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Incidence, Risk Factors And Microbiological Profile Of Catheter Associated Urinary Tract Infection In A Tertiary Care Hospital.

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Abstract:
Background: *CAUTI remain a significant concern in health care. CAUTIs cause significant morbidity and mortality for patients. Higher rates of CAUTIs and antibiotic resistant organisms have been reported in parts of Asia. The present study was done to assess the incidence of CAUTI, to identify the predisposing risk factors to study the uropathogens associated with it and to detect the antibiotic sensitivity pattern in the isolated organisms in a tertiary care hospital.*
Materials and Methods *This prospective cross sectional study was carried out in Department of Microbiology at Shridevi Institute of Medical Sciences and Research Hospital, Tumkur, Karnataka, India from June 2021 to May 2022. A total 152 patients admitted in ICU and Wards who met NHSN and CDC criteria for CAUTI were selected for this study. Urine samples were collected from clinically suspected cases of CAUTI were processed for culture and sensitivity as per by standard methods. Antibiotic susceptibility testing was performed by Kirby-Bauer s disk diffusion method on Mueller-Hinton agar as per the CLSI guidelines.*
Results*: In the present study CAUTI rate was 4.31 per 1000 catheter days over a period of one year. Out of 152 patients, 95(62.50%) were male and 57(37.50%) females. The incidence of CAUTI was highest (42.8%) in patients with respiratory system involvement and the commonest comorbid condition associated with CAUTI was Chronic obstructive pulmonary disease (33.33%) in our study. In the present study the risk of CAUTI was proportionately increased with prolonged catheterization which reaches 100% if the catheter was in place for >30 days. All the isolate were Gram negative bacilli and were resistant to third and fourth generation cephalosporin. Majority of them were sensitive to aminoglycosides and carbapenem.*
Conclusion: *Reducing the duration of urethral catheterisation and urinary catheter care bundles were highly effective in the prevention of CAUTI rate.*
Keyword: *CAUTI, incidence, risk factors, Gram negative bacilli, multidrug resistant organisms*

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I. Introduction

Catheter associated urinary tract infection (CAUTI) is the most common nosocomial infection worldwide accounting for nearly 30-40% of all institutionally acquired infections, 80% of them are associated with an indwelling catheter[1]. It is estimated that approximately12%-16% of adult hospital inpatients will have an indwelling urinary catheter (IUC) at some time during their hospitalization and each day the IUC remains, a patient has a 3%-7% increased risk of acquiring a CAUTI [2] . Catheter-associated urinary tract infections (CAUTIs) are a well-known complication of urinary tract catheterization, with rates ranging from 0.2 to 4.8 per 1000 catheter-days[3]. In the intensive care unit (ICU), where infection rates are 3–5 times higher than other hospital patient care areas, the incidence of CAUTI is 7.78 per 1000 catheter days[4]. Various risk factors for infection include longer duration of catheterization; colonization of drainage bag, diarrhea, diabetes, absence of antibiotics, female gender, renal insufficiency, error in catheter care, and immune-compromised states of the patients[5].

Escherichia coli is the most prevalent infectious agent . Additionally, often identified are additional *Enterobacteriaceae, Enterococci spp*, coagulase-negative *Staphylococcus, Pseudomonas aeruginosa*, various non-fermenters, and *Candida spp* [6], Noninfectious complications from catheterization have not received widespread attention to date , although they may be as common as CAUTIs ; they include mechanical trauma to the lower urinary tract, false passage, and accidental inflation of a catheter balloon in the urethra or prostate.Up to 5% of all catheterized patients develop acute gross haematuria, and approximately 3% suffer

urethral strictures in the long term. CAUTIs can lead to such complications as prostatitis, epididymitis, and orchitis, cystitis, pyelonephritis, gram-negative bacteremia, endocarditis, vertebral osteomyelitis, septic arthritis, endophthalmitis, and meningitis in patients. Complications associated with CAUTIs cause discomfort to the patient, prolonged hospital stays, and increased costs and mortality[2,3].

For an infection to be classified as a CAUTI under guidelines published by the US Centers for Disease Control and Prevention(CDC), a patient must have: (a) had an indwelling urinary catheter for more than2 days by the date of event (with 'day one'being the day of catheter insertion); (b) one sign or symptom including fever, suprapubic

tenderness, costovertebral angle tenderness, urinary frequency or urgency or dysuria; and(c) urine culture with more than 10 ^{5}CFU/mL of one bacterial species (non-bacterial pathogens have been excluded since 2015)[7].

However, the true impact of health-care associated infections and CAUTI remains unknown in a large part of the low-income countries in the world due to the absence or weakness of their surveillance systems, which is essential to determine the magnitude of the problem and to lead the implementation of prevention strategies[8]. Due to lack of awareness, paucity of researches and financial constraints, there is dearth of hospital specific data on CAUTIs in India. The present study was planned to determine the incidence of Catheter Associated Urinary Tract Infections (CAUTI) , to find the risk factors for its development and to identify the causative agents and their antimicrobial susceptibility.This will help in decreasing the burden of hospital acquired infection and also prevent unnecessary antibiotic use.

II. Material And Methods

This prospective cross sectional study was carried out in Department of Microbiology at Shridevi Institute of Medical Sciences and Research Hospital,Tumkur,Karnataka,India from June 2021 to May 2022 after obtaining the Institutional Ethics committee approval. A total 152 patients admitted in ICU and Wards were included in this study.

***Study Design*:** Prospective observational study

***Study Location*:** This was a tertiary care teaching hospital based study done in Department of Microbiology, at Shridevi Institute of Medical Sciences and Research Hospital, Tumkur, Karnataka, India.

Sample size:152 patients

***Subjects & selection method*:**A total of 152 patients who met NHSN and CDC criteria for CAUTI and from June 2021 to May 2022 were selected for this study.

Inclusion criteria: A total of 152 patients subjected to Foleys catheterisation in the hospital for an appropriate indication were included in the study.

Exclusion criteria*:*
1. Pregnant women
2. Patients with known allergy to latex or silicone.
3. Patients with urethral catheter in place for >24 hours at admission.
4. Patients whose sample taken on time of catheterization showed culture positivity
5. Patients with condom catheters, suprapubic catheters and percutaneous nephrostomy tubes

***Procedure methodology*:** Catheterized patients were observed for local and systemic signs of UTI, meticulously on daily basis during the study period. The demographic data , date of admission to the hospital, date of insertion of indwelling catheter, number of days with the catheter, disease data, treatment data and personal history were collected from the patients in whom CAUTI is suspected and satisfying the inclusion and exclusion criteria . Urine samples were collected from clinically suspected cases of CAUTI in a sterile wide mouthed universal container taking aseptic precautions with a sterile disposable syringe after clamping the catheter tube and disinfecting with alcohol . Each sample was immediately sent to the microbiology laboratory for culture and sensitivity.

***Sample Processing*:** The urine samples were subjected to wet mount for evaluating the presence of pus cells, epithelial cells, RBCs and microorganisms. Semi-quantitative culture of urine samples was done by calibrated loop method on 5% sheep blood agar and MacConkey agar plate and streaked using the modified Mayo's technique without flaming the loop for isolation and incubated at 35–37°C for 24 hours. The diagnosis of UTI

was made by means of a significant positive urine culture count of $>10^5$ colony forming units (CFU) per ml. cultures showing growth of more than two types of bacteria were considered contaminated. The pathogenic organism was further characterized to species level using appropriate biochemicals tests[9].

Antibiotic susceptibility testing was performed by Kirby-Bauer s disk diffusion method on Mueller-Hinton agar as per the CLSI guidelines[10] . Antibiotic discs were bought from Hi-Media laboratories, Mumbai. The Gram negative bacilli were tested with Ampicillin(10µg), Amikacin (30µg),Ceftriaxone (10µg), Ceftazidime (30µg), Cefaperazone (30 µg), Cefuroxime (30 µg),Cefipime(30µg), Ciprofloxacin (1µg), Tetracycline(30µg), Gentamicin (10µg), Imipenem (10µg),Meropenem (10µg), Doripenem(10µg),Nitrofurantoin(300µg), Norfloxacin (10µg), Levofloxacin (5µg),Piperacillin (100µg), Piperacillin-Tazobactam(30+6µg), Fosfomycin(,Trimethoprim/sulphamethazole (1.2µg/23.8µg)

Statistical analysis:

Incidence rate and CAUTI rate were calculated using the formula

1. Incidence Rate = (No. of CAUTI) x 100 /(No. of catheterized patients)
2. CAUTI Rate = (No. of CAUTI) x 1000 /(No. of indwelling catheter days)

CAUTI among various gender and age; pathogenic isolates, antibiotic sensitivity pattern and associated comorbid conditions were expressed as percentage

III. Results

A total of 152 patients catheterized patients who were fulfilled the inclusion criteria and admitted to the SIMS&RH from June 2021 to May 2022 were included in the study. Out of 152 patients, 95(62.50%) were male and 57(37.50%) females(**Table 1**).Catheterization was highest among 41-60 age group (47.36%) followed by >60yrs (32.89%)**.** Maximum number of clinically suspected cases were seen in age group 20-40yrs(56.52%) followed by 41-60yrs(34.78%)(**Table2)**.

In the present study, The incidence of CAUTI after 3-5 days of catheterization was 9.09% and the risk proportionately increased with prolonged catheterization which reaches 100% if the catheter was in place for >30 days.**(Table 3)** .

The incidence of CAUTI was highest in patients with respiratory system involvement 11(47.82%) compared to the patients with renal system 7 (30.43%) and Central nervous system involvements 3(13.04%). Diabetes milletus and hypertension was observed in one patient each(4.34%). The commonest comorbid condition associated with CAUTI was Chronic obstructive pulmonary disease (33.33%) in our study. **(Table 4).**

Out of 152, 23(15.13%) patients developed clinical signs or symptoms of UTI after 2 calendar days from the time of insertion of indwelling urinary catheter. Of 23 urine samples cultured, 7(30.43%) were culture positive and 16(69.56%) showed no evidence of growth. All the urine cultures were monomicrobial.Culture isolate from 3 urine samples were identified as *Escherichia coli* ,2 were *Klebsiella* and one isolate was *Proteus* and *Pseudomona aeruginosa* each**(Table5)**.

All 7(100%) the isolates were resistant to third and fourth generation of cephalosporins.Majority of the isolates were sensitive to aminoglycosides and carbapenems. All the *Escherichia coli* isolates 3(100%) were sensitive to fosfomycin in the present study.**(Table 6).**

In our study incidence rate of CAUTI was 4.60.A sum total of 1622 catheter days were obtained in the study period. CAUTI rate was 4.31 per 1000 catheter days over a period of one year.

Table 1: Distribution of CAUTI cases based on gender

Gender	No of subjects	Percentage	Clinically suspected CAUTI cases	Percentage
Male	95	62.50	16	69.56
Female	57	37.50	07	30.43
			23	

Table 2: Distribution of CAUTI cases based on age

Age	No of subjects	Percentage	Clinically suspected CAUTI cases	Percentage
<20yrs	3	1.97%	0	0
20-40	27	17.76	13	56.52
41-60	72	47.36	08	34.78
>60	50	32.89	02	8.69
TOTAL	152		23	

Table 3: Distribuition of cases based on duration of catheterization:

Duration of catheterization	No of subjects	Clinically Suspected CAUTI Cases	Percentage
< 5 days	74	1	1.35
5-10days	33	03	09.09
11-20days	25	10	40.00
21-30days	12	7	58.33
>30days	2	2	100

Table 4: Distribuition of CAUTI cases based on their system involvement:

System	No of subjects	Clinically Suspected CAUTI	Percentage
Respiratory system	54	11	47.82
DM	30	01	4.34
HTN	26	01	4.34
Renal system	21	07	30.43
CVS	11	0	0
CNS	10	03	13.04
Total	152	23	

Table 5: Microrganisms isolated from Confirmed CAUTI cases :

Sr.no	Organisms	Number	Percentage
01	*Escherichia coli*	03	42.85
02	*Klebsiella species*	02	28.57
03	*Proteus*	01	14.28
04	*Pseudomonas aeruginosa*	01	14.28
		07	

Table 6: Antibiotic susceptibility of CAUTI isolates:

Antibiotic	*Enterobacteriaceace* N=6	*Pseudomonas aeruginosa* N=1
Ampicillin	0(0%)	NA
Cefuroxime	0(0%)	NA
Cefotaxime	0(0%)	0(0%)
Cefoperazone	0(0%)	NA
Ceftazidime	0(0%)	0(0%)
Cefepime	0(0%)	0(0%)
Piperacillin//+	1(16.66%)	NA
Cot-Trimoxazole	0	0
Gentamicin	2(33.33%)	1(100%)
Amikacin	3(50%)	1(100%)
Tetracycline	0(0%)	0(0%)
Ciprofloxacin	0(0%)	0(0%)
Levofloxacin	0(0%)	0(0%)
Amoxyclav	0(0%)	0(0%)
Piperacillin/Tazobactum	0(0%)	0(0%)
Meropenem	4(66.66%)	1(100%)
Imipenem	2(33.33%)	1(100%)
Doripenem+	2(33.33%)	1(100%)
Ertapenem	0(0%)	NA
Nitrofurantoin	4(66.66%)	1(100%)
Fosfomycin(only for *E.coli* isolates)	3(100%)	NA

IV. Discussion

Healthcare-associated infections are considered a major public health problem by the World Health Organization (WHO) as they increase morbidity and mortality, length of stay in hospital, and healthcare-associated costs, causing additional suffering for affected patients and their families[11]. The true impact of health-care associated infections and CAUTI remains unknown in a large part of the low-income countries in the world,due to the absence or weakness of their surveillance systems, which is essential to determine the magnitude of the problem and to lead the implementation of prevention strategies[12].Designing and assessing preventive measures requires an understanding of the etiology of CAUTI. Hence the present study aims at finding the incidence of CAUTI and their microbiological profile in our hospital.

The incidence of CAUTI in our study was found to be 4.60 which was lesser than the study report of Mangukiya JD etal (30.71) and Mahim Koshariya et al (27).Incidence of CAUTI reported in literature varies from 8.7-59%[13,14,15]. This variation could be attributed to difference in study protocols, type of patients

included, number of centres where the study was performed and duration of study.It was observed that the incidence of CAUTI was more among males(69.56%) than females (30.43%) in our study. Less number of female patients in our study could be a possible reason for this result. Where as the study by Greene MT incidence of CAUTI was slightly common among the female patients, which is also comparable with other studies[16]. This increased risk in women is likely to be due to the shorter female urethra, urethra being in close proximity to the anus and hormonal influences. . In the present study it was observed that most patients (56.52%) in the age 21–40 age group had CAUTI .In contrast, other studies suggest the number of CAUTI cases increase with advancing age[17]. But we failed to find any correlation of CAUTI with advanced age. This may be due to an older individuals experience an increased susceptibility to diseases, characterized by a functional decline in the thymus and the immune system, resulting in a decrease in the ability to sterilize the bladder and urethra [18].

The duration of catheterization is the most important factor in the development of bacteriuria with a risk of 3–7% daily, and UTI risk of 0.3% per catheter day[4]. 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[19]. Study by Allison Sletica et al demonstrated a non-linear increase in the cumulative risk hazard as duration increases, suggesting that each extra day of catheterisation incrementally increases the risk of CAUTI.They also observed that the duration of IUC was identified as a contributing factor for 16.5% of the CAUTI case[20] .In our study ,the incidence of CAUTI was higher after one week of catheterization and also all the patients catheterized for more than 30 days had developed CAUTI . This is similar to the study conducted by Arunagiri Ramesh *et al*[21].

The incidence was higher in patients with respiratory system11(47.82%) involvement, followed by patients with renal system involvement 7(30.43%) in the present study.This may be due to the patients requiring ventilator support were at 8 times higher risk of acquiring CAUTI[22]. Patients with renal system involvement are more likely to have an acute or chronic renal functional compromise.This could probably explain the higher rate of CAUTI in these groups of patients[21,22].

A study that was conducted at the University of Sumatera Utara Hospital in 2019 reported that *E. coli* was the most commonly isolated bacteria found (37.14%), and Gram-negative bacteria was more predominant than the Gram-positive bacteria [23]. The most common bacteria isolates found in this study are *Escherichia coli* (42.85%), followed by *Klebsiella pneumoniae*(28.57%). The NHSN data also shows *Escherichia coli* as the major culpable pathogen, accounting for 70% of the total isolates[24] . Leelakrishna P et al. also demonstrated *Escherichia coli and other enteropathogens* are the most common etiological agent of CAUTI[25] . This has also been reported in various other studies[16,21].

Antimicrobial susceptibility pattern of the isolates obtained in the present study showed that most of the Gram negative bacilli were multidrug resistant. Enterobacteriaceae and *Pseudomonas aeruginosa* isolated showed a high level of resistance to beta-lactam antibiotics , beta-lactam inhibitors, fluroquinolones and cotrimoxazole which are commonly prescribed drugs for treatment of UTI. The very high rate of resistance observed among the isolates in our study is explained by overuse of these drugs in the last few years has contributed to this rise in resistance.Previous studies have suggested that the selective pressure from the use of antimicrobial agents is a major determinant for the emergence of resistant strains[26].

Nitrofurantoin, is another commonly used drug for treatment of UTIs. In our study,4(66.6%) of Enterobacteriaceae isolates and all the isolates of *Pseudomonas aeruginosa* were sensitive to Nitrofurantoin. Similar results were shown by Poudel et al, Kulkarni et al who found 22-44.7% of Nitrofurantoin resistant Enterobacteriaceae isolates[27,28].Aminoglycoside resistance was also observed with 33.3% of Enterobacteriaceae isolates being resistant to Gentamicin and 66.6% to Amikacin thus limiting therapeutic options. But all the isolates of *Escherichia coli* were sensitive to Fosfomycin. All(100%) the isolates of *Pseudomonas aeruginosa* were sensitive to aminoglycoside and Carbapenem .Where as a higher incidence of Carbapenem resistance in the Enterobacteriaceae isolates was obtained in present study. 66.66% Enterobacteriaceae isolates were resistant to meropenem and 33.3% to other carbapenems antibiotics. This reveals that our isolates are multidrug-resistant and similar findings were observed by Kazi *et al*[29].

Significantly higher rates of antibiotic resistance have been found in Asia as compared to Europe and North America . In addition, clinical prescribing practices and availability of antibiotics differ between countries and healthcare facilities. Hence, no single set of recommendation for empiric antibiotics can be made for the treatment of CAUTIs in Asia. Hence, antimicrobial treatment choice should be guided by local antibiograms and culture results[7].

The CAUTI rate in our study was 4.31 per 1000 catheter days which is comparable to studies done by Sabir *et al* and Kazi et al who reported a CAUTI rate of 3.65 and 4.59 respectively[29,30]. Whereas CAUTI rate was 36.2 per 1000 catheter days in the study done by Arunagiri et al .An acceptable CAUTI rate was up to four per 1000 catheter days as given by NHSN report of U.S.A.The CAUTI rate in the present study was

slightly higher than the NHSN standard but lower than several studies[21,22]. In a Study by A.whitaker et al observed that there was a remarkable downward trend in the number of hospital acquired CAUTI after implementation of the multidisciplinary team[31]. The CAUTI rate was decreased by 25% and 6% in the state of Michigan and the entire USA, respectively by implementing the Keystone Bladder Bundle Initiative ,a protocol for catheter utilization, reminders and stop orders, use of alternative strategies for urinary management, portable ultrasound to measure bladder volume, and adherence to protocols for insertion of and care for urinary catheters[3].

V. Conclusion

The urinary catheter is an essential part of the modern medical care.The urinary tract of a catheterised patient is highly susceptible to severe infection resulting in increased hospitalisation, medication and also adds to the financial burden.The CAUTI rate in our study was 4.31 per 1000 catheter days which is slightly higher than the NHSN standard.Duration of catheterization was found to be a very significant risk factor . All the pathogens were Gram negative and mutidrug resistant in our study. This study will help in selection of the appropriate antibiotic for therapeutic use.This study recommends the implementation of urinary catheter care bundles and infection control program guidelines in healthcare institutions to reduce CAUTI rates.

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