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PROGNOSTIC ACCURACY OF SERUM LACTATE IN DETERMINING MORTALITY IN SEPSIS AT DHQ HOSPITAL MIRPUR AJK

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Abstract

Background: *Sepsis is a life-threatening condition characterized by a dysregulated host response to infection, often resulting in multi-organ dysfunction and high mortality. Early identification of high-risk patients is essential for improving outcomes. Serum lactate has emerged as a valuable biomarker for assessing disease severity and guiding timely interventions. This study evaluates the prognostic utility of serum lactate levels in predicting in-hospital mortality among septic patients.*

Materials and Methods: *This prospective observational study was conducted at DHQ Hospital Mirpur, AJK over a period of six months to evaluate the prognostic utility of serum lactate in septic patients. A total of 110 adult patients diagnosed with sepsis were included based on Sepsis-3 criteria. Serum lactate levels and SOFA scores were recorded at admission, and in-hospital mortality up to 28 days was assessed as the primary outcome. Diagnostic accuracy metrics, including sensitivity, specificity, PPV, NPV, and p-values, were calculated using SPSS version 23.0. The statistical significance set at $p \leq 0.05$.*

Results: *Among 110 patients diagnosed with sepsis, 77.3% survived while 22.7% died during hospitalization. Non-survivors were significantly older and had higher serum lactate levels and SOFA scores at admission compared to survivors ($p < 0.001$). Respiratory infections were more common among non-survivors, whereas urinary tract infections predominated in survivors. A serum lactate cutoff of ≥4.0 mmol/L demonstrated high diagnostic accuracy (89.1%) in predicting mortality, with a sensitivity of 96.0% and specificity of 87.1%.*

Conclusion: *Serum lactate proved to be a valuable prognostic biomarker for predicting in-hospital mortality among septic patients. A threshold of ≥4.0 mmol/L demonstrated high diagnostic accuracy, supporting its use in early risk stratification.*

INTRODUCTION

Sepsis is a life-threatening condition resulting from a dysregulated host response to infection, leading to acute organ dysfunction.[1] It is characterized by complex physiological, pathological, and biochemical

disturbances that can rapidly progress to circulatory collapse.[2] Despite advancements in critical care, severe sepsis and septic shock remain major contributors to morbidity and mortality worldwide. Sepsis is responsible for 1 in 5 (20%) of all global deaths and represents the leading cause of mortality in patients with infectious diseases, particularly when diagnosis and treatment are delayed.[3]

The pathophysiology of sepsis involves a highly intricate cascade of inflammatory and anti-inflammatory responses, hormonal imbalances, cellular dysfunction, and hemodynamic alterations.[1] Early identification of patients at risk, along with prompt monitoring and intervention, is essential to improve clinical outcomes.[4] Accordingly, there is a pressing need for rapid, cost-effective methods that facilitate risk stratification and timely management in septic patients.[5]

A critical component of sepsis management is the early recognition of patients who are at high risk of adverse outcomes. Timely initiation of treatment—including prompt antibiotic administration and fluid resuscitation—has been shown to improve survival.[6] To aid in early detection, several scoring systems have been developed for bedside use, including track-and-trigger tools and organ dysfunction indices. One such scoring tool is the Sequential Organ Failure Assessment (SOFA) score, which quantifies the extent of organ dysfunction and is commonly employed in intensive care units (ICUs).[2,6]

Biomarkers have also emerged as valuable tools in the diagnostic and prognostic assessment of sepsis. Among these, serum lactate has gained prominence as a sensitive—albeit nonspecific—indicator of metabolic stress.[7] Under normal conditions, lactate is continuously produced and metabolized in various tissues such as the brain, gastrointestinal tract, skeletal muscle, and red blood cells, maintaining baseline serum levels around 1 mmol/L.[2,8]

Lactate levels increase in response to tissue hypoxia, physiological stress, and critical illness.[7] Higher lactate levels have been consistently associated with poorer clinical outcomes.[9,10] Therefore, early detection of hyperlactatemia may enable clinicians to identify high-risk patients and initiate timely, targeted interventions.[10]

The present study aims to evaluate the prognostic utility of serum lactate levels in predicting in-hospital mortality among patients with sepsis. By assessing its diagnostic accuracy, the study seeks to contribute to improved risk stratification and clinical decision-making in the management of sepsis.

MATERIALS AND METHODS:

This prospective observational study was conducted in the Department of Medicine at DHQ Hospital Mirpur, AJK from December 2023 to May 2024. The study was carried out following approval from the institutional ethical review board. Informed consent was obtained from all participants or their legal representatives prior to enrollment.

A sample size of 110 patients was calculated using OpenEpi software. All adult patients (aged ≥18 years) who were admitted with a clinical diagnosis of sepsis were considered eligible for inclusion. Sepsis was defined according to the Third International Consensus Definitions (Sepsis-3) as life-threatening organ dysfunction resulting from a dysregulated host response to infection.[11] Patients were included if they had a confirmed or suspected infection along with documented organ dysfunction. Exclusion criteria included patients with incomplete data, particularly missing serum lactate measurements or SOFA score calculations at the time of admission.

Relevant clinical and laboratory parameters were recorded at the time of patient admission. The collected data included demographic variables (age and gender), the primary source of infection (classified as respiratory, urinary, abdominal, skin/soft tissue, or bloodstream), initial serum lactate concentration (mmol/L), and the Sequential Organ Failure Assessment (SOFA) score, calculated upon admission. Serum lactate levels were obtained within the first hour of hospital presentation. All measurements were conducted in the hospital's central laboratory and reported in millimoles per liter (mmol/L). These values were evaluated in the clinical context and utilized as prognostic indicators for disease severity and patient outcome.

Patients were followed for in-hospital outcomes, and mortality upto 28 days was recorded as the primary endpoint.

Data were analyzed using SPSS version 23.0 (IBM Corp., Armonk, NY). Continuous variables were expressed as mean ± standard deviation (SD), and categorical variables were presented as frequencies

and percentages. Comparisons between survivors and non-survivors were performed using the independent sample *t*-test or Mann-Whitney *U* test for continuous variables, and the Chi-square test or Fisher's exact test for categorical variables, as appropriate.

The diagnostic accuracy of serum lactate in predicting mortality was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), diagnostic accuracy (DA) and *p*-values. A *p*-value of <0.05 was considered statistically significant.

RESULTS:

A total of 110 patients diagnosed with sepsis were included in the study. Among them, 85 patients (77.3%) survived, while 25 patients (22.7%) succumbed during hospitalization. This distribution of outcomes is shown in Figure 1.

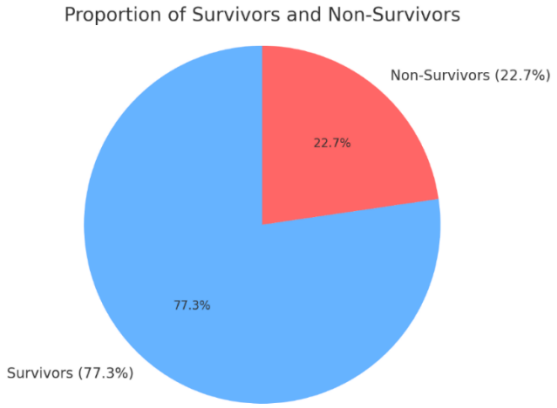

Figure 1. Proportion of Survivors and Non-Survivors

The mean age of the study population was significantly higher in the non-survivor group compared to the survivor group (60.4 ± 11.7 years vs. 48.2 ± 13.3 years, $p < 0.001$). There was no statistically significant difference in gender distribution between the two groups (male/female ratio: 48/37 in survivors vs. 16/9 in non-survivors; $p = 0.500$).

Regarding the source of infection, respiratory tract infections were the most common overall and were more frequently observed in non-survivors (60.0%) than in survivors (41.2%). Urinary tract infections were predominantly found among survivors (23.5%) compared to a lower proportion in non-survivors (8.0%). Abdominal infections accounted for 17.6% in survivors and 16.0% in non-survivors. Skin/soft tissue infections and bloodstream infections were less common in both groups. The is shown in Table 1.

Table 1. Demographic Details and Source of Infection Among Survivors and Non-Survivors

PARAMETER	SURVIVORS (n=85)	NON-SURVIVORS (n=25)	p-VALUE*
Mean Age (years)	48.2 ± 13.3	60.4 ± 11.7	<0.001
Gender (M/F)	48 / 37	16 / 9	0.500
Source of Infection			
– Respiratory	35 (41.2%)	15 (60.0%)	
– Urinary	20 (23.5%)	2 (8.0%)	
– Abdominal	15 (17.6%)	4 (16.0%)	
– Skin/Soft Tissue	8 (9.4%)	1 (4.0%)	
– Bloodstream	7 (8.2%)	3 (12.0%)	

* $p \leq 0.05$ was considered statistically significant.

The mean serum lactate level was significantly elevated in non-survivors compared to survivors (6.69 ± 1.71 mmol/L vs. 3.23 ± 0.91 mmol/L, $p < 0.001$), indicating a strong association between hyperlactatemia and mortality. Similarly, the mean SOFA score at admission was markedly higher among non-survivors (10.52 ± 2.77) than survivors (2.84 ± 1.97), with this difference also being statistically significant ($p < 0.001$). These findings are summarized in Table 2.

Table 2. Comparison of Serum Lactate Levels and SOFA Scores Between Survivors and Non-Survivors

PARAMETER	SURVIVORS (n=85)	NON-SURVIVORS (n=25)	p-VALUE*
Serum Lactate (mmol/L)	3.23 ± 0.91	6.69 ± 1.71	<0.001
SOFA Score	2.84 ± 1.97	10.52 ± 2.77	<0.001

* $p \leq 0.05$ was considered statistically significant.

Using a serum lactate cutoff value of ≥4.0 mmol/L for predicting in-hospital mortality, diagnostic performance was calculated. The sensitivity was 96.0%, specificity was 87.1%, positive predictive value (PPV) was 68.6%, while the negative predictive value (NPV) was 98.7%. The overall diagnostic accuracy was 89.1% as shown in Table 3.

Table 3: Diagnostic Performance of Serum Lactate ≥4.0 mmol/L for Predicting Mortality

PARAMETER	VALUE
Sensitivity	96.0%
Specificity	87.1%
Positive Predictive Value	68.6%
Negative Predictive Value	98.7%
Diagnostic Accuracy	89.1%

DISCUSSION:

Timely and accurate assessment of illness severity remains a fundamental objective in clinical practice, particularly in the management of sepsis.[6] Regardless of its etiology, sepsis frequently results in a mismatch between oxygen delivery and tissue demand, leading to cellular hypoxia.[2] Serum lactate has emerged as a valuable biomarker in this context due to its close association with microcirculatory dysfunction and impaired tissue perfusion, independent of conventional hemodynamic parameters.[12] Elevated lactate levels serve as a surrogate indicator of tissue hypoxia and have demonstrated utility in early risk stratification, guiding therapeutic interventions to potentially reduce mortality among septic patients.[13]

In the present study, we observed that non-survivors were significantly older than survivors, with a statistically significant difference ($p < 0.001$). These findings are consistent with those reported by Chang et al., who demonstrated that deceased patients had a higher mean age compared to survivors (69 vs. 43 years, $p = 0.003$), suggesting that advanced age is an important prognostic factor in sepsis outcomes.[14]

Gender distribution in our cohort did not differ significantly between survivors and non-survivors. This aligns with findings by Chang et al., who reported no significant association between sex and mortality ($P = 0.13$), as well as Wanrooij et al., whose multivariable logistic regression analysis confirmed that sex was not an independent predictor of 30-day mortality.[14,15]

Regarding the source of infection, respiratory tract infections were the predominant focus in our study population, followed by urinary tract infections (UTIs). These findings corroborate the work of Wanrooij et al. and Ko et al., both of whom identified the respiratory tract as the most common infection site in septic patients, with UTIs as the second most frequent.[15,16]

A significant difference was observed in mean serum lactate levels between survivors and non-survivors ($p < 0.001$), indicating a strong correlation between hyperlactatemia and adverse outcomes. Similarly, SOFA scores at the time of admission were notably higher in non-survivors ($p < 0.001$), reinforcing the prognostic relevance of organ dysfunction scoring. These results are in agreement with prior investigations. Kumrawat et al. reported significantly elevated lactate levels in non-survivors (3.56 ± 1.90 mmol/L) compared to survivors (1.47 ± 0.82 mmol/L, $p < 0.001$).[17] Sekhar et al. found comparable results, with mean lactate values of 6.73 ± 2.25 mmol/L in non-survivors versus 3.12 ± 1.19 mmol/L in survivors ($p < 0.0001$), and SOFA scores of 7.35 ± 1.38 and 2.39 ± 1.54, respectively ($p < 0.0001$).[18] Similarly, Ayaz et al. demonstrated significantly higher lactate levels (4.9 ± 0.5 mmol/L) and SOFA scores in non-survivors compared to survivors, with p-values < 0.001.[19]

In terms of diagnostic performance, our study identified a serum lactate threshold of 4.0 mmol/L as the optimal cutoff for predicting mortality. At this threshold, sensitivity was 96.0%, specificity 87.1%, positive predictive value (PPV) 68.6%, and negative predictive value (NPV) 98.7%, yielding an overall diagnostic accuracy of 89.1%. These values highlight the robustness of lactate as a predictive biomarker in septic patients. Our results compare favorably with prior literature. Ayaz et al. reported an AUROC of 0.79 for serum lactate with 81% sensitivity and 64% specificity, while Gicheru et al. found a lactate cutoff of 3.5 mmol/L to have 66.7% sensitivity and 71.4% specificity, with corresponding PPV and NPV values of 70% and 68.2%, respectively.[19,20] Das et al. reported an AUROC of 0.85, with 78% sensitivity, 79% specificity, and a diagnostic accuracy of 78%, which further supports the utility of lactate in prognostication.[9]

The limitation to our study includes the relatively small sample size, and the study was conducted at a single center, which may affect the generalizability of the findings. Additionally, we did not assess serial lactate measurements or lactate clearance, which may provide additional prognostic information in sepsis management.

CONCLUSION:

This study reinforces the utility of serum lactate as a potent prognostic biomarker in sepsis. A cutoff value of ≥4.0 mmol/L effectively predicts in-hospital mortality, facilitating timely and targeted interventions. Future multicenter studies with larger cohorts are warranted to validate these findings and explore the integration of lactate measurements with other clinical parameters to optimize sepsis management strategies.

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