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THE RELATIONSHIP OF LACTATE ALBUMIN RATIO WITH SOFA SCORE AS A PREDICTOR OF SEPSIS PATIENTS IN THE INTENSIVE CARE ROOM

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ABSTRACT
Sepsis is a life-threatening organ dysfunction due to dysregulation of the host response to infection which causes systemic changes, namely an increase in the serum lactate/albumin ratio which is associated with mortality. Method:This study is a clinical observational analytical study with a prospective cohort design at fittingAdult patients diagnosed with sepsis in the integrated inpatient ward and intensive care ward at Haji Adam Malik General Hospital, Medan. The subject sampling technique used was non-probability sampling with a consecutive sampling method where 50 subjects were required. Bivariate analysis used the Pearson correlation test and the linear relationship between the lactate-albumin ratio value and the SOFA score used linear regression. A 95% confidence interval with a p value <0.05 was considered significantly significant Results :The results of the research on the first day found that the average LAR H1 was 0.59 + 0.51 (0.12-2.26) and the average SOFA H1 score was 7.32 + 1.88 (7) where an r value of 0.726 was obtained. indicates a high and significant correlation between Lactate Albumin Ratio and SOFA Score as a predictor of sepsis patients (p value = 0.000, p<0.05). On the third day, the average LAR H3 score was 0.12 + 0.29 (0.21-0.47) and the average SOFA H3 score was 9.58 + 2.01 (10) where an r value of 0.33 was found which indicates Very low and insignificant correlation between Lactate Albumin Ratio and SOFA Score as a predictor of sepsis patients (p value = 0.818, p > 0.05). Conclusion:The lactate-albumin ratio was strongly correlated with the SOFA score on the first day of adult patients diagnosed with sepsis in the integrated inpatient ward and intensive care ward.
Keywords: *Lactate-Albumim Ratio; SOFA score; sepsis*

INTRODUCTION

Sepsis is a life-threatening organ dysfunction caused by dysregulation of the host response to infection (Cao et al., 2023; Liu et al., 2024; Pool et al., 2018). A decrease in albumin can indicate the severity of inflammation. The condition of sepsis is associated with increased vascular permeability and capillary leakage which results in loss of albumin from the intravascular compartment, and can also occur due to reduced synthesis and increased catabolism of albumin. Several studies show that albumin can function as an additional parameter to assess mortality and prognosis (Liu et al., 2019; Rahajeng et al., 2020).

Lactate is found to be elevated in many physiological and pathological conditions, and can also be increased by the use of various types of medications. Serum albumin concentrations are often decreased in many conditions, for example, in major surgery, trauma or infection. Abnormal lactate and serum albumin levels in severe sepsis and septic shock together may provide a prognostic index that is positively correlated with infection. Both parameters can each

predict mortality so that the combination of the two is intended to further increase the predictive value (Lichtenauer et al., 2017).

The combination of lactate and albumin is intended to further increase the predictive value of mortality in patients. Previous studies showed a significant relationship between serum lactate/albumin ratio and mortality. The current study was designed to evaluate the prognostic value of serum lactate/albumin ratio in sepsis patients with respect to all-cause mortality in a larger patient group. Elevated lactate/albumin ratio correctly identifies patients who are clinically in worse condition, have more comorbidities, and show more obvious signs of multi-organ failure. The lactate/albumin ratio is very easy to obtain and therefore may be very useful for assessing risk in critically ill patients (Lambden et al., 2019).

SOFA Score is a quantitative assessment index that dynamically measures the involvement of sepsis in organ dysfunction including the respiratory system, coagulation system, liver function, cardiovascular system, central nervous system and kidney function. How to measure the scoring system varies from 0 to 24 points. The SOFA Score value can predict the severity and prognosis of patients with sepsis and assess their current condition (Singer et al., 2016). In Lichtenauer's research in 2017, it was found that in patients with an increased albumin/lactate ratio, the patient was found to be in a poor clinical condition. This worsening can be accompanied by comorbidities, or due to multi-organ failure (Jaczak et al., 2021).

Previous studies have demonstrated a significant relationship between the serum lactate/albumin (L/A) ratio and mortality in sepsis patients. This study aims to evaluate the prognostic value of the L/A ratio in a larger cohort of sepsis patients, focusing on all-cause mortality. Elevated L/A ratios have been associated with worse clinical conditions, increased comorbidities, and more pronounced multi-organ failure signs. The L/A ratio is easily obtainable, making it a valuable tool for assessing risk in critically ill patients. For instance, a study by Bou Chebl et al. (2021) found that the L/A ratio was a superior predictor of in-hospital mortality compared to lactate levels alone in sepsis patients. Similarly, a study by Kabra et al. (2023) reported that a higher L/A ratio was significantly linked to increased mortality and longer hospital stays among sepsis patients. Moreover, research by Li et al. (2024) highlighted that the L/A ratio was a robust predictor of 28-day mortality in sepsis patients, with an area under the receiver operating characteristic curve of 0.868. These findings underscore the potential of the L/A ratio as a simple and effective prognostic marker in sepsis management.

SOFA Score is a quantitative assessment index that dynamically measures the involvement of sepsis in organ dysfunction, including the respiratory system, coagulation system, liver function, cardiovascular system, central nervous system, and kidney function. The SOFA score can predict the severity and prognosis of patients with sepsis and assess their current condition.

This research aims to evaluate the relationship between the lactate albumin ratio (LAR) and the SOFA score as a predictor of mortality in sepsis patients. Specifically, it seeks to determine whether the LAR on day 1 and day 3 correlates with the severity of organ dysfunction as assessed by the SOFA score, and how these factors together can improve mortality prediction in critically ill patients.

The findings of this study may enhance clinical decision-making in intensive care units by providing a simple and reliable prognostic tool. The lactate/albumin ratio could serve as an easily accessible biomarker for the early identification of patients at high risk of mortality, thereby enabling healthcare providers to implement timely interventions. Additionally, understanding the role of LAR in sepsis progression can contribute to improved patient outcomes through better risk stratification and management strategies.

RESEARCH METHODS

This research is a clinical observational analytical study with a prospective cohort design.The study population was all adult patients diagnosed with sepsis in the integrated inpatient room, Intensive Care Room at Haji Adam Malik Hospital, Medan. The subject sampling technique used was non-probability sampling with the consecutive sampling method. The number of subjects was 45 (Singer et al., 2016). subjects plus 10% subjects, so the total subjects in this study were 50 subjects. All patients who were treated in the treatment room and diagnosed with sepsis using the qSOFA criteria and who met the inclusion and exclusion criteria were used as research subjects. Then all research subjects underwent a physical examination and supporting examinations and received an albumin lactate examination when the diagnosis was made on T0 (Day 0) and T1 (Day 3). Taking blood specimens for examination of the SOFA score variable which includes examination of platelets, bilirubin, plasma lactate, and examination of AGDA (PaO2).

To align the methods section with the suggested improvements, I recommend the following revisions to the *Research Methods* section:

This study follows a clinical observational analytical approach with a prospective cohort design. The study aimed to investigate the relationship between Lactate Albumin Ratio (LAR) and SOFA score in sepsis patients. The research was conducted at the Intensive Care Unit (ICU) and integrated inpatient ward at Haji Adam Malik General Hospital, Medan.

The target population in this study consists of adult patients diagnosed with sepsis, as per the qSOFA criteria. Non-probability sampling was employed using a consecutive sampling method, where patients who met the inclusion and exclusion criteria were selected. The total sample size was calculated to be 50 subjects, based on an estimated number of 45.5 subjects, with an additional 10% added to account for any dropouts or incomplete data.

Data collection was carried out at two time points: T0 (Day 0) and T1 (Day 3). The process involved collecting blood samples from the patients for laboratory testing of albumin, lactate levels, and SOFA score variables, which include platelets, bilirubin, plasma lactate, and PaO2 measurements. All patients underwent a thorough physical examination and the necessary supporting examinations to assess their condition.

Bivariate analysis was performed to assess the relationship between Lactate Albumin Ratio and SOFA score. The Pearson correlation test was used to analyze the linear relationship between the two variables on Day 0 (T0) and Day 3 (T1). To quantify the strength and significance of the correlation, linear regression analysis was applied. A 95% confidence interval was set, with a p-value of <0.05 considered statistically significant.

Results and Discussion

Table 1. Frequency Distribution of Patient Characteristics

Variable	Mean + SD	Median	p-Value *
Age	51.46 + 11.5	54.0	0.005
Weight	62.04 + 8.391	64.0	0.029

*Normality with Kolmogorov-Smirnov

Source: Researcher

Based on Table 1. It was found that the mean age of patients was 51.46 + 11.5 years with a median of 54, body weight 62.04 + 8.391 with a median of 64. The distribution of age and weight values was not normally distributed ($p<0.05$).

Table 2. Gender Frequency Distribution, Level Toconsciousness, use of support and mortality of research subjects

Variable	Number (n)	Percentage (%)
Gender		
Man	30	60
Woman	20	40
GCS		
Apathetic	11	22
Somnolence	26	52
Sopor	12	24
Coma	1	2
Support		
With Support	35	70
Without support	15	30
Mortality		
Life	18	36
Die	32	64

Source: Researcher

From table 2, it was found that the majority of the research sample was male, namely 30 patients (60%). At the level of awareness, 26 research subjects (52%) had the highest level of initial patient admission to the ICU, and 35 patients (70%) needed vasopressor support. The overall sample had a mortality percentage of 64%.

Table 3. Mean Lactate Albumin Ratio and SOFA Score of sepsis patients in the Intensive Care Unit of Haji Adam Malik Hospital Medan

Variable	Mean + SD	Median	p-Value *
H1 lactate	15.6 + 13.6	10.4	0.001
H1 albumin	2.69 + 0.25	2.58	0.001
LAR H1	0.59 + 0.51	0.42	0.001

SOFA H1	7.32 + 1.89	7	0.001
H3 Lactate	11.75 + 6.9	9.05	0.001
Albumin H3	2.49 + 0.16	2.51	0.200
LAR H3	0.464 + 0.27	0.36	0.001
SOFA H3	9.58 + 2.01	10	0.001

*Normality with Kolmogorov-Smirnov

Source: Researcher

On the first day, the examination found that the average lactate on the first day was 15.6 + 13.6 with a median of 10.4. and the mean albumin level was 2.69 + 0.25 with a median of 2.58 and the first day albumin lactate ratio was 0.56 + 0.51 with a median of 0.42. SOFA score on the first day with an average of 7.32 + 1.89 with a median of 7. On the third day the average lactate on the 3rd day was 11.75 + 6.9 with a median of 9.05. and the mean albumin level was 2.49 + 0.16 with a median of 2.51 and the third day albumin lactate ratio was 0.464 + 0.27 with a median of 0.36. SOFA score on the first day with an average of 9.58 + 2.01 with a median of 10. For normality of data distribution, it was found that almost all of the data was not normally distributed with a p value <0.05. There is only 1 data that has a normal distribution, namely albumin levels on day 3 with a p value > 0.05.

For bivariate analysis, a Spearman correlation test was carried out to determine the relationship between Lactate Albumin Ratio and SOFA Score as a predictor of sepsis patients. On the first day, an r value of 0.726 was obtained, indicating a high and significant correlation between the Lactate Albumin Ratio and the SOFA Score as a predictor of sepsis patients (p value = 0.000, p<0.05). However, on day 3, an r value of 0.33 was found, indicating a very low and insignificant correlation between the Lactate Albumin Ratio and SOFA Score as a predictor of sepsis patients (p value = 0.818, p > 0.05).

Table 4. Relationship between Lactate Albumin Ratio and SOFA Score as a predictor of sepsis patients in the Intensive Care Unit of Haji Adam Malik Hospital, Medan

Variable	Day 1	Day 3
Lactate Albumin Ratio	0.59 + 0.51	0.12 + 0.29
SOFA Score	7.32 + 1.88	9.58 + 2.01
P Value	0.001	0.818
r	0.726	0.33

***Spearman correlation**

Source: Researcher

Table 5. Sensitivity and specificity of the relationship between Lactate Albumin Ratio and SOFA Score as a predictor of sepsis patients in the Intensive Care Unit of Haji Adam Malik Hospital Medan

Variable	Mortality		
	Die	Life	P value

LAR Day-1	Tall	26	10	0.055
	Low	6	8	

*chi-square
Sensitive test: a/a+c = 26/32 = 0.81
Specific test: d/b+d = 8/18 = 0.44
Source: Researcher

In the table shown, the sensitivity of the chi-square test shows that there is no significant relationship between the LAR value and patient mortality, and it is further shown that the sensitivity of the LAR test on patient mortality is 81% and the specificity is 44% on the first day of LAR examination.

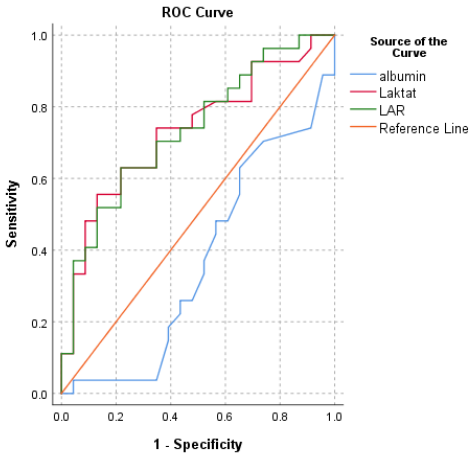

Figure 1. ROC curve of Sepsis patients (Ratio of Lactate Albumin vs Lactate vs Albumin on measurements upon admission to the ICU
Source: Researcher

In Figure 1, an analysis of the prognostic value of the Lactate Albumin ratio to mortality was carried out using the ROC (Receiver Operating Characteristic) curve in sepsis patients in the ICU at HAM Hospital. The prognostic value is measured from the AUC (Area Under the Curve) value to assess the accuracy of the albumin lactate ratio in prognosticating mortality in Sepsis patients. An AUC value above 0.5 (>50%) is considered to have a prognostic value for the dependent variable being assessed. This graph also compares the AUC ratio of albumin lactate with the lactate value or albumin value alone.

Table 6. AUC value in the variable predicting mortality in sepsis patients

Variable	AUC	95% Confidence Interval		P Value
		Lower	Upper	
Lactate	0.732	0.512	0.872	0.001
Albumin	0.367	0.209	0.525	0.099
Lactate-Albumin Ratio	0.734	0.596	0.872	0.001

Source: Researcher

In table 6, the AUC values between the variables Lactate, Albumin and Lactate-Albumin Ratio were obtained which were measured on the first day after the research subjects were treated in the ICU at Adam Malik Hospital. In this table, the highest AUC value is found in the albumin lactate ratio variable with a value of 0.734 (73.4%). The predictive value of the Albumin Lactate Ratio is better than just looking at the Lactate value or Albumin value separately.

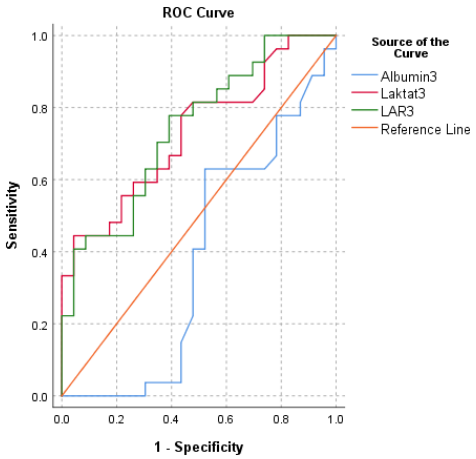

Figure 2 ROC curve of Sepsis patients (Ratio of Lactate Albumin vs Lactate vs Albumin on measurements upon admission to the ICU
source: Researcher

In Figure 2, ROC curve data analysis was carried out by looking at the levels of lactate, albumin. In this table, the highest AUC value is found in the albumin lactate ratio variable with a value of 0.741 (74.1%). The predictive value of the Albumin Lactate Ratio is better than just looking at the Lactate value or Albumin value separately and lactate albumin ratio on day 3 in sepsis patients who had been treated for 3 days in the ICU.

Table 7. Data analysis

source: Researcher

The results of this study found a high and significant correlation between Lactate Albumin Ratio and SOFA Score on the first day as a predictor of sepsis patients (p value = 0.000, p<0.0001). However, for levels on day 3, an r value of 0.33 was found, indicating a very low and insignificant correlation between the Lactate Albumin Ratio and SOFA Score as a predictor of sepsis patients (p value = 0.818, p > 0.05). This is in line with research by Azmi showing that the lactate/albumin ratio on day 1 did not have a significant relationship with the SOFA score on day 1 (P = 0.690), the lactate/albumin ratio on day 3 had a significant relationship with the SOFA score on day 3 (P = 0.006). The serial lactate/albumin ratio associated with the SOFA score can be used as a marker to predict mortality in sepsis patients treated in the ICU where high mortality and poor prognosis are seen in patients with a lactate/albumin ratio > 0.15 (Gyawali et al., 2019).

Lactate is an independent predictor of sepsis prognosis. The AUROC of lactate (AUROC, 0.664 [95% CI, 0.639–0.689]) was significantly higher than qSOFA (AUROC, 0.547 [95% CI, 0.521–0.574]), and similar to the AUROC of SOFA (AUROC, 0.686 [95% CI , 0.661–0.710]). However, the timing of lactate administration on SOFA and qSOFA scores was inconsistent. Lactate is an independent prognostic predictor of mortality in sepsis patients. Lactate had superior discriminatory power to qSOFA, and showed similar discriminatory ability to SOFA. In addition to its simplicity and accuracy, lactate is a better prognostic factor than qSOFA and SOFA in adult patients with sepsis (Li et al., 2020).

The lactate/albumin ratio is very easy to obtain and therefore very useful for risk stratification in critically ill patients. The average lactate level was found to be 5.28 while the average albumin level was found to be 28.36. The average ratio of Lactate to albumin was found to be 0.1862. Multivariate analysis by Sharma et al showed that mean lactate levels were significantly associated with mortality within 28 days. Baseline lactate area score may be a prognostic marker to predict 28-day mortality in septic shock patients. Kendall H et al examined the association between serum albumin over time and mortality in adults admitted to the intensive care unit (ICU) with sepsis. Serum albumin levels at hospital admission, and the lowest

Variable	AUC	95% Confidence Interval		P Value
		Lower	Upper	
Lactate	0.730	0.592	0.868	0.001
Albumin	0.381	0.215	0.546	0.158
Lactate-Albumin Ratio	0.741	0.605	0.876	0.001

serum albumin levels were significant predictors of mortality. The probability of survival decreases by 70.6% when there is a decrease in serum albumin levels, 63.4% with serum albumin at admission ≤2.45 g/dl, and 76.4% when the lowest serum albumin is ≤1.45 g/dl (Koch et al., 2020).

Dudoginon et al in a multivariate analysis of their study that took into account levels*lactate albumin ratio*(SAR) on admission > 0.13 was independently associated with death within 28 days (adjusted OR = 3.98 (IC95 1.88–8.35)). The efficacy of LAR at admission to

differentiate 28-day mortality showed identical AUC when compared with SOFA and ABSI scores (0.81 (IC95 0.74–0.88), 0.80 (IC95 0.72–0.85) and (0.85 (IC95 0.80–0.90), $p < 0.05$, respectively).Patients with LAR levels ≥ 0.13 at admission had a higher 28-day mortality rate (40.6% vs 6 .8%, $p < 0.001$, HR 7.39 (IC95 4.28–12.76)) (Antonelli et al., 1999).

Sepsis is defined as life-threatening organ dysfunction caused by dysregulation of the body's response to infection. The average death rate from sepsis is 33.2%. In elderly patients with sepsis, the mortality rate is much higher.Prognostic indices such as the Sequential Organ Failure Assessment (SOFA) can be used to predict the outcome of patients with sepsis. The SOFA score is a better score for predicting in-hospital mortality than the quick SOFA. 61 The sepsis biomarker based on laboratory examination is the lactate to albumin ratio (L/A). The L/A ratio may be a potential prognostic marker of sepsis considering the many physiological changes that need to be considered during sepsis. 63 A high lactate/albumin ratio is associated with mortality in patients with sepsis and septic shock so that the lactate/albumin ratio may be considered for use as a predictor marker in predict mortality in patients with sepsis and septic shock (Antonelli et al., 1999).

CONCLUSION

On the first day, a strong positive correlation was found between the lactate-albumin ratio (LAR) and SOFA score with a value of r 0.726 ($p < 0.05$), indicating that LAR can be a reliable early indicator for predicting the severity of sepsis in patients. However, on the third day, the correlation between LAR and SOFA scores decreased significantly with a value of $r = 0.33$ ($p > 0.05$), indicating that the predictive ability of LAR diminishes over time. The average LAR on the first day was 0.59 ± 0.51 with a range of 0.12 to 2.26, while on the third day, the average LAR decreased to 0.12 ± 0.29 with a range of 0.21 to 0.47. Meanwhile, the SOFA score increased on the third day to 9.58 ± 2.01, indicating that while LAR provides useful information in the early stages, its value decreases as sepsis progresses.

Additionally, calculations of sensitivity and specificity for LAR values on the first and third days showed high sensitivity, particularly on the first day, but relatively low specificity. These findings indicate that while LAR is effective in identifying patients with severe sepsis, its ability to distinguish between high- and low-risk patients requires further refinement. Future research should explore the mechanism of the decline in the correlation between LAR and SOFA scores over time, considering additional biomarkers or more detailed clinical indicators. In addition, comparing LAR with other prognostic biomarkers such as lactate or albumin separately may help validate its contribution in clinical practice.

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