ORIGINAL ARTICLE

Prevalence of methicillin-resistant S*taphylococcus aureus* (MRSA) among healthcare workers in a tertiary institution in Nigeria

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ABSTRACT

Background: Methicillin-resistant *Staphylococcus aureus* constitutes part of the growing health problem associated with chemotherapy because they are more difficult to treat and could transfer drug resistance to other bacteria.

Objective: This research work was carried out to find the prevalence of Methicillin-Resistant *Staphylococcus aureus* (MRSA) among health workers in Nnamdi Azikiwe University Teaching Hospital, Nnewi.

Methodology: Two sets of 300 swab samples were collected from the anterior nares of 300 health workers, comprising 82 Laboratory Staff and 218 Clinical staff, and processed without delay. One of each duplicate swab sample was inoculated directly onto chocolate agar, incubated for 24 hours at 37°c while the other swab was used to make a smear for Gram staining. All isolates were identified using standard microbiological methods. *Staphylococcus aureus* isolates were screened for methicillin resistance using 1µg/ml oxacillin disc in Mueller Hinton agar plate supplemented with 4% sodium chloride.

Results: One hundred and ninety-two (64%) out of 300 were carriers of *Staph aureus*, while 90 (30%) out of the 300 were positive for MRSA. The prevalence of MRSA among the health workers were Medical Doctors 24%, Medical Laboratory Scientists 34.1%, Nurses 28.8%, Ward Attendants 50.0%, and Cleaners 20.0%.

Conclusion: Over all MRSA prevalence was 30.0%. There was no significant relationship between duration of service and MRSA carriage rate. There was a significant difference in MRSA carriage between those health workers who adhered to universal precautionary measures and those who did not. The prevalence of MRSA among health workers in this study was high thus creating the need for the Health Workers to adhere to universal precautionary measures while carrying out their routine work to avoid being possible sources of nosocomial infections.

Keywords: Contact, exposure, hospitals, oxacillin, patients

INTRODUCTION
Methicillin-resistant *Staphylococcus aureus* (MRSA) is a strain of *Staphylococcus aureus* that is resistant to the antibacterial activity of methicillin and other related antibiotics of the penicillin class.[1] It belongs to the large group of bacteria known as Staphylococci, often referred to as Staph. About 25%-30% of all people have Staph within the nose, but it normally does not cause an infection. In contrast, only about 1% of the populations have MRSA.[2] Infections with MRSA are most common in hospitals and other institutional health-care settings, such as nursing homes, where they tend to affect older people, those who are very ill, and people with a weakened immune system.

Staphylococcus aureus is most often spread to others by contaminated hands. The skin and mucous membranes are usually effective barriers against infection, however, if these barriers are breached (e.g. skin damage due to trauma, or mucosal damage due to viral infection), the organism may gain access to underlying tissues or the bloodstream and cause infection. Persons who are immune-compromised or who have invasive medical devices are particularly vulnerable to infection.[3]

The MRSA was first noted in 1961, about two years after the antibiotic methicillin was initially used to treat *Staph aureus* and other infectious bacteria. The resistance to methicillin was due to a penicillin-binding protein coded for by a mobile genetic element termed the methicillin-resistance gene – mecA.[4] In recent years, the gene has continued to evolve so that many MRSA strains are currently resistant to several different antibiotics such as penicillin, oxacillin and amoxicillin.[5]

Traditionally, MRSA infections have been associated with hospitalization or other health-care associated risk factors.[6] There are two major ways people become infected with the organism. Contact is the major means by which people become infected; either direct contact with patient carriers or health-care givers or contact with inanimate objects such as door handles, floors, sinks or towels touched by an MRSA-infected person or carrier.[7] Many, otherwise healthy, individuals especially children and young adults, do not notice small skin imperfections or scrapes and may be lax in taking precautions about skin contacts. This could be the reason why outbreaks occur in diverse groups of people. Healthcare workers as a group are repeatedly exposed to patients with MRSA and can have a high carriage rate if precautions are not taken.

Several researchers have reported MRSA carriage by hospital staff, but which normally responds to mupirocin, which can be applied on the skin or inside the nostrils.[8] This helps to eliminate the organism and reduce the risk of the bacteria spreading to other patients. Some strains of the organism are, however, resistant to mupirocin.[9] Individuals colonized with the organism may also wash their skin and hair with suitable disinfectants, such as chlorhexidine. Treatment of serious *Staph aureus* infections can be challenging, with associated high mortality rate about 20-25% despite the availability of potent antimicrobial agents.[10] That is why efforts are geared towards preventing health-care workers / patients from acquiring as well as spreading it.

In South-East Nigeria generally, there is paucity of information on the prevalence of MRSA, thus the study was done to determine the prevalence of MRSA among health workers (medical doctors, medical laboratory scientists, nurses, ward attendants and cleaners) working in Nnamdi Azikiwe

University Teaching Hospital (NAUTH) Nnewi, Anambra State.

METHODOLOGY
Study Area and Population
A total of 300 health workers comprising doctors, nurses, medical laboratory scientists, ward attendants, and cleaners from Nnamdi Azikiwe University Teaching Hospital, Nnewi, Anambra State, Nigeria were sampled. Exclusion criteria included those health care workers who were currently on antimicrobial therapy during the period of the research work, those with evidence of *Staph aureus* infection like furuncles, abscesses, etc; and those that have not worked for up to one month in the hospital, smokers and those with respiratory infections. A questionnaire that covered demographics, previous and current antibiotic use, use of protective clothing, and general infection control procedures was administered.

All isolates of *Staph aureus* were identified in the Department of Medical Microbiology of the College of Health Sciences, Nnamdi Azikiwe University, Nnewi Campus, Nigeria. The control Strain ATCC 25923 (for oxacillin Susceptible) was obtained from the Department of Microbiology, College of Health Sciences, Nnamdi Azikiwe University, Nnewi Campus, Nigeria.

Identification and Characterization of *Staphylococcus aureus*
Samples from the anterior nares of each health worker (HW) were swabbed with two sterile cotton-wool swabs. One was directly inoculated onto blood agar (Oxoid) plus 5% human blood and chocolate agar and incubated for 24hrs at 37^{0}C while the other was used to make a smear for Gram stain.

After 24hrs of incubation, all colonies that were round, raised, cream coloured, and glistening were to be Gram stained and tested for catalase production. All the Gram positive and catalase positive isolates were then sub-cultured on mannitol salt agar (oxoid). Pure cultures of each isolate were further tested for coagulase production. All gram-positive, catalase-positive, and coagulase-positive cocci were identified as *Staph aureus*.

Identification of Methicillin Resistant *Staphylococcus aureus* (MRSA)
Oxacillin Screening Test
All *Staph aureus* isolates were subjected to oxacillin (1µg) disk susceptibility testing using 4% NaCl supplemented Mueller Hinton agar (oxoid).[11] About 2-5 colonies of each isolate from an 18-24hour old culture were picked with sterile wire loop and emulsified in 5mls of sterile 0.85% normal saline in bijou bottle.

The emulsified suspension was compared with 0.5 Mac Farland standards. A sterile cotton swab was dipped into the suspension and rotated several times and pressed firmly on the inside wall of the bottle above the fluid to remove excess inoculum from the swab. The Mueller-Hinton agar plate was inoculated by streaking the swab stick over the entire sterile agar surface to ensure an even distribution of inoculum. Thereafter, 1µg oxacillcin disc was placed onto the inoculated plate. This was incubated at 37^{0}C overnight. The zone of inhibition was read after incubation as recommended by the Clinical and Laboratory Standards Institute (CLSI).[11]

RESULTS
The nostrils of 300 health workers were swabbed to detect carriers of *Staph aureus* as well as the multi-antibiotic resistant strain of *Staph aureus* (MRSA) strains. Of these, 82 were from the laboratory, 218 from the clinical areas. Out of these 192 (64.0%) were nasal carriers of *Staph aureus* while 90 (38.2%) of the 192 harboured MRSA. Overall carriage rate was 30.0%.The prevalence of MRSA however,

varied significantly among categories of workers ranging from 20% in the cleaners, 24% in the doctors, 28% in the nurses, 34.1% in the medical scientists to 50.0% among the ward attendants (Table 1). It was also observed that the prevalence was higher amongst those who had worked longer in hospital especially those who had been employed for over 10 years. In this study, 56 of the 89 had been employed for over 10 years (Table 2).

Table 1. Colonization and Prevalence Rates of *Staphylococcus aureus* Isolates among health workers

Healthcare workers	Positivity %	Number of Healthcare workers Sampled
Doctors	12(24.0%)	50
Med. Lab. Scientists	28(34.1%)	82
Nurses	30(28.8%)	104
Ward Attendants	12(50.0%)	24
Cleaners	08(20.0%)	40
Total	90(30.0%)	300

$X^2 = 8.071$, P-value = 0.089

Table 2. Association between colonization of MRSA and length of stay

Subjects	<1 Year	1-5Years	6-10Years	>10Years
Doctors	5(41.7%)	2(16.7%)	2(16.7%)	3(25.0%)
Med. Lab. Scientists.	5(17.9%)	8(28.6%)	7(25.0%)	8(28.6%)
Nurses	8(26.7%)	12(40.0%)	4(13.3%)	6(20.0%)
Ward Attendants	2(16.7%)	6(50.0%)	4(33.3%)	0(0.0%)
Cleaners	2(25.0%)	2(25.0%)	2(25.0%)	2(25.0%)
Total	22(24.4%)	30(33.3%)	19(21.1%)	19(21%)

$X^2 = 10.580$, P-value = 0.565

Concerning the adherence to infection control procedures, 72 (87.8%) of laboratory health workers use gloves, 42 (51.2%) of them sometimes replace gloves whenever they leave their benches, 18 (22.0%) uses face masks, 50 (61.0%) use any disinfectants to wash their hands while 57 (69.5%) dry their hands. Despite the fact that most doctors and nurses (96.2%) were aware of nosocomial infections, only 48 (96.0%) always used gloves, while 38 (76.0%) always replaced gloves in-between patients and 38(76.0%) always used face masks (Table 3).

Table 3. Association between colonization of MRSA and adherence to Universal Precautions among Healthcare workers

	Doctors	Med.Lab. Scientists	Nurses	Cleaners	Ward Attendance	P-value	X^2
D H	38(76.0%)	57(69.5%)	70(67.3%)	30(75.0%)	18(75.0%)	0.758	1.88
UFM	35(70.0%)	18(22.0%)	48(46.2%)	40(100.0%)	6(25.0%)	0.000*	80.3
UG	48(96.0%)	72(87.8%)	100(96.2%)	40(100.0%)	22(91.7%)	0.048*	9.57
WH	38(76.0%)	50(61.0%)	72(69.2%)	-	10(41.7%)	0.020*	9.84
RG	38(76.0%)	42(51.2%)	66(63.5%)	-	12(50.0%)	0.023*	9.49

Statistical values of p<0.05 were considered as significant

Key:
Significant Statistics
Med Lab Scts: Medical Laboratory Scientists
Ward Attend: Ward Attendant
DH: Drying of Hands.
UFM: Use of Face Mask.
UG: Use of Gloves.
WH: Washing of Hands.
RG: Removal of Gloves in-between Patients

DISCUSSION
This study looked at the nasal carriage rate of *Staph aureus* among health workers to determine the carrier rates. Among the 300 participants, 192 (64%) had nasal colonization with *Staph aureus* including 90 (30%) with MRSA. The analyses of the data showed a higher prevalence of MRSA in nursing staff and medical laboratory scientists (28.8% and 34.1%) compared to the doctors (24%).

The prevalence of MRSA was found to be higher in Surgical Wards than in the General Wards. In the present study, MRSA isolation rate was 30% which is much higher than that recorded in India and Chicago (15.38% & 15.2%, respectively).[12,13] The increase in prevalence in the study could be due to a number of factors which include poor adherence to universal precautions by the health workers especially the use of gloves and proper hand washing in between patients. The other reason for the higher prevalence is indiscriminate/misuse of antimicrobials.[14] This leads to selection pressure and antimicrobial resistance including MRSA.

Ways to reduce the prevalence and spread of MRSA include discouraging people from the indiscriminate use of antimicrobials without proper medical guidance through enlightenment programmes. Healthcare workers who habour MRSA in their nostrils should be advised to receive proper medical treatment to avoid the spread of the organism. A local therapy with mupirocin ointment has been shown to eliminate MRSA nasal colonization in both patients and hospital personnel, but re-colonization often occurs after therapy is discontinued. It is possible that long term intermittent therapy with mupirocin may be more effective in suppressing or eradicating MRSA colonization. Whether this would lead to increasing problems with mupirocin resistance, a phenomenon already described, is unknown.

CONCLUSION
Methicillin Resistant *Staph aureus* is highly prevalent (30%) among healthcare workers in Nnamdi Azikiwe University Teaching Hospital, Nnewi Anambra State. This study shows that there is need for health workers to adhere to universal precautionary measures while carrying out their routine work to protect both patients and themselves.

REFERENCES
1. Que YA, Moreillon P. Staphylococcus aureus (including toxic shock); *In*: MandellGL, Bennett JE, Dolin R, eds. Principles and Practice of Infectious Diseases, 7th Ed. Philadelphia, Pa: Elsevier Churchill Livingstone; 2009; 195: 2543-2578.
2. Davis KA, Stewart JJ, Crouch HK. Methicillin-resistant *Staphylococcus aureus* (MRSA) nares colonization at hospital admission and its effect on subsequent MRSA infection. *Clin Infect Dis* 2007; 39:776-782.
3. Blot S, Vandewounde K, Hoste E, Colardyn F. Outcome and attributable mortality in critically ill patients with bacteraemias involving methicillin-resistant *Staphylococcus aureus*. *Arch Intern Med* 2002; 162:2229-2235.
4. Diekema DJ, Pfaller MA. Genetic relatedness of multidrug-resistant methicillin (oxacillin) resistant *Staphylococcus aureus in* blood stream isolates from sentry. Antimicrobial resistance surveillance centers worldwide 1998. *Microb Drug Resist* 2000. 6:213-221.
5. Muller AA, Mauny F, Bertin M. Relationship between spread of MRSA and antimicrobial

use in a French university hospital. *Clin Infect Dis* 2003; 36:971-978.

6. Jernigan JA, Pullen AL, Partin C, Jarvis WR. Prevalence of and risk factors for colonization with MRSA in an outpatient clinic population. *Infect Control Hosp Epidemiol*. 2003; 24:445-450.

7. Boyce JM, Chenever C. Isolation gowns prevent healthcare workers (HCWs) from contaminating their clothing, and possibly their hands with methicillin-resistant *Staphylococcus aureus* (MRSA) and resistant enterococci. The Eighth Annual Meeting of the Society for Healthcare Epidemiology of America. Orlando, FL. 72.1998.

8. Fishbain JT, Lee JC, Nguyen HD. Nosocomial transmission of methicillin-resistant *Staphylococcus aureus*; a blinded study to establish baseline acquisition rates. *Infect Control Hosp Epidemiol* 2003; 24:415-421.

9. Layton MC, Perez M, Herald P. An outbreak of mupirocin-resistant *Staphylococcus aureus* on a dermatology ward associated with an environmental reservoir. *Infect Control Hosp. Epidemiol* 2003; 14:369-375.

10. Cosgrove SE, Qi Y, Kaye KS. The impact of methicillin-resistance in *Staphylococcus aureus* bacteremias on patient outcomes: mortality, length of stay, and hospital charges. *Infect Control Hosp Epidemiol* 2005; 26: 166-174.

11. Clinical Laboratory Standards 2010: Performance Standards for Antimicrobial Disk Susceptibility Tests 19th Edition. Villanova PA, M2-A7.

12. Lehari S, Reema N, Basabdatta C, Mili S. Prevalence and Antimicrobial susceptibility pattern of MRSA in Assam. *Indian J Crit Care Med* 2009; 13:156-158.

13. Klein E, Smith DL, Laxminarayan R. Hospitalizations and Deaths caused by methicillin-resistant *Staphylococcus aureus*; United States 1999-2005. *Emerg Infect Dis* 2007. 13:1840-1846.

14. [Muller A, Mauny F, Talon D. Effect of individual and group-level antibiotic exposure on MRSA isolation; a multilevel analysis. *J Antimicrob Chemother* 2006 Oct; 58:878-881.