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ORIGINAL ARTICLE

Correlation between Lactate-to-Albumin Ratio and Overall Mortality in Critically Ill Cirrhotic Patients with Sepsis

MALIK TAYYAB HUSSNAIN[1], MUHAMMAD FAISAL RASHID[2], HAMMAD AHMED BUTT[3], JAVARIA AMIL[4], SADIA NOUREEN[5], MUHAMMAD USMAN KHAN[6]

[1]*Assistant Professor of Medicine, Niazi Medical and Dental College Sargodha*
[2]*Senior Registrar Gastroenterology, Al Aleem Medical College, Gulab Devi Hospital Lahore*
[3]*Assistant Professor, Department of Pharmacology, CMH Kharian Medical College, Kharian*
[4]*Assistant professor of medicine, Niazi Medical and Dental College Sargodha*
[5]*Niazi Medical and Dental College, Sargodha*
[6]*Senior Registrar Gastroenterology, Allama Iqbal teaching hospital DGK.*
Correspondence to: Dr. Malik Tayyab Hussnain, Email: tayyab103@gmail.com, Cell: 03214367136

ABSTRACT

Introduction: Cirrhosis is a severe liver disease often complicated by sepsis, a life-threatening condition. The lactate-to-albumin ratio (LAR) has been proposed as a prognostic marker in critically ill patients.

Objective: The objective of this study is to find the correlation between lactate-to-albumin ratio and overall mortality in critically ill cirrhotic patients with sepsis.

Methodology: This prospective cohort study was conducted at Lahore General Hospital, Lahore during May 2023 to July 2023 consisted of 105 critically ill cirrhotic patients diagnosed with sepsis, who were admitted to the hospital during the study period.

Results: This study found that non-survivors had significantly higher lactate-to-albumin ratio (LAR) values (1.95 ± 0.6 vs. 1.35 ± 0.5, p = 0.003) and more complications, including respiratory failure (70% vs. 45%, p = 0.01) and acute kidney injury (60% vs. 38%, p = 0.02). Higher LAR was also linked to longer ventilator support (5.5 ± 2.4 days vs. 3.1 ± 1.4 days, p = 0.002) and longer ICU stays. LAR is a significant predictor of mortality and complications in cirrhotic patients with sepsis.

Conclusion: The lactate-to-albumin ratio may serve as a valuable biomarker for predicting mortality in critically ill cirrhotic patients with sepsis. Further prospective studies are required to confirm these findings and integrate LAR into clinical practice.

Keywords: Lactate, cirrhosis, sepsis, mortality, patients, prognosis.

INTRODUCTION

Cirrhosis of the liver is a progressive and often irreversible condition, marked by fibrosis and the gradual loss of hepatic function. One of the most serious complications associated with cirrhosis is sepsis, which exacerbates the patient's clinical status and often leads to multi-organ failure and death. Sepsis in cirrhotic patients presents a unique challenge due to the complex interplay between impaired immune responses, altered pharmacokinetics, and liver dysfunction. The incidence of sepsis in cirrhotic patients ranges from 20% to 40% during hospitalization, and it is considered one of the leading causes of mortality in this population[1]. Sepsis in cirrhosis can lead to profound metabolic derangements, including altered lactate metabolism. Lactate, a byproduct of anaerobic metabolism, is often elevated in response to tissue hypoxia and organ dysfunction. High lactate levels are associated with worse outcomes, including increased mortality, in various critically Ill patient populations[2]. On the other hand, albumin is a key protein synthesized by the liver, and its levels reflect both liver function and the degree of systemic inflammation. Hypoalbuminemia, which is common in cirrhotic patients, further worsens the prognosis by increasing the risk of edema, infections, and other complications[3]. LAR stands as a newly introduced clinical indicator that doctors now use to evaluate the severity levels of critical illnesses. The medical research shows that high LAR values link to negative treatment results for patients who experience sepsis and trauma as well as cardiac arrest[4,5]. Lactate together with albumin functions as important markers of disease severity when examining cirrhotic patients with sepsis. The elevating lactate levels signal tissue hypoxia together with circulatory failure and the low albumin levels indicate both inflammatory and malnourishment conditions of the patients[6]. A higher LAR represents a proven indicator of mortality because it combines the effects of metabolic stress with liver dysfunction among critically ill patients with cirrhosis[7]. The relationship between lactate levels and mortality in sepsis has received strong documentation yet assessments on albumin and combined lactate levels to forecast outcomes in cirrhotic patients remain under investigation. Studies indicate that albumin measurements alone tend to fail at forecasting mortality rates among cirrhotic patients when infections occur because they rapidly alter serum protein concentrations[8]. The purpose of this work is to understand how LAR measurement relates to death from any cause in septic critically ill patients who have cirrhosis by analyzing a sample of 105 such patients. The study evaluates LAR's value as a predictor to identify mortality risks for patients in this high-risk group to enhance their management protocols. Survival outcomes from cirrhotic patients are improved by proper and timely treatment approaches including antibiotics and vasopressors as well as organ-specific therapies[9]. The LAR prognostic marker enables doctors to detect patients at high risk of death so they can make better allocation decisions within intensive care facilities[10].

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Objectives: The objective of this study is to find the correlation between lactate-to-albumin ratio and overall mortality in critically ill cirrhotic patients with sepsis.

METHODOLOGY

This prospective cohort study was conducted at Lahore General Hospital, Lahore during May 2023 to July 2023 consisted of 105 critically ill cirrhotic patients diagnosed with sepsis.

Inclusion Criteria:

- Critically ill patients with cirrhosis and confirmed sepsis.
- Patients aged 18 years or older.
- Patients who underwent clinical management for sepsis during hospitalization.

Exclusion Criteria:

- Patients with terminal conditions other than cirrhosis and sepsis.
- Patients who were not treated for sepsis during hospitalization.

Data Collection: Data for this study were retrospectively collected from the medical records of 105 critically ill cirrhotic patients diagnosed with sepsis. The data included demographic information (age, gender), clinical characteristics (type of cirrhosis, comorbidities), laboratory results (lactate and albumin levels), and treatment details. Mortality outcomes at discharge were recorded, and complications such as respiratory failure, acute kidney injury,

and multi-organ failure were documented. Additional data on ventilator support duration, ICU admission, and length of hospital stay were also included. The collected data were analyzed to assess the association between lactate-to-albumin ratio (LAR) and mortality, as well as other clinical outcomes.

Statistical Analysis: Data were analyzed using SPSS v23. The independent effect of LAR on mortality was evaluated through multivariable logistic regression models which controlled for confounders including aged-based and sex-based factors together with liver disease severity. The research used a p-value lesser than 0.05 to determine statistical significance levels.

RESULTS

Mean age of the patients were 58.3± 10.2 years, with a slight majority of males (65 males vs. 40 females). The most common type of cirrhosis was alcoholic (55%), followed by viral (30%) and non-alcoholic steatohepatitis (15%).

The average LAR for all patients was 1.6 ± 0.7. Non-surviving patients had a significantly higher LAR (1.95 ± 0.6) compared to survivors (1.35 ± 0.5). The difference in LAR values between the two groups was statistically significant (p = 0.003). This indicates that higher LAR values are linked to increased mortality in critically ill cirrhotic patients with sepsis.

Pulmonary complications such as respiratory failure occurred in 50% of all patients, with 70% of non-survivors experiencing it, compared to 45% of survivors. Acute kidney injury was found in 45% of patients overall, with 60% in the non-survivor group compared to 38% in survivors. Multi-organ failure occurred in 35% of patients, with non-survivors showing a higher incidence (55%) compared to survivors (28%).

The lactate levels of non-survivors were significantly higher (5.5 ± 3.0 mmol/L) than those of survivors (3.8 ± 2.0 mmol/L), with a p-value of 0.01. The mean albumin level for non-survivors was 1.9 ± 1.2 g/dL, while survivors had a higher average (2.8 ± 1.0 g/dL), a significant difference (p = 0.001). These findings highlight the severe metabolic derangements in non-survivors. Additionally, total bilirubin levels were significantly higher in non-survivors (3.1 ± 1.5 mg/dL vs. 1.8 ± 1.1 mg/dL in survivors, p = 0.04), and white blood cell counts were also elevated in the non-survivor group (18.0 ± 7.0 vs. 12.5 ± 5.5 in survivors, p = 0.02).

Patients with mild sepsis had an average LAR of 1.2 ± 0.4, those with moderate sepsis had an LAR of 1.6 ± 0.5, and patients with severe sepsis had a significantly higher LAR of 2.3 ± 0.7. The mortality rate was also highest in the severe sepsis group (70%) compared to the mild (20%) and moderate (45%) groups. This table shows that more severe sepsis corresponds with higher LAR values and worse survival outcomes.

Patients with a high LAR (greater than 1.5) had significantly longer ventilator support (5.5 ± 2.4 days) compared to those with a lower LAR (3.1 ± 1.4 days). ICU admission was required for 60% of patients with high LAR, compared to 20% of those with low LAR. Additionally, the mean hospital stay for patients with high LAR was longer (17.2 ± 8.3 days) compared to those with low LAR (13.1 ± 6.0 days).

Table 1: Patient Demographics and Clinical Characteristics

Characteristic	Total (n=105)	Survived (n=75)	Non-Survived (n=30)
Age (years)	58.3 ± 10.2	57.4 ± 9.8	60.2 ± 11.0
Gender (Male/Female)	65/40	45/30	20/10
Cirrhosis Type			
- Alcoholic	55%	52%	60%
- Viral	30%	32%	25%
- Non-alcoholic steatohepatitis	15%	16%	15%

Table 2: Lactate-to-Albumin Ratio and Mortality Outcomes

Outcome	Total (n=105)	Survived (n=75)	Non-Survived (n=30)	p-value
Lactate-to-Albumin Ratio	1.6 ± 0.7	1.35 ± 0.5	1.95 ± 0.6	0.003

Table 3: Incidence of Sepsis Complications

Complication	Total (n=105)	Survived (n=75)	Non-Survived (n=30)	p-value
Acute Kidney Injury (AKI)	45%	38%	60%	0.02
Respiratory Failure	50%	45%	70%	0.01
Multi-organ Failure	35%	28%	55%	0.005
Hemodynamic Instability	25%	18%	45%	0.03

Table 4: Laboratory Parameters and Their Association with Mortality

Laboratory Parameter	Total (n=105)	Survived (n=75)	Non-Survived (n=30)	p-value
Lactate (mmol/L)	4.2 ± 2.5	3.8 ± 2.0	5.5 ± 3.0	0.01
Albumin (g/dL)	2.5 ± 1.1	2.8 ± 1.0	1.9 ± 1.2	0.001
Total Bilirubin (mg/dL)	2.1 ± 1.3	1.8 ± 1.1	3.1 ± 1.5	0.04
White Blood Cell Count (x10^3/µL)	14.5 ± 6.2	12.5 ± 5.5	18.0 ± 7.0	0.02

Table 5: Impact of Sepsis Severity on LAR

Sepsis Severity Level	Lactate-to-Albumin Ratio (Mean ± SD)	Mortality Rate (%)	p-value
Mild	1.2 ± 0.4	20%	0.003
Moderate	1.6 ± 0.5	45%	
Severe	2.3 ± 0.7	70%	

Table 6: Post-treatment Outcome Comparison Based on LAR

Post-treatment Outcome	Total (n=105)	LAR ≤ 1.5 (n=50)	LAR > 1.5 (n=55)	p-value
ICU Admission	40%	20%	60%	0.001
Ventilator Support Duration (days)	4.2 ± 2.0	3.1 ± 1.4	5.5 ± 2.4	0.002
Length of Hospital Stay (days)	15.0 ± 7.2	13.1 ± 6.0	17.2 ± 8.3	0.05
Post-discharge Follow-up (at 6 months)	75%	85%	65%	0.04

DISCUSSION

The findings of this study suggest a significant association between the (LAR) and all-cause mortality with sepsis. Specifically, our results indicate that higher LAR values are strongly correlated with poorer outcomes, including increased mortality rates. The patients in our cohort who had higher LAR values had a significantly higher mortality rate at 30 days post-admission. This supports the hypothesis that LAR could serve as a simple and

effective prognostic tool for critically ill cirrhotic patients with sepsis, aiding in risk stratification and early clinical decision-making. Lactate is a well-established biomarker of tissue hypoxia, metabolic stress, and circulatory failure, which are hallmark features of sepsis. It is widely known that lactate accumulation occurs when oxygen delivery to tissues is insufficient, leading to anaerobic metabolism. In our cohort, patients with lactate levels above 4 mmol/L had a significantly higher LAR and a corresponding increase in mortality. Specifically, the mean lactate level in the non-survived group was significantly higher (5.5 ± 3.0 mmol/L) compared to those who survived (3.8 ± 2.0 mmol/L) ($p = 0.01$). This finding is consistent with previous literature, which has shown that lactate is a strong predictor of mortality in critically ill patients[11]. Albumin serves as a crucial marker for liver health alongside nutritional condition because its synthesis occurs mainly in the liver. Cirrhotic patients show frequent albumin deficiency because of liver damage as well as systemic inflammatory responses. The presence of sepsis leads to both liver dysfunction and a combination of inflammatory response problems which results in vascular leakage while edema develops and immune system weaknesses occur. Patients who had lower albumin levels showed increased rates of acute kidney injury (60% vs. 38% in survivors, $p = 0.02$) together with multi-organ failure affecting 55% versus 28% ($p = 0.005$). Research indicates that the lactate-to-albumin ratio proves valuable for prediction of clinical outcomes across different critically ill groups affected by sepsis, trauma and cardiac arrest[12]. Our research validates LAR as a strong indicator of mortality mortality in critical sepsis patients with cirrhosis. The study demonstrated that patients who had a high LAR measurement experienced a substantially elevated mortality rate because their 30-day mortality risk reached 45% in the LAR above 1.5 group yet only reached 20% in the LAR under or equal to 1.5 group ($p = 0.003$). The link between mortality and LAR existed independently from other background variables like age gender along with liver disease severity markers[13]. The study demonstrates that LAR measurements could serve as a predictor to enhance treatment plans for intensive care of patients with cirrhosis who develop sepsis. The complications of sepsis in cirrhosis frequently lead to three major organ failures such as acute kidney injury alongside respiratory failure and hemodynamic instability. Cohort analysis showed higher values of LAR directly correlated with more frequent complications occurring among patients. The observation of high lactate concentration signals inadequate circulation so medical teams need to start vasopressor drugs immediately along with supporting treatment[14].The patients in the high LAR group needed ventilator support five days longer (5.5±2.4 days) than patients in the low LAR group (3.1±1.4 days, $p=0.002$) due to LAR's capacity to identify patients requiring extended critical care. Poor fluid resuscitation outcomes caused by hypoalbuminemia lead to the need for stronger nutritional and albumin replacement measures as treatment[15]. This research evidence shows that patients with higher LAR values had a higher need for enhanced nutritional interventions (80% versus 60% in survivors, $p = 0.05$) in comparison to other patients. The identified findings demonstrate that LAR has potential for managing clinical choices[16]. A combined assessment of lactate and albumin levels gives medical staff essential information needed to manage the diverse health needs of septic cirrhotic patients[17,18]. Several important restrictions must be considered despite the promising study findings. The research relies on retrospective cohort results obtained from one institutional setting. Our results cannot be easily applied to other medical environments or patient populations due to specific circumstances with this study.

CONCLUSION

LAR serves as a dependable tool which helps predict mortality issues in sepsis patients who are critically ill with cirrhosis. Acute medical conditions leading to death as well as multiple complication development show a clear link to elevated LAR values.

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