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Research Article

Catheter Associated Urinary Tract Infection in Intensive Care Units: A Descriptive Study from Ahvaz Golestan Hospital in Iran

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Abstract

Introduction: Urinary tract infection (UTI) is one of the most common infections and study of its causative and related factors can be useful in the prevention and treatment of this infection. In the present study, the prevalence of catheter-associated UTI in critically ill patients was investigated.

Materials and Methods: This retrospective descriptive study was performed on patients with catheter in intensive care units of Golestan Hospital of Ahvaz/Iran during the summer of 2018 using census method. Prevalence of UTI and its relationship with age, gender, duration of catheter use, underlying disease, immune deficiency and sepsis was investigated. Also, cultured micro-organism and antibiotic resistance was investigated.

Results: 18.7% of critically ill patients had catheter-associated urinary tract infection. The most common micro-organism causing urinary tract infections were Candida, E. coli and Enterobacter. 22.4% of males and 30.8% of females had urinary tract infection ($p > 0.05$). The prevalence of urinary tract infection was highest in the age group of 40 - 80 year, but this difference was not significant. The prevalence of UTI was higher in patients with diabetes, hypertension, immune deficiency compared with those without these diseases. Suprapubic tenderness, leukocytosis and sepsis are common in urinary tract infections but there was no significant relationship between urinary tract infection and fever. The prevalence of urinary tract infection increased significantly with increasing duration of catheter use ($p < 0.05$).

Conclusion: The prevalence of UTI was high in patients with urinary catheter admitted to the intensive care units. It is recommended that appropriate strategies to diagnose, treat and prevent unnecessary administration of antibiotics be considered.

Keywords: *Infection; Urinary tract; Catheter; Candida; CDC*

Introduction

One of the most common types of nosocomial infections is catheter-associated urinary tract infection and accounts for 36% of all nosocomial infections [1,2]. Although the incidence of mortality from catheter-associated urinary tract infections is less than other nosocomial infections, both prevalence and disease effects are very high [1]. Both forms of infections are of critical concern to patients admitted to the intensive care unit who use a catheter to monitor the volume of urine output or to control urinary incontinence [3,4]. Often, about 5 - 10

percent of residents in nursing homes have been using catheters for many years [4,6]. Survivable risk factors include the use of a catheter, catheter insertion time and quality of procedure, catheter monitoring and maintenance efficiency, and hospital stay period [4]. Catheter-associated urinary tract infection typically may not have a clinical profile that involves pain, recurrent urination, and urinary incontinence, such symptoms cannot be observed until catheter removal [7]. Obviously, avoiding excessive use of the catheter and withdrawing the catheter directly after it is no longer required is the most efficient way to alleviate catheter-associated bacteriuria [8,9]. There is no clear linkage between catheter-associated bacteriuria and infection of the urinary tract. Additionally, most patients with catheter-associated bacteriuria may not become sick, but bacteriuria is an important factor in catheter-associated urinary tract infection [10]. Demographic profiles of patients with catheter-associated urinary tract infections can be assessed due to the extent of catheter usage and effects such as prolonged hospital stay and treatment expenses following catheter usage, as well as elevated incidence of catheter-associated urinary tract infections and increase resistance to antibiotics.

Materials and Methods

The current study was a descriptive retrospective analysis by census method in the Golestan Hospital Intensive care units in Ahvaz/Iran during the summer of 2018, and the statistical community composed of all patients admitted to the intensive care unit. Inclusion criteria include hospitalization in the intensive care unit, getting a urinary catheter and being older than 18 years. Exclusion criteria also included transferring patients to another ward, catheter removal less than 48 hours after installation, and death. Just after project's acceptance by Ahvaz Jundishapur University of Medical Sciences' Vice Chancellor of Research and Technology, files of patients who were admitted at the intensive care unit at the determined time of the project were reviewed and their data registered. Informed consent was obtained from the patients or his/her families included in this study at the time of admission. A total of 200 patients were admitted to the intensive care unit and catheterized within 3 months, of which 77 cases were excluded due to age under 18 years or less than 48 hours of hospitalization. The reason for admission of these patients in the intensive care unit of Golestan Hospital in Ahvaz/Iran, including various diseases such as cancer, multiple trauma, epidural or subdural hematoma, spinal canal stenosis, intracranial hemorrhage, hydrocephalus, diffuse axonal injury and so on. Data reported in a patient-specific manner, including demographic information such as age and sex, diagnosis and reason of hospitalization in the intensive care unit, period of catheterization by catheter-day unit, presence or absence of clinical or paraclinical signs and symptoms of urinary tract infection (fever above 38°C, suprapubic tenderness, leukocyturia), underlying disorders (diabetes, hypertension, hyperlipidemia, heart failure, immunodeficiency (according to CDC guidelines), the presence of sepsis on the basis of the SOFA criteria, catheter-associated urinary tract infection based on the patient's urine culture (according to CDC guidelines), antibiotics taken by the patient, were extracted from medical records of the patients. Incidence of catheter-associated urinary tract infection in patients admitted to Intensive care units of Ahvaz Golestan Hospital in Iran during the summer of 2018 and its association with age, sex, period of catheter use, underlying diseases and deficient immune system were assessed. Also, the distribution of pathogenic micro-organism and antibiotic resistance in patients with catheter-associated urinary tract infection surveyed.

Statistical analysis

SPSS software version 20 was used to analyze the total data.

Mean or median was used to describe the data center in quantitative variables and standard deviation or interquartile range was used to describe data scattering. Chi-square test (Fisher's exact test), Mann-Whitney test, ANOVA or Kruskal-Wallis test were used to analyze the univariate data. Multiple logistic regression was used to analyze the multivariate data.

Results

A total of 200 patients were admitted and catheterized in the intensive care unit over 3 months in the present study, of which 77 were excluded. The patients' mean age was 51.74 years. Positive urine culture were common (71.5%) but catheter-associated urinary tract infection according to CDC guidelines, was observed in 18.7% of patients (Table 1).

Variable	Frequency	Percent (%)
Negative urine culture	35	28.5
Positive urine culture	88	71.5
Urinary tract infection (CDC criteria)	23	18.7

Table 1: *Urine culture and prevalence of urinary tract infection.*

There was a significant association between the type of microorganism and the frequency of urinary tract infections and the most common urinary tract infection cause, were *Candida*, *Enterobacter* and *E. coli* (p= 0.00), and other micro-organism were in the following ranks (Table 2).

Micro-organism	Urinary tract infection	
	Yes	No
E. coli	2 (100%)	0 (0.0%)
Enterobacter	3 (75%)	1 (25%)
E. Coli, Enterobacter	4 (100%)	0 (0.0%)
E. Coli, Enterobacter, Candida	2 (100%)	0 (0.0%)
Enterobacter, Klebsiella, Candida	1 (100%)	0 (0.0%)
Candida	7 (100%)	0 (0.0%)
Candida, Coagulase positive Staph	2 (100%)	0 (0.0%)
Klebsiella	1 (100%)	0 (0.0%)
Pseudomonas	1 (100%)	0 (0.0%)

Table 2: *Association of urinary tract infection with the type of microorganism.*

Urinary tract infection occurred in 22.4% of men and 30.8% of women and no significant relationship was observed between urinary tract infection and patient gender (p = 0.37). Also, there was no significant relationship between age group and the rate of catheter-associated urinary tract infection (p = 0.18). Nevertheless, the largest incidence of urinary tract infections was observed in 60-80 year and 40-60 year age ranges (Table 3). There was a significant incremental correlation in the length of use of the catheter and the incidence of urinary tract infection (p < 0.05).

Variable		Urinary tract infection		P- value
		Yes	No	
Sex	Male	11 (22.4%)	38 (77.6%)	0.37
	Female	12 (30.8%)	27 (69.2%)	
Age	< 40 years	3 (11.5%)	23 (88.5%)	0.18
	40 - 60 years	11 (32.4%)	23 (67.6%)	
	60 - 80 years	9 (34.6%)	17 (65.4%)	
	> 80 years	0 (0.0%)	1 (100%)	
Duration of catheter use	< 10 days	9 (18%)	41 (82%)	0.00
	11 - 20 days	3 (16.7%)	15 (83.3%)	
	21 - 30 days	1 (12.5%)	7 (87.5%)	
	31 - 40 days	5 (83.3%)	1 (16.7%)	
	41 - 50 days	2 (66.7%)	1 (33.3%)	
	51 - 60 days	3 (100%)	0 (0.0%)	

Table 3: *Relationship between urinary tract infection and sex, age and duration of catheter use.*

There was a significant relationship between urinary tract infection and suprapubic tenderness (p = 0.00), leukocyturia and sepsis (p = 0.044). There was no significant relationship between urinary tract infection and body temperature (Table 4).

Variable	Catheter-associated urinary tract infection		P-value
	Yes	No	
Suprapubic tenderness	21 (91.3%)	2 (8.7%)	0.00
Leukocyturia	4 (11.8%)	30 (88.2%)	0.010
Sepsis	12 (38.7%)	19 (61.3%)	0.044
Average body temperature (C)	37.13 ± 6.7	36.98 ± 4.3	0.40

Table 4*: Clinical presentation of catheter-associated urinary tract infection.*

Kidney stones were not observed in any of the patients in whom urinary tract infections were evaluated. There was a significant relationship between urinary tract infection and hypertension (p = 0.001), immunodeficiency (p = 0.00) and diabetes (p = 0.00). No significant relationship was found between urinary tract infection and other diseases (Table 5).

Underlying diseases	Urinary infection		P-value
	Yes	No	
Kidney stone	0	0	-
Diabetes	10 (62.5%)	6 (37.5%)	0.00
Hypertension	13 (50%)	13 (50%)	0.001
Immunodeficiency	4 (100%)	0 (0.0%)	0.00
Other diseases	6 (42.9%)	8 (57.1%)	0.12

Table 5: *Relationship between the underlying diseases and the prevalence of infection in patients with catheter-associated urinary tract infection.*

A significant relationship was observed between the type of antibiotics prescribed and the prevalence of urinary tract infections (p < 0.05). The most effective antibiotic compounds were keflin plus gentamycin and ceftriaxone plus metronidazole, while the following compounds including meropenem plus vancomycin, tazocin plus colomycin, levofloxacin plus tazocin and tazocin plus amikacin were the most little effective compounds and were unable to prevent urinary tract infections (Table 6).

Discussion

In the present study, catheter-associated urinary tract infection was observed in 18.7% of the patients. After catheterization, bacteriuria was observed in 38 patients (6.3%) of the statistical population consisting of 87 patients in the study of Mousavian and Mashali (2004) who had no signs or symptoms of urinary tract infection before insertion of the catheter [11]. The frequency of urinary tract infections in intensive care unit patients was 6.5% according to the study conducted by Lapland., *et al*. (2009) [12]. The findings of the Clash., *et al*. (2007) study estimated that at least one episode of catheter-associated urinary tract infection was observed in 9 percent of patients with catheters [13]. Among the 757 patients admitted to the intensive care unit, 161 episodes of infection were reported based on the Talat., *et al*. (2009) research, suggesting 15.7 catheter-associated urinary tract infections per 1000 days of catheter usage [14]. Further evidences indicate that bacteriuria has been seen in 26% of patients who have used a urinary catheter for 2-10 days, as well as bacteriuria due to urinary tract infection occurred in 25% of patients. The efficacy of the urinary catheter in the occurrence of urinary tract infections

Prescribed antibiotics	Urinary infection		P-value
	Yes	No	
Keflin plus gentamycin	0 (0%)	14 (100%)	< 0.05
Ceftazidime plus vancomycin	5 (20.8)	19 (79.2)	> 0.05
Tazocin plus ambisome	0 (0.0%)	1 (100%)	> 0.05
Imipenem plus ambisom	0 (0.0%)	1 (100%)	> 0.05
Cefepime plus colomycin	1 (50%)	1 (50%)	> 0.05
Meropenem plus vancomycin	3 (100%)	0 (0%)	> 0.05
Keflin	0 (0%)	2 (100%)	> 0.05
Cefepime plus clindamycin	0 (0.0%)	1 (100%)	> 0.05
Tazocin plus colomycin	2 (100%)	0 (0%)	> 0.05
Vancomycin	1 (100%)	0 (0%)	> 0.05
Ceftriaxone plus metronidazole	0 (0%)	4 (100%)	< 0.05
Ciprofloxacin plus tazocin	0 (0%)	1 (100%)	> 0.05
Levofloxacin plus clindamycin	0 (0%)	1 (100%)	> 0.05
Ceftriaxone plus clindamycin	1 (33.33%)	2 (67.66%)	> 0.05
Cefixime plus metronidazole	4 (17.4)	19 (82.6)	> 0.05
Tazocin plus vancomycin	0 (0%)	1 (100%)	> 0.05
Colomycin plus vancomycin	1 (50%)	1 (50%)	> 0.05
Ceftazidime plus meropenem	1 (100%)	0 (0.0%)	> 0.05
Ampisulbactam plus amikacin	0 (0.0%)	1 (100%)	> 0.05
Colomycin	2 (67.66%)	1 (33.33%)	> 0.05
Ciprofloxacin plus clindamycin	1 (100%)	0 (0%)	> 0.05
Colomycin plus ampisulbactam	0 (0.0%)	1 (100%)	> 0.05
Vancomycin plus imipenem	0 (0.0%)	1 (100%)	> 0.05
Cefepime plus tazocin	0 (0.0%)	1 (100%)	> 0.05
Tazocin plus amikacin	1 (100%)	0 (0.0%)	> 0.05
Ceftriaxone plus vancomycin	1 (50%)	1 (50%)	> 0.05
Levofloxacin plus cefepime	0 (0%)	2 (100%)	> 0.05
Levofloxacin plus tazocin	1 (100%)	0 (0.0%)	> 0.05
Meropenem plus levofloxacin	0 (0.0%)	1 (100%)	> 0.05
Colomycin plus levofloxacin	0 (0.0%)	1 (100%)	> 0.05
Ceftazidime plus metronidazole	0 (0.0%)	1 (100%)	> 0.05

Table 6: *Relationship between Prevalence of urinary tract infections and prescription of antibiotics.*

is demonstrated on the basis of findings of the above experiments, which are aligned with the results of this study. Nonetheless, variables such as the features of the samples tested, the country of study and the level of health applied, etc., influence the statistics published on the basis of the findings of the various studies. Throughout the current study, there was a significant relationship between the type of micro-organism and the incidence of urinary tract infections, and *Candida*, *E. coli* and *Enterobacter* were the most widely accepted uri-

nary tract infection-causing bacteria and other micro-organism in the ranks below. In a research undertaken by Lapland., *et al*. (2009), *Escherichia coli*, *Candida albicans* and *Enterococcus* species were the most prevalent micro-organism extracted from patients admitted to intensive care unit with urinary tract infections [12]. The results of the Talat., *et al*. (2009) analysis indicate that *Candida*, gram-negative and gram-positive bacteria accounted for 51%, 33.5% and 15.4% of the population of micro-organism isolated from intensive care unit patients with catheter-associated urinary tract infection, respectively [14]. There is a coincidence between the results of the studies referred to above and the findings of the current research. Throughout this research, 22.4% of men and 30.8% of women developed urinary tract infections, although there was no significant association between urinary tract infection and the gender of the individual ($p = 0.37$). A research by Lapland., *et al*. (2009) indicated that urinary tract infections were more frequent in female critically ill patients [12]. The findings of the Talat., *et al*. (2009) study also indicates that catheter-associated urinary tract infections were much more frequent in female patients assigned to intensive care unit [14]. Other studies have identified a higher likelihood of urinary tract infections in women than in men [16], supporting the findings of this research. In this study, the highest incidence of urinary tract infection was recorded in the age group 40-80 years of age, but there was no significant association between urinary tract infection and age. In a study conducted by Mousavian and Mashali (2004), the highest and lowest rates of catheter-associated bacteremia were reported at ages 30 - 39 (28.9%) and 60 - 69 (2.6%) respectively [11]. Throughout the Talat., *et al*. (2009) report, the incidence of catheter-associated urinary tract infections was more frequent among critically ill patients aged about 40 years [14]. The statistics of the analysis by Sharif., *et al*. (2002) also found that there was no significant association between the patient's age and the occurrence of infection caused by vascular catheter [17]. Each of the above reports validate the findings of present study. A significant increase was observed in this analysis between the length of catheter use and the incidence of urinary tract infection ($p < 0.05$). A research by Talat., *et al*. (2009) found that variables such as prolonged catheter use, extended hospital stay and intensive care unit stay, and prior history of catheter usage were correlated with an increased frequency of catheter-associated urinary tract infections in patients hospitalized in the intensive care unit [14]. In other experiments, survivable risk factors like existence of catheter, length and procedure of installation of catheter, quality control and maintenance of catheter and period of hospital stay are recorded [4]. From another research, bacteriuria appears from 3 - 6% of people with variable length and is also found in all patients with increased catheter insertion time [16], confirming the findings of this research. The following strategies include avoiding the excessive use of the catheter and withdrawing it directly with the use is the most efficient way to eliminate the bacteriuria generated by the catheter [8,9]. In the present study, no significant relationship was observed between urinary tract infection and patient body temperature. Urinary tract infection is known to be a cause of fever in patients admitted to the intensive care unit based on the findings of other research [5].

It is also recorded that fever without local symptoms is one of the most frequent incidents in patients with catheters, and urinary tract infections account for about one-third of these attacks. Fever correlates with a greater frequency of systemic and local urinary tract complications including bacteremia in patients with long- or short-term catheters [16].

In the present research, the prevalence of urinary tract infections was higher in patients with symptoms and diseases such as tenderness, sepsis, diabetes, hypertension, and immunodeficiency than those without such symptoms and illnesses, whereas the patients without leukocytosis were more prone to develop a urinary tract infection compared to those with this condition. Different reports indicate that urinary tract infection is one of the major causes of leukocytosis in patients admitted to the intensive care unit [5]. The prevalence of urinary tract infections among women under 65 years old with diabetes has also been expected to enhance between 2 - 6% and 7.9 - 17.7% [16]. In the Klash., *et al*. (2007) study, mortality among patients admitted to the intensive care unit was more common in patients with catheter-associated urinary tract infection than those without it, nevertheless, no significant association has been identified between the prevalence of catheter-associated urinary tract infection and mortality despite careful monitoring of related factors [13]. The involvement of a wide variety of other clinical symptoms (recent confusion, tenderness of flank or suprapubic discomfort, chills, etc.) in addition to high incidence of fever and chronic bacteriuria, compromises the mechanism of diagnosing symptomatic urinary tract infection in patients with catheters [16]. Symptoms and indications such as emergence or exacerbation of fever, altered emotional condition,

malaise (anxiety) or lethargy without obvious cause, flank pain, tenderness of the costovertebral angle, acute hematuria and pelvic pain are resulted from catheter-related urinary tract infection, while disorders such as dysuria, urination urgency or frequency, tenderness or suprapubic discomfort (lower abdomen) are often found in patients until the catheter is withdrawn [16].

In the present study, the following compounds including ceftazidime plus vancomycin (26.8%), keflin plus gentamycin (15.2%), ceftriaxone plus metronidazole (6.3%), ceftizoxime plus metronidazole (4.5%) were the most common antibiotics prescribed. There was a significant relationship between the class of antibiotics administered and the frequency of urinary tract infections in this survey ($p < 0.05$). The most effective compounds prescribed were keflin plus gentamycin and ceftriaxone plus metronidazole, while the weakest compounds that could not prevent urinary tract infections were meropenem plus vancomycin, tazocin plus colomycin, levofloxacin plus tazocin and tazocin plus amikacin. In the study conducted by Mousavian and Mashali (2004), it was reported that the highest resistance to ampicillin, penicillin and cephalexin antibiotics and the lowest resistance to nalidixic acid, gentamicin and nitrofurantoin was applied by *Escherichia coli*, *Enterobacter aeruginosa* and *Klebsiella rhinoscleromatis*, micro-organism isolated from patients with catheter-associated urinary tract infection. Also, the highest resistance to penicillin and ampicillin (100%) and the lowest resistance to gentamicin (66.7%) and cotrimoxazole and nitrofurantoin (50%) were shown by *Staphylococcus epidermis*. Different amounts of resistance or sensitivity to the antibiotics tested are applied by other isolated bacteria [11]. The prevalence of antibiotic-resistant micro-organism was 14% in a study by Lapland., *et al*. (2009) [12]. Why routine prophylactic antibiotics should be avoided when catheter replacement, is the high prevalence of antibiotic resistance in various micro-organism. It is necessary to pay attention to antibiotic prophylaxis in patients with numerous and severe infections that frequently endanger their function or safety. Antibiotic prophylaxis should only be prescribed when a catheter is replaced, only in people with a history of catheter-related urinary tract infection. When prescribing prophylaxis, a limited dose of antibiotic such as gentamicin should be used instead of ciprofloxacin to reduce the risk of *Clostridium difficile* infection in the hospital program [16].

Conclusion

Catheter-associated urinary tract infection is common in our intensive care units, especially in diabetic, hypertensive and immune deficient patients. It is associated with clinical parameters such as leukocytouria, suprapubic tenderness and sepsis but not fever. There was a significant relationship between increasing the duration of catheter use and the prevalence of urinary tract infections. It is recommended that appropriate strategies to diagnose, treat and prevent unnecessary administration of antibiotics be considered.

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