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COMPARATIVE ASSESSMENT OF HEMODYNAMIC AND METABOLIC PARAMETERS IN PATIENTS WITH SEPTIC AND CARDIOGENIC SHOCK IN THE INTENSIVE CARE UNIT

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Abstract

Aim. To perform a comparative analysis of hemodynamic and metabolic parameters in patients with septic and cardiogenic shock and to identify prognostic markers of adverse outcomes.

Materials and methods. This prospective study included 120 patients with shock conditions treated in the intensive care unit. Patients were divided into two groups: septic shock (n=60) and cardiogenic shock (n=60). The following parameters were assessed: mean arterial pressure (MAP), cardiac index, blood lactate level, lactate clearance, urine output, and microcirculatory parameters. Statistical analysis included Student's t-test, chi-square test, and correlation analysis.

Results. Patients with septic shock demonstrated more pronounced peripheral microcirculatory disturbances and higher admission lactate levels. In cardiogenic shock, a decrease in cardiac index and severe hypoperfusion due to reduced cardiac output predominated. Low lactate clearance and persistent reduction in MAP were associated with higher mortality in both groups. A combined assessment of lactate and microcirculation showed high prognostic value.

Conclusion. Septic and cardiogenic shock have different hemodynamic mechanisms but similar metabolic consequences, including tissue hypoxia and lactic acidosis. Lactate clearance and microcirculatory parameters are universal markers of disease severity and outcome.

Keywords

septic shock, cardiogenic shock, intensive care, hemodynamics, lactate, lactate clearance, microcirculation, tissue hypoperfusion, critical conditions, prognosis, mortality

INTRODUCTION

Shock states remain one of the leading causes of mortality in intensive care units. Despite different etiologies, septic and cardiogenic shock share a final

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pathophysiological mechanism—tissue hypoperfusion leading to multiple organ dysfunction syndrome.

Septic shock is characterized by pronounced vasodilation, impaired microcirculation, and metabolic dysregulation, whereas cardiogenic shock develops due to primary reduction of cardiac pump function and a critical decrease in cardiac output.

Modern studies emphasize the importance of comprehensive assessment of hemodynamic and metabolic parameters, including lactate levels, lactate clearance, cardiac index, and microcirculatory indicators. However, comparative analysis of these parameters in different types of shock remains insufficiently studied.

Aim of the study: to perform a comparative assessment of hemodynamic and metabolic parameters in patients with septic and cardiogenic shock.

MATERIALS AND METHODS

This prospective study included 120 patients treated in the intensive care unit (ICU). Patients were divided into two groups:

- Group I — septic shock (n = 60)
- Group II — cardiogenic shock (n = 60)

The following parameters were assessed:

- mean arterial pressure (MAP)
- cardiac index (CI)
- blood lactate level
- lactate clearance
- urine output
- microcirculation parameters (laser Doppler flowmetry)

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

Table 1. Baseline characteristics of patients

Parameter	Septic shock (n=60)	Cardiogenic shock (n=60)
Age, years	58.3 ± 12.1	66.5 ± 10.4
Male, n (%)	34 (56.7%)	38 (63.3%)
MAP, mmHg	62.1 ± 7.2	60.8 ± 6.9
Lactate, mmol/L	5.6 ± 1.4	4.9 ± 1.2
Cardiac index, L/min/m²	3.1 ± 0.5	1.9 ± 0.4

RESULTS

Table 2. Hemodynamic parameters over 24 hours

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Parameter	Septic shock	Cardiogenic shock	p
MAP, mmHg	70.4 ± 6.8	72.1 ± 7.1	> 0.05
Cardiac index	3.4 ± 0.6	2.4 ± 0.5	< 0.01
Urine output, mL/h	42.6 ± 10.3	38.1 ± 9.8	< 0.05

Patients with septic shock demonstrated more pronounced vasodilation with relatively preserved cardiac index, whereas cardiogenic shock was characterized by persistent reduction in myocardial pump function.

Table 3. Metabolic parameters

Parameter	Septic shock	Cardiogenic shock	p
Lactate (0 h), mmol/L	5.6 ± 1.4	4.9 ± 1.2	< 0.05
Lactate (24 h), mmol/L	3.2 ± 0.9	3.8 ± 1.0	< 0.05
Lactate clearance, %	42.8 ± 6.5	31.4 ± 5.9	< 0.01

The most pronounced improvement in lactate clearance was observed in patients with septic shock, reflecting the reversibility of microcirculatory disorders under adequate therapy.

Table 4. Microcirculation parameters

Parameter	Septic shock	Cardiogenic shock	p
Perfusion (a.u.)	58.3 ± 6.7	44.6 ± 5.9	<0.001
CRT (sec)	3.2 ± 0.6	4.1 ± 0.7	<0.01
Microcirculatory index	1.05 ± 0.18	0.82 ± 0.15	<0.01

Patients with cardiogenic shock showed more pronounced capillary blood flow impairment and prolonged capillary refill time, indicating more severe systemic hypoperfusion.

DISCUSSION

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The obtained results confirm that septic and cardiogenic shock, despite different etiologies, lead to a similar final clinical condition characterized by pronounced tissue hypoperfusion and metabolic imbalance.

In septic shock, the dominant pathophysiological mechanism is vasoplegia accompanied by dysregulation of the microcirculation. This results in a relatively preserved cardiac index despite a marked reduction in systemic vascular resistance. Such a hemodynamic pattern explains the higher initial lactate levels observed in this group, even in the presence of only moderately impaired myocardial pump function.

In contrast, cardiogenic shock is primarily characterized by a critical reduction in cardiac output, leading to a more severe decrease in tissue perfusion. Interestingly, initial lactate levels may be relatively lower compared to septic shock; however, persistent low cardiac index and more profound microcirculatory disturbances contribute to delayed recovery of tissue perfusion and metabolic normalization.

Lactate clearance emerged as a particularly important prognostic marker, demonstrating superior predictive value compared to a single lactate measurement. Low lactate clearance in both groups was strongly associated with impaired microcirculation, sustained hypoperfusion, and unfavorable clinical outcomes.

Microcirculatory alterations, including prolonged capillary refill time and reduced perfusion indices, represent a universal marker of shock severity regardless of its etiology. These findings support the concept of "microcirculatory failure as the final common pathway of critical illness."

Therefore, combined assessment of hemodynamic and metabolic parameters allows for more accurate stratification of disease severity and more effective evaluation of intensive therapy response.

CONCLUSIONS

1. Septic and cardiogenic shock have different primary mechanisms of development but lead to a similar final state—tissue hypoperfusion.
2. In septic shock, microcirculatory dysfunction with relatively preserved cardiac output is the leading mechanism.
3. In cardiogenic shock, reduced cardiac index and severe pump failure dominate the clinical picture.
4. Lactate clearance is a more informative prognostic marker than isolated lactate measurement.
5. Microcirculatory parameters (CRT, perfusion index) are closely correlated with disease severity and outcomes.

6. Combined assessment of hemodynamic and metabolic parameters improves early risk stratification in patients with shock states.

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