



# Prevalence of hospital-acquired infections in burn patients: A six-year experience from northern Iran

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## ABSTRACT

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Burn injuries represent a major public health problem, particularly in low- and middle-income countries, where hospital-acquired infections (HAIs) are one of the leading cause of morbidity and mortality. Burn patients are especially vulnerable due to loss of skin barrier, immune suppression, prolonged hospitalization, and invasive procedures. Therefore, this study aimed to determine the six years prevalence of HAIs in burn patients admitted to a subspecialty center for burn accidents. A retrospective cross-sectional study was conducted at Velayat Hospital, Rasht, northern Iran, including all burn patients admitted between March 2018 and March 2023 with hospital stays longer than 48 hours. Demographic, clinical, microbiological, and outcome data were extracted from hospital records. A total of 1,098 HAIs were documented, corresponding to a prevalence of 3.7%. The mean age of infected patients was  $39.4 \pm 20.7$  years, and 74.1% were male. Skin and soft tissue infections were most frequent (89%), followed by ventilator-associated pneumonia (VAP) (5%), bloodstream infections (4.1%), and urinary tract infections (1.5%). *Pseudomonas* spp. (33.1%) and *Klebsiella* spp. (14.1%) were the leading pathogens. Mortality occurred in 29% of infected patients, with the highest rate among VAP cases (80%). Higher TBSA burns (>30%) and older age were significantly associated with mortality. HAIs remain a serious complication among burn patients, with *Pseudomonas* spp. as the predominant pathogen and VAP as the leading risk factor of death. Targeted infection-control strategies, improved microbiological diagnostics, and focused interventions for high-TBSA patients are critical to improving outcomes in burn centers.

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## 1. Introduction

Burn injury is a major global public health challenge, particularly in low- and middle-income countries, with high morbidity and mortality associated with subsequent infections [1,2]. Patients with burns are especially vulnerable to hospital-acquired infections (HAIs), due to loss of skin barrier, immune suppression, prolonged hospitalization, invasive procedures, and often large total body surface area (TBSA) involved [3,4].

HAIs in burn units can manifest in different forms, including burn wound infections, bloodstream infections (BSIs), urinary tract infections (UTIs), pneumonia (including ventilator-associated pneumonia), and device-related infections [5,6]. The prevalence of HAIs in burn patients reported across studies is highly variable, reflecting differences in burn severity, clinical practices, infection-control measures, patient demographics, and local microbial ecology. In Iran, HAIs represent a substantial burden in healthcare settings. A meta-analysis reported overall HAI rates of approximately 4.5% (95% CI: 3.5–5.7) [7]. A recent Iranian study estimated an HAI rate of nearly 24% among burn patients [5]. However, specific information about the prevalence of HAIs in burn centers over multiple recent years, including patterns of causative agents, temporal trends, and associated factors is scarce.

Understanding the local prevalence and distribution of HAIs among burn patients is essential for several reasons: first, to guide effective infection control policies; second, to inform empirical antibiotic therapy; and third, to identify high-risk patient groups for targeted interventions. Such data also allow benchmarking against other hospitals and regions. Therefore, this study aimed to determine the prevalence of HAIs in burn patients admitted to a subspecialty center for burn accidents in Iran over a six-year period, to characterize the types of HAIs, and to assess the major risk factors involved.

## 2. Materials and Methods

### 2.1 Study design

This retrospective cross-sectional study was conducted at Velayat Hospital, Rasht, Iran, a tertiary referral center for burn care in northern Iran. The study population included all hospitalized burn patients admitted between March 2018 and March 2023. The medical records of burn patients were reviewed using a hospital archived files. Patients of all ages and both sexes who were admitted with thermal, chemical, or electrical burns and had a hospital stay of more than 48 hours were eligible for inclusion. Patients with incomplete records or those discharged within 48 hours were excluded to minimize misclassification bias. HAIs were defined according to the criteria of the Centers for Disease Control and Prevention (CDC), which specify

that infections occurring  $\geq 48$  hours after admission and not present or incubating at the time of hospital entry are considered hospital-acquired [8].

### 2.2 Ethical considerations and data collection

This study was approved by the Ethics Committee of Guilan University of Medical Sciences (approval number: IR.GUMS.REC.1401.514). Patient confidentiality was maintained by de-identifying all data before analysis. Because of the retrospective design of the study, informed consent from individual patients was not required. Data were extracted using a standardized form developed by the research team. Variables included demographic information (age, sex), TBSA burned, clinical course (length of stay, intensive care unit (ICU) admission), microbiological findings (positive cultures and isolated organisms), type of HAI, and clinical outcomes (mortality, discharge). Data abstraction was performed independently by two trained reviewers to ensure accuracy, and discrepancies were resolved by consensus.

### 2.3 Statistical analysis

Descriptive statistics were used to summarize demographic and clinical variables. Categorical variables were expressed as frequencies and percentages, while continuous variables were presented as means  $\pm$  standard deviation (SD) or medians with interquartile ranges (IQR), as appropriate. The prevalence of HAIs was calculated as the proportion of patients with at least one documented infection during hospitalization. Comparisons between groups were performed using chi-square tests for categorical variables. A p-value of  $<0.05$  was considered statistically significant. Data analysis was conducted using SPSS version 24.0 (IBM Corp., Armonk, NY, USA).

## 3. Results

During the study period, a total of 1,098 cases of HAIs were recorded among burn patients, corresponding to a prevalence of 3.7%. The mean age of affected patients was  $39.4 \pm 20.7$  years, with a median of 38 years (IQR: 26–54). The mean hospital stay was  $12 \pm 10$  days, and the median was 9 days (IQR: 6–14). Of the infected patients, 814 (74.1%) were male and 284 (25.9%) were female. More than half of the cases occurred in surgical wards ( $n = 595$ , 54.2%), while 503 cases (45.8%) originated from the ICU. The mean percent of TBSA was  $36.9 \pm 23.5$ , and the median was 30% (IQR: 20–50).

Regarding infection type, skin and soft tissue infections (SSTIs) accounted for the majority of cases ( $n = 977$ , 89%), followed by ventilator-associated pneumonia (VAP;  $n = 55$ , 5%), BSIs ( $n = 45$ , 4.1%), UTIs ( $n = 16$ , 1.5%), and pneumonia ( $n = 5$ , 0.5%). A total of 318 patients (29%) died during hospitalization, while 780 (71%) were discharged.

Microbiological findings showed that *Pseudomonas* spp. was the predominant pathogen (n = 363, 33.1%), followed by *Klebsiella* spp. (n = 155, 14.1%), *Escherichia coli* (n = 15, 1.4%), *Proteus* spp. (n = 14, 1.3%), coagulase-negative staphylococci (n = 13, 1.2%), and coagulase-positive staphylococci (n = 5, 0.5%). In nearly half of the cases (n = 535, 48.5%), the etiological agent was not identified.

Statistical analysis revealed no significant association between gender, age, and hospital stay duration with infection profile. In contrast, mortality was significantly associated with infection type (p < 0.001), being highest among patients with VAP (80%). Also, a higher TBSA involvement was seen among patients with VAP (87.3%, p < 0.001). The detailed results of the associations between infection profile and other risk factors are presented in Table 1.

Patients who died were significantly older (p < 0.05) and had a higher TBSA involvement (p < 0.001). Specifically, patients with TBSA >30% demonstrated a greater risk of BSIs (64.4%) and VAP (87.3%) compared with those with TBSA ≤30%.

#### 4. Discussion

The present study provides contemporary data on HAIs among burn patients over a five-year period, offering insight into infection patterns, causative pathogens, and outcomes in northern Iran. By comparing our findings with national and international reports, we aim to clarify both the local epidemiology of HAIs and the broader implications for burn care. It is hoped that findings will inform strategies to reduce infection rates and improve outcomes for burn patients in this region, guiding targeted infection-control measures and empirical antibiotic policies.

This six-year retrospective study demonstrates a HAI prevalence of 3.7% among burn patients, which is within the lower range of rates reported from other Iranian burn centers (~20%) [5, 9, 10]; however, a low prevalence of HAIs in northern Iran is not uncommon (~1%) [11]. Variations in HAI prevalence can reflect differences in infection-control practices, burn severity, patient demographics, and local microbial ecology.

SSTIs were the most common (89%), aligning with prior observations that burn wounds provide a nutrient-rich environment for colonization and infection [3].

VAP accounted for 5% of HAIs but carried the highest mortality (80%), consistent with other reports highlighting VAP as a leading cause of death in burn ICUs [6, 12]. Bloodstream infections (BSIs) were less frequent but associated with larger TBSA burns, corroborating evidence that extensive burns increase invasive infection risk.

Higher TBSA involvement and older age were significantly associated with mortality, findings consistent with multicenter studies where TBSA >30% strongly predicts poor outcome. The association of VAP and BSI with larger TBSA further supports aggressive infection-control measures in patients with extensive burns [5, 13, 14].

Regarding the bacterial etiology of infections, *Pseudomonas* spp. was the predominant pathogen (33.1%), followed by *Klebsiella* spp., paralleling findings from Iranian and international burn units [5, 9, 10, 15-17]. However, the high proportion of cases with unidentified organisms (48.5%) highlights the need for access to a full range of culture media and advanced diagnostic tests to ensure comprehensive pathogen detection and guide empiric therapy.

The relatively low overall HAI prevalence suggests effective baseline infection-control policies at our studied hospital. Nevertheless, the high mortality among patients with VAP underscores the need for strengthened ventilator care bundles, antimicrobial stewardship, and early extubation protocols. Enhanced microbiological diagnostics could reduce empirical broad-spectrum antibiotic use and help control antimicrobial resistance [18].

This study has several limitations. First, because of the retrospective design, potential confounding factors such as prior antibiotic exposure, nutritional status, or comorbidities were not consistently recorded and therefore could not be analyzed. Second, temporal changes in infection-prevention policies or antimicrobial stewardship programs during the five-year period were not evaluated, which might have influenced infection rates. Finally as a key limitation, the 48.5% of infections without pathogen identification, reflecting limited access to advanced culture media and diagnostic tests in routine hospital laboratories compared with research centers, which may have led to limiting pathogen identification and antimicrobial resistance analysis.

**Table 1.** The associations between infection profile and other risk factors (results presented as percent).

Variable	Group	SSTI	BSI	VAP	UTI	PNEU	P value
Gender	Female	26.7	15.6	20	31.3	0	0.212
	Male	73.3	84.4	80	68.8	100	
Age (year)	≤38	50.3	42.2	40	62.5	52.7	0.651
	>38	49.7	57.8	60	37.5	47.3	
hospital stay (day)	≤9	97.9	95.6	94.5	100	100	0.431
	>9	2.1	4.4	5.5	0	0	
Outcome	Died	25.9	35.6	80	31.3	0	0.001
	Discharged	74.1	64.4	20	68.8	100	
TSBA (%)	≤30%	55.6	35.6	12.7	56.3	60	0.001
	>30	44.4	64.4	87.3	43.8	40	

SSTI: skin and soft tissue infection; VAP: ventilator-associated pneumonia; BSI: bloodstream infection; UTI: urinary tract infection; PNEU: pneumonia

Hospital-acquired infections remain a significant challenge in burn care. In this five-year experience from northern Iran, HAIs affected 3.7% of burn patients, with *Pseudomonas* spp. as the leading pathogen and VAP associated with the highest mortality. Strategies to reduce VAP, optimize culture-based diagnostics, and target patients with high TBSA burns are essential to further lower infection rates and improve survival.

### Authors' contributions

MM, EH: contributed to the conception and design of the study. MS: was responsible for data collection, the statistical analysis and interpretation of the results. PH, MS: drafted the initial manuscript. PH, MM, EH: performed critical revisions. All authors approved the final version to be published, and agreed to be accountable for all aspects of the work.

### Conflict of interest

No potential conflict of interest was reported by the authors.

### Ethical declarations

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