

Full Length Research Paper

## Antibiotics susceptibility profiles of bacteria from clinical samples in Calabar, Nigeria

A. O. Nkang<sup>1</sup>, I. O. Okonko<sup>1\*</sup>, A. Fowotade<sup>2</sup>, A. O. Udeze<sup>3</sup>, T. A. Ogunnusi<sup>4</sup>, E. A. Fajobi<sup>5</sup> O. G. Adewale<sup>6</sup> and O. K. Mejeha<sup>7</sup>

<sup>1</sup>Department of Virology, Faculty of Basic Medical Sciences, University of Ibadan. College of Medicine, University College Hospital (UCH), Ibadan, University of Ibadan, Ibadan, Nigeria.

<sup>2</sup>Department of Medical Microbiology and Parasitology, University of Ilorin Teaching Hospital, Ilorin, Kwara State, Nigeria.

<sup>3</sup>Department of Microbiology, Faculty of Sciences, University of Ilorin, Ilorin, Nigeria

<sup>4</sup>Department of Biological Sciences, Ajayi Crowther University, Oyo, Nigeria.

<sup>5</sup>Department of Basic Sciences, Federal College of Wildlife Management, New Bussa, Niger State, Nigeria.

<sup>6</sup>Department of Biochemistry, Olabisi Onabanjo University, Ago-Iwoye, Ogun State, Nigeria.

<sup>7</sup>Department of Microbiology, Federal University of Technology, Owerri, Imo State, Nigeria.

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The current discourse on infectious disease and drug resistance as it affects sub-Saharan Africa is limited to the pressing problems associated with HIV, TB, malaria and other emerging- and re-emerging resistant organisms. Available therapeutic options for antibiotic-resistant organisms are severely limited, as these organisms frequently display a multidrug-resistant (MDR) phenotype. This study reports on the antibiotics susceptibility profiles of bacteria from clinical samples in Calabar, Nigeria. This study was carried out using standard agar diffusion technique (sensitivity testing). Thirteen different antibiotics were tested against *Enterobacter aerogenes*, *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Staphylococcus aureus* and *Streptococcus pyogenes*. In this study, zones of inhibitions (in mm) of the antibiotics on the test microorganisms were determined and interpreted using standard interpretative chart. The antibiogram revealed that all isolates that were susceptible to ampiclox and ciprofolxacin and a good percentage to amoxicillin, however, all gram negative isolates were resistant to vancomycin. *S. aureus*, *S. typhi* and *P. mirabilis* were resistant to penicillin. *S. typhi* resistant to chloramphenicol and other recommended antibiotics. The percentage resistance of *E. aerogenes*, *P. aeruginosa*, *S. typhi*, and *P. mirabilis* was 30.8, 30.8, 69.2 and 76.9% respectively. The high susceptibility to ampiclox, amoxicillin, and ciprofolxacin is a welcome relief, since it is an indication of effectiveness of the antibiotic against the bacteria. However, high rates of drug resistance (3-10 antibiotics) were found in most of the isolates studied and this could be attributed to their prevailing usage and abuse in the area under study. These results suggest that multi-drug resistance among clinical pathogens is common and significant in Nigeria and call for nationwide surveillance programme to monitor microbial trends and antimicrobial resistance patterns in Nigeria.

**Key words:** Antibiotics, multi-drug resistant, susceptibility profile, sensitive.

### INTRODUCTION

Antibiotics are usually of microbial origin but some have

come from higher forms of life and chemotherapeutic agents made synthetically. Their selective toxicity means a low toxicity for host cells and high toxicity for parasites (Melmon and Morcelli, 1989). The sources in which antibiotics can be obtained include; microorganisms, synthesis and semi-synthesis. Thus, antibiotics can be

\*Corresponding author: E-mail: [mac2finney@yahoo.com](mailto:mac2finney@yahoo.com). Tel: +234-080-3538-0891

obtained from the culture extracts and filtrates of fungi (e.g., penicillins and cephalosporins), bacteria-like *Streptomyces spp*, *Bacillus spp*, etc (e.g., rifampicin, aminoglycosides, chloramphenicol, erythromycin, tetracyclines). The semi synthesis of an antibiotic involve the fermentation of part of the molecule using the appropriate micro organism and the product then further modified by a chemical process, example, Penicillin, Bacillus, Micro-monospora, Cephalosporium and Streptomyces species are the five genera that produce almost all the antibiotics sold in Nigeria (Adebayo, 2000).

Much of the current discourse on infectious disease and drug resistance as it affects sub-Saharan Africa is limited to the pressing problems associated with HIV, TB, malaria and other emerging- and re-emerging resistant organisms (Okeke et al., 2007, Okonko et al., 2009a, b). Available therapeutic options for antibiotic-resistant organisms are severely limited, as these organisms frequently display a multidrug-resistant (MDR) phenotype (Moland et al., 2006; Lewis et al., 2007; Chikere et al., 2008). Resistance, however, equally compromises the management of acute respiratory infections, sexually transmitted diseases, and diseases spread by the fecal-oral route, such as typhoid fever, cholera, dysentery, and other diarrheal diseases (Okeke et al., 2007, Okonko et al., 2009a, b). Resistance by microorganisms to antibiotics may be an indication of the presence of resistance factors such as R plasmids, and enzymes such as beta-lactamases, and of recent, extended beta-lactamase (ESBL) (Doughari et al., 2007).

The widespread use of broad-spectrum antibiotics has led to the emergence of nosocomial infections caused by drug resistant microbes (Courvalin and Weber, 2005; Chikere et al., 2008). Multidrug resistance and the presence of several virulence factors in the strains of many pathogens responsible for different diseases pose an increasing threat to the successful management of disease scourge. Also, the rising prevalence of drug resistance such as penicillin-resistant *pneumococci* worldwide mandates selective susceptibility testing and epidemiological investigations during outbreaks (Okonko et al., 2008). However, strategies for addressing antimicrobial drug resistance stress the need for new drugs (WHO, 2001) and yet the rate of drug development is in decline (Powers, 2004; Metlay et al., 2006).

The worldwide escalation in both community- and hospital-acquired antimicrobial-resistant bacteria is threatening the ability to effectively treat patients, emphasizing the need for continued surveillance, more appropriate antimicrobial prescription, prudent infection control, and new treatment alternatives (Mulvey et al., 2004; Rhomberg et al., 2006; Zhanel et al., 2008; Chikere et al., 2008). Adequate documentation of resistant profiles of these organisms is also lacking (Alawode, 2003). This study reports on the antibiotics susceptibility profiles of bacteria from clinical samples in Calabar, Nigeria. The clinical samples were obtained from the Microbiology section by the permission of the management of the

Sufat Medical Laboratories, Ishie, Calabar, Nigeria.

## MATERIALS AND METHODS

### Sample collection

All clinical samples such as blood (for blood culture), urine, pus swab, wound swab and sputum were collected from the Microbiology Section of the Sufat Medical Laboratories, Ishie, Calabar, Nigeria.

### Isolation and identification of isolates

All the samples were cultured and replicated on different media and the plates were then incubated at 37°C for 24 - 48 h. Discrete colonies were sub-cultured into fresh agar plates aseptically to obtain pure cultures of the isolates. Colonies identifiable as discrete on the Mueller Hinton Agar were carefully examined macroscopically for cultural characteristics. All isolates were Gram stained to determine their gram reaction. Sugar utilization tests were carried out. Other tests carried out were Coagulase, Catalase, Citrate utilization, Urease activity, Oxidase, Methyl Red (MR)- Voges-Proscauer (VP), motility, Indole production, Kligler's Iron Agar (KIA) and Carbohydrate fermentation as described by Jolt et al. (1994). The isolates were identified by comparing their characteristics with those of known taxa, as described by Cheesbrough (2006) and Oyeleke and Manga (2008).

### Antibiotic susceptibility testing

The isolates were then subjected to antibiotic sensitivity testing by the disc diffusion method on Sheep blood agar and Mueller-Hinton agar according to the National Committee for Clinical Laboratory Standards and Manual of Antimicrobial Susceptibility Testing guidelines (NCCLS, 2002; Cheesbrough, 2006; Coyle, 2005; Okonko et al., 2009a, b). Commercially available antimicrobial discs were used in the study and included: Ampiclox (10 µg), Chloramphenicol (30 µg), Erythromycin (10 µg), Co-Trimozazole (25 µg), Tetracycline (25 µg), Amoxicillin (25 mg), Ciprofloxacin (10 µg), Penicillin (21U), Fulcin (10 mcg), Gentamicin (10 µg), Ampicillin (30 µg), Rifampicin (10 µg), and Vancomycin (10 µg). Plates were incubated at 35°C. Zones of inhibition were interpreted as resistant or sensitive using the interpretative chart of the zone sizes of the Kirby – Bauer sensitivity test method as described by Cheesbrough (2006). Interpretation of results was done using the zone of inhibition sizes. Zones of inhibition of ≥ 18 mm were considered sensitive, 13-17 mm intermediate and < 13 mm resistant (NCCLS, 2002; Cheesbrough, 2006; Coyle, 2005; Okonko et al., 2009a, b). Data were analyzed using the general linear model procedure and Chi (X<sup>2</sup>) test.

## RESULTS

The microbiological characteristics of the different organisms used in this study are presented in Table 1. This shows the cultural, morphological and biochemical characteristics of these isolates. The isolates were confirmed to be *Enterobacter aerogenes*, *Escherichia coli*, *Klebsiella pneumoniae*, *Proteus mirabilis*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Staphylococcus aureus* and *Streptococcus pyogenes* (Table 1).

The antibiograms for the gram positive and gram nega-

**Table 1.** Morphological and biochemical characteristics of bacteria isolates.

Parameters	Isolates							
	KP	EA	SA	PA	EC	ST	SP	PM
Grams reaction	-	-	+	-	-	-	+	-
Cellular morphology	Rods	Rods	Cocci	Small rods	Straight rods	Rods	Cocci in chains	Small rods
Growth on Blood agar (colony)	Large greyish-white mucoid	Large grayish-white partially mucoid	Creamy white	Greenish	Large, flat spreading & circular mucoid	Greyish-white	Creamy/colourless, mucoid in chains with zones of complete haemolysis	Swarming with fishy smell
Growth on MacConkey agar	Pink Mucoid	Mucoid	N/A	Pale	Smooth Red/Pink	Pale	Pink	
Growth on Mannitol Salt agar	N/A	N/A	Bright yellow	N/A	N/A	N/A	N/A	N/A
Motility	-	+	-	+	-	+	-	+
Catalase test	+	-	+	+	+	+	-	+
Coagulase test	N/A	N/A	+	N/A	N/A	N/A	-	N/A
Citrate test	+	-	+	+	+	+	+	+
Oxidase test	-	-	-	+	-	-	-	-
Indole test	-	+	-	-	+	-	-	-
Urease activity	+	+	+	-	-	-	-	+
Methyl Red	+	+	+	-	-	+	+	+
Voges Proskauer	+	-	-	+	-	-	-	-
Bacitracine	N/A	N/A	N/A	N/A	N/A	N/A	+	N/A
<b>Growth on KIA Medium:</b>								
Slope	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Red-pink
Butt	Yellow	Yellow	Yellow	A	Yellow	Yellow	Yellow	Yellow
Hydrogen Sulphide (H <sub>2</sub> S)	-	-	+	-	-	+	+	+
Gas production	-/G	-/G	-/G	-	-/G	-/G	-/G	-/G
<b>Sugar fermentation test:</b>								
Glucose	A/G	A/G	A/G	-/-	A/G	A/G	A/G	A/G
Lactose	A/-	A/-	A/-	A/G	A/-	A/G	-	-/-
Sucrose	A/-	A/-	A/-	A/G	A/-	A/G	A/G	A/-
Mannitol	A/-	A/-	A/-	A/G	A/-	A	-/-	-/-
Maltose	A/-	A/-	A/-	-/-	A/-	A/G	-/-	-/-
Most probable organism	<i>Klebsiella pneumoniae</i>	<i>Enterobacter aerogenes</i>	<i>Staphylococcus aureus</i>	<i>Pseudomonas aeruginosa</i>	<i>E. coli</i>	<i>Salmonella typhi</i>	<i>Streptococcus pyogenes</i>	<i>Proteus mirabilis</i>

N/A = Not applicable, - = No growth, + = Growth, A/G = Acid production and gas production, A/- = Acid production only and no gas production, -/G = Gas production only, -/- = No acid and gas production, Yellow = Acidic reaction, Red-pink = Alkaline reaction

**Table 2.** Antibiotic susceptibility profiles of gram positive isolates

S/n	Antibiotics (mcg)	Zones of Inhibition (mm)		General (%)	
		<i>S. aureus</i>	<i>S. pyogenes</i>	Sensitive	Resistant
1	Amoxicillin (25)	24.5	22.3	2(100.0)	0(0.0)
2	Ampicillin (10)	38.0	34.5	2(100.0)	0(0.0)
3	Ampiclox (10)	18.8	19.7	2(100.0)	0(0.0)
4	Chloramphenicol (25)	14.0	22.0	1(50.0)	1(50.0)
5	Ciprofolxacin (10)	40.0	30.0	2(100.0)	0(0.0)
6	Erythromycin (10)	43.5	14.5	1(50.0)	1(50.0)
7	Fulcin (10)	15.0	06.0	1(50.0)	1(50.0)
8	Gentamicin (10)	43.0	02.0	1(50.0)	1(50.0)
9	Penicillin (10)	04.0	39.0	1(50.0)	1(50.0)
10	Rifampicin (10)	18.0	27.0	2(100.0)	0(0.0)
11	Seprtrin (25)	38.0	19.0	2(100.0)	0(0.0)
12	Tetracycline (25)	40.0	10.5	1(50.0)	1(50.0)
13	Vancomycin (10)	32.0	14.5	1(50.0)	1(50.0)
	Average Zones (mm)	28.4	20.1	2(100.0)	0(0.0)
	No. Sensitive (%)	9(69.2)	7(53.8)		
Total	No. Intermediate (%)	2(15.4)	2(15.4)		
	No. Resistant (%)	2(15.4)	4(30.8)		

Zones of inhibition of:  $\geq 18$ mm (sensitive), 13-17mm (intermediate),  $< 13$ mm (resistant).

tive isolates are shown in Tables 2 and 3. The susceptibility patterns obtained revealed varying degrees of resistance and sensitivity to the antibiotics used in the screening. The sensitivity testing of the test antibiotics were analyzed using *E. aerogenes*, *E. coli*, *K. pneumoniae*, *P. mirabilis*, *P. aeruginosa*, *S. typhi*, *S. aureus* and *S. pyogenes* as presented in Tables 2 and 3 respectively. These profiles were determined from the interpretation of the diameter of the zones of inhibition of these antibiotics on the organisms. Zones of inhibition of  $\geq 18$  mm were considered sensitive, 13-17 mm intermediate and  $< 13$  mm resistant.

Table 2 shows the antibiotic susceptibility profiles of gram positive isolates. The gram positive isolates were sensitive to all antibiotics except Penicillin (4 mm) and Chloramphenicol (14 mm) as in the case of *S. aureus*. Generally, *S. aureus* showed 69.2% sensitivity (9 antibiotics) and 15.4% resistivity (2 antibiotics). Resistance to Fulcin (6 mm), Gentamicin (2 mm), Erythromycin (14.5 mm), Tetracycline (10.5 mm) and Vancomycin (14.5 mm) was also observed in the case of *S. pyogenes*. *S. pyogenes* also showed 53.8% sensitivity (7 antibiotics) and 30.8% resistivity (4 antibiotics) as shown in Table 2.

Table 3 shows the sensitivity profiles of the gram negative isolates. The gram negative isolates were sensitive to all antibiotics except erythromycin (14.5 mm), fulcin (6 mm), and vancomycin (14.5 mm) as in the case of *E. coli*. *E. coli* showed 76.9% sensitivity (10 antibiotics) and 23.1% resistivity (3 antibiotics). *E. aerogenes* was resistant to ampicillin (9 mm), erythromycin (11 mm), fulcin (8 mm), and vancomycin (0 mm). *K. pneumoniae* was resistant to ampicillin (12 mm), tetracycline (6 mm) and

vancomycin (0 mm). It also showed 76.9% sensitivity (10 antibiotics) and 23.1% resistivity (3 antibiotics).

*P. aeruginosa* was resistant to rifampicin (9 mm) and vancomycin (5 mm) and showed intermediate sensitivity to chloramphenicol (13.5 mm) and fulcin (13 mm). However, *P. aeruginosa* showed with 69.2% (9 antibiotics) and 30.8% resistivity (4 antibiotics) as shown in Table 3. *Salmonella sp* and *P. mirabilis* were resistant to all test antibiotics except amoxicillin, ampiclox, rifampicin, and seprtrin as in the case of *Salmonella sp*. It showed 69.2% resistivity (9 antibiotics) and 30.8% sensitivity (4 antibiotics) while *P. mirabilis* showed 76.9% resistivity (10 antibiotics) and 23.1% sensitivity (3 antibiotics). However, all Gram negative isolates were sensitive to ampiclox (100%) and resistant to vancomycin (100%) as shown in Table 3.

## DISCUSSION

Infections caused by resistant pathogens result in significant morbidity and mortality, and contribute to escalating healthcare costs worldwide. Despite the availability of newer antibiotics, emerging antimicrobial resistance has become an increasing problem in many pathogens throughout the world (Keith and John, 2005). All the isolates used in the present study namely; *E. coli*, *E. aerogenes*, *K. pneumoniae*, *P. mirabilis*, *P. aeruginosa*, *S. typhi*, *S. aureus* and *S. pyogenes* have been shown to cause different nosocomial infections (Moland et al., 2006; Lewis et al., 2007; Leavitt et al., 2007; Lockhart et al., 2007; Mendonca et al., 2007). *S.*

**Table 3.** Antibiotic susceptibility profiles of gram negative isolates.

S/n	Antibiotics (mcg)	Zones of Inhibition (mm)					General (%)		
		EC	EA	KP	PA	ST	PM	Sensitive	Resistant
1	Amoxicillin (25)	32.3	21.0	27.3	24.0	22.0	11.0	83.3	16.7
2	Ampicillin (10)	29.0	09.0	12.0	34.0	11.0	12.0	33.3	66.7
3	Ampiclox (10)	33.0	28.0	23.5	35.6	28.0	22.0	100.0	0.0
4	Chloramphenicol (25)	30.0	24.0	28.0	13.5	07.0	09.5	50.0	50.0
5	Ciprofolxacin (10)	38.0	29.5	31.5	43.0	25.0	33.0	100.0	0.0
6	Erythromycin (10)	06.0	11.0	46.0	23.0	12.0	16.0	33.3	66.7
7	Fulcin (10)	12.0	08.0	21.0	13.0	12.0	08.0	16.7	83.3
8	Gentamicin (10)	33.0	42.0	50.0	46.0	11.0	08.0	66.7	33.3
9	Penicillin (10)	25.0	28.0	24.0	43.5	08.0	12.0	66.7	33.3
10	Rifampicin (10)	20.0	18.0	43.0	09.0	12.0	19.0	50.0	50.0
11	Septin (25)	36.0	32.0	46.0	26.0	19.0	12.0	66.7	33.3
12	Tetracycline (25)	40.0	26.0	06.0	38.0	06.0	08.0	50.0	50.0
13	Vancomycin (10)	08.0	06.0	00.0	05.0	06.0	08.0	0.00	100.0
	Average Zones (mm)	26.3	21.7	27.6	27.2	13.8	14.5	66.7	33.3
	No. Sensitive (%)	10(76.9)	09(69.2)	10(76.9)	09(69.2)	04(30.8)	03(23.1)		
	No. Resistant (%)	03(23.1)	04(30.8)	03(23.1)	04(30.8)	09(69.2)	10(76.9)		

Zones of inhibition of:  $\geq 18$  mm (sensitive), 13-17 mm (intermediate),  $< 13$  mm (resistant). EA=*Enterobacter aerogenes*, EC = *Escherichia coli*, KP = *Klebsiella pneumoniae*, PA = *Pseudomonas aeruginosa*, ST = *Salmonella typhi*, SA = *Staphylococcus aureus*, SP = *Streptococcus pyogenes*, and PM = *Proteus mirabilis*.

*aureus* had been isolated from several clinical specimens from different part of Nigeria (Kolawole et al., 2005; Obiazi et al., 2007). The isolates represented both nosocomial- and community-acquired pathogens, since the patients from whom samples were collected in these four different health centres, come from different residential and working environments (Doughari et al., 2007).

The antibiogram revealed that all isolates that were susceptible to ampiclox and ciprofolxacin and a good percentage to amoxicillin, however, all gram negative isolates were resistant to vancomycin. The high susceptibility to ampiclox, amoxicillin, and ciprofolxacin is a welcome relief, since it is an indication of effectiveness of the antibiotic against the bacteria. This study is in agreement with Doughari et al. 2007.

*S. aureus* exhibits remarkable versatility in their behaviour towards antibiotics and its capacity to produce human diseases had not diminished even with the introduction of antibiotics (Obiazi et al., 2007). Although, outbreaks of *S. aureus* resistant to beta-lactam antibiotics have been frequently associated with devastating nosocomial infections (Depardieu et al., 2007; Buhlmann et al., 2008). In this investigation, *S. aureus* had low zones of inhibitions (18.8 mm) to ampiclox compared to other isolates, marked resistance to Ampiclox which is a beta-lactam antibiotic by *S. auerus* was not found in our study. Also, *S. aureus* was highly susceptible to gentamycin, erythromycin and Tetracycline in this study. This was also reported in a study by Obiazi et al. (2007). How-

ever, gentamycin, erthromycin and tetracycline among others with relatively higher susceptibility to the *S. aureus* can be used for management of clinical conditions in our locality. This also accords the reports of Obiazi et al. (2007). The need for appropriate health education to reduce self medication and drug abuse is very imperative and desirous (Obiazi et al., 2007).

The susceptibility and resistance of *S. aureus* to antibiotics is known to be altered at relatively higher temperatures (Obiazi et al., 2007). *S. epidermidis* were reported to more resistant to Ciprofloxacin, Erythromycin, Norfloxacin and Floxapen. *S. epidermidis* is a major cause of nosocomial infections as well because of its ability to form biofilms on the surface of medical devices. According to Villain-Guillot et al. (2007) bacterial biofilms are inherently resistant to antibiotics and host defenses and this could explain the reason for the high resistance seen in the strains isolated. *Streptococcus* spp., *E. aerogenes*, *P. aeruginosa*, *Salmonella* sp. and *P. mirabilis* showed varying degrees of resistance (4 to 10 of the antibiotics) as shown in Table 2 and 3, with *Salmonella* sp. been resistant to 9 antibiotics (69.2%) and *P. mirabilis* resistant to 10 antibiotics (76.9%). The proportion of isolates with *in vitro* resistance to erythromycin has increased since 1996 (Motlová et al., 2004).

A number of studies in the literature indicated a gradual increase in the emergence of antibiotic-resistant microorganisms in hospitals especially in patients undergoing surgery (Suchitra and Lakshmedevi, 2009). *S. aureus* has

been reported to exhibit resistance to beta-lactam antibiotics of which benzyl penicillin is one. Bacterial resistance to beta-lactam antibiotics is primarily due to the production of beta-lactam ring of the antibiotics rendering them inactive (Akpan, 1992). In this present study, *S. aureus*, *S. typhi* and *P. mirabilis* were resistant to penicillin. Ineffectiveness of penicillin against *S. aureus* has been reported by Suchitra and Lakshmidevi (2009). *S. aureus* resistant to cloxacillin, penicillin, ampicillin and tetracycline was reported by Obiazi et al. (2007) in Benin City, Nigeria. Suchitra and Lakshmidevi (2009) reported 14% MRSA and 1.4% VRE in their study on surgical site infection. *S. aureus* in this surgical site infection is mainly due to its predominant role in hospital cross-infection and emergence of virulent antibiotic-resistant strains. Our present observation can be attributed in part to earlier exposure of the isolates to these drugs which may have enhanced resistant development.

In this study, the percentage resistance of *E. aerogenes*, *P. aeruginosa*, *S. typhi*, and *P. mirabilis* was 30.8, 30.8, 69.2 and 76.9% respectively. The high percentage resistance to the antibiotics studied could be attributed to their prevailing usage and abuse in the area under study. This high rate of resistance observed in this study is consistent with incidences of increased antibiotic resistance reported among Gram-negative bacilli such as *Klebsiella*, *Enterobacter*, *Salmonella*, and *Pseudomonas aeruginosa* in other parts of the world. Over the past decade, particularly in developing countries, the increase in resistance of animal origin non-typhoid *Salmonellae* to broad-spectrum antibiotics such as cephalosporins, tetracycline, and quinolones has been extremely worrisome (Streit et al., 2003). Doughari et al. (2007) reported resistance rates of *Salmonella* isolates (92.3, 88.8, 79.6, 53.5 and 20%) to amoxicillin, ampicillin, chloramphenicol, cotrimoxazole and ciprofloxacin, respectively. The implication of this high percentage resistance recorded for the antibiotics is that only amoxicillin and ciprofloxacin will effectively treat *S. typhi* infections. According to Abdellah et al. (2009), the high levels of antibiotic resistance of *Salmonella* isolates in the present study showed the possible significance of hospital as a source of multiple antimicrobial-resistant *Salmonella* for human infections and suggest more restrictions on the irrational use of antibiotics.

Also, resistance to a number of antibiotics among *S. typhi* has become a serious problem. Strains of *S. typhi* resistant to chloramphenicol and other recommended antibiotics have been identified in several parts of Latin America, Asia and Africa (Benoit et al., 2003). Other works on *S. typhi* also reported a high percentage of resistance against cloxacillin, ampicillin, erythromycin, penicillin, tetracycline, chloramphenicol, fluoroquinolones, macrolides and co-trimoxazole from other geographical areas (Amani et al., 2003).

Though, gentamicin-resistant *P. aeruginosa* was not found in our study, some studies have shown *P. aerugi-*

*nosa* was 100% resistant to gentamicin, which was one of the antibiotics used for antimicrobial prophylaxis (Suchitra and Lakshmidevi, 2009). Though, Filioussis et al. (2008) in their study reported *Salmonella* isolates that were resistant to several antimicrobials (tetracycline, trimethoprim/sulfamethoxazole, ampicillin and amoxicillin/clavulanic acid), they found some susceptible to cefuroxime and ceftriaxone, as well as to nalidixic acid, ciprofloxacin, and levofloxacin. This slightly agrees with our own findings. A prominent reason for concern with regard to gastroenteritis-causing bacteria is the recognized emergence of antimicrobial resistance among key species.

Also, in this study, we found *S. pyogenes* and all gram negative isolates to be resistant to Vancomycin. It is well documented that Gram negative bacilli harbour series of antibiotic resistant genes which can be transferred to other bacteria horizontally (Pidcock, 2006; Depardieu et al., 2007; Leavitt et al., 2007; Lockhart et al., 2007). The community acquired resistant strains on admission exchange genetic information with nosocomial isolates resulting in the emergence of 'super bugs' that could cause difficult-to-treat infections (Muvley et al., 2004). And the implication these resistance, is that many bacterial and parasitic diseases that could, until recently, be treated with inexpensive antimicrobial agents, has recently been made more expensive and less successful by the emergence and spread of resistant organisms (Okeke et al., 2007; Okonko et al., 2009a, b). However, this drug resistance as observed in some of the antibiotics used in this study, has now become a large and growing problem in infections that account for most of Africa's disease burden, including malaria, tuberculosis (TB), HIV infection, and respiratory and diarrheal diseases (Okeke et al., 2007). Because of these high incidences of antibiotic refractiveness by infectious bacteria, many people, including even the urban dwellers, have turned to traditional herbs to seek for succor (Doughari et al., 2007).

Development of multi-drug resistance by the bacterium has further complicated the problem. Antibiotic resistance is further accelerated due to irrational use of antibiotics and over-the-counter purchase attitude by the populace, which is a very common phenomenon in Africa (Doughari et al., 2007). Our observation in this study, according to Obiazi et al. (2007) can further be strengthened by the high level of antibiotic abuse in our locality, arising from self medications which are often associated with inadequate dosage and failure to comply to treatment and availability of antibiotics to consumers across the counters with or without prescription. The level of antibiotics susceptibility profiles in our locality is relatively low and therefore worrisome. This trend had been documented in different parts of Nigeria (Obiazi et al., 2007). The percentages of resistance obtained with these antibiotics are comparable with those reported in other studies in France, in Ethiopia and in Senegal (Bada-

Alamedji et al., 2006; Obiazi et al., 2007). Carraminana et al. (2004) also reported similar trends.

The limitations of this study must be mentioned. First, this is an *in-vitro* study based on relatively few samples collected from one privately owned laboratory and we do not know how many of these observed resistances occurred *in-vivo* in the area of study. The second major limitation is that testing patterns in the community are unknown as no active surveillance on antibiotics resistance testing is ongoing in the area of study and thus could also affect testing patterns and, therefore, the reporting rate.

## Conclusion

High rates of drug resistance were found in most of the isolates studied. The multiple resistances observed in this study were to those antimicrobials more frequently and commonly employed in medical, veterinary and agricultural practices. In developing countries like Nigeria, self medication is a common practice and this might probably be a major cause of antibiotic resistance in clinical isolates since patients only think of going to the hospitals when they are unable to treat themselves. Inappropriate practices like misuse and abuse of antibiotics and unskilled practitioners can also lead to emergence of resistance in bacteria. Expired antibiotics, self-medication, counterfeit drugs, inadequate hospital control measures can as well promote the development of resistance in clinical isolates (Prescott et al., 2005). According to Suchitra and Lakshmidivi (2009), intensive medical therapies and frequent use of antimicrobial drugs are capable of selection of resistant microbial flora. Nosocomial infections due to resistant organisms have been a problem with an increase in the incidence of methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* (VRE) and *P. aeruginosa* (Suchitra and Lakshmidivi, 2009). These results suggest that multi-drug resistance among clinical pathogens is common and significant in Nigeria and call for nationwide surveillance programme to monitor microbial trends and antimicrobial resistance patterns in Nigeria. One of the explanations for these high resistance rates could be antibiotic usage in the respective health institutions in Nigeria (Doughari et al., 2007).

Determining the antimicrobial patterns of the disease-causing organisms will enable health institutions to restrict the use of antimicrobials and take active measures in preventing the spread of drug resistance in hospitals. However, the insight into the antibiotic susceptibility of clinical isolates profile in any community is very imperative and desirable for effective management of the clinical conditions considering the relative differences in the pattern of susceptibility and resistance of so many pathogens to antibiotics from one locality to another. In line with the assertions by Doughari et al. (2007), the findings of this study have important implications for prac-

practicing physicians with regard to empirical antibiotic selection, for authorities involved in hospital formulary decisions, and in the development of policies regarding antibiotic utilization, infection control and public health-care. Therefore, it is important for hospitals to improve the processes of care known to impact nosocomial infection rates. However, the judicious use of antibiotics by health workers and efforts to control procurement and use of antibiotics officially in all localities in Nigeria will probably help to limit the increasing rates of multi-drug resistance in pathogens.

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