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Research Article
Nasal Carriage of *Staphylococcus aureus* Among Students of Public Schools in Sana'a, Yemen

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Abstract

Background and Objective: *Staphylococcus aureus* (*S. aureus*) is a microorganism that colonizes the skin and mucosal surfaces of healthy individuals but it is also one of the most common causes of community acquired and hospital infections. Nasal carriage of *S. aureus* represents a major risk factor especially for nosocomial infection of methicillin resistant strains (MRSA). The aim of this study was to assess the nasal carriage of *S. aureus* in healthy individuals of three public schools in the local community and the sensitivity rate of the microorganism to antibiotics. **Materials and Methods:** A total of 450 nasal swabs were obtained from students of three public schools from January to May 2014. *S. aureus* isolates were characterized by their antimicrobial susceptibility. Data were compiled and entered into MS Excel and analysed using SPSS software then presented in tabular form and analysed into frequency percentage. **Results:** Out of 450 students 104 (23.1%) were colonized with *S. aureus*, with highest carriage rates (26.2%) in females and (20.2%) males which are statically nonsignificant p>0.1485. The finding of this study shown highest resistant to almost all the antibiotics which were carried out on positive samples of different isolates of *S. aureus* against ampicillin (87.5%), followed by amoxicillin (83.6%), gentamicin (72.1%), chloramphenical (62.5%) and cotrimazole (55.7%) and ciprofloxacin exhibit least resistant (17.3%), followed by erythromycin (32.6%) and cefotaxime (34.6%). **Conclusion:** Therefore, it was concluded that providing information for students and their parents regarding precautions and preventive measures related to *S. aureus* is prudent practice. Future research may be required to establish whether such differences in nasal *S. aureus* carriage are linked to socioeconomic differences between urban and rural communities in this very poor country such as Yemen.

Key words: Nosocomial infection, *Staphylococcus aureus*, nasal carriage, antibiotic resistance, methicillin resistant strains

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Staphylococcus aureus contributes significantly to morbidity and mortality worldwide, causing a broad spectrum of diseases[1] *S. aureus* nasal colonization has been identified as the most important risk factor for subsequent invasive infections[2]. Community acquired *Staphylococcus aureus* infections have become an increasing problem among schools as well as in the general population during recent years. It is an epidemiologically important pathogen that known for its nasal colonization. *S. aureus* as an opportunistic pathogen is usually present in 20-40% of the population. *S. aureus* is the leading nosocomial pathogen in hospitals throughout the world[3,4]. It has also been documented that the carriage of *Staphylococcus aureus* by some individuals makes them more prone to skin infections and operational complications caused by the organism to non carries[5,6]. *Staphylococcus aureus* is recognized worldwide as a common cause of infection in humans and animals. It produces a spectrum of exotoxins and other determinants of virulence that contribute to its pathogenicity. *Staphylococcal* enterotoxins (SEs) are recognized as being the most important virulence factors involved in cases of food poisoning in humans[7-9]. *Staphylococcus aureus* skin and soft-tissue infections were very frequent in the community and most respond rapidly to simple local treatment. Some become extensive or chronic. It has been shown *S. aureus* nasal carriage was more frequent in chronic staphylococcal infections. Nasal decontamination with mupirocin can prevent relapses of chronic furunculosis[10]. To date, this is the first study among public school students in Yemen, therefore, the aim of this study was to evaluate the carriage rate and risk factors of multidrug resistance *Staphylococcus aureus* among Yemeni students of public schools at Sana'a city.

MATERIALS AND METHODS

Study area: Cross sectional study was conducted at Al-Kardaay, Al-Hassan ben Ali and Shohadaa Al-sabaain schools in Sana'a city, Yemen (Fig. 1) from January to May, 2014.

Collection of samples: With single swab, a single sample was collected from nasal site, from each participant. Swab from each participant was coded with a numeric number that was followed by a letter N for nasal swab. Repeated samples were excluded when indicated by information of participants. Health care facility exposure and antibiotic usage 2 weeks prior to sample collection were inquired. Nasal sample collection, a sterile cotton-tipped swab was moistened by inserting into sterile 0.85% NaCl saline solution and then expressed out extra liquid. The moistened swab was then inserted into both anterior nares, one at a time with the same swab and rotated gently against the inner surface. The swab was withdrawn and immediately streaked on a mannitol salt agar (Hi Media, India). *S. aureus* was identified by colony morphology on mannitol salt agar plates (Oxoid, Basingstoke, United Kingdom), coagulase test (plasma collected from rabbit anticoagulated blood) and catalase test (Himedia, India).

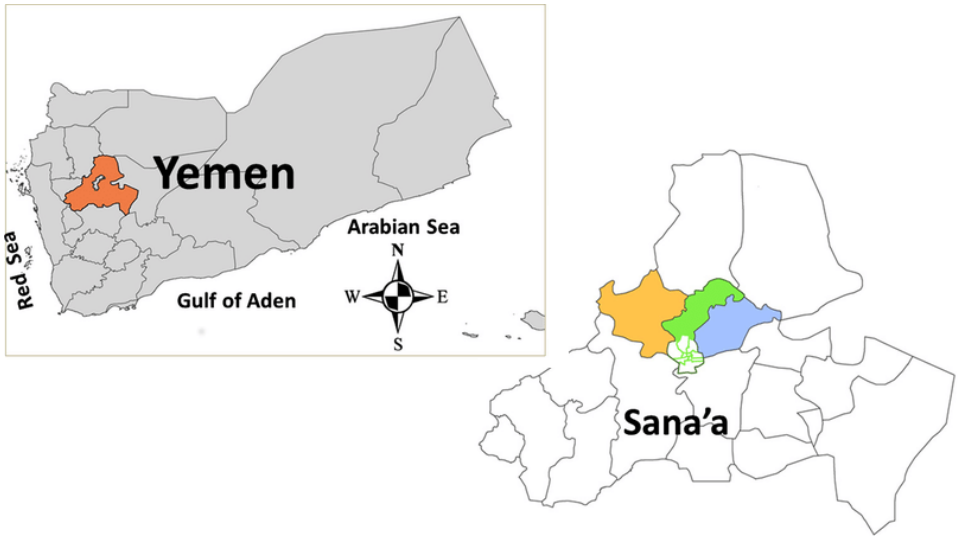

Fig. 1: Map of Yemen showing the capital city Sana'a and the three schools of three different districts

Antimicrobial susceptibility: All *S. aureus* strains were analyzed for antimicrobial susceptibility with the Kirby-Bauer disk diffusion method on Mueller-Hinton agar (Oxoid, Basingstoke, United Kingdom) including the antibiotics amoxicillin (30 µ), ampicillin (10 µ), ciprofloxacin (10 µ), erythromycin (5 µ), chloramphenical (20 µ), cotrimazole (25 µ), cefotaxime (30 µ) and gentamicin (10 µ) according to European Committee on Antimicrobial Susceptibility Testing (EUCAST) guidelines 2017[11].

Statistical analysis: Data were compiled and entered into MS Excel and analysed using SPSS 19.0 software (IBM, Armonk, NY, USA). Student's t-test and chi-square test were used to compare means and proportions respectively, with a p-value <0.05 being considered statistically significant.

RESULTS

One hundred and four isolates were yielded from culture, this include 57/271 (20.4%) from male and 47/179 (26.2%) from female as shown in Table 1.

The carriage rate were higher in females than in their males counterpart, although no statistical difference ($\chi^2 = 2.0881$, df = 3, p = 0.1485). There was more prevalent among students with aged 08-09 (34.8%), followed by 10-11 (22.4%) and 11-13 (20.8%), although no statistical significant difference was recorded among the different aged group. The result of antimicrobial test which were carried out 104 different isolates of *S. aureus* against 8 commonly used antibiotics, had shown that some strain of the pathogens were resistant to almost all the antibiotics. *S. aureus* show highest resistant to ampicillin, followed by amoxicillin, gentamicin, chloramphenical and cotrimazole as shown in Table 2 and ciprofloxacin exhibit least resistant, followed by erythromycin and cefotaxime as shown in Table 2.

Table 1: Potential risk factors for *S. aureus* nasal carriage among school children

Gender	Total	Positive	Positive (%)
Male	271	57	20.4
Female	179	47	26.2
Total	450	104	23.1

$\chi 2 = 2.0881$, df: 3, p = 0.1485

Table 2: Resistance and sensitivity pattern of 104 different isolates from nasal carriers of *Staphylococcus aureus*

Antibiotics	Sensitivity (%)	Resistant (%)
Amoxicillin	17 (15.6)	87 (83.6)
Ampicillin	13 (12.5)	91 (87.5)
Ciprofloxacin	86 (81.3)	18 (17.3)
Erythromycin	70 (68.8)	34 (32.6)
Chloramphenical	39 (37.5)	65 (62.5)
Cotrimazole	46 (43.8)	58 (55.7)
Cefotaxime	68 (65.6)	36 (34.6)
Gentamicin	29 (28.1)	75 (72.1)

DISCUSSION

S. aureus is a pathogenic microorganism able to cause a large number of diseases, starting from superficial infections of the skin and soft tissues, to severe, life-threatening infections. These infections can be endogenous or they occur after the transmission from carriers or infected individuals. The infections are commonly endogenous, i.e. caused by the strain that has already colonized the patient[5]. The most common site of colonization by *S. aureus* is the nasal mucosa. Nasal carriage of *S. aureus* thus represents the source of infection both in the community and hospital settings[12-14]. This study finding rate was lower than previous work among undergraduate medical students[3], in Kano metropolis[15], University students[16]. However, the finding of this study was similar to the previous result 29.1% among undergraduate students[17]. Implication of this finding is that despite the *S. aureus* is a microflora of the anterior nares, sometimes it may produce toxin capable of eliciting vomiting in some percentage of human population[15]. With respect to gender, the numbers of females (26.2%) implicated with nasal carriage of *S. aureus* was greater than males (20.4%). This results was inconsistent with Abdulhadi *et al.*[15], who showed that male nasal carriage of *S. aureus* was higher than their counterpart females among students population in Kano metropolis. Also, disagree with Olsen *et al.*[18] and Chatterjee *et al.*[19], who reported the prevalence of nasal carriage *S. aureus* higher in male than their counterpart female. However, in this study there is no significant difference between sex and the prevalence of the nasal carriage *S. aureus*. The presence of *S. aureus* might be attributed due to fact that school is an environment where many people with different social and economic background came together, sometimes the class may be overcrowded which enhance the transmission of this pathogens from one another through sneezing or coughing. The result of sensitivity and resistant pattern of different isolates of *S. aureus* revealed that the different strain of the pathogens exhibited higher rate of resistance to penicillin group (amoxicillin and ampicillin), followed by gentamicin (72.1%) and chloramphenicol (62.5%), while they exhibit moderate resistant to cotrimazole (55.7%). However, lower rate resistant was recorded in ciprofloxacin (17.3%), followed by erythromycin (32.6%) and cefotaxime (34.6%). Rongpharpi *et al.*[20], who reported that *S. aureus* exhibited lower resistant rate to ciprofloxacin followed by amoxiclav and cefotaxime which was similar to our finding. This study

has limitations, due to limited resources, molecular studies to confirm and typing MRSA isolates were not done. Socioeconomic statuses of families were not evaluated in this study, thus, it can be considered in further investigations. 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 the community.

CONCLUSION

The results of present study pinpointed the prevalence of *S. aureus* nasal colonization among students of Public schools at Sana'a city in Yemen. The overall prevalence rate is 23.1%, while the number of females (26.2%) implicated with nasal carriage of *S. aureus* is greater than males (20.4%). The high prevalence rate revealed in our present work is responsible for increased rate of transmission among the community. Therefore, judicious use of antibiotics accompanied by strategies for prevention of community spread of MDRSA is highly recommended.

SIGNIFICANCE STATEMENT

This is the first study to determine the prevalence rate of *S. aureus* carriage among students of public schools. This study finding indicated that nasal carriage of *S. aureus* among schools children at Sana'a city, Yemen, was 23.1%. Future studies are needed to elucidate community acquired infection to *S. aureus* among students and to apply standard health prevention and control in order to reduce the rate of exposure to antibiotic resistance *S. aureus*.

REFERENCES

1. Sollid, J.U.E., A.S. Furberg, A.M. Hanssen and M. Johannessen, 2014. *Staphylococcus aureus*: Determinants of human carriage. Infect. Genet. Evol., 21: 531-541.
2. Eibach, D., M. Nagel, B. Hogan, C. Azuure and R. Krumkamp *et al*., 2017. Nasal carriage of *Staphylococcus aureus* among children in the Ashanti region of Ghana. Plos One, Vol. 12. 10.1371/journal.pone.0170320.
3. Ravi, G.C., A. Shivaprasad, P. Shenoy and B.T. Nagaraj, 2011. Changing pattern of nasal carriage of *Staphylococcus aureus* in undergraduate medical students. Int. J. Applied Biol. Pharm. Technol., 2: 58-63.
4. Mukherjee, N., S.E. Dowd, A. Wise, S. Kedia, V. Vohra and P. Banerjee, 2014. Diversity of bacterial communities of fitness center surfaces in a US metropolitan area. Int. J. Environ. Res. Public Health, 11: 12544-12561.
5. Dinic, M., S. Vukovic, D.S. Dorđevic and M. Bogdanovic, 2013. Nasal carriage of *Staphylococcus aureus* in healthy adults and in school children. Acta Facultatis Medicae Naissensis, 30: 31-36.
6. Nsofor, C., V.N. Nwokenkwo and C. Nwaokpa, 2015. Nasal carriage of *Staphylococcus aureus* among apparently healthy school children in Owerri Metropolis, Nigeria. MOJ Cell. Sci. Rep., Vol. 2. 10.15406/mojcsr.2015.02.00038.
7. Al-Haj, N.A., E. Amghalia, M.N. Shamsudin, A. Rasedee, M. Rahmah and S. Zamberi, 2009. Novel molecular analysis for characterization of Staphylococcal cassette chromosome in a methicillin-resistant *Staphylococcus aureus* isolated from Malaysian hospital. Res. J. Biol. Sci., 4: 937-942.
8. Kong, C., H.M. Neoh and S. Nathan, 2016. Targeting *Staphylococcus aureus* toxins: A potential form of anti-virulence therapy. Toxins, Vol. 8. 10.3390/toxins8030072.
9. Rong, D., Q. Wu, M. Xu, J. Zhang and S. Yu, 2017. Prevalence, virulence genes, antimicrobial susceptibility and genetic diversity of *Staphylococcus aureus* from retail aquatic products in China. Front. Microbiol., Vol. 8.
10. Durupt, F., L. Mayor, M. Bes, M.E. Reverdy, F. Vandenesch, L. Thomas and J. Etienne, 2017. Prevalence of *Staphylococcus aureus* toxins and nasal carriage in furuncles and impetigo. Br. J. Dermatol., 157: 1161-1167.
11. European Committee on Antimicrobial Susceptibility Testing, 2017. Breakpoint tables for interpretation of MICs and zone diameters. Version 7.1. The European Committee on Antimicrobial Susceptibility Testing. http://www.eucast.org/fileadmin/src/media/PDFs/EUCAST_files/Breakpoint_tables/v_7.1_Breakpoint_Tables.pdf
12. Wertheim, H.F., D.C. Melles, M.C. Vos, W. van Leeuwen, A. van Belkum, H.A. Verbrugh and J.L. Nouwen, 2005. The role of nasal carriage in *Staphylococcus aureus* infections. Lancet Infect. Dis., 5: 751-762.
13. Kluitmans, J., A. van Belkum and H. Verbrugh, 1997. Nasal carriage of *Staphylococcus aureus*: Epidemiology, underlying mechanisms and associated risks. Clin. Microbiol. Rev., 10: 505-520.
14. Amghalia, E., N.A. Al-Haj, M.N. Shamsudin, S. Radu, R. Rosli, V. Neela and R.A. Rahim, 2009. Multiplex PCR assays for the detection of clinically relevant antibiotic resistance genes in *Staphylococcus aureus* isolated from malaysian hospitals. Res. J. Biol. Sci., 4: 444-448.
15. Abdulhadi, S.K., A.H. Hassan and A. Da'u, 2008. Nasal carriage of *Staphylococcus aureus* among students in Kano Nigeria. Int. J. Biomed. Health Sci., 4: 151-154.
16. Akinkunmi, E.O. and A. Lamikanra, 2012. A study of the intestinal carriage of antibiotic resistant *Staphylococcus aureus* by Nigerian children. Afr. Health Sci., 12: 381-387.

17. Kingdom, J.C.P., S.M. Joyce, F.L. Bradley, W. Jauch, F.R. Falkiner and C.T. Keane, 1983. Staphylococcal nasal carriage in medical students with varying clinical exposure. J. Hosp. Infect., 4: 75-80.
18. Olsen, K., M. Sangvik, G.S. Simonsen, J.U.E. Sollid, A. Sundsfjord, I. Thune and A.S. Furberg, 2013. Prevalence and population structure of *Staphylococcus aureus* nasal carriage in healthcare workers in a general population. Tromso staph and skin study. Epidemiol. Infect., 14: 143-152.
19. Chatterjee, S.S., P. Ray, A. Aggarwal, A. Das and M. Sharma, 2009. A community-based study on nasal carriage of *Staphylococcus aureus*. Indian J. Med. Res., 130: 742-748.
20. Rongpharpi, S.R., N.K. Hazarika and H. Kalita, 2013. The prevalence of nasal carriage of *Staphylococcus aureus* among healthcare workers at a tertiary care hospital in assam with special reference to MRSA. J. Clin. Diagn. Res., 7: 257-260.