

Microbiological profile, comorbidity, incidence and rate analysis of catheter associated urinary tract infections in adult intensive care unit

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Abstract

Introduction: Catheter-associated urinary tract infections (CAUTI) being the commonest hospital-acquired infection (HAI) [40%], its burden, aetiology along with antibiotic susceptibility is essential to implement and monitor an effective infection control program.

Aims: To assess the incidence and rate of CAUTI in a tertiary care hospital and to identify the common organisms and their antibiotic sensitivity pattern.

Settings and Design: Prospective hospital based observational study was carried out in a tertiary care hospital in South Tamilnadu for a period of 2 months (June 2016 to July 2016) after obtaining the Institutional Ethics committee approval.

Materials and Methods: Total of 100 catheterized adult ICU patients were observed for signs of UTI on a daily basis. On clinical suspicion of UTI, urine sample was analysed microbiologically. CAUTI among various gender and age groups; pathogenic isolates, antibiotic sensitivity pattern and associated co-morbid conditions were expressed as percentages

Results: Incidence of CAUTI was 16/100 catheterization. Device utilization ratio was 0.72. CAUTI rate was 36.2/1000 catheter days. CAUTI was commonly seen among patients with >80 years, females with altered sensorium. Diabetes mellitus (35.7%) was the most common comorbid condition followed by TB (25%). Risk of CAUTI after 3-5 days of catheterization was 11.7% and proportionately increased with prolonged catheterization (100% if >20 days). *Escherichia coli* (37.5%) followed by *Candida Spp.* (25%) were common pathogens among 3-5days of catheterization. *Pseudomonas Spp.* was the commonest isolate after one week of catheterization. Imipenem, colistin resistance was highest among pseudomonas.

Conclusions: CAUTI rate was higher than the benchmark set by NHSN (0-4). Appropriate health education, strict infection control practices, appropriate antibiotic policy, proper guided bundle care of catheter are need of the hour to prevent the CAUTI.

Keywords: Adult ICU, CAUTI, Comorbidity analysis, Incidence, Microbiological Profile.

Key Messages: Incidence of CAUTI was 16 per 100 catheterization and the CAUTI rate was 36.2 per 1000 catheter days which was higher to the benchmark of NHSN (0-4). Risk of CAUTI proportionately increased with prolonged catheterization from 11.7% after 3-5 days to 100% after 20 days. *Escherichia coli* (37.5%) followed by *Candida* (25%) were common pathogens among 3-5days of catheterization. *Pseudomonas* was the common isolate after one week of catheterization.

Introduction

Hospital-acquired infections (HAI) are the leading cause of morbidity and mortality in healthcare settings globally, especially in intensive care units (ICUs).^{1,2} HAIs also increase the economic burden on the patients in the form of prolonged hospital stay, lost work-days, laboratory and drug costs.³

Urinary tract infections (UTI) is the second commonest infection in the community, whereas it is the most common HAI, accounting for 40% of all HAIs.⁴ Though, many predisposing factors like gender, age, malnutrition, low socioeconomic conditions with poor hygiene, structural and functional abnormalities of urinary tract are reported as risk factors for developing UTI; the indwelling catheter which is an essential part of modern medical care; inserted to monitor various clinical parameters, itself is the major risk factor for hospital-acquired UTI.⁶ Approximately 25% of hospitalized patients and 70% critically ill ICU patients undergo urinary catheterization.⁷

CAUTI (CDC National Healthcare Safety Network (NHSN)) 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. If an indwelling urinary catheter was in place for more than two calendar days and then removed, the date of the event for the CAUTI must be the day of discontinuation or the next day with culture positivity.⁸ 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.⁹

Microbiological profile and antimicrobial sensitivity pattern of CAUTI vary considerably between regions and time to time.¹⁰ Nearly 30-40% of the gram-negative septicemia acquired in the hospital originates in the urinary tract. Inappropriate and recurrent use of antibiotics to treat CAUTI can lead to antimicrobial resistance.¹¹ Multiple risk factors like quality of aseptic technique, duration of catheterization, hand hygiene and care of catheter can affect the occurrence of CAUTI. Also, HAI directly reflects on the quality care of the

healthcare setting; so knowledge about the rates of HAI and organism associated with their antibiotic susceptibility is essential to implement the infection control system in a proper manner.^{12,13} The present study was aimed to assess the incidence and rate of CAUTI in a tertiary care hospital and to identify the common causative organisms and their antibiotic sensitivity pattern.

Materials and Methods

The prospective hospital-based observational study was carried out in a tertiary care multispeciality hospital in South, Tamilnadu for a period of 2 months (June 2016 to July 2016) after obtaining the Institutional Ethics committee approval.

A total of 100 adult patients including both genders with indwelling urinary Foley's catheter admitted in ICUs during the study period were included in the study. Catheterized ICU patients transferred to general ward were also followed up by two calendar days following the transfer (1st day being the day of transfer). Patients only on condom catheter or on nephrostomy tube/ suprapubic catheters were excluded from the study.

Urinary catheter insertion, maintenance, and removal were done based on standard guidelines. During the study period, catheterized study participants were observed for local and systemic signs of UTI, meticulously on daily basis. On clinical suspicion of UTI, a urine sample was collected by disinfecting a portion of the catheter tubing with alcohol & aspirating the urine aseptically by puncturing the tubing with a sterile syringe and sent to the microbiology laboratory for Culture and Sensitivity test immediately.

Sample Processing: The urine was cultured in Nutrient agar and MacConkey agar by a Semi uantitative method –calibrated 1 µL loop with a diameter of 1.3 mm (Himedia Cat.no:LA023) without intermittent flaming and incubated at 35–37°C for 24 h. The diagnosis of UTI was made by means of a significant positive urine culture count of >10⁵ colony forming units (CFU) per ml. The pathogenic organism was further characterized to species level using appropriate biochemical tests.

Antibiotic sensitivity test was done using Kirby Bauer disc diffusion method as per CLSI guidelines.

Antibiotic discs were bought from Hi-Media laboratories, Mumbai.

Statistical Analysis

Incidence rate, Device utilization rate and CAUTI rate were calculated using the formula

1. Incidence Rate = (No. of CAUTI) x 100 / (No. of catheterized patients)
2. Device Utilization Rate = No. of indwelling catheter days/No. of patient days
3. 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.

Results

Among the total 100 catheterized adult ICU patients, 66% were males and 34% were females. Catheterization was highest among 41-60 age group (51%). The incidence of CAUTI was 16% (16/100). A total number of patient days was 607; Number of indwelling catheter days was 441; Device utilization ratio was 0.72. CAUTI rate was 36.2 per 1000 catheter days.

The incidence of CAUTI was highest among the elderly (>80 years) individuals (50%) (Table 1). The difference in CAUTI incidence among females (17.6%, 6/34) and males (15.1%, 10/66) was statistically not significant. The incidence of CAUTI was higher in head injury patients with altered sensorium who were admitted in neuro ICU (42.8%) compared to the patients with other system involvements (Table 2). The commonest comorbid condition associated with CAUTI was diabetes mellitus (35.7%) followed by tuberculosis (25%) (Fig. 1). All the patients catheterized for more than 20 days had developed CAUTI (Table 3).

Common uropathogenic isolated was *Escherichia coli* (37.5%) followed by *Candida spp* (25%) (Fig. 2). All the *Escherichia coli* isolates were sensitive to Amikacin, Netilmicin, Colistin and Tigecycline. Most (66.7%) of the *Pseudomonas aeruginosa* isolates were sensitive to Colistin. Thus most of the Gram negative bacilli isolated from CAUTI were sensitive to Colistin, Amikacin and Tigecycline (Table 4).

Table 1: Incidence of CAUTI with age

Age group (Years)	No. of patients enrolled	No. of CAUTI cases	Percentage
15-20	2	0	0%
21-40	18	4	22.2%
41-60	51	8	15.6%
61-80	25	2	8%
>80	4	2	50%

Table 2: Incidence of CAUTI with respect to system involved in the primary disease/condition of patients

System involved in the primary disease	No. of patients enrolled	No. of CAUTI cases	Percentage
CNS	21	9	42.8%
RS	7	1	14.3%
CVS	6	0	0%
GIT	9	0	0%
Renal	19	4	21.1%
Metabolic	7	0	0%
Musculoskeletal	4	0	0%
Post Operative	25	2	8%
Poison	2	0	0%

CNS- Cardiovascular system, RS – Respiratory system, CVS – Cardiovascular system, GIT – Gastrointestinal system

Table 3: Interval between catheterization and Appearance of features of UTI

Catheter days	No. of patients enrolled	No. of CAUTI cases	Percentage
1-2	35	0	0%
3-5	51	6	11.7%
6-10	5	3	60%
10-15	3	2	66.6%
15-20	3	2	66.6%
>20	3	3	100%

Table 4: Antibiotic Sensitivity Pattern (%)

Uropathogen (No.)	Escherichia coli (6)	Klebsiella pneumoniae (3)	Enterobacter spp (1)	Pseudomonas aeruginosa (2)
CTR	16.6	0	0	-
CPM	33.2	0	0	0
PIT	66.4	33.3	0	0
AK	100	33.3	100	50
GEN	66.4	33.3	0	50
CIP	16.6	0	0	0
NET	100	33.3	100	0
IMP	82.6	33.3	100	0
CO	66.4	0	0	-
CL	100	100	100	50
LE	16.6	0	0	-
TGC	100	100	-	-
NIT	82.6	66.6	0	-
OF	16.6	0	100	0
DOX	33.2	0	100	-
CAZ	16.6	0	0	0

CTR- Ceftriaxone; CPM- Cefepime; PIT- Piperacillin-Tazobactam; AK- Amikacin; GEN- Gentamicin; CIP- Ciprofloxacin; NET- Netilmicin; IMP- Imipenam; CO- Cotrimoxazole; CL- Colistin; LE- Levofloxacin; TGC- Tigecycline; NIT- Nitrofurantoin; OF- Ofloxacin; DOX- Doxycycline ; CAZ- Ceftazidime.

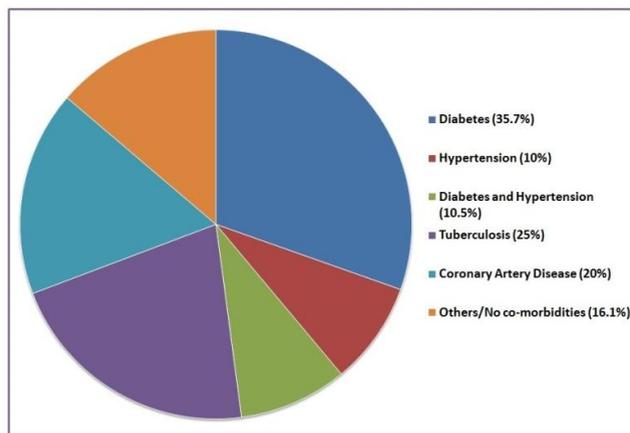


Fig. 1: Comorbid conditions associated with CAUTI

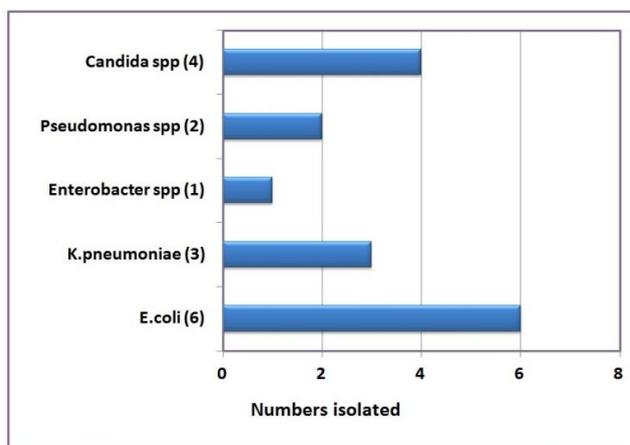


Fig. 2: Uropathogens isolated from CAUTI

Discussion

HAI directly reflect on the quality care of the healthcare settings. CAUTI which is the most common HAI was the first hospital-acquired complication chosen by the Centers for Medicare and Medicaid Services in 2008 as the basis for denial of additional payment to hospitals.¹⁴ An acceptable CAUTI rate was up to four per 1000 catheter days as given by NHSN report of U.S.A.¹⁵ If not aseptically inserted or maintained, the catheter itself may act as a portal of entry for the pathogen. Catheter-associated colonization is usually asymptomatic in healthy patients, which resolves spontaneously after removal of the catheter. In contrary, if the colonization persists that leads to infection in susceptible patients.¹⁶ Cystitis, epididymitis, prostatitis, pyelonephritis and septicemia due to Gram-negative bacteremia are some of the complications encountered in high-risk group. Furthermore, in-patient deaths among the patients of CAUTI are two to three-times higher than that among the non-bacteriuric patients.¹⁷

In this study, device utilization ratio was 0.72 which was comparable to the study report of Choudhuri JA *et al*¹⁴ in ICUs (0.77). In contrary to this, M. Todd Greene *et al*¹⁸ reported the low device utilization ratio

(0.5) in non ICU setup. This comparison clearly explains that catheter utilization is always high in ICU setup and thus the risk of CAUTI in ICU could be proportionately higher.

In this study, the incidence of CAUTI was found to be 16 per 100 catheterization which was lesser than the study report of Mahim Koshariya *et al*, Mangukiya JD *et al*, Gupta V, *et al*, Wazait HD *et al*, Chanda R *et al*, and Mulhall *et al*¹²⁻²⁰ who reported CAUTI incidence of 27,30.71,36.3,38.75,41,44 per 100 catheterization respectively. Even though its incidence appears lesser, it is not up to the standard of NHSN. This variability of incidence could be due to the varying place of surveillance as reported by Mangukiya JD *et al*²⁰ that CAUTI in Urology ward patients (33.33%) was higher than ICU patients (30.71%). This indicates that even though CAUTI incidence is higher in ICU setup; certain in-patient areas such as Urology/Nephrology wards may have a higher incidence, thus contributing to a significant percentage of CAUTI among non-ICU patients. Further research could be done in this angle to assess the burden of CAUTI in non-critically ill patients. These patients are more likely to have an acute or chronic renal functional compromise. In the latter case, device utilization may be at a higher rate than ICU

patients. This could probably explain the higher rate of CAUTI in these groups of patients.

CAUTI rate was 36.2 per 1000 catheter days which was higher than that reported by Sabir *et al*, Duszyńska *et al*, Derya keten *et al*.^{5,25,26} who reported a CAUTI rate of 3.65, 7.16 and 9.6 per 1000 catheter days respectively and it is not meeting the NHSN standard too. This may be due to better infrastructure, availability of trained staff, strict infection control practices and an appropriate antibiotic policy, proper guided bundle care for both procedure and maintenance of catheter which we are planning to implement.

In the present study, CAUTI was most commonly seen among older age group (>80 years) which is in concordance with Chanda R *et al*,²³ who also reported old age itself as a predisposing factor for CAUTI (Table 1). Even though no statistical significance was found between the incidence of CAUTI and gender, CAUTI was slightly common (2.5% higher incidence) among the female patients, which is also comparable with other studies.^{9,18} 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.

Incidence of CAUTI was higher in head injury /altered sensorium patients (42.8%) who were admitted to neuro ICU compared to those patients with diagnosis/disease condition affecting other organ systems, which was in concordance with Umesh S Kamat *et al*.²⁷ Altered sensorium and also high severity of the underlying illness are important and common indications for urinary catheterization; both of them independently act as the risk factors for CAUTI (Table 2).

In this study, diabetes mellitus (35.7%) was the most common comorbid condition associated with CAUTI which was also the major comorbid condition reported in other similar studies.^{18,23,24} In the present study, when compared to above-mentioned studies, tuberculosis (25%) was also found to be the other important comorbid condition associated with CAUTI (Fig. 1).

In the present study, the risk of UTI after 3-5 days of catheterization was 11.7% and the risk proportionately increased with prolonged catheterization which reaches 100% if the catheter was in place for >20 days. This is similar to the study conducted by Dalen *et al*.²⁸ From this fact, the risk of CAUTI was almost 5 times higher after the 5th day of catheterization (Table 3).

Commonest uropathogen in this study was *Escherichia coli* (37.5%) which was similar to the results of several other studies.^{9,16,18,23} *Escherichia coli* remains the common bacterial isolate for patients who develop symptoms of UTI in a short course catheterization (3-5days), in contrary *Pseudomonas* was the common isolate after one week of catheterization which is in concordance with the findings of Wazait HD, *et al*.²² and *Candida spp* (25%) was the second

most common isolate in our study. This emphasises the need to actively look for fungal causes of CAUTI in addition to bacterial causes.

Among the Enterobacteriaceae members, *E.coli*, *Klebsiella pneumoniae*, *Enterobacter spp* were uniformly sensitive (100%) to Colistin whereas *E.coli* & *Enterobacter spp* were 100% sensitive to Amikacin. *Klebsiella pneumoniae* differed in this aspect by only 25% being sensitive to Amikacin. Among the two *Pseudomonas aeruginosa* isolates, one was resistant to colistin.

Imipenem-resistance was seen in 25% (3/12) Gram negative isolates. One *Pseudomonas aeruginosa* was resistant to colistin, an antibiotic that is considered as a last resort drug. This reveals that our isolates are multidrug-resistant and similar findings were observed by Kazi *et al*.²⁹

This indicates measures like meticulous intervention in the form of hand hygiene, appropriate catheter maintenance practices, well defined antibiotic policy and properly guided infection control programs can reduce the extent of multidrug-resistant pathogen not only in CAUTI patients but also for the hospital in general.

Conclusion

HAI directly reflect on the quality care of the hospital and efficacy of interventions. CAUTI rate in our ICU was 36.2 per 1000 catheter days which is much high compared to the benchmark set by NHSN. So appropriate measures of educating the paramedical staff, strict infection control practices and an appropriate antibiotic policy, proper guided bundle care for both procedure and maintenance of catheter are the need of the hour to prevent the CAUTI which in turn can lessen the economic burden, work loss, and mental stress.

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