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ASSESSMENT OF THE EFFICACY OF THE SERUM LACTATE/ALBUMIN RATIO COMPARED TO LACTATE ALONE OR ALBUMIN ALONE AS A PROGNOSTIC MARKER OF SEPSIS SYNDROME

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ABSTRACT

BACKGROUND

Sepsis remains a major cause of morbidity and mortality in critically ill patients. Early identification of high-risk patients is crucial to improving outcomes. While serum lactate and albumin are widely used markers, their combined lactate/albumin (L/A) ratio may better reflect metabolic stress, tissue hypoxia, and inflammatory status. This study aimed to evaluate the prognostic significance of the L/A ratio compared to lactate or albumin alone and to assess its predictive accuracy for sepsis-related outcomes.

MATERIALS AND METHODS

A retrospective observational study was conducted in the Department of Critical Care Medicine over a period of six months, and included 200 adult patients who were admitted with sepsis (as per SEPSIS-3 criteria). Demographic data, biochemical parameters, and outcomes were recorded. Statistical analysis was performed using SPSS version 27. ROC curves were used to assess predictive accuracy, and correlations were analyzed using Pearson's coefficient. A p-value of < 0.05 was considered statistically significant.

RESULTS

The mean age of participants was 61 ± 14 years; 60.5% were males. Mortality occurred in 61.8% of patients. Mean serum lactate ($p = 0.006$), L/A ratio ($p = 0.004$), and procalcitonin ($p = 0.002$) were significantly higher among non-survivors. The L/A ratio was also significantly associated with a shorter hospital stay (< 14 days; $p = 0.034$). The ROC curve for the L/A ratio showed an AUC = 0.642 (95% CI: 0.562–0.717, $p = 0.0014$), indicating moderate discriminatory ability for mortality prediction. The ratio correlated negatively with platelet count ($r = –0.208$, $p = 0.011$) and positively with SGPT ($r = 0.200$, $p = 0.016$).

CONCLUSION
The serum lactate/albumin ratio serves as a simple, cost-effective prognostic marker for sepsis, demonstrating moderate predictive accuracy for mortality and a shorter hospital stay. It might complement or substitute more complex scoring systems.

KEYWORDS Sepsis, Lactate/Albumin Ratio, Prognostic Marker, Mortality, Critical Care.

INTRODUCTION

Sepsis is a life-threatening condition characterized by a dysregulated host response to infection that leading to organ dysfunction and high mortality worldwide.[1] Early recognition and risk stratification are essential for improving outcomes in septic patients.[2] Among biochemical markers, serum lactate is widely recognized as a predictor of mortality since elevated lactate levels reflect tissue hypoperfusion, hypoxia, or impaired clearance.[3] However, lactate alone may not fully capture the complex pathophysiology of sepsis.

Serum albumin, a negative acute-phase protein, decreases during sepsis due to capillary leakage, hepatic dysfunction, and inflammation.[4] Hypoalbuminemia has been associated with poor outcomes and increased mortality in critically ill patients.[5] Combining these two parameters, the serum lactate/albumin (L/A) ratio has recently been proposed as a composite marker that may better represent the balance between metabolic stress and systemic inflammation.[6]

Several studies have demonstrated that the L/A ratio shows superior prognostic performance compared to lactate or albumin alone. Bou Chebl et al. (2020) reported that the L/A ratio had a higher predictive accuracy for in-hospital mortality in septic patients than lactate alone (AUC = 0.65 vs 0.60; $p < 0.0001$).[7] Similarly, a meta-analysis by Zhao et al. (2023) found that an increased L/A ratios was independently associated with mortality in sepsis (OR = 2.16; 95% CI 1.58–2.95).[8]

The Sequential Organ Failure Assessment (SOFA) score is the current standard for assessing the severity of the sepsis and predicting mortality.[9] Although widely used, it requires multiple laboratory parameters that may not be readily available in all clinical settings.[10] Therefore, this study aimed to evaluate the efficacy of the serum L/A ratio compared to lactate, albumin, as prognostic indicators in sepsis, hypothesizing that the L/A ratio could provide a simple yet reliable predictor of patient outcomes.

AIMS AND OBJECTIVES

The present study aimed to evaluate the prognostic significance of the serum lactate/albumin (L/A) ratio in patients with varying severities of sepsis and to compare its predictive accuracy. It sought to determine whether the L/A ratio, as a simple and readily available biomarker, could effectively reflect disease severity and predict important clinical outcomes in sepsis. Specifically, the study evaluated the relationship between the L/A ratio and outcomes such as the need for ventilator support, vasopressor requirement, length of hospital stay, and mortality.

MATERIALS AND METHODS

Study Design

This retrospective study was conducted among patients who were admitted to the Intensive Care Unit (ICU) for the management of sepsis. A total of 200 patients were included in the study through a purposive sampling technique. The study was carried out over a period of six months and involved the review and analysis of the medical records of eligible patients who met the diagnostic criteria for sepsis.

Inclusion and Exclusion Criteria

The study included patients aged above 18 years who were admitted to the Intensive Care Unit (ICU) with a diagnosis of sepsis as defined by the Sepsis-3 criteria. Patients meeting these criteria

and who had provided informed consent were eligible for inclusion. Exclusion criteria comprised individuals younger than 18 years, as well as those with pre-existing chronic conditions that could have independently altered lactate or albumin levels, including cirrhosis of the liver, chronic kidney disease, renal failure, and nephrotic syndrome. Additionally, patients who did not provide consent to participate in the study were excluded. This careful selection ensured that the study population accurately represented critically ill sepsis patients without confounding comorbidities that might have affected the prognostic evaluation of the lactate/albumin ratio.

Sample Size Calculation

The sample size was determined to compare the prognostic accuracy (AUC) of the serum lactate/albumin (L/A) ratio (AUC = 0.976) with that of lactate alone (AUC = 0.887), based on the findings by Kinkar et al. (2023).[11] Using a significance level of 5%, a power of 80%, and an expected in-hospital mortality rate of 40%, the minimum required sample size was calculated to be 142 patients. To enhance statistical power, enable subgroup analyses, and account for potential dropouts or incomplete data, the final sample size was set at 200 patients.

Data Collection Procedure

Data for the study were collected retrospectively from the medical records of patients who were admitted to the Intensive Care Unit (ICU) with a diagnosis of sepsis, as defined by the Sepsis-3 criteria. Relevant demographic, clinical, and laboratory information were extracted, including age, gender, comorbidities, vital parameters, and results of routine investigations that were performed at the time of ICU admission. Serum lactate and albumin levels were recorded from the first blood samples that were collected upon admission, and the lactate/albumin (L/A) ratio was calculated accordingly. Patient outcomes, such as the need for ventilator support, vasopressor use, duration of ICU and hospital stay, and in-hospital mortality, were documented. All data were entered into a structured data collection form, and patient confidentiality was maintained throughout the study. The collected data were then be analyzed to compare the prognostic efficacy of the L/A ratio with lactate alone, albumin alone, in predicting outcomes among patients with sepsis.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using SPSS version 22. Categorical variables were expressed as frequencies and percentages, and continuous variables as mean ± SD. Independent t-tests were used to assess differences between quantitative variables, and Pearson correlation was applied for correlations. ROC curves was used to evaluate the prognostic value of the lactate/albumin ratio and were compared with lactate and albumin alone, with optimal cut-offs used to calculate sensitivity, specificity, and predictive values. An AUC >0.8 indicated good predictive ability. Graphs were generated using Excel and Word, and a p-value <0.05 was considered statistically significant.

RESULTS

		N	%
Age Group	<30 yrs	7	4.5%
	31-50 yrs	27	17.2%
	51-70 yrs	73	46.5%
	71-90 yrs	45	28.7%
	>90 yrs	5	3.2%
Gender	Female	62	39.5%
	Male	95	60.5%
System Involved	CNS	33	21.0%
	RS	71	45.2%

	CVS	48	30.6%
	Liver	42	26.8%
	Renal	72	45.9%
Comorbidities	Absent	24	15.3%
	Present	133	84.7%
Length of Stay	<14 days	134	85.4%
	>14 days	23	14.6%
Outcome	Discharge	60	38.2%
	Death	97	61.8%

Table 1: Descriptive analysis for baseline qualitative characteristics

In our study most patients are 51-70 years (46.5%), followed by 71-90 years (28.7%). Few are <30 (4.5%) or >90 (3.2%). 60.5% male, 39.5% female. Renal (45.9%) and respiratory (45.2%) systems are most affected, followed by cardiovascular (30.6%), liver (26.8%), and CNS (21.0%). 84.7% of the subjects had comorbidities and 15.3% do not. 85.4% of the subjects had hospital stay <14 days and 14.6% stayed >14 days. 61.8% of subjects died and 38.2% were discharged.

	Discharge		**Death**		**P Value**
	Mean	**SD**	**Mean**	**SD**	
Hb	10.6	2.9	10.8	3.2	0.719
TLC	18697	19008	17728	37630	0.855
PLT	2.23	1.40	2.09	1.47	0.543
Bilirubin	1.91	3.67	4.01	7.68	0.057
SGOT	164.6	626.7	219.0	771.1	0.660
SGPT	69	192	122	338	0.288
ALP	139	72	146	145	0.733
Urea	76	53	76	57	0.980
Creatinine	4.51	14.00	2.14	1.46	0.107
Sodium	134	7	133	15	0.404
Potassium	4.88	3.81	4.66	1.24	0.602
RBS	160	119	185	150	0.244

Table 2: Comparison of various parameter according to outcome

All the parameters in above table did not had statistically significant difference with respect to outcome.

	Discharge		**Death**		**P value**
	Mean	**SD**	**Mean**	**SD**	
Lactate	2.67	2.50	4.01	3.47	0.006
Albumin	2.9	.7	2.9	.7	0.948
Lactate/albumin	0.9184	0.810	1.48	1.57	0.004
Procalcitonin	12.66	19.05	26.66	37.66	0.002

Table 3: Comparison of Lactate, Albumin, Lactate/albumin, Procalcitonin according to outcome

Elevated lactate, lactate/albumin ratio, and procalcitonin levels are significantly associated with mortality ($p < 0.05$), while albumin levels show no significant difference between discharged and deceased patients.

	<14 days		>14 days		P value
	Mean	SD	Mean	SD	
Lactate/albumin ratio	1.36	1.43	0.711	0.58	0.034

Table 4: Comparison of Lactate/albumin ratio according to length of stay

The mean lactate/albumin ratio is significantly higher in patients with a shorter LOS (<14 days, mean = 1.36) compared to those with a longer LOS (>14 days, mean = 0.711), with a p-value of 0.034 indicating statistical significance ($p < 0.05$). The higher ratio in the <14 days group suggests that elevated lactate/albumin levels are associated with shorter hospital stays, which may reflect worse clinical outcomes, such as early mortality.

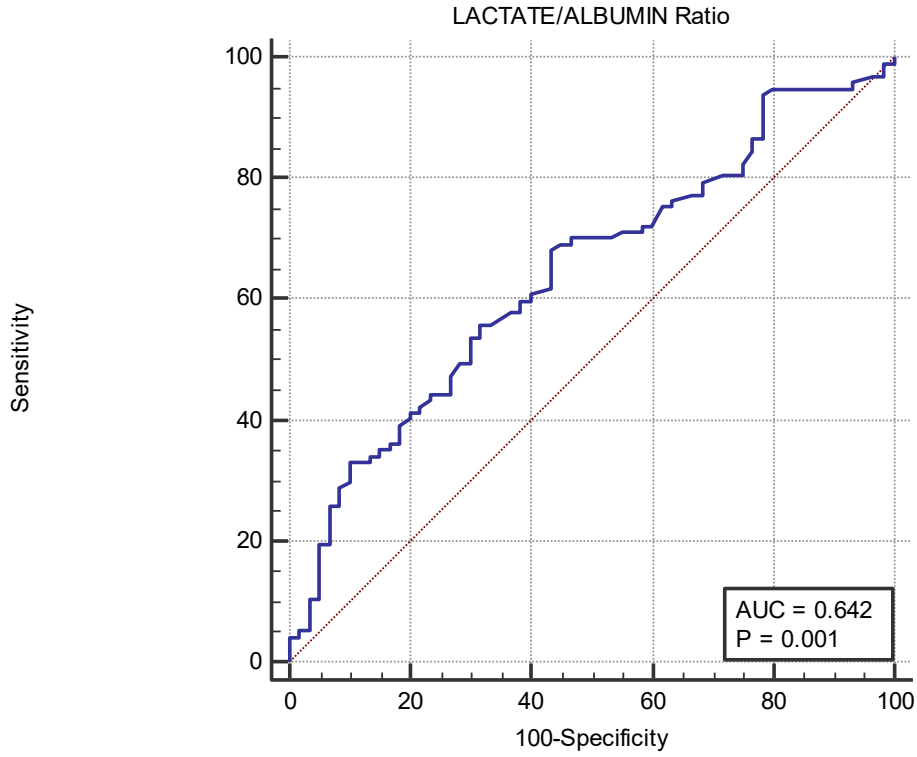

Figure 1: ROC curve for Lactate/Albumin Ratio in predicting death

The Area under the ROC Curve (AUC) is 0.642 (95% CI: 0.562–0.717), with a significant p-value of 0.0014 (z = 3.190). An AUC of 0.642 reflects moderate discriminatory ability to differentiate between patients who will die versus those who will be discharged. While better than chance (AUC = 0.5), it is not highly predictive (e.g., AUC > 0.8 would indicate strong discrimination). The confidence interval suggests some variability, but the significant p-value confirms the ratio's predictive value.

At the cut of >0.75, it shows reasonable sensitivity (68.04%) and PPV (71.7%), but lower specificity (56.67%) and NPV (52.3%).The higher PPV compared to NPV indicates the ratio is better at predicting death than confirming survival, making it more useful for identifying patients who need aggressive intervention.

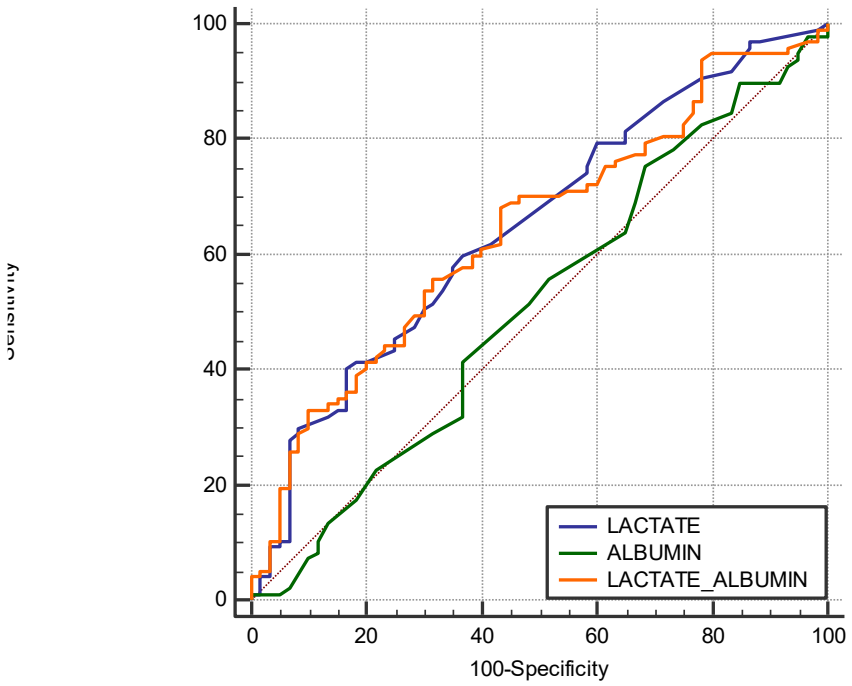

Figure 2: Comparison of ROC curve for Lactate alone, Albumin alone and Lactate/Albumin Ratio in predicting death

Variable	AUC	SE [a]	95% CI [b]
Lactate	0.649	0.0447	0.569 to 0.723
Albumin	0.510	0.0483	0.429 to 0.590
Lactate_Albumin	0.642	0.0446	0.562 to 0.717

Lactate (AUC = 0.649) has a slightly higher AUC than the lactate/albumin ratio (AUC = 0.642), suggesting it may be a marginally better standalone predictor. The overlapping CIs (0.569–0.723 vs. 0.562–0.717) indicate no significant difference in performance between the two.

Albumin's AUC (0.510) is essentially equivalent to a random guess, consistent with its lack of significant difference between groups (p = 0.948). This suggests albumin alone is not useful for outcome prediction in this population.

		Lactate/albumin ratio
Hb	Pearson Correlation	-.050
	P value	.544
TLC	Pearson Correlation	-.066
	P value	.422
PLT	Pearson Correlation	-.208*
	P value	.011
Bilirubin	Pearson Correlation	.054
	P value	.520
SGOT	Pearson Correlation	.124
	P value	.140
SGPT	Pearson Correlation	.200*
	P value	.016
ALP	Pearson Correlation	-.096
	P value	.256

Urea	Pearson Correlation	-.041
	P value	.615
Creatinine	Pearson Correlation	-.040
	P value	.621
Sodium	Pearson Correlation	-.005
	P value	.950
Potassium	Pearson Correlation	-.037
	P value	.651
RBS	Pearson Correlation	-.065
	P value	.431

Table 5: Correlation of various parameters with Lactate/albumin ratio

The lactate/albumin ratio shows weak but statistically significant correlations with platelet count (negative, r = -0.208, p = 0.011) and SGPT (positive, r = 0.200, p = 0.016), suggesting associations with thrombocytopenia and liver dysfunction, respectively. These align with the ratio's established role as a moderate predictor of mortality (AUC = 0.642) and its link to shorter LOS (<14 days, p = 0.034). No significant correlations were found with hemoglobin, TLC, bilirubin, SGOT, ALP, urea, creatinine, sodium, potassium, or RBS.

DISCUSSION

In this retrospective cohort of critically ill patients with sepsis, we found that higher serum lactate, lactate/albumin (L/A) ratio, and procalcitonin were significantly associated with mortality, while albumin alone was not. The L/A ratio demonstrated moderate discriminatory ability for in-hospital death (AUC = 0.642, 95% CI 0.562–0.717) and a cut-off >0.75 yielded a sensitivity of 68.0% and PPV 71.7%. These findings broadly aligned with the growing body of literature that recognizes the L/A ratio as an accessible prognostic marker in sepsis but also revealed variability in reported predictive performance across settings.[11]

Several studies have reported a superior prognostic value of the L/A ratio compared with lactate or albumin alone. For example, one Indian rural hospital study (n=160) found an AUC of 0.976 for the L/A ratio, with sensitivity 100% and specificity 88%, outperforming lactate or albumin alone.[12] In a larger adult sepsis cohort (n=939) the L/A ratio had AUC 0.65 (95% CI 0.61-0.70) compared with lactate alone 0.60 (95% CI 0.55-0.64) - the superiority was statistically significant though modest in magnitude.[13] Our results mirror these observations in that the L/A ratio had prognostic value beyond albumin alone (albumin AUC ≈ 0.51 in our sample), but differed in magnitude - many published studies reported higher AUCs for L/A (often 0.75–0.90 range). This suggested that the predictive strength of L/A might have been influenced by the population case-mix, timing of measurement (on admission vs serial), and underlying comorbidities.[14]

A strength of the L/A ratio was its physiological rationale: lactate reflected tissue hypoperfusion and anaerobic metabolism, while albumin reflected chronic illness, capillary leakage and systemic inflammation. Combining these two complementary axes should theoretically have improved risk stratification - an idea substantiated by multiple investigators.[15] Our correlation analysis also supported this pathophysiology: the L/A ratio correlated negatively with platelet count and positively correlated with SGPT, suggesting links with coagulopathy and hepatic dysfunction in sicker patients-findings that echoed reports showing that L/A correlated with organ dysfunctions.[16]

However, the literature also identified limitations and contexts where L/A is less useful. The large cohort study (n=939) noted that in the septic shock subgroup (n=236) the L/A ratio did not significantly outperform lactate alone (AUC 0.53 vs 0.50, p = 0.11).[13] Similarly, albumin levels are influenced by chronic nutritional state, liver disease and fluid resuscitation, which could have biased the denominator in the ratio; several investigators thus excluded patients with severe hepatic/renal dysfunction to reduce confounding.[14,17] These nuances might have explained why albumin alone

showed no difference between survivors and non-survivors in our population, while the combined metric retained prognostic value.

Many investigators have examined whether L/A could have replaced or complemented multivariable scoring systems. One recent study (n=102) found that the L/A ratio correlated with SOFA ($r = 0.33$, $p < 0.001$) and APACHE II ($r = 0.29$, $p = 0.003$), supporting its link with organ-failure burden.[18] In our cohort we did not provide direct SOFA comparisons (SOFA data not presented), but the moderate AUC of L/A suggested it could be have been used to rapidly identify the high risk patients ; however, it should have complemented - not replaced - comprehensive scoring when available.

Clinical implications and recommendations: given the ease of measurement (two routine labs) and consistent association with poor outcomes, the L/A ratio could have been implemented as an adjunctive early prognostic marker in sepsis triage. Our data suggested a practical cut-off (>0.75) with reasonable sensitivity and PPV in this cohort; however, validation in larger and prospective cohorts was necessary before adopting a universal cut-off, because published optimal thresholds vary widely between studies (from ~0.17 to >1.2).[14,19]

Limitations

Our retrospective design, single-center setting, possible selection biases, and absence of standardized timing for sample collection limited the generalizability of the findings. The higher observed mortality (≈61.8%) and predominance of renal/respiratory involvement also might have influenced predictive metrics. Future prospective studies should have recorded time-stamped lactate and albumin values, included external validation cohorts, and performed head-to-head comparisons and other biomarkers (e.g., procalcitonin) using DeLong tests and multivariable models, as recommended by prior authors.[20]

CONCLUSION

Our findings supported prior literature indicating that the lactate/albumin ratio was a useful, low-cost prognostic marker in sepsis, with consistent associations with mortality and organ dysfunction. The magnitude of predictive performance may varied by cohort, measurement timing, and case-mix; therefore, L/A was best used as part of a broader assessment strategy and validated locally before being used as a standalone decision threshold.

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