

# Mortality risk factors in burn care units considering the clinical significance of acinetobacter infections

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## ABSTRACT

**BACKGROUND:** This study aimed to evaluate risk factors and the role of *Acinetobacter* isolates in mortality due to burns since morbidity and mortality rates are considerably high.

**METHODS:** A total of four hundred and sixty-five patients hospitalized in our Burn Care Unit between January 2009 and May 2011 were reviewed retrospectively. Logistic regression analysis was used in order to predict the risk.

**RESULTS:** Mortality rates were as follows: 7.5% in general, 3.9% for under 17 years of age, 12% for between 18-64 years of age, and 24% for over 65 years of age ( $p < 0.001$ ).

**CONCLUSION:** As the burnt body surface area increased, higher mortality rates were detected. Despite higher mortality rates, *Acinetobacter* infections were not found risk factors for mortality.

**Key words:** *Acinetobacter*; burn; infection; mortality.

## INTRODUCTION

Burns are one of the most common and devastating forms of trauma. Improved outcomes for severely burnt patients have been attributed to medical advances in fluid resuscitation, nutritional support, pulmonary care, burn wound care, and infection control practices. Seventy-five percent of all deaths are currently related to sepsis from burn wound infections or other infection complications in patients with severe burns over more than 40% of Total Body Surface Area (TBSA).<sup>[1]</sup> Seriously burnt patients have an increased risk for nosocomial infections (NIs) due to the nature of the burn injury itself and NI is the most common cause of death following

burns.<sup>[2]</sup> Although recent studies indicate increased role of *Acinetobacter* infection in mortality in burn patients, some controversy still remains about its exact impact.<sup>[3]</sup> Due to the increased rate of worldwide resistance and infections, *Acinetobacter* isolates represent a challenge in the treatment of burns.<sup>[4]</sup>

The data of a total of four hundred and sixty five patients in our burn care unit were reviewed and patients' characteristics and outcome including burn data, infections encountered, pathogens and antibiotic susceptibility tests, infections caused by resistant organisms, risk factors for mortality, and the role of *Acinetobacter* isolates in mortality were evaluated.

## MATERIALS AND METHODS

This study was conducted at Samsun Education and Training Hospital, a 620-bed hospital with 13 beds reserved for the burn unit. Our burn unit is a tertiary care center serving Northern Turkey, the Black Sea region, with an approximate area population of 5.000.000. The burn unit consists an intensive care unit with 4 beds and 9 single rooms. The electronic medical records database of the burn unit and the file records of Infection Control Committee were searched to identify all patients hospitalized from January 2009 to May 2011.

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## Hospitalization Criteria

Patients at all ages with second and third degree burns with a TBSA higher than 20%, patients at all ages with third degree burns with a TBSA higher than or equal to 5-10%, burns located on face, ear, or hands and feet, burns of major joints, burns of genital and perineal regions, chemical burns, electrical burns, inhalation injuries, multitrauma accompanying burns, pregnancy and comorbidities (diabetes, hypertension, cardiac disease, immunodeficiency, and etc) were accepted.

NIs were recorded according to Center for Disease Control definitions.<sup>[5]</sup> TBSA percentage was estimated by using the Wallace’s “rule of nines” method<sup>[6]</sup> and a more accurate assessment was performed especially in children using the Lund and Browder chart.<sup>[7]</sup>

## Patient Care

Routine burn wound care consists of daily cleansing and twice-daily application of topical antimicrobial ointments. In superficial burns, dressings with chlorhexidine impregnated paraffin gauze were applied and changed daily by staff in sterile conditions. In deeper burns, silver sulfadiazine 1% was used. Due to its effect on retardation of wound healing, the use of silver sulfadiazine creams were terminated as soon as epithelization ensued. On admission, in children with TBSA higher than 10% and in adults with TBSA higher than 20%, early intravenous fluid replacement was initiated. As soon as patients tolerated, enteral feeding took place. Early operative approach was instituted for patients whose burn wounds needed debridement.

The following information was obtained for each admission: age, sex, type of injury, TBSA percentage, Injury Severity Score, comorbidities (including diabetes mellitus, epilepsy, mental retardation, chronic renal failure, hypertension, cerebro vascular accident), duration of stay in hospital and intensive care unit (ICU), NI, causative pathogens, antimicrobial resistance, leukocytosis, albumin level, devices used (ventilator, central line, and urinary catheter days), and survival following hospital discharge. In addition, microbiology records were searched to determine which patients had cultures growing *Acinetobacter baumannii*. For patients with *A.baumannii* recovered on culture, charts were further reviewed to determine whether the cultures represented infection or colonization. The bacteriological isolation and antibiotic susceptibility tests were evaluated using the micro Scan auto 4 (Siemens). Clinical and Laboratory Standards Institute criteria were used for the antibiotic susceptibility tests.<sup>[8]</sup>

Multidrug- resistance (MDR) was defined as isolates resistant to at least three drugs in the following classes:  $\beta$ -lactams, carbapenems, aminoglycosides, and fluoroquinolones. Extensive drug-resistance (XDR) was defined as non-susceptible to at least one agent in all but two or fewer antimicrobial categories (i.e. bacterial isolates remain susceptible to only one or

two categories). XDR *A. baumannii* was defined as resistant to all antimicrobial agents except polymyxins and tigecycline in this study. Pandrug-resistance (PDR) was defined as non-susceptible to all agents in all antimicrobial categories (i.e. no agents tested as susceptible for that organism).<sup>[9]</sup>

## Data Analysis

The overall rate of NIs was calculated dividing the number of NIs by the number of patients or by the number of patient days during the study period. Rates of device-related infections were calculated dividing the number of device-related infections by the total number of days that the device was used in the study population as described by NNIS.<sup>[10]</sup>

## Statistical Analysis

Data were analyzed using SPSS 17.0 program and given as numerical (%) and median (min-max). Logistic regression analysis was used to predict the risk and chi-square test was used in comparison of categorical variables. Mann-Whitney U test was used to compare both groups with data which did not represent normal distribution. A p value of <0.05 was considered statistically significant.

## RESULTS

The records of a total of four hundred and sixty-five patients were available. Mean age of the patients was  $18.6 \pm 22.0$  years (median=6.1-87) and two hundred and eighty-two (62.2%) patients were younger than 18 years of age. Of the patients, two hundred and ninety-two (62.8%) were female and one hundred and seventy-three (37.2%) were male. Mean TBSA was  $18.0\% \pm 14.0$  (range 0-95%). Percentages of TBSA distribution in patients below and over 18 years of age are presented in Figure 1. Cause of injury was recorded in four hundred and thirty-two patients. Of the patients, one hundred and eighty-eight (43.5%) had scald injury, one hundred and sixteen (26.9%) had flame injury, forty (9.3%) had electrical injury, twenty-seven (6.4%) had contact injury, and sixty (13.9%) had liquid injury (hot fluids, boiling jam). No relationship between burn type and *A. baumannii* infection was found ( $p > 0.05$ ).

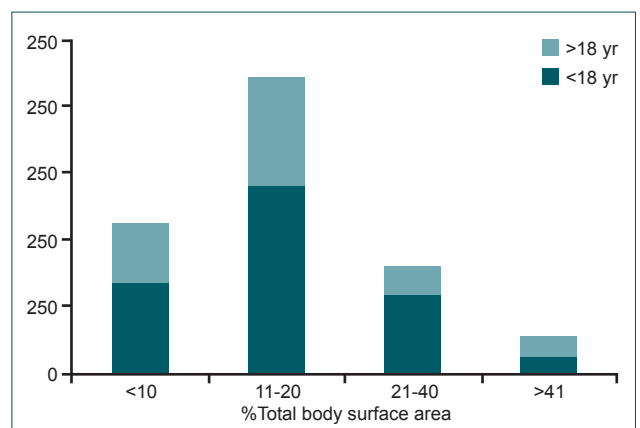


Figure 1. Burn size group (% Total body surface area)

Twenty-five patients (5.4%) had underlying diseases and one hundred and thirty-two patients (28.4%) underwent surgical corrections. Mean hospitalization period was  $18.4 \pm 17.4$  days (median=14, 2-144). Of the patients, one hundred and five (87.1%) were noninfected; whereas, sixty (12.9%) were

Of the patients, four hundred and thirty (92.5%) survived; whereas; thirty-five (7.5%) did not. Mortality rates were as follows: 7.5% in general, 3.9% for under 17 years of age, 12% for between 18-64 years of age, and 24% for over 65 years of age ( $p < 0.001$ ). Survivors and nonsurvivors were compared considering several parameters. Female: male ratio was 272:158 and 20:15 for survivors and nonsurvivors, respectively with statistically no significance ( $p > 0.05$ ). Table I shows the comparison of other parameters. Twenty-four patients had

*A. baumannii* infections and twelve of them (50%) died. In five of forty-nine patients colonized with *A. baumannii*, infections caused by this bacteria (10%) emerged. No significant differences were found considering mortality in patients colonized with *Acinetobacter*. However, in patients having *Acinetobacter* infection, mortality was significantly higher ( $p < 0.001$ ). Of the patients with TBSA over 41%, 64.3% ( $n=18$ ) died ( $p < 0.001$ ). As the burnt body surface area increased, higher mortality rates were detected. Logistic regression analysis revealed that *Acinetobacter* infections were not risk factors for mortality. Logistic regression analysis showed that burnt TBSA, older age, and albumin level were risk factors for mortality (Table I).

A total of one hundred and seven bacterial isolates were obtained. The most predominant bacterial isolate was *A. bau-*

**Table I.** Patients' characteristics and risk factors of survivors and non-survivors

Variables	Total		Survivors		Non-survivors		p	Logistic regression		
	n	%	n	%	n	%		Odds ratio	95%CI	p
Age (yr)										
<17	282	100	271	96.1	11	3.9	<0.001	1		
18-64	142	100	125	88	17	12		0.95	0.23-3.86	0.95
>65	29	100	22	75.9	7	24.1		<b>5.98</b>	<b>1.11-32.20</b>	<b>0.03</b>
Injuries										
Electrical	40	9.3	37	92.5	3	7.5	<0.001	1		
Scald	188	43.5	183	97.3	5	2.7		0.29	0.02-2.93	0.29
Liquids	60	13.9	57	95	3	5		0.31	0.02-4.00	0.37
Contact	61	6.4	59	96.7	2	3.3		1.2	0.09-16.5	0.86
Flame	116	26.9	94	81	22	19		1.5	0.22-11.18	0.65
TBSA%								<b>1.07</b>	<b>1.03-1.11</b>	<b>&lt;0.001</b>
TBSA <10	117	25.8	117	100	0	0	<0.001			
TBSA 11-20	227	50.1	221	97.4	6	2.6				
TBSA 21-40	81	17.9	70	86.4	11	13.6				
TBSA >41	28	6.2	1	35.7	18	64.3				
Comorbidity	25	5.4	16	64	9	36	<0.001			
NI	60		41	68.3	19	31.7	<0.001			
<i>Acinetobacter</i> infected	24		12	50	12	50	<0.001	4.28	0.88-20.84	0.07
<i>Acinetobacter</i> colonized	49		42	85.7	7	14.3	>0.05			
MDR, total	31	51.6	18	58.1	13	41.9	<0.001	1.97	0.47-8.10	0.34
<i>A. baumannii</i> (MDR)	19	57.5	9	47.4	10	52.6	<0.001			
<i>P. aeruginosa</i> (MDR)	12	44.4	9	75	3	25	<0.001			
		<b>Median (Min-Max)</b>		<b>Median (Min-Max)</b>		<b>Median (Min-Max)</b>	<b>p</b>			
WBC ( $10^3/\mu\text{L}$ )		14.2(1-48)		13.7(1-48)		22.5(4-40)	<0.001			
Albumin (g/dL)		3.3(0.8-4.7)		3.4 0.8-4.7)		2.3(1-3.9)	<0.001	<b>0.20</b>	<b>0.08-0.52</b>	<b>0.001</b>
ICU length of stay		0(0-32)		0(0-32)		7(0-17)	<0.001			

TBSA: Total body surface area; NI: Nosocomial infections; ICU: Intensive care unit; MDR: Multidrug-resistant; MDR total: Multidrug-resistant *A. baumannii* and *P. aeruginosa*.

*manni* 36 (33.6%), followed by *Pseudomonas aeruginosa* 27 (25.2%). Nineteen of the twenty-seven *P. aeruginosa* isolates (70.3%) and twenty-nine of the thirty-three *A. baumannii* isolates (87.8%) were multidrug resistant. Of the *Acinetobacter* isolates, fifteen had XDR and in *Pseudomonas* isolates nineteen had XDR; whereas, none had PDR.

## Incidence of Infection

Sixty (60/465=12.9%) patients had sixty-eight NIs with an incidence density of 9.9 infections/ 1000 patient days. Burn wound infection (n=38, 55%) was the most frequent NI. The rates of central vascular catheter, urinary catheter and ventilator usage per 1000 hospitalization days were 0.14, 0.15, 0.02, respectively. NI rates related to central vascular catheter, urinary catheter and ventilator usage were 5.1, 1.8 and 0 per 1000 invasive device usage days, respectively.

## DISCUSSION

In burn patients, existence of infection, especially sepsis, still remains the most prominent predictive factor affecting mortality and morbidity. Burn injury, reduced immunity, invasive therapeutic and diagnostic procedures, and longer duration of hospitalization are all responsible for serious complications in burn patients. However, NIs are solely the most common cause of death in burns. Evaluating risk factors by assessing microbiological analysis of pathogens and preventive measures, infection control and reducing the incidence of resistance are very important to lead treatment strategies.<sup>[2]</sup>

Considering emerging infection rates as success criteria, our incidence of NI was 12.9% and incidence density was 9.9/1000 patient days. It has been apparently known that burnt skin serves as an environment for colonization and infection and subsequently sepsis and possible death.<sup>[2]</sup> Despite the fact that NI was not the most important risk factor for mortality in our study, Alp et al. reported infected patients had approximately three times higher mortality rates than uninfected patients. Moreover, advanced age, underlying diseases, and higher TBSA percentage were the most significant risk factors for mortality in the study.<sup>[11]</sup> Zarei et al. have found that non-work-related burns, burnt TBSA, and body surface area affected by second- or third- degree burns are independent predictors of mortality.<sup>[12]</sup>

Although variables like age, type of injuries, TBSA percentage, co-morbidity, leukocyte, and serum albumin parameters may have affected mortality, only age over 65, TBSA percentage and serum albumin levels were found to be independent risk factors for mortality. Wang et al. have reported 30% mortality in patients with TBSA higher than 70%. In addition, burn size, severe inhalation injury, serum creatinine, inotropic support, thrombocytopenia, sepsis, and ventilator dependency have been reported as associated factors for mortality.<sup>[13]</sup> Al et al. have found that in addition to some other parameters, hypoalbuminemia and sepsis are important factors for mor-

tality.<sup>[14]</sup> Brusselaers et al. reported in a systematic review of the severe burn injuries in Europe from 1985 to 2009 that burn size and age were the main factors associated with mortality.<sup>[15]</sup> Church et al. have reported in an excellent review of burn wound infections that burns in the elderly population are more severe and result in a higher number of fatalities.<sup>[2]</sup> They have also indicated in a recent study assessing factors affecting burn mortality in the elderly population where two hundred and one patients were over 75 years of age that the mortality rate was 47.3%. In our study, mortality rates were found to gradually increase with age, 24% for over 65 years.

Due to emerging multidrug-resistant organisms mainly as *Pseudomonas* and *Acinetobacter* species, infections are associated with significant morbidity and mortality in burn patients. Of special concern, *Acinetobacter* isolates have been increasingly reported in recent years and have emerged as a significant nosocomial pathogen.<sup>[4]</sup> The most common microorganism isolated was *A. baumannii* in our study. As a high prevalence, 33.6% was in concordance with some reports. Chong et al. have reported *A. baumannii* in fifty-five of ninety-four patients<sup>[16]</sup> and Bayram et al. have found fifty-nine of two hundred and fifty isolates to be positive for *A. baumannii*.<sup>[17]</sup>

*Acinetobacter* was first considered in the 1970s as an important nosocomial pathogen. Majority of the clinical isolates were susceptible to most antimicrobials in earlier periods; however, multi-drug resistant isolates have emerged due to extensive use of broad spectrum agents worldwide.<sup>[4]</sup> Our results revealed that MDR rates were also associated with increased mortality, not emerging as an underlying risk factor. Of the thirty-three patients with *Acinetobacter*, twenty-nine of them and of the twenty-seven patients with *P. aeruginosa*, nineteen of them represented MDR. Keen et al. reported their experience over a 5-year period that more than half of *A. baumannii* isolates were multi-drug resistant.<sup>[18]</sup>

Increased mortality rates were detected in *Acinetobacter* infections ( $p<0.001$ ); however, this was not regarded a risk factor for mortality (logistic regression analysis). Albrecht et al. have revealed that *Acinetobacter* infection is associated with burn related mortality and morbidity in a univariate analysis but was not independently associated with death.<sup>[3]</sup> Recent studies have had mixed results to indicate mortality attributable of *Acinetobacter*. Some authors reported increased mortality rates secondary to *Acinetobacter*<sup>[19]</sup> while others including ours found not.<sup>[20]</sup> *A. baumannii* isolates common with relatively higher MDR rates may be due to habits of frequent prescribing or using wide spectrum antimicrobials in our country. Besides, some clinical characteristics of *A. baumannii* isolates, such as its presence in normal skin flora, easier transmissibility and viability in hospital environment due to being multi-drug resistant, may lead to increased incidences of NIs.

Older age, higher TBSA percentage, and albumin level were

found significant risk factors for mortality. Besides, *A. baumannii* was not found a risk factor for mortality in our study. However, due to higher rates of mortality occurring in infections by causative microorganisms capable of developing multidrug resistance like *A. baumannii* and *P. aeruginosa*, these microorganisms play an essential role when considering mortality in general.

Conflict of interest: None declared.

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## KLİNİK ÇALIŞMA - ÖZET

### Acinetobacter enfeksiyonlarının klinik önemi ışığında yanık ünitesinde mortalite için risk faktörleri

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**AMAÇ:** Morbidite ve mortalite oranlarının yüksek olması nedeniyle yanıklardaki mortalitede risk faktörleri ve Acinetobacter izolatlarının buradaki rolünü değerlendirmeyi amaçladık.

**GEREÇ VE YÖNTEM:** Ocak 2009'dan Mayıs 2011'e kadar yanık ünitemizde yatırılarak tedavi edilen toplam 465 hasta geriye dönük olarak gözden geçirildi. Risk belirlenmesinde lojistik regresyon analizi kullanıldı.

**BULGULAR:** Mortalite oranları genelde %7.5, 17 yaş altı %3.9, 18-64 yaş arası %12 ve 65 yaş üzeri %24 idi (p<0.001). Total Vücut Yüzey Alanı (TBSA) %41'in üzerinde olan hastaların %64.3'ü (18 hasta) kaybedildi (p<0.001). TBSA%, ileri yaş ve albümin seviyeleri mortalitede risk faktörü olarak bulundu. En sık rastlanan bakteriyel izolat Acinetobacter baumannii idi.

**TARTIŞMA:** Yanık oranları arttıkça mortalite oranlarının da arttığı görüldü. Yüksek mortalite oranlarına rağmen Acinetobacter enfeksiyonları mortalitede risk faktörü olarak bulunmadı.

**Anahtar sözcükler:** Acinetobacter; enfeksiyon; mortalite; yanık.

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