

Microbiological Evaluation of Catheter Associated Urinary Tract Infection in a Tertiary Care Hospital

Indranil Bagchi, Neelam K Jaitly, V R Thombare

Department of Microbiological, N K P Salve Institute of Medical and Sciences and Research Centre, Nagpur

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ABSTRACT

Urinary tract infections are the most common type of healthcare-associated infection, accounting for more than 30% of infections reported by acute care hospitals. Virtually all healthcare-associated UTIs are caused by instrumentation of the urinary tract. Catheter-associated urinary tract infection (CAUTI) has been associated with increased morbidity, mortality, hospital cost and length of stay. In addition, hospital acquired CAUTIs are often due to multidrug resistant strains which require higher antibiotics and these strains may spread to other patients.

Urine samples from all adult patients admitted without any recent history of UTI and where a Foley's catheter was introduced in the past 24 hours is aseptically collected, analysed by microscopy and cultured for microbiological profiling. AntibioGram of clinical isolates was studied and CAUTI was observed in 64 samples out of 220 samples collected. The most frequent isolates were E.coli (34.85%), Klebsiella spp (19.7%), Pseudomonas spp (12.12%), Candida spp (10.6%), Enterococcus spp (6.06%), CONS (6.06%), Staphylococcus aureus (4.55%), Citrobacter spp (3.03%) Proteus spp (3.03%). Infections were more with female sex, prolonged catheterization, old age and diabetes. Longer duration of catheterization increased the chances of CAUTI. Emphasis should be placed on good catheter management rather than the use of prophylaxis to reduce the incidence of CAUTI.

KEY WORDS: catheter-associated urinary tract infection (CAUTI), nosocomial urinary tract infection (NUTI), urinary tract infection (UTI)

INTRODUCTION:

Urinary tract infection (UTI) is defined as an invasive disease by microorganisms, inducing an inflammatory response and symptoms and signs such as fever > 38°C, urgency, frequency, dysuria without any other cause.

Nosocomial urinary tract infection (NUTI) refers to an UTI acquired in a hospital setting. In two thirds of the cases, the bacteria causing these infections are endogenous.

The urinary tract is the commonest site of nosocomial infections, accounting for 40% of infections. About 66% to 86% of these infections follow instrumentation of the urinary tract, particularly catheterization.

The urinary catheter is an essential part of

modern medical care. It is widely used to relieve anatomic or physiologic obstructions, to provide a dry environment for the comatose or incontinent patients, and to permit the accurate measurement of urinary output in severely ill patients. Unfortunately, when used inappropriately or when left in place for too long, it is a hazard to the very patients that it is designed to protect.

Routes of infection^[1]

- At the time of catheter insertion where organisms may be pushed into the previously uninfected bladder.
- Extra luminal colonization of the catheter with ascension of organisms into the urinary tract.
- Intraluminal colonization of the catheter with ascension of microorganisms. [Closed systems are designed to minimize intraluminal infection by preventing exogenous contamination]
- Acquisition of the infection via the lymphatic or haematogenous route is a proven, though minor portal of entry.

Corresponding Author: Dr. Indranil Bagchi,
Department of Microbiological, N K P Salve
Institute of Medical Sciences and Research
Centre, Nagpur
Phone No.: +91 9434304868
E-mail: bagchi1970@gmail.com



Within 8 hours of insertion of a catheter, a biofilm can be found on the surface of the catheter, drainage bag and mucosa consisting of Tamm-horsefall protein, struvite and apatite crystals, bacterial polysaccharides, glycocalyxes and living bacteria and is composed of three layers. Organisms within the biofilm are well protected from mechanical flushing by urine flow, other host defences and antibiotic.

Most nosocomial UTI can be benign but a systemic complication, which is gram negative bacteremia, can develop in 30-40% of patients.

Duration of catheterization is the most important, consistent risk factor for catheter associated bacteriuria; approximately 97% of UTIs in the ICU are associated with an indwelling urinary catheter. Bacteriuria develops quickly at an average daily rate of 3% to 10% per day of catheterization. Bacteriuria will develop in 26% of patients with a catheter in place for 2 to 10 days. All patients catheterized for a month will develop bacteriuria. Long-term catheterization is defined as catheterization for greater than 1 month.

Recurrent problems with these nosocomially acquired catheter-related urinary tract infections are the changes in the microbiological and antibiotic sensitivity pattern of the pathogen isolated. Documented phenomena include: the emergence of extended spectrum beta lactamase producing *E.coli*, the tendency of the fluoroquinolones both to select for resistant strains of major UTI pathogens and to induce cross-resistance among different drug classes, and beta lactum and vancomycin resistance of enterococci and coagulase-negative Staphylococci.

Catheter-Associated Urinary tract Infection (CAUTI) can lead to complications such as cystitis, pyelonephritis, gram-negative bacteremia, prostatitis, epididymitis, and orchitis in males and, less commonly, endocarditis, vertebral osteomyelitis, septic arthritis, endophthalmitis, and meningitis in all patients. Complications associated causes discomfort to the patient, prolonged hospital stay and increased cost and mortality.⁸

Prevention of nosocomial UTI and its complications would therefore reduce the rate of morbidity and mortality and expenses secondary to infection.⁵ The study had been undertaken to describe the microbiological profile of catheter associated UTI and its correlation with duration of catheterization, consequences of urethral catheterization in terms of the incidence of the catheter-related infection, the risk factors associated with its acquisition and to detect/reveal the causative microbiological pathogens and their antibiotic susceptibility pattern.

MATERIALS AND METHODS:

Inclusion criteria: Adult patient with a Foley's catheter introduction [taking all aseptic precautions] in the past 24 hours without any previous history of Urinary Tract Infection (UTI) in the recent past at different wards and ICU of the Hospital were included in the study. The catheter material used is latex and is from same manufacturer for all patients.

Exclusion criteria included. (a) Patients aged below 18 years were excluded from study; (b) Patients whose initial urine sample [taken within 24 hours of catheterization] with bacteriuria [105 CFU/ml or more] and patients whose catheters were removed or those who was discharged or transferred or who expired before obtaining urine sample for the day 3 culture were also excluded from the study; (c) Patients in whom the indwelling urethral catheter were in situ at the time of admission to the specialty, with the exception of those with catheters inserted in operation theatre and in the emergency department; (d) Patients in whom the indwelling urethral catheter was inserted before the start of the UTI surveillance period or the indwelling catheter has been in place for less than 48 hours; (e) Patients having suprapubic catheterization and (f) Patient who was undergoing treatment for UTI when the catheter was inserted.

In the study, a due consent was taken from patient/patient party. Patients excluding above criteria were admitted in different wards, ICUs of N.K.P. Salve Institute of Medical sciences and Research Centre, Nagpur, Maharashtra and followed up till 7th day of post-catheterization. Urine samples were collected on 3rd, 5th and 7th day after an initial screening. Patients were followed up to 48 hours after removal of the catheter and on removal of catheters on 5th/6th day, a follow up was done up to 7th day. The catheter tubing was clamped away from the sampling area, which was as near to the urethral meatus as possible (to collect freshly voided sample).

The site of sampling was prepared and the concerned part of the catheter was first rubbed with sterile cotton soaked in povidone iodine and then 70% ethyl-alcohol being used to disinfect the outer surface of the catheter.

The urine sample was collected by aspiration from the prepared site with a sterile 2c.c. disposable syringe with needle. The sample were then quickly transferred in a sterile container and processed within 2

hours.^[9,10]

The collected samples were analysed using microscopy and culturing for microbiological profiling. The identification of isolates was done following standard microbiological procedures.^[10]

Antibiogram of the clinical isolates was studied.

RESULTS:

Over a period of 2 years, patients admitted at various medical, surgical wards and Intensive care units were studied. A total 220 patients were followed up with respect to clinical features, risk factors, microbiological profile of CAUTI and antibiotic susceptibility. 64 cases developed CAUTI and the incidence rate was 29.09%.

In our study, the total catheterized male patients were 115 and 105 female patients respectively. The number of CAUTI cases in males was 28 (24.35%) and in females 36 (34.29%). For both male and female patients, number of CAUTI cases was minimum at the lower age group of patients, and the number increased with rise in the age group (Table 1).

Out of 64 CAUTI cases, maximum incidence was from >75 years age group which had 2 CAUTI cases out of 3 patients [66.67%] and minimum was from 18-25 years age group which had 2 cases out of 17 patients (11.76%). CAUTI were detected more in females (36 out of 105 patients, 34.29%) than in males [28 out of 115 patients, 24.35%]. It was observed that, 9 patients (14.06%) had fever, 4 patients (6.25%) showed suprapubic tenderness, whereas only 2 patients (3.13%) complained of mild costovertebral angle pain. Dysuria was complained by 5 patients (7.81%) and urgency was complained by 3 patients (4.69%). However, tenderness could not be elicited clinically. Rest of the patients were asymptomatic.

The CAUTI cases were detected from 3rd day of catheterization onwards and increased with the duration of catheterization. Maximum cases were detected on 7th day of catheterization (50.0%). It was also found that older age and presence of diabetes mellitus were risk factors for CAUTI.

A total of 66 isolates were recovered from 64

CAUTI cases. Gram negative bacilli showed predominance causing 72.73% of CAUTI and gram positive cocci caused 16.67% of CAUTI while, rest was fungal isolates. In our study, E.coli was the most common isolate followed by Klebsiella species. 2 samples showed presence of more than 1 organism. The most frequent isolated pathogens were E.coli (34.85%), Klebsiella spp (19.7%), Pseudomonas spp (12.12%), Candida spp (10.6%), Enterococcus spp (6.06%), CONS (6.06%), Staphylococcus aureus (4.55%), Citrobacter spp (3.03%) and Proteus spp (3.03%) (Table 2). All the gram negative isolates were sensitive to imipenem. E.coli and Pseudomonas spp showed maximum sensitivity to Piperacillin-Tazobactam. While, Klebsiella spp showed maximum sensitivity towards ceftazidime. All the recovered gram positive isolates displayed sensitivity against vancomycin. CONS, Staphylococcus aureus and Enterococcus spp were most sensitive towards linezolid and ciprofloxacin. It was pragmatic that all gram negative and positive isolates were least sensitive to ampicillin.

Most of the available references isolated Candida in pure culture and mentioned it in the list of the isolated organisms but did not mention about its antifungal sensitivity. Even the study of Kamath et al mentioned Candida as a causative organism, and claim that the incidence is in agreement with other studies did not mention antifungal sensitivity of Candida. Only the antibiogram of the gram positive and gram negative organisms were given in their study.

DISCUSSION:

In the present study, out of 220 cases studied 64 developed CAUTI. The incidence of CAUTI was found to be 29.09%. The incidence of CAUTI ranged from as low as 5% to as high as 73% among catheterized patients.^[11,12] This result are in corroboration with studies of Garibaldi et al., (1974) and Alavaren et al., (1993) where Urinary Tract Infection in Patients and factors in predisposing to bacteriuria during indwelling urethral catheterization was observed.^[13,14]

In our study, the number of CAUTI cases increased with increase in the age of the patient, maximum incidence was from >75 years age group

Table 1: Age and sex wise distribution of CAUTI cases.

Age Group in years	Males n=113			Females n=105			Male & Female combined n=218		
	Total patients	CAUTI + VE	Percent (%)	Total patients	CAUTI + VE	percent (%)	Total patients	CAUTI + VE	percent (%)
18-25	9	1	11.11	8	1	12.5	17	2	11.76
26-35	14	1	7.14	15	3	20	29	4	13.79
36-45	19	2	10.53	16	4	25	35	6	17.14
46-55	24	4	16.67	26	8	30.77	50	12	24.0
56-65	32	12	37.5	22	10	45.45	54	22	40.74
66-75	15	7	46.67	17	9	52.94	32	16	50.0
>75	2	1	50	1	1	100	3	2	66.67
Total	115	28	24.35	105	36	34.29	220	64	29.09

Table 2: Microbial profile in CAUTI cases.

ORGANISM ISOLATED	NO OF ISOLATES	
	n=66	PERCENTAGE [%]
E. coli	23	34.85
Klebsiella spp.	13	19.7
Pseudomonas spp.	8	12.12
Candida spp	7	10.6
Enterococcus spp	4	6.06
CONS	4	6.06
Staphylococcus aureus	3	4.55
Citrobacter spp	2	3.03
Proteus spp	2	3.03

which had 2 CAUTI cases out of 3 patients (66.67%) and minimum was from 18-25 years age group which had 2 cases out of 17 patients (11.76%). When association was seen between age > 45 years and age <45 years considering both males and females together, it was found to be statistically significant (p value 0.0005). The odds ratio was 4.65, which displayed that those aged > 45 years possess the risk of developing CAUTI 4.65 times more, than those who aged < 45 years. In our study population of catheterized patients, males were more than females. Occurrence of CAUTI was more in female patients i.e., 36 out of 105, (34.29%), than that of male patients i.e., 28 out of 115, (24.35%). The association was not significant in the study due to smaller sample size. Age and female sex have been observed as significant risk factors by most workers.^[14,15]

Duration of catheterization is strongly associated with risk of infection i.e., the longer the catheter is placed, higher is the incidence of urinary tract infection. The incidence of bacteriuria in catheterized patients is directly related to the duration of catheterization; the daily rate of acquiring bacteriuria is approximately 3% to 10%. In our study, patients were followed-up till 7th day of catheterization and out of 64 cases, 10 (15.63 %) were detected within 3 days, 22 (34.38%) within 5 days and 32 (50.0%) in 7 days of catheterization.

In the present study, 14 patients (21.88%) possessed diabetes mellitus and to compare the results 10 control patients (without CAUTI) possessing diabetes mellitus were included. The association was found to be statistically significant (p value 0.0008). The odds ratio was 4.09, signifying that those with

Table 3: Antibiotic sensitivity pattern of gram negative isolates

ANTIBIOTICS	E.coli n=23	Klebsiella spp n=13	Pseudomonas spp n=8	Citrobacters pp n=2	Proteus spp n=2
Ampicillin	5 (21.73%)	3 (23.07%)	--	1 (50.0%)	1 (50.0%)
Gentamicin	14 (60.87%)	8 (61.54%)	6 (75.0%)	2 (100%)	2 (100%)
Amikacin	18 (78.26%)	10 (76.92%)	6 (75.0%)	2 (100%)	2 (100%)
Ceftazidime	16 (69.57%)	11 (84.62%)	6 (75.0%)	2 (100%)	2 (100%)
Amoxicillin+ Clavulanic acid	7 (30.43%)	6 (46.15%)	---	0	0
Piperacillin+ Tazobactam	20 (86.96%)	9 (69.23%)	7 (87.5%)	2 (100%)	2 (100%)
Ceftriaxone	16 (69.57%)	8 (61.54%)	6 (75.0%)	2 (100%)	1 (50.0%)
Ciprofloxacin	14 (60.87%)	8 (61.54%)	2 (25.0%)	0	2 (100%)
Imipenem	23 (100%)	13 (100%)	8 (100%)	2 (100%)	2 (100%)
Norfloxacin	14 (60.87%)	8 (61.54%)	4 (50.0%)	1 (50.0%)	1 (50.0%)
Nitrofurantoin	19 (82.61%)	9 (69.23%)	--	2 (100%)	1 (50.0%)
Cotrimoxazole	10 (43.48%)	7 (53.85%)	--	2 (100%)	1 (50.0%)

diabetes mellitus had 4.09 times more risk of developing CAUTI than those without diabetes mellitus. Diabetes mellitus was found to be a risk factor for CAUTI by many studies.^[18,15,19,20,21,6]

In our study population of patients affected with CAUTI, female patients were affected with CAUTI more than males. Thus, it is in corroboration with the similar studies that female sex was found to be a risk factor for CAUTI.^[18,15,19,20,21,6]

In the present study, total 66 isolates were found where gram negative bacilli showed preponderance of CAUTI and E.coli was isolated from maximum number of CAUTI samples which are comparable with other studies. In our study, the antifungal sensitivity was of no aim as most of the researches isolated candida in pure culture and mentioned as organisms, but did not provide its

antifungal sensitivity. Even the study of Kamath et al., (2009) mentioned candida as a causative organism, and claim that the incidence is in agreement with other studies without mentioning antifungal sensitivity of Candida. Only the antibiogram of the gram positive and gram negative organisms were provided.^[22,23,24,25,26,15,27,28,29,30,31,32]

CONCLUSION:

it is concluded that the old age, prolonged catheterization, presence of diabetes are the significant risk factors for CAUTI. Indwelling urethral catheters should be avoided whenever possible and should never be resorted to unless with absolute indications. Insertion of catheter should be done in strict asepsis by trained personnel. Before catheterization, perineal areas should always be cleaned using an antiseptic or germicidal preparation. Hand washing should be done

Table 4: Antibiotic sensitivity pattern of gram positive isolates

ANTIBIOTIC	CONS n=4	S. aureus n=3	Enterococcus spp n=4
Ampicillin	1 (25.0%)	1 (33.33%)	1 (25.0%)
Gentamicin	2 (50.0%)	2 (66.67%)	4 100
Penicillin G	2 (50.0%)	2 (66.67%)	2 (50.0%)
Cefoxitin	4 (100%)	3 (100%)	4 (100%)
Linezolid	3 (75.0%)	2 (66.67%)	4 (100%)
Vancomycin	4 (100%)	3 (100%)	4 (100%)
Ciprofloxacin	3 (75.0%)	2 (66.67%)	2 (50.0%)
Norfloxacin	2 (50.0%)	2 (66.67%)	3 (75.0%)
Nitrofurantoin	2 (50.0%)	3 (100%)	4 (100%)
Co-trimoxazole	2 (50.0%)	2 (66.67%)	2 (50.0%)
Tetracycline	2 (50.0%)	2 (66.67%)	2 (50.0%)

immediately before and after manipulation of catheter site or apparatus. Closed catheter drainage system should be employed in all cases. The entire system should be replaced in an event where a break is present. The catheter should be inspected frequently to ensure that no obstruction in flow of urine. Emphasis should always be placed on good catheter management rather than the use of prophylaxis to reduce the incidence of CAUTI.

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