A CROSS SECTIONAL STUDY TO EVALUATE SYMPTOMATIC CATHETER ASSOCIATED URINARY TRACT INFECTION IN ICU SETTING AT A TERTIARY CARE HOSPITAL

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Abstract

Background: Healthcare-associated infections Also referred as nosocomial infections results in significant morbidity and mortality in hospitalized patients, especially among ICU patients. 80% of these UTIs are catheter-associated (CAUTIs). The study is planned to determine the prevalence rate, microbiological profile with antibiotic sensitivity pattern as well as risk factors, associated with symptomatic catheter-associated UTI which will ultimately help in fprmulatng and implementing the preventive measures to curb down the burden of healthcare nosocomial infections.

Material and methods: This is a hospital-based cross sectional study carried out at the Department of Microbiology from Dec 2022 to Dec 2023 A total of 100 patients requiring urinary catheter (Foley's catheter) admitted to the medical ICU, satisfying the defined inclusion and exclusion criteria, were surveyed during this period and were followed up from admission until the outcome (discharge/death). Urine samples were collected with proper aseptic precautions and processed by standerd bacteriological techniques within 2 hours of collection. Identification and antimicrobial susceptibility testing of the isolated pathogens was done as per CLSI guidelines 2022.

Results: Out of a total of 100 catheterised patients, 17% developedCAUTI. CAUTI rate was calculated as 9.004 per 1000 urinary catheter days. Most of the cases reported were in the 51–70 years age group (47.05%) As per gender, female (58.82%) were mostly affected. CAUTI cases were observed more among patients from rural areas, admitted in MICU and with longer duration of catheterization (more then 3 weeks) Among all the positive cases, majority were Gram negative bacilli 16 (94.11%) with *Escherichia coli* being the commonest pathogen

Conclusion: This study reflects a baseline data on CAUTI rate, organisms isolated, and probable risk factors implicated for CAUTI at our institute. The overall goal is to identify formulate, and implement preventive measures for curbing down the CAUTI rate.

Keywords: Catheter-associated urinary tract infection, Healthcare-associated infection, Medical intensive care unit, Urinary tract infection.

Introduction

Hospital-acquired infections, Also referred as nosocomial infections have long stood asa beacon of concern within healthcare settings, primarily due to their association with significant morbidity and mortality rates. Accounting forapproximately 35% of all nosocomial infections, urinary tract infections (UTIs) represent the most common category, with a staggering 80% of these UTIs being catheter-associated (CAUTIs). [1] As per CDC, CAUTI is defined as UTI where an indwelling urinary catheter was in place for more than two calendar days on the date of event, with day of device placement being day one, and an indwelling urinary catheter was in place on the date of event or the day before. Each day when the indwelling urinary catheter remains, a patient has 3%-10% increased the risk of acquiring CAUTI and incidence of bacteriuria with catheter reaches nearly 100% in four weeks duration[2].

There can be an endogenous source of infection i.e., via meatal, vaginal or rectal, colonization, or can be an exogenous source i.e., via the contaminated / colonized hands or equipment of the healthcare workers. [3] Infection can ascend intraluminally (from the catheter drainage tube junction) or extraluminally (contaminated urine collection bag).[3] CAUTIs are further categorized into symptomatic and asymptomaticbacteremic CAUTIs. A symptomatic CAUTI is identified based on the onset of UTI symptoms in patients with an indwelling catheter, especially if these symptoms develop more than 48 hours post-admission or within a day following catheter removal and shows at least 1 of the following signs or symptoms of UTI ; fever (>38°C), suprapubic tenderness, costovertebral angle pain or tenderness (With no other recognized cause), urgency, frequency and dysuria. [4] Prolonged Duration of catheterisation , shorter urethra in Female gender **,** extremes of age, diabetes mellitus, catheter care of patients, immunity of host, and compromised infection control practices are some significantly associated risk factoras for development of CAUTI[6] The microbial landscape of CAUTIs is predominantly occupied by Gram-negative bacilli (GNB) followed by Gram-positive bacteria. Historically, Escherichia coli was the prevalent causative agent, but recent trends indicate a shift towards non-fermentative GNBs, Enterococcus spp.

highlighting the dynamic nature of microbial populations in CAUTIs.[7] CAUTIs can lead to a broad spectrum of complications, ranging frommild conditions like fever, urethritis, and cystitis, to more severe afflictions such as acute pyelonephritis, renal scarring, calculi formation, and bacteremia. Thesecomplications not only exacerbate the patient's suffering but also significantly increase healthcare costs and the burden on healthcare facilities.[8]

The study is planned to determine the prevalence rate, microbiological profile with antibiotic sensitivity pattern as well as risk factors, associated with symptomatic catheter-associated UTI. This will abet in reviewing infection control and antibiotic policies of institution and thus constrain the burden of hospital-acquired infections

Materials and Methods

Study Population, Design and Sample Size

The current study is a hospital-based cross sectional study carried out at the Department of Microbiology. A total of 100 patients requiring urinary catheter (Foley's catheter) admitted to the medical ICU, satisfying the defined inclusion and exclusion criteria, were surveyed during this period and were followed up from admission until the outcome (discharge/death).

Ethical Clearance

The study protocol was proceeded after the approval of the Institutional Ethical Clearance Committee and Research Review Board [F.3 ( )NO.59/BATCH2021/2022 dated 09/12/2022]

Inclusion Criteria:[29]

All clinically diagnosed cases of CAUTI were classified using CDC criteria. All consented ICU patients satisfying the inclusion criteria were identified for surveillance.

- Age ≥ 18 years
- Patients admitted to the adult ICU and stayed on Foley's catheter for >2 consecutive days (more than 48 hours) on the date of event (day of device placement= day1)
- Patients whose indwelling urinary catheter in place for >2 days thathad been removed on the date of event or the day before the date ofevent.
- showing at least one of the following signs or symptoms of UTI: fever (>38°C), suprapubic tenderness, costovertebral angle pain or tenderness (with no other recognized cause), urgency, frequency, and dysuria.
- Patients willing to give consent

Exclusion Criteria

- Patients who had a positive urine culture with a significant bacterial count on day 1
- Patients catheterized before admission or transferred from another hospital with a maintained catheter
- Patients whose Foley's catheter was removed before 48 hours of catheterization
- Patients showing polymicrobial growth in cultures
- Patients who refused to participate in the study
- Patients < 18 years of age
- Catheterized patients having catheters other than Foley's, such ascondom catheters and suprapubic catheters

Collection of sample

Collection of Urine Sample[10,11]: minimum of 3 ml of Urine specimens was collected aseptically in sterile containers by using a sterile syringe having 24-28 gauge needle by disinfecting and clamping the Foleys catheter in patients with less than 7 days of catheterization.In patients with long-term catheterization (>7 days), the urine sample was collected after replacing thecatheter. The first sample was taken within 24 hours of catheterization, and the second sample was collected at 48- 72 hours of admission.

Collection of Data

The required data were collected as per the standardized CAUTI case report form for each case daily at the same time, which included patient demographic profile, clinical history, and use of any antimicrobials was collected from the patient's record file and analyzed.

Specimen Processing

Urine Samples were processed by semi quantitative method (calibrated loop method) where a calibrated sterile 1.3 mm nichrome wire loop (delivereing 0.001mL of urine) was used for the isolation of bacterial pathogens by plating and subsequently incubating urinary samples on Mc-Conkey agar & Blood agar (Hi Media Laboratories, Mumbai, India) at 37°C for 24 hours. A specimen was considered positive for UTI if growth detected at a concentration of $\geq 10^5$ CFU/mL[12]. Growth with three or more types of colonies in a sample was considered as contamination, and a repeat sample was advised. Preliminary identification of growth was done and Isolates were subjected to Gram staining and further identification by the biochemical reactions along with their antimicrobial susceptibility testing by Kirby–Bauer disk diffusion method. [13,14,15]

Statistical Analysis

The descriptive statistics for quantitative and qualitative data were calculated as mean, standard deviation, and proportions, respectively. The association between qualitative variables is tested through Chi-square test.

Results

Out of a total of 100 catheterised patients, 17% (17 patients) developedCAUTI, while 83(83%) were sterile (Table 1). CAUTI rate was calculated as 9.004 per 1000 urinary catheter days. Most of the cases reported were in the 51–70 years age group (47.05%) followed by 31–50 years (41.17%)(Table 2). As per gender, female (58.82%) were mostly affected. CAUTI cases were observed more among patients from rural areas,admitted in MICU and with longer duration of catheterization (more then 3 weeks) (Table 2). Among all the positive cases, majority were Gram negative bacilli 16 (94.11%) while Gram positive bacteria was 1 (5.88%) (table 3). In gram negative bacteria, *E. coli* was the most common 9(52.94%), followed by Klebsiella species 3(17.64%). Similarly, inGram positive bacteria, *Enterococcus* species was the most prevalent 1(5.88%) . Gram negative organisms showed highest sensitivity to Nitrofurantoin and Aztreonam (75%) (table 4), while Gram positive organisms showed highest sensitivity to Linezolid, Nitrofurantoin, Vancomycin,Piperacillin- Tazobactam, Levofloxacin, Ciprofloxacin (100%) (table 5).In this study Pseudomonas species showed highest sensitivity to Gentamycin (100%) while the least sensitive was Cefepime, Norfloxacin, Levofloxacin and Ciprofloxacin (0%) (table 6).

Table 1 : Incidence of symptomatic CAUTI

	No. of patients	**Percentage**
Yes	**17**	**17.00**
No	**83**	**83.00**
Total	**100**	**100.00**

Table 2 : Risk factor analysis of symptomatic CAUTI

		CAUTI		
	No. of patients	**No.**	**%**	**Total % of CAUTI**
Age-wise distribution in study group(N=100)				

11-30 years	**23**	**1**	**4.35**	**5.88**
31-50 years	**45**	**7**	**15.56**	**41.17**
51-70 years	**28**	**8**	**28.57**	**47.05**
>70 years	**4**	**1**	**25.00**	**5.88**
Gender distribution in study group(N=100)				
Female	**58**	**10**	**17.24**	**58.82**
Male	**42**	**7**	**16.66**	**41.17**
Geographical Distribution of urban\rural CAUTI cases (N=100)				
Rural	**68**	**13**	**19.11**	**76.47**
Urban	**32**	**4**	**12.50**	**23.52**
Duration of catheterization				
1-10 days	**11**	**4**	**36.36%**	**23.52**
11-20 days	**45**	**6**	**13.33%**	**35.29**
21-30 days	**44**	**7**	**15.90%**	**41.17**

Table 3 : Distribution of organism isolated in study group

	No. of patients	**Percentage**	**Total % of CAUTI**
Acinetobacter baumanni	**2**	**2.00**	**11.76**
E.coli	**9**	**9.00**	**52.94**

Enterococcus	**1**	**1.00**	**5.88**
Klebsiella pneumoniae	**3**	**3.00**	**17.64**
Pseudomonas aeruginosa	**2**	**2.00**	**11.76**
Sterile	**83**	**83.00**	
Total	**100**	**100.00**	

Table 4 : Antimicrobial susceptibility pattern of Gram negativebacteria

Antimicrobial drug	Sensitive	Resistance	sensitivity %
Ampicillin	**2**	**12**	**14.28**
Ampicillin/Sulbactum	**5**	**9**	**35.71**
Amoxicillin/Clavulanate	**6**	**8**	**42.85**
Cefoperazone/sulbactum	**5**	**9**	**35.71**
Ceftazidime	**9**	**5**	**64.28**
Ceftazidime/clavulanate	**10**	**4**	**71.42**
Aztreonam	**9**	**3**	**75**
Cotrimoxazole	**4**	**10**	**28.57**
Gentamycin	**8**	**6**	**57.14**
Imipenam	**7**	**7**	**50**
Amikacin	**10**	**4**	**71.42**
Nitrofurantoin	**9**	**3**	**75**
Norfloxacin	**4**	**10**	**28.57**
Piperacillin/Tazobactum	**10**	**4**	**71.42**
Cefepime	**6**	**8**	**42.85**

Ceftazidime / Tazobactum	**10**	**4**	**71.42**
Cefotaxime	**2**	**12**	**14.28**
Ciprofloxacin	**6**	**8**	**42.85**
Meropenam	**7**	**7**	**50**

Table 5：Antimicrobial susceptibility pattern of Enterococcus

Antimicrobial drug	Sensitive	Resistance
Ampicillin	**0**	**1**
Ampicillin/Sulbactum	**0**	**1**
Amoxicillin/Clavulanate	**0**	**1**
Nitrofurantoin	**1**	**0**
Norfloxacin	**0**	**1**
Piperacillin/Tazobactum	**1**	**0**
Ciprofloxacin	**1**	**0**
Doxycycline	**0**	**1**
Fosfomycin	**0**	**1**
Levofloxacin	**1**	**0**
Linezolid	**1**	**0**
Vancomycin	**1**	**0**

Table 6：Antimicrobial susceptibility pattern of Pseudomonas

Antimicrobial drug	Sensitive	Resistance
Ceftazidime	**1**	**1**
Ceftazidime/clavulanate	**1**	**1**
Aztreonam	**1**	**1**
Gentamycin	**2**	**0**
Imipenam	**1**	**1**
Amikacin	**1**	**1**
Norfloxacin	**0**	**2**
Piperacillin/Tazobactum	**1**	**1**
Cefepime	**0**	**2**
Ceftazidime / Tazobactum	**1**	**1**

Levofloxacin	**0**	**2**
Ciprofloxacin	**0**	**2**
Meropenam	**1**	**1**

Discussion

CAUTI is the commonest device associated nosocomial infection especially in critical care hospital settings.[16] Urethral catheter is one of the important predisposing factor for UTI and if not implanted aseptically, may be associated with direct entry of pathogen which can lead to complications like prostatitis, epididymitis, cystitis, pyelonephritis and septicaemia due to Gram-negative bacteraemia particularly in high-risk patients[17].As per our study, the overall CAUTI rate is 9.004 per 1000 urinary catheter days which is in accordance with other studies. [3] The overall magnitude of CAUTI in our study is 17 %, which is similar to Neha Garg et al (2015)[20] However In India there is wide variation in rate of device associated infections[18,19,22].This can be attributed to various factors like ICU based study, tertiary centre with high turnover of patient , prolong usage of urinary catheterand improper hand hygiene. In our study, the reduced incidence of CAUTI is a result of strict coherence to infection control practices, proper hand hygiene, and the efficient execution of catheter care bundle. [3,18,19] Like prior studies ,we also found female sex as an important risk factor implicated with development of CAUTI [23,24]. Shorter urethra in female predispose them for higher chance of UTI following bladder catheterization[25]. This increased risk in women is also due to urethra being in close proximity to the anus and hormonal influences[26] we found higher CAUTI rate among older age group which is in coherence with other studies[27] Various factors contribute to higher risk of infection in elderly like increased chances of acute bacterial sepsis in elderly patient, poor environmental sanitation and health conditions like Patient's nutritional status, history of previous antibiotic administration, immunological status, and the use of immunosuppressive drugs which enhance the risk for CAUTI[28].

We found that Duration of catheterisation and length of hospital stay constitute an important risk factor and has been cited in studies by Priya Datta et al[29] and Angshuman Jana et al[30]. Maximum CAUTI rate isfound among patients with longer duration of catheterisation >21 days (76 .46 %). Prolonged duration of catheterisation results in formation of biofilms which facilitates the colonization of urinary catheters and increase in resistance towards antibiotics.

In this study we found that 68 patients (68%) were from rural areas, with13 of these individuals (19.11%) developing CAUTI, accounting for 76.47% of the total CAUTI cases. Poor environmental sanitation and health conditions like lower nutritional status, resulting in compromised level of immunity and more chances of infections inrural patients attributes them for more prone to infection.

In most of the studies conducted on CAUTI in India and abroad , in our study also,most common organism was E. coli31,[32]. With poor hygiene and cross contamination, and E coli being most

common gut flora, chances of CAUTI are higher then others[33,34]. Also Enterobacteriaceae have several virulence factors which promote their attachment to the uroepithelium and colonise the urogenital mucosa like adhesin, pili, fimbriae and P1-blood group phenotype receptor[34]

In our study Enterococci has been a predominant cause of gram positive bacterial infection which is similar with the study conducted by Shobha KL et al[76]. Enterococci, tend to causeUTI in debilitated and hospitalized individuals. Patients withintravascular line have enterococcus as a frequent cause of UTI. The ability to form biofilms facilitates the colonization of urinary and vascularcatheters[35].

Antimicrobial resistance pattern vary from place to place and time to time. In this study , Antimicrobial susceptibility pattern of Gram-negative bacilli were multidrug-resistant .Antibiotic susceptibility of Enterobacteriaceae revealed that organisms showed highest sensitivity to Nitrofurantoin and Aztreonam (75%), while they showed least sensitivity to Cotrimoxazole and Norfloxacin (28.57%), The findings are in agreement with similar surveillance studies[36,37] where Enterobacteriaceae isolates have high susceptibility to nitrofurantoin and monobactam. Among Gram-positive cocci, *Enterococcus* species were highly susceptible (100%) to Linezolid, Nitrofurantoin, Vancomycin, Piperacillin- Tazobactam, Levofloxacin, Ciprofloxacin

Various studies have their different susceptibility pattern; the reason for the same may be factors related to difference in antibiotic usage, patient population and prescribing rate[38,39]. Variations of resistance to antibiotics in different regions might be due to different local antibiotic practices[40] ours study mainly focuses on ICU patient which can attribute to high resistance rates.

Conclusion

Identification of the type of organisms and selection of an effective antibiotic agent in early might help in effective management of UTI and prevention from resistance. Good cooperation between the clinician and the microbiologist is the key for better diagnosis and better treatment. Hospital-wide surveillance program and appropriate catheter care protocols should be developed and implemented from evidence- based protocol. Proper measures should be taken to decrease duration of catherization and decrease the burden of CAUTI.

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