

Microbiological Profile and Antimicrobial Susceptibility of Microorganisms Isolated From Catheter Associated Urinary Tract Infections in an Adult Intensive Care Unit of Tertiary Care Center in Jaipur

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Abstract: Introduction: Urinary tract infections (UTIs) account for 20 - 50% of all hospital - acquired infections occurring in the intensive care unit (ICU). Among these, more than 80% of nosocomial UTIs are catheter - associated UTI (CAUTI). As compared to patients in a non - critical area, those in the intensive care unit have more risk of acquiring CAUTI. Objective: To isolate & identify microorganisms commonly associated with catheter - associated urinary tract infection in adult ICU patients and to determine the antimicrobial susceptibility pattern of these isolates. Material and method: This observational study was carried out in the bacteriology laboratory, Department of Microbiology, SMS Medical College, Jaipur, (Rajasthan). A total of 150 urine samples were collected from catheterized patients from adult ICU from the suspected cases of UTI. A structured proforma was used to collect data on age, gender, and clinical history. Results: On laboratory testing, among 150 clinically suspected cases of UTI, only 59 (39.3%) had significant growth and 91 (60.7%) were sterile. Among all the positive cases, the majority of the uro - pathogens were gram - negative bacilli 31 (52.5%) followed by *Candida spp.* 17 (28.9%), gram - positive cocci were 11 (18.6%). Conclusion: Appropriate training of the paramedical staff, strict infection control practices, and an appropriate antibiotic policy, strict bundle care approach for both insertion and maintenance of catheter are the required to prevent CAUTI.

Keywords: CAUTI, Catheter, Antimicrobial susceptibility, Antimicrobial resistance, Uropathogens, ICU

1. Introduction

Nosocomial infections, or hospital - acquired infections (HAIs), are an important cause of morbidity and mortality in healthcare settings particularly among patients admitted in intensive care units (ICUs)¹. Urinary tract infections (UTIs) account for 20 - 50% of all HAIs occurring in the ICU². Among these, more than 80% of nosocomial UTIs are catheter - associated UTI (CAUTI)³.

CAUTI is defined as UTI where an indwelling urinary catheter was in place for more than two calendar days on the date of the event, with the day of catheter placement being day one, and an indwelling urinary catheter was in place on the date of the event or the day prior to. If a urinary catheter was in place for more than two calendar days and then removed, the date of the occurrence for the CAUTI must be the day of removal or the next day with culture positivity⁴. Every day when the indwelling urinary catheter remains, a patient has a 3 - 10% increased risk of acquiring CAUTI, and incidence of bacteriuria with catheter reaches nearly 100% in four weeks duration⁵.

There are various risk factors associated with CAUTI which include duration of ICU stay, duration of catheterization,

female patients, age over 50 years, immunocompromised patients (diabetes mellitus, cancer, steroid therapy, HIV, and organ transplantation), the quality of catheter care, and host susceptibility⁶. Foley's catheter can be short - term (in situ below 28 days), or long - term (in situ beyond 28 days). The risk of acquiring an infection increases by 5% each day. In females, the pathogens can reach the bladder more easily, as the female urethra is relatively short, and also lies in close to the warm, moist, peri - rectal region, which has abundant microorganisms. For men, the incidence of urinary tract infections increases after the age of 60 because the enlarged prostate causes incomplete voiding of urine. Occurrence of both types I and type II diabetes mellitus enhances the factors associated with UTI⁷.

The incidence of CAUTI rises from 0.5 to 1% for a single "in - and - out" catheterization to 10 to 30% for catheters in place for up to 4 days and up to 95% for catheters in place for 30 days or more⁸. Symptomatic CAUTI is considered when symptoms or signs consistent with UTI exist along with bacteriuria in a catheterized patient. The signs and symptoms either are restricted to the urinary tract or can comprise unexplained systemic manifestations, such as fever. The accepted threshold for bacteriuria ranges from 10³cfu/ml to 10⁵cfu/ml⁹.

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Bacteriuria develops at an average rate of 3% to 10% per day of catheterization¹⁵. CAUTI is caused by a variety of pathogens, which includes gram - negative bacilli like *E. coli*, *Klebsiella spp*, *Pseudomonas aeruginosa*, *Proteus* species as well as gram - positive bacteria such as *Staphylococcus* species, *Enterococcus* species, and also by *Candida spp*³. CAUTI if left untreated can lead to complications as prostatitis, epididymitis, and orchitis in males, and cystitis, pyelonephritis, gram - negative bacteraemia, endocarditis, vertebral osteomyelitis, septic arthritis, endophthalmitis, and meningitis. Complications related to CAUTI cause distress to the patient, lengthened hospital stay, and higher cost and mortality¹⁰.

It has been associated with a threefold greater risk of mortality in hospitals including ICUs because of inappropriate use of antimicrobial agents leading to the spread of antimicrobial resistance and emergence of multidrug - resistant uropathogens¹¹. There is an increased emergence of antimicrobial resistance in the uropathogens, probably due to the empirical administration of anti - bacterial therapy, even before the availability of the urine culture results, is a matter of concern globally¹². CAUTI due to multidrug - resistant (MDR) organisms increases the cost of treatment, morbidity, and mortality especially in developing countries like India¹³. Therefore, there is a need for periodic monitoring to identify the etiological agent of CAUTI in persons of different age groups and to investigate their responses against locally available antibiotics commonly prescribed by the physicians and in ICU settings. The present study was aimed to identify the common causative organisms of CAUTI in patients admitted in adult ICUs of a tertiary care hospital and their antibiotic susceptibility pattern.

2. Material and Methods

The present study was carried out in the Bacteriology Laboratory of the Department of Microbiology SMS Medical College & Attached Hospital Jaipur, Rajasthan from June 2019 to May 2020. A total of 150 urine samples were collected from catheterized patients from adult ICU from the suspected cases of UTI. Urine samples were collected when symptoms occur after catheterization from patients admitted in adult ICU fulfilling CDC case definition of CAUTI, aseptically using a sterile needle and syringe from the distal edge of the catheter tube into the sterile universal container and transported to the Microbiology laboratory for analysis with minimum delay. Patients with symptoms of UTI prior to the catheterization and not fulfilling the case definition of CAUTI were excluded.

A sterile 1.3 mm nichrome wire calibrated loop (semi - quantitative method) was used which delivered 0.001mL of urine for the isolation of bacterial pathogens from urinary samples¹⁴. A loopful urine sample was plated on Mc - Conkey agar & Blood agar (Hi - Media Laboratories, Mumbai, India). The inoculated plates were incubated at 37°C for 24 hours. The numbers of isolated bacterial colonies were multiplied by 1000 for the estimation of bacterial load/mL of the urine sample. A specimen was considered positive for UTI if growth was detected at a concentration of $\geq 10^5$ CFU/mL¹⁵. Growth with three or more

types of colonies in a sample was considered as contamination, and a repeat sample was advised. Significant isolates were identified by conventional methods according to the standard laboratory protocol, including colony morphology, gram staining, and biochemical reactions.

All gram - negative bacilli were identified to species level by their characteristic appearances on the media, Gram's stain, Oxidase test, Motility, and the biochemical reactions as per standard laboratory protocol. All gram - positive organisms were identified to species level by their characteristic appearances on the media, Gram's stain, and Catalase test followed by Coagulase test. *Enterococcus spp* was identified by Bile Esculin disc test and it was also confirmed by Salt tolerance test (6.5% NaCl.). Identification of *Candida* species was done by conventional techniques and a colony color on Hi Chrome *Candida* agar. Ethical clearance was obtained from Institutional Research Review Board before initiation of the study.

3. Results

Among 150 clinically suspected cases of CAUTI 59 (39.3%) have significant growth and 91 (60.7%) were sterile. Out of 150 samples tested 95 (63.3%) were male while 55 (36.7%) were female. Male outnumbered female. The male to female ratio is 1.7: 1. Out of the total significant growth, females outnumbered males. Out of 59 positive cultures, 32 (54.2%) were female and 27 (45.8%) were male. The male to female ratio is 1: 1.2 (Table 1). The majority of cases (37.3%) were found in the age group of 55 to 72 years followed by 37 to 54 years (32.2%) and the least was 1.7% in 1 - 18 years of age (Table 2).

Table 1: Gender distribution of total sample tested

Urine culture	Number of samples	Male	Female
Significant Growth	59 (39.3%)	27 (28.4%)	32 (58.2%)
Sterile	91 (60.7%)	68 (71.6%)	23 (41.8%)
Total	150 (100%)	95 (100%)	55 (100%)

Table 2: Age and gender distribution of the culture - positive urine samples (n=59)

Age Group in year	Male		Female		Total	
	No.	%	No.	%	No.	%
1 to 18	0	0	01	3.1	01	1.7
19 to 36	06	22.3	06	18.8	12	20.3
37 to 54	04	14.8	15	46.9	19	32.2
55 to 72	13	48.1	09	28.1	22	37.3
73 to 90	04	14.8	01	3.1	05	8.5
Total	27	100	32	100	59	100

Chi - square = 18.272 with 2 degrees of freedom; P = 0.022

In this study, out of 59 significant growth majority of the patients, 32 (54.3%) were from medical ICU followed by surgical ICU 18 (30.5%) while 09 (15.2%) were from trauma ICU (Figure 1).

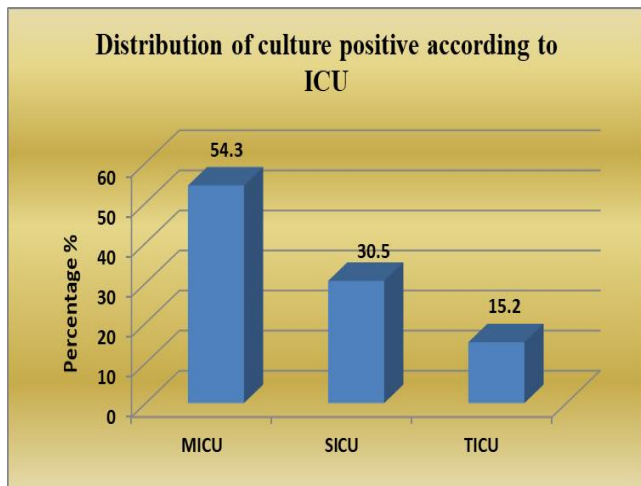


Figure 1: Distribution of culture - positive according to ICU

Among all the positive cases, the majority of the uro - pathogens were gram negative bacilli 31 (52.5%) followed by *Candida* spp 17 (28.9%) while Gram Positive cocci were 11 (18.6%). In gram - negative bacteria, *E. coli* was the most prevalent 15 (35.7%), followed by *Enterobacter* species (14.3%). Similarly, in gram - positive bacteria, *Enterococcus* species was the most prevalent 07 (16.7%) followed by *Staphylococcus aureus* 04 (9.5%) (Table 3).

Table 3: Distribution of Organism in Positive Culture (n=59)

Isolates		No.	%
Gram negative Bacteria	<i>Escherichia coli</i>	15	35.7
	<i>Enterobacter spp.</i>	06	14.3
	<i>Klebsiella spp.</i>	04	9.5
	<i>Pseudomonas spp.</i>	04	9.5
	<i>Acinetobacter spp.</i>	02	4.8
Candida spp.	<i>Candida albicans</i>	04	23.5
	<i>Candida tropicalis</i>	07	41.2
	<i>Candida parapsilosis</i>	05	29.4
	<i>Candida glabrata</i>	01	5.9
Gram Positive Bacteria	<i>Enterococcus spp.</i>	7	16.7
	<i>Staphylococcus Aureus</i>	4	9.5
Total		59	100.00

Out of 17 *Candida* species; *Candida tropicalis* was the most prevalent 07 (41.2%) followed by *Candida parapsilosis* 05 (29.4%) followed by *Candida albicans* 04 (23.5%) and the least common was *Candida glabrata* 01 (5.9%). Most of the cases belong to non albicans group (Table 3). Gram - negative organisms showed the highest sensitivity to Nitrofurantoin (77.4%), followed by Amikacin (54.8%) and Imipenem (48.3%). They showed the least sensitivity to Cotrimoxazole, Cefotaxime, and Ampicillin both (25.8%) (Figure 2).

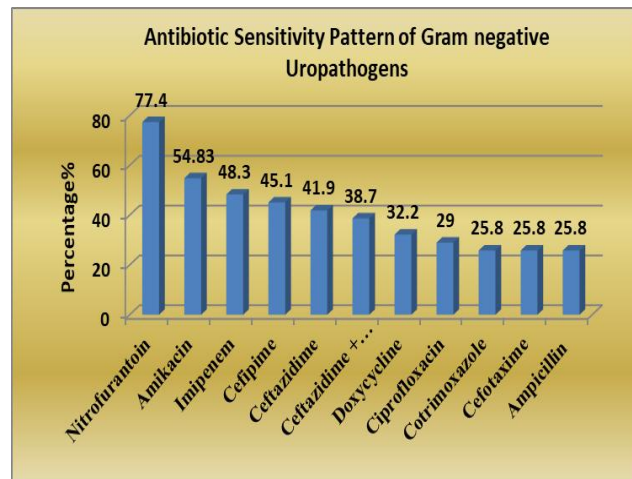


Figure 2: Antibiotic Sensitivity Pattern of Gram - negative uro - pathogens

Pseudomonas species showed the highest sensitivity to Colistin (100%), followed by Gentamycin, Tobramycin, and Cefoperazone - Sulbactam (75%) while the least sensitive was Cefepime (25%). (Figure 3).

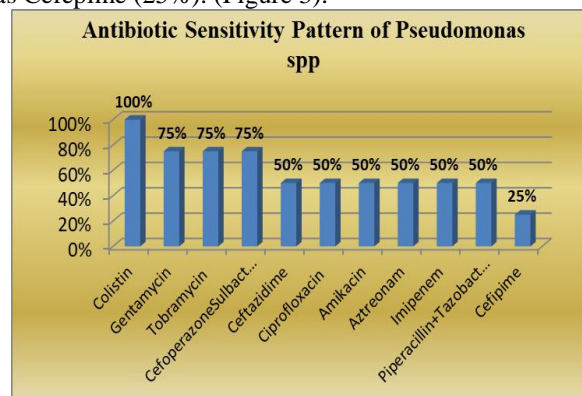


Figure 3: Antibiotic Sensitivity Pattern of Pseudomonas species

Gram - positive organisms showed the highest sensitivity to linezolid and Teicoplanin both (100%) followed by Nitrofurantoin, Vancomycin, and Fosfomycin (90.9%). They showed the least sensitivity to Norfloxacin (27.2%) (Figure 4).

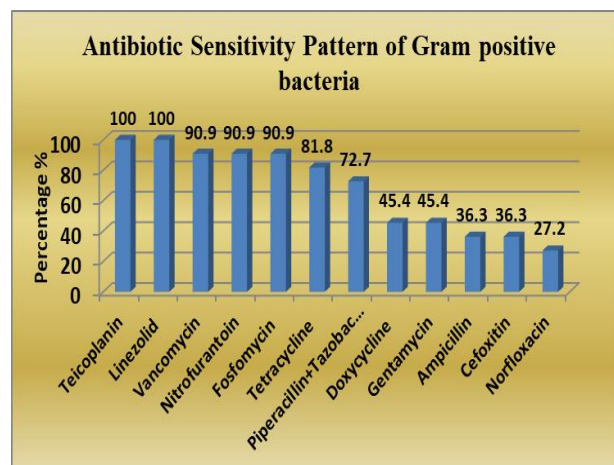


Figure 4: Antibiotic Sensitivity Pattern of Gram - positive bacteria

In the present study, the most effective antifungal drug was Amphotericin B (88.2%) followed by Itraconazole (70.5%)

while the least effective antifungal drug was Fluconazole (41.1%) (Figure 5).

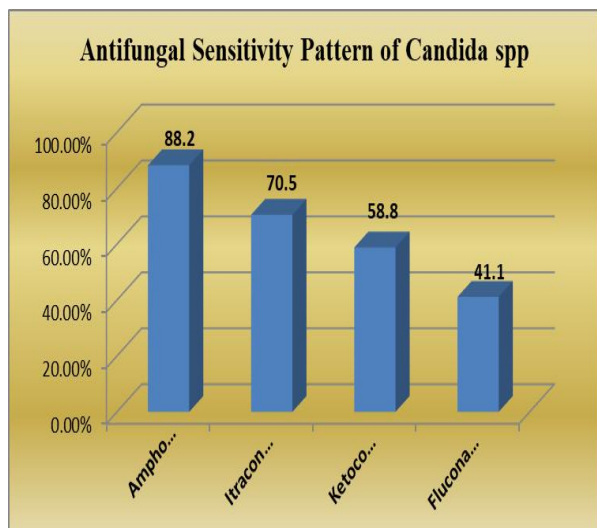


Figure 5: Antifungal Sensitivity Pattern of Candida spp

4. Discussion

Per urethral catheter is identified globally as the single most important predisposing factor for UTI. A catheter may serve as a portal of entry for the pathogen if not aseptically inserted¹⁶. In healthy individuals, catheter - related colonization is generally asymptomatic, which resolves spontaneously after the removal of the catheter. In vulnerable patients, colonization persists and leads to infection. The complication of which could be such as prostatitis, epididymitis, cystitis, pyelonephritis, and septicemia due to Gram - negative bacteremia particularly in high - risk patients¹⁷.

Among 150 clinically suspected cases of CAUTI 59 (39.3%) have significant growth and 91 (60.7%) were sterile. Our results are in accordance with Chanda et al¹⁸ and Mulhall et al¹⁹ who reported 41% and 44% of significant growth respectively. Out of 59 positive cultures, 32 (54.2%) were female and 27 (45.8%) were male. The male to female ratio is 1: 1.2. There was a slight female preponderance which was similar to Debadutta Mishra et al²⁰. The majority of cases (37.3%) were found in the age group of 55 to 72 years followed by 37 to 54 years (32.2%), 19 - 36 years (20.3%) and the least was 1.7% in 1 - 18 years of age. The age distribution was similar to the study done by Ramesh A et al²¹ and Chanda et al¹⁸ who also reported CAUTI was most commonly seen among the older age group. Other factors, including poor environmental hygiene and health conditions, too contribute to the incidence of CAUTI. The patient's condition including nutritional status, history of previous antibiotic administration, immunological status, and the use of immunosuppressive drugs also enhance the risk for CAUTI²². Out of 59 significant growth majority of the patients, 32 (54.3%) were from medical ICU followed by surgical ICU 18 (30.5%) while 09 (15.2%) were from trauma ICU. Findings are consistent with Anupama et al²³ who reported the maximum number of CAUTI was detected from MICU (57%) followed by SICU 15%.

The majority of the uro - pathogens were gram - negative bacilli 31 (52.5%) followed by Candida spp 17 (28.9%) while Gram Positive cocci were 11 (18.6%) which was similar to Ramesh A et al²¹ who also reported a majority of the uro - pathogens were gram - negative bacilli (37%) followed by Candida spp (25%). This emphasizes the need to actively look for fungal causes of CAUTI in addition to bacterial causes. Among all the positive cases, in gram - negative bacteria, *Escherichia coli* was the most prevalent 15 (35.7%), followed by *Enterobacter* species (14.3%), *Klebsiella* spp (9.5%), and *Pseudomonas* spp (9.5%). Similarly, in gram - positive bacteria, *Enterococcus* species was the most prevalent 07 (16.7%) followed by *Staphylococcus aureus* 04 (9.5%). Our results are in accordance with various authors in India and other countries (Mehta et al²⁴, Kang et al²⁵, Anupama et al²³ who all reported *E. coli* is the most common organism in CAUTI. Gram - negative aerobic bacteria colonize the urogenital mucosa with adhesin, pili, fimbriae, and P1 - blood group phenotype receptor²⁶. Enterococci are a common cause of UTI in patients with the intravascular line. The ability to form biofilms facilitates the colonization of urinary and vascular catheters²⁷. Our study showed Enterococci to be the predominant amongst gram - positive uro - pathogens (16.6%) followed by *Staphylococcus aureus* (9.5%) which is in accordance with the study conducted by Shobha KL et al²⁸.

The antimicrobial susceptibility (AST) pattern differs in different studies as well as at different times in the same hospital in Indian and overseas studies because of the wide availability of over - the - counter antibiotics and different hospital - based antibiotic policies. The pattern of antimicrobial resistance of the microorganism causing UTIs to vary in their susceptibility to antimicrobials from place to place and from time to time. In this study we found that gram - negative organisms showed the highest susceptibility to Nitrofurantoin (77.4%), followed by Amikacin (54.8%), Imipenem (48.3%), Cefepime (45.1%), Ceftazidime (41.9%), Ceftazidime with Clavulanic acid (38.7%). They showed the least susceptibility to Cotrimoxazole, Cefotaxime, and Ampicillin (25.8%). Nitrofurantoin and Amikacin were found to be the most effective antibiotics against isolated strains especially *E. coli*. Both are cost - effective and readily available in developing countries. The consistent and high - level susceptibility of *E. coli* to Nitrofurantoin may be influenced by its narrow spectrum of activity, limited indication, low tissue distribution, and limited contact with bacteria outside the urinary tract²⁹. *Pseudomonas* species showed the highest sensitivity to Colistin (100%), followed by Gentamycin (75%), Tobramycin (75%), Cefoperazone - Sulbactam (75%), Imipenem (50%), Piperacillin - tazobactam (50%), Ceftazidime (50%) Aztreonam (50%), Amikacin (50%) while the least sensitive was Cefepime (25%). In another study done by Deepa Bhani et al³⁰, *Pseudomonas* spp. isolated were 31.8% susceptible to Imipenem and Gentamycin, followed by Norfloxacin (22.7%), and Piperacillin - tazobactam (18.2%). Most Gram - positive cocci were susceptible to Linezolid and Teicoplanin (100%), followed by Nitrofurantoin, Vancomycin, and Fosfomycin (90.9%), Tetracycline (81.8%), Piperacillin - Tazobactam (72.7%), and the least sensitive to Norfloxacin (27.2%). We

observed that resistance to Vancomycin is reported among *Enterococci* which was consistent with the studies conducted by Gupta P et al³¹.

Non - albicans *Candida* has become the major pathogens, especially in hospital settings; as yet the reason for this inversion of species distribution has not been completely clarified but it could be related to their virulence potential and resistance to antifungals³². In this study we found that out of 17 *Candida* species; *Candida tropicalis* was the most prevalent 07 (41.2%) followed by *Candida parapsilosis* 05 (29.4%) followed by *Candida albicans* 04 (23.5%) and the least common was *Candida glabrata* 01 (5.9%). Most of the cases belong to the non - albicans group. There is a geographical variation in the etiological pattern of invasive *Candida* spp. infections have been reported in various countries. In North America, there is a high proportion of *C. glabrata* among the non - albicans species. However, in South America *C. parapsilosis* and *C. tropicalis* are the predominant ones³². Thus, the speciation of *Candida* is essential to provide a database for a specified geographical area. The most effective antifungal drug was Amphotericin B (88.2%) followed by Itraconazole (70.5%) while the least effective antifungal drug was Fluconazole (41.1%). Our results are correlated with Abhijit Awari et al³³ and Singhal A et al³⁴.

It has been observed that all studies have their own susceptibility pattern of that region; the reason for the difference might be factors related to the difference in antibiotic use, patient population, and prescribing rate³⁵. Diagnosis of CAUTIs and their treatment requires good cooperation between the clinician and the microbiologist.

5. Conclusion

The urinary tract of catheterized patients is highly vulnerable to severe infection. Infection of the urinary tract is associated with varied microbiological etiology. A high isolation rate of organisms from urine samples of clinically suspected CAUTI individuals shows a good correlation between clinical findings and microbiological methods. Gram - negative organisms were the commonest organisms isolated; amongst *E. coli* was the commonest urinary pathogen. Hospital - acquired uro - pathogens have increased antibiotic resistance and thus are difficult to treat. The risk of transmission of these multidrug - resistant organisms is high if health care providers do not follow preventive practices meticulously. Strict infection control practices, an appropriate antibiotic policy, and timely training & education of the paramedical staff, proper guided bundle care for both procedure and maintenance of catheters are the need of the hour to prevent CAUTI which in turn can lessen the financial burden, work loss, and mental trauma. This study highlights the need for the development of a protocol for rational use of antibiotics and local chemists as well as clinician should be trained for the importance of rational use of antibiotics. Emphasis should also be made on reducing the duration of catheterization to reduce the incidence of CAUTI. Hospital - wide surveillance programs, an appropriate antibiotic policy, and appropriate catheter care protocols should be developed and implemented.

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