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Brief Original Article

Clinical and microbiological patterns in critically ill patients with catheter-associated UTI: A report from Iran

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Abstract

Introduction: Catheter-associated urinary tract infections (CAUTIs) are among the most common nosocomial infections with different clinical and microbiological characteristics. We studied these characteristics in critically ill patients.

Methodology: This research was a cross-sectional study conducted on intensive care unit (ICU) patients with CAUTI. Patients' demographic and clinical information and laboratory data, including causative microorganisms and antibiotic susceptibility tests, were recorded and analyzed. Finally, the differences between the patients who survived and died were compared.

Results: After reviewing 353 ICU cases, 80 patients with CAUTI were finally included in the study. The mean age was 55.9 ± 19.1 years, 43.7% were male and 56.3% were female. The mean length of infection development since hospitalisation and hospital stay were 14.7 (3–90) and 27.8 (5–98) days, respectively. The most common symptom was fever (80%). The microbiological identification showed that the most isolated microorganisms were Multidrug-resistant (MDR) *Enterobacteriaceae* (75%), *Pseudomonas aeruginosa* (8.8%), Gram-positive uropathogens (8.8%) and *Acinetobacter baumannii* (5%). Fifteen patients (18.8%) died among whom infections with *A. baumannii* (75%) and *P. aeruginosa* (57.1%) were associated with more death ($p = 0.005$).

Conclusions: Although *A. baumannii* and *P. aeruginosa* can be the most important pathogens for death, MDR *Enterobacteriaceae* are still a serious concern as causes of CAUTIs.

Key words: Catheter-Associated UTI; *Enterobacteriaceae*; Gram-negative uropathogens; death.

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Introduction

Hospital-acquired or healthcare-associated infections (HAIs), also known as nosocomial infections, are infectious syndromes that develop in hospitalised patients after at least 48 hours of admission during receiving care or after discharge [1-3]. Associated with high morbidity and mortality, HAIs are considered a serious problem in healthcare settings worldwide [1,3]. According to the World Health Organization (WHO) report, up to 15% of all hospitalised patients can develop these infections, leading to prolonged hospital stay, increased antimicrobial resistance, and extra costs on the healthcare system [3]. An analysis of a report by the Healthcare Cost and Utilization Project (HCUP) showed that on an average $11 billion was spent on HAIs in the United States in 2016 [4]. Although HAIs incidence and costs have decreased in recent years as a result of quality improvement programs, it is still high globally, especially in developing countries [5]. Nosocomial infections are caused by different pathogens and are classified into various types, among which urinary tract infections (UTIs) are the most common [1,6]. Urinary tract infection is the most common infection in outpatients and the most prevalent after upper respiratory and gastrointestinal infections in hospitalised patients in the United States [6,7]. Up to 80% of nosocomial UTIs are associated with urinary indwelling catheters and are called catheter-associated UTIs (CAUTIs) [8-10]. CAUTI, like other types of

nosocomial infections, is more prevalent among intensive care unit (ICU) patients and may lead to more complications [1,3,11].

Based on the known pathogens, UTIs and CAUTIs are usually treated empirically with antibiotics. However, the frequency and susceptibility patterns of the causative microorganisms vary depending on the healthcare environment, geographical region, and patient's susceptibility [1,3,6,10]. Patients with immunodeficiency disorders, diabetes, and kidney diseases and patients on corticosteroids and prolonged use of antibiotics should be taken into consideration [12].

Moreover, the frequency of resistance to antibiotics such as penicillins, cephalosporins, and carbapenems is increasing in beta-lactamase-producing species causing nosocomial UTIs, and causative microorganisms of CAUTI are more resistant than those of UTI due to the CAUTI being multi-bacterial [8,13-16]. These highlight the important role of microbiological data in clinical judgement as well as the need for more regional and local studies on the characteristics of causative pathogens [6,17].

The results of previous studies and retrospective reviews conducted worldwide, including in Iran at both national and regional levels, indicated different epidemiological and antibiotic susceptibility patterns and related risk factors in patients with CAUTI [10,13,18-21]. In some studies conducted in Iran, *Escherichia coli* has been reported as the most isolated pathogen from CAUTIs, but the frequency and the resistance pattern differ [21-23]. Also, the antimicrobial resistance pattern in Gram-negative bacilli causing urinary tract infections in Iran is changing, and reports indicate an increase in carbapenems resistance [12,13].

Table 1. Demographic and clinical characteristics and urinalysis elements of patients with CAUTI (N = 80).

Characteristics	Values
Age (mean ± SD) (years)	55.9 ± 19.1
Gender (F/M) (%)	56.3/43.7
Hospital Stay (mean ± SD) (days)	27.8 ± 20.4
Infection development time after admission (mean ± SD) (days)	14.7 ± 15.4
Fever (%)	65 (80)
Urinary tract symptoms (%)	35 (43.8)
Discharge (%)	65 (81.3)
Death (%)	15 (18.7)
Urinalysis Elements	
WBC > 5/hpf (%)	56 (70)
RBC > 5/hpf (%)	51 (63.7)
Nitrite (%)	20 (25)
Protein ≥ 1+ (%)	43 (53.8)
Blood ≥ 1+ (%)	51 (63.7)

The aim of this study was to evaluate the clinical, microbiological, and urinalysis characteristics of ICU patients with CAUTI in a referral hospital in Tehran, Iran, between 2019 and 2021.

Methodology

Data collection

A cross-sectional retrospective study was conducted on critically ill adult patients admitted to the ICU of Imam Khomeini Hospital Complex, Tehran, Iran, between 2019 and 2021. Patients included in the study were also diagnosed with CAUTI according to the Center for Disease Control and Prevention (CDC) definition [24]. The following data were collected via electronic questionnaire from the patients' records: age, gender, duration of the ICU stay, mortality, admission diagnosis, signs and symptoms, the use of invasive devices such as urinary or venous catheters, and the type of administered antibiotics. Laboratory data including the results of urinalysis, urine culture (microorganism identification and antibiotic susceptibility tests), and cell blood count were retrieved from the hospital database. The microbiological procedures including sampling, culture, isolation, identification, and antibiotic susceptibility test had been performed according to the latest standard procedures and Clinical Laboratory Standards Institute (CLSI) guidelines [25,26]. The study protocol was approved by institutional review board (IRB) of Tehran University of Medical Sciences (ethical code: IR.TUMS.IKHC.REC.1400.068).

Data analysis

Data were then analysed using SPSS version 26.0. Normality was confirmed using the Shapiro-Wilk test. Mean and standard deviation (SD) were used to report quantitative variables, and percentage and frequency were used to describe qualitative variables. In addition, The significance of the data analyzed was categorically assessed using Pearson's chi-squared test and Student's T-Test. Statistical significance was set at $p \leq 0.05$.

Results

After reviewing the files of 353 ICU patients, 80 patients met the inclusion criteria for the study and were thus enrolled. The mean age was 55.9 ± 19.1 (range: 20–96) years, and 56.3% were female. The mean length of infection development since hospitalisation and hospital stay were 14.7 (3–90) and 27.8 (5–98) days, respectively. The most common symptom was fever (80%), and 43.8% of patients mentioned urinary tract infection symptoms (Table 1).

In the results of urinalysis, pyuria (WBC > 5/hpf) and hematuria (RBC > 5/hpf) were seen in 56 (70%) and 51 (63.7%) of patients, respectively, while the nitrite test was positive in only 20 (25%) of cases (Table 1).

The microbiological identification showed that the most frequently isolated bacteria were multidrug-resistant (MDR) *Enterobacteriaceae* (60 patients–75%) including *Klebsiella pneumonia* (52%), followed by *Pseudomonas aeruginosa* (7 patients–8.8%), Gram-positive uropathogens (7 patients–8.8%), *Acinetobacter baumannii* (4 patients–5%), and *Candida* spp. (2 patients–2.5%) respectively (Table 2).

The results of antibiotic susceptibility tests revealed that the most common resistance pattern (73.2%) in *Enterobacteriaceae* was extended-spectrum beta-lactamases (ESBLs) producing microorganisms. Fifty percent of *P. aeruginosa* and all *A. baumannii* were carbapenem-resistant (Figure 1). The most administered antibiotic in the patients was reported to be carbapenems (meropenem plus imipenem: 37.5%). Colistin plus meropenem was prescribed for all patients with carbapenem resistance gram-negative uropathogens. Vancomycin or linezolid was prescribed for the cases with Gram-positive uropathogens.

Of 80 ICU patients with CAUTI in our study, 15 (18.8%) patients died, among whom infections with *A. baumannii* and *P. aeruginosa* were notably associated with more death ($p = 0.005$).

Discussion

The aim of this research was to study the clinical, microbiological, and urinalysis characteristics of ICU patients with CAUTI in a referral hospital in Tehran, Iran, between 2019 and 2021. To achieve this, we worked on the records of 80 patients who met the inclusion criteria for this study from amongst more than 300 patients who received ICU care within the time frame stipulated for the study.

Figure 1. Pattern of antibiotic susceptibility test.

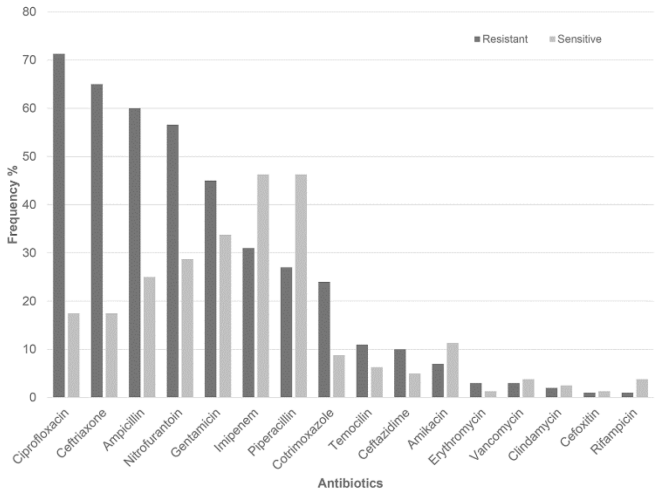

Table 2. Frequency of isolated microorganisms from patients with CAUTI and mortality rate.

Microorganism	All patients (N = 80), n (%)	Deceased patients (N = 15), n (%)
Klebsiella pneumoniae	42 (52.5)	6 (14.2)
Escherichia coli	13 (16.3)	1 (7.6)
Pseudomonas aeruginosa	7 (8.8)	3 (42.8)
Acinetobacter baumannii	4 (5)	3 (75)
Enterococcus faecium	4 (5)	0
Klebsiella oxytoca	3 (3.8)	0
Staphylococcus aureus	2 (2.5)	0
Citrobacter freundii	2 (2.5)	1 (50)
Candida spp.	2 (2.5)	1 (50)
Non-hemolytic Strep.	1 (1.3)	0

Our findings show that CAUTI is still a serious challenge in ICU patients and can be associated with high mortality, prolonged hospital stay, and long antibiotic treatment. CAUTI has already been considered a major problem, particularly in ICU settings [1,3].

Although the presence of urinary tract symptoms in patients with CAUTI was not prominent in another study and only about 20% of patients had fever [27], the urinary tract symptoms (such as dysuria, suprapubic pain, and hematuria) were reported in nearly 44% of our patients, and fever was the most common symptom. Further prospective studies are needed to evaluate the differences in clinical symptoms in these patients.

Positive urine culture with normal urinalysis in an asymptomatic patient may indicate urine colonisation or contamination rather than an actual infection, and therefore, the results of urinalysis are important in the diagnosis and management of UTI [28]. Pyuria, seen in a high percentage of our patients (70%), was reported in 85% of patients with a urinary catheter and was detectable at the end of the first week in another study by Otobo *et al*. in Nigeria [29]. Coman *et al*. suggested that nitrite-positive urinalysis cannot help the CAUTI diagnosis [30]. Similarly, only 25% of our patients were nitrite positive. However, the elements of urinalysis may change over time after catheterisation and at different rates in male and female patients [29].

Similar to our results, Gram-negative *Enterobacteriaceae* are the most common causes of CAUTIs as identified in other studies [8,10,31-33]. Although *Escherichia coli* was the most isolated microorganism in most studies, *K. pneumonia* was the most common causative agent in our findings and in

another study on ICU patients in Tehran, Iran [34,35]. One of the important points regarding pathogenic bacteria is their pattern of resistance to various antibiotics [36]. Our findings, similar to some studies, indicate that the common groups of gram-negative bacteria that cause CAUTIs, including *Klebsiella* spp., *E. coli*, *Acinetobacter* spp., and *Pseudomonas* spp. are generally resistant to ciprofloxacin and ceftriaxone [10,37]. Resistance to carbapenems is a serious challenge in the management of patients with Gram-negative bacilli infections [22]. Although Gram-negative microorganisms showed relatively high resistance to carbapenems in our study, the level of resistance has decreased compared to the results of a study by Mojtahedzadeh *et al*. conducted in the ICU in a tertiary hospital in Tehran, Iran, between 2004 and 2005 [34]. This decrease in carbapenems resistance may have been due to the implementation of the national antibiotics stewardship program in Iran, since 2016 [38].

The mean hospital stay of 28 days reported in our study is consistent with the results of previous studies in which CAUTIs were associated with a long-time hospitalisation with an average of more than 20 days [39].

Device-associated healthcare–associated infections (DA-HAIs) like CAUTIs pose a severe threat to ICU patients [40,41]. The presence of an indwelling urinary catheter was associated with an increase in urinary tract infections and mortality by 43% [42,43]. Among 15 (18.8%) patients who died in our study, infections with *A. baumannii* and *P. aeruginosa* were seen to be associated with more death. In other studies on nosocomial infections, *A. baumannii* and *P. aeruginosa* were associated with increased morbidity and mortality [44,45]. More studies on a large number of samples are suggested for a better understanding of the possible attribution of some microorganisms to the mortality of CAUTI.

Conclusions

Our findings show that CAUTIs are still a serious challenge in ICU settings. MDR *Enterobacteriaceae* are a serious concern as the cause of CAUTIs. However, *A. baumannii* and *P. aeruginosa* can probably be the most important pathogens responsible for death.

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