J Kermanshah Univ Med Sci. 2020 March; 24(1):e99490. doi: 10.5812/jkums.99490.

Published online 2020 April 8. **Research Article**

The Nasal Carriage of *Staphylococcus aureus* and Its Antimicrobial Susceptibility Pattern in Secondary School Students in Kurdistan Region, Iraq

Narin Rasheed[1] and Nawfal R Hussein[2,*]

[1]Akre Technical Institute, Duhok Polytechnic University, Duhok, Iraq
[2]College of Medicine, University of Zakho, Zakho, Iraq

[*]*Corresponding author*: College of Medicine, University of Zakho, Zakho, Iraq, Tel: +96-4627649807, Email: nawfal.hussein@yahoo.com

Received 2019 November 11; **Revised** 2020 February 04; **Accepted** 2020 March 04.

Abstract

Background: *Staphylococcus aureus* is a common commensal bacterium of the human body and a potential pathogen, causing public health hazards. Due to various virulent factors and growing antibiotic resistance, bacteria could cause various infections, ranging from minor skin infections to life-threating sepsis.
Objectives: The present study aimed to evaluate the prevalence rate of *S. aureus* and determine its antimicrobial sensitivity profile in the secondary school students in Duhok City, Iraq.
Methods: Samples were collected from the anterior nares of 492 volunteers aged more than 16 years in different cities, including Akre, Amedye, Bardarash, and Duhok. Conventional laboratory tests were performed for the identification of the bacterial isolates. In addition, the antimicrobial sensitivity test was carried out in accordance with the Clinical and Laboratory Standards Institute (CLSI).
Results: Out of 492 subjects, 185 cases (37.6%) were carriers of *S. aureus*, including 57/185 (30.8%) males. The oxacillin resistance rate was estimated at 41.08%, while the resistance rate against tetracycline, fusidic acid, ciprofloxacin, gentamicin, vancomycin, clindamycin and rifampicin was 27.02%, 19.46%, 9.19%, 8.65%, 7.56%, 3.78%, and 1.08%, respectively. All the isolates were susceptible to teicoplanin.
Conclusions: According to the results, the prevalence rate of *S. aureus* was high, and the species were more common in females. Therefore, further investigations are required to monitor the *S. aureus* antimicrobial profile and implement proper plans to manage the associated issues.

Keywords: Staphylococcus aureus, Antibiotic Sensitivity, Nasal Carriage, Duhok, Iraq

1. Background

Staphylococcus aureus is a commensal bacterium, which colonies in the nostrils in approximately 25% - 35% of healthy individuals (1), as well as the other regions in the body (e.g., inguinal region) (2). The colonization is influenced by various environmental risk factors, such as age, seasonal variations, and specific diseases (3, 4). *S. aureus* is considered to be an opportunistic microorganism, which could cause various diseases in humans through possessing several virulence factors (e.g., toxins and enzymes) or invasion to the tissues (1, 5). Furthermore, the microorganism causes various infections in the community and hospitals, including skin and soft tissue infections, pneumonia, septicemia, and urinary tract infection (1, 6, 7).

Another notable aspect of *S. aureus* isolates is the development of resistance patterns to antibiotics such as methicillin and vancomycin. Antibiotic resistance increases the potency of bacteria and severity of infections, thereby leading to high mortality (8). Recently, community-acquired methicillin-resistant *S. aureus* has raised notable concerns regarding public health in different communities (9). Several studies have been focused on the prevalence of *S. aureus* in the community in Iraq (2, 4, 10, 11), as well as among health worker (12). Therefore, the continuous monitoring of resistance patterns is required to accurately determine the prevalence status of *S. aureus* colonization in this region, followed by the provision of the antibiogram profile of the bacterium.

2. Objectives

The present study aimed to determine the prevalence rate of *S. aureus* nasal carriage in secondary school students in various districts in Duhok City, located in the Kurdistan Region of Iraq. In addition, we evaluated the antibiotic susceptibility of *S. aureus* isolates against a wide range of antibiotics of different classes.

3. Methods

3.1. Study Setting

This cross-sectional, community-based study was conducted on subject aged $\geq$ 16 years during January-August 2018. The participants were collected from the secondary schools in the cities of Akre, Bardarash, Amedye, and Duhok, located in the Kurdistan Region, Iraq. All the secondary schools in the covered region were introduced into a computer-based program, and the software randomly selected the schools and classes within each school. On the day of the experiment, all the students in the selected classes were recruited.

3.2. Exclusion Criteria

The exclusion criteria of the study were as follows: (1) history of hospitalization and surgery; (2) recent antibiotic consumption; (3) dialysis visits; (4) prolonged stay in a health care unit within one year before the nasal swab taking; (5) having a cannula/catheter during the sampling; (6) MRSA diagnosis and (7) presence of soft tissue and skin infections (2, 8, 10). The criteria were tested using questionnaires via face-to-face interviews with the participants simultaneous with the collection of their demographic data.

3.3. Sample Collection

Samples were collected from the anterior nares of the subjects using sterile swabs wetted by sterile distilled water, and smears were also collected by rolling in the nares. The brain-heart infusion (BHI) media (Neogen Company, UK) was used for the transportation of the samples to the microbiology laboratory for further experimentation.

3.4. Microbiological Procedures

3.4.1. Isolation and Identification of Staphylococcus aureus from the Swabs

S. aureus isolates were identified and isolated using several conventional tests. The swabs were inoculated into the BHI and incubated overnight. Following that, the bacterial isolates in the BHI were cultured on Mannitol salt agar (Neogen Company, UK) for the identification of *S. aureus* based on specific phenotypic characteristics, such as golden colonies and the yellow color of the culture media as an indicator of mannitol fermentation by *S. aureus*. Furthermore, catalase test and gram staining were performed to distinguish *S. aureus* from other Gram-positive cocci, and tube coagulase test was carried out to differentiate the species from other *Staphylococcus* spp. (13).

3.4.2. Antibiotic Sensitivity Test

Antibiotic sensitivity test was performed on the isolates using the Kirby-Bauer disk-diffusion method and agar dilution assay for oxacillin and vancomycin. Various antibiotics of different classes were used, and the Mueller Hinton agar (Neogen Company, UK) was applied as the standard media for the test. The examined antibiotics included oxacillin (6 μg/mL), vancomycin (8 - 30 μg/mL), tetracycline (30 μg), teicoplanin (30 μg), gentamicin (10 μg), clindamycin (2 μg), rifampicin (5 μg), ciprofloxacin (5 μg), and fusidic acid (10 μg). The antibiotic sensitivity tests for these antibiotics were performed in accordance with the Clinical and Laboratory Standards Institute (CLSI), and the results were also interpreted correspondingly (14).

3.5. Ethical Considerations

Written informed consent was obtained from the participants for sample collection and using their demographic data for research purposes. Furthermore, the study protocol was approved by the Scientific Committee of the College of Medicine at the University of Duhok in Kurdistan Region, Iraq.

4. Results

4.1. Participants

In total, 590 subjects were interviewed in the present study, and 98 participants (16.6%) were excluded based on the exclusion criteria. Finally, 492 subjects were recruited, including 204 males and 288 females aged 16 - 21 years.

4.2. Staphylococcus aureus and Antibiotic Sensitivity

Among 492 subjects, 185 cases (37.6%) had *S. aureus* isolates, including 57 males (30.8%). At the next stage, 185 isolates were assessed in terms of antibiotic sensitivity. To this end, the isolates were initially examined for methicillin resistance using oxacillin as the surrogate marker. Among the studied strains, 76 cases (41.08%) were resistant to oxacillin.

The isolates were also tested in terms of vancomycin sensitivity, and 14 of the tested samples (7.56%) were resistant to this antibiotic. The highest susceptibility was observed against rifampicin in 183 (98.92%) of the samples. The results of the antibiotics sensitivity test are presented in Table 1.

Table 1. Antimicrobial Susceptibility of Identified *Staphylococcus aureus* Isolates[a]

Antibiotics	Values		
	Susceptible	Intermediate	Resistant
Oxacillin	109 (58.92)	-	76 (41.08)
Vancomycin	171 (92.4)	-	14 (7.56)
Tetracycline	37(20)	98 (52.97)	50 (27.02)
Teicoplanin	183 (98.91)	2 (1.08)	0 (0)
Gentamicin	168 (90.81)	1 (0.54)	16 (8.65)
Clindamycin	172 (92.97)	6 (3.24)	7 (3.78)
Fusidic acid	149 (80.54)	0 (0)	36 (19.46)
Rifampicin	183 (98.92)	0 (0)	2 (1.08)
Ciprofloxacin	157 (84.86)	11 (5.95)	17 (9.19)

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

5. Discussion

Staphylococcus aureus is a predominant normal flora of the nasal passage and the most virulent species of *Staphylococci*, which leads to thousands of deaths each year (3, 7). In the present study, the prevalence of *S. aureus* was estimated at 37.6%, which is higher compared to the previous findings in the same region (17.5% -30%) (2, 4, 10, 15). In addition, the prevalence in our region was higher compared to the reported rate in the southern region of Iraq (20%) (11), Iran (28%) (9), Thailand (29.7%) (16), and Malaysia (31%) (17). In contrast, the estimated prevalence rate was lower compared to the rates in the healthy individuals employed in the cafeterias in Iraq (45.6%) (18). This discrepancy between our findings and the other studies in Iraq may be due to geographical diversity and variable environments in sample collections, which might be a risk factor for *S. aureus* colonization in the body (3, 4), as well as the differences in the sample populations.

According to the current research, 41.08% of the bacterial isolates were resistant to oxacillin, the rate of which is higher compared to the previous studies performed in Syria (9.4%) (19) and the Duhok community in Iraq, with the values reported to be 2.04% (4), 4.2% (15), 21.95% (2), and 4% in this region (10). The significantly high resistance rate of *S. aureus* against oxacillin is alarming regarding antibiotic stewardships to control this rising trend. However, the reported rate was comparatively lower in a study carried out in Nigeria (47.15%) (20).

In the current research, 7.56 % of the bacterial strains were resistant to vancomycin, and the rate was higher compared to China (4.4%) (21) and Syria (2%) (19). The high resistance rate to vancomycin in our research may highlight the misuse of antibiotics, and urgent multidisciplinary planning is required to overcome the issue of vancomycin resistance. Additionally, the resistance of the *S. aureus* isolates to tetracycline was estimated at 27.02% in the current research, which is higher than the values reported in Nepal (20%) (22) and Malaysia (17.3%) (17) and close to the other findings in the Kurdistan Region (25%) (18), while lower than the reported rate in Thailand (34.2%) (16).

In the present study, the resistance rate to ciprofloxacin and gentamicin was relatively low (9.19% and 8.65%, respectively), and the rates were lower compared to the findings in Nepal as well (36.7% and 33.3%, respectively) (22). On the other hand, gentamicin resistance was higher in the present study compared to the previous findings in the Kurdistan Region (3.22%) (18), while the same studies reported the rate of ciprofloxacin resistance rate to be approximately 19%, which is higher than the current findings in our research. In addition, our findings indicated the clindamycin resistance rate to be 3.78%, which is lower compared to the rate reported in Nepal (13.3%) (22) and Thailand (63.2%) (16), while higher than the rate reported in Malaysia (2.2%) (17). Interestingly, none of the bacterial isolates showed resistance to teicoplanin in the present study, which is similar to the findings in Nepal (22).

One of the limitations of the current research was the recruitment of students only, which might not have reflected the prevalence of the MRSA carriage in the community precisely. Therefore, further community-based investigations are required to determine the prevalence of MRSA in the community.

5.1. Conclusions

According to the results, the prevalence rate of *S. aureus* was relatively high, and this bacterial species was predominant in females. The estimated prevalence rate was higher than the previous studies conducted in Duhok City (Iraq), indicating the rising trend of antibiotic resistance pattern. Therefore, it is recommended that infection control practices be implemented and antibiotics stewardship be promoted in the form of awareness programs in order to minimize the spread of *S. aureus* infections in the community, especially in large populations (e.g., schools, dormitories, and sports gyms).

Footnotes

Authors' Contribution: Nawfal Hussein and Narin Rasheed conceptualize the project. Narin Rasheed collected data under the supervision of Nawfal Hussein. Nawfal Hussein and Narin Rasheed analyzed the data and wrote the draft.

Clinical Trial Registration Code: None decalred.

Conflict of Interests: Nothing to declare.

Ethical Approval: The scientific Committee of College of Medicine, University of Duhok, Kurdistan Region, Iraq approved the study.

Funding/Support: The project was funded by University of Duhok and Akre Technical Institute.

Informed Consent: Informed Consent was obtained from participants.

References

1. Feingold BJ, Silbergeld EK, Curriero FC, van Cleef BA, Heck ME, Kluytmans JA. Livestock density as risk factor for livestock-associated methicillin-resistant Staphylococcus aureus, the Netherlands. *Emerg Infect Dis*. 2012;**18**(11):1841–9. doi: 10.3201/eid1811.111850. [PubMed: 23092646]. [PubMed Central: PMC3559158].
2. Hussein NR, Basharat Z, Muhammed AH, Al-Dabbagh SA. Comparative evaluation of MRSA nasal colonization epidemiology in the urban and rural secondary school community of Kurdistan, Iraq. *PLoS One*. 2015;**10**(5). e0124920. doi: 10.1371/journal.pone.0124920. [PubMed: 25932644]. [PubMed Central: PMC4416827].
3. Brugger SD, Bomar L, Lemon KP. Commensal-pathogen interactions along the human nasal passages. *PLoS Pathog*. 2016;**12**(7). e1005633. doi: 10.1371/journal.ppat.1005633. [PubMed: 27389401]. [PubMed Central: PMC4936728].
4. Habeeb A. Methicillin resistant Staphylococcus aureus nasal colonization among secondary school students at Duhok City-Iraq. *J Microbiol Infect Dis*. 2014;**4**(2):59–63. doi: 10.5799/ahinjs.02.2014.02.0128.
5. Grundmann H, Aanensen DM, van den Wijngaard CC, Spratt BG, Harmsen D, Friedrich AW, et al. Geographic distribution of Staphylococcus aureus causing invasive infections in Europe: A molecular-epidemiological analysis. *PLoS Med*. 2010;**7**(1). e1000215. doi: 10.1371/journal.pmed.1000215. [PubMed: 20084094]. [PubMed Central: PMC2796391].
6. Bhatta DR, Cavaco LM, Nath G, Kumar K, Gaur A, Gokhale S, et al. Association of Panton Valentine leukocidin (PVL) genes with methicillin resistant Staphylococcus aureus (MRSA) in Western Nepal: A matter of concern for community infections (a hospital based prospective study). *BMC Infect Dis*. 2016;**16**:199. doi: 10.1186/s12879-016-1531-1. [PubMed: 27179682]. [PubMed Central: PMC4867903].
7. Boyle-Vavra S, Daum RS. Community-acquired methicillin-resistant Staphylococcus aureus: the role of Panton-Valentine leukocidin. *Lab Invest*. 2007;**87**(1):3–9. doi: 10.1038/labinvest.3700501. [PubMed: 17146447].
8. Sun DD, Ma XX, Hu J, Tian Y, Pang L, Shang H, et al. Epidemiological and molecular characterization of community and hospital acquired Staphylococcus aureus strains prevailing in Shenyang, Northeastern China. *Braz J Infect Dis*. 2013;**17**(6):682–90. doi: 10.1016/j.bjid.2013.02.007. [PubMed: 23916451].
9. Mobasherizadeh S, Shojaei H, Havaei SA, Mostafavizadeh K, Davoodabadi F, Khorvash F, et al. Nasal carriage screening of community-associated methicillin resistant Staphylococcus aureus in healthy children of a developing country. *Adv Biomed Res*. 2016;**5**:144. doi: 10.4103/2277-9175.187400. [PubMed: 27656613]. [PubMed Central: PMC5025912].
10. Assafi M, Polse R, Hussein NR, Haji A, Issa A. The Prevalence of S. aureus nasal colonisation and its antibiotic sensitivity pattern amongst primary school pupils. *Sci J Univ Zakho*. 2017;**5**(1):7–10. doi: 10.25271/2017.5.1.291.
11. Mohammed SH, Hmood MN, Abd AA. Screening of nasal carriage for Staphylococcus aureus and their resistance to oxacillin and cefoxitin among medical students in Karbala University. *J Contemp Med Sci*. 2015;**1**(1):13–6.
12. Hussein NR. Prevalent genotypes of Staphylococcus aureus strains isolated from healthcare workers in Duhok City, Kurdistan Region, Iraq. *Int J Infect*. 2016;**3**(2). doi: 10.17795/iji-35375.
13. Barrow GI, Feltham RKA. *Cowan and steel's manual for the identification of medical bacteria*. 3rd ed. Cambridge: Cambridge University Press; 2003.
14. CLSI. *Performance standards for antimicrobial susceptibilitytesting; twenty-fifth informational supplement*. Wayne, PA: Clinical and Laboratory Standards Institute; 2015. Report No.: M100-S25.
15. Assafi MS, Mohammed RQ, Hussein NR. Nasal carriage rates of Staphylococcus aureus and ca-methicillin resistant Staphylococcus aureus among university students. *Int J Microbiol Res*. 2015;**5**:123–7.
16. Treesirichod A, Hantagool S, Prommalikit O. Nasal carriage and antimicrobial susceptibility of Staphylococcus aureus among medical students at the HRH Princess Maha Chakri Sirindhorn Medical Center, Thailand: A cross sectional study. *J Infect Public Health*. 2013;**6**(3):196–201. doi: 10.1016/j.jiph.2012.12.004. [PubMed: 23668464].
17. Subri NIBM, Hlaing SS, Myint T, Emran NA, Lin Z, Thein TT, et al. Nasal carriage of Staphylococcus aureus and its antibiotic susceptibility pattern among medical and nursing students. *Asian J Pharm*. 2016;**10**(4):736–9.
18. Saeed AY. Enterotoxigenicity and antibiogram profile of Staphylococcus aureus isolated from food handlers in restaurants and cafeterias in Duhok city, Iraq. *J Am Sci*. 2015;**11**(3s):21–4.
19. Tabana YM, Dahham SS, Al-Hindi B, Al-Akkad A, KhadeerAhamed MB. Prevalence of methicillin-resistant Staphylococcus aureus (MRSA) among medical staff in three Syrian provinces: Damascus, Daraa and Al-Swayda. *Middle East J Sci Res*. 2015;**23**(8):1756–64.
20. Ghebremedhin B, Olugbosi MO, Raji AM, Layer F, Bakare RA, Konig B, et al. Emergence of a community-associated methicillin-resistant Staphylococcus aureus strain with a unique resistance profile in Southwest Nigeria. *J Clin Microbiol*. 2009;**47**(9):2975–80. doi: 10.1128/JCM.00648-09. [PubMed: 19571020]. [PubMed Central: PMC2738091].
21. Lin J, Peng Y, Xu P, Zhang T, Bai C, Lin D, et al. Methicillin-resistant Staphylococcus aureus nasal colonization in Chinese Children: A Prevalence meta-analysis and review of influencing factors. *PLoS One*. 2016;**11**(7). e0159728. doi: 10.1371/journal.pone.0159728. [PubMed: 27442424]. [PubMed Central: PMC4956239].
22. Ansari S, Gautam R, Shrestha S, Ansari SR, Subedi SN, Chhetri MR. Risk factors assessment for nasal colonization of Staphylococcus aureus and its methicillin resistant strains among pre-clinical medical students of Nepal. *BMC Res Notes*. 2016;**9**:214. doi: 10.1186/s13104-016-2021-7. [PubMed: 27068121]. [PubMed Central: PMC4828777].