Available online on 15.05.2020 at <http://ujpr.org>
Universal Journal of Pharmaceutical Research
 An International Peer Reviewed Journal

Open access to Pharmaceutical research
 This is an open access article distributed under the terms of the Creative Commons Attribution-NonCommercial Share Alike 4.0 License which permits unrestricted non commercial use, provided the original work is properly cited

Volume 5, Issue 2, 2020

Open Access

RESEARCH ARTICLE

PREVALENCE OF *STAPHYLOCOCCUS AUREUS* IN DENTAL INFECTIONS AND THE OCCURRENCE OF MRSA IN ISOLATES

Ameen Abdullah Yahya Al-Akwa¹ , Abdul Qader Mohammed Qasem Zabara¹ , Hassan Abdulwahab Al-Shamahy² , Mohammed A Al-labani¹ , Khaled M Al-Ghaffari³ , Ammar M Al-Mortada⁴ , Ahmed M. Al-Haddad⁵ , Amani Abdulhakeem Al-Sharani⁶

¹Orthodontics, Pedodontics and Prevention Department Faculty of Dentistry, Sana'a University, Yemen.

²Departement of Basic Sciences, Faculty of Dentistry, Sana'a University, Republic of Yemen.

³Department of Conservative Dentistry and Oral Health, Sana'a University, Republic of Yemen.

⁴Department of Maxillo-Facial, Faculty of Dentistry, Sana'a University, Republic of Yemen.

⁵Department of Medical Laboratories, College of Medicine and Health Sciences, Hadhramout University, Al-Mukalla, Yemen.

⁶Oral Medicine and Periodontology Department, College of Dentistry, University of Sciences and Technology, Yemen.

ABSTRACT

Objectives: *Staphylococcus aureus* is an opportunist that causes systemic infections and dental infections in the human being body. This organism increases its resistance to many categories of antibiotics all day and turn out to be more resistant, and this led to a growing feeling of concern in this era. Given this fact, the aims of this study were to determine the frequency of *S. aureus* in oral infections and to determine the prevalence of MRSA strains and the sensitivity of isolated *S. aureus* to antibiotics, in patients who attended dental clinics in major public hospitals and private clinics in the city of Sana'a-Yemen.

Subjects and methods: The study was conducted for a year, early in December 2018 and ending in November 2019. The study included 296 patients, 153 male and 143 female, ages 5 to 65, with an average age of 36.2 years. Demographic and clinical data were collected in questionnaire, then pus or oral swabs were collected from patients, cultivated, isolated and identified by standard laboratory techniques. MRSA was ascertained by means of the method of disc diffusion to 1µg of oxacillin disc and 5 µg of methacillin disc; an antimicrobial sensitivity test was carried out by disc diffusion method of selected antibiotics. The oral infections include dental abscesses, periodontal abscesses, gingivitis, periodontitis, dental caries, pulpitis and oral thrush.

Results: Of a total of 296 cultured pus and swabs, only 217 produced a positive culture (73.3%). Gram-positive bacteria formed 67.4% of the total isolates where *S. aureus* was the predominant pathogen (43.1%). The prevalence of MRSA was 23.5%. There was a higher rate of antibiotic resistance tested in MRSA isolates compared to a lower rate of resistance in MSSA as well as 22.2% of MRSA isolates were vancomycin resistant, while only 11.4% of MSSA were vancomycin resistant.

Conclusion: It can be concluded, *S. aureus* was the most widespread isolate in dental infections, high rate of MRSA, the appearance of *S. aureus* isolates resistant to vancomycin and other broad choice of antibiotics have raised MRSA in oral infections into a multi-drug-resistant, making it more and more hazardous in oral infections. Consistent assessment of oral associated infections and observing the pattern of antibiotic sensitivity and strict drug policy for antibiotics are recommended.

Keywords: Antibiotic resistance, dental infection, MRSA, *Staphylococcus aureus*, Sana'a, Yemen.

Article Info: Received 2 March 2020; Revised 3 April; Accepted 5 May, Available online 15 May 2020

Cite this article-

Al-Akwa AAY, Zabara AQMQ, Al-Shamahy HA, Al-labani MA, Al-Ghaffari KM, Al-Mortada AM, Al-Haddad AM, Al-Sharani AA. Prevalence of *Staphylococcus aureus* in dental infections and the occurrence of MRSA in isolates. Universal Journal of Pharmaceutical Research 2020; 5(2):23-27.

DOI: <https://doi.org/10.22270/ujpr.v5i2.384>

Address for Correspondence:

Prof. Hassan A. Al-Shamahy, Faculty of Dentistry, Sana'a University, P.O. Box 775 Sana'a, Yemen, Tel: +967-1-239551, E-mail: shmahe@yemen.net.ye

INTRODUCTION

The human oral cavity acts as a growth medium for pathogens as a result of its moisture, temperature, and nutritional content such as fats, carbohydrates, and protein¹. There are numerous categories of dental infections that happen in the patient's oral cavity such as periodontal disease, tooth decay, dental ache, dental plaque, dental abscess, dental calculus, dentin

hypersensitivity, hyperdontia, acid erosion, malocclusion, ulcerative gingivitis, dental fluorosis, tooth impaction, acute necrotizing, etc. *S. aureus* is a presumed pathogen for many oral diseases, such as oral mucositis, periodontitis, peri-implantitis, endodontic infections and even dental caries²⁻⁵. *S. aureus* is a Gram-positive, non-spore forming, non-motile, grape like clusters and the most important coagulase

positive pathogen from *staphylococci* due to mixture of invasiveness, toxic mediated virulence and antibiotic resistance⁶. Some *S. aureus* strains have developed drug-resistant⁷. Methicillin-resistant *S. aureus* (MRSA)⁸ are the strains of *S. aureus* that have been resistant to beta-lactam antibiotics, which include penicillins, amoxicillin, ampicillin, methicillin, oxacillin, cephalosporins, etc⁹. The tendency of *S. aureus* to acquire antibiotic resistance led to a global dissemination of clone expressing various antimicrobial resistances. Many bacterial diseases occur in hospitals and in community due to MRSA strains and sometimes lead to death¹⁰⁻¹². *S. aureus* infection, including MRSA strains, has long been common in Yemen¹³. Because the arbitrary use of antibiotics is a typical practice, hospital environments are not clean enough and crowding of patients and health workers supports the spread of infectious germs including *S. aureus*¹³. The potential presence of *S. aureus* is especially important in dental infections due to its increased resistance^{13,14}. Therefore it is very logical to check the status of the microbial resistance against the commonly used antibiotics for the treatment of dental infections that occur by *S. aureus*. Considering this, the aims of this study were to determine the frequency of of *S. aureus* in oral infections and to identify the prevalence of MRSA strains and antibiotic sensitivity of isolated *S. aureus*, in patients attended the dental clinics at the main general hospitals and private clinics in Sana'a city-Yemen.

PATIENTS, MATERIALS AND METHODS

Patients: The study was carried out for a year, from December 2018 to November 2019. The study comprised 296 patients, 153 male and 143 female, ages 5 to 65, with an average age of 36.2 years. The selected cases were defined as all patients who had a major complaint of various oral infections and entered the dental clinics previously mentioned. The technique of sampling in the study was case- finding. As for determining the size of the sample, it was relied on taking all patients who attended dental clinics during the study period and estimated one year in which the study materials were collected, which included clinical and demographic data, etc. Demographic and clinical data were collected in a questionnaire. After that pus or oral swabs were collected from patients, cultivated, isolated and identified using standard laboratory methods. The oral infections include dental abscesses, periodontal abscesses, gingivitis, periodontitis, dental caries, pulpitis and oral thrush.

Cases definition: All patients enrolled in this study, who had a major complaint of various oral infections and entered dental clinics in the city of Sana'a.

Data collection and processing: A questionnaire was filled out for each patient with the patient's personal and clinical data. This included age, gender, profession and relevant clinical information regarding bacterial and fungal oral infections. Upon initial hospitalization, cultures were obtained from the oral infection sites in order to isolate the causative agents of various bacteria and fungi.

Antimicrobial susceptibility test: Antibiotic resistance phenotypes (Methicillin/Oxacillin sensitivity test): All isolates of *S. aureus* were checked for the sensitivity to 1 µg Oxacillin disc and 5 µg Methicillin disc (Difco) by the disk diffusion method that instructed by NCCLS. The resistance breakpoints were ≥ 12 mm to ≤ 10 mm for 1 µg Oxacillin and ≥ 14 mm to ≤ 10 mm for 5 µg Methicillin. The capacity of extra antibiotic discs to inhibit MRSA or MSSA was estimated according to the instructions provided by NCCLS using commercially available discs that include: Augmentin (AC 30 µg), tetracycline (T,30 µg), erythromycin(E,15 µg), ceftizoxime (CEF 20 µg), ciprofloxacin(Ci 5 µg), clindamycin(CC, 2 µg), clarithromycin (CI 15 µg) and vancomycin(V, 30 µg). The zone of inhibition produced by *S. aureus* against each antibiotic was measured and interpreted as resistant and susceptible according to standards of Clinical Laboratory and Standards Institute¹⁵.

RESULTS

The positive culture rate was 73.3% and 26.7% of the specimens were negative (Table 1). A hundred and eighty 180 (67.4%) were Gram positive bacteria, 71 (26.6%) were Gram negative bacteria and 16 (6.0%) were *C.albicans*. The most frequent microorganism isolated was *S. aureus* (115 isolates), followed by *Bacteroides* spp (71 isolates) and *Strept. pyogenes* (38 isolates) with percentages of 43.1%, 26.6% and 14.2% respectively.

Table 1: Cultural results of the 296 patients with bacterial and fungal oral infections.

Results	No.	%
Positive cultures	217	73.3
Negative cultures	79	26.7
Total	296	100

Table 3 shows the susceptibility patterns of *S. aureus* isolates towards the different commonly used antibiotics. The resistant results for MRSA of antibiotics represented in number and percentages are shown in the following order: vancomycin (22.2%), clindamycin (26%), ciprofloxacin (29.7%), ceftizoxime (40.7%), clarithromycin (37%), augmentin (55.6%), tetracycline (74%), and erythromycin (23.3%).

Table 2: Distribution of the 217 positive culture isolates according to their group and genus.

Isolates	No.	%
Gram positive bacteria	180	67.4
<i>Staph. aureus</i>	115	43.1
<i>Strept. pyogenes</i>	38	14.2
<i>Staph. epidermidis</i>	16	6.0
<i>Strept. mutans</i>	11	4.1
Gram negative bacteria	71	26.6
<i>Bacteroides</i> spp	71	26.6
Yeasts	16	6.0
<i>Candida albicans</i>	16	6.0
Total	267	100.0

The resistant results for MSSA of antibiotics represented in number and percentages are shown in the following order: vancomycin (11.4%), clindamycin

(30.3%), ciprofloxacin (22.7%), ceftizoxime (30.3%), clarithromycin (26.3%), augmentin (30.7%), tetracycline (72.7%), and erythromycin (60.2%).

DISCUSSION

Dental patients typically take antibiotics primarily to treat postoperative and secondary infections. In the current study all 115 coagulase positive isolates of *S. aureus* were subjected to disc diffusion method to 5 µg Methicillin disc and 1 µg Oxacillin disc to determine MRSA; the test results discovered that 23.5% of isolated *S. aureus* were MRSA strain. The current rate

of 23.5% of MRSA in all isolates of *S. aureus* is lower than the rate reported from Yemen in previous reports in which MRSA was isolated from 55% of health workers in Taiz, Yemen¹⁶, also it is very lower than that reported by al-Baidani and others¹⁷, among health care workers in Al Hodeida City, Yemen where the MRSA rate was 86%. On the other hand, it was almost similar to that mentioned by Al-Safani *et al.*,¹³ (19.3%) among patients attending Military Hospital, Sana'a City; and Alyahawi, and others among patients of some private hospitals in Sana'a City (17.6%),¹⁸.

Table 3: The antibiotic sensitivity for 115 isolated MRSA and MSSA for tested antibiotics.

Antibiotics	MRSA n=27 (23.5%)		MSSA n=88 (76.5%)	
	Sensitive	Resistant	Sensitive	Resistant
Augmentin	12 (44.4%)	15 (55.6%)	61 (69.3%)	27 (30.7%)
Cefotaxime	11 (40.7%)	16 (59.3%)	61 (69.3%)	27 (30.3%)
Ciprofloxacin	19 (70.3%)	8 (29.7%)	68 (77.3%)	20 (22.7%)
Clarithromycin	17 (63%)	10 (37%)	65 (73.7%)	23 (26.3%)
Clindamycin	20 (74%)	7 (26%)	61 (69.3%)	27 (30.3%)
Erythromycin	18 (66.7%)	9 (23.3%)	35 (39.8%)	53 (60.2%)
Tetracycline	7 (26%)	20 (74%)	24 (27.3%)	64 (72.7%)
Vancomycin	21 (77.8%)	6 (22.2%)	37 (42%)	51 (58%)

HA-MRSA occurred at a higher rate than CA-MRSA in the world, but in Yemen the rates were similar for the HA-MRSA and CA-MRSA (19.4% and 17%, respectively), as mentioned by Al-Safani *et al.*,¹³ and Alyahawi *et al.*,¹⁸. This result can be explained by long hospitalization, random use of antibiotics, lack of awareness, and receiving antibiotics before coming to hospital, which are some of the potential predisposing factors for the appearance of MRSA in the hospital and community. Results of current study differs from that reported in the United States of America where a high incidence of MRSA occurred in a hospital-acquired *S. aureus* infection (HA-MRSA) (59%), compared to a community-acquired infection of *S. aureus* (17%)¹⁹. This difference can be explained by the CA-MRSA biology appearing to be different from the HA-MRSA and the MSSA, which may allow CA-MRSA to cause diseases other than those expected from MSSA^{20,21}.

With the advent of HA-MRSA, it is likely that it not only replaced HA-MSSA, but also led to a comprehensive increase in *Staph. aureus* infection in healthcare settings^{22,23}. In addition, almost all researchers say the same thing that inpatients and outpatients suffer from *S. aureus*/MRSA infection higher than *S. aureus*/MSSA due to the widespread prevalence of MRSA in a community environment and hospitals²³⁻²⁵. When comparing MRSA rate with the MRSA rate in *S. aureus* dental infections, current study result (23.5%) was almost lower than the 30% MRSA reported by Das Manisha *et al.*,²⁶. Also, the prevalence of MRSA (23.5%) was higher than the results of Ayepola *et al.*,²⁷ who reported 2.4%, as well as Smith *et al.*,²⁸ 6% of MRSA positive isolates were reported in oral infection. Another study by Renvert *et al.*,²⁹ in Sweden, observed similar results associated with periodontitis patients.

According to Kurita *et al.*,³⁰ dental patients are not the only ones responsible for spreading MRSA bacteria,

but a health professional may transfer this pathogen through their tools, so there are consistent guidelines for controlling MRSA as the CDC some standard precautions may be recommended which may help reduce the prevalence of MRSA among dental patients³¹. The reason for conducting the current study was to know the prevalence of MRSA and the current antimicrobial profile of *S. aureus* in order to choose the appropriate empirical treatment for these oral infections. In current study, vancomycin resistance (VRSA) was 22.2% in isolated MRSA. This result differs from that reported in Asian countries where the vancomycin resistance rate was no more than 10%³². The occurrence of VRSA in Asian countries has also been documented by Kaleem *et al.*,³³ in Pakistan to be 3.3%, 6% in India, by Sonavane and Mathur³⁴, 7.5% in Iran by Mehdinejad *et al.*,³⁵ and 9% in Jordan are from Al-Zoubi and others³⁶. The current study results revealed that 73% dental *S. aureus* isolates were found resistant to tetracycline followed by 53.9% to erythromycin, 46.5% to augmentin, and 35.6% to Cefotaxime where low rates of resistant occurred for ciprofloxacin (24.3%), Clarithromycin (28.7%), and Clindamycin (29.6%) (Table 3). Kim and Lee³⁷ and Das Manisha *et al.*,²⁶ reported more sensitive strains of *S. aureus* isolated from the periodontal patients showed sensitivity 95% to ciprofloxacin (vs 75.7%) and 90% to tetracycline (vs 31%), 90% to erythromycin (vs 46.1%), and to 3rd generation cephalosporins 95% (vs 62.4%) that is comparatively higher than the current study. Similar antimicrobial susceptibility results were reported by previous authors^{8,38-40}. The higher resistant rates in Yemen to commonly used antibiotics indicates indiscriminate or haphazard use that may have effect on treatment cost, poor prognosis as well as enhance the bacterial infection and growth virulent pathogens.

CONCLUSION

The prevalence of *S. aureus* in dental patients is very high and showed resistance to commonly used antibiotics in addition to a high rate of MRSA. Despite these results, the sample size of this study was insufficient and the study period was too short to reveal the actual picture of MRSA involved in dental infection in Sana'a, Yemen. We recommend extensive studies to determine the prevalence of MRSA, genome analysis, identification of toxin gene and other antibiotic resistant gene. Teeth should be brushed regularly, maintain oral hygiene, and consulting with dental doctors to check up the teeth once in a month should be taken to maintain a distance from dental infections.

AUTHOR'S CONTRIBUTION

This research work is part of a research work under the supervision of Hassan Al-Shamahy. The field, clinical and laboratory works of the research was done by the corresponding author, the fifth author, the sixth author and the eighth author. The first, second, fourth, and seventh author supervised the work and edited the manuscript.

ACKNOWLEDGEMENTS

The authors thank the University of Sana'a for financial support.

CONFLICT OF INTEREST

No conflict of interest associated with this work.

REFERENCES

- Mohapatra SB, Pattnaik M, Ray P. Microbial association of dental caries. *Asian J Exp Biol Sci* 2012; 3(2):360-367.
- Gibson J, Wray D, Bagg J. Oral staphylococcal mucositis: A new clinical entity in orofacial granulomatosis and Crohn's disease. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology* 2000; 89(2):171-176.
- Heitz-Mayfield LJ, Lang NP. Comparative biology of chronic and aggressive periodontitis vs. peri implantitis. *Periodontology* 2010; 53(1):167-181. <https://doi.org/10.1111/j.1600-0757.2010.00348.x>
- Poeschl PW, Crepez V, Rusmueller G, et al. Endodontic pathogens causing deep neck space infections: clinical impact of different sampling techniques and antibiotic susceptibility. *J Endodontics* 2011; 37(9):1201-1205. <https://doi.org/10.1016/j.joen.2011.05.029>
- Passariello C, Puttini M, Iebba V, et al. Influence of oral conditions on colonization by highly toxigenic *Staphylococcus aureus* strains. *Oral Diseases* 2012; 18(4):402-409. <https://doi.org/10.1111/j.1601-0825.2011.01889.x>
- Lair LY, Baron F, Gautier M. *Staphylococcus aureus* and food poisoning. *Genetics and Molecular Research J* 2003; 2(1):63-76. PMID:12917803
- Faden A. Methicillin-resistant *Staphylococcus aureus* (MRSA) screening of hospital dental clinic surfaces. *Saudi J Biol Sci* 2019; 26(7):1795-1798. <https://doi.org/10.1016/j.sjbs.2018.03.006>
- Rajadurai K, Mani KR, Panneerselvam K, et al. Prevalence and antimicrobial susceptibility pattern of methicillin resistant *Staphylococcus aureus*: A multicentre study. *Indian J Med Microbiol* 2006; 24(1):34-38. <https://doi.org/10.4103/0255-0857.19892>
- David MZ, Daum RS. Community-associated methicillin-resistant *Staphylococcus aureus*: epidemiology and clinical consequences of an emerging epidemic. *Clin Microbiol Rev* 2010; 23(3):616-687. <https://doi.org/10.1128/CMR.00081-09>
- Bannerman T, Peacock S. *Staphylococcus, Micrococcus, and other catalase positive cocci*. In: Murray, P., Baron, E., Jorgensen, J., Landry, M., Tenover, M. (Eds.), *Manual of Clinical Microbiology* 9th ed. ASM Press, Washington, DC, 2007; 390-411.
- Moussa IM, Al-Qahtani AA, Gassem MA, et al. Pulsed-field gel electrophoresis (PFGE) as an epidemiological marker for typing of methicillin-resistant *Staphylococcus aureus* recovered from King Saudi Arabia (KSA). *African J Microbiol Res* 2011; 5(12):1492-1499.
- Peters PJ, Brooks JT, McAllister SK, et al. Methicillin-resistant *Staphylococcus aureus* colonization of the groin and risk for clinical infection among HIV-infected adults. *Emerging Infect Dis* 2013; 19(4):623-629. <http://dx.doi.org/10.3201/eid1904.121353>
- Al-Safani AMA, Al-Shamahy HA, Al-Moyed KA. Prevalence, antimicrobial susceptibility pattern and risk factors of MRSA isolated from clinical specimens among military patients at 48 medical compound in Sana'a city-Yemen. *Universal J Pharm Res* 2018; 3(3): 40-44. <https://doi.org/10.22270/ujpr.v3i3.165>
- Vellappally S, Divakar DD, Al Kheraif AA, et al. Occurrence of vancomycin-resistant *Staphylococcus aureus* in the oral cavity of patients with dental caries. *Acta Microbiologica et Immunologica Hungarica* 2017; 64(3):343-351. <https://doi.org/10.1556/030.64.2017.033>
- Clinical and Laboratory Standards Institute [CLSI]. Performance Standards for Antimicrobial Disc Susceptibility Tests. (11th edn.), Approved standard M02-A11- Publication of Clinical and Laboratory Standards Institute [CLSI], 2012; USA, 32.
- Abdel Monem, MO. Nasal Carriage of *Staphylococcus aureus* among Healthcare Workers in Althawra Hospital, Taiz City, Republic of Yemen. *Australian J Basic App Sci* 2012; 6(7): 417-424.
- Al-Baidani AR, El-Shouny WA, Shawa TM. Antibiotic susceptibility of MRSA in three hospitals at Hodeida city Yemen. *Globe J Pharma* 2011; 5(2):106-111.
- Alyahawi A, Alkaf A, Alhomidi A. Prevalence of methicillin resistant *Staphylococcus aureus* (MRSA) and antimicrobial susceptibility patterns at a private hospital in Sana'a, Yemen. *Universal J Pharm Res* 2018; 3(3): 4-9. <https://doi.org/10.22270/ujpr.v3i3.159>
- Fridkin SK, Hageman JC, Morrison M, et al. Methicillin-resistant *Staphylococcus aureus* disease in three communities. *N Engl J Med* 2005; 352:1436-44. <https://doi.org/10.1056/NEJMoa043252>
- Askarian M, Zeinazadeh A, Japoni A, et al. Prevalence of nasal carriage of Methicillin resistance *Staphylococcus aureus* and its antibiotic susceptibility pattern in healthcare workers at Namazi Hospital, Shiraz, Iran. *Int J Infect Dis* 2009; 13:e241-e247. <https://doi.org/10.1016/j.ijid.2008.11.026>
- Mahalingam U, Thirunvukarasu T, Murugananthan K. Methicillin resistant *Staphylococcus aureus* among nurses in a tertiary care hospital in Sri Lanka. *Ceylon Medical J* 2014; S9:63-65. <https://doi.org/10.4038/cmj.v59i2.7067>
- Elie-Turenne MC, et al. Prevalence and characteristics of *Staphylococcus aureus* colonization among healthcare professionals in an urban teaching hospital. *Infection Control Hosp Epidemiol* 2010; 31:S74-S80. <https://doi.org/10.1086/652525>
- Radhakrishna M, D'Souza M, Kotigadde S, et al. Prevalence of methicillin resistant *Staphylococcus aureus* carriage amongst health care workers of critical care units in Kasturba Medical College Hospital, Mangalore,

- India. J Clin Diagnostic Research 2013; 7(12):2697–2700. <https://doi.org/10.7860/JCDR/2013/5160.3735>
24. Shibabaw A, Abebe T, Mihret A. Nasal carriage rate of methicillin-resistant *Staphylococcus aureus* among Dessie Referral hospital health care workers; Dessie Northeast, Ethiopia. Antimicrobial Resistance and Infection Control 2013; 2:25. <https://doi.org/10.1186/2047-2994-2-25>
 25. Iyer A, Kumosani T, Azhar E, Barbour E, Harakeh S. High incidence rate of methicillin-resistant *Staphylococcus aureus* among healthcare workers in Saudi Arabia. J Infect Dev Ctnes 2014; 8(3):372–378. <https://doi.org/10.3855/jidc.3589>
 26. Das Manisha, Al Momen Sabuj Abdullah, Haque Zobayda Farzana et al. Characterization of *Staphylococcus aureus* isolated from human dental infection. Afr J Microbiol Res 2019; 13(14):273–278. <https://doi.org/10.5897/AJMR2019.9076>
 27. Ayepola OO, Olasupo NA, Egwari LO, et al. Molecular characterization and antimicrobial susceptibility of *Staphylococcus aureus* isolates from clinical infection and asymptomatic carriers in Southwest Nigeria. Plos One 2015; 10(9):e0137531. <https://doi.org/10.1371/journal.pone.0137531>
 28. Smith AJ, Robertson D, Tang MK, et al. *S. aureus* in the oral cavity: a three-year retrospective analysis of clinical laboratory data. British Dental J 2003; 195(12):701–703. <https://doi.org/10.1038/sj.bdj.4810832>
 29. Renvert S, Lindahl C, Renvert H, Persson GR. Clinical and microbiological analysis of subjects treated with Brånemark or AstraTech implants: A 7-year follow-up study. Clin Oral Imp Res 2008; 19(4):342–347. <https://doi.org/10.1111/j.1600-0501.2007.01476.x>
 30. Kurita H, Kurashina K, Honda T. Nosocomial transmission of methicillin-resistant *Staphylococcus aureus* via the surfaces of the dental operator. British Dental J 2006; 201(5):297–300. <https://doi.org/10.1038/sj.bdj.4813974>
 31. Harte JA. Standard and transmission-based precautions: an update for dentistry. The J American Dent Assoc 2010; 141(5):572–581. <https://doi.org/10.14219/jada.archive.2010.0232>
 32. Mehmood A, Butt T, Usman M. A study on MRSA isolates to detect reduced susceptibility to vancomycin: A preliminary report. Infect Dis J 2007; 16:102–104.
 33. Kaleem F, Usman J, Uddin Roz. Sensitivity pattern of methicillin resistant *Staphylococcus aureus* isolated from patients admitted in a tertiary care hospital of Pakistan. Iran J Microbiol 2010; 2(3): 143–146. PMID: 22347563
 34. Sonavane A, Mathur M. Screening for vancomycin intermediate-resistant *Staphylococcus aureus* among clinical isolates of MRSA. Indian J Med Microbiol 2007; 25:79–80. <https://doi.org/10.4103/0255-0857.31078>
 35. Mehdinejad M, Sheikh AF, Jolodar A. Study of methicillin resistance in *Staphylococcus aureus* and species of coagulase negative Staphylococci isolated from various clinical specimens. Pak J Med Sci 2008; 24:719–24.
 36. Al-Zoubi, MS, Ibrahim Ali Al-Tayyar, Emad Hussein, et al. Antimicrobial susceptibility pattern of *Staphylococcus aureus* isolated from clinical specimens in Northern area of Jordan. Iran J Microbiol 2015; 7(5): 265–272. PMID: 26719783
 37. Kim GY, Lee CH. Antimicrobial susceptibility and pathogenic genes of *Staphylococcus aureus* isolated from the oral cavity of patients with periodontitis. J Periodon Implant Sci 2015; 45(6):223–228. <https://doi.org/10.5051/jpis.2015.45.6.223>
 38. Khan AH, Shamsuzzaman AKM, Paul SK, et al. Antimicrobial susceptibility and coagulase typing of MRSA strains at Mymensingh Medical College. Bangladesh J Med Microbiol 2007; 1(2):56–60.
 39. Kim Y. Multiple antimicrobial resistance patterns of *Staphylococcus aureus* isolated from periodontitis patients in Seoul, Korea. Korean J Oral Maxillofacial Pathol 2012; 36:317–339. <https://doi.org/10.5051/jpis.2015.45.6.223>
 40. Naeem M, Adil M, Naz SM, et al. Resistance and sensitivity pattern of *Staphylococcus aureus*; A study in lady reading hospital Peshawar. J Postgraduate Med Inst 2012; 27(1):42–47.