ORIGINAL ARTICLE

JIACM 2024; 25 (4): 187-91

Assessment of Prognostic Value of SOFA Score and Lactate/Albumin Ratio in Sepsis

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Abstract

Background: Sepsis necessitates prompt identification and management to improve patient outcomes. The SOFA (Sequential Organ Failure Assessment) score is commonly used to assess the severity of sepsis. The Lactate/Albumin Ratio (LAR) has emerged as a significant biomarker for sepsis prognosis. This study aims to evaluate the role of LAR in predicting sepsis outcomes compared to the SOFA score.

Method: A prospective observational study was conducted in the ICU of Hamidia Hospital, Bhopal. One hundred sepsis patients diagnosed based on systemic inflammatory response syndrome (SIRS) criteria were included. Exclusion criteria included patients requiring albumin supplementation, trauma patients, those under 18 years, pregnant ladies, and patients of malignancy. Routine blood investigations were done. Serum lactate levels, albumin levels, LAR, and SOFA scores were noted. Patients were monitored throughout their hospital stay. Data was analysed using IBM SPSS version 20. ROC curve analysis was used to assess the predictive accuracy of LAR and SOFA scores for mortality.

Results: Our study showed that the majority of the patients were male (62%).The mean age of patients was 47.31 ± 17.33 years. ROC analysis showed that SOFA had sensitivity and specificity of 76.8% and 72.7% respectively at a cut-off of 4.50 while LAR had sensitivity and specificity of 91.1% and 75% at a cut-off of 0.650 for mortality prediction.

Conclusion: The lactate/albumin ratio is a significant predictor of sepsis outcomes. While the SOFA score provides detailed organ-specific assessments, LAR offers a quick, biomarker-based tool suitable for emergency and resource-limited settings.

Key words: SOFA score, LAR, SIRS.

Introduction

Sepsis, a life-threatening organ dysfunction caused by a dysregulated host response to infection, requires prompt identification and management to improve patient outcomes[1]. Acute organ dysfunction (more than or equal to two SOFA score points) along with infection-related symptoms is one of the clinical criteria for sepsis. A total of six factors are taken into consideration while calculating the SOFA (Sequential Organ Failure Assessment) score including liver function, cardiovascular system, pulmonary functions, coagulation profile and renal functions[2].

Globally, sepsis is a leading cause of morbidity and death in intensive care units (ICUs). The epidemiology of sepsis is not well understood in India. However, a large multi-centric study involving 135 ICUs found a prevalence of 46.2% and 33.2%, respectively, based on the sepsis-2 and sepsis-3 classification with a mortality rate of 27.6%[3].

In intensive care units (ICUs), a number of prognostic scoring systems, such as SAPS (Simplified Acute Physiology Score I-III), LODS (Logistic Organ Dysfunction System), APACHE II (Acute Physiology and Chronic Health Evaluation II), MODS (Multiple Organ Dysfunction Score), and SOFA, are used to predict patient outcomes. These prognostic systems, although providing extensive organ dysfunction, are often time-consuming and frequently indicate the prognosis quite late[4-7]. Improving outcomes requires early diagnosis and proper care. Sepsis risk classification and prognosis prediction can also be achieved using various other biomarkers such as total leucocyte count, blood glucose, platelet count, serum albumin, serum lactate, and procalcitonin[8,9].

Precise prognostication is essential for directing therapeutic choices and forecasting results in patients with sepsis. One such biomarker that has gained popularity recently is the Lactate/Albumin Ratio (LAR).

SOFA Score: The sub-score measures six organ systems in respiratory, cardiovascular, hepatic, coagulation renal and neurological on a 0 - 4 scale. The cumulative SOFA score may range from 0 to 24 where higher scores suggest organ dysfunction and increased risk of mortality. By assessing

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several organ systems, the SOFA score allows for an appraisal of a patient's condition from a body-wide perspective which is specific and sensitive to sepsis severity.

Chen X *et al* (2021) found that the mean SOFA score for survivors was 7.03 ± 3.95, while it was 8.95 ± 4.42 for non-survivors which was clinically significant[10]. According to Shin J *et al* (2018), non-survivors had the highest maximum SOFA score (maximum score of 10) compared to survivors (maximum score of 7) ($p < 0.05$)[11]. Similarly, according to Shadvar K *et al's* study from 2022, non-survivors' mean SOFA scores were significantly higher than those of survivors (15.59 ± 1.34 *versus* 14.07 ± 1.19; $p < 0.05$)[12]. Hence, SOFA score has been a time proven reliable marker of sepsis.

Serum Lactate/Albumin Ratio: Increased anaerobic glycolysis, tissue hypoperfusion, and cellular dysfunction in sepsis lead to lactic acidosis, making serum lactate a significant predictive factor. According to current recommendations, serum lactate levels should be measured within an hour of any suspected sepsis episode, and if values are more than 2 mmol/L, assessments should be repeated. Elevation of serum lactate levels can also be caused by other factors such as concomitant liver or renal impairment[13]. Critically sick individuals often also have lower serum albumin levels, a vital plasma protein that is involved in many physiological functions. Serum values of albumin less than 3.5 g/dL are linked to higher rates of morbidity and increased risk of mortality[14].

While serum albumin and serum lactate levels can be used to predict death in sepsis patients on their own, research indicates that the lactate-to-albumin ratio (L/A ratio) is a more accurate predictor of high-risk sepsis cases and can avoid mortality[15]. The lactate-to-albumin ratio may also be useful in giving detailed information about the patient's nutritional condition and physiological changes. Since the lactate-to-albumin ratio is computed using regularly measured laboratory values, is straightforward to apply in clinical settings and doesn't come with extra expenditures.

Numerous studies have emphasized the lactate-to-albumin ratio's prognostic significance in sepsis. Erdogan *et al* (2022) demonstrated that among patients with pneumo-sepsis, particularly those who have renal and hepatic failure, can prognosticate mortality independently based on their lactate-to-albumin ratio The APACHE-2, SOFA scores, and lactate levels were also associated with the higher L/A ratio[16]. Nofal *et al* (2021) showed that, when compared to each score separately, the combination of lactate-to-albumin ratio with SOFA and SAPS II scores had the best predictive value for 28-day mortality in patients with septic shock[17].

Cakir and Turan (2021) mentioned lactate-to-albumin ratio was a better predictor of death in septic patients than lactate or albumin alone. However, the lactate-to-albumin ratio had similar prediction accuracy when measured against the SOFA score. Particularly in patients with liver failure, the lactate-to-albumin ratio provided extra prognostic value, although the SOFA score remained a reliable predictor of death[18].

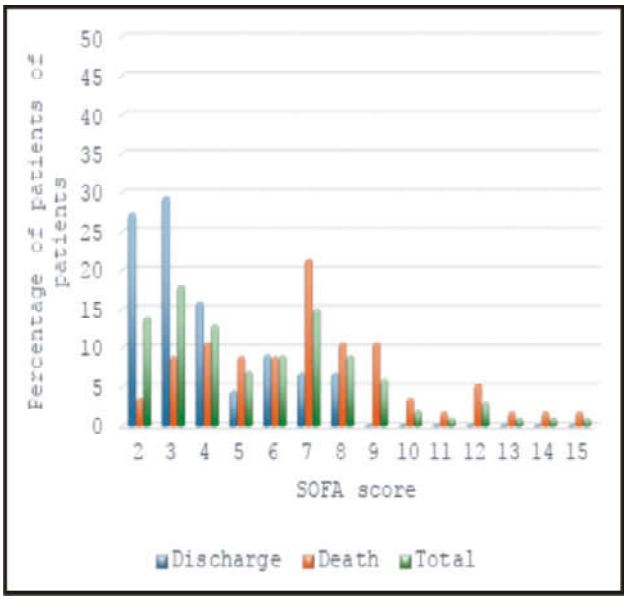

Fig. 1: *Distribution of SOFA Score among survivors and non- survivors.*

The primary aim of this study was to evaluate the role of the lactate/albumin ratio in predicting the outcome of sepsis when compared to SOFA scores. The specific objectives were: to evaluate the prognostic value of the lactate/albumin ratio in sepsis and to evaluate and compare the significance of lactate/albumin ratio with SOFA score ratio in sepsis.

Material and Methods

This prospective observational study was conducted in the ICU of Gandhi Medical College and Hamidia Hospital, Bhopal, from July 2022 to July 2023 after approval from institutional ethics committee. A total of 100 patients admitted with sepsis, as defined by SIRS criteria, were included in the study. Patients requiring albumin supplementation, pregnant ladies, patients of trauma or malignancy and those under 18 years of age were excluded.

Data Collection

Socio-demographic data, clinical presentation, co-morbidities, and laboratory investigations were recorded for all patients including complete blood count, Liver function test, Renal Function test and Arterial Blood gas analysis (ABG). Serum lactate and albumin levels were measured, and the LAR was calculated at the time of admission. SOFA score was also calculated for patients at

the time of admission. Patients were monitored throughout their hospital stay.

Statistical analysis

Data were analysed using IBM SPSS version 20. ROC curve analysis was performed to determine the optimal cut-off for LAR in predicting mortality. A p-value of less than 0.05 was considered statistically significant.

Results

Table I: Socio-demographic data.

S. No.	Variable	N (%)
1.	**Age in years** (Mean ± SD)	47.31 ± 17.33
2.	**Gender**	
	Male (mean age)	62% (46.39 ± 16.29 years)
	Female (mean age)	48% (48.82 ± 19.04 years)
3.	**Source of Infection**	
	Lower respiratory tract infections	46%
	Genito-urinary tract infections	22%
	Gastrointestinal infections	10%
	Skin and soft tissue infections	9%
	Bloodstream infections	7%
	Others	6%
4.	**Septic shock**	
	Present	45%
	Absent	55%
5.	**Co-morbidities**	
	No Co-morbidities	65%
	One Co-morbiditiy	25%
	>One Co-morbidities	10%

Table I demonstrates the socio-demographic data of the 100 patients enrolled. In our study, majority of the patients were male (62 %). Mean age of the patients was 47.31 ± 17.33 years. Co-morbidities were present in 35% of patients. Most common sources of sepsis in our patients were Lower respiratory tract infections (46%) followed by Genitourinary infections 22%. Sepsis was complicated by septic shock in 45% of patients.

In our study, majority of cases with favourable outcome had SOFA score of 3 (29.5%), whereas 27.3% cases had SOFA score of 2 (Fig. 1). However, majority of cases who succumbed to death had SOFA score of 7 (21.4%). None of the discharged cases had SOFA score above 8 whereas 26.9% cases who succumbed to death had SOFA score above 8. Mean SOFA score in all the cases was 5.63 ± 2.75. Mean SOFA score amongst discharged cases was 3.86 ± 1.89 and that among non-survivors was 7.02 ± 3.01. The observed association of SOFA score with outcome was found to be statistically significant ($p < 0.05$).

Mean serum lactate to albumin ratio in cases with sepsis at the time of presentation was 1.49 ± 0.60, which was found to be significantly higher ($p < 0.065$) among non-survivors (2.27 ± 1.79) as compared to survivors (0.52 ± 0.24).

ROC Curve Analysis

In our study, ROC curve analysis revealed SOFA score to be a good predictor of mortality with AUC of 0.816, with sensitivity and specificity of 76.8% and 72.7% respectively at a cut-off of 4.50 (Fig. 2).

ROC curve analysis was also done for LAR. The predictive accuracy of LAR was 0.943; (95% CI - 0.899 - 0.987). At the cut-off of 0.650, the sensitivity and specificty of LAR was 91.1% and 75%, respectively (Fig. 2).

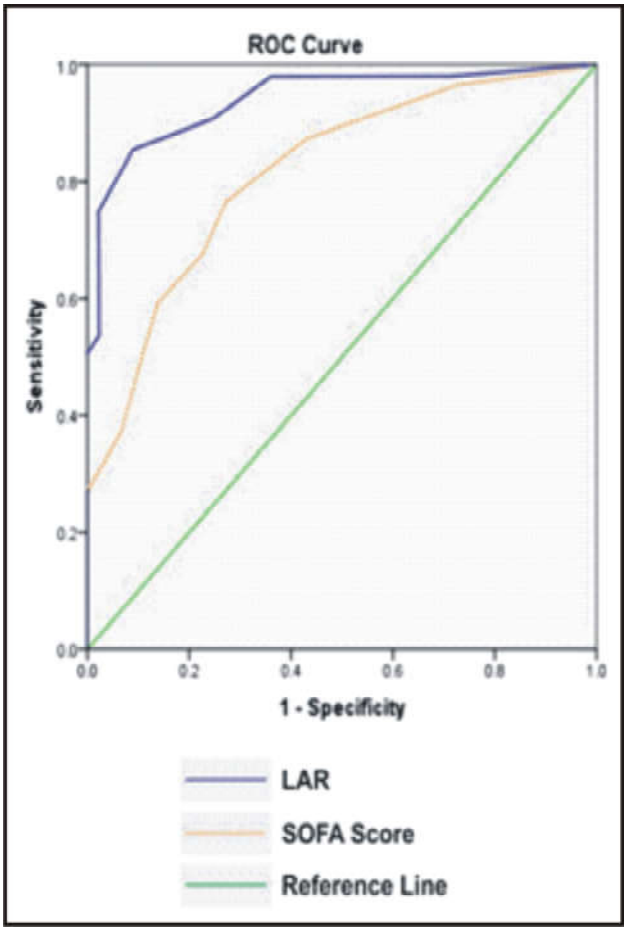

Fig. 2: ROC curve analysis comparing Lactate/Albumin ratio (LAR) and SOFA score with outcome.

Discussion

In recent years, there has been a lot of interest in comparing the Lactate Albumin Ratio (LAR) and Sequential Organ Failure Assessment (SOFA) score as prognostic measures in critical care situations. In our study, the LAR was found to be a highly reliable predictor of mortality by ROC curve analysis. The admission LAR was a good indicator of mortality (0.943; 95% CI - 0.899 - 0.987). The LAR sensitivity and specificity were 91.1% and 75% at the cut-off of 0.650.

On the other hand, the mean SOFA score for patients who were discharged was 3.86 ± 1.89, whereas the score for patients who died was 7.02 ± 3.01. Using a cut-off point of 4.50, ROC curve analysis showed that SOFA score was a good predictor of mortality with an AUC of 0.816 and sensitivity and specificity of 76.8% and 72.7%, respectively at a cut-off value of 4.50.

When reviewing literature and analyzing the comparison of SOFA score and LAR, Mishra *et al* (2018) found that a high LAR is an independent risk factor for sepsis mortality, and the Lac/Alb × age score – which is renowned for its accuracy and simplicity – offers significant clinical utility for prognosis assessment. This makes it a useful tool to use in conjunction with multi-dimensional indices like SOFA for a thorough evaluation of sepsis[19]. A more comprehensive viewpoint was offered by Cakir E *et al* in their analysis of the incorporation of both SOFA and LAR into clinical practice recommendations. They contended that merging these assessment scores may provide a more thorough evaluation of individuals who were in severe sepiss. When combined with metabolic and nutritional information from LAR, the comprehensive organ-specific assessment of the SOFA score may improve prognostic evaluation accuracy[18].

The SOFA score is extensive and provides details regarding specific organ dysfunctions but needs specific clinical data and many laboratory measures, which can be time-consuming and may not always be practical in all healthcare settings. Consistency in SOFA score evaluations may also be affected by interobserver variations at times. LAR, on the other hand, provides a faster insight which may be helpful for early diagnosis and intervention in patients suffering from sepsis, though lacking the specific organ dysfunction details that can be provided by SOFA score. Hence both SOFA score and Lactate/albumin ratio have their strengths and limitations.

Furthermore, depending on the patient demographic and clinical setting, predictive accuracy of these scores may change. For instance, the organ-specific examination of SOFA score may offer more significant prognostic information in trauma patients or those with non-septic/septic critical diseases. Conversely, LAR may be more indicative of the underlying pathophysiological mechanisms in sepsis or situations with metabolic disruptions. Hence the use of lactate-albumin ratio clinical practice may improve the management and prognosis of sepsis patients.

Conclusion

The lactate/albumin ratio is a significant predictor of sepsis outcomes and can be utilised for early risk stratification in ICU settings. Its use in clinical practice may improve the management and prognosis of sepsis patients. The comparison between SOFA score and Lactate Albumin Ratio highlights the complementary nature of these tools in critical care settings. While the SOFA score provides a comprehensive organ-specific assessment crucial for detailed prognostic evaluation, the lactate-to-albumin ratio provides a quick and easy-to-use biomarker-based tool that can be particularly useful in emergency and resource-limited settings. Our study is limited by its single-center design and relatively small sample size. Larger multicentric studies are needed to validate these findings and establish standardised LAR cut-off values for clinical use.

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