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Nasal carriage of staphylococcus aureus among apparently healthy school children in owerri metropolis, Nigeria

Abstract

Staphylococcus aureus has being identified as a risk factor for community acquired and nosocomial infections. It is a common inhabitant of the skin and mucus membrane. Children with nasal carriage of *S. aureus* play an important role in community spread of *S. aureus* and methicillin-resistant *S. aureus* (MRSA). Screening the nasal carriage isolates of *S. aureus* for antibiotic resistance patterns will provide guidelines for empiric therapy of community-acquired infections. In this study, 270 nasal swabs specimens collected from apparently healthy school children in Owerri metropolis were examined for *S. aureus* using mannitol salt agar. Antibiotic susceptibility tests were performed using Kirby-Bauer's disc diffusion method according to performance standards of Clinical and Laboratory Standard Institute guidelines. A total of 152 (56.3%) of the children were culture positive for *S. aureus*; out of the 152 cases, 78 (55.39) were males while 74 (57.3) were females. Results show that while sex is not a significant risk factor in *S. aureus* carriage, age was ($P<0.05$). The antibiotics susceptibility pattern of the isolates reveled that erythromycin and gentamicin were the most sensitive antibiotics. The high rates of nasal carriage of *S. aureus* and presence of resistance to commonly used antibiotics are disturbing. Antibiotic stewardship programs that promote judicious use of antibiotic along with strategies to prevent community spread of *S. aureus* are urgently needed.

Keywords: staphylococcus aureus; nasal carriage; school children

Volume 2 Issue 5 - 2015

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Received: October 13, 2015 | **Published:** November 02, 2015

Introduction

Staphylococcus aureus is the most common bacterial cause for diverse range of infections, from folliculitis and furunculosis to life-threatening infections, including sepsis, deep abscesses, pneumonia, osteomyelitis, and infective endocarditis Lowy.[1] *It* colonizes the skin and mucosa of human beings and several animal species Sapna et al.[2] Although multiple body sites can be colonized in human beings, the anterior nares of the nose is the most frequent carriage site for *S. aureus in both adults and children* Sapna et al.[2] The hand carriage and nasal carriage of *S. aureus* are strongly correlated[3] suggesting that contaminated hands most commonly cause the colonization of the nares. Nasal carriers can act as "cloud" individual during rhinitis, dispersing *S. aureus* into the environment Sherertz et al.[4] Also, causal association between *S. aureus* nasal carriage and staphylococcal disease has been confirmed by many studies Sapna et al.,[2] Therefore, it is important to study the prevalence of nasal carriage of *S. aureus* and factors associated with such carriage to prevent spread of *S. aureus* in the community. Screening the nasal carriage isolates of *S. aureus* for antibiotic resistance patterns will provide guidelines for empiric therapy of community-acquired infections.

There is increasing evidence that community acquired methicillin-resistant *S. aureus* (CA-MRSA) is spreading among healthy individuals, especially children Ashish et al.[5] The individuals colonized with *S. aureus* (both CA-MRSA and CA-MSSA i.e, community acquired methicillin-sensitive *S. aureus*) tend to have a complicated clinical course from a disease originating from their endogenous *S. aureus* Grundmann et al.[6] The complicated clinical course results from increasing resistance in *S. aureus* isolates and also because the bacteria can cause deep-seated infections and sepsis Kluytmans et al.[7] The difficulties in treating these deep-seated infections and sepsis require urgent measures to prevent further spread of MRSA. Setting up a bacterial surveillance system is one of the strategies to understand the epidemiology of MRSA to guide local antibiotic policy and to compare resistance patterns with other international surveillance systems. An improved understanding of epidemiology and resistance mechanisms of community acquired MRSA is required for designing better preventive strategies for further spread of resistance.

Nasal carriage of *S. aureus* has been reported across various settings in Nigeria,[8–13] and infections associated with *S. aureus* has also been reported in various parts of the country.[14–18] To the best of our knowledge, no population-based prevalence study has been carried out to determine Nasal carriage of *S. aureus* amongst school children in Owerri metropolis, Southeast Nigeria. This study was therefore, aimed at determining the nasal carriage of *S. aureus* amongst school children in various schools in Owerri and their susceptibility to conventional antibiotics used in the study area.

Materials and method

Specimen collection, cultivation and identification of *S. aureus*

Permission to sample school children was duly obtained from the head-teachers of the respective schools. At pre-arranged dates, the various schools that consented to participation of their pupils/students were visited; and the pupils/students were addressed on the nature and importance of the study. Then, a call for volunteers to be enlisted in the study was made. Those that voluntarily gave their consent were recruited for the study. Nasal swab specimens were collected using

cotton-tipped wooden swab sticks from 270 apparently healthy school children (ages 5 to 20years) that were attending primary and secondary schools in Owerri metropolis. The bio-data of each child from whom specimen was collected, including age, name, and sex, were obtained and documented. All sampling procedures were in accordance with guidelines of the National Health Research Ethics Committee, Nigeria (www.nhrec.net). Specimens were streaked on mannitol salt agar (Oxoid, England) and incubated overnight. Emergent colonies were confirmed to be *S. aureus* by catalase and coagulase tests.

Antimicrobial susceptibility tests

Susceptibility of isolates to antibiotics was tested using the disc diffusion method on Mueller Hinton agar (Oxoid, England) against the following eight antibiotics: Chloramphenicol, Tetracycline, Erythromycin, Oxacillin and Gentamycin. (Oxoid, England). The results of the antibiotics susceptibility were interpreted based on the guidelines of the Clinical Laboratory Standard Institute.[19] 0.5 Mac Farland standard was used to standardize the test inoculums.

Statistical analysis

Comparative resistant rates for *S. aureus* strains from the different sex and age groups were statistically analyzed by Test and results were considered significant at 95% confidence level.

Results

In this study, 270 apparently healthy school children were enrolled from 8 schools. Out of them 52.2% (N=141) were boys and the remaining 47.8 % (N=129) were girls (Table 1). Most children (73.9%) belonged to the age group of 5 to 9years of age. (Table 2) Out of 270 children included in the study a total of 152 (56.3%) were culture positive for *S. aureus*. Thus, the prevalence of *S. aureus* nasal carriage was 56.3%. Out of the 152 children 78 (51.3) were males while 74 (48.7) were females (Table 1). The antibiotic susceptibility pattern of *S. aureus* to individual antibiotics is shown in Table 3. Their resistance pattern showed that erythromycin and gentamicin were the most sensitive antibiotics.

Table 1 The carrier rate and sex distributions of S. aureus among the pupils of different schools sampled

Sample source	Males		Females	
	No. sampled	No. positive %	No. sampled	No. positive %
Ikenegbu Primary School, Owerri	17	13 (76.5)	13	11(84.6)
Township Primary School, Owerri	14	05(35.7)	16	12(75.0)
IMSU Staff Primary School, Owerri	19	13(68.4)	11	11(100)
Military Primary School, Owerri	30	12(50)	30	15(50)
Shell Camp Primary School, Owerri	14	06(42.8)	16	09(52.1)
Central School Oghaku, Owerri	16	13(43.3)	14	09(30.6)
Comprehensive secondary School, Oweri	16	07(43.3)	14	09(64.30)
Owerri North. Secondary School	15	06(40)	15	04(26.7)
Total	141	78(55.3)	129	74(57.3)

Table 2 The distribution of S. aureus carriage according to the age of the pupils

Age group (Years)	No. sampled	No. positive (%)
9-May	84	62(73.8)
11-Oct	36	29(80.6)
13-Dec	39	20(43.6)
14-16	17	09(52.9)
17-20	81	-48.1

Table 3 The antibiotics susceptibility pattern of S. aureus isolated from various sources

Sample source	A	N	T	I	B	I	O	T	I	C S
	T		C		E		O		G	
	%R	%S	%R	%S	%R	%S	%R	%S	%R	%S
Ikenegbu Primary School, Owerri	20	80	50	50	40	60	90	10	40	60
Township Primary School, Owerri	40	60	70	30	45	55	80	20	35	65
IMSU Staff Primary School, Owerri	30	70	50	50	40	60	50	50	20	80
Military Primary School, Owerri	60	40	60	40	50	50	75	25	30	70
Shell Camp Primary School, Owerri	80	20	80	20	90	10	100	0	30	70

Citation: Kumar S, Ricker C, Yu BD. Nasal carriage of staphylococcus aureus among apparently healthy school children in owerri metropolis, Nigeria. *MOJ Cell Sci Rep.* 2015;1(2):117–120. DOI: 10.15406/mojcsr.2015.02.00038

Table Continued....

Sample source	A	N	T	I	B	I	O	T	I	C S
	T		C		E		O		G	
	%R	%S	%R	%S	%R	%S	%R	%S	%R	%S
Central School Oghaku, Owerri	70	30	90	10	50	50	70	30	10	90
Comprehensive secondary School, Oweri	30	70	60	40	30	70	60	40	40	60
Owerri North. Secondary School	75	25	73	27	55	45	71	29	20	80

Discussion

S. aureus is an important pathogen colonizing humans and animals with an alarmingly increasing level of developing resistance to most available antimicrobial agents. In this study, 270 apparently healthy school children aged between five to twenty years were enrolled. The prevalence of *S. aureus* nasal carriage was 56.3%, the nasal carriage decreased as the aged increased. The resistance pattern of *S. aureus* showed resistance not only to single antibiotic class but co-resistance and multi-drug resistance was also common. It can be noted that *S. aureus* colonization is generally lower in resource rich countries and varies in the same community over time with increasing rates in the more recent studies. One possible explanation of high nasal carriage of *S. aureus* in resource poor countries could be low rates of exposure to antigens due to better personal hygiene leading to decreased clearing of pathogens in the tested patients Sivaraman et al.[20]

The prevalence of colonization with *S. aureus* has previously been shown to be age dependent.[21–23] The prevalence varied across different age groups in our study with lower prevalence in the age group 16-20. The peak of colonization with a respiratory pathogen may be seen at younger years.[23] During this age a lot of pathogens compete for colonization of the anterior nares; examples are pneumoccoci, *Haemophilus influenzae*, *Moraxella catarrhalis* and *S. aureus*. Bacterial interference, phenomenon by which colonization by one bacterial strain prevents colonization by another strain, plays an important role in establishing or eliminating one bacterial strain over another.[20]

In our study, the children attending primary school were shown to have significantly higher prevalence of carriage. The finding is consistent with the fact that large family size with 10 or more members had higher carriage prevalence as compared to families with less than or equal to 4 members. This might be due to poor hygiene and overcrowding. Studies have demonstrated the importance of close contacts within households[24] and with parents[25] in spread of *S. aureus* carriage among children residing in the same household. In the above two studies the children shared the genotype of *S. aureus* with one of the parents, more often the mother indicating the importance of close contact within the family.

The prevalence of *S. aureus* nasal carriage rate of 56.3% observed in this study is similar to previous findings by Chigu and Ezeronye[26] who reported 50% nasal colonization in both hospital and non-hospital subjects in Aba, Abia State Nigeria and Nsofor et al.[13] which reported 62.9% carriage in school children in Elele, Rivers State Nigeria. In contrary, Onanuga and Temedie[12] reported a lower *S. aureus* nasal colonization rate (33.3%) in healthy inhabitants of Amassoma in Niger delta region of Nigeria and Adesida *et al.*[27] reported a much lower (14.0%) nasal colonization in medical students in Lagos, Nigeria. These variations may be attributed to the characteristics of the population under study. A population that is on antibiotics as at the time of sampling may yield a much lower prevalence of *S. aureus* while a population from hospital settings may yield a much higher prevalence because of the high prevalence of infectious patients in that environment. Other factors that can cause variations may be sampling and culture techniques and age group of the subjects. Our study population comprised mainly of younger children and thus may explain the considerably high carriage rate observed in this study.

The susceptibility test results showed oxacillin and chloramphenicol to be the least effective agent with more than 70% bacterial resistance, this of course have been widely reported for *S. aureus* from various sites of healthy subjects and nosocomial infections.[28,29] This is basically due to the effect of beta-lactamases produced by *S. aureus*. The uncontrolled availability of the agent in every drug vendors, which leads to its frequent use and misuse exert greater selection pressure for the resistant strains[30] thereby makes this agents almost useless in the treatment of staphylococcal infections. The observed moderately high resistance to gentamicin and erythromycin may also be as a result of their uncontrolled usage in the environment, which favours the increasing number of resistant strains due to selection pressure.[9]

Conclusion

In conclusion, antibiotic use is one of the most important determinants of antibiotic resistance, thus antibiotic stewardship programs that promote judicious use of antibiotic are urgently needed and could prove to be more cost effective then targeted screening based on risk factors, isolation of the carriers and decolonization. Simple hygiene measures like hand washing are effective in preventing spread of resistant organisms in the community. The importance of hygiene is exemplified in an intervention program in Swedish day care centres, which introduced alcohol-based hand washing for children. This intervention significantly reduced (by 12% points) children's absence from the day care.[31] Finally there is need to implement strategies for elimination of nasal carriage of *S. aureus*, so as to prevent severe multi-drug resistant *S. aureus* infections in our environments.

Acknowledgements

None.

Conflict of interest

The author declares no conflict of interest.

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