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STUDY OF INCIDENCE AND MANAGEMENT OF CATHETER ASSOCIATED URINARY TRACT INFECTION

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Abstract

Background: The present study was undertaken to assess the incidence and management of catheter associated urinary tract infection. **Material & Methods:** This prospective randomized study was conducted after clearance from Board of Studies and Ethical committee in the Department of general Surgery, Subharti University, Meerut (U.P.) during the period 2020-2022.Demographic and clinical data including age, gender, underlying systemic diseases including diabetes mellitus and hypertension, steroid therapy, recent surgery and the indication for catheterization was collected and recorded. The data was entered into the Microsoft excel and the statistical analysis was performed by statistical software SPSS version 21.0. The Quantitative (Numerical variables) were present in the form of mean and SD and the Qualitative (Categorical variables) were present in the form of frequency and percentage. **Results:** Majority of the study population belonged to 51-60 years (33.0%) followed by 61-70 years (28.0%), 41-50 years (19.0%), above 70 years (7.0%), 31-40 years (7.0%) and 21-30 years [6%]. The study population consisted of 40.0% males and 60.0% females. Diabetes (17.0%) and Hypertension (20.0%) were the commonly reported co-morbidities. CAUTI developed in 53% of our patients. Majority of the study population had growth of E. coli (35.0%) followed by Klebseilla (11.0%), Enterococcus (5.0%) and Psuedomonas (2.0%). No growth of organisms was detected in 47% of our patients. **Conclusion:** Interventions such as incontinence care planning and hydration programs can reduce Urinary tract infections in this population and is important for overall well-being. Keywords: Catheter Associated Urinary Tract Infection, Urinary tract infection.

INTRODUCTION

Catheter-Associated Urinary Tract Infection (CAUTI) is defined as the infection in patients who use urine catheter for a minimal of three days.[4] Long term duration of urine catheter use become a predisposition factor for CAUTI event.[5] CAUTI is defined by CDC as any urinary tract infection in a patient who had an indwelling catheter in place at the time of or within 48 hours before onset of infection with at least one of the following signs or symptoms: Fever (>38°C), urgency, frequency, dysuria, suprapubic tenderness, costovertebral angle pain or tenderness, and a positive urine culture of ≥105 colony-forming units/ml with no more than two species of microorganisms.[6-8]

The Centers for Disease Control and Prevention (CDC) simplified these criteria based on the growth of mycobacteria in the urine culture. UTI is determined when the urine culture had ≥ 105colonies forming unit (CFU)/ml urine with evidence of one or two species of microorganisms, and with or without clinical features. Hospitalised UTI developed in approximately 96.2% of patients with a history of catheter use (HELICS, 2005). Long term using catheter urine is the major risk factor to develop UTI as a nosocomial infection.[2,3]

CAUTIs are the most common nosocomial infections, and account for 1 million cases per year in the United States.[9] They are the most common cause of secondary bloodstream infections. 3–10% of residents in long-term care facilities are managed with chronic indwelling catheters.[10,11] The

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associated costs of preventable CAUTI are estimated to range from $115 million to $1.82 billion annually.[12]

The National Healthcare Safety Network (NHSN) showed that CAUTI cases in ICU patients were more common in critical illness patients, due to the use of invasive equipment, like urine catheter, vein and artery catheter, an endotracheal tube.[13] The use of urine catheter interrupts the innate immune defence mechanism system by affecting the mucous barrier, which has a function to prevent uropathogenic adhesion and its migration to vesica urinary.[13,14] The risk factors in the development of a CAUTI identified so far are female gender, obesity, immune deficiency, duration of catheter use, length of hospital stay, and unnecessary placement of urinary catheters.[15] Duration of catheterization remains a significant factor in predicting CAUTI and each day of catheterization increases the risk of CAUTI by 310%.[7] The most important predisposing factor for CAUTI is the insertion of the urinary catheter.[16] Bacteriuria associated with duration of urinary catheter use is most commonly caused by a single pathogen, which is mostly a species of Candida or a gram negative enteric bacterium.[17,18] UTIs may be caused by both Gram-negative and Gram-positive bacteria, as well as fungi. Uropathogenic Escherichia coli (UPEC) is the most common pathogen for both non-complicated and complicated UTI, making up 75% and 65% of infections, respectively.2 In complicated UTI, wherein CAUTIs make of the majority of cases, the overall most common causative organisms after UPEC include Enterococcus spp. (11%), Klebsiella pneumoniae (8%), Candida spp (7%),

Staphylococcus aureus (3%), Proteus mirabilis (2%), Pseudomonas aeruginosa (2%), and Group B Streptococcus (2%). The cornerstone for management of CAUTI is antibiotics. However, the abiotic surface of the catheter is subject to biofilm formation, and thus often resistant to antibiotic penetration.[19] 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.[20] CAUTI has been associated with a threefold increased risk of mortality in hospitals because of the inappropriate use of antimicrobial agents leading to the spread of antimicrobial resistance and the emergence of multidrug-resistant uropathogens.[21] Due to the limited literature available regarding the data related to CAUTI among our population. The present study was undertaken to assess the incidence, and management of catheter associated urinary tract infection.

MATERIALS AND METHODS

This prospective randomized study was conducted after clearance from Board of Studies and Ethical committee in the Department of general Surgery, Subharti University, Meerut (U.P.) during the period 2020-2022.

Sample Size

The study population has been calculated by using Gpower with 80% of the power and 5% of the significance level. The total sample size was determined to be 100 patients.

Study Population

The study subjects were chosen as per the inclusion and exclusion criteria. The study included all patients catheterized with foleys catheter and previously catheterised patients with foleys catheter admitted in Department of Surgery in Subharti Medical College with no growth of organisms in urine culture examination at the time of catheterization. The study excluded age below 10 years and pregnant females.

After approval from the Institutional Ethical committee all patients were selected as per inclusion and exclusion criteria. A detailed history, complete physical examination and routine & appropriate investigations were done for all patients. Demographic and clinical data including age, gender, underlying systemic diseases including diabetes mellitus and hypertention, steroid therapy, recent surgery and the indication for catheterization was collected and recorded.

Specimen Collection

Urine specimen was collected using aseptic precautions at the time of catheterization with foleys catheter and after 72 hours of catheterization or when any clinical manifestation of UTI appeared. Catheter was clamped for 30 minutes after which clamp was released gradually and the specimen of urine that flowed out was collected in a sterile test tube and sent to laboratory immediately.

Quantitative analysis for the growth and type of organisms was done. Antibiotic susceptibility testing was done using the Kirby-Bauer disk diffusion technique.

Statistical Analysis

The data was entered into the Microsoft excel and the statistical analysis was performed by statistical software SPSS version 21.0. The Quantitative (Numerical variables) were present in the form of mean and SD and the Qualitative (Categorical variables) were present in the form of frequency and percentage.

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RESULTS

Table 1: Distribution of study population according to

		Frequency	Percent
Age groups	21-30 years	6	6.0%
	31-40 years	7	7.0%
	41-50 years	19	19.0%
	51-60 years	33	33.0%
	61-70 years	28	28.0%
	Above 70 years	7	7.0%
	Total	100	100%

Majority of the study population belonged to 51-60 years (33.0%) followed by 61-70 years (28.0%), 41-50 years (19.0%), 31-40 years and above 70 years (7.0%) and 21-30 years (6.0%).

Table 2: Distribution of study population according to gender

		Frequency	Percent
Gender	Male	40	40.0%
	Female	60	60.0%
	Total	100	100%

The study population consisted of 40 (40.0%) males and 60 (60.0%) females.

Table 3: Distribution of study population according to co-morbidity

Co-morbidity	Frequency	Percent
Diabetes and Pre-Diabetes [random blood sugar > 140mg/dl]	17	17.0%
Hypertension [BP > 140/90]	20	20.0%
Diabetes/Pre-Diabetes and Hypertension[Both]	18	18.0%
Steroid intake at the time of Catheterisation	6	6.0%
No Co-morbidity	39	39.0%
Total	100	100%

Diabetes (17.0%), Hypertension (20.0%) were the commonly reported comorbidities.

Table 4: Incidence of CAUTI in study population based on the Quantitative Urine Examination after 72 hours of Catheterisation or whenever Clinical manifestations appear, as well as on 7th day, on 13th day and next day after Catheter removal, Entire duration of study being 2 weeks

CAUTI	Frequency	Percent
Absent	47	47.0%
Present	53	53.0%
Total	100	100%

CAUTI was absent among 47.0% and present among 53.0% subjects.

Table 5: Distribution of study population according to growth of microbes detected on culture examination of urine after 72 hours of catheterization

Micro-organism	Frequency	Percent
No growth	47	47.0%
E. coli	35	35.0%
Enterococcus	5	5.0%
Klebseilla	11	11.0%
Psuedomonas	2	2.0%
Total	100	100%

As per culture, no growth was reported among 47.0%, E. coli among 35.0%, Enterococcus among 5.0%, Klebseilla among 11.0% and Psuedomonas among 2.0% samples.

Table 6: Distribution of study population according to

	E-coli 35	Enterococcus 5	Klebsiella 11	Pseudomonas 2	Chi-square value	p-value
Cefexime	16 45.0%	0 0.0%	3 27.3%	1 50.0%	4.619	0.202
Cefoperazone + Sulbactam	16 45.7%	0 0.0%	3 27.3%	1 50.0%	4.619	0.202%
Ciprofloxacin	2 5.7%	0 0.0%	0 0.0%	0 0.0%	1.069	0.785

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Colistin	32 91.4%	3 60.0%	7 63.6%	2 100%	6.976	0.073
Ceftriaxone	16 45.7%	2 40.0%	4 36.4%	1 50.0%	0.357	0.949
Gentamycin	22 62.9%	1 20.0%	5 45.5%	2 100.0%	5.374	0.146
Imipenem	23 65.7%	2 40.0%	6 54.5%	1 50.0%	1.531	0.675
Levofloxacin	6 17.2%	1 20.0%	2 18.2%	0 0.0%	10.233	0.011

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. CAUTI is the most common nosocomial infection which constitutes a major source of nosocomial septicemia and related mortality in acute care hospitals. The decreased rate of CAUTI in ICU might be due to the increased aseptic environment than in non-ICU. A similar study conducted by Zahranet al.[22] on the comparison of the incidence rate of CAUTI among ICU and non ICU patients had found that the incidence rate is more in non ICU.

Incidence

The incidence of catheter-associated tract infection was 53% in our study. Hariatiet al.[23] found that approximately 43.90% of patients had catheter associated urinary tract infection. Kakariaet al.[24] found that incidence of urinary tract infection in ICU was found as 30.71%. In medicine and gynecology ward, 33.33% and 30% respectively. Overall, the incidence of CAUTI was 31%. Study by Lu CC et al,[25] Taiwan in has found overall incidence of UTI 57% in catheterized patients. Danchaivijitr S et al,[26] found that incidence of CAUTI was 73.3% in their study. Billote-Domingo K et al,[27] reported 51.4% incidence of urinary tract infection in catheterized patients.

Age

In present study, majority of the study population belonged to 51-60 years (33.0%) followed by 61-70 years (28.0%), 41-50 years (19.0%), above 70 years (7.0%) ,31-40 years [7.0%] and 21-30 years (6.0%).

Anggiet al,[28] found that a significant relationship was obtained between CAUTI infection with age as a risk factor, with the most research subjects being the age group 21 ≥ 60 years. The subject who aged ≤ 50 years has two times risk than a subject who age more than 50 years. Ketenet al,[29] stated that the mean age of the patients was 64.9 years and 54.5% patients were 65 years old or older.

Khan et al,[16] showed that the maximum incidence of CAUTI in the age group of 51-70 years i.e. (70.58%) and was least in age group of 11-30 years (54.65%). CAUTI was more common after the age of 50 years (70.27%). After multivariate analysis, age factor was significantly associated with the incidence of CAUTI. The incidence of CAUTI cases increases with the age of the patient. This might be due to the ageassociated changes in immune function, exposure to nosocomial pathogens, and increased number of comorbidities in the elderly. Garibaldiet al,[30] noted that patients over the age of 50 years had approximately a two-fold incidence of bacteriuria and they concluded that advanced age is responsible for the high prevalence of catheter-associated bacteriuria. Similarly, Kulkarniet al,[31] found that patients aged 40 years and more were having more risk of developing CAUTI than those who were aged < 40 years.

The number of CAUTI cases increases with the age of the patient. Out of 44 CAUTI cases, the maximum incidence was from >40 years age group. Those aged more than 40 years were having the risk of developing CAUTI more than who were aged less than 40 years. This is comparable to studies with similar predominance of CAUTI in >40 years age like N Bhatia et al,[32] Joon Ho Lee et al,[33] and Jaggi N et al.[34]

Gender

In current study, the study population consisted of 40.0% males and 60.0% females. Khan et al,[16] showed that the incidence of CAUTI among males and females was 53.125% and 69.44% respectively. Ketenet al,[29] reported that 48.5% patients were female. Kakariaet al,[24] found that 43.54% were male patients and 56.46% were female. This shows higher incidence of CAUTI among female patients. This indicates that females are more susceptible to Cauti than male. Higher incidence of Cauti in female patients is comparable with the study conducted by Danchaivijitr S et al and Billote-Domingo K et al.[26,27]

This increased risk in women is likely to be due to easier access of the perineal flora to the bladder along the outside of the catheter as it traverses the shorter female urethra. In addition, a woman's urethra is closer to anus. This makes it easier for bacteria to spread into her urethra and cause an infection. Contrasting to our study, Kulkarni et al,[31] stated that the occurrence of CAUTI was more among male patients (68.18%) compared to females (31.81%). Male predominance has been shown in the studies by Bhatia et al,[32] Joon Ho Lee et al.[33]Jaggi N et al.[34]

Comorbidities

In present study, Diabetes (17.0%) and Hypertension (20.0%) were the commonly reported comorbidities. Diabetic Mellitus was as an independent factor for catheter-associated urinary tract infection and has been shown in another study,[35] Hariatiet al,[23] found

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that diabetes mellitus patient had 8.92 times risk have catheter-associated urinary tract infection. The Diabetic Mellitus patient has a risk suffer from catheter-associated urinary tract infection because of autonomy neuropathy.[36]

This problem can cause incomplete bladder emptying and cause microorganism colonisation. Furthermore, the diabetic Mellitus patient has pancreatic betta cells damage or do not produce enough insulin and cause hyperglycaemia. If there is a hyperglycaemia condition, the kidneys cannot reabsorb glucose. The glucose levels will be high in the urine. The glucosuria influences leukocyte function and performs as a growth medium of pathogenic microorganisms. The poor control and decreasing immune system become a risk factor of diabetic mellitus patients to suffering from catheter-associated urinary tract infection.[36]

Job et al,[37] found that patients with DM had a 4.83 times more risk of developing CAUTI than those without DM. Various impairments in the immune system, poor metabolic control, and incomplete bladder emptying due to autonomic neuropathy may all contribute to the enhanced risk of CAUTI in these patients. Sugar in the urine also promotes bacterial growth. This finding is comparable with the study conducted by Kulkarniet al,[31] and Plattet al,[38] and noted an increased risk of acquiring infection among individuals with diabetics.

Diabetics were consistently found to be associated with increased risk of CAUTI in study by Gillen et al,[35] 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

In present study, Duration of catheterization > 6 days among 30.0% subjects. Previous studies have identified certain risk factors that were significantly associated with CAUTI.[39] The duration of catheterization is the dominant risk factor for CAUTI; up to 95% of UTIs in the ICU are associated with an indwelling urinary catheter. Bacteriuria, the precursor to CAUTI, develops quickly at an average daily rate of 3-10% per day of catheterization. Almost 26% patients with a catheter in place for 2-10 days develop bacteriuria, and virtually all patients catheterized for 1 month develop bacteriuria. Hence, catheterization for greater than 1 month is generally the definition for long-term catheterization,[14] It has been shown in another study.[40] The odds of the duration of catheterisation 32.85 higher for a patient who inserted a catheter for five days or more. The length the catheter insertion, the more susceptible to infection.[41] Patients who insert the indwelling catheter have a risk to growth bacteriuria.[42] The catheter urine will form a biofilm. Bacteria can enter after catheter insertion or after three days.[43] Biofilm development occurs when cells (planktonic) contact with the surface of the catheter with the thin film.[14] Anggiet al,[28] found that a significant relationship was obtained between CAUTI infection with duration of the catheter as a risk factor with the most research in 3-6 days of duration. The subject who uses a catheter for > 6 days has two times the possibility of CAUTI infected than a subject who uses a catheter for ≤ 6 days. The frequency of CAUTI infection with the urine culture examination found that 24 subjects (44.4%) of the 54 subjects studied.

Job et al,[37] stated that the outcomes of CAUTI increased with the duration of hospitalization and recovery of patients whereas a similar study conducted by Zahranet al,[22] found that the outcomes of CAUTI were complete recovery among 98.5% of patients. Ketenet al,[29] observed that the duration of catheterization was 1-7 days for 44.8% cases, 8-30 days for 46% cases. More than 50% of the most common CAUTIs were developed within the first 30 days after the beginning of the hospitalization.

Leelakrishna and Karthik,[20] also revealed the same result. The longer the catheter is placed, the higher is the incidence of urinary tract infection. The incidence of bacteriuria in catheterized patients is directly related to the duration of catheterization; the daily rate of acquiring bacteriuria is approximately 3-10%. Duration of catheterization was found to be a very significant risk factor with an odds ratio of 2.56.

Micro-Organisms

In present study, E. coli was reported among 35.0% samples, Enterococcus among 5.0%, Klebseilla among 11.0% and Psuedomonas among 2.0% samples and no growth of microbes was detected in 47%.Enterobacteriaceae are the most common pathogens associated with CAUTI, but in the ICU setting, Candida sp (18%), Enterococcus sp (10%), and Pseudomonas aeruginosa (9%) become more prevalent.[44] In data reported from the CDC's NHSN, 24.8% of all Escherichia coli isolates from patients with CAUTIs were resistant to fluoroquinolones.[13] Many members of Enterobacteriaceae produced extended-spectrum β-lactamases; 21.2% of Klebsiella pneumoniae and 5.5% of E. coli isolates from patients with CAUTIs were resistant to ceftriaxone or ceftazidime. Even more concerning is that during this same time, 10.1% of all K. pneumoniae isolates from patients with CAUTIs were resistant to carbapenems.[45]

In most of the studies done in UTI till today, the most common organism isolated is E. coli. However, there is a reduction in the frequency of E. coli (although it remains the usual cause) in patients with indwelling catheters. Job et al,[37] found that the most common isolate was E. coli followed by Klebsiella in ICU as well as non-ICU. This observation seems to agree with several other studies with E. coli isolation rate ranged from 22.0-40.47%.[17]

Kakariaet al,[24] found that E. coli (38.71%) was found the most common isolate among all microorganisms isolated. Laupland K et al,[46] found E. coli (23%), Billote-Domingo K et al,[27] found E. coli (22.30%) and Danchaivijitr S et al,[26] has found E. coli (15.10%). After E. coli, Pseudomonas

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(20.97%) was second most common isolate. Study by Laupland K et al,[46] also shows Pseudomonas as second most common uropathogen with isolation rate 10% and 13% respectively. Isolation rate of Enterococcus, in the studies by Billote-Domingo K et al, and Danchaivijitr S et al,[26,27] was 7.40% and 12.60% respectively.

Microbiological profile in the study by Leelakrishna and Karthik,[20] revealed that Escherichia coli and other entero pathogens to be the most common pathogens. This has also been reported in various other studies.[48,49] 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 a study from Turkey by Inanet al,[50] the most frequently isolated causative agents were Candida spp. in 37.1% of the UTIs, E.coliin 21.1% of the UTIs and Pseudomonas spp. in 16.5% of the UTIs. Gikaset al. revealed that the most frequent agent was P. aeruginosa (30.6%).[51,52]

Kulkarni et al,[31] observed that E.coli was the commonest isolate (47.36%), Klebsiella species (19.2%) and Pseudomonas aeruginosa (14.10%). Comparable to study conducted by Bagchi et al,[51] Dogru et al,[52] N Bhatia et al,[32] and Dimri Sanjeev et al.[53] Klebsiella associated CAUTI was as the second most common organism in studies done by N Bhatia et al,[32] Dimrisanjeev et al,[53] and Bagchi et al.[51] respectively. Pseudomonas was seen as the third most commonly found isolate in our study which is comparable to findings seen in studies done by N Bhatia et al,[32] Dimrisanjeevet al,[53] and Bagchi et al.[51]

The prevention of CA-UTI in long term care facilities addresses primarily residents with a chronic indwelling catheter. There should be frequent, systematic review of any resident with a chronic indwelling catheter to determine whether the catheter remains necessary. Bacteriuria in these residents is not avoidable. Interventions should focus on removing the catheter, whenever feasible, minimizing catheter trauma, and early identification of catheter obstruction. Chronic indwelling catheters should not be changed routinely. They should be replaced only if there is obstruction or other malfunction, or prior to initiating antimicrobial therapy when symptomatic urinary infection is treated.[54]

CONCLUSION

Interventions that motivate catheter avoidance and catheter removal to prevent CAUTI in acute care and hospital settings are supported by the strongest available evidence, although the strength of available evidence is currently less in the nursing home setting. Although the evidence is not as robust, interventions such as incontinence care planning and hydration programs can reduce UTI in this population and is important for overall well-being.

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