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## Research Article

# Nasal Carriage of MRSA in Healthcare Workers: A Pivotal Role in Controlling Hospital-Acquired Infections

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## Abstract

**Background and Objective:** Methicillin-resistant *Staphylococcus aureus* (MRSA) is one of the emerging pathogens implicated in hospitals and nasal carriage by healthcare workers is extremely important clinically because it enables for the contamination of medical equipment, so the study aimed to determine the nasal burden of MRSA among Healthcare Workers in Khartoum State.

**Materials and Methods:** A total of 142 HCWs were enrolled, Swabs were obtained and cultivated on mannitol salt agar. The species were characterized as *S. aureus* relying on morphological features, Gram staining and biochemical tests. Antibiotic susceptibility tests, which were carried out following the Clinical and Laboratory Standards Institute guidelines. **Results:** Among 142 HCWs enrolled in the study majority of them 76(53.5%) were females, Participants age range between 25-24 years old with a mean of  $2.04 \pm 0.617$  SD, Statistically significant correlation was revealed between *S. aureus* and direct patients contact ( $p = 0.001$ , 95% CI (1.27-1.43)). The overall nasal carriage rate of MRSA was 8.4 % (12/142), the nurse staff frequently carried *S. aureus* and MRSA (21.5 and 8.4%), respectively ( $p = 0.040$ ). the highest rate of MRSA as well was found in HCWs of emergency rooms (10.5%) consequently. Almost 47(33.1%) of nurses staff have had direct contact with patients among them was positive MRSA result was statistically significant ( $p \leq 0.001$ ). (29.6%) of HCWs that regularly contact their patients revealed in the operation department while the highest MRSA (10.5%) was detected in the Emergency department ( $p \leq 0.002$ ). **Conclusion:** The high rate of nasal MRSA carriage among healthcare workers revealed in this study is concerning, emphasizing the necessity of enhanced infection control measures to avoid MRSA transmission from HCWs to endangered patients.

**Key words:** Healthcare workers, nasal swab, *Staphylococcus aureus*, MRSA, antibiotic resistance

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**Competing Interest:** The authors have declared that no competing interest exists.

**Data Availability:** All relevant data are within the paper and its supporting information files.

## INTRODUCTION

Methicillin Resistance *S. aureus* (MRSA) is arguably the most frequently defined antibiotic-resistant pathogen in the globe<sup>1,2</sup>. Treatment of *S. aureus* infections was becoming incredibly hard since the emergence of methicillin resistance as they are resistant to all-lactam antibiotics, severely restricting options for treatment<sup>3-5</sup>. With some exclusion, the overall burden of MRSA nosocomial infection keeps going up<sup>6</sup>. MRSA infections are correlated to elongated hospital admission, more antibiotics and a greater cost than infectious diseases by non-methicillin *Staphylococcus aureus* strains<sup>7</sup>. Hence colonized patients, healthcare workers (HCWs) as well as contaminated environmental surfaces will serve as a reservoir for dissemination of MRSA to the other patients and other HCWs<sup>8,9</sup>.

*S. aureus* rapidly was becoming the primary cause of healthcare-associated infections with the emergence of hospital-based medicine. MRSA colonization elevates the chance of infection and infecting strains match colonizing strains in up to 50% of cases<sup>10,11</sup>. MRSA may also survive in the household, exacerbating efforts to eradicate it<sup>12</sup>. MRSA can be outside of Healthcare settings: In the community (where you live, work, shop and go to school), it often causes skin infections, in some cases causes' pneumonia. MRSA infections can be debilitating since goes untreated, resulting in sepsis and the body's exaggerated response to inflammation. In Healthcare Settings, MRSA can lead to serious complications such as septicemia, pneumonia and post-operation infections. MRSA is widely disseminated in society via contact with infected individuals or objects that carry the pathogens. Approximately 5% of patients in hospitals carry MRSA in their nose or on their skin<sup>13,14</sup>. The medication of Aureus infections is becoming troublesome and more challenging since the progress of antimicrobial-resistant *Staphylococcus aureus* (MRSA). The global incidence of nosocomial MRSA infection is increasing and MRSA infections are associated with longer hospitalizations, aggressive medical administration and higher costs than infectious diseases by Methicillin-Sensitive *Staphylococcus aureus* (MSSA) strains. There is a greater risk now being posed that these methicillin-resistant strains could lead to heterogeneous glycopeptides resistance that was first reported from Japan in 1997 of intermediate resistance pattern to vancomycin of *Staphylococcus aureus* (VISA), bacterial isolates from invasive infections can indeed concentrate on disease progression that doesn't provide an approximate or prevalence of carriers in the normal individual, that formed the basis for their study and its importance of screening for healthy carriers of MRSA and to study the rate of

colonization among the healthcare worker<sup>15,16</sup>. Hence current study was designed to ascertain the nasopharyngeal burden of MRSA among healthcare workers in Khartoum State/Sudan.

## MATERIALS AND METHODS

**Study area:** An analytical cross-sectional study was conducted to enrol 142 healthcare workers who working at different departments in three health care units (Alban Jaded Hospital, Ibrahim Malik Hospital and Police Hospital) in Khartoum state during the period between January-May, 2021.

**Study population:** The healthcare workers HCWs particularly (doctors, nurses, cleaners), of different ages and both gender were recruited. Participants with a history of upper respiratory tract infection, common cold, nasal sinusitis, usage of nasal medications or under antibiotic therapy and immune-compromised patients were barred from participating.

**Sampling method:** Nasal samples were collected from the anterior nares of the HCWs using a sterile cotton swab. The swab was inserted into each nostril in turn to a depth of approximately 2 cm and rotated 4-5 times both clockwise and counterclockwise, at least two nasal specimens were obtained from each health care worker, swabs were instantly transported to the microbiology laboratory for further processing.

**Sampling processing:** All swab samples upon collection were immediately transferred to microbiology laboratory, then inoculated into a plate of mannitol salt agar and incubated at 37°C for 24 hrs, all mannitol positive colonies were considered and *Staphylococcus aureus* isolate was defined as gram-positive cocci, catalase producing that was positive for coagulase. Modified Kirby Bauer disc was performed for antibiotic susceptibility test diffusion for all isolates<sup>17</sup>. Mueller Hinton agar was used and Methicillin resistance was disclosed using the Oxacillin disc diffusion test. Concisely isolated colonies were inoculated in Mueller-Hinton broth till their turbidity is comparable to 0.5 McFarland turbidity standards. Then the plates were inoculated with each broth culture and left to dry at room temperature before the application of Oxacillin disc 10 mg mL<sup>-1</sup> were on the centre of the plate.

Since incubation of plates at temperature levels above 35°C might not even detect MRSA, the cultures were kept at 33-35°C<sup>17</sup>. The diameter of inhibition was measured for each antibiotic based on the National Committee for Clinical

Laboratory Standard (NCCLS). Zone of inhibition of antimicrobial agent was explained; the organism was reported as resistant, intermediate, or susceptible; if the zone of Oxacillin was >13, mean it's sensitive, ≤13 Oxacillin resistant.

**Ethical approval:** Ethical clearance was taken from Al-Fajr College for Science and Technology. The written approval of the Hospitals administration was taken and informed consent forms were given for all subjects included in the study before samples were taken.

**Statistical analysis:** The results were analyzed by SPSS version 20. Frequencies, Chi-square tests were performed; a p-value of less than 0.05 was considered significant.

### RESULTS

Among 142 HCWs enrolled in the study majority of them 76 (53.5%) were females, 59 (41.5%) were nasal carriers of *S. aureus* and among them, 20.3%(12/59) were MRSA carriers. Participants age range between 25-24 years old with a Mean 2.04±0.617 SD, almost of subjects 88 (62%) were in middle age (35-45) years old and 34 (58%) were statistically significant carriers for *S. aureus* but most of the MRSA infected

subjects were in the age group more than 45 years old. The 92 (64.8%) of them have direct patients contact, where (69.5%) and (15.3%) were *S. aureus* and MRSA, respectively. Statistically, a significant correlation was revealed between *S. aureus* and direct patients contact (p-value = 0.001, 95% CI (1.27-1.43). The prevalence of *Staphylococcus aureus* and MRSA nasal carriage among study subjects were displayed in Table 1.

The inclusive nasal carriage rate of MRSA was 8.4% (12/142), the nurse staff frequently carried *S. aureus* and MRSA (21.5 and 8.4%), respectively, the result was statistically significant (p-value = 0.040, 95% CI (-0.181-353) in Table 2.

Table 3 displayed the distribution of *S. aureus* and MRSA among healthcare workers among different departments, where the highest rate of *S. aureus* carriers and MRSA as well were found in HCWs of emergency rooms (19.7 and 4.2%) consequently. Correlation between MRSA, direct patients contact of healthcare workers at different departments was stated in Table 4, 47 (33.1%) of nurses' staff have had direct contact with patients among them was positive for MRSA result was statistically significant (p≤0.001) followed by doctors staff. High frequency (29.6%) of HCWs that regularly contact their patients was revealed in the operation department while the highest MRSA 6(10.5%) was detected in the Emergency department (p≤0.002).

Table 1: Prevalence of *Staphylococcus aureus* nasal carriage among study subjects

Characteristics	Total n = 142 (%)	<i>S. aureus</i> carriage n = 59 (%)	MRSA carriage n = 12 (%)	MSSA carriage n = 47 (%)	Confident interval p = 95%
<b>Age</b>					
25-35 years old	24 (17)	9 (15)	2 (3.4)	7 (11.9)	p = 0.022
35-45 years old	88 (62)	34 (58)	3 (5.1)	31 (52.5)	CI (-0.233-0.505)
45-55 years old	30 (21)	16 (27)	7 (11.9)	9 (15.2)	
<b>Gender</b>					
Male	66 (46.4)	23 (34.8)	5 (8.5)	18 (30.5)	p = 0.299
Female	76 (53.5)	36 (47.3)	7 (11.9)	29 (49.1)	CI (-0.247-0.352)
<b>Direct patients contact</b>					
Yes	92 (64.8)	41 (69.5)	9 (15.3)	32 (54.2)	p = 0.001
No	50 (35.2)	18 (30.5)	3 (5.1)	15 (25.4)	CI (1.27-1.43)
<b>Antibiotic use</b>					
Yes	49 (34.5)	39 (66.1)	10 (16.9)	29 (49.2)	p = 0.723
No	93 (65.5)	20 (33.9)	2 (3.4)	18 (30.5)	CI (0.207-0.363)
<b>Duration of work</b>					
≤5 years	104 (73.2)	40 (67.8)	4 (6.8)	36 (61)	p = 0.050
≥5 years	38 (26.8)	19 (32.2)	8 (13.6)	11 (18.6)	CI (-0.376-0.155)
Total	142 (100)	59 (100)	12 (20.4)	-79.6	

Table 2: Healthcare workers screened for methicillin resistant *Staphylococcus aureus*

Parameters	Total n = 142 (%)	<i>S. aureus</i> isolates n = 59 (%)	MRSA isolates n = 59 (%)	Confident interval p-value, 95%
Doctors	41 (28.8)	14 (9.9)	4 (2.8)	p = 0.040
Nurses	52 (36.6)	23 (16.2)	6 (4.2)	CI (-0.181-353)
Cleaners	49 (34.5)	22 (15.4)	2 (1.4)	
Total	142 (100)	59 (41.5)	12 (8.4)	

Table 3: Distribution of *S. aureus* and MRSA among health workers of different department

Departments	Total n = 142	<i>S. aureus</i> n = 59(%)	MRSA n = 12(%)	Confident interval p-value 95%
ICU	37 (26.1)	14 (9.9)	2 (1.4)	p = 0.661
Emergency room	57 (40.1)	28 (19.7)	6 (4.2)	CI (-0.436-0.81)
Operation room	48 (33.8)	17 (11.9)	4 (2.8)	
Total	142 (100)	59 (41.5)	12 (8.4)	

Table 4: Correlation between MRSA, direct patients contact of healthcare workers at different departments

Categories	Total n = 142 (%)	Patients contact n = 92 (%)	MRSA n = 12 (%)	p-value
<b>Occupation</b>				
Doctors	41 (28.8)	40 (28.2)	4 (2.8)	0.001
Staff nurses	52 (36.6)	47 (33.1)	6 (4.2)	
Cleaners	49 (34.5)	5 (3.5)	2 (1.4)	
Total	142 (100)	92 (64.8)	12 (8.4)	
<b>Departments</b>				
ICU	37 (26)	20 (14.1)	2 (5.4)	0.002
Emergency room	57 (40)	30 (21.1)	6 (10.5)	
Operation room	48 (34)	42 (29.6)	4 (8.3)	
Total	142 (100)	92 (100)	12 (8.4)	

## DISCUSSION

*Staphylococcus aureus* has emerged as a significant nosocomial pathogen characterized by significant multidrug-resistant, such as Methicillin and Oxacillin and the existence of *S. aureus* in the frontal nasal passages of HCW can be a reservoir for un-colonized susceptible individuals and community as well because they are at the middleman between hospital and community. Besides significant risk factors of infection pose to their immune-compromised patients, ensuing in an elongated hospitalization and then an extra economic burden. So identification of healthcare workers colonized with MRSA, In addition to other precautions, maintaining good hand hygiene will diminish spread and controlling the spread of such pathogens. Hence the current study was designed to ascertain the nasopharyngeal burden of MRSA among healthcare workers in Khartoum State/Sudan.

In the present study, current findings revealed that a nasal carriage rate of *S. aureus* was (41.5%) (59/142) among HCWs which is inconsistent with the study reported by Joachim *et al.*<sup>18</sup>, who noted (41.4%) and to some extent, Shibabaw *et al.*<sup>9</sup> in Ethiopia reported prevalence rate about (44.1%). The current notified rate of *S. aureus* is too greater than the corresponding by many other studies performed which revealed an overall frequency of *S. aureus* (12.4%)<sup>15</sup>, (17.5%)<sup>16</sup> and (22.2%)<sup>14</sup>.

On the other hand, the overall carriage rate of MRSA was 12/142(8.4%) in the current study, this conformed with the globally documented MRSA carriage ranged from 5.8-17.8% among hospitalized HCWs that are reported by Shakya<sup>19</sup>.

The measured frequency of MRSA was significantly greater than those findings reported in Indian HCWS (3.8%)<sup>20</sup>, (5.3%) Iranian<sup>21</sup>. But lower than the result revealed by Shibabaw *et al.*<sup>9</sup> that reported 12.7% of their HCWs to carry MRSA and 11.43% reported by Rongpharpi<sup>14</sup>, Ethiopia (12.7%)<sup>9</sup> and lower (2.32%) in Shrestha *et al.*<sup>22</sup>. Variability in microbiological methods (data collection method, cultural identity and technique of MRSA characterization), local standard precautions, participant or personnel sanitary conditions and the local prevalence of MRSA can all be related to these distinctions. Nasal carriage of *S. aureus* and MRSA were frequently increased in females than males (47.3%) and (11.9%), respectively, however the result is non-significant p = 0.299, CI (-0.247-0.352), this is the same findings revealed by Joachim *et al.*<sup>18</sup>. 34 (58%) of HCWs who were significantly colonized by *S. aureus* were in the middle age group, nevertheless, the majority of MRSA carriage subjects were in age group more than 45 years old (p = 0.022), this finding may be justified as 38 (26.8%) of participants enrolled their work's duration more than 5 years half of them colonized with *S. aureus* and 92 (64.8%) have direct contacts with their patients of the 41 (69.5%) and 9 (15.3%) were statistically significant carry *S. aureus* and MRSA, respectively. A dissimilarity with shreds of evidence provided by Shibabaw *et al.*<sup>9</sup>, in which increased levels were demonstrated among HCWs with less than 5 years of experience. The demonstrated distinction might be attributed to differences in the amplitudes of susceptibility to MRSA-colonized HCWs and patients. Surprisingly other variables such as gender and history of antibiotic use had no impact on the colonization of MRSA.

In the present study, a maximum colonization rate of *S. aureus* as well as MRSA, was revealed among nurses 23 (16.2%), 6 (4.2%), respectively, accompanied by physicians staff. Similar results have been reported by Shibabaw<sup>9</sup> and Dilnessa and Bitew<sup>1</sup>. Nurses and doctors are at significant risk of acquiring MRSA colonization caused by regular and direct patient care as we significantly revealed an increased frequency of patient contact and MRSA among the nurse group ( $p > 0.001$ ). With regard department, a maximum percent of *S. aureus* and MRSA carriers were statistically significantly detected among HCWs in emergency rooms (19.7%) and (4.2%) consequently ( $p \leq 0.002$ ), followed by operation room in which we observed a high frequency of direct patients contact (29.6%). The same finding noted by Adwan *et al.*<sup>23</sup>, this attributed to the reason that the emergency department is an area of elevated health workers and then patients contact, frequent patients rotation, potentially significant congesting as well as so many infected suffering from wound infections being drained, examined and dressed; maybe these features of the emergency department associated with the development of MRSA infections, that could justify the colonization identified among HCW in an emergency environment. High frequency (29.6%) of HCWs that regular contact their patients revealed in operation department while highest MRSA 6 (10.5%) was detected in the Emergency department ( $p \leq 0.002$ ), significant and strict sterilization precautions in operation room could be the possible reason justify current findings.

However, current findings conflicted with a study reported different studies who conclude that all *S. aureus* isolates managed to recover from HCW at surgery and internal medicine department were MRSA; as such these departments are widely known for their most intensive work, the overcrowded and comparative scarcity of HCWs<sup>22,24,25</sup>. Indeed, not much of the researches cited above are supports as the use of HCWs from critical trends as well as discrepancies in survey methodology such as sampling technique, followed reproducibility of methods and strategy of MRSA authentication, all these reasons may take full responsibility for the gap in carriage frequency. Furthermore, carrier rates may even be impacted by bad hygiene of healthy volunteers, inadequate hospital sanitation.

MRSA carriers must be identified among seemingly healthy hospital personnel, notably those collaborating in crucial units such as operating rooms and intensive care units. Hence HCWs are a critical group in the community because they play a significant role as well as they are median between

patients and community can be monitored through evaluating HCWs regularly, utilizing barrier of preventive and fundamental infection control measures and then going to treat them. In addition, they should sweep their hand thoroughly with soap or an alcohol-based hand sanitiser pre and post-caring for each patient to avoid MRSA infections as much as possible.

Measured variables associated with demographics, the pre-medical status of participants such as usage of antibiotics, wasn't available for analysis as well as small sample size, hand hygiene and precautions measures. Also, the study didn't include all health care workers such as lab technicians, pharmacists and radiologists. Due to the restrictions of lab facilities, MRSA was identified only by using a simplified, efficient test that must be verified by sensitive and advanced technologies such as PCR of the *mecA* gene, which didn't be used throughout the study. Some epidemiological factors impacting MRSA and MSSA nasal carriage rates have been disregarded. Nevertheless, identifying risk factors for nasopharyngeal colonization may contribute to the development of MRSA prevention plans.

## CONCLUSION

The study showed that out of total specimens collected from healthcare workers, nurses doctors and cleaners were a carrier for MRSA. The highest percentage of nasal carriage of Coagulase positive MRSA among healthcare workers was frequently observed among nurses staff and cleaners and less percentage in doctors. Assessment should be made crucial guidelines to ascertain the carrier transmissible drug antibiotic resistance of *Staphylococci* from the society to the healthcare setting and inversely.

## SIGNIFICANCE STATEMENT

This study discovered that healthcare workers, cleaners, nurses and doctors were a carrier for MRSA. The highest percentages of nasal carriage of Coagulase positive MRSA among healthcare workers were found. This study will help the researchers to uncover the critical areas of nasal carriage of MRSA transmission that many researchers were not able to explore.

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