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Original Research Article

Early Lactate Clearance as an Independent Predictor of Mortality among Critically Ill Children with Sepsis: A Prospective Observational Study

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Abstract

Background: Sepsis remains one of the leading causes of morbidity and mortality among critically ill children worldwide. Early identification of patients at high risk of adverse outcomes is essential for timely intervention and optimization of intensive care management. Lactate clearance has emerged as a dynamic biomarker reflecting tissue perfusion and response to resuscitation. However, evidence regarding its prognostic utility in pediatric sepsis remains limited.

Aim: To evaluate the prognostic value of early lactate clearance in predicting mortality among critically ill children with sepsis admitted to a pediatric intensive care unit (PICU).

Materials and Methods: A prospective observational study was conducted among 120 children with sepsis admitted to the PICU of a tertiary care teaching hospital. Blood lactate levels were measured at admission, 6 hours, and 12 hours after admission. Lactate clearance was calculated at 6 and 12 hours. Demographic characteristics, clinical parameters, vasoactive inotropic score (VIS), Pediatric Risk of Mortality (PRISM) score, duration of mechanical ventilation, PICU stay, and survival outcomes were recorded. Statistical analyses included independent t-tests, Mann–Whitney U tests, chi-square tests, receiver operating characteristic (ROC) analysis, correlation analysis, and logistic regression.

Results: The overall mortality rate was 34.2%. Survivors demonstrated significantly higher lactate clearance at both 6 hours and 12 hours compared with non-survivors ($p<0.001$). Median 12-hour lactate clearance was 71.1% among survivors and −27.3% among non-survivors. Logistic regression identified 12-hour lactate clearance as an independent predictor of survival (OR=0.925; 95% CI: 0.895–0.947; $p<0.001$). Lactate clearance showed significant correlations with PRISM scores, VIS scores, mechanical ventilation duration, and PICU stay.

Conclusion: Early lactate clearance, particularly at 12 hours, is a reliable and independent predictor of mortality in pediatric sepsis. Serial lactate monitoring may serve as a valuable bedside tool for risk stratification and therapeutic monitoring in critically ill children.

Keywords: Sepsis, Pediatric intensive care unit, Lactate clearance, Mortality, Prognostic marker, Critical illness.

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Introduction

Sepsis is a life-threatening organ dysfunction resulting from a dysregulated host response to infection and remains a major cause of pediatric mortality worldwide. Despite substantial advances in critical care medicine, sepsis continues to account for significant mortality, prolonged hospitalization, and healthcare expenditure among children admitted to intensive care units.

The pathophysiology of sepsis involves complex interactions between inflammatory mediators, endothelial dysfunction, microvascular impairment, and tissue hypoperfusion. One of the earliest biochemical consequences of inadequate tissue oxygen delivery is increased lactate production. Elevated serum lactate concentrations are frequently encountered in critically ill patients and have been associated with adverse outcomes across various critical care settings.

Traditionally, a single lactate measurement has been used as an indicator of disease severity. However, static lactate levels may not adequately reflect the dynamic response to treatment. Consequently, lactate clearance—the percentage reduction in lactate concentration over time—has

emerged as a potentially superior marker of resuscitation adequacy and restoration of tissue perfusion. Several adult studies have demonstrated that early lactate clearance is associated with improved survival in septic shock and critical illness. Nevertheless, pediatric data remain relatively sparse and inconsistent. Children exhibit unique physiological responses to sepsis, making extrapolation from adult populations difficult. Therefore, evaluating the prognostic significance of lactate clearance in pediatric sepsis is essential.

This study was undertaken to assess the role of early lactate clearance in predicting mortality among critically ill children admitted to a pediatric intensive care unit with sepsis.

Aim: To determine whether early lactate clearance can independently predict mortality among critically ill children with sepsis admitted to the PICU.

Objectives

1. To measure serum lactate concentrations at admission, 6 hours, and 12 hours.
2. To calculate lactate clearance at 6 hours and 12 hours.
3. To compare lactate clearance between survivors and non-survivors.
4. To evaluate the association between lactate clearance and clinical severity indicators.
5. To identify whether lactate clearance independently predicts mortality.

Materials and Methods

Study Design and Setting: This prospective observational study was conducted in the Pediatric Intensive Care Unit of a tertiary care teaching hospital over an 18-month period. The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from parents or legal guardians before enrollment.

Study Population: Children admitted to the PICU with a diagnosis of sepsis according to internationally accepted pediatric sepsis criteria were eligible for participation.

Inclusion Criteria

Children aged 1 month to 18 years with:

- Clinical diagnosis of sepsis
- PICU admission requiring intensive monitoring
- Availability of serial lactate measurements
- Informed parental consent

Exclusion Criteria

Children with:

- Known inborn errors of metabolism
- Chronic liver disease
- End-stage renal disease
- Congenital metabolic disorders affecting lactate metabolism
- Incomplete laboratory data
- Death within one hour of admission before repeat lactate measurement

Sample Size: A total of 120 children fulfilling the eligibility criteria were enrolled consecutively during the study period.

Data Collection Procedure: Following admission, detailed demographic and clinical information was collected. Baseline physiological parameters including heart rate, blood pressure, oxygen saturation, urine output, and temperature were recorded.

Severity assessment was performed using:

Pediatric Risk of Mortality (PRISM) Score: PRISM score was calculated within the first 24 hours of admission to assess disease severity and predict mortality risk.

Vasoactive Inotropic Score (VIS): VIS was calculated to quantify vasoactive and inotropic support requirements.

Laboratory Investigations

The following investigations were performed:

- Complete blood count
- Blood culture
- Renal function tests
- Liver function tests
- Serum electrolytes
- Arterial blood gas analysis
- Serum lactate levels

Lactate measurements were obtained:

- At admission (0 hour)
- At 6 hours
- At 12 hours

Calculation of Lactate Clearance: Lactate clearance (%) was calculated using the formula:

\text{Lactate Clearance (%)} = \frac{\text{Initial Lactate} - \text{Subsequent Lactate}}{\text{Initial Lactate}} \times 100

Positive values indicated improvement in tissue perfusion, whereas negative values indicated worsening metabolic status.

Statistical Analysis: Data were analyzed using SPSS version 26.

Continuous variables were expressed as mean ± standard deviation or median with interquartile range. Categorical variables were expressed as frequencies and percentages. Comparisons between survivors and non-survivors were performed using:

- Independent t-test

- Mann–Whitney U test
- Chi-square test

Receiver operating characteristic (ROC) analysis assessed predictive accuracy.

Multivariate logistic regression identified independent predictors of mortality. A p-value <0.05 was considered statistically significant.

Results

Baseline Characteristics A total of 120 children with sepsis were included. The mean age was 28.3 ± 41 months. The mortality rate was 34.2%.

Table 1: Baseline Characteristics of Study Population

Variable	Mean ± SD
Age (months)	28.3 ± 41.0
Weight (kg)	8.2 ± 7.5
Heart Rate (Admission)	147.9 ± 34.6
SBP (mmHg)	82.0 ± 15.9
DBP (mmHg)	56.3 ± 10.8
PRISM Score	17.5 ± 7.1
VIS Score	38.5 ± 44.8

Children who subsequently died had significantly lower blood pressures, higher heart rates, and higher PRISM scores compared with survivors.

Serial Lactate Trends

Table 2: Serial Lactate Levels and Lactate Clearance

Parameter	Mean ± SD
Lactate 0 hour	3.6 ± 1.0
Lactate 6 hour	2.3 ± 1.6
Lactate 12 hour	2.3 ± 2.0
Delta Lactate 6 hour	1.3 ± 1.5
Delta Lactate 12 hour	1.2 ± 2.0
Lactate Clearance 6 hour (%)	34.6 ± 39.9
Lactate Clearance 12 hour (%)	31.7 ± 58.6

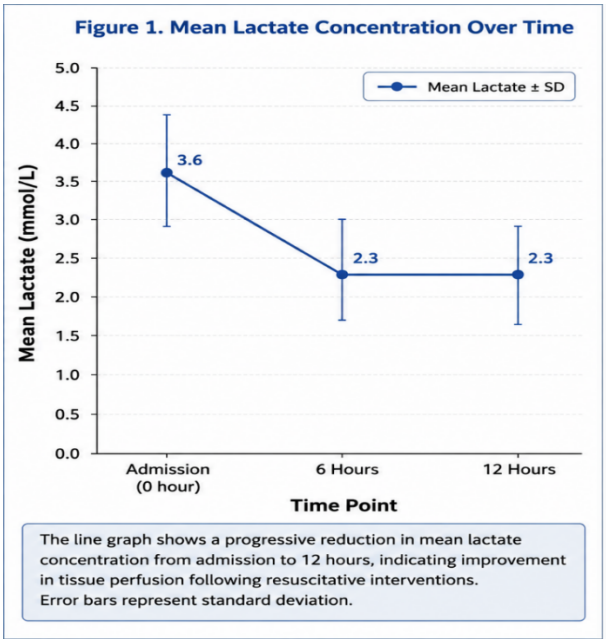

Figure 1: demonstrates a progressive reduction in mean lactate concentrations from admission to 12 hours, suggesting improved tissue perfusion following resuscitative interventions.

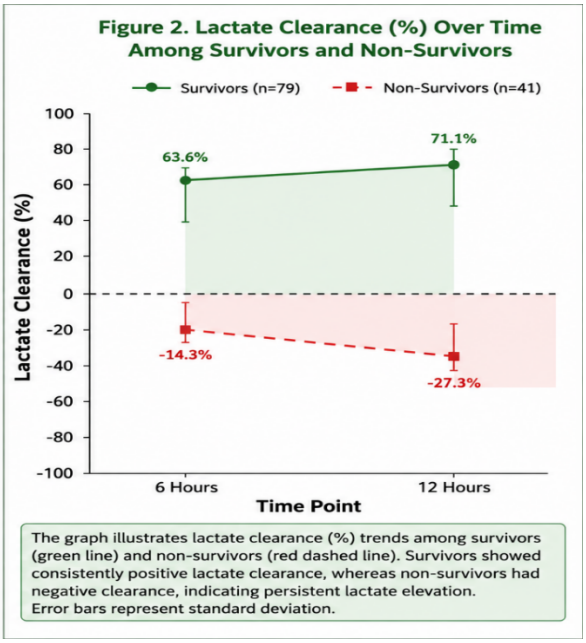

Figure 2: illustrates lactate clearance trends among survivors and non-survivors. Survivors consistently showed positive lactate clearance whereas non-survivors demonstrated persistent lactate elevation.

Lactate Clearance and Mortality

Table 3: Comparison of Lactate Clearance between Survivors and Non-Survivors

Variable	Survivors	Non-Survivors	p-value
Lactate Clearance 6 hr (%)	63.6	-14.3	<0.001
Lactate Clearance 12 hr (%)	71.1	-27.3	<0.001

As shown in Table 3, survivors exhibited substantially greater lactate clearance at both time points. Non-survivors demonstrated negative clearance values, indicating persistent tissue hypoperfusion.

Logistic Regression Analysis

Table 4: Logistic Regression Predicting Survival

Variable	Odds Ratio	95% CI	p-value
Lactate Clearance 6 hr	0.771	0.401–0.897	0.237
Lactate Clearance 12 hr	0.925	0.895–0.947	<0.001

Multivariate analysis demonstrated that 12-hour lactate clearance independently predicted survival. Each incremental improvement in lactate clearance was associated with a reduction in mortality risk.

Discussion

The present study evaluated the prognostic significance of early lactate clearance among critically ill children with sepsis. Our findings indicate that lactate clearance, particularly at 12 hours, is a powerful predictor of survival.

We observed a significant decline in lactate concentrations during the first 12 hours following PICU admission. Survivors exhibited markedly higher lactate clearance than non-survivors, indicating improved tissue perfusion and metabolic recovery.

These findings are consistent with Nguyen et al., who demonstrated that early lactate clearance is associated with improved survival among septic patients. Similarly, Choudhary et al. reported significantly higher lactate clearance among pediatric survivors of septic shock.

Kumar and Kumar identified a 6-hour lactate clearance threshold of 16.4% as predictive of mortality in critically ill children. Our findings extend these observations by demonstrating that 12-hour lactate clearance provides even greater prognostic value.

Moustafa et al. reported an AUC of 0.766 for 6-hour lactate clearance in predicting pediatric mortality. The present study similarly supports serial lactate monitoring but suggests that continued assessment beyond 6 hours may improve prognostic discrimination.

Persistent hyperlactatemia likely reflects ongoing tissue hypoxia, impaired microcirculation, mitochondrial dysfunction, and inadequate resuscitation. Consequently, failure of lactate clearance may serve as an early warning sign prompting escalation of therapy.

The significant relationship observed between lactate clearance and PRISM score further emphasizes its role as an indicator of disease severity. Associations with VIS score and duration of mechanical ventilation suggest that lactate clearance reflects overall physiological recovery rather than isolated metabolic improvement.

The major strength of the present study lies in its prospective design and serial assessment of lactate dynamics. Nevertheless, being a single-center study, the generalizability of findings may be limited.

Limitations: This study was conducted at a single center with a moderate sample size, which may limit the generalizability of the findings. The heterogeneous causes of sepsis among participants could have influenced lactate kinetics and outcomes.

Additionally, long-term follow-up was not performed, and variations in therapeutic interventions may have affected lactate clearance measurements. Despite these limitations, the study highlights the prognostic value of early lactate clearance in critically ill children.

Conclusion

Early lactate clearance is a valuable prognostic biomarker in pediatric sepsis. Children demonstrating higher lactate clearance during the first 12 hours of PICU admission experience significantly improved survival. Twelve-hour lactate clearance independently predicts mortality and may serve as an important bedside tool for risk stratification and monitoring response to therapy in critically ill children.

Ethical Approval: Approved by the Institutional Ethics Committee. Written informed consent was obtained from parents or legal guardians.

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