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Full Length Research Paper

Antimicrobial susceptibility pattern of pathogenic bacteria causing urinary tract infections at the Specialist Hospital, Yola, Adamawa state, Nigeria

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The prevalence of bacteria causing UTIs as well as their susceptibility to commonly used antibiotics have been investigated from January, 2007 - June, 2009 at the Specialist Hospital, Yola. The prevalence of UTIs in the referral hospital was 67.2%. The incidence was higher in females with a prevalence rate of 54.3%, while in males the recorded value was 45.7%. Gram-negative isolates had a prevalence of 74.7%, while gram-positive isolates had 25.30%. The bacteria isolated in order of ranking were *E. coli* (24.5%), *K. pneumoniae* (17.3%), *P. mirabilis* (14.6%), *S. faecalis* (13.4%), *S. aureus* (5.3 %), *P. vulgaris* (4.7%), *P. stuartii* (4.1%), *S. epidermidis* (3.8%), *A. faecalis* (3.4%), *S. saprophyticus* (2.8%), *P. aeruginosa* (2.5%), *S. marsescens* (2.0%) and *C. fruendii* (1.7%). The highest proportion of isolates were *E. coli* (24.5%), *K. pneumoniae* (17.3%), *P. mirabilis* (14.6%), *S. faecalis* (13.4%), *S. aureus* (5.3%), *P. vulgaris* (4.7%), and *P. stuartii* (4.1%) accounting for 83.9% of the total number of isolates recovered from the urine samples. Other less-frequent isolates in aggregate caused 16.1% of infections. Antibiotic sensitivity and resistance analysis were performed by the disc diffusion method employing commercial antibiotics discs. Susceptibility of the clinical isolates to antibiotics commonly used in the 750 bed referral hospital was variable, depending on species and drug in question. The mean susceptibility of the isolates re-corded were *E. coli* (36.3%), *K. pneumoniae* (44.1%), *P. mirabilis* (47.8%), *S. faecalis* (51.3%), *S. aureus* (43.1 %), *P. vulgaris* (48.1%), *P. stuartii* (45.0%), *S. epidermidis* (49.7%), *Al. faecalis* (54.5%), *S. saprophyticus* (54.2%), *P. aeruginosa* (38.6%), *S. marcescens* (44.2%) and *C. fruendii* (40.4%). The mean sensitivity of the antibiotics were ofloxacin (63.8%), gentamycin (13.26%), streptomycin (37.0%), colistin (49.2%), ampicillin (25.4%), nalidixic acid (45.5%), nitrofurantoin (55.4%), augmentin (64.9%), tetracycline (27.0%), cotrimoxazole (41.8%), pefloxacin (34.9%), chloramphenicol (50.9%), and erythromycin (51.6%). The data obtained in this study highlight the problems of bacterial prevalence and resistance among uropathogenic bacteria in Yola, Nigeria.

Key words: Prevalence, susceptibility, UTIs, disc diffusion, uropathogenic, sensitivity.

INTRODUCTION

Urinary tract infections are one of the most common types of bacterial infections in humans occurring both in the community and the health care settings and ranks high amongst the most common reasons that compel an individual to seek medical attention (Susman, 1998; Tice, 1999; Al-Sweih et al., 2008; Kolawale et al., 2009). UTIs encompass a spectrum of clinical entities ranging in severity from asymptomatic infection to acute cystitis, prostatitis, pyelonephritis and urithritis (Fowler, 1986; Gluisier, 1981). It represents one of the most common diseases encountered in medical practice today, affecting people of all ages, from the neonate to the geriatric age group (Kunin, 1994). Worldwide, about 150 million people are diagnosed each year with UTIs, costing in excess of 6 billion dollars (Gupta, 2001). Most infections are caused by retrograde ascent of bacteria from the faecal flora via the urethra to the bladder and kidney especially in the females who have a shorter and wider urethra and is more readily transversed by microorganisms (Inabo and Obanibi, 2006).The structure of the females urethra and vagina makes it susceptible to trauma during sexual intercourse as well as bacteria been massaged up the urethra and into the bladder during pregnancy and or child birth (Al-Sweih et al., 2008; Kolawale et al., 2009).

There are urinary pathogen virulence factors that promote adherence to mucosal surfaces and subsequent infections (Ofek and Beachey, 1980). Host factors such as the epithelial cell receptivity are also important in the infection process. Although fungi and viruses are occasional etiological agents, UTIs are predominantly caused by bacteria. The most common bacteria implicated as causative agents of UTI generally originate in the intestine and include but not limited to *E. coli*, Pseudomonas spp, Streptococcus spp, Proteus spp., Klebsiella spp., Staphylococcus spp, Neisseria gonorrhoea, Chlamydia trachomatis, Candida spp, Mycoplasma. Extremes of age, female gender, pregnancy, instrumentation, urinary tract infection, neurologic dysfunction, renal disease, and expression of A, B and H blood group oligosaccharides on the surface of epithelial cells are predisposing factors for the development of UTIs (Al-Sweih et al., 2008). UTIs are usually treated with antibiotics and microbiological testing may not always be necessary, because in most cases, urine culture and susceptibility testing cost more than the antibiotic treat-ment itself. Studies aimed at gaining knowledge about the type of pathogens responsible for UTIs and their susceptibility patterns may help the clinicians to choose the right empirical treatment. In the last three decades, there have been a lot of reports in the scientific literature on the inappropriate use of antimicrobial agents and the spread of bacterial resistance among microorganisms causing urinary tract infections (Tenover and McGowan, 1996; Hryniewicz et al., 2001; Kurutepe et al., 2005). The changing patterns in the etiological agents of urinary tract pathogens and their sensitivities to commonly prescribed antibiotics are reported (Jacoby and Archer, 1991; Hryniewicz et al., 2001; Kurutepe et al., 2005; Mordi and Erah, 2006). The emergence of antibiotic resistance in the management of UTIs is a serious public health issue, particularly in the developing world where apart from high level of poverty, ignorance and poor hygienic practices, there is also high prevalence of fake and spurious drugs of questionable quality in circulation. Knowledge of etiological agents of UTIs and their sensitivities to avai-lable drugs is of immense value to the rational selection and use of antimicrobial agents and to the development of appropriate prescribing policies (El-Astal, 2005). This study was conducted to determine the etiological agents of UTIs in the tertiary health care facility (the 750 bed Specialist Hospital, Yola, Nigeria) and their antimicrobial susceptibility pattern. It is hoped that the results will provide useful information which would be used in the formulation of policies for the rational and effective use of antimicrobial agents.

MATERIALS AND METHODS

Specimen collection

Freshly voided midstream urine specimens were collected aseptically from 2500 (1250 males and 1250 females) patients who attended the 750 bed, Specialist Hospital, Yola, Nigeria, either as inpatient or out patient with symptoms suggestive of UTIs (Cheesborough, 2006; Savas et al., 2006; Santo et al., 2007). All patients had clinical evidence of urinary tract infections, as determined by the treating physician. Only a single positive culture per patient was included in the analysis. These patients did not include those who were on antibiotics a week before the samples were collected. The urine samples were collected into labelled 20 ml calibrated sterile bottles distributed to the patients by the attending physicians suspected to have UTIs. In each container, boric acid (0.2 mg) was added to prevent the growth of bacteria in the urine. All patients were instructed on how to collect the urine samples aseptically and taken to the laboratory immediately for culture. The study was carried out between January, 2008 - June, 2009.

Total aerobic plate count

The bacterial load of the urine samples was determined using the surface plating method (Santo et al., 2007). Serial dilutions of the urine samples were carried out by pipetting 1 ml of the urine into 9 ml of peptone water in a sterile test tube. Then 1 ml of this dilution was pipetted into another test tube till a 7^{th} test tube was reached in order to obtain countable colonies. One millilitre of the final dilution was spread on sterile 90 mm Petri plates and these were then incubated at 35 - 37°C for 24 h, after which the count was obtained using a Quebec Darkfield colony counter (Leica Inc. Bufallo, New York). Only urine samples that yielded 10^5 CFU/ML was considered for further analysis. The mean of triplicate results were taken (El-Astal, 2005).

Bacteriology

In the hospital laboratory, each well mixed urine sample (5 µl) was inoculated on McConkey agar (Oxoid), Blood agar (Oxoid), and cysteine lactose electrolyte deficient agar (CLED, International Diagnostic Group). The inoculum on the plate was streaked out for discrete colonies with a wire loop following standard procedures (Cheesborough, 2006, Mordi and Erah, 2006). The culture plates were incubated at 35 - 37°C for 24 h and observed for growth through formation of colonies. All the bacteria were isolated and identified using morphological, microscopy and biochemical tests following standard procedures described by Cowan and Steel (1974) and Cheesborough (2006).

Antibiotic susceptibility testing

The antibacterial susceptibility testing of the isolates was done using the Kirby-Bauer disk diffusion method (Bauer et al., 1966) following the definition of the Clinical and Laboratory Standards Institute (CLSI, 2006) using antibiotics containing discs from Oxoid. Briefly, 20 ml of Mueller- Hinton agar (Difco Laboratories GmbH, Augsburg, Germany) was prepared and poured into sterile plates. The agar medium was allowed to solidify at room temperature on a flat bench. Then some few colonies of an 18 h culture of the isolates were streaked on the surfaces of the well-dried agar plates. Then some antibiotic discs were gently and firmly placed on the agar plates, which were then left at room temperature for 1 h to allow diffusion of the antibiotics into the agar medium. The plates were then incubated at 35 - 37°C for 24 h. Zones of growth inhibition were then measured to the nearest millimetre and recorded. The mean of triplicate results was taken as the zone diameter. The antibiotics discs and the concentration used were ampicillin 25 µg, Avicef 30 µg, Cotrimoxazole 25 µg, collistin sulphate 25 µg, Chloramphenicol 30 µg, Oflaxacin 5 µg,

Erythromycin 5 µg, Gentamycin 25 µg, Naladixic acid 30 µg, Nitofurantoin 200 µg, Penicillin 10 µg, Streptomycin 25 µg, Tetracycline 25 µg. Isolates were classified as either resistant or intermediate sensitive or sensitive based on the definition of the Clinical and Laboratory Standard Institute (CLSI, 2006) and accordance with WHO requirements (Onanuga et al., 2005). Some laboratory strains of known sensitivity of *S. aureus, E. faecalis, E. coli* and *P. aeruginosa* were used as quality control strains for the antimicrobial discs. Resistant and intermediate isolates were grouped together for analysis in this study (Onanuga et al., 2005). An isolate was considered multi-drug resistant if it was resistant to at least three of the antibiotics tested (Santo et al., 2007). Quality control on the susceptibility discs were performed using laboratory strains of *E. coli, P. aeruginosa, S. aureus and S. faecalis* of known sensitivity.

Statistical analysis

All data were analysed with SPSS for Windows, version 16.0 (SPSS Inc. Chicago, III, USA).The trend x^2 test used for statistical comparisons between the groups and a $P < 0.05$ was considered as statistically significant.

RESULTS

A total of 2500 urine specimens were collected from patients suspected of having UTI, out of which a total number of 1680 showed significant bacterial growth and were included in the study. Of the samples analysed, 2320 strains of various bacteria were isolated, consisting of 1061 (45.7%) from males and 1259 (54.3%) from females as detailed in Table 1. The gram-negative bacteria constituted the largest group with a prevalence of 1733 (74.70%) while gram-positive bacteria constituted only some 587 (25.30%) of the total isolates. The bacteria isolated were *E. coli* (24.5%), *K. pneumoniae* (17.3%), *P. mirabilis* (14.6%), *S. faecalis* (13.4%), *S. aureus* (5.3 %), *P. vulgaris* (4.7%), *P. stuartii* (4.1%), *S. epidermidis* (3.8%), *A. faecalis* (3.4%), *S. saprophyticus* (2.8%), *P. aeruginosa* (2.5%), *S. marsescens* (2.0%) and *C. fruendii* (1.7%). The highest proportion of isolates were *E. coli* (24.5%), *K. pneumoniae* (17.3%), *P. mirabilis* (14.6%), *S. faecalis* (13.4%), *S. aureus* (5.3%), *P. vulgaris* (4.7%), and *P. stuartii* (4.1%) accounting for 83.9% of the total number of isolates recovered from the urine samples. Other less-frequent isolates in aggregate caused 16.1% of infections.

The susceptibility of the clinical isolates to routinely prescribed antibiotics in the tertiary hospital is depicted in Table 2. *E. coli* was the most prevalent bacteria with a susceptibility of 50.9% (Augmentin), 64.6% (Ofloxacin), 41.0% (Nalidixic acid), 43.8% (Nirorurantoin), 35.7% (colistin), 48.1% (chloramphenicol), 43.7% (erythromycin), 20.0% (Gentamycin), 34% (cotrimoxazole), 27% (streptomycin), 32.9% (pefloxacin) and 15.7% (ampicillin) and 13.7% (tetracycline). The susceptibility of the other isolates followed similar patterns.

The mean susceptibility of the isolates as shown in Table 2 recorded *E. coli* (36.3%), *K. pneumoniae* (44.1%), *P. mirabilis* (47.8%), *S. faecalis* (51.3%), *S. aureus* (43.1%), *P. vulgaris* (48.1%), *P. stuartii* (45.0%), *S. epidermidis* (49.7%), *A. faecalis* (54.5%), *S. saprophyticus* (54.2%), *P. aeruginosa* (38.6%), *S. marcescens* (44.2%) and *C. fruendii* (40.4%). The susceptibility pattern of the isolates against the antibiotics are ofloxacin (63.8%), gentamycin (132.6%), streptomycin (37.0%), colistin (49.2%), ampicillin (25.4%), nalidixic acid (45.5%), nitrofurantoin (55.4%), augmentin (64.9%), tetracycline (27.0%), co-trimoxazole (41.8%), pefloxacin (34.9), chloramphenicol (50.9%), and erythromycin (51.6%).

The proportions of the isolates showing multidrug-resistance are given in Table 3. None of the isolates was sensitive to all the antibiotics tested and none, except *P. aeruginosa* was resistant to more than 10 different drugs. Some 37.4 % of *E. coli* isolates were sensitive to 1 - 3 different antibiotics, 28.0% resistant to 5 antibiotics, 25.0% to 7 antibiotics, while only 9.6% were resistant to 9 different antibiotics. A similar trend was observed for *K. pneumoniae, P. mirabilis* and *S. faecalis.* Some 46.7% of *S. aureus* were resistant to only 3 drugs, 40.2% resistant to 5 different drugs while 1.3 % were resistant to 7 different antibiotics. A similar trend was observed for all the other bacteria, except *S. marcescens* and *C. fruendii* which did not show any resistance to more than 6 different antibiotics tested.

DISCUSSION

This paper describes a study undertaken to evaluate the prevalence and susceptibility patterns of bacterial strains isolated from patients diagnosed with UTIs in a large referral hospital in Yola, Nigeria. It provides valuable laboratory data concerning urinary tract pathogens and enables the situation in Yola to be compared with other parts of Nigeria and with that of other countries. Comparison among different studies concerning resistance of uropathogens to different antimicrobial agents should take into account the different periods in which such studies were carried out as well as socio-economical, socio-epidemiological, and clinical parameters of the target population (El-Astal, 2005). Microorganisms and their resistance patterns vary from hospital to hospital and even from clinic to clinic in the same hospital (Snydman, 1991; Savas et al., 2006)).

The prevalence of UTI amongst the patients attending the referral hospital was 67.2%). The gram-negative bacteria constituted the largest group with a prevalence of 1733 (74.70%) while gram-positive bacteria constituted only some 587 (25.30%) of the total isolates. This value was much higher than the 60% reported for Lafia (Kolawale et al., 2009), 22% for Ibadan (Okesola and Oni (2009), 38.6% for Lagos (Akinyemi et al., 1997), 35.5% for Jos (Ebie et al., 2001), but lower than 77.9% for Enugu (Mbata, 2007) all in Nigeria. Coincidentally, these are all large cities, being State capitals with high population densities. The high prevalence may be due to such

Table 1. Prevalence of the isolates according to gender.

Bacteria	Total number isolated		Proportion			
			Male		Female	
	N	%	N	%	N	%
E. coli	568	24.5	256	24.3	312	24.8
K. pneumoniae	402	17.3	194	18.3	208	16.5
P. mirabilis	338	14.6	152	14.3	186	14.8
S. faecalis	311	13.4	148	14.0	166	13.2
S. aureus	122	5.3	52	4.9	67	5.3
P. vulgaris	108	4.7	44	4.2	64	5.1
P. stuartii	96	4.1	41	3.9	55	4.4
S. epidermidis	89	3.8	39	3.7	50	4.0
A. faecalis	78	3.4	34	3.2	44	3.5
S. saprophyticus	65	2.8	32	3.0	33	2.6
P.aeruginosa	57	2.5	27	2.5	30	2.4
S. marcescens	47	2.0	23	2.2	24	1.9
C. freundii	39	1.7	13	1.2	26	2.1
Total	2320	100	1061	45.7	1259	54.3

Key: n = number; % = percentage.

factors like promiscuity, peer group influence, pregnancy, low socio-economic status which are common among Nigerian young men and women living in urban centres (Kolawale et al., 2009). Samples obtained from female subjects (54.3%) yielded more bacteria than those obtained from males (45.7). The sex distribution of patients in the present study was consistent with that of other studies (Snydman, 1991, Savas et al., 2006). Several reports have indicated that females are more prone to having UTIs than males (Kolawale et al., 2009), because the urethra is shorter in females than males and is easily more readily transversed by microorganisms (Inabo and Obanibi, 2006). Womens propensity to develop UTIs has also been explained on the basis of certain behavorial factors, including delays in micturation, sexual activity, the use of diaphragms and spermicides (both of which promote colonization of the periurethral area with bacteria). Also, the length of the urethea (urethra), the dried environment surrounding the meatus, and the antibacterial properties of prostatic fluid contribute to a lower rate of infection in males. Urine culture is the gold standard for assessing infection, but in a majority of cases, therapy is initiated prior to having culture results. This can be rationalized in the sense that urine culture and susceptibility testing are costlier that than the costs of antibiotics in most countries. The various bacteria isolated from the urine samples were *E. coli* (24.5%), *K. pneumoniae* (17.3%), *P. mirabilis* (14.6%), *S. faecalis* (13.4%), *S. aureus* (5.3%), *P. vulgaris* (4.7%), *P. stuartii* (4.1%), *S. epidermidis* (3.8%), *A. faecalis* (3.4%), *S. saprophyticus* (2.8%), *P. aeruginosa* (2.5%), *S. marsescens* (2.0%) and *C. fruendii* (1.7%) in the order of ranking. These isolates clearly represented clinically significant pathogens, and are similar to the data obtained by El-Astal (2005) in Palestine, Al-Sweih et al. (2008) in two large teaching hospitals in Kuwait and Mordi and Erah (2006) in the University of Benin Teaching Hospital, Benin, Nigeria as well as Rai et al. (2008) in Nepal. The isolation frequency of the bacterial species reported in this study, falls within the range of frequencies reported in other countries such as Egypt (El-Kholy et al., 2003), China (Wang et al., 2001), Israel (Turner and Dagan, 2001), Belgium (Goosens, 2000), Palestine (El-Astal, 2005), Poland (Hryniewicz et al., 2001), India (Navaneeth et al., 2002), Italy (Bonadio et al., 2001), Norway (Grude et al., 2001) and the United Kingdom (Hosein et al., 2002; Farrell et al., 2003).

E. coli had the highest prevalence (24.5%), closely followed by *K. pneumoniae* (18.4%) and this is similar to the reports of Mordi and Erah (2006), but differs with that of Okesola and Oni (2009) and Akerele et al. (2000). Fluit et al. (2000) reported the prevalence of E*. coli* (52.3%), Enterococcus sp. (12.5%), Klebsiella sp. (7%), Proteus sp. (6.8%), *P. aeruginosa* (6.3%), *S. aureus* (2.4%), Citrobacter sp. (1.6%), Acinobacter sp. (1.3%), Serratia sp. (1.1%) and *M. morganii* (1.0%). Although *E. coli* was the most common uropathogen in this study, there is a difference in its prevalence rates when compared with other reports, which gave a higher prevalence rate of 60 - 90% of *E.* coli, than other isolates (Fluit et al., 2000; El-Astal, 2005; Shaikh et al., 2005). Results from several studies have shown that the proportion of *E. coli* as a principal causative agent of UTIs is slowly declining, being replaced by other members of the Enterobacteriaceae and enterococci (Gruneberg, 1994, Randrianirina et al., 2006). Winstanley et al. (1997) reported a higher incidence of Proteus sp., Klebsiella sp., Enterobacter sp.,

Table 2. Proportion of the isolates susceptible to routinely prescribed antibiotics.

ANT	Susceptibility of the isolates to antibiotics												
	EC 568	KP 4O2	PM 338	SF 311	SA 122	PV 108	PS 96	SE 89	AF 78	SS 65	PA 57	SM 47	CF 39
OF	367	235	221	220	79	80	67	59	56	48	18	29	22
	64.6%	58.5%	65.4%	70.7%	64.5%	74.1%	69.8%	66.3%	71.8%	73.9%	31.6%	61.7%	56.4%
GE	102	156	164	133	39	46	32	35	40	36	-	22	6
	20.0%	38.8%	48.5%	42.8%	32.0%	42.6%	33.3%	39.3%	51.3%	55.4%	-	46.8%	15.4%
ST	158	197	181	171	33	39	28	42	37	28	-	14	14
	27.8%	49.0%	53.5%	55.0%	27.1%	36.1%	29.2%	47.2%	47.4%	43.1%	-	29.8%	35.9%
CO	203	201	194	163	61	34	33	48	32	35	5	23	10
	35.7%	50.0%	58.0%	52.4%	50.0%	31.5%	34.4%	53.9%	41.0%	53.9%	8.8%	48.9%	25.6%
AM	89	170	159	94	26	37	27	25	34	24	-	7	6
	15.7%	42.3%	47.0%	30.2%	21.3%	34.3%	28.1%	28.1%	43.6%	36.9%	-	14.9%	15.4%
NA	233	221	172	126	34	61	39	52	44	39	6	19	21
	41.0%	55.0%	50.9%	40.5%	27.9%	56.5%	40.6%	58.4%	56.4%	60.0%	10.5%	40.4%	53.9%
NI	249	208	188	157	68	54	54	54	52	49	21	32	19
	43.8%	51.7%	55.6%	50.5%	55.7%	50.0%	56.3%	60.7%	66.7%	75.4%	36.8%	68.1%	48.7%
AU	289	263	226	219	82	84	60	59	61	50	19	31	24
	50.9%	65.4%	66.9%	70.4%	67.2%	77.8%	62.5%	66.3%	78.2%	76.9%	33.3%	66.0%	61.2%
TE	78	105	108	125	36	29	32	31	29	18	-	8	13
	13.7%	26.1%	32.0%	40.2%	29.5%	26.9%	33.3%	34.8%	37.2%	27.7%	-	17.0%	33.3%
CT	193	156	119	128	69	45	38	46	5	35	4	20	22
	34.0%	38.8%	35.2%	41.2%	56.6%	41.7%	39.6%	51.7%	44.9%	53.9%	7.0%	42.6%	56.4%
PE	187	180	105	164	47	42	34	26	37	21	6	15	11
	32.9%	44.8%	31.1%	52.7%	38.5%	38.9%	35.4%	29.2%	47.4%	32.3%	10.5%	31.9%	28.2%
CH	273	203	126	179	62	66	57	45	49	34	19	23	19
	48.1%	50.5%	37.3%	57.7%	50.8%	61.1%	59.4%	50.6%	62.8%	52.3%	33.3%	48.9%	48.7%
ER	248	212	135	196	47	58	60	53	47	41	17	27	18
	43.7%	52.7%	39.9%	63.0%	38.5%	53.7%	62.5%	59.6%	60.3%	63.1%	29.8%	57.5%	46.2%
SM	36.3%	44.1%	47.8%	51.3%	43.1%	48.1%	45.0%	49.7%	54.5%	54.2%	38.6%	44.2%	40.4%

Key: - not susceptible, OFL=Oflaxacin, GEN=Gentamycin, STR= Streptomycin, COL= Colistin, AMP=Ampicilin, NAL=Nalidixic acid, NIT=Nitrofroitoin, AUG= Augmentin, TET=Tetracycline, COT=Cotrimoxazole, PEN = Penicillin, CHL= Chloramphenicaol, ERY= Erythromycin. *E. coli* (EC), *K.pneumoniae* (KP), *P. mirabilis* (PM), *S. faecalis* (SF), *S. aureus* (SA), *P. vulgaris* (PV), *P. stuartii* (PS), *S. epidermidis* (SE), *A. faecalis* (AF), *S. saprophyticus* (SS), *P. aeruginosa* (PA), *S. marsescens* (SM) and *C. fruendii* (CF). SM=Susceptibilty mean.

Citrobacter sp., Acinetobacter sp., Serratia sp. Enterococci and Pseudomonads in the isolates along sides with *E. coli.* This changing spectrum of microorganisms causing UTIs and the emerging resistance to many of the older and cheaper antibacterial agents require continuous monitoring. *E. coli* was observed to be sensitive to almost all the antibiotics tested, though to varying degrees as shown in Table 2. *E. coli* was the most prevalent bacteria with a susceptibility of 50.9% (Augmentin), 64.6% (Ofloxacin), 41.0% (Nalidixic acid), 43.8% (Nirorurantoin), 35.7% (colistin), 48.1% (chloramphenicol), 43.7% (erythromycin), 20.0% (Gentamycin), 34.0% (co-trimoxazole), 27.0% (streptomycin), 32.9% (pefloxacin) and 15.7% (ampicillin) and 13.7% (tetracycline). The high rate of resistance to ampicillin, tetracycline, gentamicin, streptomycin and co-trimoxazole observed in this study may reflect the fact that these are the most commonly prescribed antibiotics in the hospital and also the most easily available in the community without prescription. The data presented in this investigation are similar to those obtained in other Nigerian cities of Jos, Lafia, Abuja, Enugu, Port-Harcourt, Lagos and Ibadan and have shown the changing pattern in the types of organisms causing UTIs and their resistance to many of the commonly available antibiotics, thus leading to the use of newer and more costly agents (Ako-Nai et al., 2005; Nwanze et al., 2007; Kolawale et al., 2009; Okesola and Oni, 2009). The resistance rates were much higher than reports from other countries including Italy [36%, Bonadio et al., 2001], United Kingdom [44 - 50%, Farrell et al.,

Table 3. Proportion of the isolates susceptible to a number of antibiotics.

Bacteria	Number	Proportion of bacteria susceptible to a number of antibiotics						
		0	1 - 3	4 - 5	6 - 7	8 - 9	10 - 11	12 - 13
E. coli	568	-	253	172	101	42	-	-
			44.5	30.3	17.8	7.4	-	-
K. pneumoniae	402	-	122	116	88	66	-	-
			30.4	28.9	21.9	16.4	-	-
P. mirabilis	338	-	158	120	55	5	-	-
			46.8	35.5	16.3	1.48	-	-
S. faecalis	311	-	147	101	45	18	-	-
			47.3	32.5	14.5	5.8	-	-
S. aureus	122	-	57	49	16	-	-	-
		-	46.7	40.2	1.3	-	-	-
P. vulgaris	108	-	52	34	22	-	-	-
			48.2	31.5	20.4	-	-	-
P. stuartii	96	-	38	40	18	-	-	-
		-	39.6	41.7	18.8	-	--	-
S. epidermidis	89	-	37	38	10	4	-	-
			41.6	42.7	11.2	4.5	-	-
A. faecalis	78	-	36	24	10	8	-	-
			38.5	30.8	12.8	10.3	-	-
S. saprophyticus	65	-	34	21	10	-	-	-
			52.3	32.3	15.4	-	-	-
P.aeruginosa	57	-	31	24	12	-	-	-
			54.4	42.1	21.1	-	-	-
S. marcescens	47	-	22	17	8	-	-	-
			46.8	36.2	17.0	-	-	-
C. fruendii	39	-	12	15	12	-	-	-
			30.8	38.5	30.8	-	-	-

2003], USA [43%, Mathai et al., 2001], Norway [25%, Grude et al., 2001] and Madagascar [28%, Randrianirina et al., 2006], but lower than in India (Navaneeth et al., 2002; El-Astal, 2005). The worldwide trend of empirically treating UTIs may not work well in Nigeria, because decreased susceptibility rates have been documented for majority of the common pathogens in various parts of the country. Mazzulli et al. (2001) explained the higher resistance rates in tertiary hospitals especially where both inpatients and outpatients are used to collect data, as is the case in this study, to be due to those patients having more complicated UTIs and thus exposed to more resistant flora, or may have failed previous therapy, all of which may account for the increased resistance observed.

The susceptibility profile of *K. pneumoniae* was 65.4% (augmentin), 58.5% (ofloxacin), 55.0% (nalidixic acid), 52.7% (erythromycin) 51.7% (nitrofurantoin), 50.5% (chloramphenicol), 50.0% (colistin), 49.0% (streptomycin), 38.8% (pefloxacin and gentamycin respectively), and 42.3% (ampicillin), similar to the reports of Kumari et al. (2005) and El-Astal, (2005). The results in this study showed that *S. aureus h*ad a susceptibility of 67.2% (augmentin), 64.5% (ofloxacin), 61.0% (colistin), 56.6% (co-trimoxazole) and 50.8% (chloramphenicol), similar to the observation of Nwanze et al., (2007). Ako-Nai et al. (2005) presented a report in which 67.3% of staphylococcal isolates were resistant to cloxacillin, 64.9% resistant to amoxicillin, 51.8% to augmentin, 70.2% to tetracycline, 48.8% to erythromycin, 36.9% to co-trimoxazole, 11.9% to chloramphenicol and 1.8% to gentamycin in a study Ibadan, Nigeria. Similar resistance profiles were presented among *S. epidermidis* in some hospitals in Turkey to be resistant to penicillin, ampicillin and tetracycline (Ang et al., 1985). S*. faecalis* had a profile of 70.7% (ofloxacin), 70.4% (augmentin), 60.3% (erythromycin)and a susceptibility of equal to or higher than 50.0% to chloramphenicol, pefloxacin, nitrofurantoin, colistin and streptomycin, while a susceptibility of less than 50.0 % to gentamycin, nalidixic acid, tetracycline and cotrimoxazole similar to the data presented by Nwanze et al. (2007). *P. aeruginosa* had a susceptibility profile of 36.6% (nitrofurantoin), 33.3% (augmentin and chloramphenicol respectively), 31.6% (ofloxacin), 29.8% (erythromycin), 10.5% (pefloxacin), 8.8% (colistin) and 7.0% (co-trimoxazole), but not susceptible to gentamycin,

streptomycin, ampicillin and tetracycline and was moderately sensitive to ofloxacin. Similar observations have been made in a previous study by other scholars (Ang et al., 1985; Mazzulli et al., 2001; Nwanze et al., 2007). *P. aeruginosa* maintains antibiotic resistance plasmids and are able to transfer these genes by bacterial processes of transduction and conjugation (Nwanze et al., 2007). *Proteus mirabilis* had a suscep-tibility profile of 66.9% (augmentin), 65.4% (ofloxacin), 58.0% (colistin), 55.6% (nitrofurantoin), 53.3% (streptomycin), 50.9% (nalidixic acid), 48.5% (gen-tamycin), 47.0% (ampicillin), 39.9% (erythromycin), 37.3% (chloramphenicol), 35.2% (co-trimoxazole) and 32% (tetracycline) and this is far higher than the data presented by Rai et al. (2008), but agreed with that of Shrestha et al. (2005). Data presented in this study indicate that antibiotics commonly used in UTIs are still effective, but species distribution and their susceptibility to antibiotics are changing.

Table 3 gives the multi-drug resistance profiles of the various isolates to the routinely used antibiotics in the hospital. Some of the drugs were sensitive, but a good number have also lost their usefulness. These findings are similar to the studies in Caucasian women where ampicillin and co-trimoxazole remain the most useful antibiotics todate. Among the 880 UTI isolates tested for susceptibility by Kurutepe et al. (2005) against some eight antibiotics, some 47.7% were sensitive to all the agents tested, and MDR isolates accounted for only 24.5%. Similar reports have been made by other workers in other countries (Hryniezyna et al., 2001; Kurutepe et al., 2005; Rai et al., 2008; Nwanze et al., 2007). The high resistance of the bacteria to ampicillin and other commonly available drugs observed in this study is alarming, because they are higher than the reports from India, Kuwait, Europe and the Americas. This high rate of resistance to ampicillin, tetracycline, gentamicin, streptomycin and co-trimoxazole may reflect the fact that these are the most commonly prescribed antibiotics in the hospital and also the most easily available in the community without prescription and because they are also very cheap in terms of cost, and so subject to abuse and misuse. In UTI, antimicrobial therapy is initiated even before the results of urine culture is available, hence the need for antimicrobial surveillance. Misuse of drugs in a hospital can influence further misuse outside the hospital. All the isolates in this study showed resistance to at least 1 - 3 different antibiotics, indicating the presence of strong selective pressures from the antibiotics in the community. Brown et al. (2003) have reported that horizontal gene transfer is a factor in the occurrence of antibiotic resistance in clinical isolates and suggested that the high prevalence of resistance to a particular antibiotic does not always reflect antibiotic consumption as previously suggested by other scholars (Gaynes and Monnet, 1997; Ako-Nai et al., 2005; Nwanze et al., 2007).

Even though susceptibility pattern shown by this study emphasizes the need for *in-vitro* sensitivity reports before initiation of antibiotic therapy, it must not be forgotten that *in-vitro* antimicrobial sensitivity reports serve only as guide and that conditions *in-vivo* may be quite different (Winstanley et al., 1997).The data presented in this and in previous studies may be of immense value for use to determine trend in antimicrobial sensitivities, to formulate local antibiotic policies to compare local with national and international data and above all, to assist clinicians in the rational choice of antibiotic therapy and to prevent misuse, or over use of antibiotics. The data obtained in this study shows that the bacteria causing UTIs are still susceptible to antimicrobial agents routinely used in the hospital though this is changing.

Although the disc diffusion method was used to assess sensitivity and resistance and can be correlated clinically, further investigations employing the minimum inhibitory concentrations (MIC) method will be needed to obtain more reliable results.

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