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Methicillin-Resistant *Staphylococcus aureus* Nasal Carriage among Surgical Patients, Patient Relatives and Healthcare Workers in a Teaching Hospital in Uyo, Southsouth Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Author AEM designed the study and wrote the protocol. Author IPO managed the analyses of the study and wrote the first draft of the manuscript. Author EEN managed the literature searches and performed the statistical analysis. All authors read and approved the final manuscript.

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ABSTRACT

Background: Methicillin-resistant *Staphylococcus aureus* (MRSA) is one of the major bacteria pathogens implicated in hospital and community-associated infections.
Aim: This study aimed to determine the prevalence and multidrug-resistant (MDR) pattern of Methicillin-resistant *S. aureus* carriage among surgical patients, patient relatives and healthcare workers (HCW) in a tertiary health facility in Uyo-Nigeria.
Study Design: This was a cross-sectional hospital-based study.
Place and Duration of Study: University of Uyo Teaching Hospital, Uyo-Nigeria, between April and October 2016.
Methodology: Swab samples were collected from the anterior nares of 200 participants and cultured using standard bacteriological methods for the isolation of *S. aureus*. MRSA strains were

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identified phenotypically using both Oxacillin and Cefoxitin discs diffusion methods while possession of the *mecA* gene was detected by PCR method.
Results: Overall, *S. aureus* and MRSA carriage rates among the participants were 102 (51.0%) and 22 (11.0%), respectively. Population-specific carriage rates of *S. aureus* and MRSA among surgical patients (n=65) were 41 (63.1%) and 15 (23.1%); patient relatives (n=65), 22 (33.8%) and 4 (6.2%), while HCW (n=70) were 39 (55.7%) and 3 (4.7%), respectively. The rate of HCW MRSA carriage increased as year of service increased but increment was not statistically significant. All the 22 MRSA isolates were MDR and highly resistant to commonly used antibiotics such as Ciprofloxacin (86.4%), Trimethoprim/Sulphamethoxazole (81.8%), Tetracycline (77.3%), Erythromycin (72.7%) and Gentamycin (68.1%). Eighteen (82%) of the MRSA strains possessed the *mecA* gene. Vancomycin-resistant strains (VRSA) were 2 (9.1%). MRSA strains sharing similar drug-resistant combination were observed among surgical patients, patient relatives and HCW either within or in related wards.
Conclusion: The high nasal carriage of MRSA and high frequency of MDR strains among surgical patients in this study emphasize the need for regular surveillance and strengthening of basic infection control measures in hospitals. The use of Vancomycin as drug of choice in MRSA therapy is still desirable.

Keywords: MRSA carriage; multi-drug resistance; surgical patients; patient relatives; HCW.

1. INTRODUCTION

Staphylococcus aureus has attracted global public health attention due to its high rate of resistance to various antimicrobial agents including the commonly used penicillin-related antibiotics [1]. Despite the introduction of effective antimicrobial agents, improvements to hygiene and hospital surveillance, it has over the years persisted as an important hospital and community-acquired pathogen [2]. The nasal cavity is considered one of the most important sites for MRSA colonization and Nasal carriage of the virulent MRSA is an important risk factor for subsequent MRSA infection and transmission [1].

Methicillin-resistant *Staphylococcus aureus* (MRSA) is defined as any strain of *S. aureus* that has developed resistance to beta-lactam antibiotics which include beta-lactam stable formulations such as Methicillin, Oxacillin, Cefoxitin, Nafcillin, among others [3,4]. These strains are responsible for a greater number of hospital-acquired infections which are difficult to combat in humans [5]. MRSA has been reported with alarming frequencies worldwide, and these strains majorly exhibit multi-drug resistance, that is resistant to three or more classes of antibiotics [6]. There has been a steady increase in the prevalence of MRSA across nations of the world, with several studies reporting varying carriage rates among patients in hospitals. For instance, in Japan, 44.4% has been reported, Singapore 35%, Malaysia 26%, Scotland 66.4% and 19.2% in Ekiti state, Nigeria [7-11]. Strains that are resistant to methicillin are found to exhibit varying resistance to Lincosamides, Macrolides, Aminoglycosides, Fluoroquinolones or combinations of these classes of antimicrobials [3,12]. Vancomycin (glycopeptide) which was initially very effective in the treatment of MRSA infection is recently being witnessed with intermediate resistance with MRSA strains [13].

Among the body sites that habour *S. aureus* such as throat, perineum, skin, hairline, groin and the axilla, the anterior nares are the most common ecological niches of the organism [14], and have been linked to most community and hospital-associated infections, including bacteremia [1,13]. Colonizing strains may thus serve as endogenous reservoirs for overt clinical infections and may spread to other patients in hospital settings [15]. Elimination of nasal carriage has been reported to cause a significant reduction in the incidence of *S. aureus* infections in the community [16]. Multidrug resistance of nasal *S. aureus* associated with methicillin-resistant strains is of great public health concern especially in developing countries [17]. Thus, this study aimed to assess the methicillin-resistant *S. aureus* carriage among surgical patients, patient relatives and healthcare workers in a tertiary health facility in Uyo, Nigeria.

2. MATERIALS AND METHODS

2.1 Study Area

This study was conducted in Uyo, Akwa Ibom State, South-south Nigeria. Uyo is a fast growing city both economically and population wise. The

city lies between latitude 5.5°N and 6.0°N, and longitude 6.0°E and 6.5°E of the Greenwich Meridian. It is located in the rainforest belt with an elevation of fewer than two feet above sea level. With its status as a developing capital city in Nigeria, Uyo being is surrounded by several suburban and rural communities whose inhabitants access tertiary health care at the University of Uyo Teaching Hospital (UUTH), Uyo.

2.2 Study Population

This was a descriptive cross-sectional study of surgical patients, patient relatives and healthcare workers in Surgical Wards, Orthopaedic Surgical Ward, Paediatric Surgical Ward, Obstetrics and Gynaecology Ward of the University of Uyo Teaching Hospital, Uyo-Nigeria. A total of 200 participants were recruited for the study over a period of 6 months from April 2016 to October 2016.

2.3 Sample Collection

Nasal swabs were obtained from the anterior nares of subjects using sterile swab stick and following standard procedures. The swab stick was introduced 2-3 cm into the anterior nares of the participants and rotated clock and anti-clockwise for 3-5 times. Samples were obtained from pre-operative patients on the same day of admission to the hospital ward and 48-96 hours after surgery (post-operative), when the patient must have become stable.

2.4 Isolation and Identification of *Staphylococcus aureus*

The nasal swabs were inoculated onto mannitol salt agar and blood agar plates and incubated at 37°C for 18-24 hours. Growth colonies exhibiting beta hemolysis on blood agar and yellowish appearance on mannitol salt agar plates were further identified by standard bacteriological procedures such as colony morphology, Gram reaction, catalase test, tube coagulase test and DNase test [18]. *S. aureus* were identified as Gram-positive cocci in clusters, catalase positive, coagulase positive and positive to DNase test.

2.5 Antibiotic Susceptibility Testing

Isolates were subjected to antibiotics susceptibility testing by Kirby-Bauer disc diffusion method using Mueller-Hinton Agar plates. The antibiotics used were Vancomycin (30 µg), Tetracycline (30 µg), Gentamycin (10 µg), Clindamycin (2 µg), Ciprofloxacin (5 µg), Erythromycin (5 µg) and Trimethoprim/ Sulphamethoxazole (1.25 µg/23.75 µg) (Oxoid, UK). The reference strain *Staphylococcus aureus* ATCC 25923 was used for quality control. The results were interpreted according to the CLSI 2016 guidelines [19].

2.6 Methicillin-resistant Detection Using Oxacillin and Cefoxitin Discs

Overnight cultured colonies of *S. aureus* isolates were subcultured onto peptone water and incubated for three hours at 37°C. The broth culture was diluted to 0.5 McFarland turbidity standard equivalent. Using a sterile swab stick, the diluents were inoculated onto Mueller Hinton agar plates. Oxacillin (1 µg) and Cefoxitin (30 µg) discs were placed apart on the plate and incubated at 37°C for 18 hours. The inhibition zone diameter was measured using a micrometer. An inhibition zone of <11 mm to Oxacillin and ≥21 mm to Cefoxitin was reported as methicillin-resistant [19]. Isolates that were resistant to three or more antimicrobial classes were regarded as multi-drug resistant strains.

2.7 Singleplex PCR and Agarose Electrophoresis for Detection of *mecA* Gene

The bacteria DNA were extracted using the boiling method, as described by Chapaval *et al.* [20]. Amplification of the *MecA* gene was carried out on a 9700 Applied Biosystem Thermal cycler in a final volume of 20 ul. The PCR mix included 10 ul of master mix, 0.16 ul of both forward primer: 5'-TAGAAATGACTGAACGTCCG-3; and reverse primer: 5'-TTGCGATCAAATGTTACCGTAG-3' [21], 2 ul of the gDNA and 7.68 ul of PCR water. The tubes were placed on the microtitre tray of an Applied Biosystem 9700 thermal cycler, which had been programmed to run at an initial denaturation temperature of 95°C for 3 minutes and additional 30 seconds, annealing at 55°C for 30 seconds, an extension period at 72°C for 40 seconds, a final extension period of 2 mins at 72°C followed by cooling or storage at 10°C, for 35 cycles. An 8 µl aliquot of each amplicon was resolved on 0.8% agarose gel at 110 V for 20 minutes and visualized on an ultraviolet transilluminator. The presence of a single fragment band of 154 bp was considered to be the *mecA* gene. Positive and negative controls were run along with the test isolates.

2.8 Data Analysis

Demographic variables and frequency of MRSA occurrence were analysed using SPSS version 17. Data were analysed using descriptive statistics and the statistical significant difference was considered at $p<0.05$.

3. RESULTS

Distribution of *S. aureus* and MRSA strains among surgical patients, patient relatives and healthcare workers are indicated in Table 1. Out of a total of 200 participants examined, 102 (51.0%) were colonized with *S. aureus* in their anterior nares of which surgical patients were the majority, 41 (63.1%) followed by healthcare workers, 39 (55.7%). The total MRSA strains was 22 (11.0%) and colonization was highest among surgical patients, 15 (23.1%), while healthcare workers were the least colonized, 3 (4.3%).

The age and sex distribution of *S. aureus* and MRSA strains isolates from surgical patients and their relatives are shown in Table 2. Majority of the surgical patients colonized with both *S. aureus* and MRSA strains were in the age bracket of 20-39 years, 18 (27.7%) and 7 (10.8%), respectively. The least colonized age group was those within 0-19 years, 4 (6.2%) and 1 (1.5%), respectively. More females were colonized with both *S. aureus* and MRSA strain than males, 43.1% vrs 20.0% and 12.3% vrs 10.8%, respectively. Most of the patient relatives colonized with *S. aureus* were in the age group, 20-39 years (16.9%) while 40-59 years old were mostly colonized with MRSA (3.1%). More female patient relatives had *S. aureus* (26.2%) and MRSA (4.6%) than males, 7.7% and 1.5%, respectively.

The frequency of MRSA isolates among healthcare workers by year of service is shown in Table 3. Although MRSA colonization rate appears to increase as the year of service increases, the difference was not statistically significant (p=0.406). Those with service year 12 years and above had the highest MRSA colonization rate, 1 (33.3%) while none of the healthcare workers with service year 0-3 years was detected with MRSA strain.

The Antimicrobial resistant profile of MRSA isolates from healthcare workers, surgical patients and patient relatives are indicated in Table 4. All the MRSA strains from healthcare workers (HCW) and patient relatives exhibited 100% antimicrobial resistance to Ciprofloxacin and Trimethoprim/ Sulphamethoxazole. All MRSA strains from healthcare workers and patient relatives also exhibited 100% resistance to Tetracycline and Erythromycin, respectively. A high proportion of isolates from surgical patients (66.7% - 80%) exhibited resistance to Ciprofloxacin and Trimethoprim/ Sulphamethoxazole, Tetracycline and Erythromycin. A total of 2 (9.1%) Vancomycin-resistant strains (VRSA) were recorded among surgical patients and patient relatives.

Multi-drug resistant pattern of MRSA strains with *mecA* gene is shown in Table 5. All the 22 MRSA strains were phenotypically detected using both cefoxitin and oxacillin discs and they exhibited multidrug resistance with 18 (82%) habouring the *mecA* gene. Two MRSA strains each from patients in Male Orthopaedic and Caesarean Section wards were resistant to same drug combinations (n= 6 and 7, respectively). In the Male Orthopaedic ward, one HCW's MRSA strain shared similar resistant drug combination with 2 patients' isolates in the same ward. Similar drug resistotype were shared between one HCW (HCW1) strain and three surgical patients' strains (FSW1, MSW1, ORMW1) across different wards of the hospital. Strains from a patient relative (CSW2R) and a patient (CSW1) in the Caesarean Section ward were also observed with similar drug resistotype but none possessed the *mecA* gene. Two MRSA strains, one each from a patient in Gynaecology ward (GW1) and a

Table 1. Distribution of *S. aureus* and MRSA among study participants

Subjects	No. sampled	*S. aureus* (%)	MRSA strain (%)
Surgical patients	65	41(63.1)	15(23.1)
Patient relatives	65	22(33.8)	4(6.2)
Healthcare workers	70	39(55.7)	3(4.3)
Total	200	102(51.0)	22(11.0)

Table 2. Frequency of *S. aureus* and MRSA strains isolated from patients and their relatives according to age and gender

Characteristics	Surgical patient (n=65)		Patient relative (n=65)	
	S. aureus (%)	MRSA (%)	*S. aureus* (%)	MRSA (%)
Age group (years)				
0-19	4 (6.2)	1 (1.5)	3 (4.6)	0
20-39	18 (27.7)	7 (10.8)	11 (16.9)	1 (1.5)
40-59	10 (15.4)	3 (4.6)	5 (7.7)	2 (3.1)
≥60	9 (13.9)	4 (6.2)	3 (4.6)	1 (1.5)
Total	41(63.1)	15 (23.1)	22 (33.9)	4 (6.2)
Sex				
Male	13 (20.0)	7 (10.8)	5 (7.7)	1 (1.5)
Female	28 (43.1)	8 (12.3)	17 (26.2)	3 (4.6)
Total	41(63.1)	15 (23.1)	22 (33.9)	4 (6.2)

patient relative in Pediatric ward (PDWR), were resistant to all the nine antimicrobials tested including Vancomycin and both shared similar resistant drug combinations, and were *mecA* gene negative.

The molecular detection of *mecA* genes from MRSA strains by singleplex PCR is represented in Fig. 1. In the agarose electrophoresis of amplified *mecA* genes, Lanes 1-22 represent the *MRSA* strains. Lanes 3, 15, 16 and 21 represent failed amplification while Lane M represents the 100bp Quick-Load Molecular ladder. Of the 22 MRSA strains detected by agar disk diffusion method, the *mecA* gene was detected at 154bp in 18 strains representing 81.8% of the phenotypically identified strains.

Table 3. Frequency of MRSA strains from healthcare workers by year of service

Years of service	No. examined	MRSA (%)
0-3	22	0
4-7	26	1(6.7)
8-11	15	1(12.5)
>12	7	1(33.3)
Total	70	3(7.7)

4. DISCUSSION

Cross-infection with virulent *S. aureus* has been reported to occur through nasal transmission among healthy individuals at close contacts, patient to patient, and healthcare worker to patient in hospital settings [22]. In this study, the overall nasal carriage rate of *S. aureus* was (51.0%) and is consistent with 50.0% reported in Abia State, Southeast Nigeria [23] but higher than 14.0% reported in Lagos, Southwest Nigeria [24], and 2.1% in Maiduguri, Northeast Nigeria [25]. Prevalence rates reported in other developing nations include Nepal, 12.5% [26]; Western-Iran, 17.6% [27] and Delhi, India, 12% [28]. In the developed countries like USA [22] and Japan [29], nasal cavity *S. aureus* colonization rates in adults have been reported to be 36% and 32.4% - 36%, respectively. The variation in *S. aureus* nasal carriage rates could be attributed to many factors such as geographical location, characteristics of the study population including those exposed to antibiotics as at the time of sampling and those in hospital settings, and microbiological methods such as sampling and cultural techniques used [30].

Table 4. Antimicrobial resistant profile of MRSA strains from healthcare workers, surgical patients and patient relatives (N=22)

Antimicrobial agent	Symbol	Resistant zone diameter (mm) (CLSI, 2016)	MRSA (N=22)		
			HCW (N=3) R (%)	Patient (N=15) R (%)	Patient relatives (N=4) R (%)
Gentamycin	CN	≤12	2(66.7)	10(66.7)	3(75.0)
Clindamycin	DA	≤14	2(66.7)	4(26.7)	1(25.0)
Erythromycin	E	≤13	1(33.3)	10(66.7)	4(100.0)
Tetracycline	TE	≤14	3(100.0)	10(66.7)	2(50.0)
Ciprofloxacin	CIP	≤15	3(100.0)	12(80.0)	4(100.0)
Trimethoprim/ Sulphamethoxazole	XT	≤10	3(100.0)	11(73.3)	4(100.0)
Vancomycin	VA	≤15	0	1(6.7)	1(25.0)
Oxacillin	OX	<11	3(100.0)	15(100.0)	4(100.0)
Cefoxitin	FOX	≤21	3(100.0)	15(100.0)	4(100.0)

Table 5. Multi-drug resistant MRSA strains and *mecA* gene acquisition (N=22)

MRSA strain	Subject with location	Multi-drug resistance profile	No. of combinations	*mecA* gene
MSW1R	Patient relative(MSW)	E,SXT,TE,OX,FOX	5	+
FSW1	Patient (FSW)[a]	CN,CIP,TE,OX,FOX	5	+
ORMW1	Patient(ORMW)[a]	CN,CIP, TE,OX, FOX	5	+
MSW1	Patient (MSW)[a]	CN, CIP, TE, OX, FOX	5	+
HCW1	HCW(FSW)[a]	CN, CIP, TE, OX, FOX	5	+
ORMW2	Patient(ORMW)	E, CI P, SXT, OX, FOX	5	+
PDW1	Patient(PDW)	DA, SXT, TE, OX, FOX	5	+
ORFW1	Patient(ORFW)	E, CIP, SXT, TE, OX, FOX	6	+
MSW2	Patient(MSW)	CN, CIP, SXT, E, OX FOX	6	+
CSW4	Patient(CSW)[b]	CN, CIP, SXT, E, OX, FOX	6	+
CSW3	Patient(CSW)[b]	CN, CIP, SXT, E, OX, FOX	6	+
CSW1	Patient (CSW)	CN, CIP, SXT, TE, OX, FOX	6	-
HCW2	HCW(MSW)	CN, DA, SXT, TE, OX, FOX	6	+
CSW2	Patient(CSW)[c]	CN, CIP, SXT, E, TE, OX, FOX	7	+
FSW2	Patient(FSW)[c]	CN, CIP, SXT, E, TE, OX, FOX	7	+
ORMW3	Patient(ORMW)[d]	DA, CIP, SXT, E, TE, OX, FOX	7	+
ORMW4	Patient(ORMW)[d]	DA, CIP, SXT, E, TE, OX, FOX	7	+
HCW3	HCW(ORMW)[d]	DA, CIP, SXT, E, TE, OX, FOX	7	+
FSW2R	Patient relative(FSW)[e]	CN, CIP, SXT, E, TE, OX, FOX	7	+
CSW2R	Patient relative(CSW)[e]	CN, CIP, SXT, E, TE, OX, FOX	7	-
GW1	Patient(GW)[f]	CN, CIP, SXT, E, TE, DA,VA,OX,FOX	9	-
PDWR	Patient Relative(PDW)[f]	CN, CIP, SXT, E, TE, DA, VA,OX,FOX	9	-

Key: ORFW=Orthopaedic Female Ward, ORMW= Orthopaedic Male Ward, GW= Gynaecology Ward, MSW=Male Surgical Ward, FSW=Female Surgical Ward, CSW= Caesarean Section Ward, PDW=Pediatric Ward, HCW= Healthcare Workers.

[a,b,c,d,e,f] Strains with similar resistant drug combinations

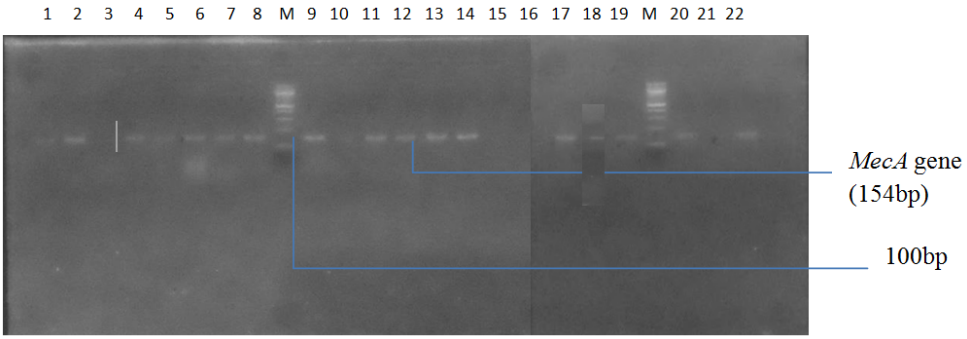

Fig. 1. Lanes 1-22 represent the MRSA strains with *mecA* gene at 154 bp exception of Lanes 3, 15, 16 and 21 which represent failed amplification while Lane M represents the 100 bp Quick-Load Molecular ladder

The overall MRSA nasal carriage rate in this study was (11%), and majority were surgical patients (23.1%). These findings underscore the need for active surveillance and screening of surgical patients and associates, to eliminate these virulent strains usually associated with series of hospital-acquired infections. Recently, higher MRSA carriage rates in the range of 30-80% have been reported among patients in Maiduguri, Northeast Nigeria [25] and other Sub-saharan African countries such as Northeast Ethiopia [31]; Kinshasha [32] and Khartoum, Sudan [33]. Many countries of the world that have put in place adequate infection control measures in their health facilities have recorded lower MRSA colonization rates among patients, including Bolivia, 0.5% [34]; Indonesia, 4.3% [35]; Western-Iran 6.6% [27] and Kenya, 7.0% [36]. The need for increase awareness and active surveillance of this organism as well as establishing hospital and community baseline data cannot be overemphasized as it will provide appreciable epidemiological information for monitoring performance of infection control measures for MRSA.

In this study, *S. aureus* and MRSA nasal carriage among surgical patients were more in females than males in agreement with previous studies [26,37,38]. In the contrary, male carriage predominance of *S. aureus* and MRSA reported in a review article by Humphreys et al. [39] was generally attributed to, among other risk factors, poor hand washing behavior among males. Age-wise, patients and their relatives in the age bracket 20-39 years in this study were mostly colonized with *S. aureus* and MRSA in their nares. The reason for this observation could not be readily established. Mainous et al. [38] in the United States reported more of *S. aureus* colonization in younger population whereas the older population (60 years and above) were seen more with MRSA and related the observation to weakened immunity in the elderly especially among nosocomial cases.

All the MRSA strains phenotypically detected in this study exhibited multidrug resistance and 82% of them harboured the *mecA* gene. We had earlier documented our findings rating both Cefoxitin and Cloxacillin as good surrogates for phenotypic MRSA detection comparable to PCR [40]. Higher resistant rates were observed with Ciprofloxacin, Trimethoprim/Sulphamethoxazole, Tetracycline, Erythromycin and Gentamycin. The incessant abuse and misuse of these commonly used and inexpensive antimicrobial agents devoid of authorized prescriptions have been observed in many parts of Nigeria and may have contributed to the high antimicrobial resistance [41,42]. This has posed a significant difficulty to clinicians in the choice of antimicrobial agent for patients with a variety of infections. Most of the antimicrobials used in this study which are indicated for serious infections may have substantially lost their place in the treatment of infections caused by these multi-drug resistant strains in this community and indirectly led to increasing costs of treatment and additional difficulty in infection control efforts [43]. Vancomycin and Clindamycin usually earmarked for empirical therapy of MRSA infection [26,27] were not spared with resistance by at least one of the MRSA strains in this study and a cause for serious public health concern.

In a hospital setting, infected patients, healthcare workers and to some extent colonized patient relatives tending to their sick ones remain major reservoirs of the organism, while hands of

healthcare workers and hospital facilities are vehicles for disseminating the organisms [44]. However, the MRSA carriage rate among healthcare personnel in this study (7.7%) was far less than 25% reported in Nepal [26]. When considering rate of MRSA colonization by year of service among healthcare workers in this study, colonization was observed to increase as the years of service increases, but the difference was not statistically significant possibly due to the small number of cases considered. However, this observation could be attributed to increase daily contact with patients, patient beddings, hospital equipment and hospital environment overtime [44].

Interestingly in this study, multidrug-resistant MRSA strains having similar resistant drug combinations (resistotype) were observed in the same and cognate wards among patients, patients and their relatives as well as patients and healthcare workers. This obviously indicates a somewhat pattern of infection spread or foci of infection with a particular or groups of MRSA strains circulating within the health facility. Leung et al. [45] recommended the implementation of admission screening of MRSA to reduce MRSA transmission in health facilities. Healthcare workers whose roles interface between the hospital and the community may serve as agents of cross-contamination of hospital or community acquired-MRSA [44] with grave epidemiological and nosocomial implications. Similarities in multidrug-resistant combinations observed among HCWs, patients and patient relatives' strains in this study testify to the fact that community-acquired MRSA (CA-MRSA) strains that spread in community settings can also spread to health care facilities [46].

5. CONCLUSION

There was evidence of *S. aureus* and MRSA nasal carriage among patients, patient relatives and HCW in the same or cognate wards of the hospital. Some of the strains had similar drug-resistant combinations (n = 5 - 9 antibiotics). Almost all the MRSA strains (82%) harboured the *mecA* gene. Two that were VRSA (9.1%) did not possess the *mecA* gene. Some of these strains could be either health facility or community-acquired emphasizing the need for regular surveillance of microbial flora among this study population, especially with the emergence of VRSA strains. Also, there is strong need to institute and strengthen infection control measures including enlightenment of healthcare workers, routine screening for MRSA nasal carriage and isolation of patients identified with MRSA in hospital facilities, as well as enforcement of empiric use and prescription of antimicrobial agents to stem the tide of MRSA in our hospitals.

ETHICAL APPROVAL AND CONSENT

Ethical approval was obtained from the ethical review board of UUTH before the commencement of this research, and informed consent was obtained from the subjects before recruiting them into the study.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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