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Original Article

Microbiology Section

Catheter Associated Urinary Tract Infections: A Cross-sectional Study from a Tertiary Care Centre in Kerala, India

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ABSTRACT

Introduction: Catheter Associated Urinary Tract Infections (CAUTIs) are the commonest nosocomial infection and may lead to serious medical complications. An early detection and appropriate antimicrobial therapy based on antimicrobial susceptibility testing together with infection control practices play a key role in management of CAUTI.

Aim: To identify the aetiological agents causing CAUTI and to understand the antimicrobial susceptibility pattern of the isolates.

Materials and Methods: A prospective cross-sectional study was conducted in the Department of Microbiology of a tertiary care centre in Kerala, India for the duration of six months from January-June 2014. Urine samples were collected from patients with urinary catheters in situ for more than three days, admitted in Intensive Care Unit (ICU) and wards. Urine samples were subjected to wet mount, culture and susceptibility testing. Responsible pathogens and their antimicrobial susceptibility pattern were obtained by using Vitek 2 automated system based on Clinical and Laboratory Standards Institute (CLSI) standards. Data was analysed using the International Business Machines Statistical Package for the Social Sciences (IBM SPSS) version 27.0. Descriptive analysis was used.

Results: Among 150 catheterised patients included, 36 cases (24%) developed CAUTI. The overall rate of CAUTI was 7.03 per 1000 catheter days in present study. The gram negative bacilli were the major isolates comprising Enterobacteriaceae 32 (87.5%) and Non fermenters 4 (12.5%). *Escherichia coli* was the predominant 19 (53%) organism followed by *Klebsiella pneumoniae*, *Pseudomaonas aeruginosa, Enterococcus faecalis*. Extended Spectrum Beta Lactamase (ESBL) producing gram negative bacteria 19 (67.8%) were isolated. The isolates in CAUTI were found to be susceptible to cefoperazone sulbactam combination 21 (65.6%), amikacin 22 (68.7%), piperacillin+ tazobactam 24 (75%), nitrofurantoin 27 (84%), imipenem 27 (84%) and tigecycline 27 (96.4%). All were susceptible to colistin. The gram positive isolates were susceptible to nitrofurantoin 3 (75%), vancomycin and linezolid (both 100%).

Conclusion: CAUTI is a preventable Hospital Acquired Infection (HAI) seen worldwide, but the incidence can be lowered by reducing the catheter procedures, the duration of catheterisation and taking aseptic precautions and by appropriate prophylactic antibiotics.

Keywords: Antimicrobial susceptibility testing, Extended spectrum beta lactamase, Hospital acquired infection, Nosocomial infection

INTRODUCTION

One of the major advances in modern medicine is the development of synthetic devices for temporary or permanent implantation. Much of the current day medical and surgical therapy is predicated upon the use of different devices. The major complication associated with the use of implanted devices is infections [1]. These are difficult to cure with antimicrobial agents and often necessitate the removal of the devices. Foley catheters are the most common devices used by the clinicians worldwide. CAUTI is an important cause of morbidity and mortality in chronically ill patients [2]. The incidence of CAUTI is directly proportional to the duration of catheterisation [3,4]. The pathogens are endogenous, rectal or vaginal or exogenous, through the contaminated hands of the healthcare worker or equipments. It is defined by the Centre for Disease Control (CDC) as a "Urinary Tract Infection (UTI) that occurs in a patient who had an indwelling urethral urinary catheter in place within the 48 hours period before the onset of the UTI" [5]. As the duration of the catheterisation increases, there will be biofilm formation which makes the bacteria resistant to the antimicrobials. Inappropriate catheter use occurs in upto half of catheterised patients, the duration of catheterisation remains the most significant factor in predicting CAUTI and each day of catheterisation increases the risk of CAUTI by 3-10% [6-8]. Undiagnosed cases of CAUTI may badly affect the health of patients. Even though it is a common study, the varying resistance pattern of organisms isolated, emphasises the importance of studying the pattern of infection in every setting. Each Institution and each ICU must have an antibiotic policy of its own which should be frequently revised by active surveillance programme. Thus, the present study was undertaken to find out the pathogens of CAUTI and their antibiotic susceptibility pattern who were admitted in Neurology, Urology wards and Neurology Intensive Care Unit (NICU) in a tertiary care hospital.

MATERIALS AND METHODS

This prospective cross-sectional study was performed for a period of six months from January-June 2014 in Jubilee Mission Medical College and Research Institute, Thrissur, Kerala, India, after obtaining approval from the Institute of Ethical Committee (IEC), 6/12/IEC/JMMC&RI dated 23/01/2012 and informed consent from the patients.

Inclusion criteria: Adult patients who are on Foley catheterisation of more than three days admitted in Neurology, Urology wards and NICU were included in the present study.

Exclusion criteria: Patients who were already on catheter before admission, patients with chronic UTI were excluded from the study.

Sample size calculation: According to the study conducted by Danchaivijitr S et al., the prevalence of CAUTI reported was 73.3% [9]. Therefore, minimum sample size calculated for 95% significant level with relative precision of 20% of 'p' was 36. Total number of 150 patients were included in the present study. Clinical history of the patients such as fever, supra pubic pain if any was obtained from the patients.

Study Procedure

Two mL of urine sample was collected by puncturing the catheter tubing with a needle and syringe after cleaning with ethyl alcohol. Samples were transported immediately. Urine was examined macroscopically, to know whether it is clear/turbid/blood stained. For the direct microscopy (wet mount examination), the urine was carefully mixed and transferred 0.15 mL on to the middle of a slide and cover slip applied. If the area of High Power Field (HPF) is 0.15 mm^2, volume of urine in one HPF will be 0.015 mm [10]. The finding of ≥3 leucocytes per HPF of uncentrifuged urine was considered as significant in CAUTI [5]. Semi-quantitative culture was done on Cystine Lactose Electrolyte Deficient (CLED) agar and the plates were incubated aerobically at 37ºC for 18-24 hours [10]. Next day colony count more than or equal to 10^5 colony forming unit (cfu) with no more than two species of microorganisms was taken as significant [11]. The identification of the isolate, antimicrobial susceptibility testing and ESBL detection was done by using Vitek 2 automatic system. Diagnosis of catheter associated UTI was made when patient had fever, dysuria or suprapubic tenderness and patient had a positive urine culture.

STATISTICAL ANALYSIS

For data collection and analysis, two important parameters were considered:

Numerator data: This included number of patients who had CAUTI as per standard definitions.

Denominator data: This included all patients exposed to the particular device during surveillance period. The catheter days were recorded for each patient which is included in the present study till the catheter was removed [1].

Device Associated Infection (DAI) rate is expressed as the number of DAIs per 1000 device days, as calculated by dividing the number of persons developing DAI by the total number of device days and multiplied by 1000 [1]. In the present study, the total number of device days was 5120. Data were collected and analysed on monthly basis and then compiled at the end. It was analysed using the IBM SPSS version 27.0. Descriptive analysis was used to determine the rate of CAUTI in different ICUs/wards and antimicrobial susceptibility pattern of the isolates.

RESULTS

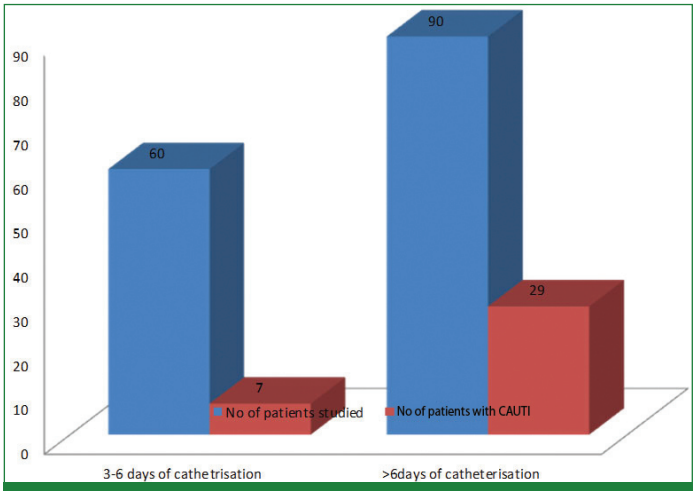
Out of 150 catheterised patients, 36 (24%) patients developed CAUTI, since the total number of device days was 5120, infection rate of 7.03 infections per 1000 catheter days were detected. Bacteriuria were diagnosed in 47 (31.3%) of the study population. The distribution of the patients and rate of CAUTI is shown in [Table/Fig-1,2]. Among 81 males studied 14 (17.3%) were positive for CAUTI while out of 69 females, 22 (31.9%) developed infection [Table/Fig-2]. In present study, females were affected more than males. The highest infection rate was found in age group of >60 years and also the patients in neurology ward [Table/Fig-1,2]. Among the 44,76 and 30 patients studied in Neurology ward, Neurology ICU and Urology 16 (36%),12 (16%) and 8 (27%) developed CAUTI respectively. Among the total cases, 29 (80.5%) were associated with more than six days catheterisation as shown in [Table/Fig-3]. [Table/Fig-4] shows the percentage of isolates obtained from CAUTI. Gram negative organisms were the predominant isolates including Enterobacteriaceae 28 (87.5%) and non fermenters 4 (12.5%). Most common isolate was found to be *Escherichia coli*, 19 (53%), followed by *Klebsiella pneumoniae, Pseudomonas aeruginosa,* and *Enterococcus faecalis*. Susceptibility pattern of the isolates are shown in the [Table/Fig-5,6]. Among the 28 gram negative bacilli comprising Enterobacteriaceae, 19 (67.8%) were ESBL producing in the present study. The gram negative isolates were found to be susceptible to ciprofloxacin 2 (6%), third generation cephalosporins 11(34.4%), gentamicin 9(28%), cotrimoxazole 17(53%), nitrofurantoin 27 (84%), amikacin 22 (68.7%), piperacillin+tazobactam 24 (75%), cefoperazone sulbactam combination 21 (65.6%), Imipenem 27 (84%) and Tigecycline 27 (96.4%). All were susceptible to colistin.

ICU/Ward	Number of patients studied	Number (%) of CAUTI
Neurology ICU	76	12 (16%)
Neurology ward	44	16 (36%)
Urology	30	8 (27%)

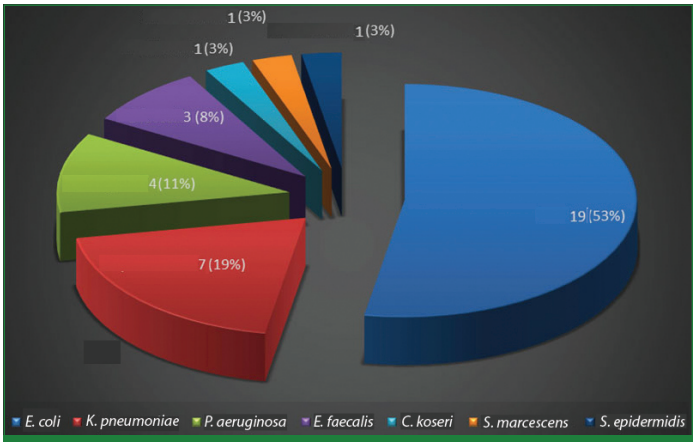
[Table/Fig-1]: Distribution of patients in the study.

Age group (years)	Male number (%) of CAUTI	Female number (%) of CAUTI	Total number (%) of CAUTI
20-40	0	4 (18.2)	4 (11.1)
41-60	3 (21.4)	5 (22.7)	8 (22.2)
>60	11 (78.6)	13 (59)	24 (66.7)
Total	14	22	36

[Table/Fig-2]: Age and gender wise distribution of the patients studied.



[Table/Fig-3]: Relationship between duration of catheterisation and CAUTI.



[Table/Fig-4]: Isolates of CAUTI-N (%).

No of Isolates	Susceptible to						
	C3 (%)	Pip+taz (%)	Cefop+sulb (%)	Ak (%)	Imi (%)	Tg (%)	Col (%)
Escherichia coli (n=19)	6 (31.5)	13 (68.4)	12 (63.1)	13 (68.4)	15 (78.9)	18 (94.7)	19 (100)
Klebsiella pneumoniae (n=7)	2 (28.5)	5 (71.4)	4 (57.1)	4 (57.1)	6 (85.7)	7 (100)	7 (100)
Pseudomonas aeruginosa (n=4)	2 (50)	4 (100)	3 (75)	3 (75)	4 (100)		4 (100)

Citrobacter koseri (n=1)	0	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)
Serratia marcescens (n=1)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)	1 (100)

[Table/Fig-5]: Susceptibility pattern of gram negative bacilli in CAUTI.
C3: Third generation cephalosporins; Pip+taz: Piperacillin and tazobactam; Cefop+sulb: Cefoperazone+sulbactam; Ak: Amikacin; Imp: Imipenem; Tg: Tigecycline; Col: Colistin

	Susceptible to								
No. of isolates	P (%)	AMP (%)	CX (%)	CIP (%)	G (%)	COT (%)	NIT (%)	VA (%)	LZ (%)
Enterococcus faecalis (n=3)	1 (33.3)	1 (33.3)	-	1 (33.3)	0	0	3 (100)	3 (100)	3 (100)
Staphylococcus epidermidis (n=1)	0	0	0	0	0	1 (100)	0	1 (100)	1 (100)

[Table/Fig-6]: Susceptibility pattern of gram positive cocci in CAUTI.
P: Penicillin; AMP: Ampicillin; CX: Cefoxitin; CIP: Ciprofloxacin, G: Gentamycin; COT: Cotrimoxazole; NIT: Nitrofurantoin; VA: Vancomycin; LZ: Linezolid

None of the isolates were found to be susceptible to ampicillin and second generation cephalosporins. Gram positive isolates were susceptible to nitrofurantoin 3 (75%), vancomycin 4 (100%) and linezolid 4 (100%).

DISCUSSION

Development in technology has allowed the use of many devices in the healthcare system. Thereby, the DAI by nosocomial pathogens and the hospital stay also have been raised. Regular surveillance of DAI in any healthcare setting is therefore highly informative not only to clinicians but also to hospital administration in deciding strategies for the prevention and control of such infections. In the present study, the overall rate of CAUTI was 7.03 cases per 1000 catheter which was compared to other international study days in [Table/Fig-7] [3,4,12-21]. The rate of CAUTI in different international studies has ranged from 1.4-18 infections per 1000 catheter days [12-16]. The incidence of CAUTI in present study was 24%, which is high compared to other Indian studies by Vinoth M et al., Hedawoo JB and Deshmukh KS, and Verma S et al., [Table/Fig-7] [3,17,19]. Singhai M et al., has reported high rate of 26.6% similar to the present study [20]. The variation could be attributed to difference in study centres, type of patients involved and duration of study. In contrast to an Indian study [3] number of patients positive for culture in the medical ward was higher compared to those in surgical ward [Table/Fig-1]. This could be due to the study participants in the present study was the patients from Neurology ward who may need prolonged catheterisation compared to others. In the present study, rate of infection was more when the duration of catheterisation is increased and also in elderly patients [Table/Fig-2,3] which was in concordance with the findings of similar studies by Vinoth M et al., Beaujean DJ et al., Hedawoo JB and Deshmukh KS, and Hanumantha S and Pilli HPK, [3,7,17,18]. As demonstrated in other studies, females, elderly patients and prolonged catheterisation were found to be the risk factors in the present study also [3,4,18]. In present study, 47 (31%) of patients were asymptomatic and diagnosed as catheter associated asymptomatic bacteriuria. Similarly in a study conducted by Vinoth M et al., 50% of patients were asymptomatic [3]. Repeated urine analysis at frequent intervals is required to find out these asymptomatic cases and appropriate measures should be taken to prevent the upcoming CAUTI. As in other studies, present study also supported that the gram negative bacilli were the major isolates [17-26]. *Escherichia coli* was the major pathogen 19 (53%) which was found to be similar as in the previous studies [17-26]. In another study conducted in India by Manish N and Tankhiwale NS had reported that 100% of *Escherichia coli* isolates were susceptible to imipenem, 82.46% to nitrofurantoin and 87.7% to amikacin [25]. In present study, *Escherichia coli* were found to be susceptible to piperacillin+tazobactam 13 (68.4%), amikacin 13 (68.4%), cefoperazone+sulbactum 12 (63.1%), imipenem 15 (78.9%) and nitrofurantoin 16 (84.2%). Similar to other reports in the present study also, majority of the uropathogens were resistant to ampicillin, ciprofloxacin, cotrimoxazole and gentamicin [17-26]. Among the *Escherichia coli* isolates 13 (68.4%) were ESBL producers in the present study. Compared to another Indian study by Dugal S and Purohit H, (70.9% ESBL producing *Escherichia coli* isolates) it was low [26]. The rate of antibiotic resistance of the isolates in present study was found to be high compared to other Indian studies [17-26]. Increasing antibiotic resistance is a major clinical problem faced by clinicians in treating nosocomial infections. *Enterococcus faecalis* was the commonest gram positive organism in this study similar to other Indian studies [3,18]. Rise in increasing of CAUTI in the hospitals is mainly because of not adopting meticulous aseptic precaution during catheter insertion, infrequent change of catheter and inadequate infection control practices.

Study	Place and publication year	Rate of CAUTI
Moreno CA et al., [12]	Colombia, 2006	4.3 cases per 1000 catheter days
Mehta A et al., [13]	India, 2007	1.41 cases per 1000 catheter days
Rosenthal VD et al., [14]	Argentina, 2004	18.5 cases per 1000 catheter days
Rosenthal VD et al., [15]	Argentina, 2006	8.9 cases per 1000 catheter days
Inan D et al., [16]	Turkey, 2006	13.63 cases per 1000 catheter days
Singhai M et al., [20]	Uttarakhand, 2012	26.6%
Kamat US et al., [21]	Goa, 2009	33.6%
Vinoth M et al., [3]	Tamil Nadu, 2017	20%
Khan Y et al., [4]	Telangana, 2016	59%
Hedawoo JB and Deshmukh KS, [17]	Maharashtra, 2019	16.25%
Hanumantha S and Pilli HPK, [18]	Andhra Pradesh, 2016	7.03%
Verma S et al., [19]	Bangalore, 2017	15.95%
Present study	Kerala, 2022	36%

[Table/Fig-7]: CAUTI rates in various Indian and International studies [3,4,12-21].

Limitation(s)

The present study was a time bound and the number of patients enrolled for the study was limited.

CONCLUSION(S)

The HAIs have proven to be the most common cause of increased morbidity, hospital stay and the economical cost of the hospitalised patients. In the present study, the incidence of CAUTI increases proportionately with duration of catheterisation. Repeated urine analysis is required to diagnose and prevent CAUTI as its complications are very difficult to treat. Each Institution and each ICU must have an antibiotic policy of its own which should be frequently revised by active surveillance programme. This will help in the selection of the appropriate antibiotic for therapeutic use and also prevent the emergence of drug resistance strains due to irrational use of antibiotics. All hospital staff must be made aware of infection control practices which must be strictly followed. Prevention is more important than management of HAIs. The actual need of indwelling urinary catheters should be assessed and more elaborate studies on that aspect are essential. Intermittent catheterisation, reduction of duration of catheterisation and periodic surveillance of the infections are recommended to reduce the incidence CAUTI.

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