

## Original Research Article

# A study of risk factors for catheter associated urinary tract infection

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### ABSTRACT

**Background:** Catheter associated urinary tract infections (CAUTIs) are the most common causes of UTIs in postoperative cases. Many risk factors are associated with its incidence. The present study was conducted with the aim to determine the related risk factors and to identify the causative agents contributing to the urinary tract infection.

**Methods:** This prospective study was conducted on 210 patients meeting the requirements of inclusion criteria during September 2012 to February 2014. Detailed history of the patients was recorded. Urine culture was done at different time intervals to identify the causative agent suggestive to CAUTI. Univariate analyses of the association of each variable with CAUTI and multivariable logistic regression were done to predict CAUTI outcome.

**Results:** The mean age of study participants was 51.61 years. Among them 141 were males and 69 were female patients. On univariate analysis purpose for urine catheterization, place of catheterization, breach in the closed system of drainage, duration of catheterization, hemoglobin value less than 10, raised renal parameters with serum creatinine more than 1.5 were all significantly associated with development of CAUTI (p value 0.000). Sex of the patient (p value 0.279) and catheter size (p value 0.279) was not found to have a significant correlation with increased risk of CAUTI. On multivariate analysis, age, catheter size, diabetes, duration of catheterization, a breach in the closed system of catheter drainage and sex were found to be the significant risk factors associated with CAUTI (p<0.05).

**Conclusion:** An understanding of the risk factors in development of CAUTI, significantly helps in reducing the additional burden on the health care system. Measures such as shortening the duration of catheterization, strict control of diabetes and sterile precautions in insertion and maintenance of indwelling catheters can help in prevention CAUTI.

**Keywords:** CAUTI, Microbial infections, Risk factors

### INTRODUCTION

The indwelling urinary catheter plays an important part of many medical practices. The National Health Care Safety Network (NSHN) defined an indwelling catheter as any tube that is inserted into the urinary bladder through the urethra and does not include supra pubic catheters and nephrostomy tubes.<sup>1</sup> Catheter associated urinary tract infection (CAUTI) is the most common nosocomial infection worldwide accounting for nearly 30-40% of all

institutionally acquired infections.<sup>2-5</sup> 80% of them are associated with an indwelling catheter. It is defined by the Center for Disease Control (CDC) as any urinary tract infection in a patient who had an indwelling catheter in place at the time of or within 48 hours prior to onset of infection.<sup>1</sup> There has not been any minimum period defined for the catheter to be in place for the urinary tract infection to be categorized as CAUTI. CAUTI can range from asymptomatic bacteremia urinary tract infection to symptomatic urinary tract infection.

It is associated with major morbidity and can lead to genitourinary complications such as pyelonephritis, cystitis, prostatitis, epididymo-orchitis and other systemic complications such as vertebral osteomyelitis, septic arthritis, endocarditis, endophthalmitis and meningitis. 3% of all patients with catheter will develop bacteremia. Complications associated with CAUTI lead to prolonged hospital stay, and increased cost, morbidity and mortality. The morbidity and mortality due to CAUTI according to Centre for Disease Control is increased by 2.8-fold and the length of hospitalization is increased by 1-3 days. The importance of CAUTI with regards to cost is best shown by the CMS (Medicare) data in the United States that estimated the annual cost due to CAUTI was between \$340 to \$450 Million.<sup>6-9</sup>

Understanding the risk factors for catheter associated urinary tract infection is essential for implementing prevention strategies in daily care of our patients. This study aims to evaluate the patient and catheter related risk factors contributing to the urinary tract infection, to help in decreasing the burden of hospital acquired infections.

## METHODS

### Study design

This prospective study was conducted in Kilpauk Medical College from September 2012 to February 2014.

### Inclusion criteria

A total of 210 patients subjected to Foleys catheterisation in the hospital (or within 24 hours of presentation to the hospital) for an appropriate indication were included in the study.

### Exclusion criteria

Pregnant women, patients with known allergy to latex or silicone, patients with urethral catheter in place for >24 hours at admission, subjects whose initial urine culture at onset of catheterization was already positive and patients with suprapubic catheters were excluded from the study.

After getting approval from institutional ethics committee, informed consent was taken from 210 patients that meeting the requirements of inclusion criteria. Demographic and clinical data including age, gender, underlying systemic diseases including diabetes mellitus and cancer, immunosuppressive therapy, recent surgery and the indication for catheterization was collected and recorded. Urine culture was done at the time of catheterization, 48 hours after catheterization and when the patient had symptoms of fever, supra pubic pain, loin pain or change in colour of urine. Samples were also sent on the day of catheter removal in all patients. The duration of catheterization was recorded as the date when symptoms appeared or when the urine specimen was sent for culture sensitivity, whichever was earlier.

Haemoglobin and renal function tests were sent on the day of admission.

Approximately 3 ml of urine was aspirated from the sampling port of the catheter after sterilizing the port with 10% povidone iodine. Each sample was immediately sent to the microbiology laboratory for inoculation into agar plates. Quantitative analysis for the growth and type of organisms were monitored at 24 and 48 hours. Antibiotic susceptibility testing was done using the Kirby-Bauer disk diffusion technique.

### Statistical analysis

Data were analyzed using the statistical analysis package SPSS version 20 for Windows and MEDCALC software. Two analyses were undertaken: univariate analyses of the association of each variable with CAUTI and multivariable logistic regression to predict CAUTI outcome. In the univariate analysis, Chi-square test and Fisher's Exact Test was used for categorical variables and Student's t-test or Mann-Whitney test was used for continuous variables. All testing was two-sided. Univariate relative risk ratios and multivariable analyses were done by assigning the continuous variables into discrete variables, based on their being above or below a set value. The Multivariable logistic analysis was done in a stepwise manner. One variable was entered at a time into the classification equation. The predictor variable with the highest association with CAUTI was first entered. Variables with a statistically significant contribution to CAUTI were then entered into the final model.

## RESULTS

**Table 1: Demographic and clinical characteristics of study participants.**

Characteristics	Number of patients (n=210)	%
<b>Age in years</b>		
<20	4	1.9
21-30	20	9.5
31-40	39	18.6
41-50	36	17.1
51-60	37	17.6
>60	74	35.2
<b>Sex</b>		
F	69	32.9
M	141	67.1
<b>Catheter size</b>		
16	77	36.7
18	126	60.0
22	7	3.3
<b>Duration of catheterization</b>		
≤6 days	156	74.3
>6 days	54	25.7
<b>Creatinine distribution</b>		
≤1.5	163	77.6
>1.5	47	22.4

**Table 2: Significant associations with CAUTI on univariate analysis.**

Risk factors			CAUTI		Total	P value
			Absent	Present		
Age in years	<20	Count	3	1	4	0.00
		% within CAUTI	2.5%	1.1%	1.9%	
		% of total	1.4%	0.5%	1.9%	
	21-30	Count	17	3	20	
		% within CAUTI	14.2%	3.3%	9.5%	
		% of Total	8.1%	1.4%	9.5%	
	31-40	Count	33	6	39	
		% within CAUTI	27.5%	6.7%	18.6%	
		% of Total	15.7%	2.9%	18.6%	
	41-50	Count	28	8	36	
		% within CAUTI	23.3%	8.9%	17.1%	
		% of Total	13.3%	3.8%	17.1%	
	51-60	Count	15	22	37	
		% within CAUTI	12.5%	24.4%	17.6%	
		% of Total	7.1%	10.5%	17.6%	
	>60	Count	24	50	74	
		% within CAUTI	20.0%	55.6%	35.2%	
		% of Total	11.4%	23.8%	35.2%	
Gender	F	Count	37	32	69	0.471
		% within CAUTI	30.8%	35.6%	32.9%	
		% of Total	17.6%	15.2%	32.9%	
	M	Count	83	58	141	
		% within CAUTI	69.2%	64.4%	67.1%	
		% of Total	39.5%	27.6%	67.1%	
Urinary retention	Absent	Count	99	47	146	0.00
		% within CAUTI	82.5%	52.2%	69.5%	
		% of Total	47.1%	22.4%	69.5%	
	Present	Count	21	43	64	
		% within CAUTI	17.5%	47.8%	30.5%	
		% of Total	10.0%	20.5%	30.5%	
Incontinence	Absent	Count	116	73	189	0.00
		% within CAUTI	96.7%	81.1%	90.0%	
		% of Total	55.2%	34.8%	90.0%	
	Present	Count	4	17	21	
		% within CAUTI	3.3%	18.9%	10.0%	
		% of Total	1.9%	8.1%	10.0%	
Diabetes	Absent	Count	103	32	135	0.00
		% within CAUTI	85.8%	35.6%	64.3%	
		% of Total	49.0%	15.2%	64.3%	
	Present	Count	17	58	75	
		% within CAUTI	14.2%	64.4%	35.7%	
		% of Total	8.1%	27.6%	35.7%	
Place of catheterization	Casualty	Count	3	26	29	0.00
		% within CAUTI	2.5%	28.9%	13.8%	
		% of Total	1.4%	12.4%	13.8%	
	OT	Count	95	19	114	
		% within CAUTI	79.2%	21.1%	54.3%	
		% of Total	45.2%	9.0%	54.3%	
	Ward	Count	22	45	67	
		% within CAUTI	18.3%	50.0%	31.9%	
		% of Total	10.5%	21.4%	31.9%	
Drainage system	Closed	Count	100	21	121	0.00
		% within CAUTI	83.3%	23.3%	57.6%	
		% of Total	47.6%	10.0%	57.6%	
	Open	Count	20	69	89	
		% within CAUTI	16.7%	76.7%	42.4%	

Cont...Table 2;

Risk factors			CAUTI		Total	P value
			Absent	Present		
Duration of catheterization	≤6 days	% of Total	9.5%	32.9%	42.4%	0.00
		Count	115	41	156	
		% within CAUTI	95.8%	45.6%	74.3%	
	>6 days	% of Total	54.8%	19.5%	74.3%	
		Count	5	49	54	
		% within CAUTI	4.2%	54.4%	25.7%	
		% of Total	2.4%	23.3%	25.7%	
Haemoglobin	≥10	Count	95	41	136	0.00
		% within CAUTI	79.2%	45.6%	64.8%	
		% of Total	45.2%	19.5%	64.8%	
	<10	Count	25	49	74	
		% within CAUTI	20.8%	54.4%	35.2%	
		% of Total	11.9%	23.3%	35.2%	
Creatinine	≤1.5	Count	114	49	163	0.00
		% within CAUTI	95.0%	54.4%	77.6%	
		% of Total	54.3%	23.3%	77.6%	
	>1.5	Count	6	41	47	
		% within CAUTI	5.0%	45.6%	22.4%	
		% of Total	2.9%	19.5%	22.4%	

Table 3: Significant associations with CAUTI on multivariable analysis.

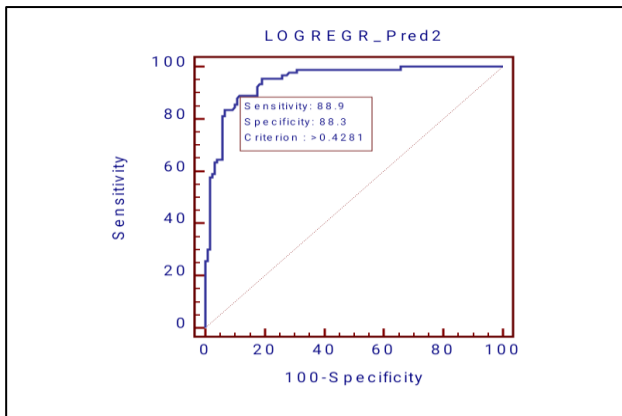
Variables	P value	Odds ratio	Std. error	95% C.I
Age	0.006	0.93	0.0248	0.88-0.98
Catheter size	0.016	1.69	0.2196	1.09-2.59
Diabetes	0.006	5.11	0.6014	1.57-16.63
Drainage system	<0.0001	10.16	0.5239	3.63-28.38
Duration of catheterisation	<0.0001	2.56	0.1888	1.77-3.71
Place of catheterisation	0.079	3.93	0.7802	0.85-18.14
Sex	0.003	6.55	0.6503	1.83-23.44

A total of 210 patients were included in the study. Demographic and clinical characteristics of the study participants were given in Table 1. The age of the patients varied from a minimum of 17 years to maximum of 88 years with a mean age of 51.61 years. Among them 141 were males and 69 were female patients. Out of 210, 64 patients were catheterized for retention of urine, 21 patients for incontinence and 13 patients were catheterized for monitoring of urine output. Three various sizes of catheters were used in the study (16 Fr, 18 Fr and 22 Fr). Majority of the patients (n=126) were inserted with 18 Fr catheter. Abnormal creatinine value was observed in 47 (22.4%) patients.

Risk factors for the development of CAUTI were analysed by univariate analysis and presented in Table 2. Purpose for urine catheterization (urinary tetention, incontinence), place of catheterization (operation theatre, inward and casualty), breach in the closed system of drainage, duration of catheterization was found to be most significant risk factors for development of CAUTI (p value 0.000). Sex of the patient (p value 0.279) and catheter size (p value 0.279) was not found to have a

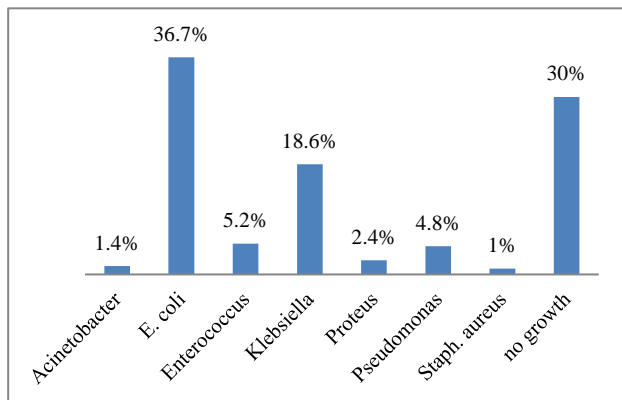
significant correlation with increased risk of CAUTI was not significantly associated with risk of catheter associated urinary tract infection in this study (p value 0.471) when studied as an independent risk factor. Patients with hemoglobin less than 10, raised renal parameters with serum creatinine more than 1.5 had shown a significant correlation to development of CAUTI (p value 0.000).

Model for multivariate analysis was done using logistic regression analysis to create an ROC curve (Figure 1). The sensitivity (88.9%) and specificity (88.3%) was used in correctly predicting the risk of CAUTI in patients when all the various risk factors were considered. Age (OR- 0.934, 95% CI- 0.88-0.98), catheter size (OR- 1.69, 95% CI- 1.09-2.59), diabetes (OR- 5.11, 95% CI- 1.57-16.6), duration of catheterization (OR- 2.56, 95% CI- 1.77-3.71), a breach in the closed system of catheter drainage (OR- 10.16, 95% CI- 3.63-28.38) and sex (OR- 6.55, 95% CI- 1.83-23.44) were found to be the significant risk factors associated with CAUTI. Of them, drainage system and duration of catheterization were the most important factors (p value <0.001) (Table 3).



**Figure 1: Receiver operating characteristic (ROC) curve of logistic regression analysis model.**

Findings of urine culture were given in Figure 2. All the urine cultures were monomicrobial. Most common organism grown in culture was *Escherichia coli* (36.7%) followed by *Klebsiella* (18.6%) and *Pseudomonas*.



**Figure 2: Microorganisms isolated of urine cultures of cauti patients.**

## DISCUSSION

Indwelling urinary catheters are a routine in most urological patients. As with any medical innovation the benefits of the catheters must be weighed against its potential adverse effects. The most common adverse effect being CAUTI.

Previous studies have identified certain risk factors that were significantly associated with CAUTI.<sup>10,11</sup> Factors that were found to be associated with an increased risk in their studies included prolonged duration of catheterization, female gender, renal insufficiency, diabetes, advancing age and catheter care violations.

The incidence of CAUTI in our study was 42.9% and is comparable to studies done by Domingo et al and Danchaivijitr et al who reported a CAUTI incidence of 51.4% and 73.3% respectively.<sup>12,13</sup> Majority of the patients were catheterized in the operation theatre

following surgery (54.3%), rest were catheterized in the ward (31.9%) and casualty (13.8%). The criteria for CAUTI were taken as bacteriuria in the presence of symptoms (symptomatic UTI) as per the CDC criteria. CAUTI rates from other studies are variable as different criteria were used to define CAUTI.<sup>12,13</sup>

Microbiological profile in our study revealed *Escherichia coli* and other entero pathogens to be the most common pathogens. This has also been reported in various other studies.<sup>2-4</sup> This study did not study the organisms infecting the urinary tract from extra luminal mechanisms wherein gram positive *Cocci* like *Staphylococcus aureus* and *Enterococcus* were more common.

In our study, seven factors were independently predictive of an increased risk of catheter associated urinary tract infection. Age, duration of catheterization, diabetes, catheterization place, drainage type, anemia and raised renal parameters were found to be significant risk factors. Other factors such as sex of the patient (p value 0.471) and catheter size (p value 0.279) were not found to be significant factors.

The first study done to evaluate risk factors for CAUTI done by Garibaldi et al in 1974 revealed that catheter care violations like break in the drainage system was not associated with an increased risk.<sup>14</sup> In the contrary other studies done by Maki et al and Platt et al concluded that catheter care violations formed an important risk factor for catheter associated urinary tract infections.<sup>15,16</sup> This was also confirmed in this study.

Seven factors were included in multivariate analysis as shown in the logistic regression Table 3. Most significant risk factors for CAUTI were duration of catheterization and drainage system (p value <0.0001). Sex (in females) (OR-6.55) and diabetes (OR- 5.11) were associated with a significantly increased risk. Shorter urethra in females and its proximity to the perineum are factors determining an increased risk in females. Diabetics were consistently found to be associated with increased risk of CAUTI in study by Gillen et al, that is similar to our study.<sup>17</sup> The possible explanation is that diabetics have an increased colonization of organisms in their perineum and urine in diabetics also supports the growth of microorganisms. Altered host immunity in diabetics may also play a role though yet to be investigated.

Duration of catheterization was found to be a very significant risk factor with an odds ratio of 2.56. Most comprehensive study of risk factors for catheter associated urinary tract infection done by Maki et al also revealed that longer duration of catheterization is associated with increased chance (OR- 5.2) of ascending infections either intra or extraluminal.<sup>15</sup> Catheter size and age were less significant factors in the logistic regression model with an odds ratio of 1.69 and 0.93 respectively. The place of catheterization plays an important role as catheterization outside the sterile confines of the



operating room was found to be associated with a 2-5 times increased risk from various prospective studies. Place of catheterization outside the operating room had an increase of CAUTI (OR-3.93) in this study but did not show a statistical significance (p value 0.079).

### Limitations of the study

- Sample size is small. Needs to study on larger number of population.
- Various guidelines and studies done to prevent catheter associated urinary tract infections need to be reviewed.
- Further research on role of antibiotic prophylaxis, instillation of antibiotics and other agents in the drainage bag, use of different perineal care agents is required.

### CONCLUSION

This study provides the data of predisposing risk factors and its causative microbial flora for CAUTI in our tertiary care. This will helps us in maintaining the conditions and use of appropriate antibiotics to manage and to prevent CAUTI during postoperative care of our patients.

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