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Phenotypic Identification and Antibiotics Susceptibility Profile of *Staphylococcus aureus* from Surgical Equipment and Hospital Environment in Lokoja, Kogi State, Nigeria

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Abstract

Staphylococcus aureus is one of the prominent causes of hospital-acquired bacteremia. Despite the availability of anti-staphylococcal antibiotics, hospital acquired S. aureus bacteremia is still a major problem with considerable morbidity and mortality. Therefore, the aim of this study was to isolate, identify and determine the Antibiotics susceptibility profile of Staphylococcus aureus from the surfaces of surgical equipment and environment of major public and private hospitals in Lokoja, Kogi State, Nigeria using colonial characteristics, microscopy and conventional biochemical techniques. The Antibiotics susceptibility profile of the isolates was determined in accordance with the Guidelines of Clinical and Laboratory Standard Institute (CLSI). A total of three hundred and fifty (350) swab samples comprising of fourty (40) from surgical equipment and three hundred and ten (310) from the environment were collected from three (3) different public and private hospitals within Lokoja metropolis. The results obtained showed that 110(31.4%) of samples from the hospital environment were confirmed positive for Staphylococcus aureus with Hospital A constituting 30(8.6%), Hospital B had 59(16.8%) and Hospital C recorded 21 (6.0%). Of the 19 selected S. aureus isolates for antimicrobial susceptibility screening, 10.52% and 5.26% were intermediately resistant to Norfloxacin and Chloramphenicol respectively. Furthermore, the screened S. aureus isolates showed 100% susceptible to Ciprofloxacin, Gentamicin and Erythromycin; 94.73% susceptible to Chloramphenicol and 89.47% susceptible to Levoflaxin. The result also revealed 100% resistance to Penicillin and 15.78% resistance to Rifampicin. The high presence of Staphylococcus aureus in the hospital environment is a potential threat to the health of the patients and the public as this organism has been implicated in several human diseases, especially hospital- acquired bacteremia. Therefore, improved personal and public hygienic practices within the hospitals are required to reduce the high presence of S. aureus and other pathogenic microorganisms.

Key words: Staphylococcus aureus, antimicrobial susceptibility profile, surgical equipment, Hospital environment, Lokoja

INTRODUCTION

Staphylococcus genus is a diverse group of bacteria with about 30 species (Al-Zoubi *et al.*, 2015). *Staphylococcus aureus* has been well-known as the most clinically important species, with huge presence in environment. It is part of the normal flora of human body and normally carried on the skin or in the nose of apparently healthy individuals, which makes it easy to be transmitted by air or fomites from patients or carriers (Asbell *et al.*, 2008; Al-Zoubi *et al.*, 2015). It is a significant pathogen in human infections (Holmes *et al.*, 2005; Rantala, 2014).

Resistance of bacteria to antibiotics has been documented since the first drugs were introduced for clinical use. Penicillin was the first set of drug introduced for clinical use in 1941, when less than 1% of *Staphylococcus aureus* strains were resistant to its action (Chinedum, 2005). By 1947, 38% of hospital strains had acquired resistance and currently over 90% of *Staphylococcus aureus* isolates were resistant to penicillin (Filius and Gyssens, 2002). Increasing resistance to antibiotics is a result of selective pressures power (Xiong *et al.*, 2015).

In orthopedics, *Staphylococcus aureus* has been implicated in surgical site infection, painful infection of joint fluid known as septic or infective arthritis, post-surgery infection,

implant devices infection following trauma, chronic osteomyelitis subsequent to an open fracture, meningitis following skull fracture (Gibb and Hadjiargyrou, 2021).

Methicillin-resistant *Staphylococcus aureus* (MRSA) has been isolated and documented more than 50 years ago. MRSA is a specific strain of the *Staphylococcus aureus* which is resistant to Methicillin and all ß-lactams. Later use of Oxacillin as an alternative to Methicillin insusceptibility tests resulted in the term Oxacillin-Resistant *Staphylococcus aureus* (ORSA), which is resistant to numerous antibiotics (Ghias *et al.*, 2016). The worldwide spread of MRSAs constitutes one of the most serious modern challenges to the treatment of hospital acquired infections (Huttner *et al.*, 2013). MRSA carries an exceptionally efficient antibiotic resistance mechanism that can defend the microorganisms against all members of ß-lactam antibiotics. This makes infections caused by these pathogens very difficult to manage and costly to treat (Lee *et al.*, 2018).

It has been estimated that 20 to 40% of hospital acquired infections have been attributed to cross infection via the hands of hospital workers who have become contaminated from direct contact with the patient or indirectly by touching contaminated environmental surfaces (Aminu *et al.*, 2014). Stethoscopes, neckties, skin cells, hair, food, computer keyboards, pens, tables, acrylic fingernails, surgical equipment, beddings and clothing are common hospital sources of pathogens (Aminu *et al.*, 2014).

Staphylococcus aureus has the ability to survive in potentially dry and stressful environments, such as the human nose and on the skin and inanimate surfaces and can remain viable in hands and environmental surfaces for extended durations after initial contact (Wertheim *et al.*, 2005). Therefore, this study was aimed at determining the antibiotic susceptibility profile of *Staphylococcus aureus* isolates from surgical equipment and environments of major public and private hospitals in Lokoja, Kogi State, Nigeria.

MATERIALS AND METHODS

Study Area

This work was conducted within Lokoja metropolis, capital of Kogi State. It lies at the confluence of the Niger and Benue rivers. Lokoja is located at latitude 7°45′0″N to 7°53′30″N and longitude 6°43′0″E to 6°51′30″E (see Fig. 1), with a total land area of 29,833 km^2. Lokoja is characterized by wet and dry seasons, with annual rainfall between 1016 mm and 1524 mm and an average annual temperature of 27 °C (Buba *et al.*, 2021).

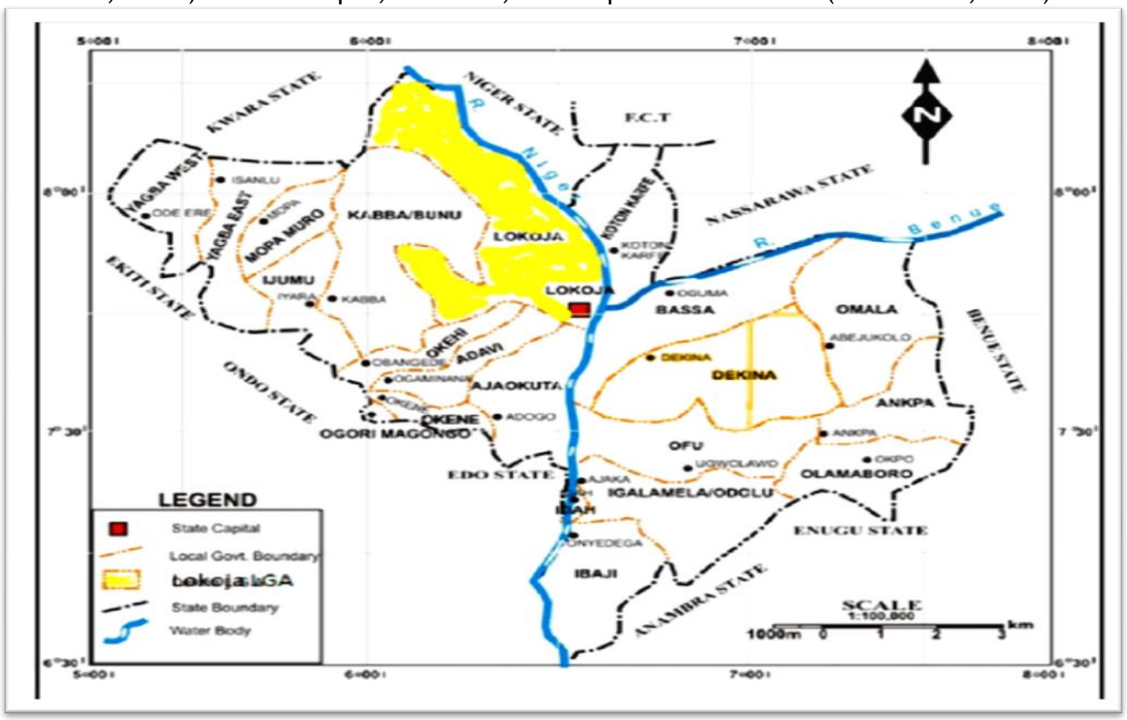

Figure 1: The Map of Kogi State showing the study Area and the neighbouring States (Adapted from Buba *et al.*, 2021).

Determination of Sample Size

The sample size was determined with a prevalent of 32.35% (Omololu, 2017) following the formular of Sarmukaddam and Gerald (2004).

$$N = \frac{Z^2\ p\ (1-p)}{L^2}$$

N = number of sample
Z = the standard normal distribution at 95% confidence interval = 1.96
P = the prevalent of previous study = 32.35% = 0.3235
I-P = 1- 0.3235 = 0.6765
L = the allowable error which is taken at 5% = 0.05

Therefore $N = \frac{(1.96)^2 \times 0.3235 \times 0.6765}{0.05^2}$

$N = \frac{0.840725510}{0.0025}$

N = 336.3

The calculated sample size was 336.3. In this study, 350 surgical and environmental samples were collected across the three selected hospitals included in this study.

Proportionate Distribution of Samples

The proportionate distribution of the sample size and types across the study population was based on the sizes of the respective hospitals included in the study.

Sample Collection

Strict aseptic procedures were followed to prevent contamination with microorganisms present on the skin of the sampler and barn environment as described by Al-Zoubi *et al*. (2015).A total of 350 swab samples were directly collected from various equipment and parts of the hospitals including floor of wards (n=60), bed railings (n=110), bed linens (n=85), water taps (n-10), door handles (n-45) and surgical equipment (n-40). All samples were immediately transferred to the laboratory at 4ºC in a cooler with ice packs for bacteriological analysis.

Inoculation

Streaking method was adopted for the inoculation on the agar plates in an aseptic condition following the procedure described by (Suleiman *et al*., 2019). All inoculated plates were incubated at 37ºC for 24hours.

Isolation and Identification of *Staphylococcus aureus*

Staphylococcus aureus was isolated from swab samples of surgical equipment and hospital environment following the procedure described by Suleiman *et al*. (2019). Briefly, the swabs were inoculated on mannitol salt agar and incubated at 37ºC for 24 hours. Colonies suspected to be staphylococci were subcultured and further identified using Gram staining reaction, catalase test, coagulase test, oxidase test, Voges-Proskauer test, Citrate utilization test, indole test and hemolysis test by standard bacteriological procedures. Typical isolates of *Staphylococcus aureus* were stored on nutrient agar slants for further studies as described by Suleiman *et al*. (2019).

Antibiotics Susceptibility Test (AST)

Antibacterial Susceptibility profile was determined using the simple disc diffusion technique on Mueller-Hinton Agar against eight (8) commonly used antibiotics in accordance with the Guidelines of Clinical and Laboratory Standards Institute (CLSI, 2016). Susceptibility of *Staphylococcus aureus* isolates were tested against Ciprofloxacin (5mg), Norfloxacin (10mg), Gentamicin (10mg), Rifampicin (5mg), Erythromycin (15mg), Chloramphenicol (30mg), Levofloxacin (5mg) and Penicillin (10mg) (Oxoid, UK). Using a sterile inoculating loop, three to four colonies were picked and suspended in 3ml sterile saline solution. Turbidity of the bacteria suspension was adjusted to 0.5 McFarland standards. Inoculation was done by streaking method and allowed to dry on the Mueller-Hinton Agar. The discs were aseptically placed on the inoculated media using sterile forceps. The discs were allowed to stand for at least 30minutes before incubating at 35^{oC} for 24hours. The diameter of the Zone of inhibition produced by each antibiotic disc was measured and interpreted using the CLSI Zone diameter interpretation standards (CLSI, 2016). The result was recorded as susceptible; intermediately resistant and resistant as described by Makolo *et al*. (2019).

RESULTS

Phenotypic Identification of *S. aureus*

The isolation and characterization result of the *S. aureus* from samples analyzed by colony morphology and biochemical tests are depicted in Tables 1 and 2 respectively.

Table 1: Colony morphology of the *Staphylococcus aureus* isolates

Isolate	Cultural Characteristics	Microscopic Characteristics	Gram-Stain
Staphylococcus aureus	Small, golden yellow colonies on MSA	Cocci, arranged in clusters and non-motile	Positive

Table 2: Biochemical characteristics of the *Staphylococcus aureus* isolates

Suspected *S. aureus* isolate	Cat.	Coag.	Oxid.	VP	Citr.	Ind.	Hem.	Probable organism
Bbr1	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
Bbl1	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
BTp1	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
BTp2	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
BTp3	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
BFl1	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
BFl2	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
B li3	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
BFl4	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
Cbri	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
Cbl1	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
CTp1	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
CFl1	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
CFl2	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
Abr1	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
Abl1	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
ATp1	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
A Fl1	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*
AFl2	+ (+ve)	+ (+ve)	+ (-ve)	+ (+ve)	+ (+ve)	+(-ve)	+ (+ve) Beta	*S. aureus*

Key = Cat = Catalase test, Coag = Coagulase test, Oxid. = Oxidase test, VP = Voges Proskaeur, Ind. = Indole, Hem.= Hemolysis

Prevalence of *S. aureus* from the study area

From the three hundred and fifty (350) samples analyzed for the presence of *Staphylococcus aureus*, the results obtained revealed that 30 (8.6%), 59 (16.8%) and 21 (6.0%) *Staphylococcus aureus* were isolated accordingly from medical facilities sampled (Hospitals A, B and C) respectively. Samples collected from Hospital B yielded the highest number of *S. aureus* isolate (Tables 3, 4 and 5).

Table 3: Prevalence of *Staphylococcus aureus* from the samples collected in Hospital A

S/N	Medical Facilities Swabbed	Number of Samples Collected	Sample Code	No (%) of *S. aureus* isolates
1	Bed railing	45	Abr	6(4.0)
2	Bed Linen	40	Abl	12(8.0)
3	Water tap	5	ATp	5(3.3)
4	Floor	20	AFl	0(0.0)
5	Door Handles	20	ADh	7(4.6)
6	Scissors	10	ASc	0(0.0)
7	Scalpel	10	Asp	0(0.0)
	Total	**150**		**30 (8.6%)**

Key:
Abr = Samples collected from bed railing in Hospital A; Abl = Samples collected from bed linen in Hospital A; ATp = Samples collected from water tap in Hospital A; AFl = Samples collected from the floor in Hospital A ADh= Samples collected from door handles in Hospital A; ASc = Samples collected from scissors in Hospital A ASp = Samples collected from scalpel in Hospital A

Table 4: Prevalence of *Staphylococcus aureus* from samples collected in Hospital B

S/N	Medical Facilities Swabbed	Number of Samples Collected	Sample Code	No (%) of *S. aureus* isolates
1	Bed railing	40	Bbr	13(11.0)
2	Bed Linen	25	Bbl	24(20.6)
3	Water tap	3	BTp	5(4.3)
4	Floor	20	BFl	2(1.7)
5	Door handle	15	BDh	15(12.9)
6	Scissors	6	BSc	0(0.0)
7	Scalpel	7	BSp	0(0.0)
	Total	**116**		**59 (16.8%)**

Key:
Bbr = Samples collected from bed railing in Hospital B; Bbl = Samples collected from bed linen in Hospital B BTp = Samples collected from water tap in Hospital B; BFl = Samples collected from the floor in Hospital B BDh= Samples collected from door handles in Hospital B; BSc = Samples collected from scissors in Hospital B BSp = Samples collected from scalpel in Hospital B

Table 5: Prevalence of *Staphylococcus aureus* from samples collected in Hospital C

S/N	Medical Facilities Swabbed	Number of Samples Collected	Sample Code	No (%) of *S. aureus* isolates
1	Bed railing	28	Cbr	5(5.8)
2	Bed Linen	30	Cbl	8(9.4)
3	Water tap	2	CTp	2(2.3)
4	Floor	10	CFl	2(2.3)
5	Door Handles	10	CDh	4(4.7)
6	Scissors	3	CSc	0(0.0)
7	Scalpel	2	CSp	0(0.0)
	Total	**85**		**21(6.0%)**

Key:
Cbr = Samples collected from bed railing in Hospital C; Cbl = Samples collected from bed linen in Hospital C CTp = Samples collected from water tap in Hospital C; CFl = Samples collected from the floor in Hospital C CDh= Samples collected from door handles in Hospital C; CSc = Samples collected from scissors in Hospital C CSp = Samples collected from scalpel in Hospital C

Antimicrobial susceptibility Profile

The zones of inhibition of selected *S. aureus* isolates displayed against the tested antibiotics and their interpretations following the CLSI guidelines are shown in Tables 6 and 7 respectively.

Table 6: Zones of inhibition of the antibiotics tested against the isolates of selected *S. aureus* (measured in milimetres) (n=19)

S/N	Isolate code	PEN	CPX	NB	CN	RD	E	CH	LEV
1	Bbr1	28	24	21	26	25	25	27	23
2	Bbl1	27	25	23	24	23	27	25	25
3	BTp1	26	27	25	27	26	25	23	24
4	BTp2	25	25	22	25	24	27	26	27
5	BTp3	27	24	27	23	16	24	17	15
6	BFl1	26	23	25	26	26	26	25	22
7	BFl2	28	26	23	24	24	24	27	25
8	B li3	25	25	26	25	22	27	24	23
9	BFl4	27	24	19	23	16	25	26	25
10	Cbri	24	27	27	24	27	27	23	27
11	Cbl1	28	25	25	23	26	23	24	25
12	CTp1	26	27	23	21	23	25	27	24
13	CFl1	28	25	26	26	25	27	22	23
14	CFl2	27	28	19	25	27	24	24	27
15	Abr1	25	25	24	23	24	26	25	15
16	Abl1	27	25	25	24	16	23	24	25
17	ATp1	26	26	27	25	26	25	27	24
18	A Fl1	24	24	25	22	22	27	25	26
19	AFl2	27	27	23	24	26	24	22	24

Key: PEN=Penicillin, NB=Norfloxacin; RD=Rifampicin; E=Erythromycin; CH=Chloramphenicol; LEV=Levofloxacin; CPX=Ciprofloxacin; CN=Gentamicin

Table 7: Result of Antibiotics susceptibility profile of *S. aureus* isolates obtained from the environment of major public and private hospitals in Lokoja (n=19)

Antibiotics	No. (%) of Sensitive isolates	No. (%) of Intermediately Resistant isolates	No. (%) of Resistant isolates	Total
Ciprofloxacin 10µg	19(100%)	0(0)	0(0)	19(100%)
Norfloxacin 10µg	17 (87.47)	2(10.52)	0(0)	19(100%)
Penicillin 10µg	0(0)	0(0)	19(100)	19(100%)
Gentamicin 10µg	19(100)	0(0)	0(0)	19(100%)
Rifampicin 20µg	16(84.21)	0(0)	4(15.78)	19(100%)
Erythromycin 30µg	19(100)	0(0)	0(0)	19(100%)
Chloramphenicol 30µg	18(94.73	1(5.26)	0(0)	19(100%)
Levofloxacin 20µg	17(89.47)	0(0)	2(10.2)	19(100%)

This study also established four (4) resistance patterns of selected *S. aureus* isolates tested against eight (8) antibiotics. The result also showed that the isolates exhibited multi drug resistance (MDR), as they were resistant to more than two (2) classes of antibiotics tested. High percentages (100%) of isolates were susceptible to ciprofloxacin, Gentamicin and Erythromycin followed by Chloramphenicol (94.73) and Levofloxacin (89.47%). However, Penicillin and Rifampicin showed (100%) and (15.78) resistance respectively as shown in Table 8.

Table 8: Antibiotics Resistance Patterns of selected *S. aureus* isolates from the environment of major public and private hospitals in Lokoja

S/N	Resistance patterns	*S. aureus* isolates	Frequency
1	PEN	Bbrl, Bbl1, BTp1, BTp2, BFl1, BFl2, BFl3, Cbrl, Cbl1, CTp1, CFl1, ATp1, AFl1 and AFl2	14
2	PEN, RD, LEV	BTpp3	1
3	PEN, RD	BFl4, Abl1	2
4	PEN, LEV	Abr	1

Key: PEN=Penicillin, RD=Rifampicin, LEV=Levofloxacin

The MAR index result established that *S. aureus* isolate (BTp3) obtained from the water tap of SPTp3 had the highest MAR index of 0.3 (resistant to 3 out of the 8 antibiotics tested), followed by the *S. aureus* isolates (BF14, Abr1 and Ab11) obtained from Floor of SPFL4, bed reentry FMCbrl and bed linen of FMCbl1 which had 0.2 MAR index each (resistant to 2 out the 8 antibiotics tested (Table 9).

Table 9: Multiple Antibiotic Resistance (MAR) index of selected *S. aureus* isolates obtained from the environment of major public and private hospitals in Lokoja

S/N	*S. aureus* isolates	Frequency
1	Bbr1	0.1
2	Bbl1	0.1
3	BTp1	0.1
4	BTp2	0.1
5	BTp3	0.3
6	BFl1	0.1
7	BFl3	0.1
8	BFl4	0.2
9	Cbr1	0.1
10	Cbl1	0.1
11	CTp1	0.1
12	CFl1	0.1
13	CFl2	0.1
14	Abr1	0.2
15	Abl1	0.2
16	ATp1	0.1
17	AFl1	0.1
18	AFl2	0.1
19	BFl1	0.1

DISCUSSION

Knowledge on the carrier rate of *Staphylococcus aureus* in the hospital environments and possible consequences on the patients, hospital workers and visitors is helpful to the mismanagement and policy makers to prevent the spread of hospital acquired *Staphylococcus aureus* bacteremia.

This study recorded a high prevalence of *Staphylococcus aureus* from the environment of the investigated hospitals. This might be due to lack of proper and regular cleaning and disinfection with appropriate disinfectants. Also, high occurrence of *Staphylococcus aureus* isolates recorded from the taps of all the hospitals could be as a result of frequent contacts with the taps by patients and health workers within the hospital since *Staphylococcus aureus* is part of the normal flora of the skin (Calfee *et al.*, 2014). The findings of this study are similar to the research conducted by Omololu-Aso *et al.* (2011) which established similar prevalence for *Staphylococcus aureus* from the hospital environments. However, *Staphylococcus aureus* was not isolated from all the surgical equipment sampled. This might be due to regular sterilization at appropriate temperature and disinfection of the equipment with appropriate disinfectants before and after use to circumvent surgical Site Infections (SSI) as *Staphylococcus aureus* has been implicated as the major cause (Shekhar *et al.*, 2019).

Furthermore, the increasing pressure of *Staphylococcus aureus* in hospitals environment is a serious challenge as many patients have weakened immune system and are vulnerable to hospital-acquired *Staphylococcus aureus* bacteremia that can complicate their health conditions (Carey *et al.*, 2008).

Staphylococcus aureus isolates were highly susceptible to Ciprofloxacin, Gentamicin, Erythromycin, Chloramphenicol, Norfloxacin and Rifampicin. Low level of resistance was demonstrated to Levofloxacin and Rifampicin, and intermediate resistance to Norfloxacin and Chloramphenicol in this study. This might be due to the increase in the use and abuse of these drugs which can lead to complete resistance development. Furthermore, the *Staphylococcus aureus* isolates in this study were all resistant to Penicillin. This finding is in line with the reports of some researchers who have found penicillin to have the highest rate of resistance by clinical isolates especially *Staphylococcus aureus* (Onwubiko and Sadiq, 2011; Sadeghi *and* Mansouri,2014;) due to the

production of beta-lactamases and permeability barriers on their cell surfaces.

CONCLUSION

This study has established that the hospital environment investigated haboured high number of *Staphylococcus aureus,* which has been implicated in several human health challenges, ranging from mild to life threatening infections. High susceptibility profile displayed by *Staphylococcus aureus* isolates to Ciprofloxacin, Gentamicin and Erythromycin in this study is an indication that these antibiotics can still be used for empirical treatment of hospital acquired staphylococcal infections within the study population and are therefore recommended as drugs of choice.

Recommendations

Based on the findings in this study, the following recommendations are made:

i. Effective disinfection of bed railings, washing and disinfection of bed linen by hospital infection control unit should be performed periodically to reduce colonization of *Staphylococcus aureus* on various surfaces of the hospitals.
ii. The floors of the wards should be cleaned and disinfected regularly with potent disinfectants.
iii. Conscientious contact control procedures should be put in place to minimize the spread of this pathogen in hospitals where interaction between patients and health care workers is very common and frequents.
iv. Based on the susceptibility profile of the *S. aureus* isolates to the antibiotics tested in this study, Ciprofloxacin, Gentamicin and Erythromycin are recommended as drugs of choice against Staphylococcal infections that may arise within the areas covered by this study.

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