

Nasal Carriage Rates of *Staphylococcus aureus* and CA-Methicillin Resistant *Staphylococcus aureus* among University Students

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Abstract The treatment of methicillin resistant *Staphylococcus aureus* (MRSA) infection is challenging because of their high resistance to different antibiotics. The objectives of this study were to determine the prevalence of *S. aureus* and MRSA nasal carriers among healthy students in Zakho University and to study their resistance pattern to vancomycin. During December 2013 to July 2014, a total of 405 nasal swabs were collected from healthy students and screened for *S. aureus*. The microorganisms were identified based on morphology and biochemical tests. Then, antibiotic susceptibility to methicillin and vancomycin was determined. The nasal carriage rate of *S. aureus* and MRSA among participated students were 17.5% (71/405) and 4.2% (17/405), respectively. The highest nasal carriage rate of *S. aureus* was found in third year students (24.7%, $p = 0.04$). The nasal carriage rate of *S. aureus* was more common in males than females (20.6% and 14.8%, respectively, $p = 0.14$). However, the nasal carriage rate of MRSA was more common in females than males (5% and 3% respectively, $p = 0.45$). All isolates were sensitive to vancomycin. *S. aureus* and MRSA nasal carriage rates observed amongst university students were comparable to other studies. The transmission of *S. aureus* and MRSA colonization, infection, and treatment should be explained to the students in order to prevent the spread and control their infections.

Keywords Nasal carriage, *S. aureus*, MRSA, Iraq

1. Introduction

Staphylococcus aureus is one of the most successful and adaptable human pathogens and responsible for difficult infections [1]. Overuse and misuse of antibiotics have led to increased levels of antibiotics-resistance. Methicillin was invented for the treatment of penicillin-resistant *S. aureus* [1]. However, methicillin-resistant *S. aureus* (MRSA) emerged and at the beginning such strains were a challenge in hospitals and health care units. Then, MRSA turned into the public-health problem affecting healthy individuals and has become the most frequent cause of skin and soft-tissue infections in the community [2-4]. As a result and to discriminate between community and healthcare facility strains, community-associated MRSA (CA-MRSA) and health care-associated MRSA (HA-MRSA) have been used. Several studies have examined the prevalence of MRSA nasal carriage among health workers, outpatient settings, injection drug users and medical students [5-8]. Also, researchers have investigated the CA-MRSA carriage rates

in a general population [9, 10]. The aims of this paper were to study the prevalence of *S. aureus* and MRSA in the anterior nares of healthy students and to study their susceptibility to vancomycin at Zakho university, Kurdistan region, Iraq.

2. Materials and Methods

Setting and sample collection

A cross-sectional study was conducted in University of Zakho, Zakho city, Kurdistan region-Iraq. The study was conducted with the approval of ethics committee in the University of Zakho. A total of 432 students aged 19 to 25 years were participated in this study from December 2013 to July 2014. Nasal swabs (moistened with sterile distilled water) were taken from anterior nares of the participants. The swab was inserted about 2 cm into the naris and directly transported for specimen processing.

Laboratory analysis of *S. aureus* and MRSA isolates

Nasal swabs were screened for *S. aureus* and MRSA. Samples were directly cultured on Mannitol Salt Agar (Oxoid) and incubated at 35°C for 24 hours. Positive colonies on mannitol salt agar were identified as *S. aureus* strains based on morphology, Gram stain and biochemical

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tests including catalase and coagulase.

The bacterial suspension was adjusted to the concentration of 0.5 McFarland and then 10 μ l inoculum was spread on the agar plate (final concentration = 10⁶ CFU/ml). Antimicrobial susceptibility testing to oxacillin was carried out according to Clinical Laboratory Standards Institute (CLSI) recommendations using Kirby-Bauer disk diffusion and agar dilution assay methods using Muller-Hinton agar (Oxoid Limited, Hampshire, England). BHI agar plates supplemented with 6 μ g/ml vancomycin were used for testing of strains for vancomycin resistance [11].

Data analysis

Statistical analysis of data was performed by using the chi-squared test with significance set at a *p* value of <0.05 using Minitab 15 software (Minitab Ltd., Coventry, UK).

3. Results

Because hospitalization and admission to healthcare facilities increase the risk of MRSA colonization, we excluded every student with history of hospitalization, surgery, dialysis or residence in a long-term care facility within one year of the MRSA culture date, the presence of an indwelling catheter or a percutaneous device at the time of culture and history of previous isolation of MRSA. A total of 432 participants volunteered in this study, 27 students (6.25%) were excluded because of the above mentioned factors. The included students (405) were examined for presence of *S. aureus* and MRSA. The male and female participants were 47% (189/405) and 53% (216/405) respectively. A total of 71 *S. aureus* and 17 MRSA were isolated from 405 participants, giving an overall positivity rate of 17.5% and 4.2%, respectively (Table 1). With regard to the year of study, prevalence of *S. aureus* rate was higher in the 3rd stage students 24.7% (24/97) than students in other stages (*p*=0.045) (Table 1).

Table 1. Distribution of *S. aureus* and MRSA nasal carriage among students

Year of study	Participants	<i>S. aureus</i> positive (%)	MRSA positive (%)
1 st	104	16 (15.4)	5 (4.8)
2 nd	101	13 (12.8)	3 (3)
3 rd	97	24 (24.7)*	5 (5.2)
4 th	103	18 (17.5)	4 (3.9)
Total	405	71 (17.5)	17 (4.2)

* *p* value = 0.045

Among the 189 males screened, 39 (20.6%) and 6 (3%) were positive for *S. aureus* and MRSA respectively, compared to 32 (14.8%) and 11 (5%) of the 216 females. However, there were no significant differences of the prevalence of *S. aureus* and MRSA among students as regard to their gender (*p* > 0.05) (Table 2). Fortunately, all isolates

were sensitive to vancomycin antibiotics.

Table 2. Distribution of *S. aureus* and MRSA nasal carriage the different genders

Year of study	Participants	<i>S. aureus</i>	MRSA
	M* F*	M (%) F (%)	M (%) F (%)
1 st	48	7 (14.6)	2 (4.2)
	56	9 (16)	3 (5.3)
2 nd	39	6 (15.4)	1 (2.6)
	62	7 (11.3)	2 (3.2)
3 rd	51	15 (29.4)	2 (4)
	46	9 (19.6)	3 (6.5)
4 th	51	11 (21.6)	1 (2)
	52	7 (13.5)	3 (5.8)
Total	189	39 (20.6)	6 (3)
	216	32 (14.8)	11 (5)

*M refers to males and F refers to females.

4. Discussion

S. aureus is a normal commensal in the nose of about 25-30% of healthy people [12]. Different factors contribute to the transmission of this microorganism such as crowded living conditions, and poor hygiene [13, 14]. The presence of *S. aureus* on the skin appears to play a key role in the pathogenesis of infection with *S. aureus* [15, 16]. Eradication of *S. aureus* from the nose reduced the incidence of invasive infection [16, 17]. In this study, the prevalence of *S. aureus* nasal carriage among students was 17.5%. This result is comparable with other studies from Iraq, Iran and Turkey [9, 18-20] and is lower than those reported in Nigeria, Ethiopia and India [21-25]. *S. aureus* nasal carriage rate was significantly higher among third year students. Outbreaks have been reported among different groups such as athletes, military recruits, prisons detainees, livestock handlers, pet owners, intravenous drug users, students [14, 26, 27]. There are different factors contributing to spread of *S. aureus* and MRSA including crowded living conditions, poor hygiene habits, close skin-to-skin contact, sharing of personal items, frequent antibiotic exposure, hospitalization and intravenous drug abuse [28]. It was found that the carriage rate of *S. aureus* was higher on participants who had been hospitalized within the past 1 year than those who had not [7]. One factor that could assist to distribute *S. aureus* among third year students is that the colonization of these bacteria among household members is shown to be higher than rates reported among the general population [4]. Member of this group of students may live in shared houses or accommodate internal departments of the university. More study is needed to explore this result.

MRSA was identified as a nosocomial pathogen which is one of the causative agents of healthcare associated infections worldwide. MRSA has traditionally considered as

associated with healthcare settings. However, new strains have emerged in the community and an increasing numbers were observed in people who have not been hospitalized or had a medical procedure [29, 30]. Different studies showed variable rate (0.8 - 36%) of MRSA nasal colonization [7, 31-34]. In our region, the nasal carriage rate of MRSA was 4.2%. Combination of factors could contribute to the nasal carriage of *S. aureus* and MRSA among population including host, geographical, environmental and bacterial factors.

Epidemiological evidence supports that the mechanism for transmission *S. aureus* and MRSA usually via direct contact with patients and other close contacts [35]. In our study, male students had a highest prevalence of *S. aureus* nasal carriage. This is in agreement with other studies that found that *S. aureus* nasal carriage rate is higher in males than females [7, 36, 37]. In agreement with other study, it was found that the prevalence of MRSA was more common in females than males [38, 39]. A similar result was obtained by Braga *et al.* [28] who showed that the prevalence of *S. aureus* are more common in males and MRSA are more prevalence in females. It is observed that females harbour a greater diversity of bacteria on their hands than males, but it is not obvious whether this is due to physiological factors or differences in hygiene and cosmetic usage [40]. Furthermore, the microbial differences between male and female could be due to the physiological and anatomical differences between genders cutaneous environments such as sweat, sebum and hormone production [41].

Vancomycin is considered one of the last options of treatment for *S. aureus* infections that are resistant to other antibiotics. Analysis of different studies revealed the emergence of Vancomycin-Resistant *Staphylococcus aureus* (VRSA) from different parts of the neighboring countries [42-45]. Fortunately, no vancomycin-resistant *S. aureus* (VRSA) isolates was found in this study.

In conclusion, the nasal carriage rate of *S. aureus* and MRSA observed in this study was relatively low and comparable to other studies in surrounding area. No vancomycin-resistant *S. aureus* was observed in our study. The implications of *S. aureus* and MRSA colonization, infection, and treatment should be explained to the students in order to prevent the spread and control their infections.

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