Occurrence of Pathogens in Patients with Indwelling Urinary Catheter at Federal Medical Centre, Abeokuta, South-west Nigeria

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Abstract: The objective of this study was to identify bacteria associated with UTI in patients with indwelling urinary catheter prior to determining their susceptibility patterns to commonly used antibiotics. A total of 114 bacterial isolates were identified with gram negative bacteria (*P. aeruginosa, E. coli, K. pneumoniae* and *P. mirabilis*) representing 97 (85.1%) of the isolates and gram positive bacteria (*S. aureus* and *S. epidermidis*) making up 17 (14.9%). The commonest isolate observed was *Pseudomonas aeruginosa* 40 (35.1%), followed by *Escherichia coli* 35 (30.7%), *Staphylococcus aureus* 16 (14%), *Klebsiella pneumoniae* 14 (12.3%), *Proteus mirabilis* 8 (7%) and *Staphylococcus epidermidis* 1 (0.9%). Polymicrobial growth was observed in 62.6% of both catheter tip and catheter urine samples while 19.4% of both samples showed monomicrobial growth. In vitro antibiotic susceptibility pattern of the gram negative bacteria showed high resistance to commonly used antibiotics such as tetracycline (85.5%), gentamicin (93.8%), ampicillin (99%), cotrimoxazole (81.4%), nitrofurantoin (82.5%), penicillin (96.9%), chloramphenicol (88.7%) and erythromycin (88.7%). Significant resistance was shown by the gram positive bacteria to both gentamicin and penicillin at 88.2% and ampicillin (100%).

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1. Introduction

Urinary tract infections (UTIs) are tied with pneumonia as the second most common type of healthcare-associated infection, second only to SSIs. UTIs account for more than 15% of infections reported by acute care hospitals (Magill *et al*., 2012). Catheter associated urinary tract infections (CAUTIs), the most common type of nosocomial infection, account for over 40% of all nosocomial infections in hospitals and nursing homes (Stamm, 1991; Stamm and Hooton, 1993; Warren, 1997) and constitute 80% of all nosocomial UTIs (Hartstein *et al*., 1981). Although an essential component of modern medical care, indwelling urinary catheter, are also the leading cause of nosocomial infections in both acute and chronic care facilities. Catheters provide microorganisms with direct access to the normally sterile urinary tract, thereby predisposing to both bacteriuria and funguria (Robert, 2008). Urinary Tract Infection (UTI) develops in 10% to 25% of patients with short-term catheter use and in essentially all chronically catheterized patients. In the acute care setting, although catheter associated UTI (CAUTI) rarely causes urinary symptoms or fever, it is associated with a 1 - 3% incidence of bacteriuria and with prolonged hospital stays and increase cost (Saint and Chenoweth, 2003).

In most Nigerian communities, use of catheter in urological cases is common. In the hospital for this research, catheterization is a frequent procedure performed for patients with urinary tract obstructive lesions such as benign prostatic hyperplasia who are awaiting surgery, caesarean surgery and also as a routine in the management of unconscious patients to monitor their urine output, urine retention, prostate cancer and urethra stricture.

Bacteria that have been found responsible for causing urinary tract infection in catheterization of indwelling catheter include *Escherichia coli*, *Pseudomonas aeruginosa*, *Morganella morganii*, *Klebsiella, citrobacter*, *Proteus mirabilis*, *Entroccocus feacalis*, coagulase negative *Staphylococcus* and *Candida spp*. (Saint, 2000). Many of these microorganisms are part of the patients' endogenous bowel flora but they can also be acquired by cross-contamination from other patients or hospital personnel or by exposure to contaminated solutions or non-sterile equipment (Selden *et al*., 1971). They may also originate from the skin of patients or health care workers, tap water to which entry ports are exposed, or other sources in the environment (Foxman, 2002).

Although hospital acquired UTI has been investigated in some groups of patients in Nigeria (Akinkugbe *et al*., 1973; Ekweozor and Onyemenem, 1996; Odutola *et al*., 1998; Taiwo and Aderounmu, 2006), not many studies have investigated and documented the etiological agents of catheter-associated UTI or their susceptibility pattern to antimicrobial agents.

The purpose of the present study was to determine the bacterial etiological agents of CAUTI in patients at Federal Medical Center, Abeokuta and their susceptibility to commonly administered antibiotics.

2. Materials and Methods

A cross sectional study was conducted involving 139 patients admitted into different wards of Federal Medical Centre, Abeokuta. Bio-data such as age, sex, date of admission diagnosis, underlying medical problems, concomitant medications, date and indication for indwelling catheterization were recorded. All patients had indwelling urinary catheters inserted for various indications and those catheterized for more than 24 hours at the obstetrics, gynecology, surgical and intensive care wards of the hospital were recruited for this study. Patients with confirmed UTI before catheterization were excluded.

Prior to catheter change or removal from each patient, 10 ml of urine was obtained from the distal edge of the catheter tube using a sterile needle and syringe into sterile universal container (Kunin *et al*., 1987; Kunin, 1979) and immediately placed in a refrigerator. The tip of the catheter removed from each patient was cut with a sterile surgical blade and also refrigerated for later use.

Urine culture was prepared by using a sterile calibrated wire loop to place 0.01ml of urine onto Blood and MacConkey agar plates. Incubation was done aerobically at 37^{o}C for 24 - 48 hours. Using sterile forceps, catheter tip was rubbed on the surface of each of the two different types of agar plates and incubated as above. Significant bacteriuria was considered when a patient had a colony count > 10^3 cfu/ml in any one sample of urine while counts < 10^3 were accepted in catheter specimens if the organisms were isolated from successive specimens.

Pure colonies of bacterial isolates were confirmed through microscopic, morphological and biochemical tests and antimicrobial susceptibility testing of all isolates was carried out on Mueller Hinton agar using disc diffusion method (Bauer *et al*., 1966), according to the Clinical and Laboratory Standards Institute (CLSI) guidelines. Antibiotics tested were tetracycline, gentamic, ampicillin, cotrimoxazole, nitrofurantoin, ciprofloxacin, penicillin, chloramphenicol and erythromycin. Antimicrobial activity was evaluated by measuring the zones of inhibition against the tested bacteria and comparing with the NCCLS table (NCCLS, 2011). Control strains of organisms used were *Escherichia coli* NCTC 10418, *Staphylococcus aureus* NCTC 6571 and *Pseudomonas aeruginosa* NCTC 10662.

3. Result Analysis

The age and gender distribution of patients studied reveals that 97(69.8%) of the catheterized patients were males and 42(30.2%) females. The overall age range was 14 - 96 years and age range 61 - 80 years made up the largest group with 31.7% whiles the age range <20 and >80 accounted for the least with 7.2% (Table 1).

Table 1: Age and sex distribution of patients with indwelling urethral catheter

Age range	**No (%) of patients**		
Years	**Male**	**Female**	**Total catheter duration (days)**
<20	7(5)	3(2.2)	2-7
21-40	28(20.1)	13(9.4)	8-14
41-60	19(13.6)	15(10.8)	15-21
61-80	39(28.1)	5(3.6)	22-28
>80	4(2.9)	6(4.3)	>28
Total	**97(69.8)**	**42(30.2)**	

Table 2 shows the number and percentage occurrence of bacterial isolates from catheter urine and catheter tip samples. Out of a total of 114 bacterial isolates recovered from both samples showing significant bacteriuria, 39 (34.2%) pathogens were isolated from catheter urine; *P. aeruginosa* 12 (10.5%), *E. coli* 9 (7.9%), *K. pneumoniae* 8 (7%), *P. mirabilis* and *S. aureus* each with 5 (4.4%). From catheter tip, 75 (65.8%) of pathogens were obtained with *P. aeruginosa* representing 28 (24.6%), *E. coli* 26 (22.8%), *S. aureus* 11 (9.6%), *K. pneumoniae* 6 (5.3%), *Proteus mirabilis* 3 (2.6%) and *S. epidermidis* 1 (0.9%). Overall, the most common pathogen isolated was *Pseudomonas aeruginosa* with 40 (35.1%). *Escherichia coli* was next with 35 (30.7%), followed by *Staphylococcus aureus* 16 (14%), *Klebsiella pneumoniae* 14 (12.3%), *Proteus mirabilis* 8 (7%) and *Staphylococcus epidermidis* 1 (0.9%).

Table 2: Number and percentage occurrence of bacterial isolates from urine and catheter samples

	Catheter urine	**Catheter tip**	
Isolates	**Number (%)**	**Number (%)**	**Total**
E. coli	9 (7.9)	26 (22.8)	35 (30.7)
K. pneumonia	8 (7)	6 (5.3)	14 (12.3)
P. mirabilis	5 (4.4)	3 (2.6)	8 (7)
P. aeruginosa	12 (10.5)	28 (24.6)	40 (35.1)
S. aureus	5 (4.4)	11 (9.6)	16 (14)
S. epidermidis	0 (0)	1 (0.9)	1 (0.9)
Total	**39 (34.2)**	**75 (65.8)**	**114 (100)**

Table 3 represents the frequency of isolation of bacteria from catheter urine and catheter tip samples. Thirty four (59.6%) out of 57 urine samples collected showed polymicrobial growth, 11 (19.2%) showed monomicrobial growth and 12 (21.1%) showed no growth. Fifty three (64.6%) out of 82 samples of the catheter tip showed polymicrobial growth, 16 (19.5%) showed monomicrobial growth and 13 (15.8%) showed no growth. Overall, polymicrobial growth was observed in 62.6% of the samples, 19.4% showed monomicrobial growth and 18% showed no growth.

Table 3: Frequency of isolation of bacteria from urine and catheter samples

Sample type	**No. of samples (%)**	**Polymicrobial (%)**	**Monomicrobial (%)**	**No growth (%)**	**No. of isolates**
Catheter urine	57(41)	34(59.6)	11(19.2)	12(21.1)	39(34.2)
Catheter tip	82 (59)	53(64.6)	16(19.5)	13 (15.8)	75(65.8)
Total	**139(100)**	**87(62.6)**	**27(19.4)**	**25(18)**	**114**

In vitro antimicrobial susceptibility patterns of gram negative bacteria isolates are shown in Table 4. High resistance was observed to commonly used antibiotics such as tetracycline (85.5%), gentamicin (93.8%), ampicillin (99%), cotrimoxazole (81.4%), nitrofurantoin (82.5%), penicillin (96.9%), chloramphenicol (88.7%) and erythromycin (88.7%). Resistance to ciprofloxacin was observed at 48.5%.

Significant resistance was shown by the gram positive bacteria to gentamicin and penicillin at 88.2%. Resistance was also observed to tetracycline (52.9%), cotrimoxazole (64.7%), nitrofurantoin (47.1%), ciprofloxacin (23.5%), chloramphenicol (58.8%) and erythromycin (76.5%). Susceptibility of gram positive bacteria to ampicillin was 100% as shown in Table 5.

Table 4: In vitro susceptibility patterns of gram negative bacterial isolates to commonly used antibiotics

Antibiotic(%)		**Tet.**	**Gent.**	**Amp.**	**Cot.**	**Nitro.**	**Cipro.**	**Pcn.**	**Chlo.**	**Ery.**
E. coli (35)	S	3(8.6)	0(0)	1(2.9)	5(14.3)	7(20)	10(28.6)	3(8.6)	4(11.4)	2(5.7)
	R	32(91.4)	35(100)	34(97.1)	30(85.7)	28(80)	25(71.4)	32(91.4)	31(88.6)	33(94.3)
K.pneumoniae (14)	S	1(7.1)	1(7.1)	0(0)	0(0)	3(21.4)	2(14.3)	0(0)	3(21.4)	4(28.5)
	R	13(92.9)	13(92.9)	14(100)	14(100)	11(78.6)	12(85.7)	14(100)	11(78.6)	10(71.4)
P.mirabilis (8)	S	1(12.5)	3(37.5)	0(0)	2(25)	1(12.5)	7(87.5)	0(0)	2(25)	0(0)
	R	7(87.5)	5(62.5)	8(100)	6(75)	7(87.5)	1(12.5)	8(100)	6(75)	8(100)
P. aeruginosa (40)	S	9(22.5)	2(5)	0(0)	11(27.5)	6(15)	31(77.5)	0(0)	2(5)	5(12.5)
	R	31(77.5)	38(95)	40(100)	29(72.5)	34(85)	9(22.5)	40(100)	38(95)	35(87.5)
Total (97)	**S**	**14(14.4)**	**6(6.2)**	**1(1)**	**18(18.6)**	**17(17.5)**	**50(51.5)**	**3(3.1)**	**11(11.3)**	**11(11.3)**
	R	**83(85.5)**	**91(93.8)**	**96(99)**	**79(81.4)**	**80(82.5)**	**47(48.5)**	**94(96.9)**	**86(88.7)**	**86(88.7)**

Tet = Tetracycline, Gent = Gentamicin, Amp = Ampicillin, Cot = Cotrimoxazole, Nit = Nitrofurantoin, Cipro = Ciprofloxacin, Pcn = Penicillin, Cam = Chloramphenicol, Ery = Erythromycin
S = Sensitive, R = Resistant

Table 5: In vitro susceptibility patterns of gram positiive bacterial isolates to commonly used antibiotics

Antibiotic(%)		Tet.	Gent.	Amp.	Cot.	Nitro.	Cipro.	Pcn.	Chlo.	Ery.
S. aureus (16)	S	8(50)	2(12.5)	16(100)	5(31.3)	8(50)	13(81.3)	1(6.3)	6(37.5)	3(18.8)
	R	8(50)	14(87.5)	0(0)	11(68.8)	8(50)	3(18.8)	15(93.8)	10(62.5)	13(81.3)
S. epidermidis (1)	S	0(0)	0(0)	1(100)	1(100)	1(100)	0(0)	1(100)	1(100)	1(100)
	R	1(100)	1(100)	0(0)	0(0)	0(0)	1(100)	0(0)	0(0)	0(0)
Total (17)	**S**	**8(47.1)**	**2(11.8)**	**17(100)**	**6(35.3)**	**9(52.9)**	**13(76.5)**	**2(11.8)**	**7(41.2)**	**4(23.5)**
	R	**9(52.9)**	**15(88.2)**	**0(0)**	**11(64.7)**	**8(47.1)**	**4(23.5)**	**15(88.2)**	**10(58.8)**	**13(76.5)**

Tet = Tetracycline, Gent = Gentamicin, Amp = Ampicillin, Cot = Cotrimoxazole, Nit = Nitrofurantoin, Cipro = Ciprofloxacin, Pcn = Penicillin, Cam = Chloramphenicol, Ery = Erythromycin
S = Sensitive, R = Resistant

3. Discussion

As reported by Brumfitt *et al*., (1961) an important host factor that predisposes to catheter associated UTI is advanced age. In this work, patients of the age range 61-80 accounted for the largest group (31.7%). This is also in ageement with what was reported by Porush and Faubert (1997), that the prevalence of urinary tract infection (UTI) increases with age. Males were also predominantly affected in this study which is similar to results obtained in previous works done within the country from different states (Nwankwo *et al*., 2014; Taiwo and Aderoumu, 2006).

From the results of this study, *P. aeruginosa* was the predominant aetiological agent (35.1%) as the causative agents of UTI. This finding is similar to what was reported in previous studies (Nwankwo *et al*., 2014; Selden, 2004; Oni *et al*., 2003). According to Koshariya *et al*., (2015), in a study done on children in Delhi, India, nosocomial UTI was found to be more due to organisms like *pseudomonas* and gram positive cocci while *E. coli* infection showed a decrease in incidence. This was not entirely the case in this study as only 15% incidence was observed in *S. aureus* and *S. epidermidis*, as against 30.7% for *E. coli* which was the second most predominant organism. Many of these pathogens are commensal organisms of the bowel but may have also been acquired by cross-contamination from other patients or hospital personnel or through exposure to contaminated solutions or equipment. A study by Taiwo and Aderoumu (2006) in another institution within the same country, reported the presence of similar organisms in the hospital environment.

Catheter associated UTI is reported in most previous studies to be polymicrobial (Koshariya *et al*., 2015; Nwankwo *et al*., 2014; Oni *et al*, 2003). This study showed similar results as 62.6% of samples obtained were polymicrobial and 19.4% monomicrobial.

Most of the gram negative isolates exhibited high resistance to tetracycline, gentamicin, ampicillin, cotrimoxazole, nitrofurantoin, penicillin, chloramphenicol and erythromycin. A similar pattern has been reported in several previous studies both within the country and internationally (Nerurkar *et al*., 2012; Smith and Almond, 2007; Taiwo and Aderoumu, 2006; Oni *et al*., 2001). Gram positive cocci were also resistant to these conventional antibiotics with the exception of ampicillin. However, Koshariya *et al*. (2015) reported 50%, 75% and 66.6% sensitivity of *E. coli, Proteus* and *Klebsiella* respectively to nitrofurantoin while, Magalit *et al.,* (2004) have reported the susceptibility of *E. coli* to Ciprofloxacin 55% in CAUTI. Hauser (2013) also reported ampicillin to have strong activity against *S. aureus* and *S. pneumoniae*. Various changes have been observed in the susceptibility pattern of uropathogens in recent studies.It is important to note that these variations in antimicrobial susceptibility in different settings may depend upon the easy availability of antimicrobial drugs over the counter resulting in frequent misuse. The increased resistance of uropathogens to conventional antibiotics can however largely be attributed plasmid mediated by lactamase producing bacteria (Patel *et al*., 2009; Ullah *et al*., 2009; Acharya, 1992).

4. Conclusion

This study was able to identify the bacterial profile of patients with indwelling urinary catheter. *P. aeruginosa*, *E. coli*, *K. pneumoniae* and *P. mirabilis* and *S. aureus* remain some of the commonest pathogens associated in patients having CAUTI. As drug resistance among these bacterial pathogens continues on the increase, treatment of catheterassociated UTI in this instiution should be guided by the results of susceptibility test of isolated organisms. Moreover, limiting chronic indwelling catheter use, proper catheter management and reinforcing infection control programs are vital in minimizing infections associated with in-dwelling urinary catheters. Urinary catheter should be inserted only when necessary and removed immediately when necessary.

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References

1. Acharya VN. Urinary tract infection: A dangerous and unrecognized forerunner of systemic sepsis. *Journal Postgraduate Medicine* 1992;38(2):52-4.
2. Akinkugbe FM, Familusi FB, Akinkugbe OO. Urinary tract infection in infancy and early childhood. *East African Medical Journal* 1973;50(9):514-520.
3. Bauer AW, Kirby WMM, Sherris JC, Turck M. Antibiotic susceptibility testing by a standardized single disk method. *American Journal of Clinical Pathology* 1966;45:493-496.
4. Brumfitt W, Davies BL, Rosser E. The urethral catheter as a cause of urinary tract infection in pregnancy and peuperium. *Lancet* 1961;2: 1059-1061.
5. Ekweozor CC, Onyemenem TN. Urinary tract infections in Ibadan; causative organism and antimicrobial sensitivity patterns. *African Journal Medicine and medical Sciences* 1996;25:125-169.
6. Foxman B. Epidemiology of urinary tract infection: Incidence, Morbidity and economic costs. *American Journal of Medicine* 2002;113: 5-13.
7. Hartstein AI, Garber SB, Ward TT, Jones SR, Morthland VH. Nosocomial urinary tract infection: A prospective evaluation of 108 catheterized patients. *American Journal of Infection and Control* 1981;2(5):380-386.
8. Hauser AR. Antibiotic Basics for Clinicians, 2nd ed. Lippincott Williams and Wikins, Philadelphia, 2013;pp25-28.
9. Koshariya M, Songra MC, Namdeo R, Chaudhary A, Agarwal S, Rai A. Prevalence of pathogens and their antimicrobial susceptibility in catheter associated urinary tract infection. *Integrated Archives of Integrated Medicine* 2015 ;(4): 96-113.
10. Kunin CM, Chin QF, Chambers S. Morbidity and mortality associated with indwelling urinary catheters in elderly patients in a nursing home –confounding due to the presence of associated diseases. *Journal of American Geriatrics Society* 1987;35:1001–100.
11. Kunin CM. Detection, prevention and management of urinary tract infections, 3rd ed. Lea and Febiger, Philadelphia, 1979.
12. Magalit SL, Gler MTS, Tupasi TE. Increasing antimicrobial resistance patterns of community and nosocomial uropathogens in Makati Medical Center. *Philippine Journal of Microbiology Infectious Diseases* 2004;33(4): 143-148.
13. Magill SS, Hellinger W, Cohen J, Kay R, Bailey C, Boland B, Carey D, de Guzman J, Dominguez K, Edwards J, Goraczewski L, Horan T, Miller M, Phelps M, Saltford R, Seibert J, Smith B, Starling P, Viergutz B, Walsh K, Rathore M, Guzman N, Fridkin S. Prevalence of healthcare-associated infections in acute care facilities. *Infect Control Hosp Epidemiol* 2012;33(33):283-91.
14. Performance standards for antimicrobial susceptibility testing; M100-S22. Clinical and Laboratory Standards Institute, Wayne, PA. 2011. 22nd informational supplement.
15. Nerurkar A, Solanky P, Naik SS. Bacterial pathogens in urinary tract infection and antibiotic susceptibility pattern. *Journal of Pharmaceutical and Biomedical Sciences* 2012;21 (12).
16. Nwankwo IU, Godwin CT, Nwankwo EO. Bacterial profile in patients with indwelling urinary catheters in Federal Medical Center, Umuahia, Abia State, Nigeria. *Sky Journal of Microbiology Research* 2014;2(5):28 – 31.
17. Odutola TA, Ogunsola FT, Odugbemi T, Mabadeje AFB. A study on prevalence of urinary tract infection in hypertensive patients attending an urban hospital in Lagos, Nigeria. *Nig Qt J Hosp Med*. 1998;8(3): 190-192.
18. Oni AA, Mbah GA, Ogunkunle MO, Shittu OB Bakare RA. Nosocomial infection: Urinary tract infection in patients with indwelling urinary catheter. *Afr J Clin Exper Microbiol*. 2003;4: 63-71.
19. Oni AA, Bakare RA, Arowojolu OA, Kehinde OA, Toki RA, Fashina NA. Comparative activities of commercially available quinolones and other antibiotics on bacterial isolates in Ibadan, Nigeria. *Afr J Med Sci* 2001;30: 35-37.
20. Patel J, Bhatt J, Javiya V, Patel K. Anti-microbial susceptibility patterns of

Enterobacteriaceae isolated from a tertiary care unit in Gujarat. *The Internet J Microbiol* 2009;6(1):1-27.
21. Porush JG, Faubert PF. Renal disease in elderly patients. *Rev Clin Gerontol* 1997;7:299-307.
22. Robert AW. Strategies to prevent catheter-Associated urinary tract infection in acute care hospitals. *Inf Con and hosp epidemol* 2008;29:51-550.
23. Saint S, Chenoweth CE. Biofilms and catheter-associated urinary tract infections. *Infect Dis Clin North Amer* 2003;17:411-432.
24. Saint S. Clinical and economic consequences of nosocomial catheter related bacteriuria. *Am J Infect Control* 2000;28(1):68-75.
25. Selden EI. Timing of post-operative voiding trial after anti-incontinence procedure. *J of Pel Med and Surg* 2004;10(1)37-38.
26. Selden R, Lee S, Wang WLL, Benet JV, Eikhoff TC. Nosocomial Klebsiella infection; intestinal colonization as a reservoir. *Ann Intern Med* 1971;74;657-664.
27. Smith, AC, Almond M. Management of urinary tract infections in the elderly. *Trends Urology, Gynecol Sexual Health* 2007;12:31-34.
28. Stamm WE, Hooton TM. Management of urinary tract infections in adults. *N Engl J Med* 1993;329:1328–34..
29. Stamm WE. Catheter associated Urinary tract infection: epidemiology, pathogenesis and prevention. *Am J Med* 1991;91(3):65-71.
30. Taiwo SS, Aderounmu AOA. Catheter Associated Urinary Tract Infection: Aetiologic Agents and Antimicrobial Susceptibility Pattern in Ladoke Akintola University Teaching Hospital, Osogbo. *Nigeria African Journal of Biomedical Research* 2006;9:141-148.
31. Ullah F, Malik SA, Ahmed J. Antibiotic susceptibility pattern and ESBL prevalence in nosocomial Escherichia coli from urinary tract infections in Pakistan. *African J Biotech* 2009; 8(16):3921-3926.
32. Warren JW. Catheter-associated urinary tract infection. *Infect. Dis Clin North Am* 1997;11:609-622.

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