AMERICAN JOURNAL OF APPLIED MEDICAL SCIENCE
ISSN: 2996-5101 (online) | ResearchBib (IF) = 10.81 IMPACT FACTOR
Volume-4| Issue-6| 2026 Published: |30-06-2026|

ASSESSMENT OF LACTATE DYNAMICS AND MICROCIRCULATION AS MARKERS OF INTENSIVE CARE EFFECTIVENESS IN SEPTIC SHOCK

https://doi.org/10.5281/zenodo.20538354

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Abstract

Septic shock remains one of the leading causes of mortality in intensive care units. Despite modern intensive care protocols, mortality associated with this condition remains high, necessitating the identification of reliable prognostic markers for treatment effectiveness.

The aim of this study was to evaluate the prognostic significance of lactate clearance dynamics and tissue perfusion parameters in patients with septic shock.

The study included patients with septic shock treated in the intensive care unit (ICU). Monitoring included blood lactate levels, lactate clearance over time, as well as indicators of peripheral microcirculation and capillary refill.

Low lactate clearance and persistent microcirculatory disturbances were found to be associated with increased mortality and poor clinical outcomes. Dynamic assessment of these parameters may be useful for early risk stratification and optimization of intensive care management.

Keywords

septic shock, intensive care medicine, lactate, lactate clearance, microcirculation, tissue hypoperfusion, intensive care, prognosis, mortality, intensive care unit.

INTRODUCTION

Septic shock is one of the most severe critical conditions encountered in intensive care medicine and is characterized by a profound systemic inflammatory response, progressive tissue hypoperfusion, and multiorgan failure. Despite substantial advances in critical care, mortality rates in septic shock remain high, ranging from 30% to 50%.

A key pathophysiological feature of septic shock is microcirculatory dysfunction and the development of tissue hypoxia, resulting in a shift toward anaerobic metabolism and lactate accumulation. Blood lactate concentration and the rate of lactate clearance are currently regarded as important markers of disease severity and treatment effectiveness.

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However, isolated lactate assessment does not always fully reflect the restoration of tissue perfusion. Therefore, the combined evaluation of lactate clearance and microcirculatory parameters may improve the accuracy of outcome prediction in patients with septic shock.

Objective of the Study

To evaluate the prognostic significance of lactate clearance and tissue perfusion parameters in patients with septic shock treated in the intensive care unit.

MATERIALS AND METHODS

This prospective study included 86 patients diagnosed with septic shock and treated in the intensive care unit. Patient age ranged from 42 to 79 years. Septic shock was diagnosed according to the **Sepsis-3 criteria**.

Patients were divided into two groups:

- **Group I (n = 44):** survivors
- **Group II (n = 42):** non-survivors

Monitoring included:

- Blood lactate level (mmol/L) at admission and after 6, 12, and 24 hours
- Lactate clearance calculation (%)
- Microcirculatory assessment using laser Doppler flowmetry
- Capillary refill time (CRT)
- Mean arterial pressure (MAP)

Lactate clearance was calculated using the following formula:

$$\textbf{Lactate Clearance (\%)} = [(\text{Lactate}_0 - \text{Lactate}_t) / \text{Lactate}_0] \times 100$$

Statistical analysis was performed using Student's *t*-test, the χ^2 test, and Pearson correlation analysis. Differences were considered statistically significant at $p < 0.05$.

RESULTS

The study demonstrated that patients with unfavorable outcomes had significantly higher lactate levels at admission and slower lactate clearance during the first 24 hours.

Table 1. Changes in Blood Lactate Levels (mmol/L)

Time Point	Survivors (n=44)	Non-survivors (n=42)
Admission	3.8 ± 0.6	6.2 ± 0.9*
6 hours	3.1 ± 0.5	5.8 ± 0.8*
12 hours	2.4 ± 0.4	5.1 ± 0.7*
24 hours	1.8 ± 0.3	4.9 ± 0.6*

* $p < 0.05$

Significant differences were also observed in lactate clearance.

Table 2. Lactate Clearance in the Study Groups (%)

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Time Point	Survivors	Non-survivors
6 hours	18.4 ± 3.2	6.1 ± 2.5*
12 hours	38.7 ± 4.6	12.3 ± 3.8*
24 hours	58.9 ± 5.1	18.6 ± 4.2*

* $p < 0.05$

Marked disturbances in microcirculation and tissue perfusion were also identified among non-survivors.

Table 3. Tissue Perfusion Parameters

Parameter	Survivors	Non-survivors
CRT (sec)	2.1 ± 0.4	4.8 ± 0.7*
Perfusion (arbitrary units)	72.6 ± 6.9	41.3 ± 5.8*
MAP (mmHg)	78.4 ± 8.1	61.2 ± 7.5*

* $p < 0.05$

Key Finding

Patients with low lactate clearance demonstrated significantly higher mortality rates, confirming lactate clearance as an important early prognostic marker of septic shock outcomes.

DISCUSSION

The findings confirm the central role of hypoperfusion and cellular metabolic disturbances in the pathogenesis of septic shock. Elevated lactate levels at admission among non-survivors reflect severe tissue hypoxia and a shift toward anaerobic metabolism.

Particular importance should be attributed to lactate clearance, which in this study demonstrated greater prognostic value than a single lactate measurement. Patients with fatal outcomes exhibited significantly slower lactate reduction during the first 24 hours, indicating persistent tissue hypoperfusion despite intensive care interventions.

Microcirculatory abnormalities, including prolonged capillary refill time and reduced perfusion, further support the systemic nature of circulatory dysfunction in septic shock. These changes were closely correlated with lactate levels and clinical outcomes.

Therefore, combined assessment of lactate clearance and microcirculatory parameters provides a more accurate evaluation of intensive care effectiveness and improves outcome prediction.

CONCLUSIONS

1. Patients with septic shock and unfavorable outcomes exhibit significantly higher blood lactate levels at admission.

2. Low lactate clearance during the first 24 hours is associated with increased mortality and represents an unfavorable prognostic indicator.
3. Microcirculatory disturbances, including prolonged CRT, reduced perfusion, and decreased MAP, are closely related to disease severity.
4. Lactate clearance combined with tissue perfusion parameters can serve as an integrated marker of intensive care effectiveness.
5. Comprehensive monitoring of these parameters improves early risk stratification in patients with septic shock.

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