



# Occurrence of Multidrug Resistant *Staphylococcus aureus* and *Klebsiella pneumoniae* Isolated from Clinical and Environmental Samples in Ondo State, Nigeria

Ojokoh, Anthony Okhonlaye<sup>1\*</sup> and Ojo, Martha Oluwatosin<sup>1</sup>

<sup>1</sup>Department of Microbiology, Federal University of Technology, Akure, P.M.B 704, Nigeria.

## Authors' contributions

This work was carried out in collaboration between both authors. Author OAO designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. Author OMO managed the analyses of the study and managed the literature searches, also the final editing of the manuscript. Both authors read and approved the final manuscript.

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## ABSTRACT

**Introduction:** Antibiotic resistant bacteria are threat to our community and hospital settings. Multi drug resistance in *Klebsiella pneumoniae* and *Staphylococcus aureus* can cause a wide range of infections, including pneumoniae, urinary tract infection and bacteremia which can lead to substantial morbidity and mortality.

**Aims:** To study multidrug resistance patterns of *K. pneumoniae* and *S. aureus* isolated from clinical (urine and post-operative wound) and environmental (air in hospital environment, market soil and well water) samples in Ondo State.

**Place and Duration of Study:** Sample: Department of Microbiology, Federal University of Technology, Akure, between November 2016 and July 2017.

**Methodology:** Collection of all the samples, isolation of *K. pneumoniae* and *S. aureus* and antibiotic susceptibility test were carried out using standard microbiological methods.

**Results:** *S. aureus* and *K. pneumoniae* counts were observed in Ondo North (wound; 50.20±0.00

\*Corresponding author: E-mail: aoojokoh@futa.edu.ng;

$\times 10^4$ cfu) and Ondo central (well water;  $42.33 \pm 0.03 \times 10^4$ cfu/ml) senatorial district respectively. *K. pneumoniae* recovery rate are; 23(23.71%) from market soil, 20(11.30%) from post-operative wound, 26(10.36%) from urine, 40(38.36%) from market well water and 13 (21.31%) hospital air while *S. aureus* was most prevalent in post-surgical wound 50 (28.25%). In Ondo north, *K. pneumoniae* isolates were at least 68% resistant to septrin, chloramphenicol, amoxicillin, and sparfloxacin while in south they were 70% resistant to septrin, chloramphenicol and amoxicillin however, all *S. aureus* isolates were 100% resistant to amoxicillin and were at least resistant to five different antibiotics. *K. pneumoniae* isolated from post-operative wound have resistance pattern of Septrin (71%), Chloramphenicol (13%), Amoxicillin (56%) and Sparfloxacin (56%) and in market soil the resistance pattern are; Augumentin (98%), Pefloxacin (99%), Septrin (98%), Chloramphenicol (97%), Gentamicin (100%), Ofloxacin (98%), Amoxicillin (98%), ciprofloxacin (98%), Sparfloxacin (98%) and Streptomycin (100%). All *S. aureus* isolated from urine samples were 100% resistant to streptomycin, chloramphenicol, ceftriazone, erythromycin, cotrimoxazole and Gentamicin.

**Conclusion:** Occurrence of these multidrug resistance *K. pneumoniae* and *S. aureus* in clinical and environmental samples could result into increase in morbidity and mortality.

**Keywords:** *Clinical sample; environmental sample; Klebsiella pneumonia; Staphylococcus aureus; multidrug resistant.*

## 1. INTRODUCTION

Resistant bacteria are emerging worldwide as a threat to the favourable outcome of common infections in community and hospital settings. Multi drug resistance in *K. pneumoniae* and *S. aureus* can cause a wide range of infections, including pneumoniae, urinary tract infection and bacteremia which can lead to substantial morbidity and mortality, treatment failures and increases healthcare costs as newer and more expensive antibiotics are needed to treat infections [1,2].

*K. pneumoniae* is found in the normal flora of the mouth, skin and intestines and causative agent of many diseases, such as pneumoniae, burns, urinary tract infection, wound infection and pyogenic liver abscesses [3]. *K. pneumoniae* have become important pathogens in nosocomial infections, they are found worldwide in soil, water, and vegetation and are part of the normal intestinal flora of most animals [4]. Moreover, extensive use of broad-spectrum antibiotics in hospitalized patients has led to development of multidrug resistant strains of *K. pneumoniae* [5]. *S. aureus* is a commensal and major pathogen of human. The bacterium is important in human infections ranging from minor skin infections to serious life threatening infections that may include endocarditis, deep seated abscesses, septicaemia, food borne illness, toxic shock syndrome and many other infections. Infection caused by multi resistant strains of multidrug resistant strains of *S. aureus* are characteristically resistant to three or more classes of antimicrobial agents other than beta

lactams. These strains have been recognized as the most common pathogen identified in wound infections [6]. The environment has been determined as a factor in transmission of resistant strains of *K. pneumoniae* and *S. aureus* especially via air and air formites. The ability of *K. pneumoniae* and *S. aureus* to survive in various environments for extended period of time without loss in viability or virulence enables it to spread within man and community [7].

The emergence of multidrug resistant *K. pneumoniae* and *S. aureus* which have been shown to be increasingly resistant to a large group of antibiotics, especially *beta lactam* antibiotics are widely spread in humans and environment, hence, it is therefore worthwhile to present multidrug resistance patterns of *K. pneumoniae* and *S. aureus* isolated from clinical (urine and wound) and environmental (air in hospital environment, market soil and well water) samples in Ondo State.

## 2. MATERIALS AND METHODS

### 2.1 Description of Study Area

Ondo State is located in south-west Nigeria, and situated at 7.1° North latitude, 4.83° East longitude and 277 meters elevation above the sea level. The city has a population of 3,441,024 which is 2.46% of Nigeria population based on 2006 population census, the people are of Yoruba ethnic group and are situated in the tropic rainforest. The State is a trade center for farmers where cocoa, bananas, palm oil, yams, cassava, corn, cotton and tobacco are mostly

cultivated, the residents also engaged in various economic activities such as trading, transportation business, civil service and education. Politically, there are three senatorial district (Ondo north, Ondo central and Ondo South). Each district has six local governments each and are; Ondo north (Akoko north east, Akoko north west, Akoko south west, Akoko south east, Ose, Owo), Ondo central (Akure north, Akure south, ifedore, Idanre, Ondo east, Ondo west) and Ondo south (Ileoluji/Okeigbo, Odigbo, Irele, Okitipupa, Ese-Odo, Ilaje) (National Population Commission, 2006).

## 2.2 Sample Collection

A total of 690 clinical and environmental samples were collected from three senatorial districts in Ondo State (Ondo north, south and central). Clinical samples (urine and post surgical wound) and environmental samples (market soil, market well water and outdoor hospital air) were collected across the state as follows;

- a. **Urine samples:** Clean catch urine samples were collected in sterile universal containers as described by [8,9]. Two hundred and fifty-one 'clean catch' midstream urine (MSU) samples were collected inside sterile disposable universal bottles from patients attending General out-patient department clinic of government hospitals in Ondo State.
- b. **post surgical wound:** One hundred and seventy-seven post-operative wound swabs were collected from patients admitted to surgical wards of government hospital in Ondo State under the supervision of medical officers. Sterile swab sticks were used to collect the wound swab carefully after which 1.0 ml of normal saline was added and immediately the swab sticks were covered.
- c. **Water sample:** One hundred and four market well water were collected early in the morning between the hour of 7.00 a.m to 8.00 a.m inside a sterile containers
- d. **Soil sample:** Ninety-seven soil samples were collected from various markets across the state using a sterile spatula from the top 0-2 cm layer and placed into sterile containers
- e. **Air sample:** Sixty-one hospital air samples were collected by exposing an already solidified prepared agar plates to the air for 5 minutes [10].

All samples were labeled, preserved in ice bag and transported to the Microbiology laboratory of The Federal University of Technology, Akure for microbiological analysis.

## 2.3 Isolation of *K. pneumoniae* and *S. aureus* from Samples

**Urine samples:** a loopful of thoroughly mixed, uncentrifuged urine samples were inoculated by spread plate method,

**Post-operative wound swabs:** the swab was allowed to stay inside the normal saline and the saline was subsequently diluted serially, pure plate method was used for the isolation.

**Water sample:** Ten-fold serial dilution method was used with sterile distilled water in a test-tube. Diluents were pure plated out on nutrient agar [10].

**Soil sample:** One gram of each soil sample was mixed with 9 ml of sterile distilled water and shaken for some minutes. The resulting suspension was allowed to settle and the supernatant was serially diluted and pure plated [10].

**Air:** Solidified agar plates were exposed to the air inside and outside the hospital for five minutes [10].

The media used were prepared according to manufacturer specification, all samples were plated on Deoxycholate agar, Mannitol salt agar, MacConkey agar, Nutrient agar and CLED agar plates at 37°C for 24 hours as described by [10]. The number of colonies were counted and microbial loads were recorded.

Colony counting was carried out visually by counting the number of visible colonies that appeared on the plates, plate that has a distinct colony was used. Calculation of colony forming unit (CFU) per gram, milliter and meter for the bacteria was based on the formula:

**soil/well samples:**  $CFU = \frac{\text{Number of colonies}}{\text{grams/ml of the sample suspended} \times \text{Dilution factor}}$

**urine samples:**  $CFU = \text{Number of colonies} \times \text{diameter of calibrated loop}$  [11]

**air:**  $N = 5a \times 10^4 (bt^{-1})$  where;  
N: microbial CFU/m<sup>3</sup> of outdoor air  
a: number of colonies per petri dish  
b: dish surface, cm<sup>3</sup>  
t: exposure time, minutes [12].

## 2.4 Characterization and Identification of Bacterial Isolates

Isolates suspected as *K. pneumoniae* and *S. aureus* on deoxycholate citrate agar and mannitol salt agar respectively were confirmed using cultural, morphological and biochemical characteristics [10,13].

## 2.5 Quality Control Strains for Antimicrobial Susceptibility Test

Typed culture (*K. pneumoniae* ATCC 33495 and *S. aureus* ATCC 25923) was used as quality control for antimicrobial susceptibility testing as recommend by Clinical and Laboratory Standards Institute [14].

## 2.6 Antibiotics Susceptibility Test

Antibiotics susceptibility test of all the isolates was determined by the disk diffusion method and interpreted as susceptible, intermediate and resistant as described by [14]. *K. pneumoniae* isolates were tested against Augmentin (25 µg), Gentamicin (10 µg), Pefloxacin (10 µg), Ofloxacin (30 µg), Streptomycin (30 µg), Septrin (30 µg), Chloramphenicol (30 µg), Sparfloxacin (30 µg), Ciprofloxacin (10 µg) and Amoxicillin (30 µg) while *S. aureus* were tested against Amoxicillin (25 µg), Ofloxacin (5 µg), Streptomycin (10 µg), Chloramphenicol (30 µg), Ceftriazone (30 µg), Gentamicin (10 µg), Pefloxacin (5 µg), Cotrimoxazole (25 µg), Ciprofloxacin (10 µg) and Erythromycin (5 µg). Multidrug resistance was defined in this study as resistance to three or more antibiotics tested.

## 2.7 Statistical Analysis

Data was statistically analysed using SPSS version 20, the results obtained were statistically analysed using analysis of variance (ANOVA), and tests of significance carried out by New Duncan's multiple range test at  $p \leq 0.05$ .

## 3. RESULTS AND DISCUSSION

### 3.1 Total Viable Bacterial Count Obtained from Clinical and Environmental Samples

Mean total viable bacterial counts are shown in Table 1. The result revealed that there were, significant difference ( $p \leq 0.05$ ) in total viable bacterial load of urine, post-operative wound market soil, well water from the market and

hospital air across the sample locations. The bacterial load of samples isolated from Ondo North, South and central ranges from  $4.43 \pm 0.10$  to  $149.04 \pm 0.05 \times 10^4$  cfu/ml,  $6.00 \pm 0.24 \times 10^4$  to  $156.82 \pm 0.04 \times 10^4$  cfu/ml and  $2.27 \pm 0.05 \times 10^4$  to  $161.24 \pm 0.77 \times 10^4$  cfu/ml respectively. The highest ( $50.20 \pm 0.00 \times 10^4$  cfu/ml) total *S. aureus* counts was observed in Ondo North and central while the highest ( $42.33 \pm 0.03 \times 10^4$  cfu/ml) total *K. pneumoniae* counts was observed in Ondo central.

Bacterial load of post-operative wound swab was significantly ( $p \leq 0.05$ ) higher than other sources and the least bacterial load was observed in air samples isolated from the hospital environment. The staphylococci counts of post-operative wound was significantly ( $p \leq 0.05$ ) higher than other sources except in Ondo south that where staphylococci counts of market soil was found to be higher.

### 3.2 Rate of Occurrence and Recovery of *K. pneumoniae* and *S. aureus* Across Different Sample Locations

Occurrence and comparison of isolated *K. pneumoniae* and *S. aureus* are presented in Tables 2 and 3. Total number of *K. pneumoniae* and *S. aureus* isolated from clinical and environmental sources were 122(17.68%) and 153(22.17%) respectively. The result (Table 2) revealed that *K. pneumoniae* recovery rate are; 23(23.71%) from market soil, 20(11.30%) from post-operative wound, 26(10.36%) from urine, 40(38.36%) from market well water and 13 (21.31%) hospital air.

The result (Table 3) revealed that 39(40.21%) from market soil, 50(28.25%) post-operative wound, 33(13.15%) urine, 20(19.23%) market well water and 11(18.03%) hospital air. The result revealed that *S. aureus* was most prevalent in post-surgical wound 50 (28.25%) and in Ondo north 53(22.36%). The least prevalent *S. aureus* was isolated from hospital air and in Ondo central, 11(18.03%).

### 3.3 Multidrug Resistance Patterns of *K. pneumoniae* and *S. aureus* Isolated from Different Sources in Ondo State

The high resistance of *K. pneumoniae* to multiple antibiotics was observed in Ondo north and south. In Ondo north (68%) to septrin, chloramphenicol, amoxacillin, and sparfloxacin while in Ondo south (70%) resistant to

**Table 1. Total viable bacterial count obtained from clinical and environmental sources in Ondo State**

Samples		Total bacterial counts on NA (cfu/ml±SE) × 10 <sup>4</sup>	Total <i>S. aureus</i> counts on MSA (cfu/ml±SE) × 10 <sup>4</sup>	Total <i>K. pneumoniae</i> counts on DCA (cfu/ml±SE) × 10 <sup>4</sup>
North	Soil	37.2±0.25 <sup>c</sup>	50.00±0.00 <sup>ef</sup>	12.33±0.33 <sup>c</sup>
	Well	72.15±2.35 <sup>e</sup>	39.33±0.33 <sup>d</sup>	30.33±0.33 <sup>f</sup>
	Urine	83.76±0.64 <sup>f</sup>	40.00±0.58 <sup>d</sup>	36.00±0.15 <sup>g</sup>
	Wound	149.04±0.05 <sup>h</sup>	50.20±0.00 <sup>ef</sup>	22.67±0.88 <sup>d</sup>
	Air	4.43±0.10 <sup>b</sup>	7.55±0.02 <sup>b</sup>	2.24±0.33 <sup>a</sup>
South	Soil	72.57±0.47 <sup>e</sup>	50.00±0.00 <sup>ef</sup>	25.17±0.44 <sup>e</sup>
	Well	60.69±2.93 <sup>d</sup>	41.33±0.30 <sup>d</sup>	34.33±0.33 <sup>g</sup>
	Urine	117.46±0.17 <sup>g</sup>	39.00±0.58 <sup>d</sup>	41.33±0.88 <sup>h</sup>
	Wound	156.82±0.04 <sup>i</sup>	49.67±0.67 <sup>e</sup>	20.00±0.58 <sup>d</sup>
	Air	6.00±0.24 <sup>b</sup>	6.42±0.86 <sup>b</sup>	5.44±0.22 <sup>b</sup>
Central	Soil	70.14±0.44 <sup>e</sup>	48.09±0.57 <sup>e</sup>	11.00±0.58 <sup>c</sup>
	Well	75.79±0.51 <sup>e</sup>	39.33±0.33 <sup>d</sup>	42.33±0.03 <sup>h</sup>
	Urine	87.28±0.10 <sup>f</sup>	34.00±0.58 <sup>c</sup>	23.00±0.57 <sup>d</sup>
	Wound	161.24±0.77 <sup>i</sup>	49.33±0.88 <sup>e</sup>	18.00±1.15 <sup>d</sup>
	Air	2.27±0.05 <sup>a</sup>	3.83±0.51 <sup>a</sup>	5.18±0.40 <sup>b</sup>

Values are means ± SE of samples. Values in the same column carrying the same superscript are not significantly different at (p ≤ 0.05) using Duncan's New Multiple Range test

**Table 2. Percentage recovery and occurrence of *K. pneumoniae***

Sample locations	Sample source					Total (%)
	Market soil (97)	Post-operative wound (177)	Urine (251)	Well water (104)	Hospital air (61)	
North (237)	7	7	10	13	4	41 (17.30)
South (202)	9	7	8	16	6	46 (22.77)
Central(251)	7	6	8	11	3	35 (13.94)
Total (690)	23 (23.71)	20 (11.30)	26 (10.36)	40 (38.46)	13 (21.31)	122(17.68)

**Table 3. Percentage recovery and occurrence of *S. aureus***

Sample locations	Sample source					Total (%)
	Market soil (97)	Post-operative wound (177)	Urine (251)	Well water (104)	Hospital air (61)	
North (237)	13	15	12	7	6	53 (22.36)
South (202)	12	19	9	9	3	52 (25.74)
Central (251)	14	16	12	4	2	48 (19.12)
Total (690)	39 (40.21)	50 (28.25)	33 (13.15)	20(19.23)	11 (18.03)	153 (22.17)

chloramphenicol, amoxicillin, SP were observed. The result revealed (68%) resistance to septrin and chloramphenicol in Ondo central and are shown in Fig. 1.

In Fig. 2, there were no significant differences (p ≤ 0.05) in resistance of *S. aureus* to amoxicillin.

In Ondo north, south and central high resistance of *S. aureus* were observed to amoxycillin (100%, 100%, 100%); streptomycin (39%, 28%, 20%); erythromycin (48%, 51%, 52%); cotrimoxazole (72%, 99%, 98%); Gentamicin (60%, 52%, 59%) respectively. There was low frequency of resistance to ofloxacin (9%) and

pefloxacin (2%) in Ondo north. There were no significant differences ( $p \leq 0.05$ ) in resistance of *S. aureus* to ofloxacin, pefloxacin and ciprofloxacin in Ondo south. Low frequency of resistance to ofloxacin (2%) and pefloxacin (2%) were observed in Ondo central.

### 3.4 Percentage Antibiotic Resistance of *K. pneumoniae* Isolated from Different Sources

The results presented in Fig. 3 revealed that resistance of *K. pneumoniae* isolated from urine samples to all antibiotics used has no significant differences ( $p \leq 0.05$ ). In post-operative wound, resistance pattern of *K. pneumoniae* isolates are Septrin (71%), Chloramphenicol (13%), Amoxicillin (56%) and Sparfloxacin (56%). In market soil, there was no significant difference ( $p \leq 0.05$ ) in resistance pattern of *K. pneumoniae* isolates to all antibiotics used for this study. Augmentin (98%), Pefloxacin (99%), Septrin (98%), Chloramphenicol (97%), Gentamicin (100%), Ofloxacin (98%), Amoxicillin (98%), ciprofloxacin (98%), Sparfloxacin (98%), Streptomycin (100%).

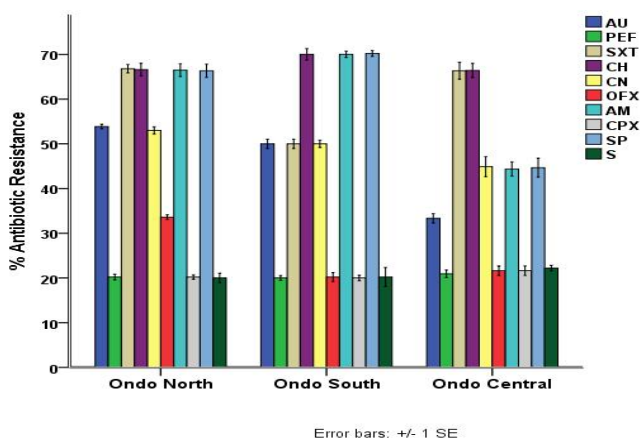
In well water, there was no significant difference ( $p \leq 0.05$ ) in resistance of *K. pneumoniae* isolates to Augmentin (99%), Septrin (99%), Chloramphenicol (98%), Gentamicin (99%), Amoxicillin (99%), Sparfloxacin (99%). In hospital air there was significant difference ( $p \leq 0.05$ ) in resistance pattern of *K. pneumoniae* isolates to Augmentin (45%), Septrin (20%), Chloramphenicol (27%), Gentamicin (28%),

Amoxicillin (26%) and Sparfloxacin (19%). There was no significant difference ( $p \leq 0.05$ ) in susceptibility of *K. pneumoniae* isolated from hospital air in pefloxacin, ofloxacin and ciprofloxacin.

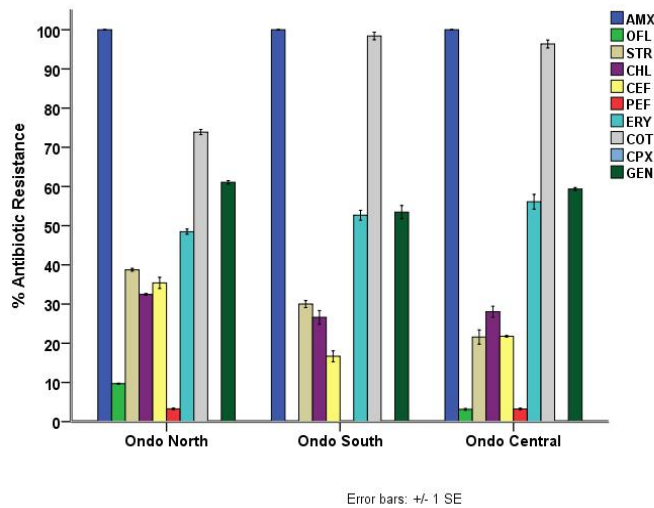
### 3.5 Percentage Antibiotic Resistance of *S. aureus* Isolated from Different Sources

There was no significant difference ( $p \leq 0.05$ ) in resistance pattern of *S. aureus* isolated from urine samples to streptomycin, chloramphenicol, ceftriazone, erythromycin, cotrimoxazole, gentamicin, they were observed to be 100% resistant. Low frequency of resistance in pefloxacin (10%) was observed and all *S. aureus* isolates from urine samples were observed to be susceptible to ofloxacin and ciprofloxacin.

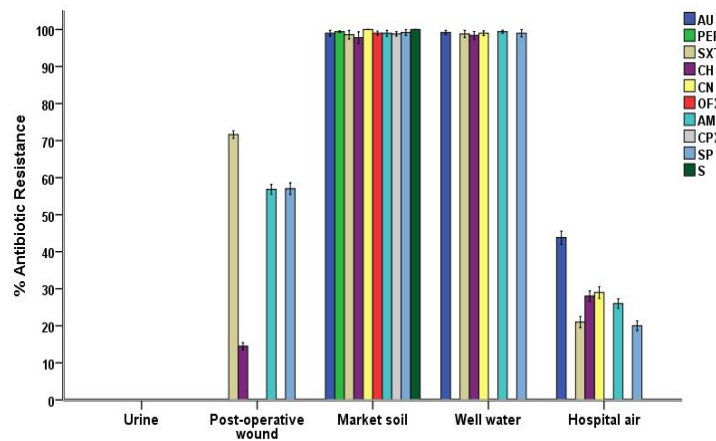
In post-operative wound, there was no significant difference ( $p \leq 0.05$ ) in resistance pattern of *S. aureus* isolates to erythromycin, cotrimoxazole, gentamicin, except in streptomycin (12%), chloramphenicol (10%) and ceftriazone (12%). All isolates of *S. aureus* from post-operative wounds were susceptible to ofloxacin and ciprofloxacin. In market soil there was no significant difference ( $p \leq 0.05$ ) in resistant patterns of *S. aureus* isolated to streptomycin, chloramphenicol, ceftriazone, pefloxacin, erythromycin, ciprofloxacin. Low frequency of resistance was observed in ofloxacin and gentamicin. High resistance was observed in amoxicillin (100%) and cotrimoxazole (64%).



**Fig. 1. Multiple drug resistance pattern of *K. pneumoniae* isolated in Ondo State**  
 KEYS: AU- Augmentin, PEF- Pefloxacin, SXT- Septrin, CH- Chloramphenicol, CN- Gentamicin, OFX- Ofloxacin, AM- Amoxicillin, CPX- Ciprofloxacin, SP- Sparfloxacin. S- streptomycin



**Fig. 2. Multiple drug resistance patterns of *S. aureus* isolated in Ondo State**  
 KEYS: AMX- Amoxicillin, OFL- Ofloxacin, STR-Streptomycin, CHL-Chloramphenicol CEF- Ceftriazone, PEF- Pefloxacin ERY- Erythromycin COT-Cotrimoxazole CPX- Ciprofloxacin, GEN- Gentamicin

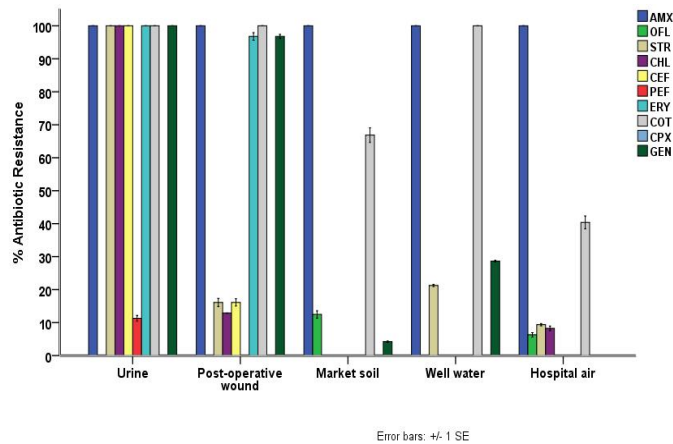


**Fig. 3. Percentage antibiotic resistance of *K. pneumoniae* isolated from different sources**  
 KEYS: AU- Augmentin, PEF- Pefloxacin, SXT- Septrin, CH- Chloramphenicol, CN-Gentamicin, OFX- Ofloxacin, AM- Amoxacillin, CPX- Ciprofloxacin, SP- Sparfloxacin. S- streptomycin

In well water, there was no significant difference ( $p \leq 0.05$ ) in resistant patterns of *S. aureus* isolates to ofloxacin, ceftriazone, pefloxacin, erythromycin and low frequency of resistance was observed in streptomycin and gentamicin. There was no significant difference ( $p \leq 0.05$ ) in resistance pattern of *S. aureus* isolate to amoxicillin and cotrimoxazole. They were observed to be 100% resistance. In hospital air, there was significant difference ( $p \leq 0.05$ ) in resistance of *S. aureus* isolates to amoxicillin (100%) and cotrimoxazole (45%) and low frequency of resistance was observed to ofloxacin (5%) streptomycin (8%) and chloramphenicol (7%). The details are shown in Fig. 4.

#### 4. DISCUSSION

The result obtained in this research has shown that there were differences in the microbial load of *K. pneumoniae* and *S. aureus* isolated from various clinical and environmental sources in Ondo State, the total viable bacterial count observed in Ondo central was higher than what was observed in Ondo north and south. However, the total viable count of *S. aureus* observed in post-operative wound was higher than other sources. High *S. aureus* count observed in this study was also in agreement with the result of Gayathree and Srinivas [15] who reported high prevalence of *S. aureus*



**Fig. 4. Percentage antibiotic resistance of *S. aureus* isolated from different sources**  
 KEYS: AMX- Amoxicillin, OFL- Ofloxacin, STR- Streptomycin, CHL- Chloranphenicol CEF- Ceftriazone, PEF-Pefloxacin ERY- Erythromycin COT-Cotrimoxacin CPX- Ciprofloxaci, GEN- Gentamicin

(32.2% out of 83 samples) from post-operative wound patients which was found to be statistically highly significant. Also studies on surgical site infections in india by Kownhar et al. [16], have shown that the incidence of 37% of *S. aureus*. This may be attributed to the fact that there may be more *S. aureus* carrier among the hospital staff in which some of the staff could be silent carriers. High *K. pneumoniae* was observed in urine samples among the clinical samples in this study, was also corroborate result of Thosar and Kamble [17], who reported that different clinical samples of *K. pneumoniae* were observed to be high in urine among all the samples collected 185(42.86%) out of 385 samples collected. Evaluation of environmental samples showed that *S. aureus* was more frequent in the soil when compared with well water and hospital air samples, whereas *K. pneumoniae* was more frequent in well water; this occurred across the State. High frequency of *S. aureus* in market soil was in agreement with the result of Raga [18] who reported high occurrence of *S. aureus* from soil samples.

Multiple antibiotics resistance in bacterial population is currently one of the greatest challenges in the effective management of infections. Antimicrobial drugs have been proved remarkably effective for the control of bacterial infections. However, it was soon evidenced that bacterial pathogens were unlikely to surrender unconditionally and some pathogens rapidly became resistant to many antibiotics [13]. In this study, clinical and environmental samples were examined for the presence of multidrug resistant *K. pneumoniae* and *S. aureus* and the effect of

plasmid curing on antibiotic resistant isolates were determined.

This result revealed high resistant of *K. pneumoniae* and *S. aureus* to antibiotics in Ondo north and south. In this study *K. pneumoniae* isolated from different sources was observed to be multidrug resistance except *K. pneumoniae* isolated from urine samples, were observed to be susceptible to all antibiotics used. This is in agreement with the [19], who reported that identification of *K. pneumoniae* and *K. oxytoca* in urine specimens where *K. pneumoniae* showed susceptibility to all antibiotics used for the study which includes (Amoxicillin, chloramphenicol, ciprofloxacin, gentamicin, sparfloxacin, augmentin). This may be due to these antibiotics have not been extensively used to cause resistance developing against them acquiring resistant genes [20]. The result also revealed that *S. aureus* strains isolated from urine samples were 100% resistant to amoxicillin, streptomycin, chloranphenicol, ceftriazone, gentamicin, erythromycin and cotrimoxazole, *S. aureus* isolated from post-operative wound were 100% resistant to amoxicillin and cotrimoxazole, 99% resistance to gentamicin and erythromycin); while isolates from market soil were resistant to amoxicillin (100%), cotrimoxazole (69%); *S. aureus* isolated from well water (100% resistance to amoxicillin and cotrimoxazole, 30% resistance to gentamicin); *S. aureus* isolated from hospital air samples (amoxicillin 100% and Cotrimoxazole 40%) which is in accordance with the study of [21], *S. aureus* resistance to Gentamicin (81.7%), ampicillin (76.9%), Nalidixic acid (72.1%), and



chloramphenicol (70.1%) and the reports of [22]. The high frequency of resistance observed in these isolates to antibiotics could be attributed to their use in treatment of diseases in humans. This implies that these antibiotics are no longer be effectively used as empirical therapy for *S aureus* infections particularly in the study area. The low activity of these antibiotics can also be attributed in part to earlier exposure of the isolates to these drugs, which may have enhanced resistant development. This assertion can further be strengthened by the high level of antibiotic abuse in our locality, arising from self-medication, failure to comply with treatment, antibiotic sale behavior for example, sale of antibiotics without prescription, sale of under dose and substituting brands.

## 5. CONCLUSION

This study revealed the occurrence of *S. aureus* and *K. pneumoniae* in clinical and environmental samples from all the three senatorial districts in Ondo state, Nigeria. These isolates showed different degrees of resistant to antibiotics and there were multidrug resistant *S. aureus* and *K. pneumoniae* in both clinical and environmental samples. The high resistance of isolates to Septtrin, Chloramphenicol, Amoxacillin and Sparfloxacin in all samples could pose a threat to public health and increase in morbidity and mortality.

## CONSENT AND ETHICAL APPROVAL

To carry out this study, authors were given ethical approval by the Ondo State Hospital Management board to carry out microbiological analysis on urine and wound swab collected from different hospitals in the state. Prior to the collection of the sample, the nature of the study was explained to the patients and they were assured that their identity will not be revealed, after which those that are not willing to participate were allowed to withdraw willingly and others that are willing to participate gave a consent to participate in the study.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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