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BACTERIOLOGICAL PROFILE OF CATHETER-ASSOCIATED URINARY TRACT INFECTIONS AND ANTIMICROBIAL SUSCEPTIBILITY PATTERN IN AN ADULT INTENSIVE CARE UNIT OF TERTIARY CARE CENTER IN JAIPUR, RAJASTHAN

Medical Microbiology

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ABSTRACT

INTRODUCTION: Amongst nosocomial infections, catheter-associated urinary tract infection (CAUTI) is one of the commonest infections. Urinary tract infections (UTIs) account for 20-50% of all nosocomial infections in the intensive care unit (ICU). Out of these, more than 80% of nosocomial UTIs are catheter-associated UTI (CAUTI). It has been associated with a threefold increased 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 uropathogens. **OBJECTIVE:** To isolate & identify Bacteria 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. A total no of 154 urine samples was 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 154 clinically suspected cases of UTI, only 59 (38.3%) had significant growth and 95 (61.7%) 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, stringent infection control practices, and a proper antibiotic policy, strict bundle care approach for both insertion and maintenance of catheters are requisite to prevent CAUTI.

KEYWORDS

CAUTI, Catheter, Antimicrobial susceptibility, Antimicrobial resistance, Uropathogens, ICU.

INTRODUCTION

Amongst nosocomial infections, catheter-associated urinary tract infection (CAUTI) is one of the commonest infections. Urinary tract infections (UTIs) account for 20-50% of all HAIs occurring in the ICU[1]. Among these, more than 80% of health-care associated UTIs are catheter-associated UTI[2].

CAUTI is defined as UTI where an indwelling urinary catheter was in situ for more than two days on the date of the event, with the day of catheter placement being calendar day one, and an indwelling catheter was in place on the date of the incident or the day earlier. If a catheter was in situ for two or more calendar days and then removed, the date of the incidence for the CAUTI must be the day of detachment or the next day with culture positivity[3]. 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 duration[4].

There are a variety of risk factors related to CAUTI which comprises the length of ICU stay, duration of catheterization, female patients, age over 50 years, immunocompromised patients, the quality of catheter care, and host susceptibility[5]. 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 situ for 30 days or more[6]. Bacteriuria develops at an average rate of 3% to 10% per day of catheterization[7]. The accepted threshold for bacteriuria ranges from 10^3cfu/ml to 10^5cfu/ml[8].

CAUTI is caused by a variety of pathogens, which includes gram-positive bacteria such as *Staphylococcus* species, *Enterococcus* species, as well as gram-negative bacilli like *E. coli, Klebsiella spp, Pseudomonas aeruginosa*, *and Proteus* species and also by Candida spp[2]. Complications allied to CAUTI result in distress to the patient, prolonged hospital stay, and higher cost and mortality[9].

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, which is a matter of concern globaly[10]. CAUTI due to multidrug-resistant (MDR) organisms increases the cost of treatment, morbidity, and mortality especially in developing countries like India[11]. 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 accessible antibiotics usually 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 antimicrobial susceptibility pattern.

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 no of 154 urine samples was collected from catheterized suspected cases of UTI from adult ICU. Urine samples were collected from symptomatic catheterized 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 Bacteriology laboratory for analysis with minimum delay. Patients with symptoms of UTI before the catheterization and not satisfying 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 samples[12]. A loopful urine sample was plated on Mc-Conkey agar & Blood agar (Hi-Media Laboratories, Mumbai, India). The inoculated plates were incubated for 24 hours at 37°C. For the estimation of bacterial load/mL of the urine sample, the numbers of isolated bacterial colonies were multiplied by 1000. A specimen was considered positive for UTI if growth was detected at a concentration of $\geq 10^5$ CFU/mL[13]. Three or more types of colonies grown in a sample were considered as contamination, and a repeat sample was advised. Identification of significant isolates was done 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 bacteria were identified 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.). Ethical clearance was obtained from Institutional Research Review Board prior to commencement of the study.

RESULTS

Among 154 clinically suspected cases of CAUTI 95 (61.7%) were sterile and 59 (38.3%) have significant growth. Out of 154 samples tested 98 (63.6%) were male while 56 (36.3%) were female. Male outnumbered female. The male to female ratio is 1.7:1. Out of the total significant growth, the total number of females was more than 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 (38.3%)	27 (28.6%)	32 (**57.1%**)
Sterile	95 (61.7%)	71(**72.4%**)	24(42.9%)
Total	154(100%)	98 (100%)	56 (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 to18	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 the present study, out of 59 significant growth, most 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).

ISOLATES		No.	%
Gram negative Bacteria	*Escherichia coli*	15	25.4
	Enterobacter spp.	06	10.2
	Klebsiella spp.	04	6.8
	Pseudomonas spp.	04	6.8
	Acinetobacter spp.	02	3.4
Candida spp.	17	28.9	
Gram Positive Bacteria	*Enterococcus spp.*	7	11.8
	Staphylococcus Aureus	4	6.8
Total		**59**	**100.00**

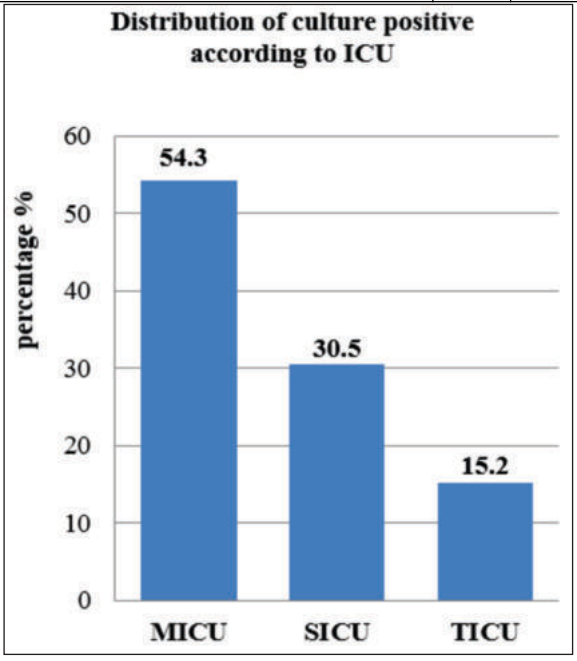

Fig 1: Distribution of culture-positive according to ICU

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).

Gram-negative organisms showed the highest Susceptibility to Nitrofurantoin (77.4%), followed by Amikacin (54.8%) and Imipenem (48.3%). They showed the least Susceptibility to Cotrimoxazole, Cefotaxime, and Ampicillin (25.8%) (Figure 2). Pseudomonas species showed the highest Susceptibility to Colistin (100%), followed by Gentamycin, Tobramycin, and Cefoperazone-Sulbactam (75%) while the least Susceptible was Cefepime (25%). (Figure 3).

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

ISOLATES		No.	%
Gram negative Bacteria	*Escherichia coli*	15	25.4
	Enterobacter spp.	06	10.2
	Klebsiella spp.	04	6.8
	Pseudomonas spp.	04	6.8
	Acinetobacter spp.	02	3.4
Candida spp.	17	28.9	
Gram Positive Bacteria	*Enterococcus spp.*	7	11.8
	Staphylococcus Aureus	4	6.8
Total		**59**	**100.00**

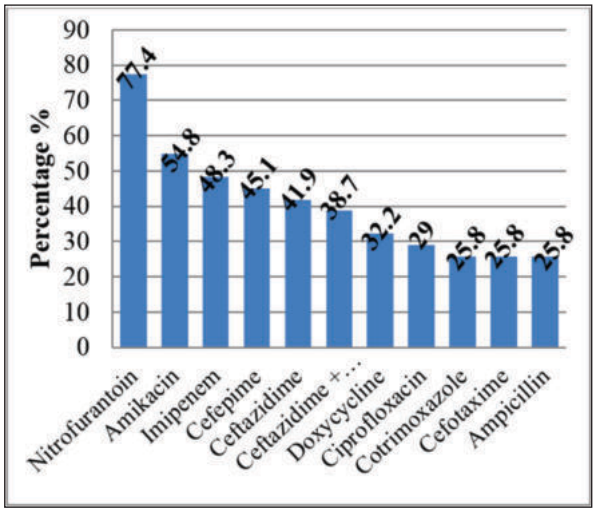

Fig. 2: Antibiotic Susceptibility Pattern of Gram-negative uro-pathogens

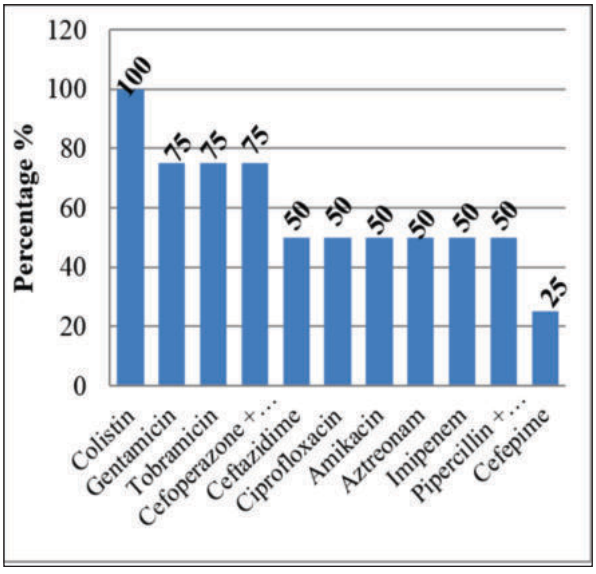

Fig. 3: Antibiotic Susceptibility Pattern of Pseudomonas species

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

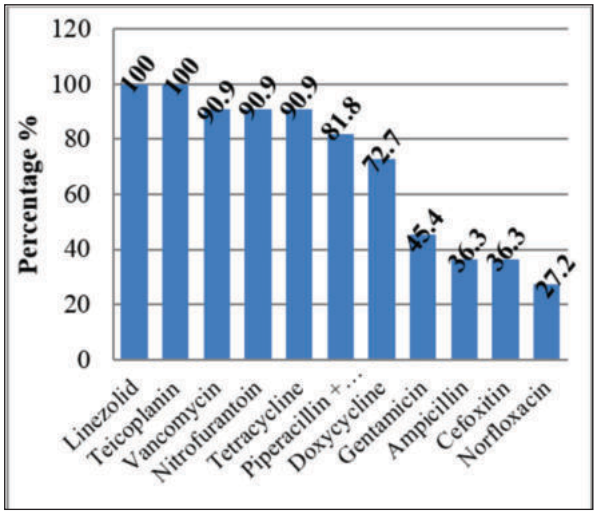

Fig. 4: Antibiotic Susceptibility Pattern of Gram-positive bacteria

DISCUSSION

CAUTI has been associated with a threefold increased 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 uropathogens[14]. The complication of which could be such as prostatitis, epididymitis, cystitis, pyelonephritis, and septicemia due to Gram-negative bacteremia particularly in high-risk patients[15].

Among 154 clinically suspected cases of CAUTI 95 (61.7%) were sterile and 59 (38.3%) have significant growth. Our results are in accordance with Chanda et al[16] and Mulhall et al[14] who reported 41% and 44% of significant growth respectively. Out of 59 positive cultures, 27 (45.8%) were male and 32 (54.2%) were female. The male to female ratio is 1:1.2. There was a slight female preponderance which was similar to Debadutta Mishra et al[17]. 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 al[18] and Chanda et al[16] who also reported CAUTI was most commonly seen among the older age group. 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 CAUTI[19]. Out of 59 significant growth, most of the patients 32(54.3%) were from MICU followed by SICU 18 (30.5%) while 09 (15.2%) were from trauma ICU. Findings are consistent with Anupama et al[20] 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 al[18] who also reported a majority of the uro-pathogens were gram-negative bacilli (37%) followed by Candida spp (25%). 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 al[21], Kang et al[22], Anupama et al[20] 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 receptor[23]. 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 catheters[24]. 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 al[25].

The antimicrobial susceptibility (AST) pattern differs from place to place and from time to time in different studies as well as at different times in the same hospital because of the wide availability of over-the-counter antibiotics and different hospital-based antibiotic policies. 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 tract[26]. Pseudomonas species showed the highest Susceptibility 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 Susceptible was Cefepime (25%). In another study done by Deepa Bhani et al[27], 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 Susceptible 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 al[28]. Diagnosis of CAUTIs and their treatment requires good cooperation between the clinician and the microbiologist.

CONCLUSION

The urinary tract of catheterized patients is highly vulnerable to a wide variety of infections. 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. Nosocomial uro-pathogens have increased antibiotic resistance and thus are difficult to treat. 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 have to be developed and implemented.

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