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Full Length Research Paper

Urinary tract infections at a Nigerian university hospital: Causes, patterns and antimicrobial susceptibility profile

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Treatment of urinary tract infections (UTIs) is becoming difficult due to the increasing trend of antibiotics resistance and this may necessitate an up to date knowledge of resistance pattern. This study was therefore set up to ascertain bacterial resistance patterns from UTIs at a University hospital. The study was retrospective in nature. Data generated from urine cultures of patients at the University of Calabar Teaching hospital for a period of five years (2004 to 2009) were compiled. Relevant information obtained were age and gender of patients, organisms recovered and their antibiotic susceptibility patterns. The incidence of UTI was found to be 7.7% (565/7,348) comprising of 264 (46.7%) males and 53.3% (301) females (P>0.05); 391 (69.2%) were of community acquired (CA) while 174 (30.8%) were nosocomial (NC) in origin. Infections were significantly lower among those aged below 20 years (P<0.05). The commonest bacteria recovered were *Escherichia coli* 18.6% (109), *Klebsiella pneumoniae* 14.8% (87), *Proteus* species 13.1% (77) and *Staphylococcus aureus* 10.7% (63). Penicillin G, ampicillin, tetracycline, cloxacillin were among the most inactive drugs while ofloxacin, clavulanate + amoxycilline, ceftriaxone, colistin and cefuroxime were among the most active with sensitivity of CA isolates generally higher than the NC ones. Rationality should be applied in antibiotics prescription, consumptions and prophylaxis. Hospitals should adopt strict infection control methods; also the use of antibiotics in agricultural, veterinary and pharmaceutical activities should be regulated in order to halt or reverse this growing resistance trend.

Key words: Antibiotics, infections, susceptibility, urinary tract.

INTRODUCTION

Urinary tract infection (UTI) no doubt is a common clinical encounter in established health settings world over. It is generally estimated that the yearly global episodes of UTI could be in the range of 150 million with a large proportion of the infections being inapparent; many also manifest with obvious clinical features while others still show complications in addition (Owa, 2007; Al-Asmary et al., 2004; Padmakumar et al., 2004). Over the years, treatment of UTI has thrown up a lot of challenges due to the increasing level of antimicrobial resistance (Belet et al., 2004; Loivukene et al., 2006; Gur et al., 2008). Findings from Japan (Ishikawa et al., 2004), India (Miskeen and Deodhar, 2002), Poland (Rudy and Nowakowska, 2004) and Serbia (Minovic, 2002) showed varying and high levels of multiple resistance of uropathogenic *Enterococcus* species and other urinary bacterial isolates to quite a large number of antibiotics commonly used in treatment of UTIs, and in Brazil a high rate of vancomycin-resistant uropathogenic bacteria were encountered (Reis et al., 2001).

In most parts of sub-Saharan Africa as well as other developing parts of the world, UTIs are among the most common findings in everyday clinical practice (Jombo et al., 2005, 2006a, b). Effective management of these infections is often hampered by the lack of adequate

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facilities for proper microbial isolation as well as for their antimicrobial susceptibility testing (Ikeh, 2003; Iregbu et al., 2002). This often gives rise to urologic or otherwise complications arising from untreated, undetected as well as improperly treated UTIs (Brown et al., 2003; Olowu and Oyetunji, 2003). A continuous review of the pattern of microbial isolates causing UTIs and their antimicrobial susceptibility patterns in clinical practice is essential (Abe-Aibinu et al., 2000). This would provide useful and up-to-date information about this common clinical disease, especially as concerns its correct and timely antimicrobial treatment; in order to forestall the irreversible damages that may follow thereafter (Ibadin, 2002; Rehmani, 2004; Podmakumar et al., 2004). It is in this light that antimicrobial susceptibility patterns of uropathogenic bacteria at a Nigerian University hospital was carried out.

MATERIALS AND METHODS

Setting

The study was carried out at the University of Calabar Teaching Hospital (UCTH), which is situated in Calabar city, the capital of Cross Rivers state, south Nigeria.

Procedure

The study was retrospective in nature; data generated from cultured urine specimens and the antibiotic susceptibility pattern of bacteria recovered from such cultures by the Microbiology laboratory of UCTH were compiled for a period of five years (1st February, 2004 to 31st January, 2009). The urine specimens were collected, transported, stored and processed using standard laboratory procedures while modified Kirby-Bauer's diffusion method was used to carry out susceptibility testing (Scott, 1989; Baron et al., 1994). Microorganisms recovered were grouped into nosocomial or community acquired, based on the epidemiological circumstance of the urine specimens.

Nosocomial infection

Micro-organisms recovered from urine specimens of patients who have been on admission for more than 24 h for which features of bacterial colonization were not present at the time of initial presentation to the hospital.

Community acquired infection

Microorganisms recovered from the urine of patients who were not on admission in the hospital, and from patients within 24 h of admission or patients originally admitted for probable blood related infections. Other relevant information such as: age, sex were obtained from patients records.

Analysis of results

The results were analyzed using Epi Info-6, statistical software, values ≤ 0.05 were considered significant.

RESULTS

A total of 7,348 urine specimens were processed by the Microbiology laboratory during the study period with 565 (7.7%) infections. Infections of Community Acquired (CA) origin were 391 (69.2%) while 174 (30.8%) were Nosocomial (NC) in nature. The age range of those infected was 1to 83 years, mean age was 41 years, median age range of 40 to 49 years, and a bimodal age of 36 and 43 years; 264 (46.7%) of the cases of UTI were males while 301 (53.3%) were females. There was no significant gender difference in the rate of UTIs among the subjects (P>0.05), however rate of UTIs among those aged less than 20 years was significantly lower than those aged 20 years and above (P<0.05) (Table 1).

An analysis of the microbial isolates from the urine samples of the respondents showed that two microbial isolates each were recovered from 22 urine samples. The most common microbial isolates recovered from the urine samples were *Escherichia coli* 18.6% (109), *Klebsiella pneumoniae* 14.8% (87), *Proteus* species 13.1% (77) and *Staphylococcus aureus* 10.7% (63). The least encountered microbial isolate however was *Candida albicans* 2.2% (13) (Table 2). A review of the antimicrobial susceptibility profile of the bacterial isolates from urine samples showed that the susceptibility of almost all the bacterial isolates to penicillin G, ampicillin, cloxacillin, amoxicillin, tetracycline, co-trimoxazole, chloramphenicol and erythromycin was less than 50% (Range, 0 to 46.6%) except susceptibility of CA isolates of Citrobacter which was more than 50% to most of the listed antibiotics and *Escherichia coli* against chloramphenicol (60%).

The most active drugs against majority of the bacterial isolates were colistin, streptomycin, Ofloxacin, ciprofloxacin, ceftazidime, cefuroxime, clavullanate + amoxycilline, ceftriaxone, rifampicin, nalidixic acid and nitrofurantoin (65 to 100%), none was however active against all the bacterial isolates tested. The susceptibility of the NC bacterial isolates to chloramphenicol, erythromycin, penicillin G, ampicillin, tetracycline and co-trimoxazole was significantly lower than the CA isolates (P<0.05) (Table 3). Bacteria that recorded the highest rate of resistance were *Enterococcus faecalis*, *Proteus* species, *Pseudomonas aeruginosa* and *Staphylococcal* species (100 to 0%) while *Enterobacter* and *Citrobacter* species were the most susceptible to majority of the antibiotics (4.5 to 100%) (Table 3).

DISCUSSION

The incidence of UTI in Calabar among the samples processed was found to be 7.7% and there was no significant gender difference in the rates of infection (P>0.05). The commonest bacteria recovered were *E. coli* 18.6%, *K. pneumoniae* 14.8%, and *Proteus* species 13.1%. Antibiotics that recorded the highest resistance were penicillin G, cloxacillin, ampicillin, tetracycline,

Table 1. *Age and **gender distribution of cases of UTI at a university hospital in Nigeria.

Age (Years)	Male		Female		Total (%)
	CA (%)	NC (%)	CA (%)	NC (%)	
0-9	11 (57.9)	3 (15.8)	0	5 (26.3)	19
10-19	6 (22.2)	9 (33.3)	9 (33.3)	3 (11.1)	27
20-29	19 (28.8)	14 (21.2)	15 (22.7)	18 (27.3)	66
30-39	37 (33.3)	10 (9.0)	42 (37.8)	22 (19.8)	111
40-49	38 (40.9)	5 (5.4)	29 (31.2)	21 (22.6)	93
50-59	18 (22.2)	7 (8.6)	39 (48.2)	17 (21.0)	81
60-69	41 (47.7)	3 (3.5)	32 (37.2)	10 (11.6)	86
70-79	21 (38.9)	8 (14.8)	16 (29.6)	9 (16.7)	54
≥80	10 (47.6)	0 (0.0)	5 (23.8)	6 (28.6)	21
Unclassified	3 (42.9)	1 (14.2)	0 (0.0)	3 (42.9)	7
Total	204	60	187	114	565

*X^2 (Yates corrected) = 57.29, OR=0.10-0.29, RR= 0.12-0.32, 95% CI P= 0.000. **X^2 (Yates corrected) = 1.49, OR=0.71-1.08, RR= 0.80-1.05, 95% CI P= 0.22.

Table 2. Microorganisms recovered from clinical urine specimens at a University hospital in Nigeria.

Micro-organisms	Frequency (%)
Escherichia coli	109(18.6)
Klebsiella pneumoniae	87 (14.8)
Proteus mirabilis, vulgaris, retgerri	77 (13.1)
Enterococcus faecalis	73 (12.4)
Staphylococcus aureus	63 (10.7)
Pseudomonas aeruginosa	50 (8.5)
Coagulase Negative Staphylococci (CONS)	47 (8.0)
Enterobacter species	33 (5.6)
Citrobacter species	25 (4.3)
Candida albicans	13 (2.2)
Unclassified	10(1.7)
Total	587 (100)

Multiple infections (two microbial isolates) encountered in 22 cases.

co-trimoxazole, erythromycin and chloramphenicol. On the other hand, those with the highest activity were ofloxacin, colistin, ciprofloxacin, clavulanate + amoxicillin, ceftazidime, cefuroxime, ceftriaxone, rifampicin and nalidixic acid. The findings from the present study are similar to findings from similar studies in Greece (Giamarellou, 2010), Tunisia (Khalifa and Khedher, 2010) and Poland (Justynska et al., 2010) where sensitivity of Enterobacteriaceae and *P. aeruginosa* showed high rates of multiple resistance (for the aforementioned four drugs) among the commonly available antibiotics. Also, Mendoza-Voldes in Mexico (Mendoza-Voldes et al., 2010) reported a high activity of nitrofurantoin on urinary bacterial isolates, and also Chavez-Valdecia in Spain who reported *E. coli, K. pneumoniae* and *Staphylococcus* species as the commonest bacterial isolates from urine of patients with activities of aminoglycosides above 70% (Chavez-Valencia et al., 2010). These findings point to the fact that the era of empirical treatment for bacterial infections in clinical settings may be gradually easing out.

Physicians should therefore strive at always making reference to sensitivity reports before commencement of antimicrobial chemotherapy of infections including UTIs. Where it is impracticable to obtain such reports, local antimicrobial susceptibility profile of bacteria should be consulted in order to narrow the margin of therapeutic failures occasioned by high rates of multiple resistant bacteria (Chavez-Valencia et al., 2010; Vieja and Asensio, 2010). The high rates of multiple resistances (resistance up to 8 antibiotics) among NC bacteria in the present study were significantly higher than the CA bacterial isolates, even though multiple resistance

Table 3. Antimicrobial susceptibility profiles of community acquired (CA) and nosocomial (NC) bacterial isolates from clinical urine specimens at a university hospital (microorganisms + percentage susceptible).

Antibiotics	*E. coli* (n=109)	Klebsiella (n=87)	Proteus (n=77)	*E. faecal* (n=73)	*S. aureus* (n-63)	*P. aerugin* (n=50)	CONS (n=47)	Enterobac (n=33)	Citrobac (n=25)
Penicillin G	NA	NA	NA	6.8* 0.0	5.4* 0.0	NA	10.7* 0.0	NA	NA
Ampicillin	15.1* 8.3	36.2* 17.2	12.9* 2.2	15.9* 0.0	12.5* 0.0	10.3* 0.0	17.9* 0.0	25.0* 9.5	56.3* 22.2
Cloxacillin	23.3* 11.1	39.7* 17.2	12.9* 2.2	15.9* 6.9	23.2* 14.2	10.3* 0.0	14.2* 0.0	41.6* 9.5	56.3* 11.1
Amoxicillin	23.3 19.4	46.6* 17.2	9.7* 0.0	38.6 20.6	51.7* 0.0	17.2* 0.0	39.3* 15.7	41.6* 9.5	56.3* 11.1
Tetracycline	31.5 30.6	39.7* 24.1	29.0* 4.3	13.6* 0.0	5.4* 0.0	6.9* 0.0	14.2* 0.0	25.0* 4.8	43.8* 11.1
Co-trimoxazole	31.5* 19.4	46.6* 24.1	12.9* 0.0	15.6* 0.0	12.5* 0.0	17.2* 4.8	14.2* 5.3	25.0* 9.5	56.3* 22.2
Clavullanate+Amoxycilline	93.2 75.0	96.6 89.7	80.6 71.7	81.8 65.5	78.6* 57.1	72.4 71.4	60.7 89.2	100 90.5	100 88.9
Colistin	100 100	100 100	96.8 95.7	NA	NA	100 90.4	NA	100 100	100 100
Streptomycin	93.1 93.1	96.6 96.6	86.6 86.6	88.6 81.8	78.6* 57.1	79.3 71.4	89.2* 39.3	90.5 95.2	100 88.9
Gentamicin	93.1 91.7	100 96.6	80.6 71.7	81.8 65.5	78.6* 57.1	72.4* 52.4	60.7* 39.3	90.5 95.2	100 88.9
Amikacin	100 100	100 100	80.6* 29.0	88.6* 38.6	78.6 85.7	90.4 90.4	89.2 89.2	100 95.2	100 88.9
Ofloxacin	100 93.1	96.6 96.6	96.8* 71.7	65.5 65.5	78.6* 57.1	79.3* 52.4	60.7 52.6	100 100	100 100

Table 3. Contd.

Ciprofloxacin	100 100	100 100	80.6 71.7	61.3 58.6	48.2 57.1	79.3 72.4	46.4 52.6	100 95.2	95.2 88.9
Ceftazidime	93.1 91.7	100 96.6	80.6 71.7	65.5 58.6	48.2 57.1	90.4 80.9	60.7 52.6	100 100	95.2 88.9
Cefuroxime	93.1 91.7	96.6 100	96.8 82.6	65.5 58.6	48.2 42.8	79.3 71.4	60.7* 39.3	90.5 95.2	95.2 100
Ceftriaxone	100 91.7	100 100	80.6 71.7	61.3 58.6	48.2 57.1	90.4 80.9	46.4 39.3	100 100	100 100
Chloramphenicol	60.2* 31.5	39.7* 17.2	12.9* 2.2	15.9* 6.9	23.2* 14.2	10.3* 0.0	14.2* 0.0	41.6* 9.5	56.3* 11.1
Erythromycin	31.5 30.6	39.7 24.1	29.0* 4.3	13.6* 0.0	5.4* 0.0	6.9* 0.0	14.2* 0.0	25.0* 4.8	43.8* 11.1
Rifampicin	93.1 91.7	96.6 100	96.8 82.6	65.5 58.6	48.2 42.8	79.3 71.4	60.7* 39.3	90.5 95.2	95.2 100
Nalidixic acid	100 91.7	100 100	80.6 71.7	NA	NA	79.3 71.4	NA	100 100	100 100
Nitrofurantoin	100 91.7	100 100	80.6 71.7	NA	NA	90.4 80.9	NA	90.5 95.2	95.2 100

Each bacterial isolate was resistant to an average of 4 antibiotics (Range 2 to 8), NA = Not applicable, n = number of microbial isolates, Upper numbers = Percentage susceptibility of CA isolates, Lower numbers = Percentage susceptibility of NC isolates, * = P< 0.0.

was a common finding among the later group as well. Apart from the established incessant exposure of bacteria to drugs in hospital settings, community sources of exposure such as supplementation of animal feeds with antibiotics, animal husbandry, veterinary and agricultural activities are other important sources of exposure of bacteria to antibiotics with the attendant resistance (Alhamba et al., 2004; Tamayo et al., 2007). Rationality in the use of antibiotics in both the clinical, veterinary and agricultural settings, need to be emphasised here as a way of slowing down the present rate of multiple antibiotics resistance within and outside hospital settings (Dalgic et al., 2011).

The findings from the present study are however different from a similar study in: Italy (Savini et al., 2010) where a bacterium *Stenotrophomonas maltophilia* was recovered from a patient with bladder device; Spain (Canton et al., 2002), where *Enterococcus aerogenes* and *Enterococcus cloacae* were recovered from specimens. It shows the geographic microbial diversity of uropathogens and the influence of premorbid conditions

on it (Hsueh et al., 2010; Akram et al., 2007). Also, the high rate of resistance (100%) of ESBL producing strains of *E. coli* against cephalosporins in Turkey (Akyar, 2008); the high rate of resistance of Enterobacteriaceae against quinolones in Sweden (Ostholm-Balkhed et al., 2010); and the high resistance of Enterobacter against ceftazidime in Brazil (Sader et al., 2011) clearly shows the global variations in antimicrobial susceptibility patterns. Laboratory physicians and scientists should always develop local antimicrobial susceptibility profiles (antibiograms) of local bacterial isolates, and the patterns regularly updated for ready consultations (Morosini et al., 2006; Bouchillon et al., 2005).

Even though the rate of UTIs among females in the present study was not significantly higher than that among males contrary to established facts, this may be a reflection of the pattern of patient presentation at the hospital for medical attention, and partly a reflection of the disease pattern among the study population (Bratu et al., 2005; Hernandez et al., 2005; Dielubanza and Schaeffer, 2011). The rate of infection among those aged 20 years and below was significantly lower than that among those aged more than 20 years ($P<0.05$). This may rightly be attributed to differentials in rates of exposure to predisposing factors such as instrumentations, social factors, aging, and diseases which are generally lower in the youger age groups (Gernohorska and Slavikova, 2010; Anonymous, 2010). In view of the high antimicrobial resistance recorded in the present study, choices of drugs for prophylaxis of UTIs should be carefully selected and the most appropriate drugs chosen. Cephalosporins should therefore not be used for prophylaxis of UTIs in children due to the propensity of bacteria to produce beta-lactamases and neutralize the drugs. Rather quinolones are strongly recommended.

The strict application of infection control measures remains the cornerstone for nosocomial infection prevention and control of resistance, surveillance and appropriate duration of antibiotic therapy and adjustment of dosages. These practices should be emphasised in hospital settings (Cheng et al., 2009; Chakupurakal et al., 2010). Since the widespread use of antibiotics in animal husbandry and agricultural activities is propelled by economic motives, a coordinated approach from many parties concerned will be necessary, not just from the medical sector but also from the veterinary and agricultural world, and from food producers and pharmaceutical companies, to combat the spread of multiresistant bacteria effectively (Kuijper and Van Dissel, 2010; Lutter et al., 2005).

In conclusion, the present study has shown that majority of CA and NC bacteria recovered from cases of UTIs in Calabar were multiply resistant, while the resistance of NC bacteria was significantly higher than the CA counterpart against many antibiotics. Rationality therefore, it should be exercised in empirical treatment of UTIs and sensitivity reports consulted where practicable. Furthermore, caution and restraint should be exercised in the the use of antibiotics in veterinary, agricultural and pharmaceutical settings. Finally, ofloxacin, cefuroxime, gentamicin, nitrofurantoin, nalidixic acid, ceftriaxone, augmentin and ceftazidime could be considered for treatment of UTIs in the absence of a comprehensive sensitivity report.

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