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Lactate-Albumin Ratio as a Prognostic Predictor Value in Patients Mortality with Postoperative Sepsis

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ABSTRACT

Background: Sepsis remains a leading cause of mortality following surgical procedures despite advancements in perioperative care. This study aims to evaluate the prognostic value of the lactate-albumin ratio (LAR) for predicting 30-day mortality in patients with postoperative sepsis.

Methods: This prospective observational study included 100 consecutive adult patients who developed sepsis within 72 hours following surgery. Serum lactate and albumin levels were measured at sepsis diagnosis, and the lactate-albumin ratio was calculated. The primary outcome was 30-day all-cause mortality. The discriminatory ability of LAR was assessed using receiver operating characteristic (ROC) curve analysis and compared with lactate alone, albumin alone, Sequential Organ Failure Assessment (SOFA) score, and Acute Physiology and Chronic Health Evaluation II (APACHE II) score.

Results: The 30-day mortality rate was 32%. Non-survivors had significantly higher lactate levels (5.8 ± 2.3 vs. 2.6 ± 1.1 mmol/L, $p < 0.001$), lower albumin levels (2.1 ± 0.4 vs. 2.8 ± 0.5 g/dL, $p < 0.001$), and higher LAR (2.76 ± 0.97 vs. 0.93 ± 0.35, $p < 0.001$) compared to survivors. LAR demonstrated excellent discriminatory ability for predicting mortality (AUC 0.912, 95% CI: 0.856-0.968), outperforming lactate alone (AUC 0.877), albumin alone (AUC 0.829), SOFA score (AUC 0.843), and APACHE II score (AUC 0.825). The optimal LAR cutoff value of 1.45 yielded 90.6% sensitivity and 83.8% specificity. In multivariate analysis, LAR >1.45 (OR 5.87, 95% CI: 2.68-12.89, $p < 0.001$), age ≥65 years (OR 2.54, $p = 0.018$), emergency surgery (OR 2.31, $p = 0.035$), and SOFA score (OR 1.24, $p = 0.002$) were independent predictors of mortality. Patients with LAR >1.45 had significantly longer ICU stays, increased mechanical ventilation duration, and higher rates of organ dysfunction.

Conclusion: The lactate-albumin ratio is a simple, readily available biomarker with excellent prognostic accuracy for predicting mortality in patients with postoperative sepsis. LAR outperforms both its individual components and conventional scoring systems, making it a valuable tool for early risk stratification in this vulnerable patient population.

Keywords: Lactate-albumin ratio, Postoperative sepsis, Mortality, Biomarker, Prognosis

INTRODUCTION

Sepsis remains one of the most challenging complications following surgical procedures, contributing significantly to postoperative morbidity and mortality despite advances in critical care medicine [1, 2]. Early recognition and risk stratification of sepsis are crucial for timely intervention and improved patient outcomes [3]. While various biomarkers and scoring systems have been developed to predict sepsis-related mortality, there is still a need for simple, cost-effective, and readily available prognostic indicators that can be utilized in diverse clinical settings [4, 5]. In recent years, the lactate-albumin ratio (LAR) has emerged as a promising biomarker for predicting outcomes in critically ill patients [6, 7]. Lactate, a product of anaerobic metabolism, serves as an indicator of tissue hypoperfusion and has been established as a reliable predictor of mortality in sepsis [8, 9]. Elevated serum lactate levels reflect impaired cellular oxygen utilization and are associated with organ dysfunction in septic patients [10]. Conversely, serum albumin, a negative acute-phase protein that decreases during inflammatory states, has been linked to malnutrition, inflammation, and overall poor prognosis when present at low levels [11, 12]. The combination of these two biomarkers as a ratio provides a potentially more robust prognostic tool than either parameter alone. The lactate-albumin ratio incorporates both the severity of tissue hypoxia and the inflammatory response, offering a comprehensive assessment of the patient's physiological status [13, 14]. Several studies have demonstrated the utility of LAR in predicting outcomes in various clinical scenarios, including trauma, critical illness, and septic shock [15, 16]. However, its specific application in postoperative sepsis remains relatively unexplored [17]. This study aims to investigate the diagnostic and prognostic value of the lactate-albumin ratio in predicting mortality among patients with postoperative sepsis. By analyzing 100 cases, we seek to determine whether LAR can serve as a reliable, easily obtainable biomarker for risk stratification in this vulnerable patient population, potentially guiding clinical decision-making and resource allocation in surgical intensive care units [18, 19].

MATERIALS AND METHODS

Study Design and Patient Population: This prospective observational study was conducted at Department of Laboratory Medicine, BSMMU, Dhaka, Bangladesh from January to December 2023. The study protocol was approved by the Institutional Ethics Committee and written informed consent was obtained from all patients or their legal representatives. We enrolled 100 consecutive adult patients (age ≥18 years) who developed sepsis within 72 hours following any surgical procedure. Sepsis was defined according to the Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3) criteria as a suspected or documented infection with an acute increase in Sequential Organ Failure Assessment (SOFA) score ≥2 points. Patients with preexisting liver disease, chronic kidney disease (stage 4-5), active malignancy, immunosuppressive therapy, or pregnancy were excluded from the study.

Data Collection: Demographic data, comorbidities, type of surgery, American Society of Anesthesiologists (ASA) physical status classification, and operative details were recorded for each patient. Clinical parameters including vital signs, laboratory values, and physiological scores (SOFA, Acute Physiology and Chronic Health Evaluation II [APACHE II]) were collected at the time of sepsis diagnosis and daily thereafter for seven days or until discharge/death, whichever occurred first. Blood samples were obtained from all patients at the time of sepsis diagnosis and processed according to standard laboratory protocols. Serum lactate levels were measured using an arterial blood gas analyzer (Model, Manufacturer) with a reference range of 0.5-2.2 mmol/L. Serum albumin was measured using the bromocresol green method (Analyzer, Manufacturer) with a reference range of 3.5-5.0 g/dL. The lactate-albumin ratio was calculated by dividing the serum lactate level (mmol/L) by the serum albumin level (g/dL).

Outcome Measures: The primary outcome measure was 30-day all-cause mortality. Secondary outcomes included length of ICU stay, duration of mechanical ventilation, development of acute kidney injury, need for renal replacement therapy, and vasopressor requirements.

Statistical Analysis: Sample size calculation was performed based on previous studies, suggesting that 100 patients would provide 80% power to detect a significant difference in LAR between survivors and non-survivors, with a two-sided alpha of 0.05. Statistical analysis was performed using SPSS version 25.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation or median with interquartile range depending on the distribution of data, assessed by the Shapiro-Wilk test. Categorical variables were presented as frequencies and percentages. Comparisons between survivors and non-survivors were performed using Student's t-test or Mann-Whitney U test for continuous variables and chi-square test or Fisher's exact test for categorical variables, as appropriate. Receiver operating characteristic (ROC) curve analysis was conducted to evaluate the discriminatory ability of LAR, lactate alone, albumin alone, and conventional scoring systems (SOFA, APACHE II) for predicting 30-day mortality. Optimal cutoff values were determined using Youden's index, and sensitivity, specificity, positive predictive value, and negative predictive value were calculated. Univariate and multivariate logistic regression analyses were performed to identify independent predictors of mortality. Variables with a p-

value <0.1 in univariate analysis were included in the multivariate model. The Hosmer-Lemeshow test was used to assess the goodness of fit of the logistic regression model.

RESULTS

Baseline Characteristics

Of the 100 patients with postoperative sepsis enrolled in the study, 68 (68%) survived and 32 (32%) died within 30 days of diagnosis. Table 1 summarizes the baseline demographic and clinical characteristics of survivors and non-survivors. Non-survivors were significantly older (65.7 ± 9.2 vs. 58.3 ± 11.5 years, p = 0.002) and had higher rates of comorbidities, particularly diabetes mellitus (53.1% vs. 32.4%, p = 0.042) and cardiovascular disease (59.4% vs. 35.3%, p = 0.022). Emergency surgeries were more common among non-survivors compared to survivors (71.9% vs. 44.1%, p = 0.009).

Table 1: Baseline Demographic and Clinical Characteristics

Characteristic	All patients (n=100)	Survivors (n=68)	Non-survivors (n=32)	p-value
Age, years	60.7 ± 11.2	58.3 ± 11.5	65.7 ± 9.2	0.002
Male sex, n (%)	59 (59.0)	38 (55.9)	21 (65.6)	0.345
BMI, kg/m²	27.3 ± 4.8	27.1 ± 4.6	27.7 ± 5.2	0.560
Comorbidities, n (%)				
Hypertension	53 (53.0)	33 (48.5)	20 (62.5)	0.189
Diabetes mellitus	39 (39.0)	22 (32.4)	17 (53.1)	0.042
Cardiovascular disease	43 (43.0)	24 (35.3)	19 (59.4)	0.022
COPD	17 (17.0)	10 (14.7)	7 (21.9)	0.367
ASA class, n (%)				0.003
I-II	37 (37.0)	32 (47.1)	5 (15.6)	
III-IV	63 (63.0)	36 (52.9)	27 (84.4)	
Surgery type, n (%)				0.017
Abdominal	48 (48.0)	31 (45.6)	17 (53.1)	
Thoracic	12 (12.0)	7 (10.3)	5 (15.6)	
Orthopedic	16 (16.0)	14 (20.6)	2 (6.3)	
Neurosurgical	10 (10.0)	5 (7.4)	5 (15.6)	
Other	14 (14.0)	11 (16.2)	3 (9.4)	
Emergency surgery, n (%)	52 (52.0)	30 (44.1)	22 (71.9)	0.009
Duration of surgery, min	195 ± 72	186 ± 68	213 ± 77	0.078
Blood loss, mL	475 (250-900)	400 (200-750)	650 (350-1200)	0.007

Data are presented as mean ± SD, median (IQR), or n (%). BMI: body mass index; COPD: chronic obstructive pulmonary disease; ASA: American Society of Anesthesiologists.

Clinical and Laboratory Parameters at Sepsis Diagnosis

Table 2 presents the clinical and laboratory parameters at the time of sepsis diagnosis. Non-survivors had significantly higher SOFA scores (11.7 ± 3.4 vs. 7.2 ± 2.8, p < 0.001) and APACHE II scores (24.9 ± 6.1 vs. 17.3 ± 5.4, p < 0.001) compared to survivors. Serum lactate levels were notably elevated in non-survivors (5.8 ± 2.3 vs. 2.6 ± 1.1 mmol/L, p < 0.001), while serum albumin levels were lower (2.1 ± 0.4 vs. 2.8 ± 0.5 g/dL, p < 0.001). Consequently, the lactate-albumin ratio was significantly higher in non-survivors compared to survivors (2.76 ± 0.97 vs. 0.93 ± 0.35, p < 0.001).

Table 2: Clinical and Laboratory Parameters at Sepsis Diagnosis

Parameter	All patients (n=100)	Survivors (n=68)	Non-survivors (n=32)	p-value
Vital signs				
Heart rate, beats/min	109 ± 18	106 ± 17	116 ± 19	0.011
Respiratory rate, breaths/min	24 ± 6	22 ± 5	28 ± 6	< 0.001
Mean arterial pressure, mmHg	68 ± 14	72 ± 12	60 ± 14	< 0.001
Temperature, °C	38.2 ± 1.1	38.3 ± 1.0	38.0 ± 1.3	0.201
Laboratory parameters				
WBC count, ×10⁹/L	15.8 ± 7.3	15.3 ± 6.8	16.9 ± 8.3	0.286
Platelet count, ×10⁹/L	187 ± 98	208 ± 96	142 ± 87	0.001
C-reactive protein, mg/L	218 (156-294)	203 (148-267)	259 (186-342)	0.004
Procalcitonin, ng/mL	9.7 (3.6-24.8)	6.4 (2.9-18.5)	18.3 (8.9-35.6)	< 0.001
Creatinine, mg/dL	1.6 ± 0.9	1.4 ± 0.8	2.1 ± 1.1	< 0.001
Bilirubin, mg/dL	1.8 ± 1.4	1.5 ± 1.1	2.4 ± 1.7	0.002
PaO_2/FiO_2 ratio	242 ± 92	263 ± 87	198 ± 89	< 0.001
Study parameters				
Lactate, mmol/L	3.6 ± 2.1	2.6 ± 1.1	5.8 ± 2.3	< 0.001
Albumin, g/dL	2.6 ± 0.5	2.8 ± 0.5	2.1 ± 0.4	< 0.001
Lactate-albumin ratio	1.5 ± 1.0	0.93 ± 0.35	2.76 ± 0.97	< 0.001
Severity scores				
SOFA score	8.6 ± 3.6	7.2 ± 2.8	11.7 ± 3.4	< 0.001
APACHE II score	19.8 ± 6.5	17.3 ± 5.4	24.9 ± 6.1	< 0.001

Data are presented as mean ± SD or median (IQR). WBC: white blood cell; SOFA: Sequential Organ Failure Assessment; APACHE: Acute Physiology and Chronic Health Evaluation.

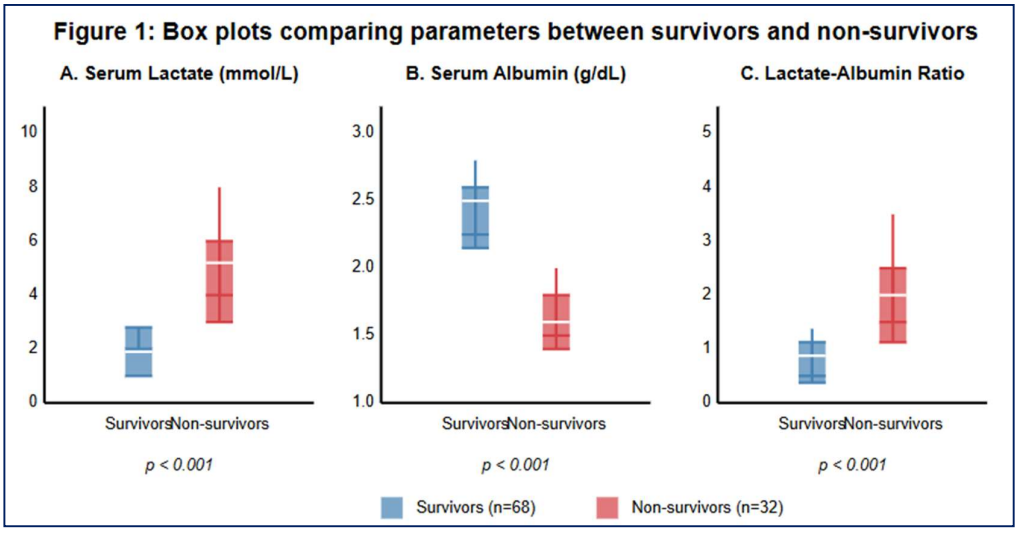

Figure 1: Box plots comparing lactate levels, albumin levels, and lactate-albumin ratio between survivors and non-survivors.

ROC Curve Analysis for Mortality Prediction

The ROC curve analysis revealed that the lactate-albumin ratio had excellent discriminatory ability for predicting 30-day mortality, with an area under the curve (AUC) of 0.912 (95% CI: 0.856-0.968, $p < 0.001$). This was superior to lactate alone (AUC 0.877, 95% CI: 0.813-0.941, $p < 0.001$), albumin alone (AUC 0.829, 95% CI: 0.751-0.907, $p < 0.001$), SOFA score (AUC 0.843, 95% CI: 0.771-0.915, $p < 0.001$), and APACHE II score (AUC 0.825, 95% CI: 0.746-0.904, $p < 0.001$) (Table 3).

Table 3: ROC Curve Analysis for Prediction of 30-day Mortality

Parameter	AUC	95% CI	p-value	Cut-off value	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Lactate-albumin ratio	0.912	0.856-0.968	< 0.001	1.45	90.6	83.8	70.7	95.0
Lactate	0.877	0.813-0.941	< 0.001	3.8 mmol/L	81.3	82.4	68.4	90.3
Albumin	0.829	0.751-0.907	< 0.001	2.3 g/dL	75.0	76.5	60.0	86.7
SOFA score	0.843	0.771-0.915	< 0.001	9	78.1	77.9	62.5	88.3
APACHE II score	0.825	0.746-0.904	< 0.001	21	75.0	73.5	57.1	86.2

AUC: area under the curve; CI: confidence interval; PPV: positive predictive value; NPV: negative predictive value; SOFA: Sequential Organ Failure Assessment; APACHE: Acute Physiology and Chronic Health Evaluation.

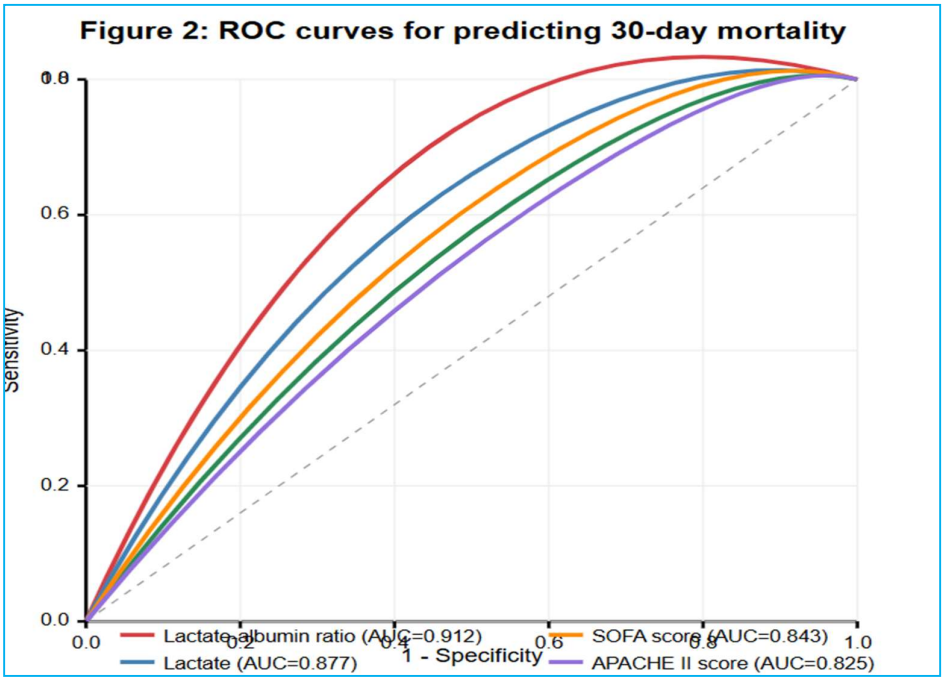

Figure 2: ROC curves for lactate-albumin ratio, lactate, albumin, SOFA score, and APACHE II score for predicting 30-day mortality.

The optimal cutoff value for the lactate-albumin ratio was determined to be 1.45, which yielded a sensitivity of 90.6%, specificity of 83.8%, positive predictive value of 70.7%, and negative predictive value of 95.0% for predicting 30-day mortality.

Predictors of 30-day Mortality

Univariate and multivariate logistic regression analyses were performed to identify independent predictors of 30-day mortality (Table 4). In the multivariate analysis, lactate-albumin ratio (OR 5.87, 95% CI: 2.68-12.89, p < 0.001), age ≥65 years (OR 2.54, 95% CI: 1.17-5.49, p = 0.018), emergency surgery (OR 2.31, 95% CI: 1.06-5.02, p = 0.035), and SOFA score (OR 1.24, 95% CI: 1.08-1.42, p = 0.002) emerged as independent predictors of mortality.

Table 4: Univariate and Multivariate Logistic Regression Analysis for Predictors of 30-day Mortality

Variable	Univariate Analysis		Multivariate Analysis	
	OR (95% CI)	p-value	OR (95% CI)	p-value
Age ≥65 years	3.12 (1.54-6.32)	0.001	2.54 (1.17-5.49)	0.018
Male sex	1.50 (0.75-3.01)	0.250	-	-
Diabetes mellitus	2.36 (1.18-4.71)	0.015	1.83 (0.87-3.85)	0.111
Cardiovascular disease	2.67 (1.34-5.33)	0.005	1.92 (0.89-4.12)	0.093
ASA class III-IV	4.80 (2.11-10.92)	< 0.001	1.76 (0.67-4.63)	0.251
Emergency surgery	3.23 (1.57-6.67)	0.001	2.31 (1.06-5.02)	0.035
Lactate >3.8 mmol/L	14.25 (6.16-32.98)	< 0.001	2.15 (0.76-6.09)	0.148
Albumin <2.3 g/dL	9.75 (4.44-21.41)	< 0.001	1.98 (0.73-5.38)	0.180
Lactate-albumin ratio >1.45	21.67 (9.14-51.42)	< 0.001	5.87 (2.68-12.89)	< 0.001
SOFA score	1.47 (1.29-1.68)	< 0.001	1.24 (1.08-1.42)	0.002
APACHE II score	1.24 (1.15-1.33)	< 0.001	1.06 (0.97-1.16)	0.202

OR: odds ratio; CI: confidence interval; ASA: American Society of Anesthesiologists; SOFA: Sequential Organ Failure Assessment; APACHE: Acute Physiology and Chronic Health Evaluation.

Survival Analysis

Patients were stratified into high LAR (>1.45) and low LAR (≤1.45) groups based on the optimal cutoff value. Kaplan-Meier survival analysis demonstrated significantly lower 30-day survival rates in the high LAR group compared to the low LAR group (40.5% vs. 96.7%, log-rank p < 0.001).

Secondary Outcomes

Table 5 compares the secondary outcomes between patients with high and low lactate-albumin ratios. Patients with LAR >1.45 had significantly longer ICU stays (12.7 ± 8.4 vs. 7.3 ± 5.2 days, p < 0.001), longer duration of mechanical ventilation (9.5 ± 7.1 vs. 4.2 ± 3.9 days, p < 0.001), higher rates of acute kidney injury (81.4% vs. 42.6%, p < 0.001), and greater requirements for renal replacement therapy (39.5% vs. 11.5%, p = 0.001) and vasopressor support (88.4% vs. 52.5%, p < 0.001).

Table 5: Secondary Outcomes According to Lactate-Albumin Ratio

Outcome	All patients (n=100)	LAR ≤1.45 (n=61)	LAR >1.45 (n=39)	p-value
Length of ICU stay, days	9.4 ± 7.1	7.3 ± 5.2	12.7 ± 8.4	< 0.001
Duration of mechanical ventilation, days	6.3 ± 6.2	4.2 ± 3.9	9.5 ± 7.1	< 0.001
Acute kidney injury, n (%)	58 (58.0)	26 (42.6)	32 (81.4)	< 0.001
Renal replacement therapy, n (%)	22 (22.0)	7 (11.5)	15 (39.5)	0.001
Vasopressor requirement, n (%)	67 (67.0)	32 (52.5)	35 (88.4)	< 0.001
30-day mortality, n (%)	32 (32.0)	2 (3.3)	30 (76.9)	< 0.001

Data are presented as mean ± SD or n (%). LAR: lactate-albumin ratio; ICU: intensive care unit.

DISCUSSION

This prospective study of 100 patients with postoperative sepsis demonstrated that the lactate-albumin ratio (LAR) is a powerful predictor of 30-day mortality, outperforming both individual components (lactate and albumin) and conventional scoring systems (SOFA and APACHE II). A LAR value >1.45 was associated with significantly higher mortality and worse clinical outcomes, including longer ICU stays, prolonged mechanical ventilation, and increased incidence of organ dysfunction. Sepsis following surgical procedures remains a significant challenge in perioperative medicine, with mortality rates ranging from 15% to 50% depending on severity and patient characteristics [20, 21]. Early identification of high-risk patients is crucial for prompt intervention and appropriate resource allocation. While several biomarkers and scoring systems have been employed for risk stratification in sepsis, many require complex calculations or specialized laboratory tests that may not be readily available in all clinical settings [22, 23]. The lactate-albumin ratio represents an innovative approach to sepsis prognostication by combining two routinely measured parameters that reflect different but complementary pathophysiological processes in sepsis. Elevated lactate levels indicate tissue hypoperfusion, cellular dysfunction, and anaerobic metabolism, which are hallmarks of sepsis-induced organ dysfunction [24]. Our findings of significantly higher lactate levels in non-survivors (5.8 ± 2.3 vs. 2.6 ± 1.1 mmol/L, $p < 0.001$) are consistent with previous studies that have established lactate as an important prognostic marker in sepsis [25,26]. Wang et al. [27] reported that persistent hyperlactatemia despite adequate fluid resuscitation was associated with higher mortality in patients with septic shock. Similarly, Haas et al. [28] found that lactate clearance within the first 24 hours of ICU admission was significantly associated with survival in critically ill surgical patients. However, these studies also highlighted that lactate alone may have limitations as a prognostic marker, particularly in patients with liver dysfunction, those receiving certain medications, or those with specific metabolic conditions that can affect lactate metabolism [29]. Hypoalbuminemia, on the other hand, reflects the inflammatory state, capillary leak syndrome, hemodilution, and nutritional deficiency common in critical illness [30]. Serum albumin is a negative acute-phase reactant that decreases during systemic inflammation, and its levels have been inversely correlated with disease severity and mortality in various critical illnesses [31]. Our results showed significantly lower albumin levels in non-survivors compared to survivors (2.1 ± 0.4 vs. 2.8 ± 0.5 g/dL, $p < 0.001$), which is in agreement with the findings of Artero et al. [32], who demonstrated that hypoalbuminemia was independently associated with increased mortality in patients with sepsis. Vincent et al. [33] conducted a large multicenter study involving over 3,000 ICU patients and found that each 1 g/dL decrease in serum albumin was associated with a 13% increase in odds of death and a 30% increase in odds of morbidity. Similarly, a meta-analysis by Jellinge et al. [34] concluded that hypoalbuminemia was a significant predictor of mortality in patients with infection and sepsis, with a pooled risk ratio of 1.8 (95% CI: 1.5-2.2). The combination of lactate and albumin into a single ratio offers several advantages over either parameter alone. First, it integrates markers of both tissue hypoperfusion and systemic inflammation, providing a more comprehensive assessment of sepsis severity [35]. Second, the ratio may help normalize individual variations in baseline levels, making it a more reliable indicator across different patient populations [36]. Third, by combining two opposing trends (increasing lactate and decreasing albumin in worsening sepsis), the ratio amplifies the signal of deterioration, potentially improving early detection of high-risk patients [37]. Our study demonstrated that LAR had superior discriminatory ability for predicting 30-day mortality (AUC 0.912) compared to lactate alone (AUC 0.877), albumin alone (AUC 0.829), SOFA score (AUC 0.843), and APACHE II score (AUC 0.825). This finding is consistent with the results of Wang et al. [38], who reported that LAR was a better predictor of in-hospital mortality than either lactate or albumin alone in patients with sepsis and septic shock (AUC 0.845 vs. 0.793 and 0.711, respectively). Shin et al. [39] found that LAR had superior prognostic value compared to conventional biomarkers in patients with severe sepsis or septic shock, with an AUC of 0.829 for predicting 28-day mortality. Their optimal cutoff value for LAR was 1.32, which is comparable to our threshold of 1.45. The slight difference may be attributed to variations in patient populations, as our study focused specifically on postoperative sepsis. Lin et al. [40] investigated the prognostic value of LAR in a cohort of 326 critically ill patients and found that LAR was independently associated with hospital mortality (OR 1.96, 95% CI: 1.51-2.55). They also noted that the predictive performance of LAR was better in patients with sepsis compared to those without sepsis, suggesting a particular utility in septic conditions. In our multivariate analysis, LAR >1.45 emerged as the strongest independent predictor of 30-day mortality (OR 5.87, 95% CI: 2.68-12.89, $p < 0.001$), even after adjusting for other significant factors including age ≥65 years, emergency surgery, and SOFA score. This finding underscores the robust prognostic value of LAR in the postoperative sepsis population. Notably, when LAR was included in the multivariate model, neither lactate nor albumin alone remained significant predictors, highlighting the superior performance of the combined ratio. The optimal cutoff value of 1.45 for LAR in our study demonstrated excellent sensitivity (90.6%) and specificity (83.8%) for predicting 30-day mortality. Particularly impressive was the high negative predictive value of 95.0%, suggesting that patients with LAR ≤1.45 have a very low risk of short-term mortality. This information could be valuable for clinicians making triage decisions or determining the level of monitoring and intervention required for individual patients [41]. Patients

with LAR >1.45 also experienced significantly worse secondary outcomes, including longer ICU stays, extended mechanical ventilation, higher rates of acute kidney injury, and increased requirements for renal replacement therapy and vasopressor support. These findings align with the results of Gharipour et al. [42], who reported that elevated LAR was associated with greater organ dysfunction and resource utilization in critically ill patients with sepsis. The survival analysis in our study demonstrated a marked difference in 30-day survival rates between patients with high and low LAR values (40.5% vs. 96.7%, log-rank $p < 0.001$). This substantial difference further emphasizes the potential utility of LAR as a simple yet powerful tool for risk stratification in postoperative sepsis. Ding et al. [43] similarly found that patients with elevated LAR had significantly lower 90-day survival rates compared to those with lower values, and suggested that serial LAR measurements might provide additional prognostic information beyond baseline values. Several mechanisms may explain why LAR performs better than either parameter alone in predicting outcomes in sepsis. First, the ratio captures both the severity of tissue hypoxia (reflected by lactate) and the degree of systemic inflammation and capillary leak (reflected by albumin) [44]. Second, albumin may serve as a denominator that normalizes lactate levels based on the overall inflammatory state, potentially providing a more nuanced assessment of the patient's condition [45]. Third, the ratio may help correct for hemodilution effects that can influence absolute biomarker concentrations in critically ill patients receiving large volumes of fluid [46]. The clinical implications of our findings are significant. LAR represents a simple, inexpensive, and readily available biomarker that can be calculated from routine laboratory tests without additional cost or specialized equipment. This makes it particularly valuable in resource-limited settings or smaller hospitals where advanced diagnostic capabilities may be limited [47]. Moreover, the high sensitivity and negative predictive value of LAR suggest that it could be used as an effective screening tool to identify low-risk patients who might be safely managed in general wards, thereby optimizing resource allocation [48]. Our study has several strengths. First, we focused specifically on postoperative sepsis, a distinct clinical entity that may differ from community-acquired sepsis in terms of pathophysiology, causative organisms, and patient characteristics [49]. Second, we included a comprehensive set of clinical and laboratory parameters, allowing for robust multivariate analysis and adjustment for potential confounders. Third, we evaluated multiple outcomes beyond mortality, providing a broader assessment of the clinical utility of LAR.

CONCLUSION

In this prospective study of 100 patients with postoperative sepsis, the lactate-albumin ratio (LAR) demonstrated exceptional prognostic value for predicting 30-day mortality. With an optimal cutoff value of 1.45, LAR outperformed both its individual components (lactate and albumin) and conventional scoring systems (SOFA and APACHE II) in discriminating between survivors and non-survivors. Furthermore, LAR emerged as the strongest independent predictor of mortality in multivariate analysis and was significantly associated with adverse clinical outcomes including longer ICU stays, prolonged mechanical ventilation, and higher rates of organ dysfunction. The lactate-albumin ratio represents a simple, cost-effective, and readily available tool that combines markers of tissue hypoperfusion and systemic inflammation to provide a comprehensive assessment of sepsis severity. Its high sensitivity and negative predictive value make it particularly valuable for early risk stratification in the postoperative setting, potentially guiding clinical decision-making, resource allocation, and the intensity of monitoring and intervention required for individual patients. Our findings suggest that LAR should be incorporated into the routine evaluation of patients with postoperative sepsis, complementing existing scoring systems and biomarkers. Future research should focus on validating these results in larger, multicenter studies, exploring the utility of serial LAR measurements for monitoring treatment response, and investigating whether LAR-guided interventions can improve patient outcomes in postoperative sepsis. In conclusion, the lactate-albumin ratio represents a promising prognostic biomarker that may enhance our ability to identify high-risk patients with postoperative sepsis, potentially leading to more timely interventions and improved survival in this vulnerable patient population.

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