A Prospective Study to Evaluate the Correlation of Serum Lactate and Serum Albumin as a Predictor of Outcome in ICU Patients Regarding Mortality and Length of ICU Stay

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ABSTRACT

Background: The critical condition of patients admitted to the ICU is vulnerable to oxidative stresses caused by reactive oxygen species which result in injuries to cells and tissues and activating extracellular antioxidant defense network consecutively. Many variables measured in critically ill patients have been used to estimate severity of disease, prognosis, cost of treatment, monitoring the response to treatment and tailoring treatment regimen and in identifying high risk patients.

Materials & Methods: A hospital based prospective type of observational cohort study done on 30 ICU patients in department of Medicine, Government Medical College, Barmer, Rajasthan, India. 3samples in the first 24 h of ICU admission in form of: 2 ml of venous blood was sent for analysis of serum lactate, serum albumin on ICU admission to all cases (sample 1) then a sample after 12 h (sample 2) then after 24 h (sample 3), with correlation with the patients' clinical condition and progression of the case.

Results: Our study showed that comparison of mean value of age, APACHE II Score & Glasgow coma scale (GCS) was statistical significant (p<0.05** each respectively) in between survivors and non-survivors group. But gender wise distribution was statistical non-significant (p>0.05). The comparison of mean value of serum albumin level, serum lactate and serum lactate albumin ratio at admission (sample 1), after 12 hours (sample 2) and after 24 hours (sample 3) was statistical significant in survivors and non-survivors group. The mean value of hospital stay was 4.065±1.436 in survivors and 6.263±1.881 in non-survivors, which was statistical significant (P<0.05**).

Conclusion: We conclude based on our observations that increased lactate levels and lactate/albumin ratio usually reflect poorer prognosis. Further studies can help in providing cut-off values for risk stratification and to familiarize the physicians with these parameters.

Keywords: ICU, Serum Lactate, Serum Albumin, Serum Lactate/Albumin Ratio, Survivors, Non-Survivors.

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INTRODUCTION

Intensive care units cater to patients with severe or life-threatening illnesses and injuries, which require constant care, close supervision from life support equipment and medication in order to ensure normal bodily functions.

Severe exacerbations requiring hospitalizations are responsible for a large share of these costs and among these, treatment cost for those who require intensive care unit (ICU) admission is highest. It is important to identify patients at the time of admission who are likely to have poor outcome, so that such patients can be managed aggressively. Many prognostic scoring systems have been devised for the same purpose. These scoring systems help to segregate patients who are the sickest and are likely to die from those who are expected to have better outcome and survive. Most of these scoring systems have been devised for a broad range of

critically ill patients.[1] However, predicting the prognosis of critically ill patients whose condition fluctuates every other moments is challenging. Recently developed assessments based on physiologic variables have limitations due to requiring many variables which are not collected for all patients admitted to ICU.[2] Their usefulness in identifying critically ill patients at higher risk of death has led to the adoption of lactate measurement in most blood gas analyzers and the frequent measurement of lactate in the critically ill. However, it is unknown whether a higher blood lactate concentration within the current reference range (relative hyperlactataemia) might also be associated with increased hospital mortality. This knowledge would be clinically important because the currently used upper reference limit for lactatemia may fail to identify many patients who are at higher risk of death.[3]

The critical condition of patients admitted to the ICU is vulnerable to oxidative stresses caused by reactive oxygen species which result in injuries to cells and tissues and activating extracellular antioxidant defense network consecutively.[4,5] Therefore, serum albumin as an indicator of the disease severity and the mortality is suggested and studied in adult patients[6,7] and it has been found that the decrease in serum albumin concentration significantly raises the mortality.[8]

The finding of hyperlactatemia in patients with normal tissue perfusion and oxygen delivery additionally suggests that an overstimulation of the Na+ -K+ -ATPase leads to an increased lactate production in septic patients similar to hypokalemia.[9,10] It has been shown that activation of the skeletal muscle Na+ -K+ -ATPase pump is a relevant factor in lactate production, as it has been observed that lactate is released from muscular tissue in septic shock patients. Several studies[11-13] have proven that lactate levels are a reliable parameter in diagnosis, therapy evaluation, and prognosis in circulatory shock. Multiple conditions resulting in inadequate oxygen delivery, disproportionate oxygen demand and diminished oxygen use may lead to elevated lactate levels. Consequently, the early identification and rapid treatment of these patients with hyperlactatemia is widely acknowledged as a vital step toward improving survival.

MATERIALS & METHODS

A hospital based prospective type of observational cohort study done on 30 ICU patients in department of Medicine, Government Medical College, Barmer, Rajasthan, India.

Inclusion Criteria

- Critically ill patient more than 18 years of both sex admitted to ICU
- Patient& attender who will give valid written informed consent.

Exclusion Criteria

- Patient younger than 18 year
- Alcoholics or in Hepatic failure
- Systemic disease such as malignancy, epilepsy and acute renal failure
- Trauma patient
- Sepsis & surgical patient
- The use of any of these therapeutic interventions such as epinephrine, metformin, isoniazide, zidovudine cyanide, valproic acid.

Serum Lactate, Serum Albumin

3samples in the first 24 h of ICU admission in form of: 2 ml of venous blood was sent for analysis of serum lactate, serum albumin on ICU admission to all cases (sample 1) then a sample after 12 h (sample 2) then after 24 h (sample 3), with correlation with the patients' clinical condition and progression of the case.

The sample was centrifuged within 2 h and sent for lactate analysis, hemolyzed samples were repeated.

The normal reference values for lactate are traditionally considered 1 ±0.5 mmol/L in normal patients and<2 mmol/L in critically ill patients.[14] Acute physiology and chronic health evaluation (APACHEII score)[15] as well as Glasgow coma score were calculated and recorded for all patients.

Need for Mechanical Ventilation: All the patients with decompensated ABGs that matched the indication of mechanical ventilation from the start or did not respond to conservative treatment were intubated and connected to the ventilator. Ventilator settings were tailored according to the clinical condition and the cause of respiratory failure. Follow up parameters

- Length of stay in ICU.
- Outcome whether death or discharge for improvement.

Statistical Analysis: Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Science) version 16. Correlations between quantitative variables were done using Spearman correlation coefficient. P-values less than 0.05 were considered as statistically significant.

RESULTS

Our study showed that comparison of mean value of age, APACHE II Score & Glasgow coma scale (GCS) was statistically significant (p<0.05** each respectively) in between survivors and non-survivors' group. But gender wise distribution was statistical non-significant (p>0.05). (Table 1) The comparison of mean value of serum albumin level, serum lactate and serum lactate albumin ratio at admission (sample 1), after 12 hours (sample 2) and after 24 hours (sample 3) was statistical significant in survivors and non-survivors group. Mean serum lactate & serum lactate albumin ratio was significantly lower in the survivors' group and serum albumin ratio was higher in survivor's group at admission, after 12 hours and after 24 hours. (Table 2)

Our study showed that the mean value of hospital stay was 4.065±1.436 in survivors and 6.263±1.881 in non-survivors, which was statistical significant (P<0.05**). (Table 3)

Table 1: The comparison of various parameters in survivors and non-survivors group

Parameters	Survivors (N=19)	Non-Survivors (N=11)	p-value
Age (yrs)			
Mean±SD	59.56±10.31	65.76±9.312	<0.05**
Gender			
Male	13 (68.42%)	6 (54.54%)	>0.05
Female	6 (31.58%)	5 (45.46%)	
APACHE II Score			
Mean±SD	13.48±3.512	22.38±5.012	<0.05**
Glasgow coma scale (GCS)			
Mean±SD	14.73±0.6129	11.27±2.012	<0.05**

Table 2: Comparison between survivors and non survivors regarding serum lactate, serum albumin and lactate albumin ratio in sample 1, sample 2 & sample 3

Biochemical analysis	Sample -1			Sample-2			Sample-3		
	Survivors	Non-survivors	p-value	Survivors	Non-survivors	p-value	Survivors	Non-survivors	p-value
Serum lactate	2.97±0.81	5.31±0.75	<0.05**	2.76±0.74	4.93±1.22	<0.05**	2.49±0.70	4.35±1.99	<0.05**
Serum albumin	4.22±0.82	2.79±0.60	<0.05**	4.29±0.77	2.83±0.89	<0.05**	4.37±0.75	2.62±1.23	<0.05**
Serum lactate/albumin ratio	0.76±0.37	1.88±0.51	<0.05**	0.69±0.30	1.70±0.55	<0.05**	0.60±0.28	1.46±0.73	<0.05**

Table 3: Comparison between survivors and non survivors regarding duration of hospital stay

Hospital stay (days)	Survivors (N=19)	Non-Survivors (N=11)	p-value
Mean±SD	4.063±1.422	6.279±1.871	<0.05**

DISCUSSION

The critical condition of patients admitted to the ICU is vulnerable to oxidative stresses caused by reactive oxygen species which result in injuries to cells and tissues and activating extracellular antioxidant defense network consecutively.[4,5] In today's clinical practice, lactate levels are usually used to detect tissue hypoxia; however, increased lactate levels reflect more than just this aspect. Albumin levels also reflect the severity of inflammation as albumin is a negative acute phase protein.

Alaa Shalaby et al.,[16] founded mean age of 62.18 ±10.94, there were 21 (63.6%) males and 12 (36.4%) females and Wan-Ling Chen et al.,[17] founded mean age was 69.2 years, which was correspondence with our results.

The comparison of mean value of APACHE score& GCS score was statistical significance (P<0.05**, P<0.05**).A study done by Alaa Shalaby et al[16] APACHE II score was higher in non survivors but did not reach statistical significance. GSC was significantly lower in non survivors.

The comparison of mean value of serum albumin level, serum lactate and serum lactate albumin ratio at admission (sample 1), after 12 hours (sample 2) and after 24 hours (sample 3) was statistical significant in survivors and non-survivors group. Mean serum lactate & serum lactate albumin ratio was significantly lower in the survivors' group and serum albumin ratio was higher in survivor's group at admission, after 12 hours and after 24 hours.

Domínguez de Villota E et al[18] found that mean serum albumin was 2.88 /+- 0.74 g/100 mg. Survivors had a mean serum albumin (3.18 /+- 0.60) higher than non-survivors (2.35 /+- 0.68 g/100 ml) (p < 0.05).

Nichol AD et al[19] concluded in critically ill patients, relative hyperlactataemia is independently associated with increased hospital mortality. Blood lactate concentrations > 0.75 mmol.L-1 can be used by clinicians to identify patients at higher risk of death. The current reference range for lactate in the critically ill may need to be re-assessed. Jat et al[20] enrolled 30 patients with septic shock and serum lactate was withdrawn on admission, at 12 h and after 24 h of admission. In agreement with our results the three different lactate levels were significantly higher among non survivors as compared to survivors.

Michael Lichtenauer et al[21] found that the lactate/albumin ratio was elevated in non-survivors (p < 0.001). Patients with an increased lactate/albumin ratio were of similar age, but clinically in a poorer condition and had more pronounced laboratory signs of multi-organ failure.

Our study showed that the mean value of hospital stay was 4.065±1.436 in survivors and 6.263±1.881 in non-survivors, which was statistical significant (P<0.0001).

H. Gunen et al[22] found in-hospital mortality was significantly associated with lower arterial oxygen tension (Pa,O2), higher carbon dioxide arterial tension, lower arterial oxygen saturation and longer hospital stay. The overall 6-month mortality rate was 24%, with 1, 2and 3yr mortality rates of 33%, 39% and 49%, respectively.

CONCLUSION

We conclude based on our observations that increased lactate levels and lactate/albumin ratio usually reflect poorer prognosis. Further studies can help in providing cut-off values for risk stratification and to familiarize the physicians with these parameters.

REFERENCES

1. GC Khilnani, Amit Banga and SK Sharma. Predictors of mortality of patients with acute respiratory failure secondary to chronic obstructive pulmonary disease admitted to an intensive care unit: A one-year study. BMC Pulmonary Medicine 2004;4:12.
2. Straney L, Clements A, Parslow RC, Pearson G, Shann F, Alexander J, et al. Paediatric index of mortality 3: an updated model for predicting mortality in pediatric intensive care. Pediatr Crit Care Med 2013;14:673-81.
3. Alistair D Nichol, MoritokiEgi, Ville Pettila, Rinaldo Bellomo, Craig French, Graeme Hart, Andrew Davies, Edward Stachowski, Michael C Reade, Michael Bailey and David James Cooper. Relative hyperlactatemia and hospital mortality in critically ill patients: a retrospective multi-centre Study. Critical Care 2010;14:R25.
4. Sitar ME, Aydin S, Cakatay U. Human serum albumin and its relation with oxidative stress. Clin Lab 2013;59:945-52.
5. Abiles J, de la Cruz AP, Castano J, Rodriguez-Elvira M, Aguayo E, Moreno-Torres R, et al. Oxidative stress is increased in critically ill patients according to antioxidant vitamins intake, independent of severity: a cohort study. Crit Care 2006;10:R146.

6. Barchel D, Almoznino-Sarafian D, Shteinshnaider M, Tzur I, Cohen N, Gorelik O. Clinical characteristics and prognostic significance of serum albumin changes in an internal medicine ward. Eur J Intern Med 2013;24:772-8.

7. Jellinge ME, Henriksen DP, Hallas P, Brabrand M. Hypoalbuminemia is a strong predictor of 30-day allcause mortality in acutely admitted medical patients: a prospective, observational, cohort study. PLoS One 2014;9:e105983.

8. Nagumo K, Tanaka M, Chuang VT, Setoyama H, Watanabe H, Yamada N, et al. Cys34-cysteinylated human serum albumin is a sensitive plasma marker in oxidative stress-related chronic diseases. PLoS One 2014;9:e85216.

9. James, J.H.; Luchette, F.A.; McCarter, F.D.; Fischer, J.E. Lactate is an unreliable indicator of tissue hypoxia in injury or sepsis. Lancet 1999;354: 505–8.

10. McCarter, F.D.; Nierman, S.R.; James, J.H.; Wang, L.; King, J.K.; Friend, L.A.; Fischer, J.E. Role of skeletal muscle Na+ -K+ ATPase activity in increased lactate production in sub-acute sepsis. Life Sci. 2002;70:1875–88.

11. Peretz, D.I.; Scott, H.M.; Duff, J.; Dossetor, J.B.; MacLean, L.D.; McGregor, M. The significance of lacticacidemia in the shock syndrome. Ann. NY Acad. Sci. 1965;119:1133–41.

12. Weil, M.H.; Afifi, A.A. Experimental and clinical studies on lactate and pyruvate as indicators of the severity of acute circulatory failure (shock). Circulation 1970;41:989–01.

13. Mikkelsen, M.E.; Miltiades, A.N.; Gaieski, D.F.; Goyal, M.; Fuchs, B.D.; Shah, C.V.; Bellamy, S.L.; Christie, J.D. Serum lactate is associated with mortality in severe sepsis independent of organ failure and shock. Crit. Care Med. 2009;37:1670–77.

14. B.A. Mizock, Lactic acidosis, Dis. Mon. 1989;35(4):233–300.

15. W.A. Knaus, D.P. Wagner, E.A. Draper, J.E. Zimmerman, M. Bergner, et al, The APACHE III prognostic system. Risk prediction of hospital mortality for critically ill hospitalized adults, Chest 1991;100:1619–36.

16. Alaa Shalaby, Osama Khalafallah, Mohamed Galal, Hebatallah Hany Assal, Nermeen Ahmed. Correlation between serum lactate and other oxygenation indices as a predictor of outcome in respiratory ICU patients. Egyptian Journal of Chest Diseases and Tuberculosis.2016;65:695–700.

17. Wan-Ling Chen, Wei-Ting Lin, Shu-Chen Kung, Chih-Cheng Lai and Chien-Ming Chao. The Value of Oxygenation Saturation Index in Predicting the Outcomes of Patients with Acute Respiratory Distress Syndrome. J. Clin. Med. 2018;7:205.

18. Dominguez de Villota, E.; Mosquera, J.M.; Rubio, J.J.; Galdos, P.; DiezBalda, V.; de la Serna, J.L.; Tomas, M.I. Association of a low serum albumin with infection and increased mortality in critically ill patients. Intensive Care Med. 1980;7:19–22.

19. Nichol AD, Egi M, Pettila V, Bellomo R, French C, Hart G, et al. Relative hyperlactatemia and hospital mortality in critically ill patients: a retrospective multi-centre study. Crit Care.2010;14:R25.

20. K.R. Jat, U. Jhamb, V. Gupta, Serum lactate levels as the predictor of outcome in pediatric septic shock, Indian J. Crit. Care Med. 2011;15:102–7.

21. Michael Lichtenauer, BernhardWernly, Bernhard Ohnewein, Marcus Franz, Bjoern Kabisch and Johanna Muessig et al. The Lactate/Albumin Ratio: A Valuable Tool for Risk Stratification in Septic Patients Admitted to ICU. Int. J. Mol. Sci. 2017;18:1893.

22. H. Gunen, S.S. Hacievliyagil, F. Kosar, L.C. Mutlu, G. Gulbas, E. Pehlivan I. Sahin and O. Kizkin. Factors affecting survival of hospitalized patients with COPD. Eur Respir J 2005;26:234–41.