

Hand and nasal carriage of *Staphylococcus aureus* and its rate of recolonization among healthcare workers of a tertiary care hospital in Nepal

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Background: Carriers of *Staphylococcus aureus* among healthcare workers (HCWs) can spread the bacteria to patients and the environment, in addition to their own risk of infection.

Objectives: To determine the prevalence of *S. aureus* carriers among HCWs and the rate of recolonization after decolonization therapy with mupirocin.

Methods: Nasal and hand swabs from HCWs of a tertiary care hospital in Nepal were cultured on mannitol salt agar and *S. aureus* isolated were identified using standard microbiological procedures. Detection of MRSA and mupirocin-resistant *S. aureus* (MupRSA) isolates were done phenotypically. Identified *S. aureus* carriers were decolonized with 2% mupirocin nasal ointment. Recolonization of the carriers was assessed monthly for the next 5 months.

Results: Among the 213 HCWs, 18.3% were *S. aureus* carriers (35 nasal carriers, 4 both nasal and hand carriers, and no hand carriers). Overall, 9.4% of the HCWs were MRSA carriers and none were MupRSA carriers. After decolonization, 25.6% of them were recolonized and 50.0% of the recolonization was detected after 3 months of decolonization. All recolonized carriers had only MSSA strains (which colonized only nose), and none were recolonized with MupRSA.

Conclusions: HCWs are frequent carriers of *S. aureus* and MRSA. Due to their continuous exposure to the hospital environment, they are at risk of colonization by this MDR organism. Regular screening and decolonization of HCWs working with high risk, vulnerable patients would reduce the risk of MRSA transmission from HCWs to patients.

Introduction

Healthcare workers (HCWs) harbouring pathogens are an important reservoir of pathogens responsible for hospital-acquired infection (HAI) and are considered the interface between the healthcare centres and the community.¹ *Staphylococcus aureus*, a common pathogen of HAI, causes infections ranging from minor or localized infections to fatal systemic infections, that have severe consequences, even with antimicrobial therapy.^{2,3} This pathogen is also a commensal of the skin and nasal mucosa.² Nasal and hand carriage of the bacteria are strongly correlated as hands are the main vector for transmitting the pathogen between the nose-picking area (anterior nares) and the surfaces.^{2,4} Asymptomatic nasal carriers among HCWs are at a high risk of

subsequent *S. aureus* infection and are presumed to be an important source of MRSA.^{1,5} Mupirocin, a mixture of many pseudomonic acids that can bind to the isoleucine-specific binding pocket of the bacterial isoleucyl-tRNA synthetase (IleRS), is recommended as a potent decolonizing agent in the carrier HCWs.^{6,7} However, there have been reports of increasing mupirocin resistance.⁸

Materials and methods

Ethics

The ethical clearance for this study was obtained from the Institutional Research/Ethical Review Committee (RERC) of Nepal Medical College in Kathmandu, Nepal.

Methods

Nasal and hand swabs were collected using commercially available sterile non-absorbent cotton swabs from HCWs of six departments of a tertiary care centre in Nepal. Those who gave informed consent and who had not used mupirocin ointment nasally or had a chlorhexidine bath in the last 1 month were included in the study. Required details were obtained using questionnaires. For nasal swab, the swab was inserted 2–3 cm into the anterior nares and rotated four times both clockwise and anticlockwise before withdrawal. For hand swab, the web-space of the hand was swabbed with sterile cotton swab moistened in sterile brain heart infusion (BHI) broth. Swabs were immediately inoculated on mannitol salt agar (MSA) and incubated at 37°C. Yellow distinct colonies on MSA were presumed to be colonies of *S. aureus* and subcultured on nutrient agar (NA). Golden yellow colonies on NA that were Gram-positive cocci in clusters, producing catalase and coagulase were identified as *S. aureus*. All confirmed *S. aureus* isolates were tested for detection of methicillin and mupirocin resistance by Kirby–Bauer disc diffusion and interpreted as per CLSI 2017 guidelines⁹ and Kaur and Narayan.¹⁰ All identified carriers were decolonized with 2% mupirocin nasal ointment bilateral application twice a day for 5 days. Nasal and hand swabs were collected from all carriers on a monthly basis five times. All swabs were subjected to identification of *S. aureus*, MRSA and mupirocin-resistant *S. aureus* (MupRSA).

Statistical analysis

All the data were recorded and analysed using International Business Machine Statistical Package for the Social Sciences (IBM SPSS) version 19. χ^2 test was used to analyse the results and P value < 0.05 was considered statistically significant.

Results

Among the total 213 HCWs included in the study, 39 (18.3%) were identified as *S. aureus* carriers. The prevalence was higher among the females (22.8%) compared to the males (12.2%) ($P < 0.05$). Table 1 shows that majority of the carriers were from the Obstetrics and Gynaecology Department, followed by Neurosurgery, Surgery (general surgery, gastrointestinal surgery and urosurgery), Medicine, Clinical Laboratory and Paediatrics, including paediatric ICU (PICU) and neonatal ICU (NICU). Attendants had the highest prevalence followed by nurses, laboratory personnel and doctors. All participants were adults (lowest age of 22 years; highest age of 45 years) and there were more *S. aureus* carriers as well as MRSA carriers among HCWs in the age group of 40–49 years.

The association of the habit of nose-picking with *S. aureus* carriage was statistically significant with OR of 14.6 (95% CI = 6.485 to 32.725) using Pearson's χ^2 test. There were more carriers among the HCWs who did not follow the WHO guideline of hand washing than those who followed the guideline. This finding was statistically significant using Pearson's χ^2 test with OR of 0.376 (95% CI = 0.185 to 0.764). Among the 39 carriers, 13 had the habit of nose-picking as well as did not follow the WHO guideline of hand washing, 12 followed the WHO guideline of hand washing but had the habit of nose-picking, 10 had no habit of nose-picking but did not follow the WHO guideline of hand washing, and 4 had no habit of nose-picking and also followed the WHO guideline of hand washing. Out of the total 213 HCWs, 20 (9.4%) were MRSA carriers and none were MupRSA carriers.

The 39 *S. aureus* carriers were decolonized with 2% mupirocin nasal ointment. The decolonization therapy was 100% successful, as proven by no detection of *S. aureus* in all carriers after a month of decolonization. Recolonization was detected in 10 (25.6%) of the 39 carriers and the highest recolonization was after 3 months of decolonization followed by 4 months and 2 months. Ten (28.6%) of the 35 nasal carriers were recolonized while none (0/4) of those who were both nasal and hand carriers were recolonized ($P > 0.05$).

The rate of recolonization was slightly more in MSSA carriers than MRSA carriers ($P > 0.05$). All 10 were recolonized with MSSA. Additionally, none of the recolonized carriers were MupRSA carriers. Recolonization was seen more among the carriers with the habit of nose-picking than those without this habit ($P > 0.05$). Interestingly, the carriers who followed the WHO guideline of hand washing had more recolonization than those who did not ($P > 0.05$). All recolonized carriers were only nasal carriers. Females had a higher rate of recolonization than males ($P > 0.05$). Recolonization was highest among carriers in the age group of 20–29 years while none in the age group of 40–49 years were recolonized.

The highest rate of recolonization was seen in the Paediatrics (including PICU and NICU) and Surgery departments, followed by the Obstetrics and Gynaecology, Neurosurgery, Clinical Laboratory and Medicine departments. Overall, recolonization was highest among doctors (42.9%), followed by nurses (35.3%), attendants (8.3%) and laboratory personnel (0.0%) but this was statistically not significant using Pearson's χ^2 test. Females had a higher recolonization rate in all departments, except in the surgical department where recolonization was equal among males and females, although this finding was statistically not significant. As shown in Table 2, the highest rate of recolonization was among doctors in Surgery, Obstetrics and Gynaecology and Clinical Laboratory departments, nurses in Neurosurgery and Medicine departments and both nurses and attendants had an equal rate of recolonization in Paediatrics (including PICU and NICU) department ($P > 0.05$).

Discussion

The carrier status of *S. aureus* among HCWs in this study, i.e. 18.3%, is exactly the same as reported in 2017 from Nepal by Khatri et al.¹¹ The present finding was also comparable to other reports from Nepal by Khanal et al. (15.7%),¹² Sah et al. (20.4%)¹³ and Mukhiya et al. (20.9%).¹⁴ On the contrary, Pant and Rai¹⁵ reported a significantly higher prevalence of 51.9% among the HCWs of the same tertiary care in 2007. This reduction in prevalence could be due to increased awareness and implementation of infection control measures during recent years. The present finding was lower than those reported from Nepal (27.3% to 92.0%),^{16–18} India (22.2% to 48.0%),^{3,10,19,20} Northeast Ethiopia (28.8%),²¹ Iran (31.0%)²² and Israel (31.0%).²³ However, lower prevalence of 7.7% to 15.6% has also been reported.^{24–26}

S. aureus was detected more from the anterior nares than the hands in this study, which is similar to the report of Pant and Sharma.¹⁸ This finding corresponds to the fact that anterior nares are the most common site of *S. aureus* colonization. Reports of hand carriers are limited in comparison to the nasal carriers.

Table 1. Prevalence of *S. aureus* carriers and MRSA carriers among different types of HCWs in each department

Department	Profession	Total	<i>S. aureus</i> carriers (%)	<i>P</i> value	MRSA carriers (%)	<i>P</i> value
Obstetrics and Gynaecology	Doctor	10	1 (10.0)	0.2	0 (0.0)	0.7
	Nurse	11	5 (45.5)		2 (18.2)	
	Attendant	4	2 (50.0)		1 (25.0)	
	Total	25	8 (32.0)		3 (12.0)	
Neurosurgery	Doctor	6	1 (16.7)	0.2	0 (0.0)	0.5
	Nurse	8	1 (12.5)		0 (0.0)	
	Attendant	3	2 (66.7)		1 (33.3)	
	Total	17	4 (23.5)		1 (5.9)	
Surgery	Doctor	9	1 (11.1)	0.1	1 (11.1)	0.3
	Nurse	15	3 (20.0)		3 (20.0)	
	Attendant	3	2 (66.7)		1 (33.3)	
	Total	27	6 (22.2)		5 (18.5)	
Medicine	Doctor	21	2 (9.5)	0.2	1 (4.8)	0.3
	Nurse	26	6 (23.1)		2 (7.7)	
	Attendant	5	2 (40.0)		2 (40.0)	
	Total	52	10 (19.2)		5 (9.6)	
Clinical Laboratory	Doctor	14	2 (14.3)	0.7	0 (0.0)	0.3
	Laboratory personnel	24	3 (12.5)		2 (8.3)	
	Attendant	8	2 (25.5)		1 (12.5)	
	Total	46	7 (15.2)		3 (6.5)	
Paediatrics (including PICU and NICU)	Doctor	12	0 (0.0)	0.1	0 (0.0)	0.2
	Nurse	27	2 (7.4)		2 (7.4)	
	Attendant	7	2 (28.6)		1 (14.3)	
	Total	46	4 (8.7)		3 (6.5)	

The prevalence of hand carriers in this study was lower than those reported by Mukhiya *et al.*¹⁴ and Pant and Sharma,¹⁸ which could indicate better hand hygiene among the participating HCWs in this study. All four hand carriers in this study were also nasal carriers and the isolates from both sites had the same antibiogram, suggesting them to be of same clone phenotypically. Additionally, these carriers had the habit of nose-picking, which supports the fact of hands being the main vector in dissemination of *S. aureus* from surfaces to the anterior nares and vice versa. Other information of *S. aureus* dissemination to external environment and vice versa (such as mere contact with anterior nares) and identification of throat carriers were not assessed in this study.

While there are reports of more female carriers than males similar to this study,^{10,13,17} many reports show male preponderance too.^{2-4,11,12,21} On the contrary, Askarian *et al.*²² reported no significant difference between males and females in their study among HCWs of Iran.

The Obstetrics and Gynaecology department had the highest rate of carriers, which does not correspond to the other reports of highest findings in Orthopaedics,³ in Medicine²³ and in the Post-operative Ward.¹¹ In this study, the Paediatrics department (including PICU and NICU) had the lowest prevalence of carriers, which could be due to stricter implementation of masks and hand hygiene protocols by HCWs during patient care. However, there are other reports of the highest rate of carriers in the Paediatrics department and in the ICU.^{13,21}

Similar to the finding in this study, Kaur and Narayan¹⁰ also reported the lowest prevalence of carriers among the doctors. The highest prevalence among attendants in this study could have

been due to lesser awareness of hygiene maintenance and infection control practices.

The majority of the HCWs with the habit of nose-picking were identified as carriers. This habit transmits *S. aureus* from contaminated surfaces to the nasal niche, and vice versa.² HCWs following the WHO guideline of handwashing had a lower carrier rate than those who did not. Appropriate hand hygiene practices among HCWs is effective in MRSA control.²⁷ However, these data were obtained from questionnaires and may be biased.

In this study, there were 9.4% MRSA carriers among a total of 213 HCWs, which is more than other reports from Nepal: 5.7% in 2007 (from the same study area), 2.3% in 2009 from another tertiary care centre in Nepal,¹⁶ 3.4% in 2015 from western Nepal,¹² 6.3% in 2015 from Iran,²⁵ 3.3% in 2015 from India.²⁶ The global rise in antimicrobial-resistant strains, especially in hospital settings, could be the reason behind this. But the present finding was lower than the 25.0% reported by Shakya *et al.*¹⁷ from western Nepal in 2010, 12.5% from India in 2016¹⁹ and 12.7% from Northeast Ethiopia in 2014,²¹ which could be due to differences in implementation of infection control practices.

The *in vitro* finding of no MupRSA carriers was further confirmed by effective decolonization of all the carriers by 2% mupirocin ointment. In contrast, there are reports of MupRSA carriers among 31.4% of *S. aureus* carriers from India in 2016,¹⁹ 7.0% among MRSA carriers by Agarwal *et al.* from India in 2015,²⁰ and 1.4% among MRSA carriers by Kaur and Narayan from India in 2014.¹⁰

Ten (25.6%) of the 39 carriers were recolonized after decolonization in this study, which is comparable to the finding (24.0%) of

Table 2. Rate of *S. aureus* recolonization among different types of HCW from each department

Department	Profession	<i>S. aureus</i> carriers	Recolonized carriers	%	P value
Paediatrics (including PICU and NICU)	Doctor (n=12)	0	0	0.0	1.000
	Nurse (n=27)	2	1	50.0	
	Attendant (n=7)	2	1	50.0	
	Total (n=46)	4	2	50.0	
Surgery	Doctor (n=9)	1	1	100.0	0.189
	Nurse (n=15)	3	2	66.7	
	Attendant (n=3)	2	0	0.0	
	Total (n=27)	6	3	50.0	
Obstetrics and Gynaecology	Doctor (n=10)	1	1	100.0	0.155
	Nurse (n=11)	5	1	20.0	
	Attendant (n=4)	2	0	0.0	
	Total (n=25)	8	2	25.0	
Neurosurgery	Doctor (n=6)	1	0	0.0	0.135
	Nurse (n=8)	1	1	100.0	
	Attendant (n=3)	2	0	0.0	
	Total (n=17)	4	1	25.0	
Clinical Laboratory	Doctor (n=14)	2	1	50.0	0.233
	Lab personnel (n=24)	3	0	0.0	
	Attendant (n=8)	2	0	0.0	
	Total (n=46)	7	1	14.3	
Medicine	Doctor (n=21)	2	0	0.0	0.690
	Nurse (n=26)	6	1	16.7	
	Attendant (n=5)	2	0	0.0	
	Total (n=52)	10	1	10.0	

Watanakunakorn et al.²⁸ All recolonized carriers were nasal carriers, which supports the statement that the anterior nares are the primary niche for colonization. Watanakunakorn et al.²⁸ also had a similar finding of the highest recolonization after 3 months (12 weeks) of decolonization, as in this study. Similarity in the rate of recolonization among MRSA and MSSA carriers suggest that MRSA or MSSA carriage has no significant impact on recolonization. As all the recolonized HCWs were MSSA carriers, it might be possible that MSSA has advantage over MRSA when competing for the same niche. Although resistance to mupirocin has been implicated as one of the risk factors for recolonization, none of the carriers as well as recolonized carriers harboured MupRSA in this study. A similar finding has been reported by Buehlmann et al.⁶ as no MupRSA carriers among recolonized MRSA carriers.

Females were recolonized more than males, adding support to the finding of more carriers among females in this study. All the recolonized carriers either had the habit of nose-picking or did not follow the WHO guideline of handwashing or both. Both recolonized carriers from the Paediatrics department (including PICU and NICU), i.e. the department with highest recolonized carriers, had the habit of nose-picking and did not follow the WHO guideline of handwashing. Overall, doctors were recolonized the most as well as in three individual departments. Nurses had highest recolonization in two departments. This finding could be explained by closer contact of doctors and nurses with the patients.

This study has shed light on the prevalence of not only *S. aureus* carriers (including MRSA and MupRSA) among HCWs

but also the possibility of recolonization even after successful decolonization. Routine screening of specifically MRSA carriers among HCWs sheds light on the effectiveness of the hospital infection control measures as well as providing a basis to improve the flaws in the prevalent methods, if any. Although there were no MupRSA carriers in this study, the ongoing trend of an increase in mupirocin resistance emphasizes the need for prudent use of mupirocin. As recolonization seems inevitable in some individuals, the strict practice of handwashing as per the WHO guideline and refraining from the habit of nose-picking might be beneficial steps to prevent recolonization as well as spread of the bacteria by the carrier. As carriers in this study were identified only phenotypically, further genotyping could have helped to assess the genetic relatedness among the isolates, including transmission events.

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Transparency declarations

None to declare.

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