

# Nasal carriage of *Staphylococcus aureus*: Frequency and antibiotic resistance in healthy adults

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**BACKGROUND:** This study aimed to determine the frequency of nasal carriage and antibiotic susceptibility profile of *Staphylococcus aureus* (*S. aureus*) among healthy young adults who referred to premarital screening clinics. **METHODS:** A cross-sectional study including 158 adults (79 men and 79 women) was conducted at health care centers, Isfahan, Iran, during February-August 2008. Nasal swabs from anterior nares of healthy adults were cultured and tested for *S. aureus*. Antibiotic susceptibility testing was performed on Muller-Hinton Agar using disc diffusion method according to Clinical Laboratory Standards Institute (CLSI). **RESULTS:** The prevalence of *S. aureus* nasal carriage was 26.6%. Resistance to penicillin had the highest rate. The isolates demonstrated higher sensitivity to vancomycin, clindamycin, and rifampicin. In addition, twenty-two *S. aureus* isolates had intermediate resistance to antibiotics. **CONCLUSIONS:** The importance of implementing strategies to eliminate nasal carriage of *S. aureus* to prevent the spread of infection is highlighted. Effective strategies in this field are thus strongly recommended.

**KEYWORDS:** *Staphylococcus Aureus*, Nasal Carriage, Antibiotic Resistance

## BACKGROUND

*Staphylococcus aureus* (*S. aureus*) is a spherical bacterium frequently found in the nose, throat, intestine, vagina, and skin of human body.<sup>[1]</sup> It is the most common nosocomial pathogen, accounting for approximately 20% of all nosocomial pathogens.<sup>[2]</sup> Colonization of *S. aureus* in humans is a critical prerequisite of subsequent clinical infection of the skin, blood, lung, heart, and other deep tissues, and also sepsis.<sup>[3,4]</sup> *S. aureus* infections are growing problems worldwide,<sup>[5]</sup> with mortality rates ranging from 6% to 40%.<sup>[4]</sup>

Healthy individuals can host *S. aureus* in the nasopharynx, body surface, and vagina.<sup>[6]</sup> It is estimated that 80% of infections with *S. aureus* are endogenous, caused by the colonizing strain.<sup>[7]</sup> Risk factors for colonization include young age, male sex, underlying comorbidities, sharing a carrier's household, smoking, having a history of hospitalization, and recent contact with animals.<sup>[8]</sup> Persistent nasal carriage of *S. aureus* is the primary reservoir for this pathogen.<sup>[9]</sup> The organism is normally present in the nasal vestibule of about 35% of apparently healthy individuals and its carriage varies

between different ethnic and age groups.<sup>[5]</sup> Its prevalence has been severally reported in healthy populations including 36% in nares of Japanese adults and 32.4% in nasal cavity of adults in the USA.<sup>[10]</sup>

*S. aureus* has become resistant to various antimicrobial agents including the commonly used penicillin-related antibiotics. Multi-drug resistant strains of *S. aureus* have been reported with increasing frequency worldwide.<sup>[10]</sup> Moreover, its burden has increased recently due to the emergence of methicillin-resistant *S. aureus* (MRSA) strains in the community<sup>[8]</sup> which increases the importance of screening to avoid epidemic spread of MRSA.<sup>[2]</sup>

Asymptomatic carriage of *S. aureus* in healthy individuals has a high prevalence and it can be the source of transmission to other susceptible persons.<sup>[11]</sup> Therefore, identification of *S. aureus* carriers is a key point in an infection control program, enabling treatment before infection develops. In addition, rapid detection of MRSA carriers allows the initiation of appropriate control measures to prevent the spread.<sup>[2]</sup> The aim of this study was to determine the prevalence of nasal

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carriage of *S. aureus* and antibiotic resistance among healthy young adults who referred to premarital screening clinics.

## METHODS

This cross-sectional study was carried out from February to August 2008. Healthy young couples participating premarital screening and counseling were included and screened for nasal carriage of *S. aureus*. Ethical clearance was obtained from the Ethical Committee of Isfahan University of Medical Sciences, Isfahan, Iran. Minimum sample size required to accurately assess *S. aureus* carriage was estimated as 160 individuals based on the expected prevalence of nasal colonization (30%) and an  $\alpha$  risk of 5%. Finally, 158 young adults of both sexes, 79 males and 79 females, who aged 18-35 years were enrolled. The volunteers gave informed consents. Demographic data was collected and the participants ensured that they were not on any antibiotics for at least two weeks at the time of sampling and that they had not been admitted into any hospitals in the one year period prior to the study. The volunteers were healthy on physical examination and none of them had nasal abnormalities, chronic diseases, and smoking habits.

The nasal specimens from anterior nares of the subjects were collected using labeled sterile cotton wool swabs. All swabs were obtained by 1 of the 2 investigators using a standard method. They were then taken to the laboratory within 2 hours of collection. The samples were inoculated on sterilized Mannitol salt agar (MSA) plates. After 48 hours of incubation at 37°C, yellow colonies were counted and isolated for further use. The colonies with pink or red zones were excluded. The isolates were identified as *S. aureus* based on colony morphology, Gram stain, catalase test, coagulase test, and manitol salt agar fermentation.

Susceptibility to antibiotics was assessed by the disc diffusion method, as recommended by the Clinical Laboratory Standards Institute (CLSI).<sup>[12]</sup> The panel of antibiotics used in sensitivity tests included penicillin, oxacillin, erythromycin, tetracycline, doxycycline, clindamycin, rifampicin, trimethoprim-sulfamethoxazole, methicillin, and vancomycin. The susceptibility test was performed on Mueller-Hinton agar (MHA). The strain's suspension was matched with 0.5 McFarland standards to give a resultant concentration of  $1.5 \times 10^8$  CFU/mL (colony-forming unit per milliliter). While the plates were incubated at 35°C for 16-18 hours, the plate containing oxacillin was incubated for 24 hours. The results were analyzed using commercially available software (SPSS15; SPSS Inc, Chicago, IL, USA). Data analyses were performed using descriptive and inferential statistics. P-values less than 0.05 were regarded as significant.

## RESULTS

Our participants included 158 healthy young Iranian couples who referred to selected health care centers in Isfahan, Iran. The male to female ratio was 1:1. The mean age of participants was  $25 \pm 3.2$  years (range: 18-35 years). Overall, 42 individuals in the screened population (26.6%) were identified as nasal carriers of *S. aureus*. On the other hand, 116 subjects (73.4%) without positive test results of nasal specimens for *S. aureus* were classified as non-carriers. Of the 42 nasal carriers, 23 (54.8%) were male and 19 (45.2%) were female. There was no statistical difference in carriage rates between male and female participants ( $p = 0.68$ ).

The sensitivity of *S. aureus* isolates to the tested antibiotics is shown in table 1. While resistance to penicillin had the highest rate (88%), no resistance to vancomycin was noted. The isolates demonstrated higher sensitivity to vancomycin (100%), clindamycin (95.2%),

**Table 1. Antibiotic susceptibility of *Staphylococcus aureus* isolates from volunteers**

Antibiotic	Sensitive n (%)	Intermediate n (%)	Resistant n (%)
Penicillin	5 (12%)	0	37 (88%)
Oxacillin	20 (47.6%)	8 (19.1%)	14 (33.3%)
Trimethoprim-sulfamethoxazole	18 (42.9%)	10 (23.8%)	14 (33.3%)
Tetracycline	32 (76.2%)	0	10 (23.8%)
Erythromycin	33 (78.6%)	0	9 (21.4%)
Doxycycline	36 (85.7%)	0	6 (14.3%)
Methicillin	33 (78.6%)	4 (9.5%)	5 (11.9%)
Rifampicin	39 (92.9%)	0	3 (7.1%)
Clindamycin	40 (95.2%)	0	2 (4.8%)
Vancomycin	42 (100%)	0	0

and rifampicin (92.9%). In addition, intermediate resistance to trimethoprim - sulfamethoxazole, oxacillin, and methicillin was observed in a total number of twenty-two *S. aureus* isolates including 10 (23.8%), 8 (19.1%), and 4 (9.5%) isolates, respectively.

## DISCUSSION

*S. aureus* is a pathogen of high concern because of its ability to cause a various array of life-threatening infections and its capacity to adapt fast to different environmental conditions.<sup>[1]</sup> Elucidating the ambiguous determinants of this phenomenon is of major public health interest. As a first step towards understanding the microbial ecology of *S. aureus* carriage, we assessed the nasal carriage and antibiotic resistance in healthy individuals.

Our study showed the overall prevalence of *S. aureus* to be 26.6% in healthy young adults. Carrying *S. aureus* in nares has been shown in several studies on healthy adults in different countries including Malaysia (23.4%),<sup>[13]</sup> Nigeria (33.3%),<sup>[10]</sup> Iran (26.5%),<sup>[14]</sup> and Jordan (40%).<sup>[15]</sup> These variations may be attributed to the characteristics of the quality and size of samples,<sup>[16]</sup> population under study, and culture techniques.<sup>[5,10]</sup> Furthermore, longitudinal studies have found 10-35% of healthy adults to persistently carry *S. aureus* in their nares while 20-75% of the adults have been reported to be intermittent carriers. On the other hand, 5-70% of healthy adults do not carry the organism.<sup>[17]</sup> The question is why are some individuals apparently resistant to colonization and thus at a lower risk of infection.

In the present study, gender was not an important risk factor for *S. aureus* carriage. Similarly, Ghasemian et al. did not find any associations between gender and nasal carrier state.<sup>[18]</sup> Moreover, no vancomycin resistance was detected in this study. Likewise, a previous study did not find vancomycin resistance in clinical isolates or nasal carriers.<sup>[15]</sup> Heysell et al. reported all their isolates to be susceptible to vancomycin.<sup>[19]</sup> The high susceptibility of *S. aureus* to vancomycin, clindamycin, and rifampicin in our survey indicates that these antibacterial agents were effective for the treatment of *S. aureus* infections in our subjects. Clinically significant MRSA is being isolated with greater frequency in many countries, often posing problems as causes of nosocomial infections.<sup>[20]</sup> Study of nasal carriage of MRSA is important to the community since carriage plays a key role in the epidemiology and pathogenesis of community-associated diseases.<sup>[21]</sup>

It is notable that asymptomatic colonization can persist for months to years.<sup>[22]</sup> In addition, the increasing resistance of this pathogen to various antibiotics would complicate the treatment of *S. aureus* infections. Therefore, effective strategies to prevent *S. aureus* infections are urgently needed.<sup>[23]</sup> Determination of additional factors that naturally protect individuals from *S. aureus* colonization may lead to novel strategies for preventing infections. In this respect, Matheson et al. found that consumption of hot tea, coffee, or both is associated with a lower likelihood of MRSA nasal carriage. Their findings suggest a promising new method to decrease MRSA nasal carriage that is safe, inexpensive, and easily accessible.<sup>[24]</sup> In another survey, Karabay et al. indicated MRSA colonization rates to be decreased using simple precautions like hand-washing after a short period of education.<sup>[25]</sup>

In conclusion, this study emphasizes the need to discourage antibiotics abuse and to implement strategies for elimination of nasal carriage of *S. aureus* to prevent severe *S. aureus* infections in our environments. Consequently, further studies are required to accurately assess the epidemiology of *S. aureus* nasal carriage in various geographical locations. Screening of population at increased risk for colonization is a cost-effective strategy for clinical application.

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