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Original Research Article

Bacterial colonization associated with prolonged catheterization: Who is at risk?

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ABSTRACT

Background: CAUTI (Catheter-associated urinary tract infection) is the most common adverse event associated with indwelling urinary catheter use. Despite innate mechanisms of intact urinary tracts, uropathogens are capable of colonizing and persisting in this environmental niche. This prospective observational study was done to evaluate age and gender as independent risk factor associated with acquisition of infection..
Methods: Study was done on 339 non-repetitive urine samples from catheterized patients. Semi-quantitative bacterial culture was performed and isolates were identified by standard biochemical tests.
Results: In present study 82.00% (278/339) significant bacteriuria was observed. No predilection of infection to any particular gender was observed, patients of both genders were affected, males being marginally more 201/239 (84.10%) than females 77/100 (77.00%). Females with significant bacteriuria were more asymptomatic 50/77 (70.12%) where as men had symptomatic CAUTI 115/201 (57.21%). Distribution of culture results were studied with respect to age, maximum number of significant bacteriuria was observed among age group >60 years 95/104 (91.34%). Further, it was analyzed that elderly females (93.33%) were more prone to CAUTI then males (90.54%). Gram negative bacteria (GNB) were predominant isolates 215/278 (77.33%) and among GNB, Escherichia coli was most common isolate 85/278 (30.57%).
Conclusions: Thus, we observed significant bacteriuria is common among catheterized patients but predisposition to UTI results from several factors. Though in this study no predilection of infection was observed to any particular gender but prevalence varies widely with age and more among elderly.

Keywords: CAUTI, E coli, Elderly, Risk factors, Significant bacteriuria

INTRODUCTION

Urinary catheters, commonly deployed prosthetic medical devices used in managing bladder dysfunction, unfortunately provides attractive surface for bacterial colonization. As they have none of protective mechanisms of healthy tissue surfaces from contaminated external environment thus providing a portal to pathogens into a vulnerable body cavity.[1] Despite innate mechanisms of intact urinary tracts, some organisms are capable of colonizing and persisting in this environmental niche. Majority of uropathogens are fecal contaminants or skin residents from the patient's own native or transitory microflora colonizing periurethral area. Transitory microflora originates from hospital personnel or through contact with other patients, may represent antimicrobial-resistant nosocomial strains complicating treatment protocols. Preferred mechanism of bladder entry during catheter associated urinary tract infection (CAUTI) is extra luminal (66%), where organisms ascend from the urethral meatus along the catheter urethral interface. Organisms can also enter bladder intraluminally (34%),

where they migrate as a result of manipulation of catheter system. Indwelling devices favor colonization by providing surface for attachment of host cell binding receptors that are recognized by bacterial adhesins, thus enhancing microbial adhesion. Damage caused to uroepithelium, upon catheter insertion, leads to exposure of new binding sites for bacterial adhesins. Also, presence of catheter results in over distension of bladder and incomplete voiding that leaves residual urine for microbial growth.

Bacterial adhesins initiate adherence by recognizing host cell receptors located on surfaces of host cell or catheter, by overcoming electrostatic repulsion observed between bacterial cell membranes and surfaces, therefore allows intimate interactions to occur. Once firmly attached to catheter surface bacteria begins phenotypic changes, producing exopolysaccharides that entrap and protect them. These attached bacteria replicate forming micro colonies that eventually mature into biofilms. Once colonized on the catheter, uropathogens adapt to local environment, secreting degradative enzymes and toxins leading to tissue breakdown, releasing nutrients. To maintain an infection pathogens must evade host immune response, number of mechanisms followed by uropathogens include uropathogens production of capsules, immunoglobulin A, proteases, and lipopolysaccharides.

However, due to the introduction of foreign body, organisms require fewer recognized virulence factors to colonize and establish infection than those required by pathogens to infect a fully functional urinary tract.[2]

Among various risk factors cited to be associated with CAUTI, this prospective observational study was done to evaluate age and gender as independent risk factor associated with acquisition of infection.

METHODS

This prospective study was undertaken in the Department of Microbiology in a tertiary care hospital. A total of 339 randomly selected urinary catheterized patients (symptomatic and asymptomatic), admitted in various wards of hospital were included in present study. Urine samples were collected in sterile containers with proper aseptic precautions. Samples were cultured on Mac Conkey agar and blood agar and incubated overnight aerobically at 37°C. A specimen was considered positive, if a single / two potential pathogens were cultured at a concentration of $\geq 10^5$ Colony forming unit (CFU)/ml from catheterized urine specimens. Organisms were identified by conventional microbiological methods.[3]

RESULTS

In present study 82.00% (278/339) significant bacteriuria was observed. We observed susceptibility increases with longer duration as bacteriuria is inevitable while catheter is in place. Distribution of culture results with respect to catheter days is shown in Table 1.

Table 1: Distribution of culture results with duration of catheterization.

Duration of catheterization	Total samples	Significant bacteriuria
0-7 days	198	145 (73.23%)
8-15 days	130	122 (93.84%)
16-22 days	08	08 (100.00%)
23-28days	03	03 (100.00%)
Total	339	278 (82.00%)

Demographic characteristics of study subjects showed that among 339 catheterized patients, majority were males 239 (70.50%) and 100 (29.49%) were females. Predisposition to UTI results from several factors, here we considered age and gender as independent risk factors associated with CAUTI.

In present study, there was no predilection of infection to any particular gender; patients of both genders were affected, males being marginally more 201/239 (84.10%) than females 77/100 (77.00%) (Table 2).

Table 2: Distribution of culture results with respect to gender.

Males		Females	
Total patients	Culture positive	Total patients	Culture positive
239	201 (84.10%)	100	77 (77.00%)

Table 3: Clinical profile of patients.

Clinical presentation	Males	Females
Asymptomatic	86/201 (42.78%)	50/77 (70.12%)
Symptomatic	115/201 (57.21%)	27/77 (35.06%)

In present study we observed that females with significant bacteriuria were more asymptomatic 50/77 (70.12%) where as men had symptomatic CAUTI 115/201 (57.21%) (Table 4).

Table 4: Distribution of culture results with respect to age.

Age	Total patients	Culture positive
16-30 years	55	37 (67.27%)
31-45 years	85	71 (83.52%)
45-60years	85	75 (88.23%)
>60 years	104	95 (91.34%)
Total	339	278 (82.00%)

We observed that among females of reproductive age group (16-45years) symptomatic bacteriuria was more

common 20/27(74.07%) then elderly (>60 years), who had asymptomatic bacteriuria 23/27(85.18) (Figure 1).

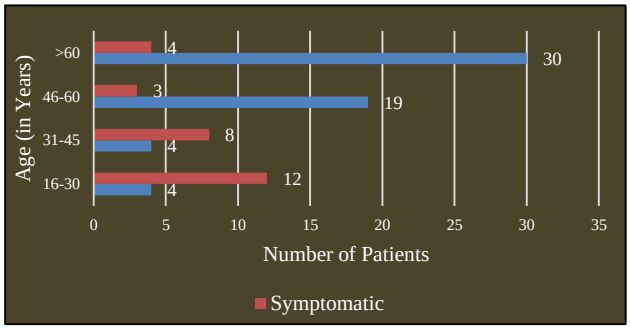

Figure 1: Clinical presentation among female patients.

Distribution of culture results were studied with respect to age, maximum number of significant bacteriuria was observed among age group >60 years 95/104 (91.34%) (Table 4). Further, it was analyzed that among elderly females (93.33%) were more prone to CAUTI then males (90.54%).

Gram negative bacteria (GNB) were predominant isolates 215/278 (77.33%) and among GNB, *Escherichia coli* was most common isolate 85/278 (30.57%).Other isolates include *Klebsiella spp.* 57/278 (20.50%), *Pseudomonas spp.* 45/278 (16.18%), *Proteus spp.* 32/278 (11.51%) and gram positive bacteria (GPB) 31/278 (8.86%). Bacteriological profile was studied with respect to duration of catheterization, Pseudomonas spp. and Proteus spp. were predominant isolates with prolonged catheterization (Figure 2).

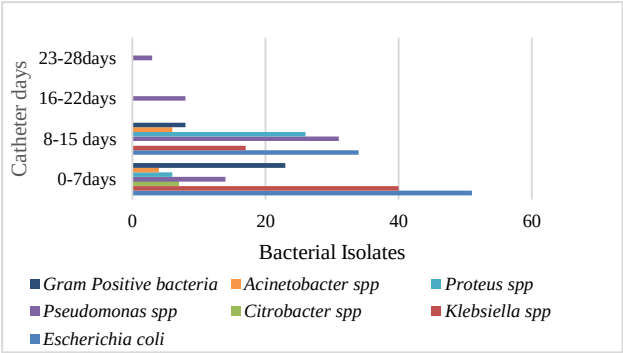

Figure 2: Bacteriological profile of Uropathogens with duration of catheterization.

DISCUSSION

In present study 278/339 (82.00%) significant bacteriuria was observed. Higher prevalence of significant bacteriuria was observed in present study as compared to Bakke et al, Teshager L et al and Mohamed E et al who observed 50.6%, 43.3% and 53.33% respectively.[4-6] Once uropathogen gains access, adhesion to catheter material and uroepithelium is imperative for the initial establishment in CAUTI. Bacterial attachment to catheter surfaces depends on is hydrophobicity of the organisms and biocompatible surface of catheter. When urine flows through catheter lumen, conditioning layer is formed from the deposition of proteins, minerals, polysaccharides, and other host-derived factors in urine. This also occurs extraluminally due to interaction with host urogenital surfaces, thus providing binding sites for uropathogens. Even with appropriate preventive measures in place, catheterized patients, and in particular those with long-term catheterization, will experience bacteriuria due to cross-contamination.[2]

In prospective studies by Garibaldi et al and Warren et al daily risk of bacteriuria with catheterization ranged from 3% to 10% and approached 100% after 28 days, which is considered to be the delineation between short- and long-term catheterization.[7,8]

In most cases, it was just catheter-associated asymptomatic bacteriuria (ASB), which is different from CAUTI. Relationship between catheter-associated ASB and CAUTI is unclear, but the presence of catheter-associated ASB is necessary for development of CAUTI. Development of urinary symptoms must require some facilitating events, with prolonged catheterization possibility of these events occurring is increased also. This suggested, over time urinary catheters become colonized with microorganisms living in sessile colonies within biofilm, rendering them resistant to antimicrobial and host defenses. Thus, virtually impossible to eradicate without removing catheter.[9]

Demographic characteristics of the study subjects showed that among 339 catheterized patients, majority were males 239 (70.50%) and 100 (29.49%) were females. These results were in concordance with Munir T et al where majority of catheterized patients were males (68.3%) and (31.7%) were females.[10] However, this is contradictory to Getenet B et al who observed significant proportion of study subjects were females (64.90%) than males (35.1%), as men are usually less prone to UTI as compared to females, owing to the longer course of the urethra and bacteriostatic properties of prostrate.[11] But, in our study there was no predilection of infection to any particular gender, patients of both genders were affected, males being marginally more 201/239 (84.10%) than females 77/100 (77.00%) (Table 2).

Urinary catheter connects heavily colonized perineum with sterile bladder, providing route for bacterial entry along both its external and internal surfaces.9 Urine often pools in the bladder or in the catheter itself, and urinary stasis encourages bacterial multiplication. Obstruction of the catheter can lead to over distension and ischemic damage of the bladder mucosa, thus increasing its susceptibility to bacterial invasion.[12] King C et al observed the highest Population attributable risk (PAR%) was associated with urinary catheterization, with the calculation that 79.3% of UTI would be prevented if catheterization was not performed.[13]

In present study, 77/100 (77.00%) female patients had significant bacteriuria, more than half of them were asymptomatic 50/77 (70.12%) while 27/77 (35.06%) were symptomatic and majority of asymptomatic were elderly (>60 years) 30/77 (38.96%) (Figure 1). Thus, in contrast to UTI, ASB was more common among older adults than in younger. Changes in immune function, exposure to nosocomial pathogens and increased number of comorbidities make elderly more prone for developing infection. In younger women, estimated prevalence of ASB is 1–5%, increasing to 6-16% in women over the age of 65 years. In women > 80 years, incidence reported to be almost 20% whereas in long-term care facilities, prevalence is even higher with estimates in women ranging from 25 to 50%. Risk in catheterized older adults further increases from 3 to 10% per day of catheterization, eventually reaching 100% in adults with chronic indwelling catheters. Several factors associated with UTI in post-menopausal women have been identified. Most consistent and strongest predictor across all age groups is having a history of UTI. Relationship between sexual activity and UTI is well established in younger women, though association in postmenopausal women is not as clear. During intercourse, vaginal bacteria gain access into urinary tract by colonizing periurethral mucosa and ascending to the bladder through the urethra.[14]

Distribution of culture results were studied with respect to age, maximum number of significant bacteriuria was observed among age group >60 years 95/104 (91.34%) (Table 4). Further, it was analyzed that among elderly females (93.33%) were more prone to CAUTI then males (90.54%). Almost similar findings were observed by Niveditha S, et al and Sayal et al where 36.00% and 46.25% of study population respectively were elderly.[15,16] Genitourinary infections has been reported as second most common form of the infections, accounting nearly 25% among elderly.[17]

Urinary retention and high post void residual (PVR) urine has been postulated as risk factor for UTI in older adults. In men, prostatic hypertrophy causing obstruction to the normal urine flow leads to high PVR. High PVR and urinary stasis as a result of chronic obstruction are thought to be important factors for developing UTI and ASB among elderly. Further, hospitalized adults have more functional impairments, higher rates of cognitive deficits and greater number of medical comorbidities compared with older adults living in the community. Medical comorbidities, such as stroke and dementia, may predispose them to bowel and bladder incontinence, other predictive factors include disability in activities of daily living and having a history of urinary incontinence. All of these characteristics predispose them to higher rates of ASB and UTI.[14]

Gram negative bacteria (GNB) were predominant isolates 215/278 (77.33%), *Escherichia coli* was most common 85/278 (30.57%) among GNB. Other isolates were *Klebsiella spp* 57/278 (20.50%), *Pseudomonas spp* 45/278(16.18%), *Proteus spp* 32/278(11.51%) and gram positive bacteria (GPB) 31/278(8.86%). Present study is in concordance with other authors who observed *E.coli* as most common uropathogen as shown in Table 5.[15,16,18]

Table 5: Observation by various authors.

Author	% *E.coli* isolated
Mohamed E et al[18]	43.8%
Sayal P et al[16]	29.74%
Niveditha S et al[15]	70.00%
Present study	30.57%

With prolonged catheterization patients tended to have *P.aeruginosa*, *P. mirabilis* and other less common GNB as *Acinetobacter spp*. *Pascual* and *Sheretz* documented, in short term catheterization, catheters are colonized by skin flora or fecal contaminants (70-90%), followed by bacteria from the hub/lumen (10-50%), the blood stream (3-10%) and infusate (3%).[19,20] In the case of long term catheters, most frequent source of colonization is the hub followed by the skin. Bacterial subversion of innate responses involves invasion into bladder superficial cell and bacteria matured into biofilms, creating pod-like bulges on the bladder surface. Pods contained bacteria encased in a polysaccharide-rich matrix surrounded by a protective shell of uroplakin.[21] Therefore, catheter-associated bacteriuria results from ascending bacterial colonization inside and/or outside surfaces of the catheter and drainage systems. For either short or long term catheters, the infection rate was about 5% per day.[22]

CONCLUSION

Thus, we observed significant bacteriuria is common among catheterized patients but predisposition to UTI results from several factors. Though in this study no predilection of infection was observed to any particular gender but prevalence varies widely with age and more among elderly. Other factors include history of UTIs, inherited predispositions, urodynamic factors, incontinence, residual urine volume, and presence of a cystocele.

Therefore, the greatest impact of an intervention may be to reduce the frequent occurrence of colonization and reduction of inappropriate urinary catheter durations is important for that. The development of affordable catheters constructed with anti-infective surfaces may be key to the success in preventing infection. Building better catheters should certainly be possible, as there is plenty of scope for improving their design and it is disappointing that little has changed in the meantime.

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REFERENCES

1. Morris NS, Stickler DJ, Leran RJ. The development of bacterial biofilm on indwelling catheters. World J Urol. 1999;17:343-50.
2. Jacobsen SM, Stickler DJ, Mobley HLT, Shirtiliff ME. Complicated Catheter associated urinary tract infection due to Escherichia coli and Proteus mirabilis. Clin Microbio Rev. 2008;21(1):26-59.
3. Collee JG, Duguid JP, Fraser AG, Marmion BP, Simmons A. Laboratory strategy in the diagnosis of infective syndrome. In Collee JG, Fraser AG, Marmion BP, Simmons A, editors. Mackie & McCartney Practical Medical Microbiology. 14th ed. New Delhi: Elsevier, a division of Reed Elsevier India Pvt. Ltd. 2006:53-94.
4. Bakke A, Digranes A. Bacteriuria in patients treated with clean intermittent catheterization. Scand J Infect Dis. 1991;23(5):577-82.
5. Teshager L, Asrat D, Tamiru S. Catheterized and non-catheterized urinary tract infections among patients attended at Jimma University Teaching Hospital, Southwest, Ethiopia. Ethiop Med J. 2008;46(1):55-62.
6. Mohamed E, Shalakany HE. Detection of biofilm formation in uropathogenic bacteria. Egypt J med Microbiol. 2015;24(1):49-57.
7. Garibaldi RA, Mooney BR, Epstein BJ, Britt MR. An evaluation of daily bacteriologic monitoring to identify preventable episodes of catheter-associated urinary tract infection. Infect Control. 1982;3:466-70.
8. Warren JW, Tenney JH, Hoopes JM, Muncie HL, Anthony WC. A prospective microbiologic study of bacteriuria in patients with chronic indwelling urethral catheters. J Infect Dis. 1982;146:719-23.
9. Nickel JC, Costerton JW, McLean RJ, Olson M. Bacterial biofilms: influence on the pathogenesis, diagnosis and treatment of Urinary tract infections. J Antimicrob Chemother. 1994;33(Suppl A):31-41.
10. Munir T, Lodhi M, Hussain RM, Mubeen M. Association between periurethral colonization with uropathogens and subsequent bacteriuria in catheterized patients. J Coll Physicians Surg Pak. 2009;19(3):169-72.
11. Getenet B, Wondewosen T. Bacterial uropathogens in urinary tract infection and antibiotic susceptibility pattern in jimma university specialized hospital, southwest, Ethiopia. Ethiop J Health Sci. 2011;21(2):141-6.
12. Warren JW. Catheter-associated urinary tract infections. Int J Antimicrob Agents. 2001;17:299-303.
13. King C, Garcia AL, Holmes A, Moore L, Galletly T, Aylin P. Risk factors for healthcare-associated urinary tract infection and their applications in surveillance using hospital administrative data: a systematic review. J Hosp Infect. 2012;82(4):219-26.
14. Rowe TA, Mehta MJ. Urinary tract infection in older adults. Aging Health. 2013;9(5):1-15.
15. Niveditha S, Pramodhini S, Umadevi S, Kumar S, Stephen S. The isolation & the biofilm of uropathogens in the patients with CA-UTI. J Clin Diag Res. 2012;6(9):1478-83.
16. Sayal P, Singh KD, Devi P. Detection of bacterial biofilms in patients with indwelling urinary catheters.CIBTech J Microbiol. 2014:3(3):9-16.
17. Mahesh E, Ramesh D, Indumathi V A, Khan W, Kumar P, Punith K. Community acquired urinary tract infection in the elderly. British J Med Pract. 2010;4(1):a406-8.
18. Mohamed E, Shalakany HE. Detection of biofilm formation in uropathogenic bacteria. Egypt J med Microbiol. 2015;24(1):49-57.
19. Pascaul A. Pathogenesis of catheter-related infections: lessons for new designs. Clin Microbiol Infect. 2002;8:256-64.
20. Sheretz RJ. Pathogenesis of vascular catheter-related infections. In: Seifert H, Jansen B, Farr BM, Dekker MM editors. Catheter-related infections. New York. 1997
21. Anderson GG, Palermo JJ, Schilling JD, Roth R, Heuser J, Hultgren SJ. Intracellular bacterial biofilm-like pods in urinary tract infections. Science. 2003;301(5629):105-7.
22. Nicolle LE. The catheter related urinary tract infections. Drugs Aging. 2005;22:627-39.

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