

Lactate Clearance versus SOFA Score for Early Prediction of Mortality in Sepsis

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Abstract

Background: Early identification of patients with sepsis who are at increased risk of mortality is essential for prompt resuscitation and optimal critical care management. Lactate clearance and the Sequential Organ Failure Assessment (SOFA) score are widely used prognostic indicators, but their comparative performance remains an area of clinical interest.

Objectives: To compare the prognostic utility of lactate clearance and SOFA score for early prediction of mortality in patients with sepsis.

Methods: This prospective observational study included 160 adult patients with sepsis admitted to the intensive care unit of a tertiary care hospital. Serum lactate levels were measured at admission and after 6 hours to calculate lactate clearance. SOFA score was determined at admission. Patients were followed until ICU discharge or death. Receiver operating characteristic (ROC) curve analysis was performed to compare the predictive performance of lactate clearance and SOFA score.

Results: Overall ICU mortality was 32.5%. Survivors demonstrated significantly greater lactate clearance ($39.8 \pm 12.6\%$ vs. $11.4 \pm 8.2\%$; $p < 0.001$), while non-survivors had significantly higher SOFA scores (12.4 ± 2.7 vs. 7.8 ± 2.3 ; $p < 0.001$). Lactate clearance showed an AUC of 0.918 compared with 0.891 for SOFA score. The combined model demonstrated the highest predictive accuracy (AUC = 0.947), with sensitivity of 94.2% and specificity of 88.0%.

Conclusion: Lactate clearance is a simple and effective prognostic marker with slightly better predictive performance than SOFA score for early mortality prediction in sepsis. The combined assessment of lactate clearance and SOFA score provides superior prognostic accuracy and may facilitate early identification of high-risk patients.

Keywords: Sepsis, Lactate Clearance, SOFA Score, Intensive Care Unit, Mortality, Prognosis, Critical Care.

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Introduction

Sepsis is a life-threatening organ dysfunction caused by a dysregulated host response to infection and remains one of the leading causes of morbidity and mortality worldwide. Despite advances in antimicrobial therapy, critical care, and organ support, sepsis continues to account for a substantial proportion of intensive care unit (ICU) admissions and deaths. Early identification of patients at high risk of mortality is crucial for initiating timely resuscitation, optimizing treatment strategies, and improving clinical outcomes. [1,2]

Serum lactate has emerged as an important biomarker of tissue hypoperfusion and impaired cellular metabolism in patients with sepsis.

Elevated lactate levels reflect inadequate oxygen delivery, increased anaerobic glycolysis, mitochondrial dysfunction, and impaired lactate clearance. Persistent hyperlactatemia has consistently been associated with increased disease severity, multiple organ dysfunction, and mortality. However, a single lactate measurement may not adequately reflect the patient's response to treatment. Therefore, lactate clearance, which represents the percentage reduction in serum lactate concentration following resuscitation, has gained increasing attention as a dynamic indicator of tissue perfusion and therapeutic response. [3,4]

Several studies have demonstrated that early lactate clearance is associated with improved survival in patients with severe sepsis and septic shock. Patients achieving higher lactate clearance within the first few hours of resuscitation have been shown to experience lower mortality, reduced organ dysfunction, and shorter ICU stay compared with those with persistent hyperlactatemia. Consequently, lactate clearance has become an important target during early goal-directed therapy and is incorporated into contemporary sepsis management protocols. [5]

The Sequential Organ Failure Assessment (SOFA) score is a validated clinical scoring system designed to quantify the degree of organ dysfunction in critically ill patients. It evaluates respiratory, cardiovascular, hepatic, coagulation, renal, and neurological function, providing an objective assessment of illness severity. Higher SOFA scores correlate strongly with increased mortality and have become an integral component of the Sepsis-3 definition. Although SOFA score is widely used for prognostic assessment, it requires multiple clinical and laboratory parameters and may not always be immediately available in emergency settings. [1,6]

Both lactate clearance and SOFA score have demonstrated significant prognostic value in patients with sepsis. However, limited studies have directly compared their ability to predict early mortality in routine clinical practice. Identifying the more reliable and practical prognostic tool may facilitate early risk stratification and guide critical care management.

Therefore, the present study was undertaken to compare the prognostic utility of lactate clearance and SOFA score for the early prediction of mortality in patients with sepsis.

Materials and Methodology

Study Design

This was a prospective observational comparative study conducted to compare the prognostic utility of lactate clearance and SOFA score for early prediction of mortality in patients with sepsis.

Study Setting: The study was carried out in the Department of Critical Care Medicine/Intensive Care Unit of a tertiary care teaching hospital.

Study Duration: The study was conducted over a period of 24 months.

Study Population: Adult patients admitted to the ICU with a diagnosis of sepsis according to the Sepsis-3 criteria were consecutively enrolled.

Sample Size: A total of 160 patients were included in the study.

Sample Size Calculation: The sample size was calculated using the formula:

$$[n = \frac{Z^2 pq}{d^2}]$$

Where:

- **Z** = 1.96 (95% confidence level)
- **p** = Expected mortality among septic patients = 30%
- **q** = 70%
- **d** = 7%

The calculated sample size was approximately 165 patients. Based on feasibility and anticipated completeness of follow-up, 160 patients were enrolled.

Inclusion Criteria

- Patients aged 18 years or older.
- Diagnosis of sepsis according to Sepsis-3 criteria.
- ICU admission within 24 hours of presentation.
- Availability of serum lactate estimation at admission and at 6 hours.
- Informed consent from the patient or legally authorized representative.

Exclusion Criteria

- Patients below 18 years of age.
- Pregnant women.
- Patients with chronic liver failure or known inborn errors of lactate metabolism.
- Patients transferred from another ICU after more than 24 hours of treatment.
- Patients with incomplete laboratory or clinical data.

Data Collection: Detailed demographic information, comorbid illnesses, source of infection, clinical examination findings, vital parameters, and laboratory investigations were recorded at admission.

Serum lactate was measured at admission (0 hour) and repeated after 6 hours of standardized resuscitation. Lactate clearance (%) was calculated using the following formula:

$$[\text{Lactate Clearance (\%)} = \frac{\text{Initial Lactate} - \text{6-hour Lactate}}{\text{Initial Lactate}} \times 100]$$

The SOFA score was calculated at ICU admission using six organ system parameters (respiratory, cardiovascular, hepatic, coagulation, renal, and neurological).

Patients were managed according to institutional sepsis management protocols and followed until ICU discharge or death.

Outcome Measures

Primary Outcome

- ICU mortality.

Secondary Outcomes

- Length of ICU stay.
- Requirement for mechanical ventilation.
- Vasopressor requirement.
- Development of multiorgan dysfunction syndrome (MODS).

Study Variables

- Age and gender.
- Source of sepsis.
- Comorbidities.
- Initial serum lactate.
- Six-hour serum lactate.
- Lactate clearance (%).
- SOFA score.
- Mechanical ventilation.
- Vasopressor requirement.
- ICU length of stay.
- Survival outcome.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 26.0. Continuous variables were expressed as mean $\pm$ standard deviation, whereas categorical variables were presented as frequency and percentage.

Continuous variables were compared using the Independent Student's t-test or Mann–Whitney U test, while categorical variables were analyzed using the Chi-square test or Fisher's exact test. Receiver operating characteristic (ROC) curve analysis was performed to compare the predictive accuracy of lactate clearance and SOFA score for ICU mortality. The area under the curve (AUC), sensitivity, specificity, positive predictive value, and negative predictive value were calculated. Multivariate logistic regression analysis was used to identify independent predictors of mortality. A p-value <0.05 was considered statistically significant.

Ethical Considerations: The study was conducted after obtaining approval from the Institutional Ethics Committee, and written informed consent was obtained from all participants or their legally authorized representatives before enrollment.

Results

A total of 160 patients with sepsis admitted to the intensive care unit (ICU) were included in the study. Patients were followed until ICU discharge or death. Of the 160 patients, 52 (32.5%) died during ICU stay, while 108 (67.5%) survived.

Table 1: Baseline demographic and clinical characteristics of the study population

Variable	Survivors (n=108)	Non-survivors (n=52)	p-value
Age (years), Mean $\pm$ SD	51.8 $\pm$ 14.2	60.6 $\pm$ 13.8	0.001*
Male, n (%)	66 (61.1)	34 (65.4)	0.603
Female, n (%)	42 (38.9)	18 (34.6)	
SOFA score at admission, Mean $\pm$ SD	7.8 $\pm$ 2.3	12.4 $\pm$ 2.7	<0.001 *
Initial serum lactate (mmol/L), Mean $\pm$ SD	3.1 $\pm$ 1.2	5.6 $\pm$ 1.8	<0.001 *
Mechanical ventilation, n (%)	46 (42.6)	47 (90.4)	<0.001 *
Vasopressor support, n (%)	44 (40.7)	49 (94.2)	<0.001 *
ICU stay (days), Mean $\pm$ SD	6.9 $\pm$ 2.8	9.2 $\pm$ 3.9	0.004*

Non-survivors were significantly older and had higher admission SOFA scores and serum lactate levels. They also required mechanical ventilation and vasopressor support significantly more frequently than survivors ($p<0.001$).

Table 2: Comparison of lactate clearance and SOFA score between survivors and non-survivors

Parameter	Survivors (n=108)	Non-survivors (n=52)	p-value
Initial lactate (mmol/L), Mean $\pm$ SD	3.1 $\pm$ 1.2	5.6 $\pm$ 1.8	<0.001 *
6-hour lactate (mmol/L), Mean $\pm$ SD	1.9 $\pm$ 0.8	5.0 $\pm$ 1.6	<0.001 *
Lactate clearance (%), Mean $\pm$ SD	39.8 $\pm$ 12.6	11.4 $\pm$ 8.2	<0.001 *
SOFA score, Mean $\pm$ SD	7.8 $\pm$ 2.3	12.4 $\pm$ 2.7	<0.001 *

Survivors demonstrated significantly greater lactate clearance compared with non-survivors, whereas non-survivors had significantly higher SOFA scores, indicating greater organ dysfunction and poorer prognosis.

Table 3: Association of lactate clearance and SOFA score categories with ICU mortality

Variable	Total (n=160)	Survivors n (%)	Non-survivors n (%)	p-value
Lactate Clearance				
≥30%	72	67 (93.1)	5 (6.9)	
10–29%	50	33 (66.0)	17 (34.0)	
<10%	38	8 (21.1)	30 (78.9)	<0.001*
SOFA Score				
≤8	70	65 (92.9)	5 (7.1)	
9–11	45	30 (66.7)	15 (33.3)	
≥12	45	13 (28.9)	32 (71.1)	<0.001*

Patients with lactate clearance below 10% and those with SOFA scores ≥12 experienced significantly higher ICU mortality. Both parameters showed a strong association with survival outcomes ($p < 0.001$).

Table 4: Comparison of prognostic performance of lactate clearance and SOFA score for predicting ICU mortality

Parameter	Cut-off Value	Sensitivity (%)	Specificity (%)	AUC (95% CI)	p-value
Lactate clearance	<20%	90.4	84.3	0.918 (0.873–0.963)	<0.001*
SOFA score	≥10	86.5	80.6	0.891 (0.840–0.942)	<0.001*
Combined lactate clearance + SOFA model	—	94.2	88.0	0.947 (0.911–0.983)	<0.001*

Both lactate clearance and SOFA score were excellent predictors of ICU mortality. However, lactate clearance demonstrated slightly higher predictive accuracy than the SOFA score alone. The combined model incorporating lactate clearance and SOFA score achieved the highest diagnostic performance (AUC = 0.947), indicating superior early prediction of mortality in patients with sepsis.

Discussion

Early prediction of mortality in patients with sepsis is essential for appropriate risk stratification and timely therapeutic intervention. The present study compared the prognostic performance of lactate clearance and the Sequential Organ Failure Assessment (SOFA) score for predicting ICU mortality. The findings demonstrated that both lactate clearance and SOFA score were significant predictors of mortality; however, lactate clearance showed slightly better prognostic accuracy. The combination of both parameters further improved the prediction of adverse outcomes.

In the present study, survivors exhibited significantly higher lactate clearance than non-survivors. Patients with lactate clearance below 10% had the highest mortality, whereas those achieving lactate clearance of 30% or more showed excellent survival. These findings indicate that early improvement in tissue perfusion following resuscitation is closely associated with favorable outcomes. Similar observations were reported by Vincent et al., who developed the SOFA score and emphasized that progressive organ dysfunction reflects ongoing tissue hypoperfusion and increased mortality risk in critically ill patients. [7] Ferreira et al. further demonstrated that serial assessment of

organ dysfunction using the SOFA score accurately predicts clinical outcomes and that persistent organ failure is associated with poor prognosis. [8] Admission serum lactate levels were significantly higher in non-survivors, and failure to achieve adequate lactate clearance was strongly associated with mortality. These findings are consistent with those of Khosravani et al., who reported that hyperlactatemia is an independent predictor of mortality across critically ill populations and that persistent elevation in lactate reflects ongoing circulatory failure and impaired cellular metabolism. [9] Similarly, Filho et al. observed that increasing blood lactate concentrations were associated with progressively higher mortality in septic patients and suggested that lactate thresholds should be interpreted in conjunction with the patient's clinical condition. [10]

The present study also showed that higher SOFA scores at admission were significantly associated with ICU mortality. Since the SOFA score evaluates dysfunction across multiple organ systems, it remains a valuable tool for assessing illness severity. However, unlike lactate clearance, it requires several clinical and laboratory parameters, making it relatively more complex for rapid bedside assessment. Bhat et al. demonstrated that early lactate clearance was a reliable predictor of survival in patients with severe sepsis and could serve as a practical bedside marker of treatment response. [11] Likewise, Nguyen et al. reported that incorporation of lactate clearance into early sepsis resuscitation bundles significantly improved patient outcomes, emphasizing the importance of dynamic metabolic monitoring during the initial hours of treatment. [12] Receiver operating characteristic analysis in the present study demonstrated that

lactate clearance had a slightly higher area under the curve than the SOFA score for predicting mortality, while the combined model achieved the highest diagnostic accuracy. Similar findings were reported by Jones et al., who showed that lactate clearance was comparable to central venous oxygen saturation as a resuscitation target and was associated with improved survival during early sepsis management. [13] The Surviving Sepsis Campaign also recommends repeated lactate measurement to assess the adequacy of resuscitation and guide ongoing management, highlighting the clinical importance of serial lactate monitoring in patients with sepsis. [14] Overall, the findings of the present study suggest that both lactate clearance and SOFA score are effective prognostic tools for early mortality prediction in sepsis. However, lactate clearance offers the additional advantage of reflecting the patient's response to treatment in real time. Combining lactate clearance with SOFA score provides superior prognostic accuracy and may assist clinicians in identifying high-risk patients who require aggressive monitoring and advanced supportive care.

Conclusion

Both lactate clearance and SOFA score are valuable predictors of mortality in patients with sepsis. Reduced lactate clearance and higher SOFA scores were significantly associated with increased ICU mortality. Lactate clearance demonstrated slightly superior prognostic performance compared with SOFA score, while the combined assessment of both parameters provided the highest predictive accuracy. Routine evaluation of lactate clearance together with SOFA score may improve early risk stratification, facilitate timely therapeutic interventions, and enhance clinical outcomes in patients with sepsis.

References

1. Singer M, Deutschman CS, Seymour CW, Shankar-Hari M, Annane D, Bauer M, et al. The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA*. 2016;315(8):801-810. doi:10.1001/jama.2016.0287
2. Rhodes A, Evans LE, Alhazzani W, Levy MM, Antonelli M, Ferrer R, et al. Surviving Sepsis Campaign: International Guidelines for Management of Sepsis and Septic Shock: 2016. *Crit Care Med*. 2017;45(3):486-552. doi:10.1097/CCM.0000000000002255
3. Vincent JL, Quintairos ESA, Couto L Jr, Taccone FS. The value of blood lactate kinetics in critically ill patients: A systematic review. *Crit Care*. 2016;20(1):257. doi:10.1186/s13054-016-1403-5
4. Nguyen HB, Rivers EP, Knoblich BP, Jacobsen G, Muzzin A, Ressler JA, Tomlanovich MC. Early lactate clearance is associated with improved outcome in severe sepsis and septic shock. *Crit Care Med*. 2004; 32(8):1637-1642. doi:10.1097/01.CCM.0000132904.35713.A7. (PubMed)
5. Casserly B, Phillips GS, Schorr C, Dellinger RP, Townsend SR, Osborn TM, et al. Lactate measurements in sepsis-induced tissue hypoperfusion: Results from the Surviving Sepsis Campaign database. *Crit Care Med*. 2015;43(3):567-573. doi:10.1097/CCM.0000000000000742. (PubMed)
6. Ryoo SM, Lee J, Lee YS, Lee JH, Lim KS, Huh JW, et al. Lactate level versus lactate clearance for predicting mortality in patients with septic shock defined by Sepsis-3. *Crit Care Med*. 2018;46(6):e489-e495. doi:10.1097/CCM.0000000000003030. (PubMed)
7. Vincent JL, Moreno R, Takala J, Willatts S, De Mendonça A, Bruining H, et al. The SOFA (Sepsis-related Organ Failure Assessment) score to describe organ dysfunction/failure. *Intensive Care Med*. 1996;22(7):707-710. doi:10.1007/BF01709751
8. Ferreira FL, Bota DP, Bross A, Mélot C, Vincent JL. Serial evaluation of the SOFA score to predict outcome in critically ill patients. *JAMA*. 2001;286(14):1754-1758. doi:10.1001/jama.286.14.1754
9. Khosravani H, Shahpori R, Stelfox HT, Kirkpatrick AW, Laupland KB. Occurrence and adverse effect on outcome of hyperlactatemia in the critically ill. *Crit Care*. 2009;13(3):R90. doi:10.1186/cc7918
10. Filho RR, Rocha LL, Corrêa TD, Pessoa CMS, Colombo G, Assuncao MSC. Blood lactate levels cutoff and mortality prediction in sepsis: Time for a reappraisal? *Shock*. 2016;46(5):480-485. doi:10.1097/SHK.0000000000000667
11. Bhat SR, Swenson KE, Francis MW, Wira CR. Lactate clearance predicts survival among patients in the emergency department with severe sepsis. *West J Emerg Med*. 2015;16(7):1118-1126. doi:10.5811/westjem.2015.10.27577. (PubMed Central (PMC))
12. Nguyen HB, Kuan WS, Batech M, Shrikhande P, Mahadevan M, Li CH, et al. Outcome effectiveness of the severe sepsis resuscitation bundle with addition of lactate clearance as a bundle item: A multinational evaluation. *Crit Care*. 2011;15(5):R229. doi:10.1186/cc10469. (PubMed)
13. Jones AE, Shapiro NI, Trzeciak S, Arnold RC, Claremont HA, Kline JA; Emergency Medicine Shock Research Network (EMShockNet) Investigators. Lactate clearance vs central venous oxygen saturation as goals of early sepsis therapy: A randomized clinical

- trial. JAMA. 2010;303(8):739-746. doi:10.1001/jama.2010.158
14. Levy MM, Evans LE, Rhodes A. The Surviving Sepsis Campaign Bundle: 2018 update. Intensive Care Med. 2018;44(6):925-928. doi:10.1007/s00134-018-5085-0.