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Nasal Carriage and Resistance Pattern of *Staphylococcus aureus* Among Healthy Medical Students

Reza Khashei,[1] Khosrow Zamani,[1] Mohammad Kaveh,[1] Mohammad Motamedifar,[1,2] and Hadi Sedigh Ebrahim-Saraie[1,3,*]

[1]Department of Bacteriology and Virology, School of Medicine, Shiraz University of Medical Sciences, Shiraz, IR Iran
[2]Shiraz HIV/AIDS Research Center, Shiraz University of Medical Sciences, Shiraz, IR Iran
[3]Student Research Committee, Shiraz University of Medical Sciences, Shiraz, IR Iran

[*]*Corresponding author*: Hadi Sedigh Ebrahim-Saraie, Department of Bacteriology and Virology, School of Medicine, Shiraz University of Medical Sciences, Shiraz, IR Iran. Tel: +98-9368829763, Fax: +98-7132304356, E-mail: seddigh.hadi@gmail.com

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Abstract

Background: *Staphylococcus aureus* nasal carriage plays an important role in the epidemiology and pathogenesis of infections, and this status accounts for both community-acquired and nosocomial infections.
Objectives: This study was conducted to determine the frequency of the nasal carriage of *S. aureus* in healthy medical students.
Patients and Methods: This cross-sectional study was undertaken among medical students from August of 2012 until January of 2013. Nasal samples from both anterior nares were obtained from the subjects using sterile moistened swabs, and the isolates were identified as *S. aureus* by the standard microbiological tests. The antibiotic susceptibility profiles were determined by the disc diffusion method according to the Clinical and Laboratory Standards Institute (CLSI) guidelines.
Results: Out of the 200 nasal swabs obtained, the overall nasal carriage of *S. aureus* was 24.5% (49/200). The prevalences of the methicillin-susceptible and resistant *Staphylococcus aureus* nasal carriage were 20% (40/200) and 4.5% (9/200), respectively, while the antibiotic susceptibility tests revealed that all 49 *S. aureus* isolates were sensitive to mupirocin.
Conclusions: Despite the higher frequency of *S. aureus* nasal carriage in the interns, compared to the first year students, the difference did not reach statistical significance. Therefore, attendance at medical centers cannot be considered a risk factor for increasing carriage.

Keywords: Nasal Carriage, Antibiotic Resistance, *Staphylococcus aureus*

1. Background

Staphylococcus aureus is the most frequently isolated bacterium in the clinical setting, and the most common causative agent of nosocomial infections (1, 2). It appears that the carriage of *S. aureus* in people's noses plays an important role in the epidemiology and pathogenesis of infections caused by *S. aureus*, and this status accounts for both community-acquired and nosocomial infections, affecting nearly 20% of the population (2). Nowadays, methicillin-resistant *S. aureus* (MRSA) strains are of concern within healthcare organizations and in the community, and the frequency of these isolates is widely variable from region to region (3, 4). The nasal carriage of community-acquired MRSA (CA-MRSA) is associated with a much higher incidence of clinical manifestations in comparison to other *S. aureus* strains (5). The CA-MRSA isolates, in addition to the beta-lactams, demonstrate resistance to other antimicrobial agents such as mupirocin (4, 6). Mupirocin, as an antibacterial agent (via binding to isoleucyl tRNA synthetase, preventing protein synthesis), has been used in the form of a topical ointment for the eradication of MRSA or methicillin-susceptible *Staphylococcus aureus* (MSSA) infections and colonization to prevent the spread of this pathogen (4, 7).

2. Objectives

To the best of our knowledge, in our region (the southwest of Iran) there is no information on the prevalence of mupirocin resistance among *S. aureus* isolates; therefore, this study was conducted to determine the prevalence of resistance to methicillin and mupirocin in the nasal carriage of *S. aureus* in healthy medical students.

3. Patients and Methods

3.1. Study Design and Setting

This cross-sectional study was undertaken among volunteer medical students aged $\geq$ 18 years in different wards

of a tertiary care hospital and school of medicine (100 interns and 100 first year students, respectively), from August of 2012 through January of 2013. This study was approved by the ethics committee of the Shiraz University of Medical Sciences (EC-90-5575). Signed informed consent and written questionnaires concerning the demographics (sex, age) and medical history data were obtained from all participants. The exclusion criteria were as follows: history of hospitalization, undergoing nasal surgery, history of upper respiratory infection, smoking, and antibiotic therapy in the past one month.

3.2. Sampling and Bacterial Identification

Nasal samples from both anterior nares were obtained from the subjects using sterile swabs moistened with saline. All of the samples were sent to the laboratory in nutrient broth (NB) within 1 hour. The samples were then inoculated into NB and, after overnight incubation at 37°C, subcultured onto blood agar and mannitol salt agar plates. Microbiological standard tests, including colonial morphology, Gram staining, coagulase, and DNase, were used for the identification of the *S. aureus* isolates. Methicillin resistance was assessed for all of the isolates using a 1 μg oxacillin disc (BBL, US), and confirmed by the detection of *mecA* with the previously described primers (8).

3.3. Antimicrobial Susceptibility Testing

Antibiotic susceptibilities to ampicillin (10 μg), ciprofloxacin (5 μg), gentamycin (10 μg), erythromycin (15 μg), clindamycin (2 μg), tetracycline (30 μg), cotrimoxazole (25 μg), rifampicin (5 μg), and teicoplanin (30 μg) were performed on the *S. aureus* isolates by the disk diffusion method on Muller-Hinton agar (Merck, Germany), according to the CLSI guidelines (9). In addition, resistance to mupirocin was carried out using 5 μg discs. Those isolates presenting diameters $\geq$ 14 mm were considered to be susceptible (7). All of the discs were obtained from the Mast Group, Ltd., United Kingdom, and *S. aureus* ATCC 25923 was used as a control strain.

The statistical analysis was performed using the SPSSTM software, version 21. The Chi-square or Fisher's exact tests were used to analyze the results, and $P < 0.05$ was considered to be significant.

4. Results

Out of a total of 200 nasal swabs which were taken from our subjects, the overall nasal carriage of *S. aureus* was 24.5% (49/200). Of the 49 *S. aureus* isolates, 59.2% (15 male, 14 female) were isolated from the interns and 40.8% (12 male, 8 female) were isolated from the first year students. Although, the frequency of *S. aureus* isolation was higher among the interns, when compared to the first year students, the differences were not significant. The frequencies of the MSSA and MRSA nasal carriages were 20% (40/200) and 4.5% (9/200), respectively. Overall, the majority of the *S. aureus* isolates were MSSA (81.6%), and mostly isolated from males. However, no significant association was found between the pattern of methicillin resistance and gender. The details of the isolation rate based on the methicillin resistance pattern are shown in Table 1.

The results of the antibiotic susceptibility pattern revealed that all 49 *S. aureus* isolates were sensitive to mupirocin and teicoplanin. The antibiotic resistance profiles of the tested isolates are presented in Table 2.

5. Discussion

In the entire human, the anterior nares have been shown to be the most common site of *S. aureus* colonization (2, 6), and in different regions, the rate of the nasal carriage of *S. aureus* varies between 18% - 50% (4). Although there are many reports about the prevalence of the nasal carriage of *S. aureus* among different populations, especially hospitalized patients and healthcare workers (10, 11), there is little information about medical students. In the current study, 24.5% of the participants carried *S. aureus*. In previous studies from the central regions of Iran, which showed the closest findings to ours, Erami et al. from Kashan city and Khorvash et al. from Isfahan city reported a prevalence of *S. aureus* healthy carriage at 26.3% and 26.6%, respectively (1, 12). In some studies conducted among healthcare workers and healthy people from other parts of the world, the nasal carriage rates of S. *aureus* were reported to be in the range of 18% to 29% (2, 5, 6).

In our results, the frequency of MRSA isolates among the carriers was 4.5% (9/200), which is lower than the observation rate of Askarian et al. among healthcare workers, with 5.3% at the Namazi hospital in our studied area, Shiraz city (13).

The mupirocin resistance among the *S. aureus* clinical isolates is very low in many countries (4). In this investigation, all of the *S. aureus* isolates were sensitive to mupirocin, and similar results have been shown by Mohajeri et al. from western Iran (14). It has been reported that there is a remarkable increase in the rate of *S. aureus* mupirocin-resistant isolates, despite the low use of mupirocin (15). However, this negative result may be due to the lack of mupirocin use among our participants, even in the clinical setting in our region. Therefore, it seems that the very low rate of resistance to mupirocin among both

Table 1. The Distribution of the Recovered *S. aureus* Isolates According to the Methicillin Resistance Pattern

Gender	First Year Students (Total No. 100)		Interns (Total No. 100)		P Value
	MSSA Positive No.	MRSA Positive No.	MSSA Positive No.	MRSA Positive No.	
Male	11	1	12	3	0.762
Female	6	2	11	3	0.736
Total	17	3	23	6	0.896

Table 2. Antibiotic Resistance Profiles of the *S. aureus* Isolates Among the Nasal Carriers[a]

Isolates Antibiotics	MSSA (Total No. 40)	MRSA (Total No. 9)
Ampicillin	28 (72.5)	9 (100)
Erythromycin	13 (32.5)	5 (55.6)
Clindamycin	9 (22.5)	5 (55.6)
Tetracycline	6 (15)	3 (33.3)
Co-trimoxazole	4 (10)	2 (22.2)
Gentamycin	2 (5)	1 (11.1)
Ciprofloxacin	0	3 (33.3)
Rifampicin	0	1 (11.1)
Teicoplanin	0	0
Mupirocin	0	0

[a]Values are expressed as No. (%).

the CA-MRSA and hospital-acquired MRSA in our country is rational.

In summary, despite the higher frequency of *S. aureus* nasal carriage among interns in comparison to first year students, the absence of statistical significance suggests that attendance at medical centers is not a risk factor for increasing *S. aureus* nasal carriage. Moreover, to achieve a comprehensive conclusion, further studies with larger sample sizes and more follow-up time are required.

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Footnotes

Authors' Contribution: Study concept and design: Reza Khashei; acquisition of the data: Khosrow Zamani, Mohammad Kaveh; statistical analysis and interpretation of the data: Hadi Sedigh; drafting of the manuscript: Reza Khashei; critical revision of the manuscript for important intellectual content: Reza Khashei, Mohammad Motamedifar, and Hadi Sedigh.

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