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# Early diagnostics and treatment with acute burn sepsis

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ABSTRACT

**Objective:** To determine the value of the procalcitonin test used for early diagnosis of sepsis and to study the course and treatment of burn sepsis in patients with severe burns.
**Methods:** Eighty patients in the Burn Department of Republican Scientific Centre of Emergency Medical Care, aged 17–75 years with burn injuries covering 30%–85% of the body surface, were enrolled in the study. Procalcitonin is marker of sepsis, procalcitonin > 2 ng/mL, sensitivity –89%, specific feature –94%.
**Results:** The result showed that among septic patients with severe burns, rational use of intensive therapy for burn sepsis and septic shock in combination with parentrial ozonotherapy resulted in decreases of syndrome of poly organ insufficiency and lethal outcomes from 70% accordingly. The result allows the conclusion that the treatment examined leads to a significant increase in survival coefficient.
**Conclusions:** This in turn confirms the efficacy of early necrectomy and auto dermoplasty of deep burn wounds in victims with sepsis.

## 1. Introduction

Burn trauma remains one of the real problems of modern medicine, because of its heavy clinical course, the difficulties of treating the victims, the high mortality rate, and sometimes unacceptable results of treatment. However, according to the World Health Organization data, more than 95% of fatal fire-related burns in 2002, for example, occurred in low- and middle-income countries [1].

In spite of great success achieved in burn treatment, a lethal outcome among severely burnt patients remains high even in specialized hospitals. Lethality is particularly high in critical (40%–50% of body surface) and extra critical (over 50%) deep burns [2,3].

Burn sepsis is a systemic response to infection, characterized by inflammatory reaction symptoms on the background of a marked inflammatory process [4–6]. The data on contemporary statistics, devoted to patients with generalized inflammatory complications show their significant number and also identify the tendency for constant growth to 78%–80% [7–9].

In burn sepsis pathogenesis, an important role is played by anti-inflammatory cytokines: interleukine-1, tumor factor, inteleleukine-6, interleukine-8 and others, which form specific body responses to so-called cytokine storms. Damage to different organs and tissues as a result of interleukine effects results in marked inflammatory disturbances, accompanied by development of interstitial edema (shock lung, shock kidney, *etc*.) formation of great number of circulating immune complexes, and others [10].

Severe burn trauma causes the systematic inflammatory response syndrome, which leads to damage from possible sepsis and severe sepsis development [11].

In light of the severity of these issues, the study aimed to determine the value of the procalcitonin test used for early diagnosis of sepsis and to study the course and treatment of burn sepsis in patients with severe burns.

## 2. Materials and methods

Over a period of 2010–2012, 80 patients with sepsis were treated at Burns Department of the Republican Scientific Centre of Emergency Medical Care, Samarkand, Uzbekistan. Generalization of purulent infection is most frequently marked in deep burns of more than 40% of the body surface [(45.1% ± 1.5%) on average]. The patients underwent procalcitonin test for early diagnosis.

Eighty patients aged 17–75 years with burn injuries covering 30%–85% of the body surface were enrolled in the study. All patients were admitted to the hospital during the first 12 h after

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the burn trauma. There were no thermoinhalation injuries or accompanying chronic diseases in all examined patients. For the purposes of the investigation, patients with sepsis were subdivided into 2 groups.

In addition to standard clinical laboratory test, the following were carried out: measurement of body temperature and heart rate, clinical and biochemical analyses of blood and urine, and microbiological analysis of discharge from burn wounds with determination of flora sensitivity to antibiotics according to the procalcitonin (PCT)-Q (BRAHMS, Germanya) method of measuring PCT level in blood serum on 2, 3, 5, 7, and 10 days after the burn trauma.

PCT-Q is an immunochromatographic test for half-amount determination of PCT level, used for diagnosis and control of therapy for acute bacterial infections and sepsis. PCT-Q requires only a 30 min incubation period and not need calibration and additional apparatus. The advantages of this method include: simplicity of usage; absence of complex equipment; and short time for receiving results. To obtain PCT sensitivity findings, specific features, positive prognostic significance (PPS), and negative prognostic significance (NPS) were determined.

On the background of sepsis PCT concentration was (4.8 ± 1.1) ng/mL in the 50 patients in Group 1, sensitivity 67%, specific features 92%, PPS 85%, NPS 81%. For the 30 patients in Group 2, with severe course of sepsis, PCT level was (15.6% ± 2.2) ng/mL, sensitivity 3.3%, specific futures 98%, PPS 83%, NPS 81%.

Analysis of microflora and its sensitivity to antibacterial preparations was carried out for 45 patients, aged 16–75 years, of whom 29 were males and 16 females, with deep burns covering 25%–65% of the body surface [(39.5% ± 5.0%) on the average].

Examination was carried out on admission, then on 4–5 and 10–15 day of treatment. For sterility, blood was taken from central vein. Cultivation of microorganisms was carried out according to standard methods of microbiological blood study on a double medium.

The result was estimated according to the presence of colonies of microorganisms. In addition, analysis of sowings from the wounds to microflora was carried out. Sensitivity to 15–20 antibiotics produced in foreign countries was determined in isolated pathogenetic and conventionally pathogenetic microorganisms.

## 3. Results

Group 1 consisted of 50 patients with Index Frank > 70 units, in the acute period of burn trauma (3–6 days); significant bacterial contamination (> 10.5 KOE/g) was revealed, PCT level was < 2 ng/mL and scale assessment was SOFA 11–12.

Group 2 consisted of 30 patients with severe burns with Index Frank > 100 units, PCT level of more than 2 ng/mL in all cases correlated with development of a burn sepsis clinical picture. In 5 patients with PCT levels of more than 10 ng/mL, specific features were 95%, and NPS 70%; diagnosis of burn sepsis was confirmed morphologically as well. Reliable effect on patients death was presented by PCT index > 2 ng/mL and scale assessment SOFA 18–20.

Thus, PCT test is prospective in diagnosis of burn sepsis. PCT levels in blood of more than 2 ng/mL in patients with burn trauma with Index Frank > 70 units in the acute period of burn injury is evidence for the expediency of performing a deescalation regimen of antibacterial chemotherapy.

In 50 (62.5%) patients with burns (Group 1) with signs of burn sepsis, standard intensive therapy with intravenous infusion of 200 mL ozonized physiological solution was performed during the term of (11.54 ± 2.11) days after receiving burns, with ozone concentration of 4 mg/L the fluid, once every 24 h for 10 days at the stage of burn shock and acute burn toxemia.

The 30 patients with burns in Group 2 showed Frank Index of 105.75 ± 3.54 conventional units and signs of burn sepsis. Complex intensive therapy was carried out during 10–11 days after receiving burn trauma (at stage of burn shock and acute burn toxemia).

In blood sowings with positive results, 13 cases (37.2%) showed resistance to *Staphylococcus aureus* (*S. aureus*), 10 cases (28.6%) to *Enterococcus*, 5 cases (14.3%) to *Pseudomonas aeruginosa* (*P. aeruginosa*), with these 74.3% were polyresistant strains (Table 1).

Of the studied samples, 42 cases showed positive results to *S. aureus* (37.8%), 30 cases to bacteria of intestinal bacilli (27.1%), 20 cases to *P. aeruginosa* (18.0%). Polyresistance of microorganisms from wounds to antibacterial preparations was noted in 63.1% in purulent strains of burn wound (Table 2).

The most frequent strains of sepsis are *S. aureus* and *P. aeruginosa,* which are discharged from burn wounds and, according to our findings, predominate at 65%–85% in septic patients. Correlation of sowing of *S. aureus* and *P. aeruginosa* strains in patient blood with burn sepsis is 2:1. Less often, the agents of sepsis are *Escherichia coli*, *Acinetobacter* spp., *Enterobacter* spp., B-hemolytic streptococcus, and non-sporogenetic anaerobic bacteria. The most severe septic course is noted in discharge of three or more microorganisms in hemoculture.

Taking into account clinic laboratory findings (Hb, A/G coefficient, lymphocytes, leucocytes, body temperature higher than 38 °C) and 3 times Regis rated bacterimia, we diagnosed sepsis in 80 patients with burns, which accounts for 4.1% of the total number of victims and 38% among patients with severe burns.

In septic patients with rate of heart beats more than 90 b/m, respiratory rate more than 20 per minute, average Hb level 72 g/L, lymph of 11%, A/G coefficient of 0.97, there was marked leucocytosis of more than 12 × 10/mL or leukopenia of less than 4 × 10/mL or the immature form of more than 10% and body temperature higher than 38 °C or lower than 35 °C.

In patient with critical burns, the risk of developing generalized infections complications increases. When such patients have deep burns covering more than 20% of the body surface, they undergo complex therapy consisting of antibacterial preventive therapy and then treatment of complications

**Table 1**
Type of strains isolated from the blood of patients with burns.

| Type of strains | Number of samples | | Including resistant | |
|---|---|---|---|---|
| | *n* | % | *n* | % |
| *S. aureus* | 13 | 37.2 | 11 | 31.4 |
| *Enterococcus* spp. | 10 | 28.6 | 10 | 28.7 |
| *P. aeruginosa* | 5 | 14.3 | 2 | 5.8 |
| *Staphylococcus epidermidis* | 3 | 8.6 | 1 | 2.8 |
| *Candida* spp. | 2 | 5.7 | 0 | 0.0 |
| *E. coli* | 1 | 2.8 | 1 | 2.8 |
| *Acinetobacter* spp. | 1 | 2.8 | 1 | 2.8 |
| Total | 35 | 100.0 | 26 | 74.3 |

*E. coli*: *Escherichia coli.*

**Table 2**
Purulent strains of burn wound.

| Type of strains | Number of samples | | Including resistant | |
|---|---|---|---|---|
| | *n* | % | *n* | % |
| *Staphylococcus aureus* | 42 | 37.8 | 37 | 33.3 |
| *E. coli* | 30 | 27.1 | 10 | 9.1 |
| *Pseudomonas aeruginosa* | 20 | 18.0 | 11 | 9.9 |
| *Staphylococcus epidermidis* | 10 | 9.0 | 3 | 2.7 |
| *Streptococcus* spp. | 4 | 3.6 | 4 | 3.6 |
| *Enterococcus* spp. | 3 | 2.7 | 3 | 2.7 |
| *Acinetobacter* spp. | 2 | 1.8 | 2 | 1.8 |
| Total | 111 | 100.0 | 70 | 63.1 |

immediately after elimination of shock. All antibacterial preparations are introduced intravenously. Development of infections complications is considered to be absolute indication for providing immediate and intensive antibacterial therapy. Administration of antibacterial preparations must be based on a complex evaluation of the patients' condition, taking into consideration the extent of the injury, the stage of burn disease, complications, degree of invasion of the burn injury by microflora, immune status, patients' age and the character and severity of accompanying pathology.

Preparations of choice in septic patients with burns are polysynthetic penicillin (ampicilline, carbenicilline) along or in combination with beta-lactamaze inhibitors (amoxicilline + clavulone acid, ampicciline + sulbactam), aminoglycosides (gentamycine, tobramycine and sistomycin), ftorchinolons (ofloxacin, petroxacin and lomefloxacin). Sandal burns with affected bone structures are treated with lincomycin, and nonclostridial anaerobic infections are treated with clindomycin and metronidazol.

Of 80 patients with burn sepsis, 40 underwent operative treatment.

In the first group (25 patients) that underwent burn trauma, necrectomy was performed on 5%–10% of the body surface and the area covered with xeroderma (15 patients) or amniotic membrane (10 patients) on an area of 500–950 $cm^2$. Five or six days later, necrectomy of the rest area was performed with one-moment autodermoplasty by split skin graft (1:2). In the postoperative period on 3–4 days in 19 patients bacterimia was absent in hemocultures. In all patients PCT level was decreasing and did not exceed 0.5 ng/mL after early necrectomy (to 850 $cm^2$) with one-moment autoplasty; septic signs were absent.

In the second group (17 patients) bloodless spare necrectomy was performed, after cleaning of wounds, autoplasty on granulating wounds (950–1 050 $cm^2$) was performed. Before and after the operation hemocultures with growth sight were revealed. During the period of 7–10 days after the operation, PCT was limited to 2–5 ng/mL, which confirms continuation of the burn sepsis course.

Among patients of Group 1, lethal outcomes were 20% (5 patients); in Group 2, it was 41.2% (7 patients).

## 4. Discussion

Burn sepsis is a systemic host response to infection and can in some conditions lead to severe sepsis. According to the authors' data 23%–82% of patients die of sepsis in late periods of septic disease [12–14].

Severe burn trauma causes the syndrome of systematic inflammatory response with possible sepsis and severe sepsis development [15,16].

PCT was discovered accidentally and described for the first time in 1993 as a new marker of bacterial infection. It is prohormone of calcitonine and is related to anti-inflamatory cytokines. Procalcitonin is a polypeptide with a molecular mass of 12.793 Da. It develops in the neuroendoctine cells (gland, lungs, liver). In bacteriemia the unsplitted PCT molecule is discharged from cells, and the calcitonin level does not increase. The concentration of PCT circulating in the plasma of healthy people is very low at 0.01 ng/mL however, in severe bacterial infections it can increase to 20–200 ng/mL.

We designed prospective study to validate the diagnosis of burn sepsis. The results showed that therapy for burn sepsis and septic shock in combination with parenteral ozonotherapy revealed that among septic patients with severe burns, syndrome of poly organ insufficiency and lethal outcome decreased from 70% to 80%.

## Conflict of interest statement

The authors report no conflict of interest.

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