

Clinical infection in burn patients and its consequences

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ABSTRACT

BACKGROUND: Burn injuries facilitate invasive infections and sepsis not only by destroying the continuity of the protective skin barrier but also through systemic effects. The burn wound, blood, and urine samples are frequently cultured to determine the pathogen agent. The aim of this study was to analyze pathogen growth in patients' cultures confirmed as "infection positive" by the hospital Infection Control Committee and to assess the clinical implications of these growths.

METHODS: Hospitalized patients included in the study were those with a total burned body surface area of >10% and "presence of infection" confirmed by the Infection Control Committee. The patients were evaluated with respect to age, gender, burn etiology, the total body surface area burned (TBSA), the presence of inhalation injury, sepsis, positive cultures, the microorganisms cultured in wound-blood-urine samples, and septic focus.

RESULTS: Of the total 36 (10.3%) "infection-positive" patients, 26 (72.2%) were male; the mean age of patients was 44±21 years. The mean burned TBSA of the whole group was 45.58%±23.1%. *Acinetobacter baumannii* was the most isolated organism in the wound cultures. In patients with confirmed infection, there was a correlation between the pathogen isolated in urine cultures and mortality rates ($p=0.023$). Sepsis was diagnosed in 23 (63.9%) patients, of whom 21 had inhalation injuries. There was a significant correlation between inhalation injury and sepsis ($p=0.015$), and both the presence of sepsis or inhalation injury increased mortality ($p=0.027$ and $p=0.009$, respectively).

CONCLUSION: According to the study data, the TBSA burned demonstrated a greater significance for mortality, although the presence of sepsis and/or urinary tract infection should also be noted as a cause of mortality in burned patients.

Keywords: *Acinetobacter baumannii*; *Candida albicans*; infection; sepsis.

INTRODUCTION

Burn injuries constitute hard-to-manage trauma both for the patients and physicians due to the development of many complications following the injury, the treatment process, and even after wound healing. One of the major functions of the body skin is to ensure protection against microorganisms in the external environment. When burn injuries occur, this integrity is destroyed, thereby facilitating penetration of micro-

organisms from the injured area and microorganism growth in the necrotic tissues resulting from the burn. Burn injuries have a suppressive effect on the immune system; therefore, there is a tendency for endogenous and exogenous infections to increase in these patients. The incidents caused by the state of infection or the progression of infection in burn patients constitute a serious cause of mortality.^[1]

The aim of this study was to analyze pathogen growth in patients' cultures, confirmed as "infection positive" by the hospital Infection Control Committee, to assess the clinical implications of these growths, to reveal the septic focus, and to examine the relationship of these parameters with mortality.

MATERIALS AND METHODS

The records of patients hospitalized in the Burn Treatment Center and Burn Intensive Care Unit of our hospital be-

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tween 01/01/2014 and 07/31/2015 were reviewed. The admission criteria of the Turkish Burn Treatment Algorithm were followed in all cases.^[2] Of the total patients hospitalized between the aforementioned dates, those with late complications of burn and social indications were excluded from the study. Patients included in the study had moderate and major burns with a total burned body surface area of >10% and "presence of infection" confirmed by the Infection Control Committee. The patients were evaluated with respect to age, gender, burn etiology, the total body surface area burned (TBSA), the presence of inhalation injury, sepsis, positive wound-blood-urine cultures, the microorganisms cultured, septic focus, and the microorganisms cultured in the septic focus.

In our clinic, the wound, catheter, blood, and urine cultures of patients transferred from other units are sampled once they are hospitalized. These samples are routinely cultured once a week from the intensive care unit (ICU) patients. In non-ICU patients, cultures are taken in the case of an emerging im-

paired general condition (such as incongruity, appetite disturbance, decrease in exercise capacity, or behavioral changes) or changes in laboratory values (such as observed in leukopenia, thrombocytopenia, or leukocytosis). Wound swab cultures were taken after wound cleansing during changing of dressings.

The Pearson Chi-square and Student-t tests were used for statistical analysis of the study data. Multivariate analysis was performed using the logistic regression test. A P value of <0.05 was considered statistically significant.

RESULTS

The records of 649 in-patients who met the study criteria were retrospectively evaluated. After excluding patients with minor burns, 349 patients with burned TBSA >10% constituted the study group. Of these, 36 (10.3%) patients were confirmed with "infection" by the Infection Control Committee. The incidence of infection on the study date was 11.07%. There were 26 (72.2%) male and 10 (27.8%) female patients with a mean age of 44±21 years. Patients in the 15–39 years age group comprised 52.8% of the patient group (Table 1). In the evaluation of burn percentages of the patients, the mean burned TBSA of the whole group was 45.58%±23.1% (range, 11%–94%), 18.00%±5.7% (range, 11%–27%) in patients with burned TBSA <30%, and 57.72%±16.2% (range, 30%–94%) in patients with >30% burned TBSA.

Flame burn was found to have the leading etiology (n=26, 72.2%), followed by scalding, electrical burn, and chemical burn (Table 1).

Acinetobacter baumannii was the most isolated organism in the wound cultures and it was positive in 19 patients, as the single factor of infection in 13 patients (36.1%) and among the multiple factors in six patients. *Pseudomonas aeruginosa* was isolated in 14 wounds. Of these wounds, it was the single factor in eight patients (22.2%) and among the multiple factors

Table 1. Grouping of patients by age and etiology of burns

	n	%
Age		
15–39	19	52.8
40–59	9	27.8
≥60	8	19.4
Total	36	100
Etiology		
Flame	26	72.2
Scalding	5	13.9
Electrical	4	11.1
Chemical	1	2.8
Total	36	100

Table 2. Microorganisms isolated from wound, blood, and urine cultures

Wound cultures			Blood cultures			Urine cultures		
	n	%		n	%		n	%
<i>A. baumannii</i>	13	36.1	<i>A. baumannii</i>	2	50	<i>C. albicans</i>	4	80
<i>P. aeruginosa</i>	8	22.2	MSSA	1	25	<i>P. mirabilis</i> + <i>A. baumannii</i>	1	20
MRSA	1	2.8	<i>P. aeruginosa</i> + <i>A. baumannii</i>	1	25			
<i>P. aeruginosa</i> + <i>A. baumannii</i>	5	13.9						
MRSA + <i>P. aeruginosa</i>	1	2.8						
<i>A. baumannii</i> + <i>E. coli</i>	1	2.8						
<i>M. morgani</i>	1	2.8						
<i>C. albicans</i>	1	2.8						
Total	31	100		4	100		5	100

MRSA: Metisilin resistant *Staphylococcus aureus*; MSSA: Methisilin sensitive *Staphylococcus aureus*.

Table 3. Growth rates in cultures according to %TBSA burned

Culture		Total body surface area <%30		Total body surface area >%30		Total		p
		n	%	n	%	n	%	
Blood	+	2	18.2	2	8	4	11.1	0.356
	-	9	81.8	23	92	32	88.9	
Total		11	100	25	100	36	100	
Urine	+	1	9.1	4	16	5	13.9	0.510
	-	11	90.9	21	84	31	86.1	
Total		12	100	25	100	36	100	
Wound	+	9	81.8	22	88	31	86.1	0.490
	-	2	18.2	3	12	5	13.9	
Total		11	100	25	100	36	100	

in six patients (Table 2). The most frequently yielded multiple bacteria were the coexistence of *P. aeruginosa* + *A. baumannii* (13.9%).

Of the 36 patients with confirmed “infection,” blood cultures were positive for infection in 4 (11.1%). *A. baumannii* was isolated in 50% of these patients, followed by methicillin-sensitive *Staphylococcus aureus* (MSSA) and coexistence of *P. aeruginosa* + *A. baumannii* (Table 2). In the study group, 5 (14%) patients had positive urine culture. The most frequently isolated microorganism was *Candida albicans* (80%) (Table 2).

Eleven (30.6%) patients had <30% TBSA burned, whereas 25 (69.4%) had major extensive burn injuries. The comparison of the cultured microorganisms between these groups is summarized in Table 3.

The overall mortality rate in the study group was 30.56% (11/36). There was no mortality in the patients with burned TBSA of <30%, whereas it significantly increased in patients with burned TBSA of >30% (Table 4).

In patients with confirmed infection, there was a statistically significant correlation between the isolation in urine cultures and the mortality rates ($p=0.023$; Table 5). However, no statistically significant difference was found between the blood and wound-borne infections and mortality.

Sepsis was diagnosed in 23 (63.9%) patients, of whom 21 had inhalation injuries. There was a significant correlation between inhalation injury and sepsis ($p=0.015$). In patients with inhalation injury, infection progresses to sepsis at a rate as high as 81%.

Of the patients with sepsis, 10 (45.5%) died. The presence of sepsis was determined to significantly increase mortality ($p=0.027$), and the presence of inhalation injury also significantly increased mortality ($p=0.009$) (Table 5). There was

Table 4. Mortality rates according to the total body surface area burned

Total body surface area	Mortality		p
	+	-	
<%30	0	11	0.007
>%30	11 (44%)	14 (56%)	

Table 5. The relationship between microorganism isolation in cultures, sepsis, and inhalation injury with mortality

		Mortality +		Mortality -		p
		n	%	n	%	
Blood	+	2	50	2	50	0.356
	-	9	28.1	23	71.9	
Urine	+	4	80	1	20	0.023
	-	7	22.6	24	77.4	
Wound	+	9	29	22	71	0.490
	-	2	40	3	60	
Sepsis	+	10	43.5	13	56.5	0.027
	-	1	7.7	12	92.3	
Inhalation	+	10	47.6	11	52.4	0.009
	-	1	6.7	14	93.3	

only one case of mortality who did not have sepsis and that patient was in >30% TBSA burned group.

The wound itself was the only septic focus in 16 patients. In one patient (4.3%), positive culture was determined in the wound, blood, and urine, and this was a fatal case (Table 6). The causes of sepsis are shown in Table 12. *A. baumannii* was

the only septic organism isolated in nine patients (39.1%), followed by *P. aeruginosa* (13%) (Table 7).

The organism causing sepsis in cases of isolated focus was determined as *A. baumannii* as the sole cause of infection in the

Table 6. Septic focus

Septic focus	n	%
Wound	16	69.6
Blood	1	4.3
Wound-urine	3	13
Wound-blood	1	4.3
Blood-urine	1	4.3
Wound-blood-urine	1	4.3

Table 7. Cause of sepsis

Cause of sepsis	n	%
<i>A. baumannii</i>	9	39.1
<i>P. aeruginosa</i>	3	13
MRSA	2	8.7
<i>C. albicans</i>	1	4.3
<i>A. baumannii</i> – <i>P. aeruginosa</i>	4	17.4
<i>A. baumannii</i> – <i>C. albicans</i>	1	4.3
MRSA - <i>P. aeruginosa</i>	1	4.3
<i>P. aeruginosa</i> – <i>C. albicans</i>	1	4.3
<i>A. baumannii</i> – <i>P. aeruginosa</i> – <i>C. albicans</i>	1	4.3

MRSA: Metisilin resistant *Staphylococcus aureus*.

wound, blood, and urine in 9 (39.1%) patients. In cases with multiple infectious agents, coexistence of *A. baumannii* and *P. aeruginosa* was determined as the cause of sepsis in 4 (17.4%) patients. Wound was the most frequently encountered septic focus. In 16 (69.6%) patients, the focus was limited to the burn wound; and the wound site was determined to contribute to sepsis in a total of 21 (21/23, 91.3%) patients (Table 8).

The Chi-square test was used to determine the significance of the variables of inhalation injury, sepsis, TBSA burned, age, presence of septic focus, and pathogen growth in urine. These independent variables were subjected to logistic regression analysis to determine the variables to be used in the multivariate analysis, which was used to predict the likely effects of prognostic factors on mortality.

In determining the prognostic factors affecting the dependent variable of "survival" in the logistic regression analysis, the Forward Stepwise Selection technique was used. In the model created with all the independent parameters, TBSA was found to be the parameter with the greatest effect on mortality. Exp (β) values show the odds ratios. The probabilities would have an adverse effect if the β coefficients obtained are positive. Based on these results, the level of the surface area burned was found to increase mortality 0.766 fold.

DISCUSSION

Patients in the 15–39 years age group constituted the vast majority of the study group with "infection" confirmed by the Infection Control Committee. This shows that the time taken for treatment and rehabilitation would cause a serious workforce loss.^[3] Those in the 40–59 years age group constituted the second largest group of patients in this study, followed by those aged ≥ 59 years.

Table 8. The relationship between the culture site and the cause of sepsis

Culture site	W	B	B+U	W+U	W+B	All	Total	
	n	n	n	n	n	n	n	%
Cause of sepsis								
<i>A. baumannii</i>	7	–	1	–	1	–	9	39.1
<i>P. aeruginosa</i>	3	–	–	–	–	–	3	13
MRSA	1	1	–	–	–	–	2	8.7
<i>C. albicans</i>	–	–	–	1	–	–	1	4.3
<i>A. baumannii</i> - <i>P. aeruginosa</i>	4	–	–	–	–	–	4	17.4
<i>A. baumannii</i> - <i>C. albicans</i>	–	–	–	1	–	–	1	4.3
MRSA - <i>P. aeruginosa</i>	1	–	–	–	–	–	1	4.3
<i>P. aeruginosa</i> - <i>C. albicans</i>	–	–	–	1	–	–	1	4.3
<i>A. baumannii</i> - <i>P. aeruginosa</i> - <i>C. albicans</i>	–	–	–	–	–	1	1	4.3
Total, n (%)	16 (69.6)	1 (4.3)	1 (4.3)	3 (13)	1 (4.3)	1 (4.3)	23	100

W: Wound; B: Blood; B+U: Blood+urine; W+U: Wound+urine, W+B: Wound+blood; MRSA: Metisilin resistant *Staphylococcus aureus*.

In recent years, there has been a significant increase in the success rates of burn shock and early resuscitation, with better understanding of burn physiology and developments in both medical monitoring and ICU patient management. This has consequently decreased morbidity and mortality rates. Through the degradation of the integrity of the protective skin barrier due to burn injuries, both endogenous and exogenous access and proliferation of bacteria are facilitated. Furthermore, the necrotic tissue remnants serve as a proliferative medium for microorganisms. The prolonged hospital stay increases the likelihood of exposure to nosocomial infections, which then complicates the treatment of the patient.^[4] Although wound infection rates are reduced with appropriate antibiotic selection and rational drug use, wound infection continues to be a cause of sepsis and mortality in burn patients.^[1,5,6] The incidence of infection on the study date was 11.07%. The detected prevalence rates of infected patients (6.9%) appear to be in line with results of similar studies performed both in Europe and Turkey.^[7,8]

The application of early excision and grafting as burn management practice is known to reduce the mortality rate in burn patients.^[9] In our facility, early excision and grafting has become a standard treatment. However, wound infection and sepsis remain a common problem among hospitalized patients. In the current study, the most common wound infection agents were found to be *A. baumannii* (36.1%), *P. aeruginosa* (22.2%), and the coexistence of these two (13.9%). This is similar to data reported by experienced burn centers.^[10] These two microorganisms should certainly be considered prior to empirical treatment.

Approximately 10% of the current study patients diagnosed with infection had positive blood cultures. The organism most commonly isolated in blood cultures was *A. baumannii*, followed by MSSA and the coexistence of *P. aeruginosa* + *A. baumannii*. These microorganisms have come into prominence as a cause of sepsis in many burn units.^[11] Antibiotics should not be used for prophylaxis in burn, because it is well known that prophylactic antibiotic usage leads to colonization of resistant strains.^[12] In cases where sepsis is strongly suspected, the initial antibiotic regimen to be delivered until the laboratory results are obtained should cover these organisms.

In the current study, positive urine cultures were observed in 14% of the patients and *C. albicans* was isolated in 80% of the patients. In patients with infection, positive urine cultures significantly increased the mortality rates. Our previous study revealed urinary candidiasis as a more indicative factor for mortality than positive blood culture.^[9] Venous blood samples are taken during routine microbiological procedures. Not sampling arterial blood for culture may result in delay for fungal isolation; during this period until fungal findings are determined in the urine, the critical fungal threshold for patients may be reached. However, further studies are required

to confirm this hypothesis and because arterial sampling is an invasive procedure, the clinical consequences should be included in the studies.

Inhalation injury is a well-known cause of mortality in burn victims. The presence of inhalation injury in the current study patients significantly increased the mortality rate. On examination of the relationship between the presence of infection and sepsis in patients with inhalation injury, it was concluded that inhalation injury facilitates progression of the infection to sepsis. In this study, the rate of progress to sepsis was found to be 81% in patients with inhalation injury, thus indicating that presence of inhalation injury in burn patients increases susceptibility to sepsis and this must be taken into consideration in the treatment of burns.

The results of this study showed that development of sepsis is a serious determinant for mortality. Infection with *A. baumannii*, in particular, was found to be a significant factor in increasing mortality rate. In burn patients considered to have infection or sepsis, the antibiotics to be selected for the period until the culture results are obtained should also cover these microorganisms.

In this study, higher mortality rates were observed in patients with extensive burn injuries and wound infection. However, despite positive wound cultures, no mortality was observed in the group with burned TBSA <30%. This suggested that in patients with extensive burn injuries, many other factors in addition to wound sepsis could affect mortality. However, as reported previously,^[9] an accompanying positive urine culture significantly increases mortality rates. Nonetheless, as a result of the multivariate analysis of patients with “infection” confirmed by the Infection Control Committee, the most prominent factor affecting mortality was determined as the percentage of body surface area burned.

Conclusion

The infections and sepsis that develop in burn wounds are still a significant cause of mortality in patients with burn injuries. Cases with extensive burn injuries are subjected to multi-systemic effects; therefore, mortality can also occur for various reasons other than wound sepsis. The wounds of these patients should be regularly evaluated, cultures should be taken whenever a wound infection is suspected, and antibiograms should be performed. Antibiotherapies administered should be prescribed according to the antibiogram result, although the possible microorganisms should be previously identified, and the antibiotics to be administered until the antibiogram results are obtained should be decided by taking the clinical flora into consideration. With the use of multivariate analysis in the group studied, the results of the current study demonstrated a greater significance of the body surface area burned, and it should be noted that the presence of urinary tract

infection and sepsis can be a cause of mortality in patients with burn injuries.

Conflict of interest: None declared.

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ORJİNAL ÇALIŞMA - ÖZET

Yanık hastalarında klinik enfeksiyonlar ve sonuçları

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AMAÇ: Yanık yaralanmaları, koruyucu cilt bariyerinin sürekliliğini bozmakla kalmayıp aynı zamanda sistemik etkiler yoluyla invaziv enfeksiyonları ve sepsisi de kolaylaştırır. Yanık sahası, kan ve idrar örnekleri, patojen ajanı belirlemek için sıklıkla kullanılır. Bu çalışmanın amacı, hastane Enfeksiyon Kontrol Komitesi tarafından 'enfeksiyon açısından pozitif' olarak onaylanan hastaların kültüründeki üremeleri analiz etmek ve bu üremelerin klinik etkilerini değerlendirmektir.

GEREÇ VE YÖNTEM: Çalışmaya %10'dan fazla yanık yüzey alanı olan ve Enfeksiyon Kontrol Komitesi tarafından "enfeksiyon varlığı" olan yatan hastalar dahil edildi. Hastalar yaş, cinsiyet, yanık etiolojisi, toplam yanık vücut alanı (TYVA), inhalasyon hasarı varlığı, sepsis, pozitif kültürler, yarak-an-idrar numunelerinden alınan mikroorganizmalar ve septik odak açısından değerlendirildi.

BULGULAR: Toplam 36 (%10.3) "enfeksiyon pozitif" hastanın 26'sı (%72.2) erkek, yaş ortalaması 44±21 idi. Tüm grupta ortalama TYVA %45.58±23.1 idi. *Acinetobacter baumannii*, yara kültürlerinde en fazla izole edilen organizma idi. Enfeksiyon varlığı doğrulanan hastalarda, idrar kültürlerinde izolasyon ile mortalite oranları arasında bir korelasyon vardı (p=0.023). Yirmi üçünde (%63.9) sepsis tespit edildi; bunlardan 21'inde inhalasyon yaralanması vardı. İnhalasyon hasarı ile sepsis arasında anlamlı bir ilişki vardı (p=0.015) ve hem sepsis hem de inhalasyon yaralanmasının mortaliteyi artırdığı görüldü (sırasıyla, p=0.027 ve p=0.009).

TARTIŞMA: Çalışmanın verilerine göre, yanıklı hastalarda toplam yanıklı vücut yüzey alanı mortalitede daha büyük öneme sahipken, sepsis ve/veya idrar yolu enfeksiyonu varlığı da mortalite nedeni olarak işaret edilmelidir.

Anahtar sözcükler: *Acinetobacter baumannii*; *Candida albicans*; enfeksiyon; sepsis.

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