Original Research Article

Nasal colonization of Methicillin-Resistant *Staphylococcus aureus* among nursesat a Sri Lankan hospital

ABSTRACT

Aim: Study determined the nasal colonization of methicillin-resistant *Staphylococcus aureus* (MRSA) and associated factors among a cohort of nurses in a Sri LankanHospital.
Study design: A hospital based, cross-sectional study was conducted including nurses attached to different wardsat a Sri Lankan hospital, located in the capital of the country.
Place and Duration of the study: University Hospital Kotelawala Defence University (UHKDU),from October 2022 to January 2023
Methodology: After obtaining written informed consent, a total of 80 nurses were included in the study. Relevant socio-demographics and behavioral data were collected using a self-administered pre-tested questionnaire. Nasal swabs were collected and processed to identify MRSA according to laboratory protocols and Clinical Laboratory Standards Institute guidelines. Associations between categorical variables were assessed by chi-square test using SPSS version 25 software.
Results: Majority of the participants were females (73.8%) and the mean age was 31.93 ± 8.99 years. Coagulase negative *Staphylococcus* spp. were 41 (50.62%) while 14 (17.28%) were *Staphylococcus aureus* out of which, seven were MRSA with a colonization rate of 8.6%. None of the demographics or behavioral factors showed a statistically significant association ($p > 0.05$) with the presence of MRSA nasal colonization.
Conclusion: This is the first-time screening of nurses at this hospital for MRSA colonization. These findings can be used as a baseline for future studies to minimize further transmission of MRSA colonizers and to strengthen the infection control measures. In addition, antibiotic stewardship programs can be implemented towards early identification of MRSA positive cases. Lack of statistically significant associations between considered factors raises the requirement of additional investigations with larger sample size for comprehensive understanding.
The study findings help to identify the trends of MRSA colonization among nurses as they can be treated and prevent further spread to the community, health care workers and immunocompromised critical patients.

Keywords: Cross-sectional study, Methicillin Resistant Staphylococcus aureus, Nasal colonization, Nurses, Screening, Sri Lanka

INTRODUCTION

Methicillin Resistant *Staphylococcus aureus* (MRSA) is a group of bacteria, which cause a significant public health challenge worldwide,due to its potential to cause both hospital acquired (HA) and community acquired (CA) infections and its resistance to many beta lactam and other groups of antibiotics [1-3]. Asia is one of the regions with the highest incidence of HA-MRSA and CA-MRSA. Since 1980, the reported rate was increased from 26% to 73% in health care settings [2, 4, 5]. Direct person-to-person contact, indirect contact via hands of health care workers and fomites are common modes of transmission of MRSA in hospital settings [6-8].

Staphylococcus aureus can be colonized in the human body on which the most frequent carriage site is the anterior nares. Carriers of MRSA can serve as a source of infection to hospitalized patients and to other healthcare workers. MRSA colonization rates of health care workers can vary among different geographical locations and settings [9].Lack of adherence to infection prevention practices when handling patients is one major reason for high rates of colonization among health care workers. In hospital settings, MRSA causes excess mortality, morbidity and economic burden compared to Methicillin Sensitive *Staphylococcus aureus* (MSSA) [3, 10]. The risk of death due to MRSA infections was three times greater than other hospital acquired infections [11, 12].

MRSA are resistant to beta-lactam antibiotics due to the acquisition of penicillin- binding protein known as PBP2a, which is encoded by mecA gene [8]' In addition to resistance to beta-lactams, MRSA bacteria frequently exhibit resistance to multiple classes of antibiotics becoming Multi Drug Resistant (MDR) [13].Therefore, treatment alternatives for MRSA infections are limited, demanding the use of last resort antibiotics like vancomycin [12]. The persistent development of antibiotic resistance among MRSA organisms for other antibiotics encountered a great difficulty for health care providers in deciding the treatment regime and also requires more complicated, and expensive treatment [11, 13, 14]. Identifying the difference between colonization and infection among health care workers, is important in minimizing the colonization by MRSA and to prevent transmission of MRSA from healthcare workersto patients. Understanding the current MRSA colonization rates and the associated factors for colonization in a category of healthcare workers will be important in implementing, increasing awareness and adherence to infection prevention and control practices.

Based on the previous studies conducted in the country and elsewhere, MRSA colonization rate varies between different hospitals and patient populations [15-17]. However, published data are lacking on the occurrence of MRSA colonization among nursing staff in the Colombo district, Sri Lanka. None of the studies have been conducted in University Hospital, Kotelawala defence university (UHKDU) which is a 704 bedded hospital comprised of ultra-modern facilities, in the capital of the country and serves patients living over a wide area. Therefore, the aim of this study was to identify the occurrence and associated factors of MRSA nasal colonization among a cohort of nurses attached to UHKDU as nurses play a crucial role in spreading the disease to patients at the hospital setting.

2. MATERIALS AND METHODS

A hospital based descriptive cross-sectional study was conducted from October 2022 to January 2023. Written informed consent was obtained. A pretested self-administered questionnaire was given to selected, consented participants, to collect socio-demographic details and details related to dissemination of MRSA. Consented nursing officers attached to gynecology, obstetric, pediatric, oncology, surgical, medical wards and adult and neonatal intensive care units were included in the study. The nursing officers with upper respiratory tract infections, nasal deformities or septal deviations, who have undergone nasal surgeries within three months, who were on antibiotics and who were not giving consent to participate in the study were excluded. The nasal swabs were collected by a trained nursing officer. Sterile cotton swabs were used to collect the specimens. Collected specimens were transported within one hour of collection to the microbiology laboratory. Swabs were enriched in 7% sodium chloride broth immediately after receiving to the laboratory and incubated overnight at 35°C. Enriched samples were inoculated on Mac Conkey agar and blood agar and incubated overnight at 35°C. In the following day, colony morphologies were observed and *Staphylococcus aureus* colonies were identified according to the standard operating procedures using Gram stain, catalase test, tube coagulase test and DNase test.

The methicillin susceptibility of identified *Staphylococcus aureus* colonies was tested by disc diffusion test using cefoxitin 30 µg disc and results were interpreted according to Clinical Laboratory Standard Institute (CLSI) 2022 standards [18] Quality control of disc diffusion testing was performed using American Type Culture Collection (ATCC) 25923 *Staphylococcus aureus* strain according to CLSI 2022 standards. Data analysis was done by SPSS 25.0 version and the associations between categorical variables were tested by the chi-square test. The limit for statistically significant differences was set as $p<0.05$.

3. RESULTS

A total of 80 consented nurses were selected for the nasal sampling which comprised of two matrons, two nursing sisters and 76 nurses. The age ranged from 24 years to 65 years with a mean age of 31.93 ± 8.99 years. The highest percentage of the population was females (73.8%). On laboratory examination all the specimens showed a bacterial growth on agar plates out of which 41 (50.62%) were Coagulase Negative Staphylococcus (CNS), 26 (32.10%) were *Streptococcus/Enterococcus* spp., and 14 (17.28%) were *Staphylococcus aureus*. Out of 14 *Staphylococcus aureus* isolates, seven (50%) were MRSA. Colonization rate of MSSA and MRSA were equal (7/80, 8.75%). When the MRSA colonization was categorized according to the unit the relevant nursing officer was attached to, highest MRSA colonization rate was observed among the medical ward (16.67%) followed by the obstetric ward (15.79%). (Table 1).

Table 1. Methicillin sensitive and resistant *Staphylococcus aureus* distribution among the participated nurses

Ward/clinical unit	Total tested	MSSA (n=7) (%)	MRSA (n=7) (%)
Oncology	11	0	0
Surgical	6	0	0
Pediatric	17	1 (5.88%)	2 (11.76%)
Gynecology	5	1 (20.00%)	0
Obstetrics	19	4 (21.05%)	3 (15.79%)
Medical	12	1 (8.33%)	2 (16.67%)
NICU	5	0	0
ICU1	5	0	0
Overall rate (No. MRSA/Total tested*100)		8.75%	8.75%

None of the considered demographic and other factors related to MRSA colonization showed a significant association with the MRSA colonization rate ($P>0.05$). Associations between the demographic and other factors related to MRSA colonization are tabulated in Table 2.

Table 2. Association of demographic and other factors with MRSA colonization among the study sample (n=80)

	Associated factors		Frequency	MRSA colonization		*P* value*
				Positive (%)	Negative (%)	
Demographic factors	Age	< 25	6	0.0	100.0	0.62
		26-35	61	8.	90.3	
		36-45	2	0.0	100.0	
		46-55	7	14.3	85.7	
		56-65	4	25.0	75.0	
	Gender	Male	21	4.8	95.2	0.67
		Female	59	10.2	89.8	
	Ethnicity	Sinhala	79	8.9	91.1	1.00
		Muslim	1	0.0	100.0	
	Marital status	Single	35	8.6	91.4	1.00
		Married	45	8.9	91.1	
	Accommodation	Own home	37	5.4	94.6	0.21
		Live in an apartment	8	25.0	75.0	
		Shared accommodation	35	8.6	91.4	
	Duration in healthcare service	<3 years	44	6.8	93.2	0.55
		3-9 years	25	8.0	92.0	
		>9 years	11	18.2	81.8	
	Designation	Matron	2	0.0	100.0	0.10
		Sister	2	50.0	50.0	
		Nurse	76	7.9	92.1	
MRSA colonization related other factors	Hand washing when handling MRSA patients	Always	68	7	61	0.27
		Sometimes	11	0	11	
		Never	1	0	1	
	Use of PPE when handling MRSA patients	Yes	79	8.9	91.1	1.00
		No	1	0.0	100.0	
	Co-morbidities	Yes	5	20.0	80.0	0.38
		No	75	8.0	92.0	
	Diabetic mellitus	Present	4	0.0	100.0	1.00
		Absent	76	9.2	90.8	
	Current Antibiotic usage	Yes	10	10.0	90.0	1.00
		No	70	8.6	91.4	
	Knowledge on MRSA	Yes	71	8.5	91.5	0.50
		No	9	11.1	88.9	

**P values <0.05 were considered statistically significant*

4. DISCUSSION

The emergence and spread of MRSA has become a significant public health concern [19].Asia is identified as one of the regions with high prevalence rate of both CA-MRSA and HA-MRSA. It is the continent with highest population density as well as inappropriate

treatment therapies for infections. Self-medication with over- the-counter antibiotics are also frequently used. The high selective pressure created by these malpractices gradually creates a favorableenvironment for the development and spread of numerous pathogens that are resistant to multiple antibiotics resulting MDR organisms [20].

7, *P-value*

Health care settings are identified as potential sources of MRSA organisms due to the close contact of patients with healthcare workers, patient care equipment and hospital environment. Moreover, there is a possibility of transmission of these organisms from patient to patient and healthcare worker to patient [13, 21].According to literature,colonized healthcare workers are a recognized cause for the transmission of MRSA to patients [3] out of which, nurseswere reported as the significant risk factor among other health care workers (odds ratio=3.6, 95% confidence interval=1.3 to 9.7, *P*=0.012) [31]. In addition, most of the hospitals in Asia are known to endemic for HA-MRSA [20].Therefore, it is crucial to identify the nasal colonization of MRSA among nurses, as they act as the frontline healthcare workers in patient care. Thus, this study aimed to assess the presence of nasal colonization of MRSA and to identify any associated demographic or behavioral factors which can contribute to higher colonization rates among the nurses at a university hospital.

The present study revealed that 8.8% of the nurses were colonized with MRSA organisms. Previously published local studies showed varying ranges of MRSA colonization rates among healthcare workers ranging from 5.8% to 17.8% in different locations which is in line with the observed percentage in the present study [14, 17, 19, 22]. The worldwide prevalence of MRSA colonization ranges between 0.34% to 32.8% in different settings [23-27].This discrepancy of nasal colonization of MRSA between different hospitals and countries may be due to, differences in size and quality of the samples studied, usage of different microbiological techniques from sampling to culturing of bacteria, antibiotic usage and differences in infection control policies and interpretation guidelines. [25]

The present study found highest MRSA occurrence in the age group of 56-65 years (25.0%). However, no significant association was noted between age groups and the presence of MRSA colonization. (*P*> 0.05). Similar result was observed in a study conducted in Germany, which reported a highest MRSA prevalence in the age group of 50-59 years (25%), with no statistically significant association between age and the MRSA prevalence (*P*>0.05) [28].Another study conducted in United Kingdom also found the highest MRSA prevalence in the age group of >30 years but, in contrast to the present study, it indicated a statistically significant association between age and MRSA prevalence (*P*< 0.05) [29].Reasons for increment of MRSA colonization with the age may be because, the older aged nursing officers are more experienced and they expose to high-risk areas. In addition, with the experience there is a possibility to neglect infection control practices. Moreover, factors such as co-morbidities, increased exposure to MRSA colonized patients, overall immune status and use of antibiotics play a crucial role in MRSA colonization than the age alone. Therefore, lack of significant association in our study confirm that age by itself may not be a primary risk factor for MRSA colonization [30].

In our study, females (10.2%) were found to have higher occurrence of MRSA than in males (4.8%) but, no statistically significant association was found between gender and MRSA colonization (*P*>0.05). Reason for the observed high female MRSA carriers may be due to female predominance in the study sample and the sample size that may not have been large enough for the detection of a statistically significant difference between genders. In addition, gender alone is not a strong contributing factor.Confounding factors like antibiotic consumption, co-morbidities etc. may also cause for MRSA colonization. Similarly, another study conducted participating Iranian health-care workers showed a female predominance of MRSA carriers without any statistically significant difference[31]. Moreover, published

studies reported high female MRSA carriers than males among health-care workers supporting the present study findings but, on contrary a statistically significant difference was noted among genders[28], [30]. In contrast to the present findings, another study conducted in Ethiopia reported twice high MRSA carrier rate among male health care workers than females [30].

The nurses attached to the medical ward demonstrated the highest rate of MRSA colonization (16.67%) in comparison to other wards. However, the difference was not statistically significant (*P*>0.00). The reason for this could be because of the small sample sizes across wards may have limited statistical power to detect significance. Another published article also reported higher MRSA prevalence in the medical ward which is in line with the present study findings [30].On contrary, highest MRSA nasal colonization prevalence among surgical wards was also reported [25, 31].

When the type of accommodation among the sample was analyzed, the nurses resided in the apartment accommodations demonstrated the highest rate of MRSA colonization (25.0%), raising the question about the potential causes contributed to such MRSA colonization. None of the remaining factors showed any statistically significant difference with MRSA colonization (*P*>0.05) (Table 2). The reason may be either due to the small number of samples or variabilities within each sub group. It is also important to consider that the smaller sample size might have masked the significant associations between potential factors and MRSA colonization.

There is a possibility of transmission of MRSA to healthcare workers by high risk patient population and these workers act as reservoirs of MRSA infections at healthcare settings. Moreover, there is a significant danger in transmission of hospital acquired infections to the community, resulting in outbreaks of CA-MRSA. On the other hand, transmission of nosocomial pathogens like MRSA from carrier healthcare workers to immunocompromised patients are critical, due to the inability of their immunity systems to withstand infections. This clearly demonstrates the necessity of establishing and implementing screening protocols among nurses on a regular basis in order to prevent the further spread of hospital acquired infections to the patients and also to the community at large.

MRSA organisms' transmission are known to be reduced by consistent hand washing [32]. Interestingly, some studies have reported no significant difference between health-care workers who are washing hands frequently and rarely after handling patients [30]. In addition, adherence to infection control protocols, educating nursing staff and proper training on infection control protocols, and rational use of antibiotics are important measures to prevent MRSA colonization and transmission [33, 34]. There are no any published data on MRSA colonization among nurses who are working at UHKDU. Future studies with larger sample size and targeting all types of healthcare workers might be helpful to assess the associations between MRSA colonization and associated factors. Furthermore, identification of MRSA positive nurses and sending for decolonization procedure would be beneficial to the hospital at large which was not possible in the current study as the participants were anonymized. The findings provide timely, up-to-date surveillance information that are essential for infection prevention and planning control measures. Thereby, enable to implement new protocols and to change existing protocols regarding MRSA prevention and control at hospitals including UHKDU. Although, this study advances the existing knowledge of MRSA occurrence among nurses, lack of statistically significant associations between considered factors raises the requirement of additional investigations for the comprehensive understanding of the associations between these factors and MRSA colonization among the nurses in the health care setting.

5. CONCLUSION

In conclusion, this cross-sectional study provides insights into the occurrence and factors likely for MRSA colonization among nurses at UHKDU. The study findings demonstrated overall MRSA colonization rateof 8.75% among the participated nurses whereas did not find any statistically significant association between considered factors and MRSA colonization.

CONSENT

All authors declare that written informed consent was obtained from the participated nursing officersfor publication of research study. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

ETHICAL APPROVAL

Ethical approval was obtained from the Ethics Review Committee (ERC) of the faculty of medicine (RP/S/2022/15) and permission from the hospital director was also obtained. The process of the research was performed in accordance with the ethical standards laid down in 1964 Declaration of Helsinki.The data collected for the study was password protected in a computer and was accessible only to the investigators and the personnel authorized by the investigators. Both computer based and paper based data will be safely discarded one year after publication of the research. These samples will not be used for any other study or purpose. The data set used in the current study is available on request from the corresponding author.

ABBREVIATIONS

MRSA: Methicillin-resistant Staphylococcus aureus
CLSI: Clinical laboratory standards institute
UHKDU: University hospital, Kotelawala defence university
HA: Hospital acquired

Disclaimer (Artificial intelligence)

All authors hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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