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Nasal Carriage of Staphylococcus aureus and Antibiogram among Medical Undergraduate Students of a Private University in Ogun State, Nigeria

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Funding: The author(s) received no specific funding for this work.

Potential competing interests: The author(s) declared that no potential competing interests exist.

Abstract

Nasal carriage plays a crucial role in the transmission *Staphylococcus aureus* (*S. aureus*) infection in hospital settings and methicillin-resistant strains in particular have become a major issue worldwide. The aim of this study is to assess the nasal carriage of *S. aureus* and methicillin resistant strain among medical undergraduate students of a private University in Ogun state. A total of 200 nasal swabs were collected from the consenting study participants and streaked on mannitol salt and chocolate agar. Culture plates were incubated at 37°C for 18-24hours and isolates were identified using Gram stain and standard biochemical tests. Antibiotic sensitivity was performed by both disc diffusion and agar dilution methods. Percentage occurrence of *S. aureus* among the study participants was 34%. Occurrence of methicillin sensitive *S. aureus* (MSSA) was 38.2%; while that of methicillin resistant *S. aureus* (MRSA) was 61.8%. Highest nasal carriage of MRSA was found among the medicine and surgery students (30%). The 500 level students were the most colonized by MRSA strains with a prevalence of 66.6%. Amongst the six antibiotics tested, vancomycin and cefoxitin had the highest resistance rate, 47.1% and 61.8%, respectively, while clindamycin and erythromycin were the most sensitive of all the antibiotics assayed, recording a susceptibility rate of 70.6%, each. A major risk factor associated with the occurrence of MRSA is misuse of antibiotics. To this end, policy regulation on antibiotics prescription and usage, as well as guidelines on MRSA detection and control measures is therefore very crucial to stem the upsurge of resistant strains.

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Key Words: Nasal carriage, Staphylococcus aureus, Methicillin, Resistance, Prevalence.

Introduction

The human nose serves as habitat and means of transmission for various pathogenic microorganisms. Infection and transmission of *Staphylococcus aureus* have been linked to nasal carriage in hospitals and hospital-related community settings (Wertheim *et al.,* 2005; Mohammed *et al.,* 2020). The pathogenic bacterium *S. aureus* colonizes primarily the epithelial surfaces of the human skin. *S. aureus* can infect both healthy people and people who are immunocompromised. The genus *Staphylococcus* belongs to the Micrococcaceae family, which includes a broad collection of bacteria capable of causing a broad spectrum of diseases. They are Gram-positive cocci that produce a variety of extracellular and cell surface virulence agents and are catalase-positive in their biochemical identification (Cheesbrough, 2006; Gillaspy and Landolo, 2009).

Staphylococci are common commensals that colonize approximately one-third of the human population, unless they obtain entrance through a cut or injury, colonists are usually harmless. Even though staphylococci were once susceptible to penicillin, nearly all recent clinical isolates are now resistant, and the emergence of multiple drug resistance is also frequent, as this is mostly associated with the methicillin-resistant *S. aureus,* the (MRSA) strains. These strains are usually resistant to medications that are frequently used to treat staphylococcal related infections, and many have recently developed resistance to vancomycin, which is (a last-resort antibiotic for the treatment of staphylococcal infection). MRSA strains have been found in community-acquired infections, and most significantly, their involvement in hospital-acquired infections. As a result, a concerted effort has been made to identify and characterize new antibiotics and vaccines effective against the MRSA strain (Gillaspy and Iandolo, 2009; Garoy *et al.,* 2019; Chai *et al.,* 2022; Mamman *et al.,* 2022; Nandhini *et al.,* 2022).

Nasal carriage plays an important role in the aetiology of *S. aureus* infections (Kluytmans *et al*., 1997) among patients in intensive care unit - ICU (Garrouste-Orgeas *et al.,* 2001; Nouwen *et al.,* 2005; Wertheim *et al.,* 2005) and among patients undergoing dialysis (Kluytmans *et al.,* 1996; Nouwen *et al.,* 2005), surgery (Perl *et al.,* 2002; Mohammed *et al.,* 2020). *S. aureus* must successfully engage with human nasal epithelial cells and get past host's defence system in order to establish infection and colonize human nares. However, *S. aureus* colonization can be impacted by or even prevented by a number of circumstances, including bacterial interactions in the human nose. Also, specific host characteristics and environmental factors can favor colonization (Sakr *et al.,* 2018). Nasal colonization can therefore lead to the development of opportunistic and potential fatal infections in non-surgical patients, as well as surgical patients mostly at surgical sites, causing surgical site infections or other forms of infections with attending increase in healthcare costs, disease-burden and even death (Sakr *et al*., 2018).

Staphylococcal infections have been mostly implicated among the hospital acquired infection, most importantly the MRSA

strain which has posed a threat due to its antibiotic resistance, thus the role of medical undergraduates in the transmission of nosocomial infections like *S. aureus* infections to their health care attendants (patients) needs emphasis. These groups of people in the hospital can be a source of carrier and a reservoir for transmission to patients because nasal colonization of the pathogenic organism can lead to infection and re-infection amongst hospitalized patients. Also, nasal colonization of healthcare workers by MRSA constitutes potential enormous public health threat to the well-being of in-patients due to their ability to transmit this multidrug-resistant (MDR) bacteria strain in hospital settings.

To the best of our knowledge, no data on nasal carriage of*Staphylococcus aureus* among undergraduate students of Babcock University exists. Scarcity of data in this regard, therefore necessitates this research. The aim of this study is therefore to assess the nasal carriage of *S. aureus* and methicillin resistant strain (MRSA), as well as the antibiotic susceptibility pattern among medical undergraduate students of Babcock University, Ilishan-Remo, Ogun state.

Methodology

Study Design

This cross-sectional institutional based and descriptive study was carried among undergraduate medical students of a Babcock University, Ogun state, Nigeria.

Study Area

This study was carried out among medical undergraduate students of a private university in Ogun state, Nigeria. Ogun state is situated in the south western part of Nigeria, between the latitude 6.2^0N and 7.8^0N and longitude 3.0^0 and 5.0^0E east of the Greenwich Meridian. On the west, the state is bounded by the Republic of Benin, and on the east, by Ondo state, Oyo State is to the north, Lagos State and the Atlantic Ocean to the south. Ogun State is the 24th largest State in Nigeria with land area of 16,762 km^2. There are a total of twenty (20) Local Government Areas (LGAs) in the state, predominantly covered by rain forest and wooden savanna in the northwest. Ogun State has a total population of 3,751,140 residents as of 2006, ranking the State the 16th most populated state in Nigeriain terms of landmass (*https://en.wikipedia.org/wiki/Ogun_State*).

Duration of Study

The research work lasted for 2 months (May to June, 2022).

Sampling Size Calculation

The sample size for this study was calculated using the formula as described by Sharma*et al.* (2020).

$$N = \frac{(z1\text{-}a/2)^2 * (p)(q)}{d^2}$$

n= minimum sample size required

Z1-a/2= Critical value for corresponding level of confidence (At 95% cl or 5% level of significance, it is 1.96).

p = Expected Prevalence of *S. aureus* nasal carriage

q = 1-p, where p=0.168, 1-0.168=0.832

d= Margin of error or Precision is 0.05 (Sharma*et al.*, 2020).

For the calculation, a 95% confidence level, a P value of 0.148,*i.e,* a prevalence rate of 16.8% of*S. aureus* in the anterior nares of food handlers by (Ibrahim and Sule, 2021), and margin of error (d) set at 0.05 was used to determine the minimum sample size required.

$$N = \frac{(z1\text{-}a/2)^2 * (p)(q)}{d^2}$$

Z=1.96

P=16.8% (Ibrahim and Sule, 2021).

d=0.05

$$N = \frac{1.96^2 \text{ x } (0.168) \text{ x } (1\text{-}0.168)}{(0.05^2)}$$

$$N = \frac{3.8416 \text{ x } (0.168) \text{ x } (0.832)}{0.0025}$$

$$N = \frac{0.5369}{0.0025}$$

N= 214.76 ≈ 215

N= 215.

Sample Selection

A total of 200 subjects from three (3) departments were enrolled for this study: Medicine and Surgery (70), Nursing Sciences (62), and Medical Laboratory Science (68).

Eligibility of Subjects

Inclusion Criteria

Consenting medical undergraduate students of Babcock University were recruited for the study.

Exclusion Criteria

Non-medical undergraduate students were excluded from the study.

Informed Consent

Each subject gave their informed consent. Prior to sample collection, each participant received a thorough explanation of the study's aim and methodology. Following this, participants were asked to voluntarily complete a consent form in their own handwriting and sign it as a sign of their desire to supply samples for the test. Their confidentiality regarding the result from the study was also affirmed to them.

Data Collection

A standardized questionnaire was used to gather demographic data from the subjects prior to specimen collection. To distinguish the three departments from one another, each questionnaire included a special participant identification number and other pertinent biographical information. Data collection took an average of 14 days. During this time, the questionnaires were distributed and collected, the study participants were chosen, and samples were collected from each department.

Sample Collection and Transportation

Swab samples were collected aseptically from the nostrils of study participants. The collected samples were thereafter transferred immediately into a sterile physiological saline (to ensure the viability of the organism in questioned prior the time of analysis in the laboratory. The samples were transported eventually to the laboratory where the analysis was carried out. The swab sticks were streaked directly on a medium (Mannitol salt agar - MSA) made selective for the isolation of *S. aureus*, and a chocolate medium to support growth of the fastidious strains of this organism. Both plates were incubated at 37°C for 48 hours.

Characterization and Identification

S. aureus was identified on the basis of colonial characteristics from the cultured plate, with a distinguishing yellowish coloration on mannitol salt agar (indicating mannitol fermentation on the plate), further identification using Gram staining and biochemical tests namely, catalase and tube coagulase test were performed for further confirmation of the isolates.

Antibiotic sensitivity testing

Antimicrobial susceptibility testing was performed using both Kirby Bauer disc diffusion method and dilution method. Clinical laboratory standard institutes guidelines (CLSI, 2013; 2019) were followed strictly. A 0.5 McFarland turbidity standard solution was used to correct the inoculum's density, and Mueller Hinton agar (Oxoid, UK) plates were inoculated aseptically with the resulting inoculum. The following antibiotics: Clindamycin (10µg), Gentamycin (10µg), Ciprofloxacin (5µg), Erythromycin (15µg), and Cefoxitin (30µg) were introduced on the solidified Mueller Hinton agar plates (Oxoid, UK) with the use of sterile forceps. For Vancomycin susceptibility testing, vancomycin injection was purchased and incorporated into Mueller Hinton agar at concentration of µg/ml. Incubation was then performed at 37°C for 18-24 hours. After incubation, the zones of inhibition generated by the antibiotics were measured and interpreted according to (CLSI, 2013; 2019) guidelines.

Kirby Bauer disc diffusion method

Briefly, using a sterile wire loop, 2- 3 well isolated colonies of test organism was be picked and emulsified in 5 ml of sterile normal saline. Using a Spectrophotometer, the turbidity of the test organism suspension was compared to the turbidity of 0.5 McFarland Standard. A drop of the inoculum was introduced into the Mueller Hinton agar plate, and a sterile swab stick was used to streak out the organism on the agar plate using the four quadrant streaking method so as to ensure an even distribution. The petri dish was covered with the lid and the agar surface was left to dry for around three to five minutes. Using sterile forceps, selected antibiotic discs were positioned and evenly spread on the inoculation plate. The discs were placed at about 15mm from the edge of the plate and were not closer to each other than about 25mm from disc to disc. Five (5) different antibiotic discs were placed on a typical 90mm petri dish namely: Erythromycin, Cefoxitin, Gentamycin, Ciprofloxacin, and Clindamycin respectively. Each antibiotic disc was gently pressed into the agar using the sterile forceps to ensure direct contact and diffusion without any disruption once in situ. The plate was inverted and incubated aerobically at 35°C for 16–18 hours after the discs were applied. The test plate underwent a zone of inhibition examination following an overnight incubation.

Result

Resistant

When a pathogen is labeled "resistant," it means that no matter the dose or the site of the infection, the infection it has caused cannot be treated with the drug to which it is resistant. Regardless of the size of the inhibitory zone, all strains exhibiting a heaped-up zone edge will be classified as "Resistant."

Intermediate

A pathogen that has been classified as intermediately susceptible means that the illness it has brought on is probably going to respond to treatment when the medication is given in higher dosages than usual or when it is concentrated at the infection site.

Susceptible
A pathogen classified as susceptible suggests that the infection it has caused is likely to respond to treatment when the drug to which it is susceptible is administered through the appropriate route and at the usual recommended dose.

Agar dilution Method

Briefly, one vial of vancomycin injection was used for this testing, it measured 1 gram (gm), having a standardized diluent of 10 ml from the manufacturer. The standard MIC for Vancomycin injection for Vancomycin resistant Staphylococcus aureus is 16 µg/ml in 1000ml of Mueller Hinton agar, which was equated for the standard 30 µg for Vancomycin on the CLSI (2019) chart. A total of 8µg/ml was incorporated into a 500ml of Mueller Hinton agar. A sterile needle and syringe was used to draw out the 10ml diluent from the manufacturer, it was then introduced inside the injection bottle. It was mixed vigorously to ensure the injection was properly dissolved. Using a sterile syringe, 3mls of the injection was drawn out and then dispensed in a new sterile test tube. 40 µl of the antibiotic was drawn out from the injection tube with the use of a micropipette with new sterile tips, the measured antibiotics was then carefully dispensed into 500ml of cooled molten Mueller Hinton agar. 30 ml of the Mueller Hinton antibiotic preparation was poured into petri dish, and allowed to solidify before drying in the hot air oven. An overnight nutrient broth culture of the test organism was compared with the turbidity of McFarland standard. Twenty microlitre (20 µl) of the organism solution was dropped in the Mueller Hinton agar in the various columns drawn out on the agar plate. It was allowed to stay on the plate for 30mins after which it was incubated at 37°C for 18 hrs. Presence or absence of colony formation on the plate was checked for, and this indicates sensitivity or resistivity to the queried antibiotics.
Clear zone of inhibition ---------- Indicates that the organism is sensitive to the antibiotics.
No zone of inhibition ---------- Indicates that the organism is resistant to the antibiotics.

Interpretation of zone sizes

The CLSI recommendations were used to interpret the antibiotic susceptibility test. The zones sizes of each antibiotic were evaluated using the Interpretative chart, and the isolate was classified as either "resistant" or "sensitive."

Data Analysis

Socio-demographic, clinical and laboratory data were entered into Excel and analyzed using Statistical software using packages within the Statistical Package for Social Sciences (SPSS) version 21.0 software statistical program. P-values

less than or equal to 0.05 was considered statistically significant at 95% confidence interval. Statistical analysis outputs were presented using both tables and charts.

Results

This present study assessed the nasal prevalence of*S. aureus*, and its antibiotic susceptibility amongst medical undergraduate students of a private university in Ogun state. The socio-demographic information of study participants including their course of study and level were presented in Table 1. A total of 200 nasal swabs were recruited for this study, and an overall of 68 (34%) isolates were recovered from the collected samples. Gram reaction characteristics, mannitol fermentation properties, and biochemical tests (catalase and coagulase positive results) were used to identify the *S. aureus* isolates. The colonization rate of *S. aureus* from the isolates showed that the females 39 (57.4%) were more colonized than the male 29 (42.6%) participants. There was no association between the prevalence of *S. aureus* based on gender differences (Chi square= 17.42; p>0.05). *S. aureus* colonization estimated among the age groups recorded that the higher age group were more colonized than the younger age group. Age group 16-20 years recorded a total colonization rate of 31 (45.6%), while age group 21-25 years recorded a total of 37 (54.4%) colonization. There was no association of *S. aureus* colonisation based on age differences, (Chi square= 24.28; p>0.05).

Table 1. *S. aureus* colonization among the study participants

Variables	Category	No of samples examined	No of Isolates (68) N (%)	Pearson Chi-square	P- value
Gender	Male Female	81 119	29(42.6) 39(57.4)	17.42	0.872
Age (Yrs)	16 – 20 21 – 25	110 90	31(45.6) 37(54.4)	24.28	0.432
Course of Study	Medicine Nursing Med Lab Sci.	70 62 68	26(38.2) 26(38.2) 16(23.6)	10.47	0.012
Level of Study	200 300 400 500 600	56 15 24 91 14	4(5.9) 5(7.4) 7(10.2) 47(69.1) 5(7.4)	12.52	0.005
Tribe	Yoruba Igbo Others	134 55 21	38(55.9) 23(33.8) 7(10.3)	17.25	1.142
	Total	200	68		

Nasal colonization of *S. aureus* among students of the three departments is as follows; Medicine 26 (38.2%), and Nursing 26 (38.2%) and Medical Laboratory Science 16 (23.5%). There was association of *S. aureus* colonization among the departments, (Chi-square=10.47; p=0.012). Three tribes were assessed in this study with nasal colonization of 38 (55.9%)

among the Yoruba, 23(33.8%) among the Igbos and others 7(10.3%), having the Yoruba as the most colonized among the three tribes, (Chi square = 17.25; p>0.05) [Table 1]. There was also association between the nasal colonization of *S aureus* and the study level, from the total 68 isolates obtained, 4(5.9%) were recovered from 200L, and 5(7.4%) from 300L students, 7(10.2%) from 400L, 47 (69.1%) from 500L and 5 (7.4%) from 600L students respectively, (Chi square = 12.52; p<0.05).

The prevalence of MSSA and MRSA were presented according to the socio-demographics of the study participants. From the 68 isolates, MSSA had a prevalence of 38.2% (26 out of 68), while MRSA had a prevalence of 61.8% (42 out of 68). Cefoxitin antibiotic susceptibility was used in differentiating and classifying the MRSA from the MSSA strain. There was no association between MRSA prevalence across the gender, age and tribe (Chi square=2.01; 4.02; and 14.07; p>0.05) [Table 2]. The prevalence of MRSA according to the departments showed that 20 (50%) of the 42 MRSA isolates were from the department of Medicine and Surgery, 13 (31%) were from the department of Nursing, and 8 (19%) from the department of Medical Laboratory Science [Figure 1]. Course of study was found to be associated with the prevalence of MRSA (Chi-square = 10.47; p=0.012) [Table 2]. Degree of association was found between MRSA prevalence and the study level, the least colonized among the study level was the 200L with the prevalence of 2 (4.8%), followed by 300L 2 (4.8%), 400L 6(14.3%), 500L 28(66.6%), and 600L 4(9.5%). (Chi square=34.28; p=0.000).

Table 2. Prevalence of of MSSA and MRSA among study participants.

Variables	Category	No. of samples examined N (%)	MSSA N (%)	MRSA N (%)	P- Value	Chi-square
Gender	Male Female	81 (40.5) 119 (59.5)	11 (42.3) 15 (57.4)	18 (42.9) 24 (57.1)	0.905	2.01
Age (Yrs)	16 – 20 21 – 25	110 (55) 90 (45)	13 (11.8) 13 (14.4)	18 (42.9) 24 (57.1)	0.134	4.02
Course of study	Medicine Nursing Med. Lab. Science	70 (35) 62 (31) 68 (34)	5 (7.1) 13 (21.0) 8 (11.8)	21 (50) 13 (31) 8 (19)	0.016*	12.43
Level of Study	100 200 300 400 500 600	NA 56 (28) 15 (7.5) 24 (12) 91 (45.5) 14 (7)	NA 2 (3.6) 3 (20.0) 1 (4.2) 19 (20.9) 1 (7.1)	NA 2 (4.8) 2 (4.8) 6 (14.3) 28(66.6) 4 (9.5)	0.000*	34.28
Tribe	Yoruba Igbo Others	124 (67) 55 (27.5) 21 (10.5)	15 (12.1) 8 (14.5) 3 (14.3)	23 (54.8) 15 (35.7) 4 (9.5)	0.671	14.07
	Total	200	26	42		

Keys: *MSSA = Methicillin Sensitive Staphylococcus aureus, MRSA = Methicillin Resistant Staphylococcus aureus. * p-*

value <0.05 was considered to be statistically significant.

With regards to nose hygiene among the participants, it was found that there were association between nose hygiene belief and nose hygiene practices among participants from the three departments. The questionnaire assessed that nose hygiene belief was least among the medicine students 50 (71.4%), followed by medical lab students 54(79.4%) and highest among nursing students 58 (93.5%) (Chi square =6.81; p=0.000), but mostly practiced and observed among the medical lab students 60 (88.2%), followed by the medicine students 54 (77.1%), and the least were the nursing students 46 (74.2%) (Chi square = 14.20; p=0.017) [Table 3].

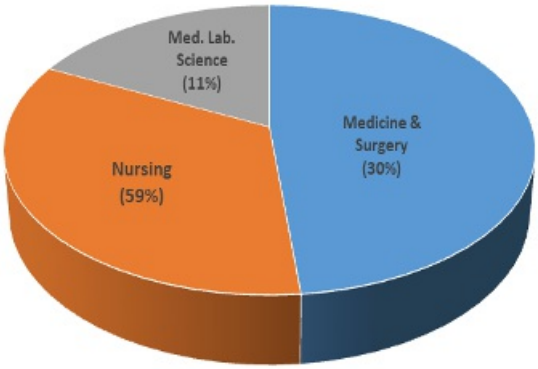

Fig. 1. *A pie chart showing MRSA prevalence & distribution amongst the three departments.*

Table 3. Nose hygiene practices among study participants.

Parameters	Medicine (n =70)		Nursing (n = 62)		Med Lab Sci. (n=68)		Total (%)	P -value	Chi square
	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)			
Do you believe in nose hygiene?	50(71.4)	20(28.6)	58(93.5)	4(6.5)	54(79.4)	14(20.6)	100	0.000	6.81
Do you maintain nose hygiene?	54(77.1)	16(22.9)	46(74.2)	16(25.8)	60(88.2)	8(11.8)	100	0.017	14.20
Do you apply bare hands in picking/cleaning your nose?	54(77.1)	16(22.9)	51(82.3)	11(17.7)	40(58.8)	28(41.2)	100	0.004	4.51

The frequent use of antibiotics was recorded mostly to be 35 (45.7%) among the medicine students and among the nursing students to be 25 (40.3%) and medical lab students as 11 (16.2%). There was association with frequent use of antibiotics among the departments, (Chi square = 10.02; p = 0.000) [Table 4]. Also, wound infection was not recorded among medical lab students 0 (0%), and least occurred among nursing students 8(12.9%), while the medicine students 12 (17.1%) had the most occurrence of wound infection amongst the three departments (Chi square = 19.00; p = 0.002), statistical relationship was observed among the study departments with regards to wound infection.

The antibiotic susceptibility pattern of the nasal isolates from the study participants is presented in Table 5 and Figure

2. All antibiotics used were recorded either as resistant or sensitive; none was intermediate in its susceptibility. Varying degrees of susceptibility to antibiotics were observed with the highest antibiotic resistance observed for cefoxitin as 42 (61.8%) and vancomycin 32 (47.1%). The highest degree of antibiotic sensitivity was observed in clindamycin and erythromycin respectively, with the sensitivity record of 48 (70.6%) (Chi square =5.47; $p < 0.05$). There was statistical difference with the antibiotics used and the 68 isolates of *S. aureus*.

There were associations among the following antibiotics; erythromycin, clindamycin, cefoxitin and vancomycin from the three study groups [Table 6]. All 16 isolates from the medical lab departments were sensitive to vancomycin antibiotics 16 (100%) (Chi square=45.71; p=0.000), as well as erythromycin 16 (100%) (Chi square=12.68; p=0.013). Vancomycin had the highest level of resistant record from the medicine department, all 26 isolates from this group were resistant to vancomycin 26 (100%) (Chi square = 45.71; p=0.000.

Table 4. Frequent use of antibiotics and the presence of wound infection among study participants

Parameters	Medicine (n = 70)		Nursing (n = 62)		Med Lab. Sci. (n = 68)		Total (%)	P -value	Chi square
	Yes N (%)	No N (%)	Yes N (%)	No N (%)	Yes N (%)	No N (%)			
Frequent use of antibiotics	32(45.7)	38(54.3)	25(40.3)	37(59.7)	11(16.2)	57(83.8)	100	0.000	10.02
Present skin/ wound infection	12(17.1)	58(82.9)	8(12.9)	54(87.1)	0(0)	68(100)	100	0.002	19.00

Table 5. Antibiotic susceptibility pattern of *S. aureus* isolates according to the participants' department.

Antibiotics	Medicine (n = 70) No. of isolates tested = 26		Nursing (n = 62) No. of isolates tested = 26		Med Lab (n =68) No. of isolates tested = 16		Pearson chi square	P - Value
	R N (%)	S N (%)	R N (%)	S N (%)	R N (%)	S N (%)		
Gentamycin	10(38.5)	16(61.5)	9(34.6)	17(65.4)	6(37.5)	10(62.5)	5.47	0.242
Clindamycin	13(50)	13(50)	6(23.1)	20(76.9)	1(6.25)	15(93.75)	14.65	0.000
Cefoxitin	21 (80.8)	5(19.2)	13 (50)	13(50)	8(50)	8(50)	12.24	0.016
Ciprofloxacin	10(38.5)	16(61.5)	10(38.5)	16(61.5)	8(50)	8(50)	5.91	0.206
Erythromycin	11(42.3)	15(57.7)	9(34.6)	17(65.4)	0(0)	16(100)	12.68	0.013
Vancomycin	26(100)	0(0)	6(23.1)	20(76.9)	0(0)	16(100)	45.71	0.000

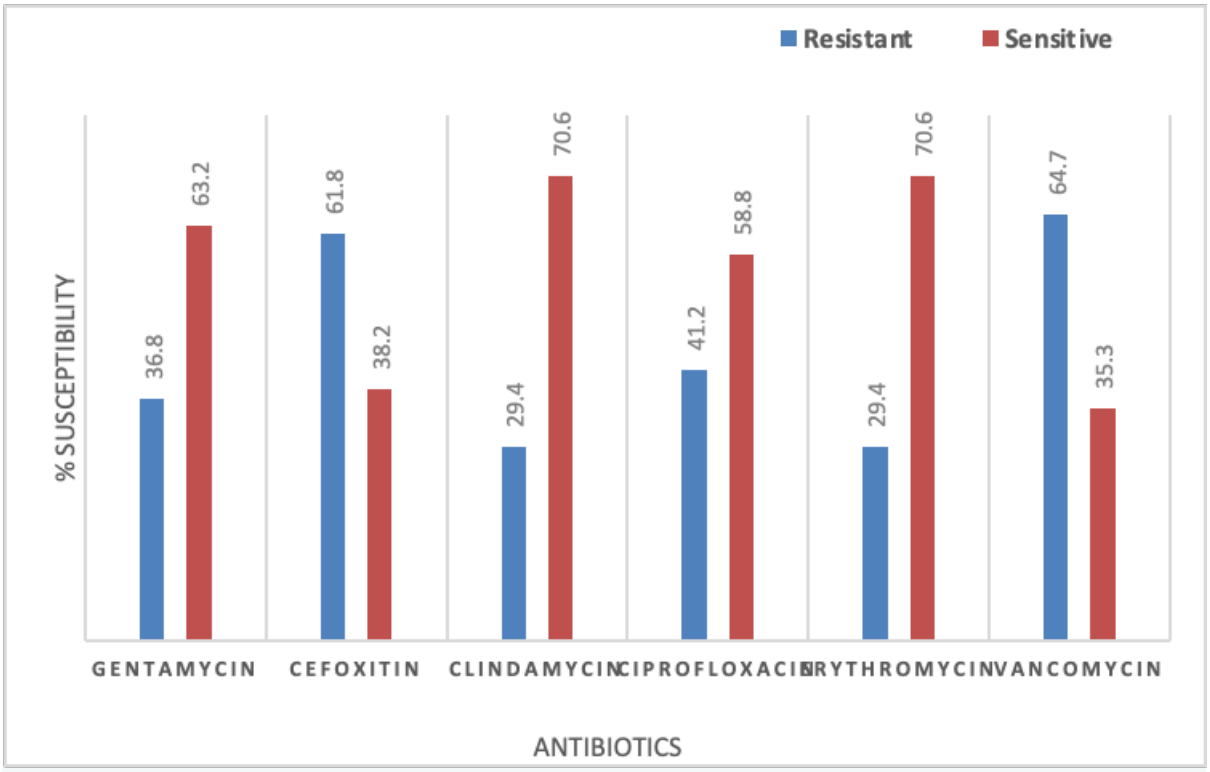

Figure 2. *Bar chart showing the overall antibiotic susceptibility pattern of S. aureus nasal isolates recovered from the study participants.*

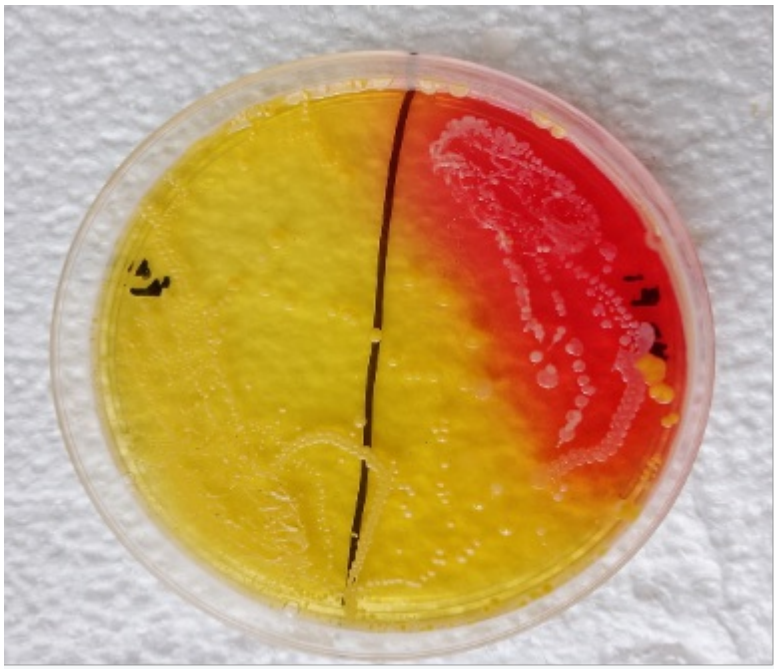

Fig. 3. *A picture showing mannitol fermentation properties of S. aureus on mannitol salt agar.*

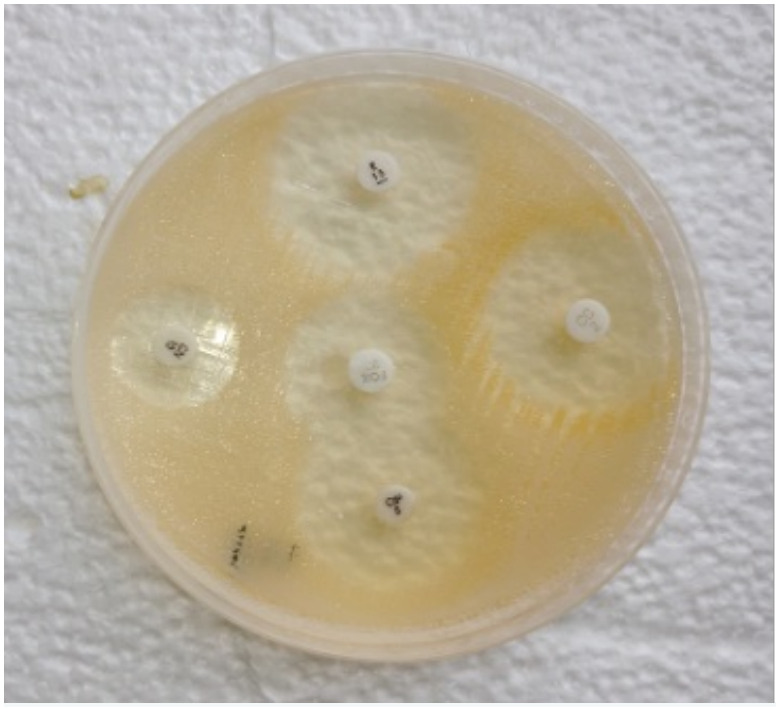

Fig. 4. *A picture showing the sensitivity of S. aureus to CN (Gentamycin), CC (Clindamycin), FOX (Cefoxitin), E (Erythromycin), and CIP (Ciprofloxacin).*

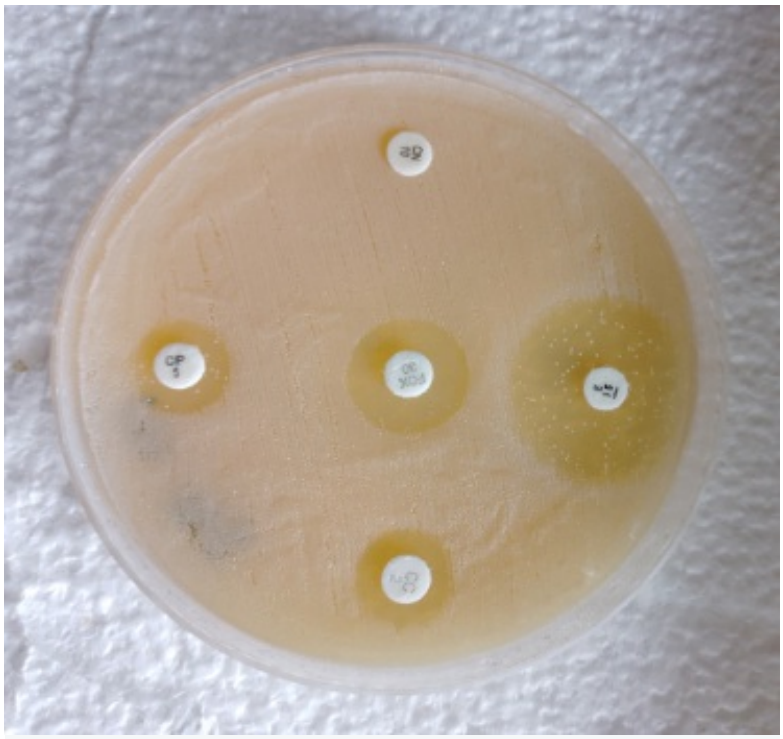

Fig. 5. *A picture showing the resistance of some isolates of S. aureus to the antibiotics on Mueller Hinton Agar.*

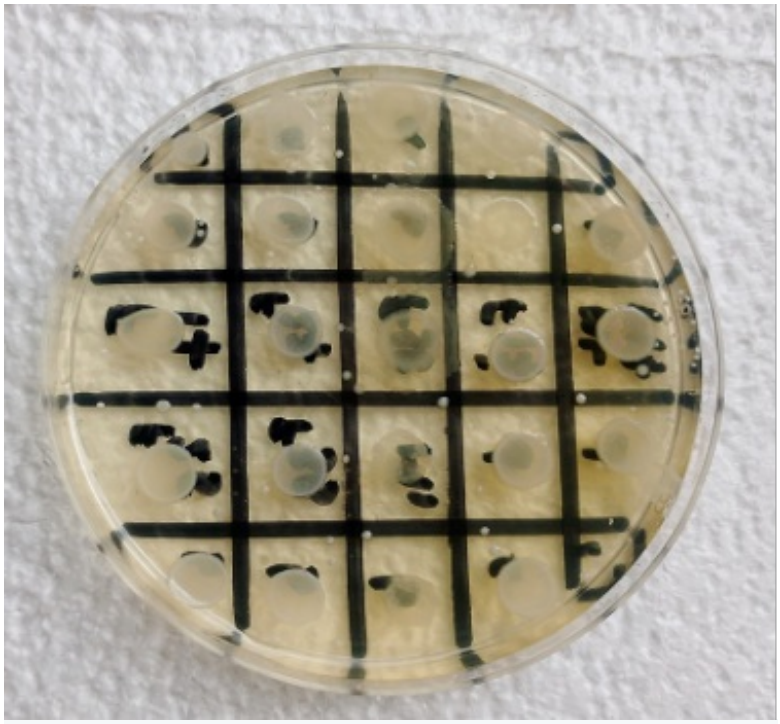

Fig. 6. *A picture showing some isolates of S. aureus resistant to the vancomycin antibiotics on Mueller Hinton agar.*

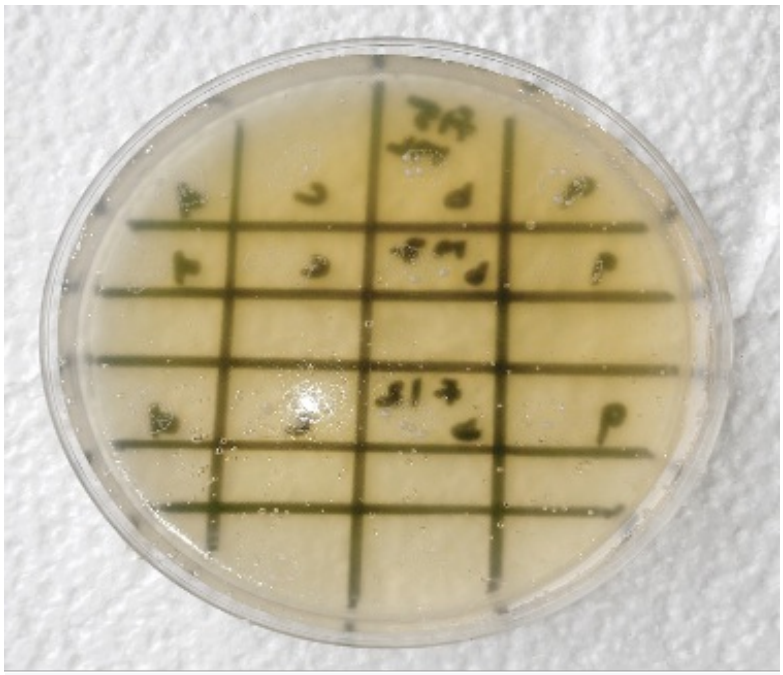

Fig. 7. A picture showing a clear zone of inhibition of *S. aureus* isolate by vancomycin on Mueller Hinton Agar plate.

Discussion

About 20–30% of healthy individuals have *S. aureus* as a common commensal in their noses, and many are carriers without knowing (Van Belkum *et al.,* 2009). The nasal carriage of *S. aureus* particularly the methicillin resistant strain

(MRSA) has been implicated mostly among health care workers and people within the hospital environment (Joachim*et al.,* 2018; Garoy et al., 2019; Walana *et al.,* 2020; Chai et al., 2022; Mamman et al., 2022; Nandhini et al., 2022). MRSA has been linked to several geographical locations around the globe (Crum et al., 2006), including Nigeria, where studies have revealed an overall rise in the prevalence of this strain (Alli *et al.,* 2015). This current study assessed the nasal carriage of *S. aureus* and the methicillin resistant strain (MRSA) among medical undergraduate students of Babcock University, Ilishan-Remo, Ogun State. From the 200 nasal swabs examined, carriage rate of *S. aureus* among the study participants was found to be 34%. This is lower than the 63.1% reported by Garoy *et al.* (2019) among hospital patients in Asmara, Eritrea, but higher than the 16.8% reported by Ibrahim and Sule (2021) among food vendors in a tertiary institution in North-East of Nigeria. It was also higher than the 30.5% reported by Chai *et al.* (2022) among animal handlers in Peninsular Malaysia. These differences may be due to variation in geographical locations, socio-demographics and hygiene levels of the study participants.

Furthermore, in this present study, the prevalence of MRSA was found to be 61.8%. This is higher compared to the 46.9% and 1.2% reported by Adeiza *et al.* (2020) and Chai *et al.* (2022) in a study carried out among patients and staff of state-owned hospitals in North-West Nigeria and animal handlers in Malaysia, respectively, but lower than the 72.0% reported by Garoy *et al.* (2019) among patients in Asmara, Eritrea.

In this current study, on the basis of gender, the carriage rate was found to be higher among females (57.4%) than their male counterparts 29 (42.6%). A similar study by Nagi *et al.* (2017) reported a much lower *S. aureus* carriage rate among the males (20.4%) than the females (26.2%). This is consistent with the outcome of this present study. But on the other, it contradicts the work of Ibrahim and Sule (2021) who reported a higher carriage rate among males (11.2%) than in females (5.6%).

On the basis of age, carriage of*S. aureus* and MRSA was highest among age group 21-25 years, 54.4% and 57.1%, respectively. This is similar to the work of Ibrahim and Sule (2021), who reported highest carriage rate among 21-30 years (8.4%) and is also consistent with the work of Garoy *et al.* (2019), who reported a higher carriage of *S. aureus* in patients under the age of 18 than over the age of 61 years.

In addition, on the basis of departments assessed in this study, MRSA prevalence was highest among the Medicine and Surgery students, with a prevalence of 30%, followed by the Nursing students (21%) and Medical Laboratory Science students (11.8%) with the least prevalence. A similar study by Adeiza *et al.* (2020) reported highest prevalence of MRSA among physicians in a health Centre in Sokoto, North-West of Nigeria. According to Albrich *et al.* (2008), the exposure of health care attendants to the hospital environment without necessary preventive measure and hospital hygiene contributes to the high prevalence rate of MRSA among health workers.

From the questionnaire, the least practice of nose hygiene was observed among the medical students than in other two groups. A similar study by Rongpharpi *et al.* (2013) highlighted major risk factors contributing to the spread of*S. aureus* in a hospital community to include poor sanitary and hygienic measures among healthcare workers.

S. aureus isolates recovered in this study showed varying susceptibility pattern to the different antibiotics tested. Clindamycin and erythromycin were the most effective, with the highest overall susceptible rate of 70.6% each, while the highest resistant rates were recorded for Cefoxitin (61.8%) and vancomycin (47.1%). A contrasting result from a study in south Brazil recorded clindamycin and erythromycin to have the least sensitivity to *S. aureus* (Rossato *et al.,* 2020). An

earlier study conducted in a Teaching Hospital in Abakaliki, Nigeria, reported a high resistance for clindamycin (76.9%) and erythromycin (74.4%), (Chika *et al.,* 2018). Meanwhile, Chai *et al.* (2022) reported that *S. aureus* was highly resistant against penicillin (72.3%) and amoxicillin (52.3%); while gentamicin and linezolid were highly effective against all the S. aureus isolates recovered from animal handlers.

Misuse of antibiotics is a major factor contributing to the development of drug resistance among drug- resistant pathogens, and a study by Tarai *et al.* (2013) identified easy availability and access to antibiotics at the drug store without a physician prescription as the main factor contributing to the development of drug resistance among pathogenic organisms. Also the development of resistance to several other antibiotics by *S. aureus* can be liken to their ability to acquire the determinants by horizontal gene transfer of mobile genetic elements (Malachowa and DeLeo, 2010). From the study, it was observed that other antibiotics like gentamycin and ciprofloxacin were also effective, but less effective compared to clindamycin and erythromycin. Ciprofloxacin susceptibility was (58.8%), while gentamycin was (63.2%) which is a bit lower compared to other research findings like that of Siddiqui *et al.* (2013) where a higher susceptibility rate of 74% was recorded for ciprofloxacin. It is therefore essential to study the antibiotic susceptibility patterns of *S. aureus* based on global geographic regions. According to Oladipo *et al.* (2019), doing so will enable researchers to better understand the organism's new and emerging resistance trends, which will be useful for the management of both hospital- and community-acquired infections.

Conclusion

From this present research, it is clear that the prevalence of MRSA is relatively high (61.8%) and a major associate risk factor is misuse of antibiotics. In addition to the use of nose masks and proper personal hygiene to prevent the spread of MRSA, policy regulation on antibiotics prescription and usage, as well as guidelines on MRSA detection and control measures is therefore very crucial to stem the upsurge of resistant strains.

Limitation of the Study

The study was carried out during the summer break of the University. We were only able to enrol a total of 200 students for the study instead of the 215 calculated due to the unavailability of most of the students as most of them have gone home summer break. Nevertheless, this shortfall in sample size did not have adverse impact on the study. Another limitation of the study was that only Gram stain and biochemical tests were used to identify and characterise nasal *S. aureus* isolates recovered from the study participants. Further characterization of the isolates using molecular techniques like Polymerase Chain Reaction (PCR) was not done due to cost.

Ethical Approval

Ethical approval (with the ethical registered number: BUHREC 342/22) was obtained from the Babcock University Health Research Ethics Committee (BUHREC), before the commencement of the research.

Acknowledgments

We are incredibly appreciative of the cooperation received from all the study participants.

Competing Interests

The authors declare that they have no competing interests.

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