RESEARCH ARTICLE

A cross sectional study to assess nasal carriage of methicillin resistant *Staphylococcus aureus* in healthcare professionals in a tertiary care hospital

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Abstract

Objective: To determine the nasal carriage of staphylococcus aureus and methicillin-resistant staphylococcus aureus among healthcare workers in a tertiary care setting.

Methods: The cross-sectional study was conducted at the Pakistan Institute of Medical Sciences, Islamabad, Pakistan, from April to July 2018, and comprised healthcare workers at the institution. Nasal swabs were collected and cultured on Mannitol salt agar. Mannitol fermenting colonies which were gram-positive cocci, catalase-positive and coagulase-positive were identified as staphylococcus aureus. Antibiotic susceptibility test was performed by modified Kirby-Bauer disc diffusion method. Methicillin resistance was detected using cefoxitin disc diffusion method. Data was analysed using SPSS 23.

Results: Of the 210 nasal swabs, 52(24.76%) had a staphylococcus aureus growth, and of them, 15(7.1%) were methicillin-resistant. No association could be established with either any single category of healthcare worker or an inter-department variation ($p>0.05$). Likewise, there was no association with age, gender, duration of service, smoking, co-morbidities, use of antibiotics in the preceding six months, treating a patient with methicillin-resistant staphylococcus aureus in the preceding six months and hospitalisation in the preceding year ($p>0.05$).

Conclusion: The frequency of nasal carriage of methicillin resistant staphylococcus aureus amongst healthcare workers was regardless of the nature of their professional engagement.

Keywords: Methicillin resistant staphylococcus aureus, Nasal carriage, Healthcare professionals. (JPMA 71: 205; 2021)

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Introduction

Staphylococcus (S.) aureus and coagulase-negative staphylococci are both commensal and opportunistic pathogens that colonise humans.[1] Although asymptomatic carriage of these microorganisms is common but they also contribute significantly to hospital associated infections (HAIs).[2] Methicillin-sensitive staphylococcus aureus (MSSA) and methicillin-resistant staphylococcus aureus (MRSA) have been responsible for endemic and epidemic nosocomial infections. MRSA is undoubtedly the most common antimicrobial resistant pathogen worldwide and poses a threat in the hospital and the community.[3]

S. aureus can cause a multitude of infections, including, but not limited to, the skin, soft tissues, bones, joints, indwelling catheters and prosthetic devices infections, infective endocarditis, pneumonia, bacteraemia, septicaemia and shock.[4] MRSA is associated with poorer clinical outcomes compared to MSSA infections. With limited treatment options, MRSA infections not only have a higher treatment cost but also higher mortality.[5]

The anterior nares are the main reservoir of MRSA, although other body sites are also colonised, such as skin, hands, axillae and intestinal tract.[1,6] Three types of MRSA carriers have been described: non-carriers, persistent carriers and intermittent carriers. Persistent carriers are chronically colonised by the same strain. Intermittent carriers are colonised with varying strains for short periods of time. A form of short-term carriage is transient carriage which is identified during or after a work shift and in most cases lost before the next shift.[7] Nasal carriage of S. aureus has been associated with an increased risk of infection for the colonised individual, but the risk to persistent carriers is unclear.[8] Approximately 5% of the colonised healthcare workers develop clinical infections.[7]

Healthcare workers (HCWs) are likely to play an important role as vectors through transmission of MRSA rather than being the main sources.[7] The issue for screening HCWs for colonisation with resistant bacteria has been broached, but the topic remains controversial and open to further discussion based on evidence.[9,10] The nasal carriage of MRSA varies widely amongst HCWs and data from Pakistan is limited, especially from the federal capital territory. Additionally, factors that

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could influence the nasal carriage of MRSA, including duration of employment, smoking status, co-morbidities, use of antibiotics, treating patients with MRSA etc., have not been previously assessed in Pakistan.

The current study was planned to fill the gap by identifying the frequency of MRSA in the anterior nares of HCWs working in a tertiary care setting. It also planned to identify any risk factors for nasal carriage of staphylococci based on personal and professional parameters.

Subjects and Methods

The cross-sectional study was conducted at the Pakistan Institute of Medical Sciences (PIMS), Islamabad, Pakistan, from April to July 2018. After approval from the institutional ethics review committee, the sample size was calculated by taking MRSA prevalence 8.5 % in HCWs[11] using Rao online calculator at 95% confidence level and standard error 5%.[12] HCWs from all categories and departments of the hospital were included, while all individuals suffering from a nasal pathology, rhinitis or upper respiratory tract infection were excluded.

Those included after taking informed consent were categorised as doctor, nurse, paramedic staff (technician, operation theatre assistant, anaesthesia assistant, physiotherapist and dispenser), office worker (clerk, peon, computer operator and receptionist) and janitorial staff. HCW profile was recorded, such as age, gender, ward where they worked, working category and duration of service in the healthcare sector. Additional information, such as smoking status, the presence of co-morbidities, such as diabetes mellitus (DM), hypertension (HTN), ischaemic heart disease (IHD), chronic kidney disease (CKD) and the presence of respiratory diseases, was also noted. It was also noted if the individual had received antibiotics in the preceding six months, had treated patients with MRSA in that period, or was hospitalised due to any reason in the preceding year. A sterile cotton swab with sterile test tube was used for sample collection. The swabs were moistened with sterile normal saline and carefully inserted into each nostril. The sample was collected by rotating the swab five to six times in both nares. The samples were immediately transported to the laboratory for further processing.

The samples were inoculated onto Nutrient agar and Mannitol salt agar within one hour of collection, and incubated at 37°C for 18-24 hours. Mannitol fermenting, yellow-coloured colonies were subjected to gram staining. Further biochemical tests, like catalase and deoxyribonuclease (DNase), were performed for the confirmation of staphylococcus. In accordance with the Clinical Laboratory Standards Institute (CLSI) guidelines, resistance to methicillin was determined by disk diffusion method using 30µg Cefoxitin disk (Oxoid, UK) on Mueller Hinton agar plates. For each strain, a bacterial suspension adjusted to 0.5 McFarland turbidity standards was used. The plates were incubated for 24 hours at 37°C. The results were interpreted according to CLSI criteria. A zone of $\leq$21mm was considered resistant and $\geq$22mm was considered sensitive. MRSA ATCC 33591 was used as resistant control while MSSA ATCC 25923 was taken as sensitive control.[13]

Data was analysed using SPSS 23. Continuous variables were reported as means ± standard deviation (SD), and categorical variables were reported as frequencies and percentage. Chi-square test was applied to find association of different variables between those positive for MRSA and those negative for it. After checking for data normality, t-test was applied for comparison of mean values related to age and duration of service with nasal carriage of MRSA. $P<0.05$ was taken as significant.

Results

Of the 210 HCWs, 106(50.5%) were males. The overall mean age was 37.2±10.47 years, and mean duration of employment was 12.52±10.63 years.

S. aureus was isolated in 52(24.76%) specimens. Of them,

Table-1: The frequencies of MRSA and MSSA in various healthcare worker categories.

Category of healthcare worker	MRSA Positive n (%)	MRSA Negative n(%)	MSSA positive n (%)	MSSA negative n (%)
Doctors	8 (8.4%)	87 (91.6%)	22(23.2%)	73(76.8%)
Nurses	2 (3.7%)	52 (93.6%)	6(11.1%)	48(88.9%)
Technicians	3 (11.5%)	23 (88.5%)	4(15.4%)	22(84.6%)
Clerical Staff	Nil (0%)	4 (100%)	Nil(0%)	4(100%)
Janitorial Staff	2 (6.5%)	29 (95.3%)	5(16.1%)	29(83.9%)

MRSA: Methicillin-resistant staphylococcus aureus
MSSA: Methicillin-2ensitive staphylococcus aureus).

Table-2: Methicillin-resistant staphylococcus aureus (MRSA) nasal carriage amongst healthcare workers from different departments.

Department	MRSA		Total
	Positive	Negative	
General Medicine	1	33	34
Pulmonology	Nil	4	6
Gastroenterology	3	18	21
General Surgery	3	25	28
Orthopaedics	1	7	8
Neurosurgery	Nil	4	4
Neurology	1	8	9
Psychiatry	Nil	3	3
Urology	Nil	5	5
Ear, Nose, Throat (ENT)	Nil	6	6
Emergency	1	18	19
Nephrology	Nil	8	8
Oncology	Nil	3	3
Cardiology	Nil	7	7
Plastic surgery	Nil	3	3
Ophthalmology	1	4	5
Paediatrics	Nil	7	7
Gynaecology& Obstetrics	3	20	23
Dermatology	Nil	4	4
Radiology	1	6	7
Total	15	195	210

37(17.6%) were MSSA and 15(7.1%) were MRSA.

From among MRSA samples, 8(53.3%) were from males. In the 195(92.9%) individuals who tested negative for MRSA, 98(50.2%) were males (p>0.05). The mean age of the individuals who tested positive for MRSA was 39.07±11.26 years, while the mean age of individuals who tested negative was 37.62±10.435 years (p>0.05). The highest prevalence of MRSA nasal carriage was amongst doctors (Table-1).

Of the 15 MRSA cases, 3(20%) each were found in Gastroenterology, General Surgery, and Gynaecology departments (Table-2).

The mean duration of employment in the MRSA group was 13.67±12.28 years, and in the non-MRSA group it was 12.43±10.526 years (p>0.05); 7(46.7%) in MRSA and 64(32.9%) in non-MRSA groups were smokers (p>0.05); in MRSA group, 1(9.1%) had DM, 3(12%) had HTN and none had IHD, while in the non-MRSA groups the corresponding numbers were 10(5.13%), 22(11.28%) and 1(0.51%) (p>0.05); in the MRSA group, there was none with a history of hospitalisation within the preceding years, while there was 1(0.51%) in the non-MRSA group (p>0.05); 11(73.3%) in the MRSA group and 112(57.43%) in the non-MRSA group had received antibiotics in the preceding six months (p>0.05), and none in the MRSA group and 1(0.51%) in the non-MRSA group had treated a patient with MRSA in the preceding six months (p>0.05).

In the MSSA group, 23(62.1%) were males compared to 83(47.97%) in the non-MSSA group. The mean age in MSSA was 36.11±10.23 years compared to 38.07±10.52 years in on-MSSA (p>0.05). The mean duration of service 11.05±10.64 years in MSSA compared to 12.83±10.63 years in non-MSSA subjects (p>0.05).

In the MSSA group, 15(40.54%) were smokers; 9(24.3%) had co-morbidities; none (0%) had been hospitalised over the preceding year; and 25(67.57%) had received antibiotics in the preceding six months. The corresponding numbers in the non-MSSA group were 57(32.95%); 28(15.7%); 1(0.56%); and 99(72.26%). None of the differences were was statistically significant (p>0.05).

Discussion

Nosocomial infections are a major problem for infection control worldwide. MRSA has been recognised as one of the most sinister pathogens responsible for such infections.[14]

The present study was designed keeping in mind the threat of cross-transmission of MRSA through nasal carriage in HCWs. One of the most effective methods of reducing nosocomial infections by this organism may be by identifying the carriers and eradicating it. MRSA healthy carriers are asymptomatic, but they transmit the pathogen to others.[15]

As elsewhere, MRSA epidemiology varies in different parts of Pakistan. The current study reported that out of 210 HCWs evaluated, 52(24.76%) were positive for staphylococcus; 37(17.6%) MSSA and 15(7.1%) MRSA. A study in Rawalpindi showed 18.2% HCWs were nasal carriers of S. aureus and 1.5% (7/468) were nasal carriers of MRSA.[16] In Lahore General Hospital, 380 samples were studied, and 89(23.42%) yielded growth of S. aureus, with overall MRSA frequency of 8.15%.[17] A study in Allama Iqbal Medical College, Lahore, evaluated 100 nasal swabs; 40% were S. aureus and 27% were MRSA.[18]

In a study in Peshawar, MRSA prevalence in HCWs was 62.7% compared was to 37.22% in the community.[19]

A study which was limited to the orthopaedic staff of a hospital in Peshawar reported 1.4% MRSA-positive cases.[20] A few studies have found inter-department variation in MRSA prevalence,[16,17] while the current study could not establish such a variation. Some studies also

reported a relationship between HCW category and MRSA status.[16-18] The current study found the highest prevalence amongst doctors but the difference was not significant.

None of the studies from Pakistan looked into any factors which could be associated with MRSA positivity, like duration of service, smoking status, presence of co-morbidities, hospitalization in the preceding year, use of antibiotics in the preceding six months and treating a patient with MRSA infection. One study evaluated only the duration of service.[16]

Several studies from India have also shown varying MRSA prevalence in HCWs.[21,22] A tertiary care hospital in Nepal had 3.4% MRSA prevalence.[23] A meta-analysis in Europe and the United States showed a pooled MRSA colonisation rate of 1.8% for high-quality studies. The pooled prevalence in studies of moderate quality was 4%.[24]

Various studies have shown a higher frequency of MRSA nasal carriage amongst nurses.[22,24]

There is some evidence that nasal carriage of MRSA is higher among HCWs than the community.[25] HCWs may act as intermediate carriers which may be responsible for a number of MRSA nosocomial infections, hence contributing to morbidity, mortality, cost and duration of hospital stay.

The current study is limited by the fact that it did not make a comparison between nasal carriage of MRSA in HCWs. It could not establish an association between various individual factors, like age, gender, duration of service, smoking status, presence of co-morbidities, use of antibiotics and treating a patient with MRSA infection in the preceding six months or hospitalisation in the preceding year, with nasal carriage of MRSA or MSSA.

Further studies comparing the infection rate between hospitalised patients treated by MRSA-positive and MRSA-negative HCWs can be useful in evaluating the clinical impact of MRSA nasal carriage in HCWs.

Conclusion

The nasal carriage of MRSA in healthcare workers was appreciable and its significance in the spread of nosocomial infections needs to be evaluated to identify the gravity of the problem.

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References

1. Grice EA, Segre JA. The skin microbiome. Nat Rev Microbiol. 2011;9:244–53.
2. Danzmann L, Gastmeier P, Schwab F, Vonberg RP. Health care workers causing large nosocomial outbreaks: a systematic review. BMC Infect Dis. 2013;13:98.
3. European Antimicrobial Resistance Surveillance Network: Antimicrobial resistance surveillance in Europe. Annual Report of the European Antimicrobial Resistance Surveillance Network (EARS-Net) 2012. Stockholm: ECDC;2013.
4. Tong SY, Davis JS, Eichenberger E, Holland TL, Fowler Jr VG. Staphylococcus aureus infections: epidemiology, pathophysiology, clinical manifestations, and management. Clin Microbiol Rev. 2015;28:603–61.
5. van Hal SJ, Jensen SO, Vaska VL, Espedido BA, Paterson DL, Gosbell IB. Predictors of mortality in Staphylococcus aureus Bacteremia. Clin Microbiol Rev. 2012;25:362–86.
6. Acton DS, Plat-Sinnige MJ, van Wamel W, de Groot N, van Belkum A: Intestinal carriage of Staphylococcus aureus: how does its frequency compare with that of nasal carriage and what is its clinical impact?. Eur J Clin Microbiol Infect Dis. 2009;28: 115-27.
7. Albrich WC, Harbarth S: Health-care workers: source, vector, or victim of MRSA? Lancet Infect Dis. 2008;8:289-301.
8. Wertheim HF, Melles DC, Vos MC, van Leeuwen W, van Belkum A, Verbrugh HA, et al. The role of nasal carriage in Staphylococcus aureus infections. Lancet Infect Dis. 2005; 5:751-62.
9. Moher D, Liberati A, Tetzlaff J, Altman DG: Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med 2009;6:e1000097.
10. Higgins JP, Green S. Cochrane Handbook for Systematic Reviews of Interventions Version 5.1. 0 updated March 2011 [Internet]. Melbourne: The Cochrane Collaboration; 2011 [cited 2011 June 10].
11. Asif A, Javed I, Mushtaq S, Anwar S. Nasal carriage of methicillin resistant staphylococcus aureus among tertiary care hospital employees in a non-outbreak setting. Pak J Pathol. 2017: 28:171-5.
12. Raosoft online sample size calculator. [online] 2014 [Cited 14 Jan. 2019]. Available from:URL: http://www.raosoft.com/samplesize.html
13. Cheesbrough M. District laboratory practice in tropical countries. Cambridge university press; 2006.
14. Basak S, Rajurkar MN, Mallick SK, Attal RO. Infection control practices in health care set-up. Infection Control. 2013; 1: 67-9.
15. Arshad J, RasheedF, Yousaf NW,Iram S.Nasal Carriage rate of of methicillin resistant staphylococcus aureus(MRSA) among health care workers of a tertiary care hospital. Biomedica 2017;33:9-13.
16. Naeem Akhtar. Staphylococcal Nasal Carriage of Health Care Workers. J Coll Physicians Surg Pak 2010;20:439-43.
17. Asif A,Javed I,Mushtaq S,Anwar S.Nasal carriage of methicillin resistant staphylococcus aureus among tertiary care hospital employees in a nonoutbreak setting. Pak J Pathol 2017; 28: 171-5.
18. Arshad J,Rasheed F,Yousaf NW,Iram S.Nasal carriage og methicillin resistant staphylococcus aureus (MRSA)among healthcare workers of a tertiary care hospital. Biomedica 2017;33:9-13.
19. Asghar M,Asghar N,Mumtaz S,Khan SA,Ihsanullah,Munir AH et al.Frequency of Methicillin Resistant Staphylococccus aureus(MRSA) colonization amongst hospital staff in teaching hospitals of Peshawar. J Med Sci. 2016;24:4.
20. Khan A,Jamshid K,Iqbal MJ.Siraj M.Frequency of nasal carriage of methicillin resistant staphylococcus aureus in orthopedic staff. KJMS 2016; 9.

21. Sangeetha, K.T., S. Sreeja and Ruby Thomas. 2018. A Prospective Study Estimating the Mupirocin Resistance in Health Care Providers with MRSA Nasal Carriage in a Tertiary Care Hospital in Rural South India. Int J Curr Microbiol App Sci. 7: 659-63.
22. Rutvi V, Sangeeta PD, Sima BK, Piyush PA. Nasal Carriage Rate of Methicillin Resistant Staphylococcus aureus (MRSA) among Civil Hospital Health care workers. Int J Med Public Health. 2016;6:180-3.
23. Khanal R, Sah P, Lamichhane P, Lamsal A, Upadhaya S, Pahwa VK. Nasal carriage of methicillin resistant Staphylococcus aureus among health care workers at a tertiary care hospital in Western Nepal. Antimicrob Resist Infect Control. 2015;4:39.
24. Dulon M, Peters C, Schablon A, Nienhaus A. MRSA carriage among healthcare workers in non-outbreak settings in Europe and the United States: a systematic review. BMC Infectious Diseases2014;14:363.
25. Salgado CD, Farr BM, Calfee DP: Community-acquired methicillin-resistant Staphylococcus aureus: a meta-analysis of prevalence and risk factors. Clin Infect Dis. 2003; 36: 131-9.