamic. *Am J Emerg Med*. 2015;33(7):925–930.
12. Attan P, Lazzeri C, Chiostri M, Picariello C, Gensini GF, Valente S. Lactate clearance in cardiogenic shock following ST elevation myocardial infarction: A pilot study. *Acute Card Care*. 2012;14(1):20–26.
13. Lazzeri C, Valente S, Chiostri M, Picariello C, Gensini GF. Lactate in the acute phase of ST-elevation myocardial infarction treated with mechanical revascularization: a single-center experience. *Am J Emerg Med*. 2012;30(1):92–96.
14. Kawase T, Toyofuku M, Higashihara T, Okubo Y, Takahashi L, Kagawa Y. Validation of lactate level as a predictor of early mortality in acute decompensated heart failure patients who entered intensive care unit. *J Cardiol*. 2015;65(2):164–170.
15. Gjesdal O, Braun JG, Smith F, Schersten P, Tyden. Blood lactate is a predictor of short-term mortality in patients with myocardial infarction complicated by heart failure but without cardiogenic shock. *BMC Cardiovascular Disorders*. 2018;18:8–8.
16. Schmiechen NJ. ED use of rapid lactate to evaluate patients with acute chest pain. *Ann Emerg Med*. 1997;30:571–577.
17. Sadovsky R. Serum Lactate as a Marker of Acute Myocardial Infarction. *Am Fam Physician*. 1998;57(8):1993–1994.
18. Daniel AM, Taylor ME, Kapadia B, Maclean LD. Metabolism of prolonged shock. *Adv Shock Res*. 1993;9:19–30.
19. Revelly JP, Tappy L, Martinez A, Bollmann M, Cayeux MC, et al. Lactate and glucose metabolism in severe sepsis and cardiogenic shock. *Crit Care Med*. 2005;33:2235–2240.
20. Chiolro RL, Revelly JP, Leverve X, Gersbach P, Cayeux MC, et al. Effects of cardiogenic shock on lactate and glucose metabolism after heart surgery. *Crit Care Med*. 2000;28:3784–3791.

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