Assessment of Antibiotic Management for Catheter-Associated Urinary Tract Infection: An Observational Study at a Tertiary Care Hospital, Bangalore

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ABSTRACT

Background: Catheter-Associated Urinary Tract Infection (CAUTI) is a common healthcare-associated infection that contributes significantly to patient morbidity, prolonged hospital stays and increased healthcare costs. This study aims to evaluate the antibiotics used in CAUTI treatment and identify the pathogens responsible, contributing to improved management and patient outcomes. **Materials and Methods:** A prospective observational study spanning six months was performed at a tertiary care institution. Data were collected from 60 patients diagnosed with CAUTI. The study examined patient demographics, antibiotic regimens, pathogen identification and antibiotic sensitivity profiles. Outcomes were assessed based on clinical improvement and microbiological results. **Results:** Among the 60 patients, 42% were treated with Inj. Cefoperazone and sulbactam. *Escherichia coli* emerged as the most frequent pathogen, identified in 57% of cases, with *Klebsiella* species following at 17%. Antibiotic therapy was adjusted in 42% of cases based on culture sensitivity results. The most commonly used catheters were Foley's catheters, accounting for 77% of the cases. **Conclusion:** This study emphasizes the significance of using targeted antibiotic therapy, guided by culture sensitivity results, in managing CAUTI. The findings underline the need for stringent infection control measures and the importance of adhering to antibiotic stewardship programs to reduce CAUTI incidence and improve patient outcomes.

Keywords: Catheter-associated urinary tract infection, Antibiotics, *Escherichia coli*, Hospital acquired infection, Antibiotic Resistance.

INTRODUCTION

Catheter-Associated Urinary Tract Infection (CAUTI) is a major Healthcare-Associated Infection (HCAI) concern, significantly impacting patient safety on a global scale. According to the CDC, CAUTI refers to any Urinary Tract Infection (UTI) that arises in a patient with an indwelling catheter either at the time of, or within 48 hr prior to, the infection onset. As a leading source of gram-negative infections and bacteraemia among hospitalized patients, CAUTIs account for nearly 75% of all hospital-acquired UTIs.[1,2] The UK government, recognizing the gravity of CAUTI, aimed to halve healthcare-associated Gram-Negative Bloodstream Infections (GNBSIs) by 2020, acknowledging that 34-56% of CAUTIs could be prevented through reduced catheter use.[3] Effective strategies for prevention include limiting catheter use, following aseptic techniques, maintaining a closed drainage system and exploring alternative bladder management methods. While evidence supporting routine catheter exchange and antibiotic prophylaxis remains limited, adhering to established guidelines and conducting vigilant monitoring can play a significant role in reducing CAUTI rates and enhancing patient outcomes.[4-8]

In India, the management of CAUTIs is particularly challenging due to inadequate infection control measures and limited data, especially in the ICU setting.[9,10] Here, CAUTI rates vary considerably, with substantial implications for treatment, especially when dealing with the types, natures and resistance patterns of infectious micro-organisms. Limited published data exists on device-associated infections from Indian ICUs, highlighting the need for focused research in this area.[10] Prolonged catheter use is the primary risk factor for CAUTI and catheters should be promptly removed when no longer necessary. Other risk factors include prolonged catheterization, drainage bag colonization, underlying health conditions such as diabetes and renal insufficiency, patient characteristics like female gender and specific hospital departments (e.g., Orthopedic and Neurology).

The symptoms of CAUTI can be subtle when a catheter is in place, making it difficult to rely on traditional signs such as urgency, frequency and dysuria, which are less reliable due to the lack of voluntary voiding. Pathogen entry into the urinary tract occur either extraluminal or intraluminal, with microorganisms forming biofilms on catheter surfaces, often leading to infection. Common pathogens responsible for CAUTI include *Escherichia coli, Klebsiella pneumoniae*, *Proteus mirabilis* and *Pseudomonas aeruginosa*.[7] The primary objective of this study is to evaluate the antibiotics used for treating CAUTI and to identify the various pathogens responsible for these infections. Secondary objectives include analyzing the sociodemographic characteristics of the affected patients, exploring the different types of catheters associated with CAUTIs and understanding the antibiotic resistance patterns within this context. By understanding these factors, the study aims to contribute to better management practices for CAUTI, particularly in terms of prevention, diagnosis and treatment.

Furthermore, recent study on CAUTI has not been done in last 4 years in Bangalore and this research seeks to provide valuable insights into improving CAUTI prevention strategies, including reducing unnecessary catheter use, employing effective aseptic techniques and optimizing antibiotic treatment regimens. Antibiotics such as Trimethoprim-Sulfamethoxazole, Nitrofurantoin, Cephalosporins and Fluoroquinolones are commonly used to treat CAUTI, with specific choices depending on the pathogen involved and the infection's severity. This study will also contribute to a deeper understanding of the risk factors and preventive strategies that can lead to a significant reduction in CAUTI rates and improve overall patient outcomes, ensuring more targeted and effective treatment protocols.

MATERIALS AND METHODS

Study Design

This prospective observational study was conducted over a six-month period in the Department of Medicine at a tertiary care unit to evaluate the use of antibiotics in CAUTIs. The study focused on hospitalized patients in medicine wards, private wards and semi-private wards who met specific eligibility criteria. Data were collected from various sources, including inpatient case sheets, inpatient medication charts, CAUTI Daily Catheter Maintenance Bundle sheets, microbiological reports and patient interactions. Additional information was also gathered from the hospital's antibiotic policy documents to provide insight into the institution's prescribed practices for antibiotic use in CAUTI cases. The sample size was fixed at 60 patients, taking into several factors. The study's inclusion criteria encompassed patients with underlying comorbidities, such as diabetes, retroviral infections, or those receiving immunosuppressant drugs. Both male and female patients were included, regardless of age, as well as those with renal infections and disorders predisposing them to CAUTI.

Additionally, post-surgical patients were eligible for inclusion to examine the broader range of factors associated with CAUTIs. Exclusion criteria were defined to ensure patient safety and data relevance. Pregnant and lactating women were excluded, along with patients known to have allergies to latex or silicone. Patients from the emergency department and outpatients were also excluded to maintain consistency in the inpatient study environment.

Data Collection

Demographic details, including patient age, sex, weight, admission date and discharge date, were systematically gathered. Medication-related information, such as drug names, dosages, administration routes, treatment duration and relevant laboratory findings, was recorded using a specially designed data collection form. To evaluate medication dispensing practices and antibiotic resistance patterns in UTIs, case sheets, prescriptions and nursing records were thoroughly reviewed.

Study Procedure

Patients who met the inclusion criteria were enrolled in the study, with demographic and clinical information collected upon admission. If a urinary infection was suspected, empirical antibiotic therapy was started based on the presenting symptoms, while microbiological cultures were conducted to confirm the infecting bacterial species and determine antibiotic susceptibility. Initial antibiotic treatments were reviewed against antibiogram results; if effective, the same antibiotic was continued, whereas a change was made if resistance was identified. Patients' clinical progress was observed daily, with treatment effectiveness evaluated based on symptomatic improvement. Antibiotics were stopped once the therapeutic goals were reached. All findings were carefully recorded, analyzed and compiled into a comprehensive final report. All the data was analyzed only from the starting date of the antibiotic till the patient's discharge.

RESULTS

Socio-demographics and Clinical Characteristics

In this study of 60 patients at a tertiary care unit, most participants were male (72%), aged between 61-70 years, while females were mainly aged 31-40 years. The mean score between the two was 30, accompanied by a standard deviation of 13. A significant number of patients remained in the hospital for 6 to 10 days. The most common conditions were diabetes mellitus (26%) and hypertension (25%), with an overall mean of 15.82 and a standard deviation of 17.28 for past conditions. The majority of patients consumed a mixed diet (40%), with normal bowel movements observed in 87% of cases. Alcohol consumption was highest for duration of 1-5 years. Complications were present in 70% of the patients, with chronic kidney disease (34%) and acute kidney disease (18%) being the most frequent. Prostatomegaly and the

Table 1: Sociodemographics and Clinical Characteristics of Study Population.

Parameter	Categories	Counts (Percentage)	Mean	Standard Deviation
Gender-Age Distribution	Male (61-70 years)	43 (72%)	30	13
	Female (31-40 years)	17 (28%)		
Duration of Stay	1-5 Days	Very Low	N/A	N/A
	6-10 Days	Highest		
	11-15 Days	Low		
	16-20 Days	Very Low		
Past History (Conditions)	CKD	16 (8%)		
	AKD	5 (2%)		
	HTN	55 (Approx. 25%)	15.82	17.28
	DM	55 (Approx. 26%)		
	CVA	11 (5%)		
	BPH	8 (4%)		
	Pedal Oedema	6 (3%)		
	Pyelonephritis	8 (4%)		
	IHD	9 (5%)		
	Seizure	2 (1%)		
	Atherosclerosis	3 (1%)		
	Anaemia	4 (2%)		
	Hypothyroidism	7 (4%)		
	Dyslipidemia	1 (0%)		
	Prostatomegaly	1 (0%)		
	Urosepsis	6 (12%)		
Personal History (Diet)	Mixed diet	24 (40%)	N/A	N/A
	Renal diet	15 (25%)		
	Non-veg diet	7 (12%)		
Bowel Movement	Normal	52 (87%)		
Bladder Movement	Normal	21 (35%)		
	Dysuria	13 (22%)		
Alcohol Consumption	1-5 Years	Highest		
Complications	CKD	17 (34%)		
	AKD	9 (18%)		
	Urosepsis	6 (12%)		
Medications	Immunosuppressant drugs	1 (0%)		

use of immunosuppressant drugs were noted in isolated cases, details are depicted in Table 1.

Descriptive Statistics of Catheter Use and CAUTI

The study included a total of 60 individuals, with males making up 72% of the population and females 28%. Foley's catheter was the most commonly used catheter type across both genders, accounting for 77% of all cases, while silicone and condom catheters were used less frequently (13% and 8% respectively). The duration of catheterization varied, with the majority of infections occurring between the 3rd and 4th days of catheterization (53%) and fewer infections occurring between the 1st and 2nd days (27%). Hospital-acquired Catheter-Associated Urinary Tract Infections (CAUTI) were reported in 48% of the cases, indicating a significant prevalence of infection associated with prolonged catheter use, details are depicted in Table 2.

Types of pathogens Identified in CAUTI

In the study, *Escherichia coli* were identified as the most common pathogen, accounting for 57% of the cases. Other pathogens

included *Klebsiella species*, which was found in 17% of the cases, *Enterococcus species* in 13% and *Pseudomonas aeruginosa* in 3%., details are depicted in Figure 1.

Assessment of Antibiotics Used in the Treatment of CAUTI

The study analyzed the frequency of antibiotic use among 60 individuals undergoing empirical treatment for CAUTI. Inj. Cefoperazone and Sulbactam was the most frequently administered antibiotic, with 24 patients (40%) receiving it twice daily (BD). Tab. Nitrofurantoin was used by 8 patients (13%) on a twice-daily basis, while Inj. Meropenem and Inj. Piperacillin and Tazobactam were administered to 7 patients (12%) each,

with various dosing schedules. The least used antibiotics were Inj. Amikacin and Tab. Trimethoprim and Sulfamethoxazole, prescribed to 2 (3%) and 5 (8%) patients, respectively. The data suggests that Inj. Cefoperazone and Sulbactam was the preferred choice for treating CAUTI in this population, details are depicted in Table 3.

Specific antibiotics used for specific pathogen

For specific pathogens, antibiotics are chosen based on their mode of action, either by killing the bacteria (bactericidal) or inhibiting bacterial growth (bacteriostatic). Various bacteria possess distinct features, such as differences in cell structure, metabolism and resistance mechanisms, which affect how they react to antibiotics.

Table 2: Descriptive Statistics of Catheter Use and CAUTI.

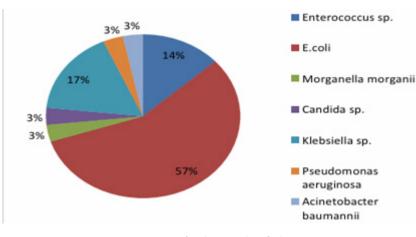| Variable	Male (n)	Male (%)	Female (n)	Female (%)	Total (n)	Total (%)
Type of Catheter						
Silicone Catheter	4	7%	4	7%	8	13%
Condom Catheter	5	8%	0	0%	5	8%
Foley's Catheter	23	39%	23	39%	46	77%
Duration of Catheterization (Days)						
1-5 Days	0	0%	5	8%	5	8%
6-10 Days	1	2%	22	37%	23	39%
11-15 Days	0	0%	12	20%	12	20%
16-20 Days	0	0%	1	2%	1	2%
21-25 Days	0	0%	2	3%	2	3%
26-30 Days	0	0%	0	0%	0	0%
31-35 Days	8	13%	0	0%	8	13%
Day of Infection						
Day 1-2	11	18%	5	8%	16	27%
Day 3-4	22	37%	10	17%	32	53%
Hospital Acquired CAUTI						
Yes	29	48%			29	48%
No	31	52%			31	52%

Figure 1: Types of pathogens Identified in CAUTI.

Antibiotics	OD (Once Daily)	BD (Twice Daily)	TID (Three Times Daily)	Q8H (Every 8 Hr)	Total (n)
Inj. Cefoperazone and Sulbactam	0	24	0	0	24
Tab. Linezolid	0	7	0	0	7
Tab. Trimethoprim and Sulfamethoxazole	1	4	0	0	5
Inj. Meropenem	0	5	2	0	7
Inj. Piperacillin and Tazobactam	0	0	6	1	7
Tab. Nitrofurantoin	0	8	0	0	8
Inj. Amikacin	1	1	0	0	2
Total	2	49	8	1	60

Organisms	CES	FLU	TRS	AMP	PIT	CEF
Enterococcus sp.	0	0	0	8	0	0
E. coli	2	0	0	0	0	0
Morgonella morganii	0	0	2	0	0	0
Candida sp.	0	2	0	0	0	0
Klebsiella sp.	0	0	0	0	8	0
Pseudomonas aeruginosa	0	0	0	0	0	1
Acinetobacter baumannii	0	0	0	0	2	0
Total	2	2	2	8	10	1

By selecting an appropriate antibiotic for each pathogen, its ability to eliminate the bacteria or halt its growth is maximized, effectively controlling the infection while also reducing the chances of developing antibiotic resistance. This study reveals that *E. coli* was the most commonly identified organism, while *Morganella morganii, Candida* species, *Pseudomonas aeruginosa* and *Acinetobacter baumannii* were among the least frequently observed, details are depicted in Table 4.

DISCUSSION

Urinary catheters, commonly used for bladder drainage in hospitalized patients, are associated with an increased risk of CAUTI especially when not managed under strict medical guidelines. CAUTI remains a significant healthcare-associated infection, contributing to higher patient morbidity, prolonged hospital stays, increased healthcare costs and a rise in mortality rates. It is critical to understand the underlying factors that contribute to CAUTI development, as this knowledge can help in devising strategies to reduce its incidence and improve patient outcomes.

In the present study, 48% of the 60 hospitalized patients developed hospital-acquired CAUTI, while the remaining 52%

did not develop the infection. This rate of CAUTI is consistent with findings from other studies that report varying incidence rates, largely influenced by patient comorbidities, catheterization duration and infection control practices. The most commonly identified pathogen in this study was *Escherichia coli*, accounting for 57% of cases. This finding is in line with previous research, where *E. coli* was consistently identified as the primary causative organism of CAUTI. Following *E. coli*, *Klebsiella* species (17%) and *Enterococcus* species (13%) were also prominent, highlighting the diversity of pathogens associated with CAUTI. Less frequently observed pathogens included *Morganella morganii, Pseudomonas aeruginosa, Candida* species and *Acinetobacter baumannii*, all of which present unique challenges in treatment due to their variable resistance profiles.

The choice of catheter used in this study was predominantly Foley's catheter, which accounted for 77% of cases. Silicone and condom catheters were used less frequently. Foley catheters are commonly associated with a higher risk of infection, particularly when they are left in place for extended periods. This finding is consistent with existing literature, which underscores the need for careful management and timely removal of urinary catheters to reduce the risk of infection. Foley catheters are often necessary in certain clinical scenarios, but prolonged catheterization

without proper care can significantly increase the risk of bacterial colonization and subsequent infection.

Antibiotic therapy in the study varied depending on the identified pathogens and clinical presentations. The most commonly administered antibiotic combination, used in 42% of cases, was Inj. Cefoperazone and sulbactam. This combination is frequently used in managing mixed infections due to its broad-spectrum activity against both Gram-positive and Gram-negative bacteria. Other antibiotics prescribed included Tab. Nitrofurantoin, Tab. Linezolid and Inj. Meropenem, which were selected based on the pathogen's resistance profile and the patient's clinical condition. Antibiotic therapy was adjusted in 42% of patients following the culture and sensitivity results. This highlights the importance of tailoring antibiotic therapy based on the microbiological findings to ensure the most effective treatment, thus reducing the risk of treatment failure and antibiotic resistance.

In cases where *E. coli* was identified, treatment was shifted from Tab. Nitrofurantoin to Inj. Cefoperazone and sulbactam. Similarly, treatment for *Enterococcus* species was changed to Inj. Ampicillin, reflecting the sensitivity profiles of these pathogens. For *Morganella morganii, Candida* species, *Pseudomonas aeruginosa, Klebsiella* species and *Acinetobacter baumannii*, therapy was adjusted based on the susceptibility of the pathogens to specific antibiotics, ensuring that the most appropriate therapy was administered.

The hospital stay of most patients ranged from 6 to 10 days, with CAUTI typically developing between the 3rd and 4th day of catheter use. This timing suggests that the risk of CAUTI increases after prolonged catheterization, especially when catheters are left in place for more than 48 hr without proper care. The study by Vishwajith *et al*. reported a lower CAUTI rate of 1.74 per 1000 catheter days, which was attributed to the implementation of strict infection control practices and catheter care protocols.[11] This finding emphasizes the effectiveness of proper infection control measures, such as timely catheter removal, maintaining sterile techniques and adhering to antibiotic stewardship policies.

Comparable patterns were noted in the studies conducted by Nandini M.S. *et al*., Bagachi *et al*., Kazi *et al*. and Jayashri *et al*., all of which found *E. coli* as the predominant pathogen. These studies also highlighted an increasing resistance to fluoroquinolones,[12-15] a class of antibiotics commonly used to treat UTIs. The emergence of antibiotic-resistant pathogens poses a significant challenge in the management of CAUTI and reinforces the importance of careful antibiotic selection, frequent surveillance and prudent use of antibiotics.

LIMITATIONS

This study, being observational in nature, has several limitations and boundaries. Firstly, as an observational study, it does not represent a conclusive endpoint for this research topic and

further results beyond those presented here may be attainable. Additionally, the study did not include pregnant and lactating women, which limits the generalizability of the findings. Another limitation is that some patients with a history of catheterization were unable to provide accurate details regarding the specifics of their past catheter use, such as the insertion date and duration, which could affect the study's accuracy and comprehensiveness.

CONCLUSION

The study reveals that while certain antibiotics remain effective for treating CAUTIs, rising antibiotic resistance is diminishing the efficacy of others. These findings emphasize the need for pharmacists to adjust prescribing practices based on resistance trends and to advocate for robust antibiotic stewardship programs. By doing so, pharmacists can improve the management of CAUTIs, ensuring more effective treatments and better patient outcomes.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

ABBREVIATIONS

CAUTI: Catheter-associated urinary tract infection; **UTI:** Urinary tract infection; **HCAI:** Health-care associated infections; **CDC:** Center for Disease Control and Prevention; **GNBSIs:** Gram-negative bloodstream infections; **UK:** United Kingdom; **ICU:** Intensive care unit; **CKD:** Chronic kidney disease; **AKD:** Acute kidney disease; **HTN:** Hypertension; **DM:** Diabetes mellitus; **IHD:** Ischemic heart disease; **CVA:** Cerebrovascular accident; **BPH:** Benign prostatic hyperplasia; **E. coli:** *Escherichia coli*. **Candida sp.:** *Candida* species; **Pseudomonas sp.:** *Pseudomonas* species; **Enterococcus sp.:** *Enterococcus* species; **OD:** Once a day; **BD:** Twice a day; **TID:** Three times a day; **Q8H:** Every 8 hr; **CES:** Cephalosporin and sulbactam; **FLU:** Fluconazole; **TRS:** Trimethoprim and sulfamethoxazole; **AMP:** Ampicillin; **PIT:** piperacillin and tazobactam; **CEF:** Ceftriaxone.

SUMMARY

This study highlights the prevalence of CAUTIs in hospitalized patients, with *Escherichia coli* being the most common pathogen identified. The findings emphasize the importance of proper

catheter management, including timely removal and adherence to infection control practices, to minimize CAUTI risk. Antibiotic therapy was adjusted in a significant portion of patients based on culture and sensitivity results, underscoring the need for tailored treatment to combat bacterial resistance. The study also aligns with previous research in demonstrating the increasing resistance to commonly used antibiotics, particularly fluoroquinolones. Ultimately, the results underscore the need for rigorous infection control protocols, continuous monitoring of resistance patterns and prudent use of antibiotics to improve patient outcomes and reduce the incidence of CAUTI in hospitalized settings.

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