



Microbial distribution and antimicrobial resistance patterns of urinary tract infections in a specialized burn hospital in northern Iran: A six-year retrospective study

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ABSTRACT

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Urinary tract infections (UTIs) are an important healthcare-associated complication among hospitalized burn patients. However, the distribution of urinary pathogens and their antimicrobial susceptibility patterns may vary across burn-care settings. This study aimed to describe the microbial distribution and antimicrobial resistance patterns of UTIs among hospitalized burn patients. A retrospective observational study was conducted at Velayat Burn Injuries Hospital, northern Iran, including eligible burn patients with documented UTI and microbiological investigation between March 2021 and March 2026. Data were obtained from medical records, microbiology laboratory reports, and infection-control surveillance records. Demographic and clinical characteristics, hospitalization-related variables, urinary catheterization, bacterial isolates, and antimicrobial susceptibility results were reviewed. Only the first eligible UTI episode per patient during the hospitalization was included. Thirteen hospitalized burn patients with documented UTI were included. The mean age was 43.85 ± 15.10 years, and most patients were male, admitted to the intensive care unit, and had burns involving $\geq 30\%$ of the total body surface area. Catheter-associated UTI (CAUTI) was documented in 5 patients (38.5%). *Klebsiella* spp. and *Pseudomonas* spp. were the predominant urinary isolates, each accounting for 46.2% of cases, whereas *Escherichia coli* accounted for 7.7%. Substantial resistance was observed among *Pseudomonas* and *Klebsiella* isolates to several commonly tested antimicrobial agents, particularly imipenem, piperacillin, and ceftazidime. *Klebsiella* spp. and *Pseudomonas* spp. were the predominant urinary pathogens identified in this specialized burn hospital, with considerable antimicrobial resistance among the recovered Gram-negative isolates. Continuous local microbiological surveillance and institution-specific susceptibility data may support appropriate empirical therapy, antimicrobial stewardship, and infection-prevention strategies in burn-care settings.

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1. Introduction

Burn injuries are associated with substantial morbidity and mortality, and infectious complications remain an important challenge during hospitalization [1]. Extensive disruption of the skin barrier, alterations in immune function, prolonged hospitalization, repeated surgical procedures, and frequent exposure to invasive devices can increase the susceptibility of burn patients to healthcare-associated infections [2]. The microbiological environment of burn units is also influenced by prolonged antimicrobial exposure and repeated contact with healthcare settings, creating favorable conditions for colonization and infection by multidrug-resistant organisms (MDROs) [2,3].

Although burn wound infections have traditionally received considerable attention, infections at other anatomical sites, including the urinary tract, represent an important component of the infectious burden among hospitalized burn patients. Urinary tract infections (UTIs), particularly catheter-associated urinary tract infections (CAUTIs), may occur in burn patients because indwelling urinary catheters are frequently required for accurate urine-output monitoring, fluid management, perioperative care, and management of extensive or perineal burns [4,5]. Studies conducted in burn populations have demonstrated that urinary infections constitute a clinically relevant proportion of healthcare-associated infections, emphasizing the need for systematic surveillance of urinary pathogens in this population [6,7].

The microbial etiology of UTIs in burn patients may differ according to patient characteristics, duration of hospitalization, antimicrobial exposure, catheter use, local infection-control practices, and the epidemiological characteristics of individual burn units [2]. Both Gram-negative and Gram-positive organisms have been reported among urinary isolates from burn patients. However, the microbial profile of a burn unit should not be assumed to be equivalent to that of the general hospital population because the distinctive clinical characteristics and intensive antimicrobial exposure of burn patients can create a specific ecological environment [1,8,9].

Antimicrobial resistance represents an additional concern in this setting. Burn patients may receive repeated courses of broad-spectrum antimicrobial agents because of suspected or confirmed infections, potentially exerting selective pressure that favors resistant organisms. Multidrug-resistant Gram-negative bacteria, have been repeatedly reported among hospitalized burn patients. A systematic review and meta-analysis of Iranian studies demonstrated a substantial burden of antimicrobial resistance among Gram-negative bacteria recovered from burn patients, with considerable resistance reported against several commonly used antimicrobial agents. These findings highlight the importance of institution-specific surveillance because resistance patterns can vary

substantially between hospitals and over time [10].

Antimicrobial resistance patterns are dynamic and may change in response to antimicrobial prescribing practices, infection-control interventions, patient referral patterns, and changes in the local microbial ecology [11,12]. Longitudinal analysis of microbiological data can provide information not only on the overall distribution of urinary pathogens but also on changes in antimicrobial susceptibility over time. Such information may contribute to the selection of appropriate empirical antimicrobial therapy, antimicrobial stewardship, and infection-prevention strategies within burn-care settings. Therefore, the present study was conducted to characterize the microbial distribution and antimicrobial resistance patterns of UTIs among hospitalized burn patients in a specialized burn hospital in northern Iran over a six-year period.

2. Materials and Methods

In this cross-sectional study, in order to evaluate the frequency of request and transfusion of blood products with an emphasis on the MSBOS table, the Razi Hospital, Rasht, Iran, in 2020 and 2021, the demographical and clinical data of the 15405 patients were recorded from the patient's archive in hospital. The data included the gender and age of the patients, hospital units, types and numbers of requested and transfused blood products (cryo-poor plasma (CPP), cryo, fresh frozen plasma (FFP), packed cell, platelet, platelet apheresis, washed cells). The ratio of cross-matched blood products to transfusion blood products (C/T) was in all cases. Also, in the case of elective surgeries, according to the type of surgery, the number of blood products requested and cross-matched products was evaluated based on the MSBOS pattern. All patients gave their consent to participate in the study, which was approved by the ethical committee of the Guilan University of Medical Sciences (IR.GUMS.REC.1400.225). Statistical tables were used to describe the data, and numbers and percentages were used to describe qualitative variables. All data were analyzed using SPSS version 22.

3. Results

3.1 Study design and setting

A retrospective observational study was conducted to investigate the microbial distribution and antimicrobial resistance patterns of UTIs among hospitalized burn patients. The study was performed at a specialized burn hospital in northern Iran (Velayat Burn Injuries Hospital), and included eligible patients hospitalized between March, 2021, and March, 2026. The study protocol was reviewed and approved by the institutional ethics committee of Guilan University of Medical Sciences (IR.GUMS.REC.1404.460). Because the study

involved retrospective review of existing medical records and did not require direct patient intervention, a waiver of informed consent was requested and applied where permitted by the ethics committee. Patient identifiers were removed from the analytical dataset, and confidentiality was maintained throughout data extraction, analysis, and reporting.

3.2 Study population

The study population comprised burn patients who were hospitalized at the study center during the study period and had a documented UTI for which microbiological investigation was performed. Eligible patients were identified through microbiology laboratory records, and infection-control surveillance databases. Patients were included if their medical records contained sufficient information regarding demographic characteristics, hospitalization, burn severity, urinary catheterization, microbiological findings, and antimicrobial susceptibility results. Patients with insufficient clinical or microbiological documentation were excluded from the final analysis. When more than one urine culture was available for the same patient during the same hospitalization, only the first eligible episode per patient was considered the primary observation.

3.3 Definition and microbiological assessment

UTI was defined according to the clinical and microbiological criteria documented in the hospital records and applicable institutional diagnostic practices during the study period. Particular attention was given to urine culture results and the clinical documentation supporting the diagnosis. Because urinary catheterization is common among severely burned patients, culture results were interpreted in the context of catheter use and the clinical diagnosis recorded by the treating team. Urine specimens were processed by the hospital microbiology laboratory using routine microbiological procedures in place during the corresponding study period. Bacterial isolates were identified using the laboratory's standard identification procedures. The species and, when applicable, genus-level identification of the organisms recovered from urine cultures were recorded. For patients with more than one bacterial species recovered from the same urine specimen, polymicrobial infection was considered as contamination. Contaminated or non-significant cultures were excluded from the analysis according to the laboratory's routine interpretation criteria [13,14].

3.4 Antimicrobial susceptibility testing

Antimicrobial susceptibility results were obtained from the microbiology laboratory reports. Susceptibility testing was performed by the diagnostic microbiology laboratory using the standardized antimicrobial

susceptibility testing procedures routinely applied at the study hospital during the corresponding study years. Where available, the laboratory method included disk diffusion or another validated susceptibility testing method appropriate for the isolated organism. Interpretation of susceptibility results was based on the antimicrobial susceptibility standards adopted by the laboratory at the time of testing. The Clinical and Laboratory Standards Institute (CLSI) M100 standard provides standardized interpretive criteria and quality-control recommendations for antimicrobial susceptibility testing, including disk diffusion and dilution methods [15]. The original laboratory interpretation was used to avoid applying contemporary breakpoints retrospectively to historical results without adequate supporting laboratory data.

3.5 Statistical analysis

Data were entered into a statistical database and analyzed using IBM SPSS Statistics, version 24.0 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for distribution and summarized as mean $\pm$ standard deviation (SD) for approximately normally distributed data or median and interquartile range (IQR) for non-normally distributed data. Categorical variables were summarized as frequencies and percentages. Continuous variables were assessed for normality using the Shapiro-Wilk test and graphical methods.

4. Results

A total of 13 hospitalized burn patients with UTI were included in the analysis. The mean age of the patients was 43.85 ± 15.10 years, with an age range of 21 to 76 years. The mean duration of hospitalization was 16.0 ± 8.51 days, ranging from 2 to 30 days. The study population consisted of 8 male patients (61.5%) and 5 female patients (38.5%). Regarding the setting of hospitalization, 8 patients (61.5%) were admitted to the intensive care unit (ICU), whereas 5 patients (38.5%) were hospitalized in the surgical ward. Based on the available TBSA data, 10 patients (76.9%) had burns involving $\geq 30\%$ of the total body surface area, whereas 3 patients (23.1%) had burns involving $<30\%$ TBSA.

Urinary catheterization was documented in 5 patients (38.5%), while 8 patients (61.5%) were categorized as having no catheter-associated UTI (CAUTI) according to the available records. The hospital outcome was death in 6 patients (46.2%), whereas 7 patients (53.8%) were discharged alive.

Three bacterial groups were identified among the 13 urinary isolates. *Klebsiella* spp. and *Pseudomonas* spp. were the predominant organisms, each accounting for 6 isolates (46.2%). *Escherichia coli* was identified in 1 patient (7.7%). The detailed results of antimicrobial susceptibility testing showed in Table 1. Briefly, among the six *Pseudomonas* isolates, 50.0% were susceptible to amikacin, and gentamicin.

Table 1. Results of antibiotic susceptibility testing of studied isolates

Antibiotic	<i>Pseudomonas</i> spp. (n=6)		<i>Klebsiella</i> spp. (n=6)		<i>E. coli</i> (n=1)	
	Susceptible No. (%)	Resistant No. (%)	Susceptible No. (%)	Resistant No. (%)	Susceptible No. (%)	Resistant No. (%)
AMK	3 (50)	3 (50)	3 (50)	3 (50)	0	1 (100)
GEN	3 (50)	3 (50)	3 (50)	3 (50)	0	1 (100)
IMP	1 (16.7)	5 (83.3)	2 (33.3)	4 (66.7)	1 (100)	0
PIP	1 (16.7)	5 (83.3)	1 (16.7)	5 (83.3)	0	1 (100)
CAZ	1 (16.7)	5 (83.3)	2 (33.3)	4 (66.7)	0	1 (100)
CIP	0	6 (100)	3 (50)	3 (50)	1 (100)	0

AMK: amikacin; GEN: gentamicin; IMP: imipenem; PIP: piperacillin; CAZ: ceftazidim; CIP: ciprofloxacin

Resistance to imipenem was observed in 5 of 6 isolates (83.3%), while only 1 isolate (16.7%) was susceptible. Among the six *Klebsiella* isolates, 50.0% were susceptible to amikacin. The same distribution was observed for gentamicin. For imipenem, 2 isolates (33.3%) were susceptible and 4 (66.7%) were resistant. Only one *E. coli* isolate was identified, limiting interpretation of its susceptibility profile. This isolate was resistant to amikacin, gentamicin, piperacillin, and ceftazidime, while it was susceptible to imipenem and ciprofloxacin.

5. Discussion

The present study provides a microbiological description of UTIs among hospitalized burn patients in a specialized burn hospital in northern Iran. Despite the relatively small number of eligible cases, several clinically relevant findings were observed. In the present study, *Klebsiella* spp. and *Pseudomonas* spp. were the predominant urinary pathogens, each accounting for 46.2% of the isolates, whereas *E. coli* represented 7.7%.

This distribution differs from the classical predominance of *E. coli* observed in uncomplicated community-acquired UTIs and is more consistent with the microbiological characteristics of healthcare-associated infections in highly vulnerable hospitalized populations. Previous investigations of burn patients have repeatedly demonstrated a substantial contribution of Gram-negative organisms, particularly *Pseudomonas*, *Klebsiella*, and *Acinetobacter*, although their relative proportions differ considerably among institutions and clinical specimen types [7,10,16-18]. The differences between these studies and the present findings may reflect differences in infection site, patient characteristics, local antimicrobial exposure, infection-control practices, and the period during which samples were collected.

The antimicrobial susceptibility findings represent an important observation of this study. Among *Pseudomonas* isolates, resistance was particularly frequent to imipenem, piperacillin, and ceftazidime, while ciprofloxacin resistance was also substantial. *Klebsiella* isolates similarly demonstrated frequent resistance to piperacillin, ceftazidime, and imipenem. These findings suggest that several conventional antimicrobial options may have limited activity against urinary Gram-negative pathogens in this population.

However, the results should be interpreted as local surveillance data rather than as estimates applicable to all burn hospitals in Iran. The high resistance observed in the present study is consistent with the broader Iranian literature. A systematic review and meta-analysis involving 107 studies reported a high prevalence of multidrug-resistant Gram-negative bacteria among Iranian burn patients, with particularly high resistance to several broad-spectrum antimicrobial agents [10]. Studies from other burn centers have likewise documented substantial resistance among *P. aeruginosa*, *Klebsiella*, and *Acinetobacter* isolates [16,19,20]. Importantly, resistance patterns are not static; they may change over time in response to antimicrobial prescribing, patient referral patterns, infection-control interventions, and selective pressure. Longitudinal surveillance at the institutional level is therefore necessary to guide empirical treatment and antimicrobial stewardship.

Most patients in the present study had extensive burns, with 76.9% having a TBSA of at least 30%, and 61.5% were admitted to the ICU. These characteristics are consistent with the increased vulnerability of severely burned patients to healthcare-associated infections. Extensive tissue injury, prolonged hospitalization, invasive procedures, and critical illness can collectively increase exposure to antimicrobial selection pressure and healthcare-associated pathogens [2,21]. In addition, previous systematic-review evidence has identified urinary catheterization as an important potentially modifiable factor associated with multidrug-resistant Gram-negative infection or colonization in critically ill burn patients [22].

Hospital mortality was 46.2%, while 53.8% of patients were discharged alive. This relatively high mortality should be interpreted cautiously because the study included a selected group of hospitalized burn patients with documented UTI rather than all burn admissions. Furthermore, the available dataset does not establish whether UTI or antimicrobial resistance directly contributed to death. Severe burn injury, ICU admission, extensive TBSA involvement, invasive procedures, and other complications may independently influence prognosis. Previous literature has established that infection is an important contributor to morbidity and mortality in severely burned patients, but the present sample is insufficient to determine independent predictors of mortality [2,21].

Several limitations should be considered when

interpreting these findings. First, the retrospective design limits the study to information documented in existing medical records and therefore introduces the possibility of incomplete or inconsistent documentation. Second, the final sample consisted of only 13 patients, substantially limiting statistical power and preventing reliable multivariable assessment of potential risk factors for antimicrobial resistance or mortality. Finally, the study was conducted in a single specialized burn hospital; consequently, the findings may reflect the local microbiological ecology and cannot necessarily be generalized to other burn centers in Iran or elsewhere.

This retrospective study identified *Klebsiella* spp. and *Pseudomonas* spp. as the predominant urinary bacterial isolates among hospitalized burn patients. A substantial proportion of these isolates showed resistance to several commonly tested antimicrobial agents, including important antipseudomonal and broad-spectrum drugs. The findings emphasize the value of continuous local microbiological surveillance and institution-specific antimicrobial susceptibility data in burn-care settings. Given the limited sample size and single-center retrospective design, these findings should be regarded as descriptive rather than definitive estimates of the regional burden of antimicrobial resistance. Larger multicenter studies incorporating longitudinal microbiological surveillance, antimicrobial exposure, catheter-days, and standardized definitions of multidrug resistance are warranted to better characterize the epidemiology of UTIs and antimicrobial resistance among burn patients in northern Iran.

Declaration of artificial intelligence (AI) in the writing process

The authors declare whether AI or AI-assisted technologies were used during the preparation of this manuscript. If used, AI tools were employed solely to improve language quality, grammar, readability, and organizational structure. The authors carefully reviewed and edited all AI-generated content and take full responsibility for the accuracy, integrity, and originality of the final manuscript. No AI tool was used to generate, analyze, or interpret scientific data or images, or to draw scientific conclusions. The use of AI-assisted technologies complies with current publication ethics recommendations and journal policies.

Authors' contributions

Investigation, data collection, writing original draft: PC, FK. Conceptualization, project administration, validation, review, and editing: MM. All authors have read and approved the final version of the manuscript.

Conflict of interest

No potential conflict of interest was reported by the authors.

Ethical declarations

The study protocol was reviewed and approved by the institutional ethics committee of Guilan University of Medical Sciences (IR.GUMS.REC.1404.460). Because the study involved retrospective review of existing medical records and did not require direct patient intervention, a waiver of informed consent was requested and applied where permitted by the ethics committee.

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