ORIGINAL ARTICLE

Risk factors analysis for catheter-associated urinary tract infection in urology patients: A cross-sectional survey

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ABSTRACT

Background: Urinary tract infection (UTI) is the most prevalent infectious condition in global healthcare facilities. Urinary tract infections are predominantly attributable to catheter insertion. Approximately 40% of infections in healthcare settings are urinary tract infections, with 80% of these cases resulting from catheter insertion. The aim of this paper is to identify and analyze the risk factors associated with catheter-associated urinary tract infections (CAUTI) in urology patients.

Material and Methods: A cross-sectional study involving 365 urology patients who needed catheterization was conducted at Bacha Khan Medical College and Mardan Medical Complex. Information on infections, catheterization, clinical features, demography, and antiseptic use was gathered. Significant risk factors were found using regression analysis after patients were categorized according to their CAUTI status.

Results: The average age of the participants was 58.2 years, and 57.5% of them were men. The majority (76.2%) had indwelling catheters, mostly for urine retention (34.5%) or post-operative treatment (41.9%). Significant risk factors for CAUTI included diabetes (AOR: 2.36), longer catheter duration (AOR: 1.27), prolonged hospitalization (AOR: 1.18), and lack of antiseptic measures (AOR: 2.09). CAUTI affected 26.8% of patients. Catheter type, age, and gender did not substantially correlate with CAUTI.

Conclusion: Prolonged catheter duration, diabetes, prolonged hospitalization, and lack of antiseptic measures are significant risk factors for CAUTI in urology patients.

Keywords: Antiseptic measures, Catheter-associated urinary tract infection, Catheter duration, Diabetes, Risk factors, Urology

BACKGROUND

Urinary tract infection is the most prevalent infectious condition in global healthcare facilities.[1] Approximately 40% of infections in healthcare settings are urinary tract infections, with 80% of these cases resulting from catheter insertion.[2] Approximately 12%-16% of adult patients utilised indwelling catheters during hospitalisation, while 3%-7% experienced catheter-associated UTI.[3,4] UTI is the most prevalent infection, with 560,000 cases annually, of which 387,550 are catheter-associated UTI.[5] An estimated 222 million individuals globally are affected by UTI. The estimated incidence of UTI is 90-100 cases per 100,000 individuals, equating to around 180,000 new cases annually in Indonesia.[6-8]

Infection frequently arises following the insertion of a urinary catheter, with a daily increase of 5-10% in urinary bacteria associated with catheter installation.[9] The infection rates for indwelling catheter implantation range from 3% to 5% daily for short-term use and from 3% to 10% daily for long-term use.[10-12] UTIs can lead to consequences including sepsis and kidney infections, they raise morbidity, mortality, hospital stays, and healthcare expenses. They further complicate therapy and raise costs by contributing to antibiotic resistance.[13] In a patient suffering from a UTI, pathogenic bacteria negatively impacted the urinary system. Both Gram-positive and Gram-negative bacteria, as well as fungi, can cause UTIs. The most frequent pathogen, uropathogenic *Escherichia coli* (UPEC), is in responsible for 75% of uncomplicated illnesses and 65% that are complicated ones.[14,15] The majority of CAUTIs are caused by common pathogens after UPEC, such as *Enterococcus species* (11%), *Klebsiella pneumoniae* (8%), *Candida species* (7%), and others like

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Staphylococcus aureus, *Proteus mirabilis*, *Pseudomonas aeruginosa*, and Group B *Streptococcus* (2% each).[16] Analyzing risk factors for CAUTIs is essential for directing nursing care and assessing its efficacy.[17]

The purpose of this research was to identify risk factors for CAUTI in order to avoid these infections and to guide preventative measures and enhance patient outcomes, it focuses on identifying and evaluating these risk factors in urological patients, paying special attention to demographic, clinical, and catheter-related traits.

MATERIAL AND METHODS

This cross-sectional study was conducted at the Urology Department of Mardan Medical Complex Mardan (Teaching Hospital of Bacha Khan Medical College) over six months.

The study included patients aged 18 years and above who required urinary catheterization for clinical indications. Patients with indwelling urinary catheters in place for more than 48 hours were eligible. The inclusion criteria for the sample were: 1) patients undergoing catheter placement at MMC Mardan exhibiting signs and symptoms such as fever ≥ 38°C, suprapubic pain, and costovertebral pain for over 48 hours; 2) culture results indicating ≥ 105 CFU/ml or the identification of more than two bacterial species; and 3) a minimum patient length of stay of two days. The exclusion criteria for the sample were: 1) patients diagnosed with an infectious disease; 2) patients exhibiting signs and symptoms such as fever ≥ 38°C, suprapubic pain, and costovertebral pain within 48 hours of catheter placement; 3) patients treated in a paediatric room; 4) patients unwilling to participate and 5) patients having pre-existing urinary tract infections at the time of catheterization and incomplete medical records were excluded.

A total of 365 patients were recruited. The sampling method employed was nonprobability sampling, specifically convenience sampling. The Ethics Commission of BKMC Mardan has approved the study vide reference number 745/BKMC dated 21st December 2022, and the researcher has obtained the respondents' informed consent.

Criteria established by the Centres for Disease Control and Prevention (CDC) for diagnosing catheter-associated urinary tract infections include a temperature of ≥ 38ºC, suprapubic and costovertebral pain persisting for over 48 hours, and culture results of ≥ 105 CFU/ml or the identification of more than two bacterial species. The researchers have executed the study steps, specifically: The researcher recorded the respondents' demographic information, including age, gender, diabetes mellitus status, and catheter implantation indication, in the observation sheet. The researcher monitored the duration of catheter placement, drainage system, catheter maintenance, and indicators of catheter-associated urinary tract infection, including a temperature of ≥ 38°C, suprapubic and costovertebral pain, and culture results of ≥ 105 CFU/ml or the identification of more than two bacterial species; 2) The researchers assessed patients for signs and symptoms of catheter-associated urinary tract infection following catheter placement; 3) The patients were observed for a duration of seven days for signs and symptoms of catheter-associated urinary tract infection by the researchers; and 4) Urine specimens were collected from patients for culture analysis.

The authors established the fifth day of catheterization as the cut-off date for this study, seventh day as the longest, with fifth day serving as the cut-off point and median in this study. CAUTI may develop after the second day of catheter insertion. The CAUTI commenced on the third day means on the third day following catheterization, CAUTI started or was initially discovered.

A urine catheter specimen was obtained for culture analysis. Hand hygiene was conducted prior to and during the specimen collection, and gloves were utilised throughout the operation. The drainage port was disinfected with an antimicrobial before to and following the specimen collection. The drainage system was secured beneath the port drainage. The sample was obtained using a sterile syringe. A urine sample of 3 ml to 5 ml was aspirated. The clip was detached to avert pee reflux. The urine sample was conveyed from the sterile syringe to the specimen cup. The specimen cup was placed in a cooler box and transported to the laboratory. The microbiologists conducted the urine culture. The urine specimens were inoculated onto Blood Agar and MacConkey agar. The plates were incubated at 35°C for 24 hours, after which the total plate count (CFU/ml) was determined. The identification of bacterial shape and

bacterial kind utilised traditional microbiological procedures. Urinary tract infection was determined when there were ≥105 CFU/ml or more than two bacterial species detected.

A statistical analysis test was conducted utilising Statistical Package for Social Sciences (SPSS) 22.00. Chi-square and Fisher's exact test were employed for bivariate analysis due to the ordinal scale of the variable, while logistic regression was utilised for multivariate analysis. The significance level for the p-value was established at $p < 0.05$. The multivariate quantitative analysis was the most significant factor in catheter-associated urinary tract infections. The threshold for entering the logistic regression models was established at $p < 0.25$. The logistic regression models were executed six times. The two most influential variables were ultimately identified.

RESULTS

The research examined 365 urology patients with an average age of 58.2 ± 15.3 years, of which 57.5% were male 42.5% were female. The average BMI was 26.8 ± 4.3 kg/m². Concerning smoking status, 25.2% were current smokers, 29.6% were past smokers, and 45.2% had never smoked. Diabetes mellitus and hypertension were observed in 30.7% and 48.2% of patients, respectively, whereas 25.2% had chronic kidney disease (CKD).

The average catheter duration was 8.6 ± 4.7 days, with catheterization conducted mostly for post-surgical care 153 (41.9%), urine retention 126 (34.5%) or incontinence 86 (23.6%) The average period of hospitalization for patients was 14.3 ± 7.5 days. Within the cohort, 98 (26.8%) experienced catheter-associated urinary tract infections (CAUTIs), whereas 267 (73.2%) did not. Antibiotics were supplied to 212 (58.1%) of patients during hospitalization. This demographic analysis emphasises critical elements that may influence CAUTI risk (Table-I).

The study comprised 365 patients, of whom 278 (76.2%) utilised indwelling urinary catheters and 87 (23.8%) engaged in intermittent catheterization. Concerning catheter materials, 51.2% were silicone, 30.7% were latex, and 18.1% were categorised as other. Catheter insertion primarily took place in hospital environments (86.0%), whilst 14.0% happened in outpatient facilities. Antiseptic procedures were utilised in 80.8% of instances, while 19.2% did not implement these precautions. The average interval for catheter replacement was 9.3 ± 3.5 days (Table-II). This data underscores the prevalence of catheter types, materials, and behaviours that may affect the risk of catheter-associated urinary tract infections.

Escherichia coli (*E. coli*) was the predominant pathogen recovered from patients with catheter-associated urinary tract infections (CAUTIs), representing 47 (48.0%) of cases. *Klebsiella pneumoniae* accounted for 20.4%, *Pseudomonas aeruginosa* for 15 (15.3%) and *Enterococcus faecalis* for 10 (10.2%). *Candida species* were detected in 6 (6.1%) of instances shown in Table-III. These data highlight the varied microbiological characteristics of CAUTI bacteria, underscoring the necessity for focused infection control and antibiotic stewardship methods.

The examination of risk factors for catheter-associated urinary tract infection (CAUTI) identified multiple significant correlations. Patients who got CAUTI had a greater mean age (62.4 ± 14.8 years) than those who did not acquire CAUTI (56.3 ± 15.1 years), with a p-value of 0.012. The duration of catheterization was markedly prolonged in patients with CAUTI (11.5 ± 5.1 days) relative to those without CAUTI (7.5 ± 4.2 days), with a p-value of <0.001. The prevalence of diabetes mellitus was higher in the CAUTI group (42.9%) compared to the no CAUTI group (26.2%), with a p-value of 0.002. Antiseptic measures were utilised less frequently in the CAUTI group (69.4%) than in the no CAUTI group (85.0%), with a p-value of 0.004. The period of hospitalisation was considerably extended in the CAUTI group (18.6 ± 6.9 days) compared to the non-CAUTI group (12.7 ± 7.2 days), with a p-value of <0.001. The data indicate that advanced age, extended catheterization, diabetes mellitus, absence of antiseptic protocols, and prolonged hospitalisation are substantial risk factors for the onset of CAUTI in urological patients.

Patients who acquired CAUTI were older (61.47 ± 3.93years) than those without CAUTI (55.67 ± 4.82years, $p = 0.012$). The gender distribution was comparable between groups ($p = 0.91$), although catheter duration was considerably prolonged in patients with CAUTI (11.5 ± 5.1 days) relative to those without (7.5 ± 4.2 days, $p < 0.001$). Diabetes mellitus was more common in the CAUTI group (42.9%) compared to the

non-CAUTI group (26.2%, p = 0.002). Antiseptic measures were utilised less frequently in the CAUTI group (69.4%) than in the non-CAUTI group (85.0%, p = 0.004). The period of hospitalisation was considerably prolonged in CAUTI patients (18.6 ± 6.9 days) compared to non-CAUTI patients (12.7 ± 7.2 days, p < 0.001) shown in Tabe-IV. Logistic regression analysis for risk factors associated with CAUTIs shown in Table-V. These findings underscore extended catheterization, absence of antiseptic protocols, and preexisting diseases as significant risk factors for CAUTI.

Table-I: Demographic characteristic among respondents.

Variable	Mean ± SD / n (%)
Age (years)	58.2 ± 5.26
Gender	
Male	210 (57.5%)
Female	155 (42.5%)
BMI (kg/m²)	26.8 ± 4.3
Smoking Status	
Current smoker	92 (25.2%)
Former smoker	108 (29.6%)
Never smoked	165 (45.2%)
Diabetes Mellitus	112 (30.7%)
Hypertension	176 (48.2%)
Chronic Kidney Disease (CKD)	92 (25.2%)
Catheter Duration (days)	8.6 ± 4.7
Reason for Catheterization	
Post-surgical care	153 (41.9%)
Urinary retention	126 (34.5%)
Incontinence	86 (23.6%)
Hospitalization Duration (days)	14.3 ± 7.5
CAUTI Status	
Developed CAUTI	98 (26.8%)
No CAUTI	267 (73.2%)
Antibiotic Use	
Yes	212 (58.1%)
No	153 (41.9%)

Table-II: Catheterization details of study participants (n = 365).

Variable	n (%) / Mean ± SD
Type of Catheter Used	
Indwelling urinary catheter	278 (76.2%)
Intermittent catheterization	87 (23.8%)
Material of Catheter	
Silicone	187 (51.2%)
Latex	112 (30.7%)
Other	66 (18.1%)
Catheter Insertion Setting	
Hospital	314 (86.0%)
Outpatient	51 (14.0%)
Use of Antiseptic Measures	
Yes	295 (80.8%)
No	70 (19.2%)
Catheter Replacement Frequency (days)	9.3 ± 3.5

Table-III: Microbiological Data of Patients with CAUTIs (n = 98).

Pathogen	n (%)
Escherichia coli (E. coli)	47 (48.0%)
Klebsiella pneumoniae	20 (20.4%)
Pseudomonas aeruginosa	15 (15.3%)
Enterococcus faecalis	10 (10.2%)

Candida species	6 (6.1%)

Table-IV: Risk factor analysis for CAUTIs in patients (n = 365).

Risk Factor	CAUTI (n = 98)	No CAUTI (n = 267)	p-value
Age (years)	61.47 ± 3.93	55.67 ± 4.82	0.012
Gender (Male)	56 (57.1%)	154 (57.7%)	0.91
Catheter Duration (days)	11.5 ± 5.1	7.5 ± 4.2	<0.001
Diabetes Mellitus	42 (42.9%)	70 (26.2%)	0.002
Use of Antiseptic Measures	68 (69.4%)	227 (85.0%)	0.004
Hospitalization Duration (days)	18.6 ± 6.9	12.7 ± 7.2	<0.001

Table-V: Logistic regression analysis for risk factors associated with CAUTIs (n = 365).

Risk Factor	Univariate logistic regression			Multivariate logistic regression		
	Un-adjusted OR	95% CI	p-value	Adjusted OR	95% CI	p-value
Age (per year increase)	0.78	(0.75 – 0.83)	< 0.001	1.04	(1.01 – 1.06)	0.009
Catheter Duration (per day)	0.638	(0.57 – 0.72)	< 0.001	1.27	(1.15–1.40)	<0.001
Diabetes Mellitus	2.50	(1.53 – 4.09)	< 0.001	2.36	(1.45–3.84)	0.001
Hospitalization Duration (per day)	0.695	(0.64 -0.75)	< 0.001	1.18	(1.08–1.30)	<0.001
Use of Antiseptic Measures (No)	2.49	(1.53 – 4.01)	< 0.001	2.09	(1.12–3.90)	0.021

DISCUSSION

This study emphasizes risk variables and microbiological patterns in relation to catheter-associated urinary tract infections (CAUTIs) in urology patients. The results highlight how prolonged catheterization, insufficient antiseptic precautions, and underlying comorbidities raise the incidence of CAUTI. Our study shows prevalence of CAUTI 26.8% which are in line with earlier studies that found a range of 20% in comparable populations.[18] A major risk factor was found to be advanced age, with CAUTI patients averaging 61.47 years compared to the non-CAUTI group's 55.67 years (p = 0.012). A significant factor was also found to be prolonged catheterization, with a mean duration of 11.5 days in CAUTI patients compared to 7.5 days in non-CAUTI patients. These findings are consistent with earlier research linking the length of catheterization to the development of biofilms and the likelihood of infection that follows.[19]

We determined that the gender is not linked with catheter-associated tract infection. Both males and females have equal susceptibility to infection; nevertheless, the incidence of infection is higher among males in proportion to females.[20] Concerning catheter materials, 51.2% were silicone, 30.7% were latex, and 18.1% were categorised as other. A study conducted by Sabir *et al*., 2017 showed patients with latex indwelling catheters had a higher prevalence of CAUTI (69.6%), while individuals with silicone indwelling catheters had a lower incidence (30.4%).[20] The results of microbiological examination showed that *Escherichia coli* was the most common pathogen (48%) followed by *Pseudomonas aeruginosa* (15.3%) and *Klebsiella pneumoniae* (20.4%). These findings are consistent with earlier research showing that Gram-negative bacteria are the main cause of CAUTIs. According to the findings of earlier research by Ronald, 2002 *Escherichia coli* accounted for 52.3% of all isolated pathogens, while *K pneumoniae* came in second with 14.5%.[21] The most frequently identified bacterial type in our study was *Escherichia coli*, representing 47 (48.0%) of cases. Likewise, the study indicated that Escherichia coli was the most prevalent pathogen in catheter-associated urinary tract infections.[22] By encouraging bacterial persistence and boosting the inflammatory response to infection, type 1 fimbriae make *Escherichia coli* more virulent for the urinary tract.[23] We determined that the gender is not linked with catheter-associated tract infection. Both males and females have equal susceptibility to infection. It is not unexpected that those over 60 years of age are at a higher risk of developing catheter-associated urinary tract infections. This aligns with theories of immunosenescence[4] and prior cohort studies indicating elevated rates of catheter-associated urinary tract infections in elderly patients with an average age of 64.6 years.[23]

Diabetes Mellitus was identified as an independent risk factor for CAUTI, as demonstrated in another investigation. A study conducted by Geerlings, 2008 states that among patients with a urinary catheter, whether or not they had diabetes mellitus, Candida spp. were the most often reported cause of hospital-acquired UTI.[24] Another study conducted by Nitzan *et al*., 2015 stating that patients with type 2 diabetes mellitus

frequently get UTIs. Compared to those without diabetes, these patients have more severe UTIs, more resistant bacteria, and worse outcomes.[12] Talaat *et al*., 2010 examined the hospital length of stay (LOS) between the CAUTI and non-CAUTI group. Longer hospital and intensive care unit stays were associated with greater CAUTI risks, according to the pooled data.[25]

LIMITATION

Our research possessed multiple limitations. Initially, patients may have experienced catheter-associated urinary tract infections. The use of diapers in patients is suspected. The organism infiltrates the urinary tract from the anal region or the perineal area. The improper placement of the urinary catheter fixation resulted in contact with the perineal area. Third, clinical specimens may have been improperly collected and contaminated by the pathogen. This study may be subject to prejudice.

CONCLUSION

Prolonged catheter duration, diabetes, prolonged hospitalization, and lack of antiseptic measures are significant risk factors for CAUTI in urology patients. Preventive measures targeting these factors could help reduce CAUTI incidence.

CONFLICT OF INTEREST

None

GRANT SUPPORT & FINANCIAL DISCLOSURE

Declared none

AUTHOR CONTRIBUTION

Zafar Ahmad Khan: Data collection, curation, validation, drafting and editing of manuscript, data interpretation, final approval, accountable for every aspect of the research

Adnan Akhtar: Conceptualization, supervision, revision of manuscript and suggestions, study design, final approval, accountable for every aspect of the research

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