

Nasal Carriage of Methicillin-Resistant *Staphylococcus aureus* among Healthcare Workers of Sharif Medical City Hospital, Lahore and their Response to Treatment with Mupirocin Ointment

Aqsa Aslam, Maria Aslam, Saima Inam

ABSTRACT

Objective: To detect the frequency of nasal carriage of methicillin-resistant *Staphylococcus aureus* among healthcare workers of Sharif Medical City Hospital, Lahore and observe their response to treatment with mupirocin ointment.

Methodology: It was a cross-sectional descriptive study conducted at Pathology Department of Sharif Medical City Hospital (SMCH), Lahore. The study was approved by the ethical committee of the hospital. One hundred and two healthcare workers (HCWs) including doctors and paramedical staff were included in the study by probability random sampling. Informed consent was taken from all the participants. The nasal swabs of HCWs were taken and inoculated on blood agar. The plates were incubated for 24-48 hours at 37°C. The isolates of *Staphylococcus* were identified by colony morphology, gram staining and catalase test. The DNase agar was inoculated for *Staphylococcus* and incubated for 24 hours at 37°C. The antibiotic (cefoxitin) sensitivity testing of DNase positive *Staphylococcus aureus* was performed using disc-diffusion method. The zone diameter of 22mm or more was considered sensitive according to Clinical and Laboratory Standards Institute (CLSI) guidelines. The MRSA carrier HCWs were treated with mupirocin ointment for 7 days and their nasal swabs were repeated after treatment.

Results: Out of 102 HCWs, *Staphylococcus aureus* was isolated from nasal swabs of 25(24.5%) HCWs. Twenty two strains of *Staphylococcus aureus* were methicillin-sensitive and only 3 were methicillin-resistant. Coagulase-negative *Staphylococcus* species (CoNS) was predominant in the nasal swabs of most of the HCWs (75.5%). The 3 MRSA positive HCWs were one doctor from pathology department, one staff nurse from nursery and one OTA from anesthesia department. They were given mupirocin nasal ointment for 7 days. Their nasal swabs were again taken after a week. The nasal swabs of all the 3 HCWs became MRSA negative.

Conclusion: The nasal carriage of MRSA was low (2.9%) in Sharif Medical City Hospital, Lahore and mupirocin ointment is effective in the treatment of nasal MRSA carriers.

Keywords: *Methicillin-Resistant Staphylococcus aureus (MRSA). Healthcare workers (HCWs). Mupirocin ointment.*

INTRODUCTION

Staphylococci are the normal flora of skin and nose. *Staphylococcus aureus* is the most virulent species. *Staphylococcus aureus* has many virulence factors such as capsule, teichoic acid, protein A, enzymes and toxins. It causes a variety of diseases such as skin, soft tissue and systemic infections as well as exotoxin-mediated diseases. The skin and soft tissue infections include folliculitis, abscess, furuncles, impetigo, carbuncles, cellulitis, conjunctivitis and surgical site infections. The systemic infections are pneumonia, osteomyelitis, arthritis, endocarditis and sepsis. The exotoxin-mediated diseases are food poisoning, toxic shock syndrome and scalded skin syndrome. *Staphylococcus aureus* is responsible for both community and hospital-acquired infections.^{1,2} These infections are still common in hospitalized patients despite the wide use of antibiotics. The

detection of methicillin-resistant *Staphylococcus aureus* (MRSA) is an alarming problem in hospitals.³

Currently, MRSA has become the most common antibiotic-resistant pathogen worldwide.⁴ Hospital-acquired MRSA is common in the Middle East, North Africa, Australia, Italy, Europe and UK. In the year 2008, 44% hospital-acquired infections caused by MRSA were reported in Europe.⁵ The infections caused by these strains are very difficult to treat because they are resistant to all beta-lactam antibiotics.⁴ Penicillin was first introduced in 1940 and used for the treatment of *Staphylococcus aureus* infections.^{6,7} *Staphylococcus aureus* resistant to penicillin was first reported in 1945. The mechanism of penicillin resistance is that bacteria acquire an enzyme beta-lactamase which breaks down the β lactam ring of penicillin. In 1959, a newer penicillin antibiotic methicillin was launched for treatment of penicillin-resistant *Staphylococcus aureus* strains. However, the bacteria acquired resistance to methicillin after only 2 years in 1961. Methicillin resistance is mediated by *mecA* gene. The penicillin-binding proteins (PBPs) are normally present in the cell wall of bacteria. These PBPs play a role in the formation of peptidoglycan which is an important component of the bacterial cell wall. The PBPs have a strong affinity for beta-lactam antibiotics. The beta-

Sharif Medical & Dental College, Sharif Medical City,
Sharif Medical City Road, Off Raiwind Road, Jati Umra,
Lahore 54000, Pakistan.

Correspondence: Dr. Aqsa Aslam
Assistant Professor Department of Pathology
Sharif Medical & Dental College
E-mail: aksaaslam@hotmail.com

Received: May 2, 2018; Accepted: May 28, 2018.

lactam drugs first bind to PBPs and then inhibit the formation of peptidoglycan. The strains of *Staphylococcus aureus* acquire resistance to methicillin by encoding a new penicillin-binding protein known as PBP2a. This PBP has decreased affinity for β -lactam antibiotics so these drugs cannot exert their action.^{8,9}

Healthcare workers (HCWs) are a major source of MRSA in addition to colonized patients and contaminated environmental surfaces. The frequency of hospital-acquired infections caused by MRSA is increasing globally. These infections are associated with a prolonged hospital stay, longer antibiotic courses and high costs.^{7,10} The colonization of a body site by the pathogen is an important predisposing factor for acquiring the infection. *Staphylococcus aureus* can colonize many body areas such as nose, axilla and perineum. Nose is most commonly colonized area. It has a major role in the pathogenesis of the disease. The rate of infection is higher in colonized individuals as compared to others. The factors associated with colonization are the chronic disease, antibiotics use and hospitalization.^{9,11} Most of the carriers remain well. However, postoperative patients in the recovery phase, immunocompromised patients and patients with severe disease are more prone to develop infections.² According to a study, approximately 20% of the population are persistent carriers of *Staphylococcus aureus*, 30% are intermittent carriers and 50% are non-carriers.¹² The persistent carrier state commonly occurs in healthcare workers and in the hospital environment.² Mupirocin is the most effective drug for MRSA nasal carriers. The success rate is 90% after 1 week of treatment. The drug resistance was reported in 1% patients after treatment with mupirocin ointment.¹² The prevalence of MRSA infections is high in the hospitals. Therefore, this study was planned to identify MRSA positive healthcare workers so that further transmission of MRSA can be prevented.

METHODOLOGY

The study was conducted at Pathology Department of Sharif Medical City Hospital, Lahore. It was a cross-sectional descriptive study. The study was approved from the ethical committee of the hospital. One hundred and two healthcare workers including doctors and paramedical staff were included in the study by probability random sampling. The participants were from operation theaters, intensive care units (ICUs), coronary care units (CCUs), laboratory, surgery, medicine, paediatrics, gynaecology and pathology department. Informed consent was taken from all the participants and the sampling technique was explained to them. The nasal swabs of HCWs were taken. The sterile cotton swab was rotated 5 times in the anterior nares of both the nostrils. The name, age, designation

and relevant department of HCWs were noted on request form. The nasal swabs were inoculated on blood agar. The plates were incubated for 24-48 hours at 37°C. The isolates of *Staphylococcus* were identified by colony morphology, gram staining and catalase test. The DNase agar was inoculated for *Staphylococcus* and incubated for 24 hours at 37°C. The *Staphylococcus* isolates that produced a clear zone around inoculated area after addition of 1N hydrochloric acid were labeled as *Staphylococcus aureus*. The antibiotic (cefoxitin) sensitivity testing was performed using disc-diffusion method. The suspension of *Staphylococcus aureus* was made in normal saline, matched with turbidity standard (0.5 MacFarland) and then inoculated on Mueller-Hinton agar plate. The cefoxitin disc was applied on the plate and incubated for 24 hours at 35°C. Cefoxitin is used to report methicillin sensitive or resistant. The zone diameter of 22mm or more was considered sensitive according to Clinical and Laboratory Standards Institute (CLSI) guidelines (2017). The isolates giving zone of ≥ 22 mm were reported as methicillin-sensitive and isolates giving zone of < 22 mm were reported as methicillin-resistant.¹³ The MRSA carrier HCWs were isolated and advised to use face masks, saline nasal washing and mupirocin ointment for 7 days. Their nasal swabs were repeated after treatment.

STATISTICAL ANALYSIS

The data analysis was done using **Statistical Package for Social Sciences (SPSS)** version 24. The quantitative variables were presented as the mean \pm standard deviation and the qualitative variables were expressed as frequency & percentage. The p-value of ≤ 0.05 was considered statistically significant.

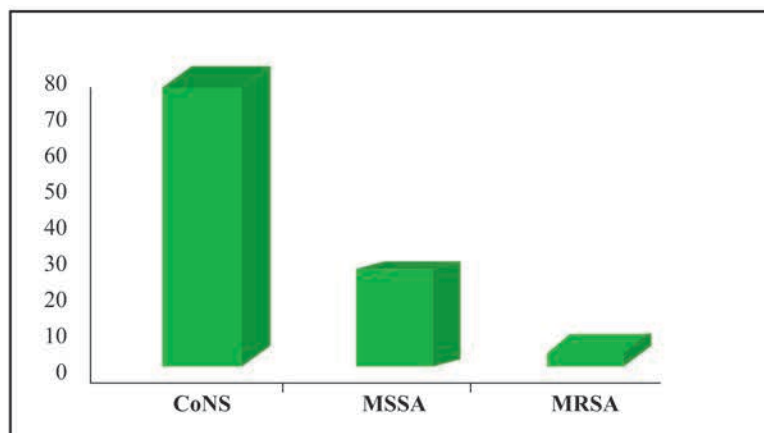
RESULTS

The mean age of the study participants was 32 ± 8.94 years. Fifty seven healthcare workers were females and 45 were males. Twenty six (25.5%) participants were from pathology department, 14(13.7%) from ICUs, 4(3.9%) from CCU, 7(6.9%) from nursery, 4(3.9%) from anesthesia, 4(3.9%) from surgery, 5(4.9%) from gynaecology & obstetrics, 5(4.9%) from medicine, 5(4.9%) from pediatrics, 28(27.5%) from operation theaters. Thirty two (31.4%) HCWs were doctors, 28 (27.5%) nurses, 16(15.7%) lab technicians, 17(16.7%) OTAs and 9(8.7%) were ward boys.

Out of 102 HCWs, *Staphylococcus aureus* was isolated from nasal swabs of 25(24.5%) HCWs. Twenty two (88%) strains of *Staphylococcus aureus* were methicillin-sensitive and only 3(12%) were methicillin-resistant. Coagulase-negative *Staphylococcus* species (CoNS) was predominant in the nasal swabs of most of the HCWs (77 HCWs, 75.5%).

Table 1: Frequency distribution of study participants

Department	Frequency	Percentage
Pathology	26	25.5
ICU	14	13.7
CCU	4	3.9
Nursery	7	6.9
Anesthesia	4	3.9
Surgery	4	3.9
Gynaecology & Obstetrics	5	4.9
Medicine	5	4.9
Pediatrics	5	4.9
Operation theaters	28	27.5%

**Figure 1: Frequency of CoNS, MSSA and MRSA in nasal swabs of healthcare workers**

Among the 22 methicillin-sensitive *Staphylococcus aureus* (MSSA) strains, 4 were isolated from pathology laboratory technicians, 4 from ICU staff, 3 from nursery staff, 6 from OT staff and 5 from doctors. The 3 MRSA positive HCWs were one doctor from pathology department, one staff nurse from nursery and one OTA from anesthesia department. The ones from nursery and anesthesia OT were shifted from their duty to wards. All MRSA positive HCWs were advised to use face masks, saline nasal wash and mupirocin nasal ointment for 7 days. Their nasal swabs were again taken after a week. The nasal swabs of all the 3 HCWs became MRSA negative.

DISCUSSION

The incidence of *Staphylococcus aureus* infections has increased in the last 200 years. Various studies showed that 20 to 30% healthcare workers are colonized with *Staphylococcus aureus* and they transmit the bacteria. Infection outbreaks have been reported from intensive care units, burn units, nurseries and surgical units.

These outbreaks are related to inappropriate use of antibiotics, inadequate nursing care, lack of hand washing and presence of nasal carriers among the healthcare workers.²

The prevalence of MRSA in healthcare workers varies greatly worldwide according to literature. It can be attributed to the difference in sampling technique, culture inoculation, its interpretation, the prevalence of MRSA in that area and infection control measures.³ The frequency of MRSA in HCWs was 12.7% in Ethiopia,³ 25.5% in Gaza strip,¹⁴ 32.8% in Iran,¹⁵ 13.5% in Egypt,¹⁶ zero in Kenya,⁵ 4.6% in Germany,¹ 4.7% in China¹¹ and 4.6% in Switzerland.¹⁹

Our results showed that the prevalence of MRSA in HCWs was 2.9%. This was in accordance with other studies in which the MRSA carriage rate was low.^{6,17} In a study done in Germany, 726 HCWs were enrolled for nasal swabs screening. Methicillin-resistant *Staphylococcus aureus* was isolated from 4.6% HCWs. The prevalence rate was higher in nurses than in physicians.¹⁷ In another study conducted in Germany,

759 nursing staff and 422 residents were enrolled from 19 institutions. Prevalence of MRSA was 1.6% among staff and 5.5% among residents.¹⁸ In Kenya, 246 healthcare workers were randomly screened for nasal carriage of MRSA. Methicillin-resistant Staphylococcus aureus was not isolated whereas methicillin-sensitive Staphylococcus aureus (MSSA) was found in 18.3% of HCWs.⁶

A study conducted at Holy Family Hospital, Rawalpindi enrolled 468 HCWs. Eighty five (18.2%) HCWs were nasal carriers of Staphylococcus aureus, of which 7(1.5%) were methicillin-resistant. Staphylococcus aureus was found in 30% midwives, 23.5% technicians, 22.7% nurses and 20% house officers. The nasal carriage of Staphylococcus aureus was highest in surgical ICU (40%) followed by gynaecology (34.9%) and medicine (22.7%).²⁰

According to a study by Arshad et al. in Jinnah Hospital Lahore, the nasal swabs were positive for Staphylococcus aureus and CoNS in 40% and 60% healthcare workers. Out of 40% Staphylococcus aureus strains, 67.5% were MRSA.¹

The study conducted in the Children Hospital Complex, Multan included 129 HCWs. Staphylococcus aureus was isolated in the anterior nares of 48 HCWs out of which 13.95% were MRSA. Most of the HCWs with nasal carriage were nurses and doctors. Methicillin-resistant Staphylococcus aureus was isolated in 27.3% nurses and 18.5% doctors.²

A study conducted in Ethiopia revealed 12.7% nasal carriage rate of MRSA among healthcare workers. One hundred eighteen HCWs were included in that study. Out of 118, 34(28.8%) were Staphylococcus aureus carriers and 15(12.7%) were MRSA carriers. The greatest carriage rate was found in nurses (21.2%) followed by doctors (12.5%) and technicians (12.5%). Most of the HCWs in pediatrics and surgery department were carriers.³ In another study done in Argentina, out of 320 HCWs, 96(30%) were nasal carriers of Staphylococcus aureus. Twenty carried MRSA and 76 MSSA. The carriage rate was 57% in technicians and 30% in physicians.²¹

El-Aila et al. reported that among 200 healthcare workers, 51(2.5%) carried MRSA. The carriage rate among nurses and doctors was 30.4% and 16% respectively. Most of the MRSA carriers were from medicine and surgery department (41.3 and 35% respectively).¹⁴

CONCLUSION

The nasal carriage of MRSA was low (2.9%) in Sharif Medical City Hospital, Lahore and mupirocin ointment is effective in the treatment of nasal MRSA carriers.

RECOMMENDATIONS

- The healthcare workers should be enrolled from various hospitals to see the frequency of nasal carriage of MRSA in different setups. So that the transmission of MRSA can be prevented.
- The infection control measures including personal protective equipment and hand washing should be strictly observed by doctors & paramedical staff in hospitals to avoid the transmission of MRSA.

REFERENCES

1. Arshad J, Rasheed F, Yousaf NW, Iram S. Nasal carriage rate of methicillin-resistant Staphylococcus aureus (MRSA) among healthcare workers of a tertiary care hospital. Biomedica. 2017 March; 33(1):9-13
2. Rashid Z, Farzana K, Sattar A, Murtaza G. Prevalence of nasal Staphylococcus aureus and methicillin-resistant Staphylococcus aureus in hospital personnel and associated risk factors. Acta Poloniae Pharmaceutica and Drug Research. 2012; 69(5):985-91.
3. Shibabaw A, Abebe T, Mihret A. Nasal carriage rate of methicillin-resistant Staphylococcus aureus among Dessie Referral Hospital healthcare workers; Dessie, Northeast Ethiopia. Antimicrobial Resistance and Infection Control. 2013; 2:25.
4. Truong H, Shah SS, Ludmir J, Tawanana EO, Bafana M, Wood SM, et al. Staphylococcus aureus skin and soft-tissue infections at a tertiary hospital in Botswana. S Afr Med J. 2011 June; 101(6):413-6.
5. Green BN, Johnson CD, Egan JT, Rosenthal M, Griffith EA, Evans MW. Methicillin-resistant Staphylococcus aureus: an overview for manual therapists. Journal of Chiropractic Medicine. 2012; 11:64-76.
6. Omuse G, Kariuki S, Revathi G. Unexpected absence of methicillin-resistant Staphylococcus aureus nasal carriage by healthcare workers in a tertiary hospital in Kenya. J Hosp Infect. 2012, 80(1):71-3.
7. Kumar P, Shukla I, Varshney S. Nasal screening of healthcare workers for nasal carriage of coagulase positive MRSA and prevalence of nasal colonization with Staphylococcus aureus. Biology and Medicine. 2011; 3(2):182-6.

8. Askarian M, Zeinalzadeh A, Japoni A, Alborzi A, Memish ZA. Prevalence of nasal carriage of methicillin-resistant *Staphylococcus aureus* and its antibiotic susceptibility pattern in healthcare workers at Namazi Hospital, Shiraz, Iran. *International journal of infectious diseases*. 2009; 13(5):241-7.
9. Halablab MA, Hijazi SM, Fawzi MA, Araj GF. *Staphylococcus aureus* nasal carriage rate and associated risk factors in individuals in the community. *Epidemiol Infect*. 2010 May; 138(5):702-6.
10. Kirecci E, Ozer A, Aral M, Miraloglu M. Research of nasal methicillin-resistant/sensitive *Staphylococcus aureus* and pharyngeal beta-haemolytic streptococcus carriage in midwifery students in Kahramanmaraş, Eastern Mediterranean Region of Turkey. *Ethiop. J Health Dev*. 2010; 24(1):57-60.
11. Chen BJ, Xie XY, Ni LJ, Dai XL, Lu Y, Wu XQ, et al. Factors associated with *Staphylococcus aureus* nasal carriage and molecular characteristics among the general population at a Medical College Campus in Guangzhou, South China. *Ann Clin Microbiol Antimicrob*. 2017; 16(28):1-10.
12. Ammerlaan HSM, Kluytmans AJW, Wertheim HFL, Nouwen JL, Bonten MJM. Eradication of methicillin-resistant *Staphylococcus aureus* carriage: A systematic review. *Healthcare Epidemiology*. 2009; 48:922-9.
13. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial disk susceptibility tests: approved standard. 27th ed. Wayne (PA): Clinical and Laboratory Standards Institute; 2017.
14. El-Aila NA, Al Laham NA, Ayesb BM. Nasal carriage of methicillin-resistant *Staphylococcus aureus* among healthcare workers at Al Shifa hospital in Gaza Strip. *BMC Infectious Diseases*. 2017; 17(28):1-7.
15. Emaneini M, Jabalameli F, Rahdar H, van Leeuwen WB, Beigverdi R. Nasal carriage rate of methicillin resistant *Staphylococcus aureus* among Iranian healthcare workers: a systematic review and meta-analysis. *Rev Soc Bras Med Trop*. 2017; 50(5):590-7.
16. Hefzy EM, Hassan GM, Abd El Reheem F. Detection of Panton-Valentine leukocidin-positive methicillin-resistant *Staphylococcus aureus* nasal carriage among Egyptian health care workers. *Surg Infect (Larchmt)*. 2016; 17(3):369-75.
17. Sassmannshausen R, Deurenberg RH, Kock R, Hendrix R, Jurke A, Rossen JWA, et al. MRSA prevalence and associated risk factors among healthcare workers in non-outbreak situations in the Dutch-German Euregio. *Front Microbiol*. 2016; 7(1273):1-8.
18. Peters C, Dulon M, Kleinmuller O, Nienhaus A, Schablon A. MRSA prevalence and risk factors among health personnel and residents in nursing homes in Hamburg, Germany: a cross-sectional study. *Plos one*. 2017; 12(1):1-13.
19. Albrich WC, Harbarth S. Healthcare workers: source, vector, or victim of MRSA? *Lancet Infect Dis*. 2008; 8(5):289-301.
20. Akhtar N. Staphylococcal nasal carriage of health care workers. *J Coll Physicians Surg Pak*. 2010 Jul; 20(7):439-43. doi: 07.2010/JCPSP.439443.
21. Boncompaini CA, Suarez CA, Morbidoni HR. *Staphylococcus aureus* nasal carriage in health care workers: First report from a major public hospital in Argentina. *Rev Argent Microbiol*. 2017; 49(2):125-31.

