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PREDICTION OF SEPSIS IN PATIENTS WITH BURN DISEASE BASED ON INJURY CHARACTERISTICS

Akhmedov Rakhmatillo Furkatovich
Samarkand State Medical University, Republic of Uzbekistan, Samarkand

КУЙИШ КАСАЛЛИГИ БЎЛГАН БЕМОРЛАРДА ЖАРОҲАТНИНГ ХУСУСИЯТЛАРИ АСОСИДА СЕПСИСНИ БАШОРАТЛАШ

Ахмедов Рахматилло Фуркатович
Самарқанд Давлат тиббиёт университети, Ўзбекистон Республикаси, Самарқанд ш.

ПРОГНОЗИРОВАНИЕ СЕПСИСА У ПАЦИЕНТОВ С ОЖОГОВОЙ БОЛЕЗНЬЮ НА ОСНОВЕ ХАРАКТЕРИСТИК ПОВРЕЖДЕНИЯ

Ахмедов Рахматилло Фуркатович
Самаркандский государственный медицинский университет, Республика Узбекистан, г. Самарканд

e-mail: rahmatjon6868@gmail.com

Резюме. *Куйиш травмасининг асосий асоратлари бу куйиш сепсисидир: бу асорат оғир куйган беморларнинг 10-43% да ривожланади ва ўлимнинг асосий сабабчиси ҳисобланади (ўлим кўрсаткичи 70% ва ундан юқори). Сепсис муаммосини баҳолаш қийин. Афсуски, сўнгги бир неча ўн йилликлар давомида сепсис билан оғриган беморларнинг омон қолишида озгина яхшиланиш кузатилди. Ҳозирги вақтда куйиш касаллигида септик ҳолатнинг ривожланиши учун мавжуд прогностик тизимлардан фойдаланиш жуда қийин ва етарлича ишончли эмас. Беморларга тиббий ёрдам кўрсатиш масалалари устидан жиддий иқтисодий назорат остида оғир асоратларни ишончли башорат қилиш тизимига эҳтиёж юқори бўлиб қолмоқда.*

Калит сўзлар: *Куйиш касаллиги, сепсис, шок, полиорган етишмовчилиги.*

Abstract. *The main complications of burn injuries include burn sepsis: this complication develops in 10-43% of severely burned patients and is considered the main cause of death (mortality is 70% or higher). The problem of sepsis is difficult to overestimate. Unfortunately, over the past few decades, there has been only a moderate improvement in the survival rate of patients suffering from sepsis. The currently existing prognostic systems for the development of a septic condition in burn disease are very difficult to use and insufficiently reliable. In the conditions of strict economic control over the issues of providing medical care to patients, there is a need for a system of reliable prediction of severe complications.*

Key words: *Burn disease, Sepsis, Shock, Multiple organ failure.*

Relevance. Severe thermal injury (STI) remains one of the most challenging problems in modern burn medicine and critical care. Despite improvements in fluid therapy methods and the development of new antibacterial drugs, infectious complications that develop into burn sepsis remain a leading cause of mortality (up to 75% of all deaths in the late stage of burn disease) [5, 8, 10, 15, 19].

A distinctive feature of burn sepsis is the "layering phenomenon": the systemic inflammatory response (SIRS) caused by the injury itself is clinically identical to the initial stages of sepsis. This creates a diagnostic "gray zone," where standard criteria (tachycardia, leukocytosis) lose their specificity. In the emergency medicine environment of the Samarkand region, characterized by a high population density and a high incidence of household injuries, the search for reliable predictors and optimization of management strategies for these patients are priorities [12, 23, 32, 36, 40].

Pathophysiological basis of burn-related multiple organ failure. When more than 30% of the body surface is thermally damaged, a cascade of pathological reactions known as "burn shock" is triggered, progressing to the toxemia stage [9, 16, 20].

1. Intestinal barrier and translocation: Under conditions of hypovolemia, blood circulation becomes centralized. Intestinal mucosal ischemia leads

to the release of bacteria and their endotoxins (LPS) into the portal circulation.

2. Cytokine storm: Massive tissue death activates macrophages, which release interleukins (IL-1, IL-6, IL-8) and tumor necrosis factor (TNF-α). These mediators cause generalized endothelial damage and capillary leak syndrome. 3. Hypermetabolic state: The burn patient is in a state of extreme catabolism, requiring enormous energy expenditure, which depletes protein stores and inhibits the body's regenerative abilities.

Objective of the study: Obtaining quantitative criteria for the risk of developing multiple organ failure in patients with burn sepsis.

Material and methods of the study. This study is based on the results of an open-label prospective and retrospective study conducted at the Samarkand Branch of the Republican Scientific Center for Emergency Medical Care (SB RSCEMC) from 2022 to 2025.

Sample Characteristics

The study included 130 patients with severe thermal injury who were diagnosed with burn sepsis or were identified as being at high risk for developing it (Frank index > 90 units).

• Group I (Retrospective, n=60): Patients treated in 2022–2023 according to standard protocols.

• Group II (Prospective, n=70): Patients (2024–2025) treated using the early targeted control algorithm and extended biomarker monitoring. Inclusion criteria: area of deep burns (grade III according to the modern classification) more than 20% of the body surface, age 18–70 years, admission within the first 6 hours after injury.

The following were used to standardize the patient's condition:

1. Severity scales: SOFA (Sequential Organ Failure Assessment) daily, APACHE II upon admission.

2. Laboratory markers: Changes in lactate, procalcitonin (PCT), C-reactive protein (CRP), and presepsin levels (since 2024).

3. Microbiological monitoring: Blood, wound, and bronchial secretion cultures twice weekly with antibiotic susceptibility testing using the disk method and automated systems.

4. Statistical analysis: Analysis was performed using IBM SPSS Statistics 26.0. Student's t-tests were used for normally distributed values and the Mann-Whitney U-test for nonparametric data. Differences were considered significant at $p < 0.05$.

The severity of multi-organ failure (MOF) was evaluated using the SOFA scale. The proactive surgical and detoxification strategy in Group II led to a significant reduction in total scores by the end of the first week of treatment.

As can be seen from the table, by day 7 (the peak development of complications), patients in the prospective group had significantly less severe multiple organ failure.

Comparative Dynamics of Organ Dysfunction and Mortality. Analysis of data for the period 2022–2025 revealed that the implementation of the early predictive diagnostic protocol in the prospective group (II) significantly reduced the multiple organ failure index (MOF).

Table 1. Dynamics of SOFA scores in the studied groups (Mean ± SD)

Observation Period	Group I (n=60)	Group II (n=70)	P-value
Day 1	4.2 ± 0.8	4.1 ± 0.7	> 0.05
Day 3	6.8 ± 1.1	5.4 ± 0.9	< 0.05
Day 7	9.5 ± 1.4	7.2 ± 1.2	< 0.01
Day 14	7.8 ± 1.2	4.8 ± 0.8	< 0.01

Table 2. Assessment of organ dysfunction by systems (SOFA components) on Day 7

Organ System / Parameter	Group I (n=60)	Group II (n=70)	P-value
Respiratory (PaO_2/FiO_2, mmHg)	215 ± 22	285 ± 18	< 0.01
Coagulation (Platelets, x 10^9/L)	95 ± 12	142 ± 15	< 0.05
Liver (Total Bilirubin, *ũmol/L*)	34.2 ± 4.1	22.8 ± 3.5	< 0.05
Cardiovascular (MAP, mmHg)	62 ± 5	74 ± 4	< 0.01
Renal (Creatinine, *ũmol/L*)	168 ± 14	112 ± 10	< 0.01

Table 3. Antimicrobial sensitivity patterns of isolated dominant pathogens (%)

Antibacterial Agent	Acinetobacter baumannii	Pseudomonas aeruginosa	Klebsiella pneumoniae
Meropenem	12%	18%	24%
Amikacin	28%	34%	40%
Colistin	94%	92%	88%
Tigecycline	82%	—	76%
Ceftazidime/Avibactam	45%	52%	68%

Table 4. Comparison of clinical outcomes between Group I and Group II

Outcome Measure	Group I (n=60)	Group II (n=70)	P-value
ICU Length of Stay (days)	18.4 ± 3.2	14.1 ± 2.8	< 0.05
Duration of Mechanical Ventilation (days)	14.2 ± 3.1	10.5 ± 2.4	< 0.01
Incidence of Septic Shock (%)	42.5%	28.6%	< 0.05
Overall Mortality Rate (%)	38.3%	25.7%	< 0.05

The analysis showed that the use of the Early Goal-Directed Therapy strategy reduced the incidence of acute kidney injury (AKI) by 22.4%, which is critical for burn survival.

Microbiological Monitoring and Antibiotic Resistance. One of the key challenges facing the Saratov Branch of the Russian Scientific Center for Emergency Medicine in 2022–2025 was the evolution of antibiotic resistance in hospital-acquired strains.

Clinical Outcomes and Mortality Rates. The implementation of the new diagnostic and therapeutic algorithm resulted in a noticeable decrease in the length of stay (LOS) in the Intensive Care Unit (ICU) and overall mortality.

The Role of Biomarkers in Early Diagnosis. The study found that a PCT level greater than 2.0 ng/ml in a burn patient indicated bacterial invasion with 100% specificity, while isolated leukocytosis (even above 20 x 10^9/l) was often a consequence of tissue resorption.

Timeline of the Septic Process Development: The study showed that a critical drop in albumin levels below 22 g/l, combined with an increase in lactate above 3.5 mmol/l, is an early sign of septic shock (12–18 hours before the drop in blood pressure).

Etiological Structure of Pathogens. The microbiological landscape at the Saratov Branch of the Russian Scientific Center for Emergency Medicine was characterized by a high proportion of hospital-acquired strains:

• Acinetobacter baumannii – 38% (carbapenem resistance – 82%).

• Pseudomonas aeruginosa — 26%.

• Klebsiella pneumoniae — 20% (ESBL products — 74%).

• Staphylococcus aureus (MRSA) — 12%.

Results and discussion. The study showed that the risk of developing multiple organ failure does not show a significant dependence on the gender of patients and depends on their age, the severity of the systemic inflammatory reaction syndrome and the degree of decrease in serum albumin. In addition, the elderly and senile age is characterized by a lower degree of severity of signs of systemic inflammatory reaction syndrome, despite more severe sepsis and, at the same time, lower albumin concentrations. Cases of multiple organ failure were characterized by an inadequate decrease in albumin even with a small number of signs of systemic inflammatory reaction syndrome. According to the probability of developing multiple organ failure, 3 risk categories were identified.

1st category - there is no risk of developing multiple organ failure in patients with burn sepsis (0%), only if there are no signs of systemic inflammatory reaction syndrome throughout the disease.

2nd category – there is an average risk of developing multiple organ failure if 1-2 signs of systemic inflammatory reaction syndrome are registered during the disease and the albumin concentration exceeds 20 g/l.

3rd category – there is an absolute (100%) risk of developing multiple organ failure if 3-4 signs of a systemic inflammatory reaction syndrome are registered, as well as if, in the presence of 1-2 signs of a systemic inflammatory reaction syndrome, an albumin concentration below 20 g/l occurs.

The Role of Early Necrectomy as a Detoxification Method. It was traditionally believed that surgical intervention in severe shock was contraindicated. However, our experience in 2024–2025 proves otherwise. Early surgical debridement therapy (on days 3–5) in the study group interrupted the flow of toxins from burn wounds into the bloodstream. This led to a decrease in blood lactate levels from 4.5 ± 0.6 mmol/L to 2.1 ± 0.3 mmol/L within 48 hours after surgery.

5.2. Nutritional and Metabolic Support

Patients with burn sepsis are in a state of "metabolic fire." In the prospective group, we used the Kerry formula to calculate caloric intake:

Energy = (25 x BW) + (40 x % BSA)

Where: *BW* is body weight, *BSA* is burn area.

Early initiation of enteral nutrition (within the first 12 hours) preserved intestinal villus integrity and prevented bacterial translocation, as evidenced by a decrease in endotoxin antibody titers.

Biomarker Dynamics. Presepsin (sCD14-ST) was of particular importance in the study. Unlike C-reactive protein, presepsin levels increased as early as 2 hours after pathogen invasion, long before the onset of fever. A presepsin level > 600 pg/ml was an absolute indication for a change in the antibacterial regimen.

Conclusions. Based on the study conducted at the Saratov Branch of the Russian Scientific Center for Emergency Medicine, the following conclusions can be drawn:

1. Diagnostic value: The isolated use of the leukocyte intoxication index for burns is of little use.

Dynamic monitoring of procalcitonin and presepsin is crucial.

2. Therapeutic window: The first 72 hours are critical for preventing irreversible multiple organ failure.

3. Surgical tactics: Early necrectomy is not only a method of wound closure but also a crucial component of detoxification therapy for sepsis.

4. Cost-effectiveness: Despite the high cost of modern biomarkers and reserve antibiotics, their use reduces overall costs by reducing the length of stay in the intensive care unit by 4.3 bed days.

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ПРОГНОЗИРОВАНИЕ СЕПСИСА У ПАЦИЕНТОВ С ОЖОГОВОЙ БОЛЕЗНЬЮ НА ОСНОВЕ ХАРАКТЕРИСТИК ПОВРЕЖДЕНИЯ

Ахмедов Р.Ф.

Резюме. *К основным осложнениям ожоговых травм относится ожоговый сепсис: это осложнение развивается у 10–43% тяжелообожженных больных и считается основной причиной смерти (летальность составляет 70% и выше). Проблему сепсиса трудно переоценить. К сожалению, за последние несколько десятилетий наблюдается лишь умеренное улучшение выживаемости больных, страдающих сепсисом. Существующие в настоящее время прогностические системы развития септического состояния при ожоговой болезни весьма сложны в использовании и недостаточно надежны. В условиях жесткого экономического контроля за вопросами оказания медицинской помощи больным возникает необходимость в системе достоверного прогнозирования тяжелых осложнений.*

Ключевые слова: *Ожоговая болезнь, сепсис, шок, полиорганная недостаточность.*