

Lactate/albumin index as mortality predictor in abdominal sepsis

Índice de lactato/albúmina como predictor de mortalidad en sepsis abdominal

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Abstract

Objective: To evaluate the predictive value of the lactate/albumin ratio (LAR) for mortality in patients with abdominal sepsis admitted to the intensive care unit (ICU). **Methods:** An analytical cross-sectional study to validate the diagnostic test for abdominal sepsis. Patients over 18 years old with a diagnosis of abdominal sepsis admitted to the ICU. The LAR was calculated in the first 24 hours of admission to the ICU to evaluate its prognostic value for mortality. **Results:** We included 85 patients diagnosed with abdominal sepsis. The main causes of abdominal sepsis are secondary to closed abdominal trauma with hollow organ injury in 22 patients (26%) and severe acute pancreatitis in 21 (25%) patients. The LAR was calculated with a cutoff point of 1.04 as a predictor of mortality for abdominal sepsis, with 90.6% sensitivity, 72.5% specificity, 66.5% positive predictive value and 92.75% negative predictive value. **Conclusions:** The LAR may be useful in patients with abdominal sepsis as a quick, easy, and inexpensive prognostic marker of mortality, compared to other scales that require multiple values for their performance.

Keywords: Abdominal sepsis. Mortality. Albumin-lactate index.

Resumen

Objetivo: Evaluar el valor predictivo del índice lactato/albúmina (ILA) para mortalidad en pacientes con sepsis abdominal ingresados a la unidad de terapia intensiva (UTI). **Métodos:** Se realizó un estudio transversal analítico de prueba diagnóstica. Se incluyeron pacientes mayores de 18 años con diagnóstico de sepsis abdominal ingresados a la UTI. Se calculó el ILA en las primeras 24 horas de su ingreso a la UTI para evaluar su valor pronóstico para mortalidad. **Resultados:** Se incluyeron 85 pacientes con diagnóstico de sepsis abdominal, cuyas principales causas fueron secundarias a trauma abdominal cerrado con lesión de víscera hueca en 22 (26%) y pancreatitis aguda grave en 21 (25%). Se calculó el ILA con un punto de corte de 1.04 como predictor de mortalidad para sepsis abdominal, con sensibilidad del 90.6%, especificidad del 72.5%, valor predictivo positivo del 66.5% y valor predictivo negativo del 92.75%. **Conclusiones:** El ILA puede ser útil en pacientes con sepsis abdominal como un marcador pronóstico de mortalidad rápido, fácil y económico, en comparación con otras escalas que requieren múltiples valores para su aplicación.

Palabras clave: Sepsis abdominal. Mortalidad. Índice lactato/albúmina.

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Introduction

Severe sepsis and septic shock are among the leading causes of morbidity and mortality worldwide. The global estimate of sepsis diagnoses per year is 31.5 million cases. This condition remains an important burden on health care systems, responsible for approximately 30%-40% of in-hospital mortality and with an overall worldwide mortality rate of nearly 25%^{1,2}.

Abdominal sepsis is the 2nd most common cause of sepsis; the first is pulmonary origin. It is defined as organ dysfunction manifested by a SOFA (Sequential Organ Failure Assessment) score ≥ 2 , caused by a condition of the GI tract or an intra-abdominal hollow viscus³. Patients who survive continue to represent a health care cost due to the multiple physical, psychological, and cognitive sequelae they present. Despite advances in the diagnosis and treatment of sepsis, its incidence has increased. Therefore, predictive biomarkers of mortality are important for early diagnosis and timely treatment⁴.

Although various prognostic scores and biomarkers exist, none has been established as a reference standard to predict outcomes in patients with abdominal sepsis. One of the most widely used is SOFA, applied for the management of severe sepsis and predicting the length of stay and risk of mortality. Throughout time, efforts have been made to simplify these scores to establish prognosis more rapidly and efficiently, as delays in identifying this condition increase mortality⁵⁻⁷.

Lactate is one of the most studied biomarkers in sepsis, and elevated levels have been shown to be associated with increased mortality. Unlike lactate, hypoalbuminemia is associated with an increased risk of mortality and serves as a biomarker in patients with severe sepsis.

The lactate/albumin ratio (LAR) is thought to be a better prognostic marker because it is associated with multiple organ failure and mortality in severe sepsis. Lactate and albumin levels should move in opposite directions during sepsis, since albumin decreases as a negative acute-phase protein, correlating with the intensity of the inflammatory response. When interpreted appropriately in a clinical setting, it has diagnostic and prognostic value to guide patient management and medical decision-making. Early identification of sepsis is one of the most significant factors for prognosis, as adequate management can prevent the development of septic shock with a poor outcome⁸⁻¹⁰.

We designed this study to investigate the relationship of LAR as a prognostic marker of mortality in patients admitted to the intensive care unit (ICU) with a diagnosis of abdominal sepsis.

Methods

We conducted an analytical cross-sectional study evaluating the prognostic value of LAR for mortality. Patients ≥ 18 years with laboratory and clinical diagnosis of abdominal sepsis, with a mean SOFA score > 9 , admitted to the ICU in the general surgery service from March 2019 through February 2021 were included. Exclusion criteria were patients diagnosed with COVID-19 during the ICU stay.

Variables recorded included age, sex, body mass index (BMI), cause of abdominal sepsis, comorbidity, serum lactate, and serum albumin.

Clinical history and serum biochemical parameters of lactate and albumin were obtained for patients meeting diagnostic criteria for abdominal sepsis to determine SOFA score within the first 24 hours of admission.

LAR was calculated by dividing serum lactate (mmol/L) by serum albumin (g/dL). Normal values in the adult population are < 2 mmol/L for serum lactate and 3.4-5.4 g/dL for albumin¹¹.

The relationship between LAR and mortality associated with abdominal sepsis was analyzed. Follow-up was performed individually through the medical note system of the *Instituto Mexicano del Seguro Social* until patient discharge from the unit.

We used the statistical program Stalcalc within Epi-Info 6.0. Crude numbers, proportions, and measures of central tendency and dispersion were reported. To evaluate the ability of LAR to predict mortality, ROC (receiver operating characteristic) curve analysis was used, and the optimal cutoff point was identified. Test validation was established by sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, and negative likelihood ratio of LAR.

Results

We included a total of 85 patients with abdominal sepsis and determination of albumin and lactate within the first 24 hours of ICU admission were included. Of the total, 60 (71%) were men and 25 (29%) women. Mean age was 43.18 ± 16.10 years (Table 1).

Only 3 patients (3.5%) did not undergo surgery during their stay; 55 (64.7%) underwent one surgery and

27 (31.8%) underwent two. The mean BMI was 30.1 ± 6.5 kg/m², corresponding to grade I obesity.

Mean LAR was 1.37 ± 1.09 in patients with abdominal sepsis. Mean serum lactate in the first 24 hours was 3 ± 2.1 mmol/L and mean albumin was 2.3 ± 0.5 g/dL.

LAR as a predictor of mortality in patients with abdominal sepsis showed a cutoff value of 1.04, with sensitivity of 90.6%, specificity of 72.5%, positive predictive value of 66.5%, negative predictive value of 92.75%, positive likelihood ratio of 3.2, and negative likelihood ratio of 0.12 (Fig. 1 and Table 2). Of the 85 patients, 32 (37.6%) died. Mean hospital stay was 20 ± 17.9 days.

Discussion

Septic shock is currently the most severe complication of sepsis and contributes to high morbidity and mortality in hospitalized patients. It occurs in response to an infectious agent, with an increased and dysregulated inflammatory/anti-inflammatory response and endothelial involvement, leading to capillary leak¹¹⁻¹³.

Timely diagnosis and initiation of appropriate treatment can change prognosis, in addition to identifying which patients will require more advanced therapies through predictive scales of morbidity and mortality. At present, multiple mortality scales are used daily in clinical practice, but most require multiple values not readily available at admission¹⁴⁻¹⁷.

Notably, 96.5% of patients in this study underwent surgery, which may alter the microbial population causing sepsis, highlighting the importance of early culture collection to establish specific antibiotic treatment. In all patients with abdominal sepsis, LAR was obtained at ICU admission, which was useful in predicting mortality in our series.

Lactate, as a marker of tissue perfusion, rises significantly in cellular ischemia and hypoxia, leading to metabolic disturbances from reduced effective tissue circulating volume. Serum lactate is considered a sensitive marker for sepsis and septic shock, reflecting cellular metabolism. Lactate and albumin levels independently predict mortality and combining both may further increase predictive value. A study by Bou Chebl et al⁹ demonstrated that LAR has greater prognostic value for mortality than initial lactate levels in adult inpatients with sepsis.

This work attempts to validate LAR as a predictor of mortality in patients with abdominal sepsis to calculate prognosis, as it is easy to reproduce, rapid, practical, and low-cost for early management.

Table 1. Characteristics of patients with a diagnosis of abdominal sepsis treated in the intensive care unit

	Mean $\pm$ SD/nMin–Max / %	
Age (years)	43.18 $\pm$ 16.10	18-83
	n	%
Sex		
Male	60	71
Female	25	29
Etiology of abdominal sepsis		
Blunt abdominal trauma with visceral injury	22	26
Severe acute pancreatitis	21	25
Visceral perforation by firearm	14	16
Colon perforation	9	11
Ileal perforation	6	7
Duodenal perforation	8	9
Complicated appendicitis	5	6
Comorbidity		
Smoking	33	39
Alcoholism	26	31
Type 2 diabetes mellitus	24	28
Systemic arterial hypertension	23	27
Chronic kidney disease	1	1
Other*	18	21

*Hypothyroidism, heart disease, liver disease, lung disease, or autoimmune disease.
SD: standard deviation.

Table 2. Results of the lactate/albumin index with a cutoff value > 1.04 as a predictor of mortality in patients with abdominal sepsis

Cutoff value	1.04
Sensitivity	0.906
Specificity	0.725
Positive predictive value	0.665
Negative predictive value	0.9275
Positive likelihood ratio	3.2
Negative likelihood ratio	0.12

However, it will be necessary to evaluate it prospectively and on a larger scale to define its role and compare its accuracy with other established scales. LAR may be useful in predicting mortality, as with other prognostic scales¹⁸⁻²⁰.

In our results, the cutoff with greatest sensitivity and specificity was 1.04 (90% and 72.5%, respectively), lower than that established in another prospective study¹¹ of 54 patients with sepsis and septic shock, which determined a cutoff > 1.735, sensitivity of 51%, and positive predictive value of 17%. The difference may be explained by sepsis etiology, comorbidities,

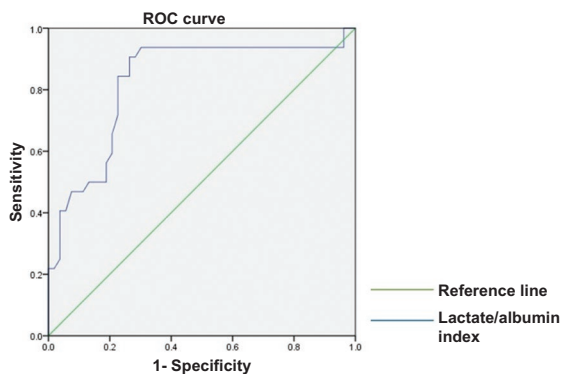


Figure 1. ROC curve for the lactate/albumin ratio.

number of interventions, and timing of sepsis onset relative to hospital admission. In the study by Ghari-pour et al.¹¹ LAR was found to predict 28-day mortality when > 1.01 , regardless of initial lactate. Conversely, an observational study comparing LAR and lactate clearance showed that the best predictor of mortality was LAR at 6 hours in ICU patients with septic shock^{11,21,22}.

In studies by Yoo et al.²³ a cutoff of 1.016 within the first 24 hours predicted mortality. This was similar to Chen et al.¹⁴ including 4555 patients with sepsis, age ≥ 60 years, BMI ≥ 24 kg/m², SOFA ≥ 2 , and LAR ≥ 0.16 , which were independent risk factors for death; however, sensitivity and specificity were not reported.

The cutoff obtained in our study was higher vs Yoo et al.²³ and Chen et al.¹⁴ likely due to the critically ill population included, most with one or more surgeries, which may alter LAR, as surgery triggers a metabolic response to trauma that exacerbates the septic response, increasing tissue hypoxia markers. Additionally, fasting between surgeries leads to decreased albumin, which may elevate LAR postoperatively, explaining the marked differences between cutoff values reported²⁴.

We found a statistically significant LAR cutoff associated with mortality, though different from that reported in the literature, as no established value currently exists²⁵. A prospective large-scale evaluation in nonspecific populations is required to define its role, find optimal cutoffs, and compare prognostic accuracy.

Limitations of our study include its retrospective design, analysis based only on clinical charts without complete data for comparison with other scales, and small sample size due to the COVID-19 pandemic

period, which limited non-COVID ICU admissions despite our hospital being a referral center.

There is substantial heterogeneity across studies. Causes of abdominal sepsis are diverse, which may lead to divergent results, as well as differences in surgical interventions.

Conclusions

Our study demonstrates that LAR plays an adequate role in identifying and prognosticating patients with severe sepsis and septic shock, with high sensitivity and specificity, requiring few parameters for estimation. LAR may be useful in abdominal sepsis as a rapid, simple, and inexpensive prognostic marker of morbidity and mortality from the time of admission vs other scores requiring multiple values.

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Conflicts of interest

The authors declared no conflicts of interest whatsoever.

Ethical Considerations

Protection of humans and animals. The authors declare that no experiments were performed on humans or animals for this research.

Confidentiality, informed consent, and ethics approval. The authors obtained approval from the Ethics Committee for analysis of routinely collected anonymized clinical data; therefore, informed consent was not required. Pertinent recommendations were followed. The study adhered to the Declaration of Helsinki (1989) and the Mexican Health Guidelines. It was approved by Ethics Committee 1301, registration no. R-2021-1301-130.

Statement on the use of artificial intelligence. The authors declare they did not use generative artificial intelligence for manuscript preparation.

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