

ASSOCIATION OF SERUM LACTATE IN PATIENTS WITH SEPSIS IN A TERTIARY CARE CENTRE

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Abstract

Background: Sepsis is a severe condition characterised by organ dysfunction resulting from an uncontrolled host response to infection. Serum lactate levels are valuable in predicting the prognosis of critically ill patients. Elevated blood lactate levels and delayed clearance have been associated with increased mortality in sepsis. The present study aimed to study the association of mean serum lactate level with sepsis in patients admitted to the ICU department of SBMCH, Chennai. **Materials and Methods:** A descriptive cross-sectional study was conducted at a tertiary care centre among the patient with sepsis presenting to the ICU department of SBMCH, Chennai, for 18 months. History taking and detailed examination were done. Blood was sent for serum lactate, and other parameters as proforma were sent. All patients' APACHE II and SOFA scores were calculated and correlated with mean serum lactate. **Results:** Male predominance was observed in 68 (63%), and the maximum number of patients was reported in the age group of 25 to 50 with a mean age of 48.87±3.21 years. A total of 24 (22%) patients required ventilation. The association between mean serum lactate level and patient mortality was statistically significant (p<0.05). There was a significant increase in patient mortality with an increase in mean serum lactate level. The association between mean serum lactate level with Apache II and the SOFA scoring system was also statistically significant (p<0.05). **Conclusion:** The present study concludes that increased serum lactate levels were significantly associated with increased SOFA, APACHE II scores and mortality.

INTRODUCTION

Sepsis is characterised as a life-threatening condition resulting from a disturbed host response to infection, often leading to acute circulatory failure associated with the infection.^[1] The in-hospital mortality rate for sepsis patients can exceed 10%. In 2017, there were approximately 48.9 million global sepsis cases with a mortality rate of 19.7%.^[2] Early detection and timely treatment are essential to prevent fatalities associated with sepsis. A new definition of septic shock, incorporating serum lactate levels, has been proposed to enhance sepsis care.^[1]

Serum lactate levels are a valuable predictor of sepsis mortality and should be measured within the first hour of presentation.^[3-4] For sepsis patients with a serum lactate level of ≥4mmol/L, rapid crystalloid therapy is recommended.⁴ Repeated measurements are advised if the initial serum lactate level is ≥2mmol/L. While serum lactate is not a direct

indicator of tissue perfusion, several randomised controlled trials have demonstrated a 23% reduction in mortality with lactate-guided resuscitation compared to no lactate monitoring.^[5] Furthermore, serum lactate levels are associated with tissue hypoxia, aerobic glycolysis, and liver or renal failure, which are closely linked to sepsis severity, septic shock, and mortality.^[6-7]

Sepsis and its consequences are a menace in countries like India. Early diagnosis and treatment help to reduce morbidity and mortality. Monitoring lactate levels may aid clinicians in understanding tissue perfusion and detecting unrecognised shock, and necessary interventions can be done on time. In addition to serum lactate levels, the acute physiology and chronic health evaluation II score, also known as APACHE II, and the Sepsis-related organ failure assessment, also known as SOFA, are also reported to assess the severity of organ dysfunction and failure in sepsis patients.^[8-9]

Aim and Objectives

The study was conducted to study the association of serum lactate in patients with sepsis. Further, this study also assessed the serum lactate association with APACHE II and SOFA scoring systems for critically ill patients.

MATERIALS AND METHODS

The cross-sectional study was performed on 108 patients admitted to the ICU at SBMCH, Chennai, for 18 months. The written consent and ethical committee approval were taken before the start of the study.

Inclusion Criteria

All patients older than 18 who present with suspected or proven sepsis or severe sepsis were included.

Exclusion Criteria

The patients discharged against medical advice, unwilling to consent or die of the patient within 24 hours of admission. Suppose two or more systemic inflammatory response syndrome criteria are not present. In addition, patients who did not fulfil the criteria for severe sepsis and if an infection was not suspected in patients were excluded.

Methodology

Patients were screened initially for evidence of severe sepsis and excluded if two or more systemic inflammatory response syndrome criteria were absent, infection was not suspected, and criteria for severe sepsis were not met. Selected patients' serum lactate and other necessary samples were taken, and based on this, SOFA and APACHE II scores were calculated on admission and repeated when required.^[8-9] Patient's outcomes and duration of hospital stay were noted and followed up.

Septic shock was defined as severe sepsis and hypotension refractory to adequate fluid resuscitation. APACHE II (Acute Physiology and Chronic Health Evaluation II): A severity of disease classification system with a final score of 0 to 71, with higher scores corresponding to more severe disease and a higher risk of death. SOFA SCORE: Sequential organ failure assessment score is based on six scores, one each for the respiratory, cardiovascular, hepatic, coagulation, renal and

neurological systems. It is used to track a person's status during the stay in an intensive care unit (ICU) to determine the extent of a person's organ function or rate of failure.

Statistical Analysis

Data collected were entered in Microsoft Excel and analysed using SPSS Version 24. Qualitative variables were expressed in percentage and proportion. Quantitative variables were expressed in Mean and standard deviation. The significance of a difference between two quantitative variables was calculated using the Chi-square test, and a p-value of less than 0.05 was considered significant.

RESULTS

Male predominance was observed in 68 (63%), and the maximum number of patients was reported in the age group of 25 to 50 with a mean age of 48.87 ± 3.21 years. A total of 24 (22%) patients required ventilation, and 38 (35%) mortality was reported. At 0 to 3 hours mean serum level of more than 4 mg/dL showed 32 patients' death, whereas ≤ 4 mg/dl mean serum level was observed with six patients' death. During the 24 hours, the mean serum level of more than 4 mg/dl showed 20 patients' death, whereas ≤ 4 mg/dl mean serum level was observed with 18 patients' death. Whereas at 48 hours mean serum level of more than 4 mg/dl showed 18 patients' death, whereas ≤ 4 mg/dl mean serum level was observed with 20 patients' death (Table 1).

The association between mean serum lactate level and patient mortality was statistically significant ($p < 0.05$). There was a significant increase in patient mortality with an increase in mean serum lactate level. The association between mean serum lactate level with Apache II and the SOFA scoring system was also statistically significant ($p < 0.05$). The mean serum lactate level of more than 4 mg/dl was observed with a maximum (28) mean Apache II score. In comparison, a mean serum lactate level of more than 4 mg/dl was observed with a maximum (3) SOFA score. The mean serum lactate level of more than four was observed with significantly ($p < 0.05$) the highest duration of hospital stay (11.2 days) (Table 2).

Table 1: Observation demographic and other evaluation parameters of patients

Parameters	Observations Frequency (%)
Gender	
Female	40 (37%)
Male	68 (63%)
Age group (years)	
<25	4 (3.7%)
25 to 50	86 (79%)
>50 years	18 (17%)
Age (years) (mean \pm SD)	48.87 ± 3.21
Ventilation	
Yes	24 (22%)
No	86 (78%)
Outcome	
Survived	70 (65%)
Not survived	38 (35%)
Serum lactate levels mg/dl	

(0- 3 hours)	
> 4.0	12 (32%)
≤4.0	58 (6%)
Serum lactate levels mg/dl (24 hours)	
> 4.0	7 (20%)
≤4.0	63 (18%)
Serum lactate levels mg/dl (48 hours)	
> 4.0	2 (18%)
≤4.0	68 (20%)

Table 2: Observation of correlation of mean serum lactate with outcome, mean APACHE II, SOFA score and duration of hospital stay

Mean Serum lactate levels	Outcome		P-value
	Survived (mean± SD)	Not-survived (mean± SD)	
<2	0.9 ±0.16	1.9 ±0.28	0.01
2 to 4	2.6± 0.19	3.7 ±0.32	0.01
>4	4.1 ±0.43	4.6 ±0.46	0.01
Mean Apache II score			
<2	12		0.01
2 to 4	18		
>4	28		
SOFA Score			
<2	1.2		0.01
2 to 4	2.2		
>4	3		
Duration of hospital stay			
<2	5.6		0.001
2 to 4	7.8		
>4	11.2		

DISCUSSION

Sepsis is a major problem in the emergency department since it has high morbidity and mortality. Male predominance was observed in 68 (63%), and the maximum patients were reported in the age group of 25 to 50 years with a mean age of 48.87±3.21 years. These findings in the present study follow the earlier reported study.^[10] At 0 to 3 hours, a mean serum level of more than 4 mg/dl showed 32 patients' death, whereas ≤4 md/dl mean serum level was observed with six patients' death. During the 24 hours, the mean serum level of more than 4 mg/dl showed 20 patients' death, whereas ≤4 md/dl mean serum level was observed with 18 patients' death. Whereas at 48 hours mean serum level of more than 4 mg/dl showed 18 patients' death, whereas ≤4 md/dl mean serum level was observed with 20 patients' death. The mean serum lactate level at 0-3 hours correlated well with the outcome, whereas it showed a similar outcome at other time points (24 and 48 hours). These findings in our study are confirmed by previous studies where it was reported that early serum lactate level showed a better correlation with mortality.^[11]

The association between mean serum lactate level and patient mortality was statistically significant ($p<0.05$). There was a significant increase in patient mortality with an increase in mean serum lactate level. Studies have identified a substantial correlation between mortality in our group and a lactate cut-off range of 4 mmol/L, distinguishing between sepsis and severe sepsis. In a multi-centre prospective study,

Arnold et al. discovered that lactate non-clearance was an independent predictor of death in 166 patients with severe sepsis (odds ratio, 4.9 [confidence interval, 1.5-15.9]).^[12] The study concluded that there was a significant risk of death if lactate was not removed during resuscitation.

The association between mean serum lactate level with Apache II and the SOFA scoring system was also statistically significant ($p<0.05$). The mean serum lactate level of more than 4 mg/dl was observed with a maximum (28) mean Apache II score. In comparison, a mean serum lactate level of more than 4 mg/dl was observed with a maximum (3) SOFA score. Rudd et al. also reported similar findings in their investigation, where a significant correlation of serum lactate with SOFA score was observed.^[2] Alsar et al. reported a significant correlation between serum lactate and APACHE II score.^[13] The study showed that the fatal outcome following major torso trauma was principally associated with the APACHE II score and lactate. The specificity and sensitivity of this logistic regression model were 94.6 and 79.2%, respectively. The mean serum lactate level of more than four was observed with significantly ($p<0.05$) the highest duration of hospital stay (11.2 days). Previous studies have repeatedly shown that higher than-normal serum lactate is linked to higher hospital and intensive care unit mortality.^[14] These findings have influenced management plans based on blood lactate levels, with recommendations for early assessment and certain studies showing the clinical benefit of a serum lactate-targeted strategy.

Limitations

Understanding a single lactate measurement presents challenges due to blood lactate levels being influenced by various factors. Patients with sepsis and hepatic dysfunction might show elevated lactate levels, even if stress is similar to those without liver issues. Lactate elevation can stem from factors beyond hypoxia, like muscle activity or metabolic changes. Serial lactate readings hold greater prognostic value than isolated measurements.

CONCLUSION

The study concludes that increased serum lactate levels were significantly associated with increased SOFA and APACHE II scores, suggesting increased disease severity. Improvement in serial lactate levels was associated with better outcomes. The higher serum lactate level was directly proportional to increased hospital stay duration and mortality. Hence serial serum lactate levels can be used to monitor the patient's prognosis and response to treatment.

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REFERENCES

1. Shankar-Hari M, Phillips GS, Levy ML, Seymour CW, Liu VX, Deutschman CS, et al. Developing a new definition and assessing new clinical criteria for septic shock: For the third international consensus definitions for sepsis and septic shock (sepsis-3). *JAMA* 2016;315:775. <https://doi.org/10.1001/jama.2016.0289>
2. Rudd KE, Johnson SC, Agesa KM, Shackelford KA, Tsoi D, Kievlan DR, et al. Global, regional, and national sepsis incidence and mortality, 1990–2017: analysis for the Global Burden of Disease Study. *Lancet* 2020;395:200–11. [https://doi.org/10.1016/s0140-6736\(19\)32989-7](https://doi.org/10.1016/s0140-6736(19)32989-7)
3. Thomas-Rueddel DO, Poidinger B, Weiss M, Bach F, Dey K, Häberle H, et al. Hyperlactatemia is an independent predictor of mortality and denotes distinct subtypes of severe sepsis and septic shock. *J Crit Care* 2015;30:439.e1-439.e6. <https://doi.org/10.1016/j.jcrc.2014.10.027>
4. Levy MM, Evans LE, Rhodes A. The Surviving Sepsis Campaign Bundle: 2018 update. *Intensive Care Med* 2018;44:925–8. <https://doi.org/10.1007/s00134-018-5085-0>
5. Rhodes A, Evans LE, Alhazzani W, Levy MM, Antonelli M, Ferrer R, et al. Surviving sepsis campaign: International guidelines for management of sepsis and septic shock: 2016. *Intensive Care Med* 2017;43:304–77. <https://doi.org/10.1007/s00134-017-4683-6>
6. Lee SM, An WS. New clinical criteria for septic shock: serum lactate level as new emerging vital sign. *J Thorac Dis* 2016;8:1388–90. <https://doi.org/10.21037/jtd.2016.05.55>
7. Shapiro NI, Fisher C, Donnino M, Cataldo L, Tang A, Trzeciak S, et al. The feasibility and accuracy of point-of-care lactate measurement in emergency department patients with suspected infection. *J Emerg Med* 2010;39:89–94. <https://doi.org/10.1016/j.jemermed.2009.07.021>
8. Vincent JL, Moreno R, Takala J, Willatts S, De Mendonça A, Bruining H, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure: On behalf of the Working Group on Sepsis-Related Problems of the European Society of Intensive Care Medicine (see contributors to the project in the appendix). *Intensive Care Med* 1996;22:707–10. <https://doi.org/10.1007/bf01709751>
9. Wang B-W, Mok K-T, Chang H-T, Liu S-I, Chou N-H, Tsai C-C, et al. APACHE II score: A useful tool for risk assessment and an aid to decision-making in emergency operation for bleeding gastric ulcer. *J Am Coll Surg* 1998;187:287–94. [https://doi.org/10.1016/s1072-7515\(98\)00158-6](https://doi.org/10.1016/s1072-7515(98)00158-6)
10. Asati AK, Gupta R, Behera D. To determine blood lactate levels in patients with sepsis admitted to a respiratory intensive care unit and to correlate with their hospital outcomes. *Int J Crit Care Emerg Med* 2018; 4:045. <https://doi.org/10.23937/2474-3674/1510045>
11. Chen H, Zhao C, Wei Y, Jin J. Early lactate measurement is associated with better outcomes in septic patients with an elevated serum lactate level. *Crit Care*. 2019;23:351. <https://doi.org/10.1186/s13054-019-2625-0>
12. Arnold RC, Shapiro NI, Jones AE, Schorr C, Pope J, Casner E, et al. Multicenter study of early lactate clearance as a determinant of survival in patients with presumed sepsis. *Shock* 2009;32:35–9. <https://doi.org/10.1097/shk.0b013e3181971d47>
13. Aslar AK, Kuzu MA, Elhan AH, Tanik A, Hengirmen S. Admission lactate level and the APACHE II score are the most useful predictors of prognosis following torso trauma. *Injury* 2004;35:746–52. <https://doi.org/10.1016/j.injury.2003.09.030>
14. Mikkelsen ME, Miltiades AN, Gaieski DF, Goyal M, Fuchs BD, Shah CV, et al. Serum lactate is associated with mortality in severe sepsis independent of organ failure and shock. *Crit Care Med* 2009;37:1670–7. <https://doi.org/10.1097/ccm.0b013e318197fc68>