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Original Article

Catheter associated urinary tract infections in intensive care units patients in a tertiary care hospital

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ABSTRACT: Introduction: Catheter associated urinary tract infections (CAUTI) is the most common health care associated infection (HAI), accounting for 40% of all HAIs in particularly in patients admitted to intensive care units (ICU) due to their more frequent necessity of urinary catheterization and longer duration of catheter use. Knowledge about Microbiological profile and antimicrobial sensitivity pattern of CAUTI is essential to implement the infection control system in a proper manner.

Aims and objectives: To study the rate and microbiological profile of catheter associated urinary tract infections and in patients admitted in Intensive Care Units.

Materials and methods: A one-year prospective study was conducted in which urine samples were collected from patients admitted in Medical ICUs on indwelling urinary catheter for >48 hours and processed in Microbiology Department according to standard procedures. CA-UTI rate was calculated and their microbiological profile and various resistance patterns were studied as per CLSI guidelines.

Results: Out of 1406 enrolled patients, 64 patients developed CAUTI. Overall CAUTI rate was 4.06/1000 catheter days. Most common isolate in CAUTI cases was *Klebsiella spp.* (32.3%), followed by *Escherichia coli* (24.6%). Gram negative isolates showed higher sensitivity to aminoglycosides, imipenam and nitrofurantoin as compared to cephalosporins The *Enterococcus spp.* were 100% sensitive to linezolid and 71.4% sensitive to both vancomycin and teicoplanin.

Conclusion: CAUTI rate in our ICUs was high compared to the benchmarks. Antibiotic sensitivity pattern of the pathogens involved was also low. This study provides the data of predisposing risk factors and its causative microbial flora for CAUTI in our tertiary care.

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INTRODUCTION

Indwelling medical devices have become very important in modern medical care. The ubiquitous medical devices, though continuing to be essential in permitting lifesaving treatment and ensuring physiologic monitoring among critically ill patients, unfortunately are a major cause of infections especially in intensive care patients.

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 [1].

Patients admitted to intensive care units (ICU) are the most appropriate candidates for UTIs due to their more frequent necessity of urinary catheterization and longer duration of catheter use [1,2,3].

CAUTI (according to 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 [4]. 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 [5].

Catheter may serve as portal of entry for the pathogen if not aseptically inserted [6,7]. Biofilm formation along the catheter surface is the most important cause of bacteriuria [8]. Biofilm formation begins immediately after catheter insertion, when organisms adhere to a conditioning film of host proteins which forms along the catheter surface. Both the interior and exterior catheter surfaces are involved

CA-UTI is an important device-associated health care acquired infection. The use of an indwelling urethral catheter is associated with an increased frequency of symptomatic urinary tract infection and bacteremia, and additional morbidity from non-infectious complications.

Thus, this study aims to determine rate, risk factors and bacterial etiology of UTI and evaluate their in vitro susceptibility pattern to commonly used antimicrobial agents which will help in implementing the preventive strategies.

MATERIALS AND METHODS

This study was a prospective study conducted from 1st February 2018 to 31st January 2019 in the Department of Microbiology, Dayanand Medical College and Hospital (DMC&H), Ludhiana. All patients with indwelling urinary catheter admitted in Medical ICU, Pulmonary ICU and, Stroke ICU were included in the study. During the study period, urine sample for routine examination from catheterized patients were taken on admission to screen for UTI. Then the catheterized patients were observed for local and systemic signs of UTI, meticulously on daily basis. On clinical suspicion of UTI, urine sample was collected after adhering to the standard precautions. Sample was then transported to the Microbiology laboratory immediately for processing.

Sample processing: All samples received were processed as per standard protocols. Urine samples were inoculated on blood agar and MacConkey's agar by semiquantitative method. An inoculating loop of internal diameter 4 mm with holding capacity of 0.01 ml was used to take up a small, fixed and known volume of mixed uncentrifuged urine and the sample was inoculated on the agar plates. The plates were then incubated at 35 – 37°C overnight. Samples were also examined by making wet mounts for polymorphonuclear leucocytes, red blood cells, epithelial cells and parasites by direct microscopy.

The plates were then examined for growth after overnight incubation. The number of colonies were counted and this number was used to calculate the number of viable bacteria per ml of urine. Colony count of $\geq 10^5$ CFU/ml was taken as significant. Identification and anti-microbial susceptibility testing of the organisms was done by using VITEK-2 system.

In order to evaluate MIC results, and zone sizes CLSI 2018 (Clinical & Laboratory Standards Institute) recommendations were used

Calculation of CAUTI rate: Catheter days were calculated by adding the number of days, urinary catheter was in situ in all patients in a particular area.

CAUTI rate was calculated as:

$$\frac{\text{No. of CAUTI CASES}}{\text{No. of catheter days}} \times 100$$

Statistical analysis:

Data were described in terms of range; mean \pm standard deviation (\pm SD), median, frequencies (number of cases) and relative frequencies (percentages) as appropriate. For comparing categorical data, Chi square (χ^2) test was performed and exact test was used when the expected frequency is less than 5.

A probability value (p value) less than 0.05 was considered statistically significant. All statistical calculations were done using SPSS (Statistical Package for the Social Science) SPSS 21 version statistical program for Microsoft Windows.

RESULTS

A total of 1406 patients were enrolled in the study who were admitted in Medical ICU (MICU), Pulmonary critical care unit (PCCU), Stroke ICU (STICU), and were catheterised in DMCH. Out of these 62.2% were males as compared to females 37.8%. Maximum no. of catheterized patients was in the age group of 61-80 years (39.8%). Out of 1406 patients, 242 patients developed UTI within 48 hours of catheterization and 64 patients developed CAUTI. Overall CAUTI rate in patients admitted in Medical ICUs was 4.06/1000 catheter days. CAUTI rate was maximum among patients admitted in STICU (7.13), followed by MICU (2.92) & PCCU (1.69).

Although CAUTI was more common in males (62.5%) as compared to females (37.5%) but it was not statistically significant (Figure 1). CAUTI cases were most common in the age group between 61 – 80 years (43.8%) (Figure 2). Maximum no. of patients who developed CAUTI, had duration of catheterization for > 21 days (n=37) (Table 1).

Most of the patients who had duration of catheter in situ for >21 days had underlying neurological disease (n=31). Hence CAUTI was most common in patients with underlying neurological disease (67.2% of CAUTI cases) (Table 1).

Table 1: Duration of catheterization in CAUTI patients with underlying disease (n = 64)

| Underlying disease | Duration of catheterization | | | | Total | p-value |
|--------------------------|--------------------------------|------------------------|------------------------|------------------------|-----------|---------|
| | 1-7 days (No. of patients) (%) | 8-14 days | 15-21 days | > 21 days | | |
| Neurological disease | 1 (33.3%) | 6 (46.2%) | 5 (45.5%) | 31 (83.8%) | 43 | 0.000 |
| Renal disease | 0 (0.0%) | 2 (15.4%) | 2 (18.2%) | 0 (0.0%) | 4 | |
| Gastrointestinal disease | 0 (0.0%) | 0 (0.0%) | 1 (9.1%) | 2 (5.4%) | 3 | |
| Poisonings | 0 (0.0%) | 1 (7.7%) | 1 (9.1%) | 1 (2.7%) | 3 | |
| Respiratory disease | 1 (33.3%) | 2 (15.4%) | 0 (0.0%) | 0 (0.0%) | 3 | |
| Tropical fevers | 1 (33.3%) | 0 (0.0%) | 0 (0.0%) | 1 (2.7%) | 2 | |
| Autoimmune disease | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 1 (2.7%) | 1 | |
| Cardiovascular disease | 0 (0.0%) | 1 (7.7%) | 0 (0.0%) | 0 (0.0%) | 1 | |
| Hepatic disease | 0 (0.0%) | 0 (0.0%) | 1 (9.1%) | 0 (0.0%) | 1 | |
| Metabolic disease | 0 (0.0%) | 0 (0.0%) | 1 (9.1%) | 0 (0.0%) | 1 | |
| Oncological disease | 0 (0.0%) | 1 (7.7%) | 0 (0.0%) | 0 (0.0%) | 1 | |
| Trauma | 0 (0.0%) | 0 (0.0%) | 0 (0.0%) | 1 (2.7%) | 1 | |
| Total | 3 (100.0%) | 13 (100.0%) | 11 (100.0%) | 37 (100.0%) | 64 | |

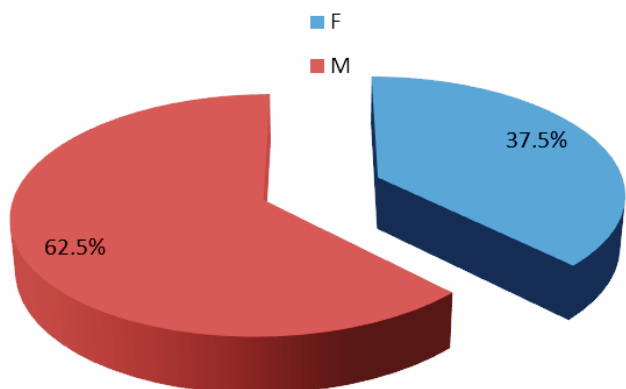


Figure 1: Gender distribution of CAUTI Cases (n = 64)

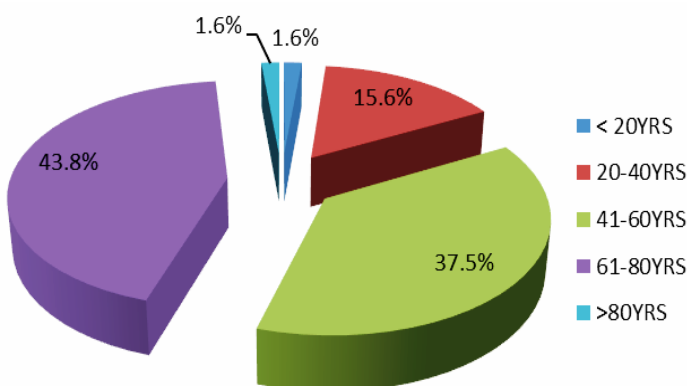


Figure 2: Age Distribution of CAUTI cases (n = 64)

- Out of 64 CAUTI cases monomicrobial growth was obtained in 63 cases (98.4%) whereas polymicrobial growth was obtained in 1 case (1.6%). Out of the isolates in CAUTI cases Gram negative bacteria were 89.2%, whereas Gram positive bacteria were 10.8%. Most common isolate in CAUTI cases was *Klebsiella pneumoniae*. (32.3%), followed by *Escherichia coli* (24.6%) and *Pseudomonas aeruginosa* (13.8%). Enterococci were the only Gram-positive isolate obtained. (10.8%) (Figure 3).

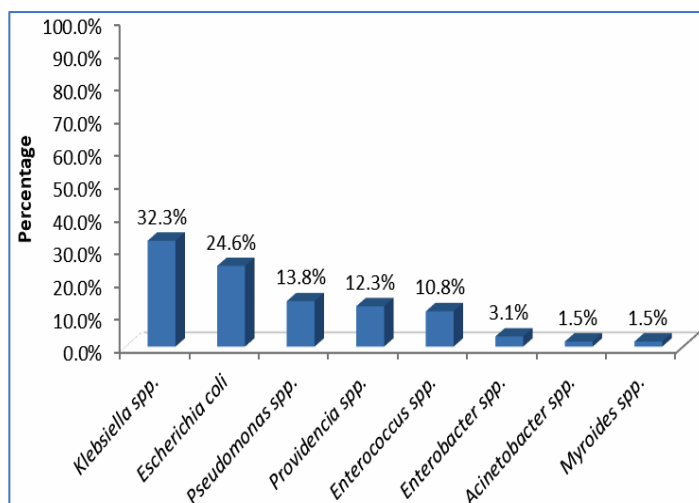


Figure 3: Description of isolates in CAUTI cases

- Most of the *Klebsiella pneumoniae* were 38.1% sensitive to Amikacin and Imipenem as compared to Fluoroquinolones and Cotrimoxazole (9.5% each). *E. coli* isolates were 100% sensitive to Fosfomycin and showed good sensitivity to Amikacin (75%) and Imipenem (56.3%). Isolates were relatively resistant to Cephalosporins. *Pseudomonas aeruginosa* were 56% sensitive to imipenem as compared to cephalosporins (0-11.1%) and fluoroquinolones (11.1%). *Providencia rettgeri* were resistant to most of the antibiotics except cefoperazone sulbactam (37.5%) and imipenem (25%) (Table 2). The *Enterococci* isolated were 100% sensitive to Linezolid and 71.4% sensitive to both Vancomycin and Teicoplanin. Among the total no. of *Enterococcus* spp. (n = 7), 28.57% (n = 2) were vancomycin resistant *Enterococci* (VRE).

DISCUSSION

In our study, out of the total patients (n = 1406), maximum number of catheterized patients were admitted in MICU (43.9%), followed by PCCU (31.2%) and STICU (25%).

Among these males were more (62.2%) as compared to females (37.8%) with male to female ratio of 1.6:1. In another study done in Madurai, Tamil Nadu to study CAUTI in ICUs, out of the total catheterized patients 66% were males and 34% were females which was similar to our study [9]. CAUTI in our study was also more prevalent in males (62.5%) as compared to females (37.5%) and gender association was not found to be statistically significant. Another study done by Arunagiri Ramesh *et al* in Tamil Nadu revealed similar results. This might be due to multiple factors. A higher number of male samples as compared to female samples received and male are prone to obstructive urinary lesion especially from benign prostate hypertrophy, Ca prostate and stricture associated with advanced age [9].

Old age itself is the predisposing factor for CAUTI. In the current study maximum number of patients who developed CAUTI were in the age group of 60-80 years but it was not found to be statistically significant. Similarly, in a study conducted in Kilpauk Medical College, Tamil Nadu also showed maximum number of CAUTI cases in age group of more than 60 years. However, age was found to be statistically significant in their study [10].

Table 2: Antibiotic susceptibility pattern of Gram-negative isolates (n=58)

| ANTIBIOTIC | <i>Klebsiella pneumoniae</i> | <i>Escherichia coli</i> | <i>Pseudomonas aeruginosa</i> | <i>Providencia rettgeri</i> |
|-------------------------------|------------------------------|-------------------------|-------------------------------|-----------------------------|
| | (n=21) | (n=16) | (n=9) | (n=8) |
| No. of isolates (%) | | | | |
| Ampicillin | - | 0 | - | - |
| Ticarcillin | - | 0 | 0 | 0 |
| Cephalothin | 1 (4.8) | 0 | 0 | - |
| Cefixime | 2 (9.5) | 1 (6.3) | - | 0 |
| Ceftriaxone | 3 (14.3) | 1 (6.3) | - | 0 |
| Ceftazidime | 3 (14.3) | 1 (6.3) | 1 (11.1) | 0 |
| Amoxicillin clavulanic acid | 0 | 0 | - | - |
| Piperacillin- Tazobactam | 1 (4.8) | 2 (12.5) | 1 (11.1) | 0 |
| Cefoperazone sulbactam | 4 (19) | 4 (25) | 1 (11.1) | 3 (37.5) |
| Trimethoprim-sulfamethoxazole | 2 (9.5) | 3 (18.8) | - | 0 |
| Amikacin | 8 (38.1) | 12 (75) | 1 (11.1) | 0 |
| Gentamicin | 4 (19) | 10 (62.5) | 2 (22.2) | 0 |
| Nitrofurantoin | 3 (14.3) | 8 (50) | - | - |
| Norfloxacin | 2 (9.5) | 2 (12.5) | 1 (11.1) | 0 |
| Ofloxacin | 2 (9.5) | 2 (12.5) | 1 (11.1) | 0 |
| Ertapenem | 4 (19) | 4 (25) | - | 0 |
| Imipenem | 8 (38.1) | 9 (56.3) | 5 (56) | 2 (25) |
| Fosfomycin | - | 16 (100) | - | - |

Enterobacter spp. (n=2) obtained were sensitive to imipenem and ertapenem, whereas *Myroides* spp. (n=1) and *Acinetobacter* spp. (n=1) were resistant to all of the drugs.

In the current study patients with neurological involvement developed maximum number of CAUTI cases. (n = 43) with 84% of cases with prolonged duration of catheterization for >21 days. These results are similar to a study done in Chennai, Tamil Nadu from 2012-2014 in which CAUTI was most common in patients with neurological involvement (42.8%) [10]. Risk of developing CAUTI increases as the duration of catheter increases. In our study, maximum number of patients developed CAUTI after 21 days of catheterization (32.8%). This is in contrast to the study done in Karnataka in which the incidence of CAUTI was highest within 1 week of catheterization (61.54%) [11]. This could be due to difference in following proper catheter care bundles.

Results in our study depict the overall CAUTI rate of 4.06. In STICU, the rate was maximum (7.13), followed by MICU (2.92) & PCCU (1.69). This is similar to studies by Puri *et al.* and Patel *et al.* which demonstrated that the prevalence of CAUTIs in neurosurgical and neurology patients is around 8-10%, with a mean of 8.5 to 12.5 infections per 1000 catheter days [12].

But in another study conducted in ICUs in Vardhman Mahavir Medical College & Safdarjung Hospital, New Delhi, overall CAUTI rate was much higher (9.17 per 1000 catheter days) [13].

In our study, majority of the pathogens were Gram negative (89.2%) and few were Gram positive (10.8%). These results were similar to study done by Sreedevi Hanumantha *et al* in which 79% of the uropathogens were Gram negative bacteria, 10.5% were Gram positive and rest were Candida [14].

Most common isolate in our study was *Klebsiella pneumoniae*. (32.3%), followed by *E. coli* (24.6%), and *Pseudomonas aeruginosa*. (13.8%). Among Gram positive isolates only *Enterococcus faecium* were isolated (10.8% of the total isolates). However, in another study done by Deepa Bhani *et al* *E. coli* was found to be the most common uropathogen (27.2%), followed by *Pseudomonas* spp. (20%), *Klebsiella* spp. (15.4%), *Enterobacter aerogenes* (9%), *Enterobacter cloacae* (0.09%), *Proteus* spp. (2.7%) and *Citrobacter* spp. (2.7%). Enterococcal isolates were 6.7 % [15]. Although *E. coli* is known to be the most predominant etiology for UTI, it was the second most common in this study. This finding might reflect dissimilarity in bacterial population according to different locality and suggests a role of the environment in shaping the bacterial population in each hospital

In our study, the *Klebsiella pneumoniae* were relatively sensitive to Amikacin and Imipenem (38.1% each) as compared to Fluoroquinolones and Cotrimoxazole (9.5% each). These results were similar to a study done by Arunagiri Ramesh *et al* in which sensitivity was 33.3% each for aminoglycosides and Imipenem [9]. *E. coli* isolates in our study were 100% sensitive to Fosfomycin and showed good sensitivity to Amikacin (75%) and Imipenem (56.3%). However, in another study done by Neha Garg *et al.*, *E. coli* isolates were found to be 100% sensitive to Amikacin, Imipenem and Piperacillin tazobactam [16].

Pseudomonas aeruginosa were relatively more sensitive to Imipenem (56%) and Gentamicin (22.1%) as compared to Cephalosporins (0-11.1%) and Fluoroquinolones (11.1%) in our study. In another study by Deepa Bhani *et al*, *Pseudomonas* spp. isolated were 31.8% sensitive to Imipenem and Gentamicin, followed by Norfloxacin (22.7%), and piperacillin + tazobactam (18.2%). These demonstrated a low sensitivity to Cefepime (10.6%), Amikacin (9%), Ceftazidime (9%) [15]. In the present study, *Providencia* spp were resistant to most of the antibiotics except cefoperazone sulbactam (37.5% sensitive) and imipenem (25% sensitive). Similar results were obtained in other studies done by Seong-Heon Wie in Korea [17].

Among the Gram positive uropathogens only *Enterococci* spp. were isolated which were 100% sensitive to linezolid and 71.5% sensitive to both vancomycin and teicoplanin. However, in another study done by Nandini. M.S *et al*, in Chennai the sensitivity to linezolid was same as in our study but vancomycin was 100% sensitive in the Enterococcal isolates [18]. In our study, 28.5% of the isolates were VRE. This is in contrast to other studies done by Sherine A. Aly *et al*, in Egypt in which 85.7% were VRE [19].

CONCLUSIONS

HAI directly reflect on the quality care of the hospital and efficacy of interventions. CAUTI rate in our ICUs was high compared to the benchmark set by NHSN.

The urinary tract of catheterized patients is highly susceptible to severe infection. This infection is associated varied microbiological etiology. Antibiotic sensitivity pattern of the pathogen involved is also low. This along with existing underlying condition increases hospitalization, medication, morbidity and also adds to the financial burden. Therefore, it is imperative to carry out microbiological testing to determine etiology and ascertain effective antibiotics. This study provides the data of predisposing risk factors and its causative microbial flora for CAUTI in our tertiary care. The high level of resistance among bacteria causing CAUTI limits the use of antimicrobial agents for therapy. This study will help us in maintaining the conditions and use of appropriate antibiotics to manage and to prevent CAUTI in our patients.

Conflict of Interest: None to declare.

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