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Nosocomial infection characteristics in a burn intensive care unit: Analysis of an eleven-year active surveillance

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ABSTRACT

Aims: The objective of this study was to describe nosocomial infection (NI) rates, risk factors, etiologic agents, antibiotic susceptibility, invasive device utilization and invasive device associated infection rates in a burn intensive care unit (ICU) in Turkey.

Methods: Prospective surveillance of nosocomial infections was performed according to Centers for Disease Control and Prevention (CDC) and National Healthcare Safety Network (NHSN) criteria between 2001 and 2012. The data was analyzed retrospectively.

Results: During the study period 658 burn patients were admitted to our burn ICU. 469 cases acquired 602 NI for an overall NI rate of 23.1 per 1000 patient days. 109 of all the cases (16.5%) died. *Pseudomonas aeruginosa* (241), *Acinetobacter baumannii* (186) and *Staphylococcus aureus* (69) were the most common identified bacteria in 547 strains.

Conclusion: Total burn surface area, full thickness burn, older age, presence of inhalation injury were determined to be the significant risk factors for acquisition of NI. Determining the NI profile at a certain burn ICU can lead the medical staff apply the appropriate treatment regimen and limit the drug resistance. Eleven years surveillance report presented here provides a recent data about the risk factors of NI in a Turkish burn ICU.

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1. Introduction

The developments in sufficient resuscitation, hemodynamic stabilization, adequate nutrition and success in treating inhalation injury has improved survival among burn patients [1–3]. Although the acute phase of the burn can be successfully managed, infection associated mortality during the hospitalization period of the burn patients is an ongoing major problem [4]. Burn patients are highly susceptible to infection due to the loss of the skin barrier, prolonged hospital stays, intensive invasive diagnostic and therapeutic procedures and immune

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deficiency caused by burn. Infections are negative predictors of clinical outcome in burn patients. Nosocomial infections (NIs) are challenging problems to treat during the long hospital stay periods of burn patients.

Centers for Disease Control and Prevention (CDC), have reported the highest rates of blood stream infection in burn patients with central venous lines, most probably originating from the burn wounds [5]. Thus determining the etiology and risk factors for NI and applying the appropriate measures for infection control is a crucial step in preventing infection related deaths among burn patients [6].

Clinical surveillance reports provide a precious source about local NI profile, antibiotic susceptibility and the risk factors for NIs among burn patients. These data lets the treatment staff employ the most convenient treatment protocol against local pathogens.

In this respect, the aim of this study was to describe NIs, investigate epidemiologic features, risk factors, infection agents, antibiotic susceptibility profile, invasive device utilization and invasive device associated infection (IDAI) rates of a burn intensive care unit (ICU) between 2001 and 2012 in Istanbul, Turkey.

2. Materials and method

The study was conducted between the dates January 2001 and January 2012 including 11-year period at the Gulhane Military Medical Academy, Haydarpasa Training Hospital tertiary step burn ICU with nine-bed capacity in Istanbul, Turkey.

The hospitalized patients were not transferred to another center nor discharged from the burn ICU until the patients were eligible for standard clinic or outpatient care. During the 11-years period, 1062 burn patients were admitted to our burn unit and 658 of those were hospitalized and were included to the study. The patients treated in outpatient settings or the patients who died during the first 72 h of hospitalization were excluded from the study.

An established infection control surveillance program was already in place at our burn unit. Prospective surveillance data of the burn patients consecutively hospitalized at the burn unit until discharge or death were investigated according to CDC and National Healthcare Safety Network (NHSN) criteria in this retrospective database research study [5,7]. The protocol of this study was approved by the local ethical committee.

The total burn surface area (TBSA) percentage was calculated by Lund and Browder's chart, burn depth was assessed by clinical observation [8]. Any patient with 10% TBSA burn and patients with localized deep burn $\geq$2% TBSA were admitted to the burn unit. All the burn patients' fluid replacement was performed according to the Parkland Formula.

A protective gown and disposable gloves were used during the patient contact and infection control measures were applied to all patients. Hands were washed with conventional soap, and disinfected with 70% ethanol/glycerol before and after patient contact. Routine burn wound care consisted of daily cleansing and the daily application of a topical antimicrobial ointment (silver sulfadiazine in a 1% cream) for the cases infected by *Pseudomonas aeruginosa* and vaseline impregnated gauze containing chlorhexidine gluconate for the cases with no evidence of infection.

Full thickness burns and inhalation injury, TBSA $>$ 60%, and clinical infection signs were accepted as the indication of empiric antibiotic therapy. Perioperative prophylaxis was introduced to all patients. Prophylactic antibiotics were otherwise not administered to the patients. Positive culture results were considered to be the absolute indication of rational antibiotherapy. Conventional laboratory methods in addition to automated API Rapid ID 32 Staph (BioMerieux, France) system were used to identify the isolates. Antimicrobial resistance investigation of the isolates was determined by using Kirby-Bauer disk diffusion method, according to Clinical and Laboratory Standards Institute (CLSI) criteria. In cases with repetitive positive culture results of the same microorganism or positive results of more than one isolates, only one of the organisms was accepted as the infection agent in order to eliminate duplication.

A statistical package was used in statistical analysis. Student's *t*-test or the Mann–Whitney *U*-test was used for continuous variables, and chi-square test or Fisher's exact test was used to analyze categorical variables. Logistic regression model was used to identify risk factors for nosocomial infections. Clinically important variables and the variables with p value lower than 0.20 in the univariate analysis were included in the multivariate analysis as the candidate variables in order to compose the best model. Odds ratios and 95% confidence intervals were calculated using Backward LR multivariate logistic regression analysis. A p value $<$0.05 represented statistical significance for all statistical comparisons.

3. Results

Among the hospitalized 658 patients, 469 cases acquired 602 NIs. The mean age of the hospitalized patients was 34.8 $\pm$ 8.6 and 392 (59.6%) were male. The mean TBSA was 32.4 $\pm$ 8.7%. The mean length of hospital stay was 35.6 $\pm$ 5.8 days and the mean hospital admission day, from injury to hospitalization in our burn ICU, was 3.5 $\pm$ 0.5. The overall Acute Physiology and Chronic Health Evaluation (APACHE) II displayed a median score of 8 (IQR = 6–14). Mean Multiple Organ Dysfunction Score (MODS) was 2.6 $\pm$ 0.7.

The mean age (39.4 $\pm$ 2.7 years), the mean length of hospital stay (41.5 $\pm$ 9.3 days) and TBSA (36.3 $\pm$ 9.6%) of the patients with NI were higher than those with non-infected patients age (21.8 $\pm$ 6.4 years), length of stay (25.1 $\pm$ 7.1 days) and TBSA (18.9 $\pm$ 4.3%) (p = 0.03, p = 0.01, p = 0.01) respectively. The length of hospital stay for infected and non-infected cases with TBSA $\leq$ 40% were 31.4 $\pm$ 4.2 and 21.2 $\pm$ 3.4 days respectively (p = 0.01), whereas the length of hospital stay for infected and non-infected cases with TBSA $>$ 40% were 53.8 $\pm$ 6.4 and 29.6 $\pm$ 6.7 days respectively (p = 0.01).

Mortality occurred in 109 (16.5%) patients and 103 of those had NI and 6 of them were non-infected. More than one NIs were observed in 62 of 103 mortality developed infected patients. Mortality was significantly higher among burn patients with NI and mix infections.

Table 1 – Univariate analysis of risk factors for acquisition of NI in burn patients.

Variables	Cases with NI[a] (n = 469)	Cases with non NI (n = 189)	OR	95% CI	p-Value
TBSA[a] %					
≤40	337	186	1.91	(0.85–3.72)	0.09
>40	131	4	5.94	(3.03–8.73)	<0.001
Full thickness burn	435	60	3.82	(2.65–5.83)	<0.001
Age ≥65	224	15	3.29	(2.06–4.87)	<0.001
Inhalation injury	83	2	4.67	(3.13–6.51)	<0.001
APACHE[a] II score					
<10	164	108	1.23	(0.67–3.19)	0.194
≥10	305	81	2.01	(0.88–4.36)	0.081
Transfer from another hospital	221	30	2.24	(1.08–3.99)	<0.001
Burn type					
Flame	364	116	1.31	(0.26–3.10)	0.215
Scalding	81	44	1.44	(0.84–2.83)	0.341
Electric	21	19	1.03	(0.81–3.35)	0.247
Other	3	10	1.96	(0.92–3.26)	0.089
Previous antibiotherapy	163	78	0.65	(0.27–2.17)	0.433
MODS	3 (2–5)	2 (1–4)	0.83	(0.51–1.75)	0.071
The mean WBC[a] count	18,600 ± 1200	12,500 ± 700	0.55	(0.29–1.97)	0.09
The mean length of hospital stay	41.5 ± 9.3	25.1 ± 7.1	0.69	(0.22–0.93)	0.01
Index of the mean length of hospital stay/TBSA	1.14 ± 0.24	1.32 ± 0.18	1.65	(1.04–2.27)	0.001

[a] NI, nosocomial infection; TBSA, total burn surface area; APACHE, acute physiology and chronic health evaluation; MODS, multiple organ dysfunction score; WBC, white blood cell.

Table 2 – Infection agent distribution among infections.

	BWI[a] (n = 223)	BSI[a] (n = 122)	Pneumonia (n = 69)	UTI[a] (n = 33)	Mixed (n = 155)
P. aeruginosa (n = 241)	97	73	12	17	42
A. baumannii (n = 186)	47	36	41	7	55
S. aureus (n = 69)	51	6	2	2	8
E. coli (n = 12)	5	3	–	2	2
Proteus spp. (n = 8)	5	–	–	1	2
Enterococcus spp. (n = 4)	2	–	–	2	–
Coagulase-negative staphylococci (n = 11)	7	2	–	–	2
Candida spp. (n = 13)	7	2	1	2	1
Klebsiella pneumoniae (n = 1)	–	–	1	–	–
Stenotrophomonas maltophilia (n = 1)	1	–	–	–	–
S. pyogenes (n = 1)	1	–	–	–	–
Total isolates (n = 547)	**223**	**122**	**57**	**33**	**112**

[a] BWI, burn wound infection; BSI, blood stream infection; UTI, urinary tract infection.

In this study, univariate analysis suggested TBSA, full thickness burn, age, inhalation injury, the mean length of hospital stay, transfer from another hospital and index of the mean length of hospital stay/TBSA as potential risk factors for acquisition of NI (Table 1).

Among 658 burned patients, 469 cases acquired 602 NI (223 burn wound infection (BWI), 155 mixed, 122 blood stream infection (BSI), 69 pneumonia, 33 urinary tract infection (UTI)) for an overall NI rate of 23.1 per 1000 patient-days. All of the demonstrated BSI cases also concurrently had BWI.

Antimicrobial therapy was introduced to 493 patients (101 patients between 0 and 3 days, 229 patients between 4–7 days, and 163 patients in 7th and following days) either due to the presence of clinical signs of infection, positive culture results, full thickness burn, inhalation injury or TBSA > 60%. Among them only 469 cases encountered NI. The empirical antimicrobial therapy of 24 patients was terminated as soon as the clinical course or the culture results of the patients were determined to be negative for infection. Prior to identification of NI, 47 of the patients received antibiotherapy in our burn ICU. Antibiotherapy was introduced to 446 cases upon detection of the infection.

The number of microorganisms isolated from 382 patients was 547: Of all the pathogens, gram negatives were isolated from 82.1% (449), gram-positives from 15.5% (85) and fungi from 2.4% (13), respectively. The total number of cases with NI was 469 and despite the significant clinical NI signs, 87 of them had negative culture results. *P. aeruginosa* (241), *Acinetobacter baumannii* (186) and *Staphylococcus aureus* (69) were the most common isolated bacteria (Table 2).

The most effective antibacterial agent for *P. aeruginosa* was meropenem (91.3%) and, that for *A. baumannii* was netilmicin (83.3%) respectively (Table 3). One hundred and nine (45.2%) strains of *P. aeruginosa* and 120 (64.5%) strains of *A. baumannii* were panresistant to all tested antibiotics except for colistin. No strains of *P. aeruginosa* and *A. baumannii* were resistant to

Table 3 – Antibacterial susceptibility of the Gram-negative microorganisms in burn patients.

	P. aeruginosa (*n* = 241)	*A. baumannii* (*n* = 186)	*E. coli* (*n* = 12)	*Proteus* spp. (*n* = 8)	*Klebsiella pneumoniae* (*n* = 1)	*Stenotrophomonas maltophilia* (*n* = 1)
Ciprofloxacin	138 (57.3%)	112 (60%)	8 (66.7%)	6 (75%)	0 (0%)	1 (100%)
Ceftriaxone	76 (31.5%)	59 (31.7%)	8 (66.7%)	5 (62.5%)	0 (0%)	0 (0%)
Amikacin	192 (79.7%)	129 (69.4%)	12 (100%)	8 (100%)	1 (100%)	0 (0%)
Cotrimoxazole	88 (38.5%)	79 (42.5%)	6 (50%)	5 (62.5%)	0 (0%)	1 (100%)
Cefepime	184 (76.3%)	58 (76.3%)	10 (83.3%)	8 (100%)	0 (0%)	0 (0%)
Meropenem	220 (91.3%)	140 (75.3%)	12 (100%)	8 (100%)	1 (100%)	0 (0%)
Cefoperazone-sulbactam	205 (85.1%)	142 (76.3%)	11 (91.7%)	6 (75%)	0 (0%)	0 (0%)
Piperacillin/tazobactam	210 (87.1%)	103 (55.4%)	11 (91.7%)	6 (75%)	0 (0%)	0 (0%)
Netilmicin	210 (87.1%)	155 (83.3%)	11 (91.7%)	8 (100%)	1 (100%)	1 (100%)

Table 4 – Antibacterial susceptibility of the Gram-positive microorganisms in burn patients.

	S. aureus (*n* = 69)	*Enterococcus* spp. (*n* = 4)	Coagulase-negative staphylococci (*n* = 11)	*S. pyogenes* (*n* = 1)
Penicillin	4 (5.8%)	3 (75%)	2 (18.2%)	1 (100%)
Ampicillin-sulbactam	40 (58%)	3 (75%)	7 (63.6%)	1 (100%)
Ciprofloxacin	50 (72.5%)	3 (%)	8 (72.7%)	1 (100%)
Cotrimoxazole	43 (62.3%)	0 (0%)	7 (63.6%)	1 (100%)
Vancomycin	69 (100%)	4 (100%)	11 (100%)	1 (100%)
Teicoplanin	69 (100%)	4 (100%)	11 (100%)	1 (100%)
Linezolid	69 (100%)	4 (100%)	11 (100%)	1 (100%)

colistin. Twenty-nine (42%) of *S. aureus* strains were detected as methicillin resistant. Vancomycin was still an effective antibacterial for *S. aureus* and gram-positive microorganisms (Table 4).

The mean mechanical ventilator (MV), urinary catheter (UC) and central vascular catheter (CVC) utilization ratio were 0.39, 0.88 and 0.64, respectively. On the other hand, ventilator associated pneumonia (VAP), catheter associated urinary tract infection (CAUTI) and central vascular line associated blood stream infection (CLABSI) rates were 18.2, 3.6 and 6.4 per 1000 invasive device days, respectively (Table 5).

The mean CVC (0.64), UC (0.88) and MV (0.39) utilization rates were higher than that of NHSN CVC (0.45), UC (0.51) and MV (0.30) utilization rates [9]. The mean CLABSI (6.4) and VAP (18.2) rates in our burn unit were higher than that of NHSN CLABSI (3.5) and VAP (5.1) rates. The CAUTI (3.6) rate was lower than NHSN CAUTI (4.7) rates.

The fourth day of hospitalization had the most common frequency for nosocomial infections (3.6%). Gram-positives were the most common isolated microorganisms in the first six days in our cases (Fig. 1). No difference was seen in mortality rates between years, whereas extremely drug resistant *A. baumannii* and *P. aeruginosa* rates increased after 2004 ($p = 0.01$) (Fig. 2).

In the multivariate logistic regression analysis, TBSA > 40, full-thickness burn, age ≥65 and inhalation injury were determined to be the independent risk factors for acquisition of NI (Table 6).

4. Discussion

One of the most common complications associated with death in burn patients is the NI. Wenzel et al. reported 64 NIs per 100

Table 5 – Incidence of invasive device associated infections and device utilization ratio by year.

	Infection rate per 1000 device days			Device utilization ratio		
Year	VAP[a]	CAUTI[a]	CLABSI[a]	MV[a]	UC[a]	CVC[a]
2001	19.6	3.9	6.9	0.41	0.103	0.70
2002	20.3	3.6	6.7	0.44	0.97	0.75
2003	21.4	4.5	7.3	0.41	0.101	0.71
2004	23.5	3.8	7.2	0.43	0.96	0.79
2005	21.8	4.1	7.8	0.47	0.87	0.63
2006	21.4	4.6	6.9	0.51	0.83	0.67
2007	17.5	3.5	5.2	0.43	0.85	0.70
2008	18.2	3.5	6.0	0.37	0.94	0.61
2009	14.5	3.0	6.2	0.39	0.76	0.64
2010	12.0	2.7	5.2	0.22	0.71	0.43
2011	10.0	2.4	5.0	0.21	0.75	0.41
Mean	18.2	3.6	6.4	0.39	0.88	0.64

[a] VAP, ventilator associated pneumonia; CAUTI, catheter associated urinary tract infection; CLABSI, central vascular line associated blood stream infection; MV, mechanical ventilator; UC, urinary catheter; CVC, central vascular catheter.

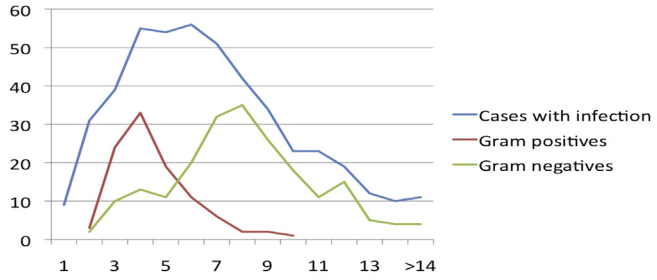

Fig. 1 – Distribution of microorganisms in relation to the hospitalization days.

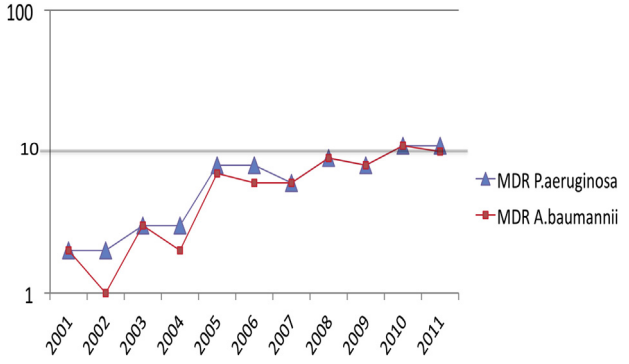

Fig. 2 – Multidrug (MDR) resistance rates between 2001 and 2012.

Table 6 – Multivariate logistic regression analysis of risk factors for acquisition of nosocomial infection in burn patients.

Variables	OR	95% CI	*p*-Value (0.05)
TBSA[a] > 40%	2.81	1.91–4.33	<0.001
Full thickness burn	2.32	1.19–4.57	0.004
Age ≥65 years	1.78	1.06–3.02	0.017
Inhalation injury	2.43	1.38–3.95	0.003
Transfer from another hospital	1.14	0.79–3.02	0.095
The mean length of hospital stay	1.33	0.97–2.95	0.089
Index of the mean length of hospital stay/TBSA	1.04	0.43–1.37	0.110

[a] TBSA, total burn surface area.

admissions for burn unit patients [10]. Wurtz et al. reported NI rate as 32.3 per 1000 patient days in burn ICU [11]. NI rate of 23.1 per 1000 patient-days in our burn unit was less than some previous reports regarding surgical and burn ICUs [10–13].

The most frequently used invasive devices were urinary catheter, whereas the less frequently used invasive devices were ventilators in our report. Compared with the NHSN results, our results showed that the rates of central vascular catheter, urinary catheter and ventilator utilization were in 75%, 90% and 75% percentile, respectively. Our results showed that, the rate of CVC, UC and MV utilization were higher than the NHSN burn intensive care unit invasive device utilization rates.

The NI rates associated to central vascular catheter, urinary catheter and ventilator utilization were in 75%, 25% and 90% percentile, respectively. The CLABSI (6.4) rate was higher than that of NHSN burn ICU rates (3.5). The CAUTI (3.6) rate was lower than NHSN rates (4.7). VAP (18.2) was determined to have the highest IDAI rate similar to NHSN rates (5.1). The rate of VAP in our unit was significantly higher than the NHSN burn ICU rates. However VAP rates in our burn intensive care unit was lower than previously reported surgical ICU VAP rates (overall 26.5 per 1000 ventilator days) in Turkey. The etiologic agent for the majority of the VAP was reported to be *Acinetobacter* spp. in the same report. In our surveillance report the *Acinetobacter* spp. was similarly the primary cause of the nosocomial pneumonia. The CLABSI rate in our report was lower than the previous Turkish report and the primary cause of the BSI was *Pseudomonas* spp. in our report. The CAUTI rate was also lower than the report of Leblebicioglu et al. (overall 8.3 per 1000 catheter days) and the *Pseudomonas* spp. was the first cause of the infection in our report [13]. There are limited numbers of reports considering only the burn ICUs infection rates. Thus the comparison of the IDAI rates could only be made between our burn ICU and surgical ICUs in Turkey.

Presence of invasive device is globally accepted as a risk factor for NI. Thus burn patients are inevitably under a great risk for NI due to the nature of the burn and intensive invasive procedures. However the IDAI rates of our burn unit were lower than some previously reported ICU infection rates in Turkey [13].

The present study reflects the BWI as the most common infection among burn patients at our burn unit in contrast to other reports in which there was a predominance of blood stream infection [5], pneumonia [11] or UTI [14]. Wurtz et al. [11] conducted prospective surveillance for nosocomial infections among burn patients. The average age of their patients was similar to ours (37.4 years) but the TBSA of burns were slightly lower (average burn size, 30.2%). In contrast to our results, they did not determine any statistically significant association between the NIs and TBSA or age and pneumonia was the most common infection in their report. Intubation rather than inhalation injury was reported to be a significant risk factor in the development of NI. The predominance of BWI over other NIs in our report may be attributed to the longer hospitalization and relatively larger TBSA.

S. aureus and gram-positive microorganism associated NIs are reported to be more prevalent than *P. aeruginosa* and *A. baumannii* associated NIs. Gram-positive organisms were more prominent than gram-negative organisms at the first week of hospitalization in our burn center similar to previously reported data [15–17]. However the burn wound

microorganism flora is subject to change and the gram-positive agents are replaced by gram-negatives over time as in our report [18,19]. Prolonged hospital stay among burn patients is reported as a risk factor for acquisition of multidrug resistant nosocomial infections such as *P. aeruginosa* and *A. baumannii* [16,20–22].

Wurtz et al. [11] also reported a gram-positive associated NI predominance and attributed this to the duration of hospital stay (mean 19 days). However we determined the gram-negatives and *P. aeruginosa* as the most common isolated microorganisms at a longer hospitalization period. The length of hospital stay (mean 35.6 ± 5.8 days) was convenient with the risk of acquisition of gram-negative microorganism infection such as *Pseudomonas* and *Acinetobacter* in our study. [23].

P. aeruginosa and *A. baumannii* associated BSIs are reported to be more common at tropical and warm climates like Middle-East and South-East Asia.

There are various different reports in the literature about the origin, risk factors and the agent responsible from the NI. The reports regarding the NIs among burn patients may differ according to the region of the burn center and the time period due to the changing drug resistance and infection profiles of the microorganisms [24–26].

In our burn unit *P. aeruginosa* and *A. baumannii* were the most prominent infection agents for BSIs and gram-positives rarely caused BSI. This may be either associated with the warm climate in Istanbul or the concomitant presence of BWI with BSI.

The second most common isolated microorganism was *A. baumannii* in our burn unit. Some characteristics of burn patients such as high APACHE II scores, device utilization, previous antimicrobial therapy, length of stay are the reported risk factors for epidemic *A. baumannii* infections [27]. Patel BM reported higher TBSA and elevated APACHE II scores as the factors predictive of *P. aeruginosa* related mortality among burn patients [16]. Age, high APACHE II score, high TBSA, presence of invasive devices, presence of prior broad spectrum antibiotherapy, transfer from another hospital, operation time, the mean length of hospital stay and the mean admission days were previously suggested as risk factors for acquisition of NI in Turkish intensive care units [21,28]. Patient characteristics such as gender, kinds of burn and mean white blood cell count were not determined as risk factors for NI at our burn unit. Previous antibiotherapy was also not determined as risk factor for NI in our practice. This may be attributed to our antibiotherapy application policy. In our burn ICU prophylactic antibiotics are not used. Antibiotherapy, if any started prior to referral to our ICU, was terminated upon hospitalization. Thus the narrow spectrum antibiotics started from other centers were used only for a very short period before hospitalization. Short-term use of previous narrow spectrum antibiotherapy may account for the insignificant relation between previous antibiotic use and NI. Elevated APACHE II and MODS scores were determined among the burn patients with NI. However high scores were not statistically associated with the NI acquisition risk in this report.

A. baumannii is capable of causing nosocomial and community infections. Multidrug resistant *A. baumannii* may cause outbreaks at ICUs [27]. *P. aeruginosa* also causes serious, drug resistant nosocomial infections in burn patients [21]. Multidrug resistant nosocomial infections caused by *P. aeruginosa* are usually difficult to treat due to the intrinsic resistance against antimicrobial agents. Imipenem is one of the most effective drugs against *P. aeruginosa*. However imipenem-resistant *P. aeruginosa* isolation is reported to increase 15% in 2003 versus 1998–2002 periods [7,21]. Besides multidrug resistant *P. aeruginosa* strains were reported to be most prevalent in Turkey [29]. An increase in multi-drug resistance was also noticed after 2004 for *P. aeruginosa* and *Acinetobacter* spp. at our burn center. Still meropenem was the most effective drug against *Pseudomonas*. No strains of *Pseudomonas* or *Acinetobacter* were resistant to colistin.

In summary, due to the high incidence of NI and extremely drug resistant strains in burn ICUs, more strict infection control policies are required, and a comprehensive education campaign should be introduced to medical staff in burn units. Universal precautions to prevent cross-contamination should be strictly applied to reduce nosocomial infections. Preventing contact isolation is essential in the presence of a multidrug-resistant microorganism associated NI [30]. Restricting antibiotherapy, reducing the hospitalization period if applicable may contribute preventing multidrug resistance and minimize NI rates.

Constituting local prospective NI surveillance programs to evaluate the patient profile, infection rate, treatment protocols and drug resistance of microorganisms at local burn ICUs is crucial in developing the strategies to control the spread of multidrug-resistant microorganism strains. Such programs will provide a precious data to reduce the multidrug resistant NI rate. A conscious burn management protocol, based on local NI data can positively affect the mortality and morbidity.

In this 11 years surveillance report from Turkey, TBSA $> 40\%$, full thickness burn, age ≥ 65 and inhalation injury were found to be significantly associated with NI according to multivariate analysis of the risk factors. *P. aeruginosa* was the most frequently isolated agent in our burn unit. BWI was the most common NI in this study. Multidrug resistance was also determined as a growing problem in our surveillance. Transfer from another hospital, length of hospitalization and index of the mean length of hospital stay/TBSA were potential risk factors for acquisition of NI. However they were not determined as independent risk factors for NI.

Conflict of interest statement

The authors do not have any conflict of interest or commercial associations or financial interests to disclose.

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