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Interpretation of Lactate–Albumin Ratio, Lactate and Its Clearance in Predicting Clinical Outcomes in Patients with Sepsis and Septic Shock: An Observational Study.

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Abstract

Background: Sepsis and septic shock are associated with substantial mortality, making early prognostic assessment essential. The LAR (Lactate–Albumin Ratio) has emerged as a potential prognostic marker. This study aimed to compare the predictive value of LAR, serum lactate levels, and lactate clearance for mortality in patients with sepsis and septic shock. ***Methods:*** This observational study was conducted in the Medical Intensive Care Unit of Dr. Moopen's Medical College, Wayanad, and included 100 patients diagnosed with sepsis according to Sepsis-3 criteria. Serum lactate levels were measured at admission, 6 hours, and 12 hours, while serum albumin was measured at admission. LAR, lactate clearance at 6 and 12 hours, and the qSOFA (quick Sequential Organ Failure Assessment) score were evaluated. Statistical analyses included comparative analysis and ROC (Receiver Operating Characteristic) curve analysis to assess prognostic performance. ***Results:*** Among the 100 patients, 60% were male, and the median age was 66 years. The 28-day mortality rate was 38%. Respiratory infections were the predominant source of sepsis (64%), followed by skin and soft tissue infections (23%). The area under the ROC curve (AUC) for LAR was 0.6014, while qSOFA demonstrated an AUC of 0.6452. Lactate clearance showed better predictive performance, with an AUC of 0.7050 at 6 hours and 0.7932 at 12 hours. The findings indicated that serial lactate measurements and lactate clearance were valuable prognostic indicators. No statistically significant associations were observed between mortality and common comorbidities. ***Conclusion:*** Serum lactate and its clearance are useful prognostic indicators in patients with sepsis and septic shock. Although LAR demonstrated predictive potential comparable to qSOFA, it did not provide substantial additional prognostic benefit over lactate alone. Serial lactate monitoring, particularly at 12 hours, may improve risk stratification. Larger multicentre studies are required to validate these findings and establish optimal cut-off values.

Keywords: Sepsis, Septic Shock, Lactate, Albumin, Lactate–Albumin Ratio, Lactate Clearance, Mortality, Prognosis, qSOFA.

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INTRODUCTION

Sepsis is a major global health concern associated with substantial morbidity and mortality among critically ill patients. It is defined as life-threatening organ dysfunction caused by a dysregulated host response to infection.[1,2] In 2017, an estimated 48.9 million cases and 11 million sepsis-related deaths occurred worldwide, accounting for approximately 20% of all deaths.[3] In the United States, sepsis affects nearly 1.7 million people and causes approximately 270,000 deaths annually.[4] Early identification of high-risk patients and timely intervention are essential to improve outcomes.[5,6]

Serum lactate is an established prognostic biomarker in sepsis, reflecting tissue hypoperfusion and cellular dysfunction.[7] Inadequate oxygen delivery promotes anaerobic glycolysis and lactate accumulation, although hyperlactatemia may also arise through non-hypoxic mechanisms.[8,9] Elevated lactate levels are associated with increased mortality,[10] while serial measurements help assess treatment response. The Surviving Sepsis Campaign recommends repeat lactate measurement to guide resuscitation in patients with elevated lactate levels.[11] Serum albumin, a negative acute-phase protein, reflects systemic inflammation and disease severity. Hypoalbuminemia has been associated with infection severity and increased mortality in patients with sepsis.[12,13] Combining lactate and albumin as the lactate/albumin ratio may improve prognostic assessment by incorporating metabolic dysfunction and inflammatory status. Preliminary studies have demonstrated its potential association with mortality, although evidence in adult sepsis populations remains limited.[14,15]

The qSOFA (quick Sequential Organ Failure Assessment) score is a bedside tool used to identify patients with suspected infection who are at increased risk of poor outcomes. It incorporates altered mentation, systolic blood pressure ≤100 mmHg, and respiratory rate ≥22/min.[2,16]

Aims and Objectives

The present study aims to compare, correlate, and validate the lactate–albumin ratio, serum lactate levels, and lactate clearance at admission, 6 hours, and 12 hours for predicting in-hospital mortality among patients with sepsis and septic shock admitted to the ICU (Intensive Care Unit). The primary objective was to correlate and compare the lactate–albumin ratio with 6-hour lactate clearance as the reference standard for predicting in-hospital mortality. The secondary objectives were to assess the correlation between the lactate–albumin ratio and the qSOFA score and to determine the optimal cutoff value of the lactate–albumin ratio for predicting in-hospital mortality in patients with sepsis and septic shock.

MATERIALS AND METHODS

Study Design

The present study was designed as an analytical observational study conducted in the Medical Intensive Care Unit of the Department of General Medicine at Dr. Moopen's Medical College, Wayanad. The study was carried out over a period of 18 months.

Inclusion and Exclusion Criteria

The study included patients aged above 18 years, irrespective of gender, who were diagnosed with sepsis according to the Sepsis-3 criteria and admitted to the Medical Intensive Care Unit. Informed consent was obtained from the legally authorized representative of each participant before enrolment. Patients with a history of chronic metformin use for the treatment of type 2 diabetes mellitus were excluded from the study.

Sample Size Calculation

Based on the mean and standard deviation of lactate albumin ratio (0.09 ± 0.03, 0.31 ± 0.46) from a previous study by Lichtenauer et al. (2017), and with 95% confidence interval and 90% power, the minimum sample size was calculated to be 46 per group. The total sample size was rounded up to 100.

Data Collection Procedure

After obtaining written informed consent from the legally authorized representative of each patient, baseline demographic and clinical data were collected using a pre-structured proforma. The qSOFA score was recorded at the time of admission to the MICU (Medical Intensive Care Unit). Arterial blood samples (2 mL) were collected in heparinized syringes at three time points: at admission, 6 hours after admission, and 12 hours after admission. Blood lactate levels were measured at all three time points using an arterial blood gas analyzer, while serum albumin levels were measured at admission to calculate the lactate–albumin ratio. Additional clinical and laboratory parameters, including age, gender, GCS (Glasgow Coma Scale), and arterial blood gas parameters such as pH and bicarbonate (HCO_3^-), were recorded. Lactate clearance was calculated at 6 and 12 hours using the formula: [(initial lactate level − lactate level at the respective time point) / initial lactate level] × 100%. All enrolled patients were followed up until discharge from the MICU or death, whichever occurred earlier, and in-hospital mortality was documented as the primary outcome.

Statistical Analysis

Statistical analysis was performed using Epi Info version 7.2 and Python, utilizing the pandas, scikit-learn, plotnine, seaborn, lifelines, and matplotlib libraries. Quantitative variables were expressed as mean and standard deviation, while qualitative variables were presented as frequencies and percentages. The chi-square test was used to compare categorical variables, and the t-test was employed to compare continuous variables. Correlation analysis was performed to assess the relationships between the study variables. Univariate and multivariate logistic regression analyses were conducted to identify factors associated with in-hospital mortality. ROC curve analysis was performed to assess the predictive performance of the study parameters and determine optimal cutoff values for predicting mortality. Survival analysis was carried out using Kaplan–Meier survival curves, and differences in survival were assessed using the log-rank test. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table 1. Demographic Profile of the Study Population

Characteristic	Result
Total sample	100 patients
Male	60 (60%)
Female	40 (40%)
Age	Median: 66 years

Table 1 illustrates the demographic characteristics of the 100 enrolled patients. Males constituted 60% of the study population, females 40%, and the reported median age was 66 years.

Table 2. Clinical Profile and Source of Infection

Variable	Result reported in thesis
qSOFA score	Range 1–3; median 2
qSOFA score of 2	68%
Primary source: respiratory	64%
Primary source: genitourinary	20%
Skin and soft-tissue infection	23% reported in abstract
Mean ICU stay	4.7 ± 3.3 days
GCS distribution	Majority had scores between 10 and 15; exact counts not stated

Table 2 summarizes clinical severity and infection source. Most patients had a qSOFA score of 2, respiratory infection was the most frequently reported source, and the mean ICU stay was 4.7 days.

Table 3. Comorbidities in the Study Population

Comorbidity/History	Reported Prevalence
Any previous comorbidity	73%
Hypertension	52%
Coronary artery disease (CAD)	43%
Diabetes mellitus	42% derived from alive/expired counts in Table 6
Hypertension + diabetes + CAD together	18 patients

Table 3 illustrates the burden of pre-existing illness. Nearly three-quarters of the cohort had at least one comorbidity; hypertension and CAD were the most frequently reported individual conditions.

Table 4. Comparison of Survivors and Non-Survivors

Variable	Alive (mean ± SD)	Expired (mean ± SD)
Age (in years)	62.17 ± 16.59	65.31 ± 10.12
6-hour lactate clearance	22.45 ± 67.30	−9.91 ± 67.16
12-hour lactate clearance	31.75 ± 148.09	−35.7 ± 120.48
Lactate/albumin ratio	2.12 ± 1.33	2.57 ± 1.43

Table 4 compares selected characteristics between survivors and patients who died. Survivors had positive mean lactate clearance at both 6 and 12 hours, while non-survivors had negative mean clearance. The mean lactate/albumin ratio was higher among non-survivors.

Table 5. Association between Mortality and Clinical Factors

Factor	Alive	Expired	Odds ratio (95% CI)	p value
Gender: Male	37	23	1.03 (0.45–2.36)	1.00
Gender: Female	25	15	—	—
Hypertension: present	34	18	0.74 (0.32–1.67)	0.60
Hypertension: absent	28	20	—	—
Diabetes: present	25	17	1.91 (0.52–2.71)	0.82
Diabetes: absent	37	21	—	—
CAD: present	26	17	1.12 (0.49–2.53)	0.94
CAD: absent	36	21	—	—

Table 5 presents the reported associations between mortality and gender, hypertension, diabetes mellitus, and CAD. The thesis states that none of these clinical factors had a statistically significant association with mortality (all p values >0.05).

Table 6. Diagnostic Performance of Prognostic Markers

Marker	Sensitivity (95% CI)	Specificity (95% CI)	PPV (95% CI)	NPV (95% CI)
6-hour lactate clearance	0.63 (0.54–0.71)	0.58 (0.47–0.68)	0.67 (0.62–0.71)	0.70 (0.66–0.74)
12-hour lactate clearance	0.72 (0.64–0.69)	0.58 (0.46–0.53)	0.69 (0.64–0.73)	0.77 (0.72–0.82)
Lactate/albumin ratio	0.54 (0.45–0.62)	0.57 (0.48–0.65)	0.58 (0.56–0.60)	0.68 (0.65–0.70)

Table 6 compares sensitivity, specificity, positive predictive value, and negative predictive value for the three markers. The reported NPV was highest for 12-hour lactate clearance (0.77), while the lactate/albumin ratio had lower sensitivity and PPV.

Table 7. ROC Analysis and Optimal Cut-Offs

Marker	AUC Reported	Optimal Cut-off Reported	Youden J / p Value Reported
6-hour lactate clearance	0.7050(approximately 0.70)	36.94 (unit/cut-off definition unclear)	0.69
12-hour lactate clearance	0.7932(approximately 0.79)	42.0 in ROC text; 42.8 in survival text	0.75; survival p <0.005
Lactate/albumin ratio	0.6014(approximately 0.60)	2.0	p = 0.03 in survival comparison
qSOFA score	0.6452(approximately 0.64)	2.0	0.62

Table 7 summarizes discrimination by ROC analysis. Twelve-hour lactate clearance had the highest reported AUC, followed by 6-hour clearance. The AUC for lactate/albumin ratio was approximately 0.60, comparable to qSOFA (approximately 0.64).

DISCUSSION

Lactate/Albumin Ratio Compared with Lactate Clearance

The results indicated that lactate clearance had better discriminatory performance than LAR. The ROC analysis showed an area under the curve (AUC) of 0.7050 for 6-hour lactate clearance and 0.7932 for 12-hour lactate clearance. These values indicate that both measurements had prognostic value in this cohort, with the 12-hour measurement showing the higher AUC.

This finding is consistent with the work of Nguyen H. B. et al.,[17] who reported that greater lactate clearance during the first 6 hours of resuscitation was associated with lower mortality in patients with severe sepsis and septic shock. Puskarich M. A. et al.[18] likewise emphasized the value of serial lactate monitoring and the relationship between lactate clearance and improved survival. Taken together, these studies and the present findings support the use of lactate clearance as a dynamic indicator of response to treatment, rather than relying exclusively on a single baseline value.

In the present study, the 12-hour lactate clearance AUC (0.7932) was higher than the 6-hour AUC (0.7050), suggesting better discrimination at 12 hours in this sample. This is in keeping with the discussion by Huang et al.,[19] who suggested that a longer observation period can provide a more complete picture of a patient's response to treatment. Serial measurements may capture delayed improvement or persistent hyperlactatemia that is not apparent during the first few hours. Similarly, Marty P. et al.[20] reported better associations with mortality for 12- and 24-hour static lactate measurements and for H0–H12 and H0–H24 lactate clearance.

Lactate Clearance Cut-offs

The cut-off reported in the present study was 36 for 6-hour lactate clearance and 42 for 12-hour lactate clearance. The discussion in the source document also notes that many previous studies have used a lactate reduction of more than 10% from baseline as a favourable threshold, together with achievement of an absolute lactate concentration below 2 mmol/L by 6 hours. Nguyen et al.[17] and Puskarich et al.[18] are cited in support of the importance of early lactate clearance. Huang et al.[19] reported that a decrease of more than 20% over 12 hours was associated with reduced mortality in critically ill patients; the absolute lactate target of 2 mmol/L at 12 hours is also discussed in the source. In comparison, Lee et al.[21] reported a 6-hour lactate concentration of ≥3.5 mmol/L and 6-hour lactate clearance of <24.4% as optimal cut-offs for predicting 30-day mortality. The present study found a statistically significant relationship between lactate clearance and outcome at both 6 and 12 hours.

Prognostic Performance and Cut-off of the Lactate/Albumin Ratio

In the present study, the reported LAR cut-off was 2.0 this is higher than the values reported by Wang B. et al.[22] (1.735). The high LAR cut-off in the present cohort may be related to the inclusion of patients with severe sepsis, a greater inflammatory burden, pre-existing comorbidities, and lower baseline albumin concentrations. These are plausible explanations, although they were not independently established by the present analysis. In the present study, LAR showed prognostic potential but did not provide a substantial advantage over lactate alone. The AUC for LAR was reported as 0.6014, while qSOFA had an AUC of 0.6452. Thus, LAR had a predictive value broadly comparable to qSOFA in this cohort, although its discriminatory performance was modest.

Lactate, LAR, and qSOFA: Interpretation of the Present Findings

The present study supports the continuing role of lactate measurement in the assessment of patients with sepsis. Initial lactate provides an early indication of physiological disturbance, while subsequent measurements help assess the direction of change after treatment. The finding that lactate clearance at both 6 and 12 hours was associated with outcome is

consistent with previous research emphasizing the prognostic value of serial lactate measurements.[23,24] The present study found that LAR and qSOFA both had prognostic value, with AUCs of 0.6014 and 0.6452, respectively. LAR may therefore be considered a supplementary marker rather than a replacement for clinical assessment or lactate clearance. Since qSOFA is a bedside score and LAR is derived from laboratory measurements, the two may provide different types of information. However, the present study does not establish that combining the two improves prediction beyond either measure alone; this would require a formal analysis of combined model performance.

Limitations

First, the sample size was limited to 100 patients, which may reduce the precision of estimates and limit generalizability. Second, it was conducted at a single centre, and the findings may not be directly applicable to institutions with different patient populations, referral patterns, or treatment resources. Third, the timing of measurements in relation to the onset of sepsis may have varied, potentially affecting lactate and LAR values.

CONCLUSION

In conclusion, our study highlights the prognostic value of the LAR in sepsis, demonstrating performance comparable to qSOFA, while reaffirming the importance of 6-hour and 12-hour lactate measurements as reliable predictors of sepsis outcomes. The higher mortality observed in our study emphasizes the heterogeneity of sepsis and the need for context-specific management strategies, particularly in resource-limited settings. Further research is essential to validate LAR across diverse clinical settings and explore its integration with established clinical scores to facilitate early risk stratification, guide clinical decision-making, and improve outcomes in patients with sepsis.

REFERENCES

1. Singer M, Deutschman CS, Seymour CW, et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). JAMA 2016;315(8):801-10.
2. Seymour CW, Liu VX, Iwashyna TJ, et al. Assessment of Clinical Criteria for Sepsis: For the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). JAMA 2016;315(8):762-74.
3. Rudd KE, Johnson SC, Agesa KM, et al. Global, regional, and national sepsis incidence and mortality, 1990-2017: analysis for the Global Burden of Disease Study. Lancet 2020;395(10219):200-11.
4. Rhee C, Dantes R, Epstein L, et al. Incidence and Trends of Sepsis in US Hospitals Using Clinical vs Claims Data, 2009-2014. JAMA 2017;318(13):1241-9.
5. Kumar A, Roberts D, Wood KE, et al. Duration of hypotension before initiation of effective antimicrobial therapy is the critical determinant of survival in human septic shock. Crit Care Med 2006;34(6):1589-96.
6. Vincent JL, Moreno R, Takala J, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. Intensive Care Med 1996;22(7):707-10.
7. Bakker J, Gris P, Coffernils M, et al. Serial blood lactate levels can predict the development of multiple organ failure following septic shock. Am J Surg 1996;171(2):221-6.
8. Kraut JA, Madias NE. Lactic acidosis. N Engl J Med 2014;371(24):2309-19.
9. James JH, Luchette FA, McCarter FD, et al. Lactate is an unreliable indicator of tissue hypoxia in injury or sepsis. Lancet 1999;354(9177):505-8.
10. Nichol AD, Egi M, Pettila V, et al. Relative hyperlactatemia and hospital mortality in critically ill patients: a retrospective multi-centre study. Crit Care 2010;14(1):R25.
11. Levy MM, Evans LE, Rhodes A. The surviving sepsis campaign bundle: 2018 update. Intensive Care Med 2018;44(6):925-8.
12. Vincent JL, Dubois MJ, Navickis RJ, et al. Hypoalbuminemia in acute illness: is there a rationale for intervention? A meta-analysis of cohort studies and controlled trials. Ann Surg 2003;237(3):319-34.
13. Artero A, Zaragoza R, Camarena JJ, et al. Prognostic factors of mortality in patients with community-acquired bloodstream infection with severe sepsis and septic shock. J Crit Care 2010;25(2):276-81.
14. Shin J, Hwang SY, Jo IJ, et al. Prognostic value of the lactate/albumin ratio for predicting 28-day mortality in critically ill sepsis patients. Shock 2018;50(5):545-50.
15. Wang B, Chen G, Cao Y, et al. Correlation of lactate/albumin ratio level to organ failure and mortality in severe sepsis and septic shock. J Crit Care 2015;30(2):271-275.
16. Bone RC, Balk RA, Cerra FB, et al. Definitions for sepsis and organ failure and guidelines for the use of innovative therapies in sepsis. The ACCP/SCCM Consensus Conference Committee. American College of Chest Physicians/Society of Critical Care Medicine Chest 1992;101(6):1644-55.
17. Nguyen HB, Loomba M, Yang JJ, et al. Early lactate clearance is associated with biomarkers of inflammation, coagulation, apoptosis, organ dysfunction and mortality in severe sepsis and septic shock. J Inflamm 2010;7:6.
18. Puskarich MA, Trzeciak S, Shapiro NI, et al. Prognostic value and agreement of achieving lactate clearance or central venous oxygen saturation goals during early sepsis resuscitation. Acad Emerg Med 2012;19(3):252-8.

19. Huang DT, Angus DC, Barnato A, et al. Harmonizing international trials of early goal-directed resuscitation for severe sepsis and septic shock: methodology of ProCESS, ARISE, and ProMISe. Intensive Care Med 2013;39(10):1760-75.
20. Marty P, Roquilly A, Vallée F, et al. Lactate clearance for death prediction in severe sepsis or septic shock patients during the first 24 hours in Intensive Care Unit: an observational study. Ann Intensive Care 2013;3(1):3.
21. Lee SG, Song J, Park DW, et al. Prognostic value of lactate levels and lactate clearance in sepsis and septic shock with initial hyperlactatemia: a retrospective cohort study according to the Sepsis-3 definitions. Medicine (Baltimore) 2021;100(7):e24835.
22. Wong HR, Cvijanovich NZ, Anas N, et al. Developing a clinically feasible personalized medicine approach to pediatric septic shock. Am J Respir Crit Care Med 2015;191(3):309-15.
23. Levy B. Lactate and shock state: the metabolic view. Curr Opin Crit Care 2006;12(4):315-21.
24. Mikkelsen ME, Miltiades AN, Gaieski DF, et al. Serum lactate is associated with mortality in severe sepsis independent of organ failure and shock. Crit Care Med 2009;37(5):1670-7.