TMJ
Original research **Published by** OJS
Doi: 10.4314/tmj.v33i4.547.g309

OPEN ACCESS JOURNAL

Nasal *Staphylococcus Aureus* and Methicillin-Resistant *Staphylococcus Aureus* Colonization among Hospital Janitors in Central Zone, Tanzania

Saada A. Seif[1]*, Angelina A. Joho[2]

[1]Department of Nursing Management and Education, School of Nursing and Public Health, The University of Dodoma, Dodoma, Tanzania
[2]Department of Clinical Nursing, School of Nursing and Public Health, The University of Dodoma, Dodoma, Tanzania

***Corresponding author:**
Saada A. Seif
University of Dodoma
P. O. Box 259
Dodoma, Tanzania
Email: saadudat@gmail.com

TMJ
Original research
Published by OJS
Doi: 10.4314/tmj.v33i4.547.g309

Abstract

Background

Methicillin-resistant *Staphylococcus aureus* (MRSA) is responsible for several difficult-to-treat infections than ordinary staphylococcal infections. It is associated with an increased hospital stay, mortality, and morbidity. Evidence shows that hospital janitors act as an important reservoir of MRSA, which if left undetected, may contribute to its spread. This study determines the colonization rates of *Staphylococcus aureus* and MRSA together with their antimicrobial sensitivity among hospital janitors in the central zone of Tanzania.

Methodology

This was a baseline report from a quasi-experimental hospital-based study that was conducted in central Tanzania, involving 122 hospital janitors selected using a systemic random sampling from three regional hospitals. Nasal swabs were collected, pre-enriched, and inoculated into blood and mannitol agar plates. The confirmation of MRSA was done using a cefoxitin disc, and the antibiotic susceptibility test was done using the disc diffusion. SPSS was used for analysis; descriptive statistics were employed; a chi square coefficient was reported; and a p-value of ≤ 0.05 was considered statistically significant.

Results

The prevalence of *Staphylococcus aureus* was 21% (25/119); among them, MRSA was 44% (11/25). The colonization was more common among females (23.1% vs. 17.1%), with a low education level (25% vs. 17.5%), with working experience of two years or more (26.5% vs 17.5%), and those who were cleaning in the laboratory (28.6% vs. 14.3% in the office). Clindamycin was effective against the majority of Staphylococcus aureus isolates (20/25) tested positive. MRSA isolates were more likely than Methicillin-Susceptible Staphylococcus aureus to be resistant to many antimicrobial drugs tested ($p < 0.001$). The multi-drug resistance was 36%, and it was higher among the MRSA (81.8%) isolates than the MSSA ($p <0.001$).

Conclusion

There is a high prevalence of nasal colonization with *Staphylococcus aureus* and MRSA among hospital janitors. Most *Staphylococcus aureus* isolates were sensitive to clindamycin. The MRSA isolates were resistant to many antimicrobial drugs compared to the MSSA. Findings suggest that hospital janitors may contribute to spreading MRSA if they do not observe proper hygienic practices. Therefore, efforts should be made to ensure they are adhering to infection prevention and control measures while working.

Key words: *Methicillin-Resistant Staphylococcus aureus (MRSA), Hospital Janitors, Hospital Acquired Infection, Staphylococcus aureus, Drug resistance, Tanzania*

Published by OJS
Doi: 10.4314/tmj.v33i4.547.g309

Introduction

Health care associated infection (HAI) is of public health concern, and it is estimated to be higher in countries with limited resources (1). They cause serious morbidity, mortality and increase health costs throughout the world (1). Bacteria such as *Staphylococcus aureus*, which is an opportunistic pathogen, are an important cause of skin and soft-tissue infections, endovascular infections, bacteremia, and sepsis in hospital settings (2). These organisms colonize the skin and nostrils and are transmitted through skin-to-skin contact or contact with shared items or surfaces (3). *S. aureus* has become increasingly resistant to the methicillin drug, and its colonization is considered a risk factor for eventual infection as well as a potential source of the spread of resistant strains (2). Methicillin is a semisynthetic derivative of natural penicillin that is resistant to beta-lactamase, the bacterial enzyme responsible for typical penicillin resistance (4). Methicillin was once effective in treating penicillin-resistant staphylococcal infections until resistance emerged (5). Methicillin-Resistant *Staphylococcus aureus* (MRSA) is a staphylococcus aureus strain resistant to all B-lactam antibiotics, including penicillin, cephalosporins, monobactam and carbapenems, because of the presence of meCA, a gene that produces an altered penicillin-binding protein (PBP2a) with low affinity for B-lactam antibiotics. Mechanisms of oxacillin resistance other than mecA are rare. How the resistance comes about is due to unnecessary drug use or incorrect drug use , given enough time; bacteria can change and adapt, thus rendering the drug inactive (6). Although the drug methicillin is no longer in use but, the original term “MRSA” is still used to refer to all antibiotics that are susceptible to the bacterial enzyme beta-lactamase (5).

MRSA isolates were once confined largely to hospitals and other health care environments (7), and are reported as responsible for several difficult-to-treat infections in humans since they do not respond well to many common antibiotics used to kill bacteria, thus making it harder to get rid of the infection (5). While some antibiotics still work, MRSA is constantly adapting (8). Currently, vancomycin is the most frequently prescribed antimicrobial therapy for MRSA infections; however, rare cases of vancomycin resistance have made vancomycin a less appealing option (9). A notable presence of antibiotic resistance is an indication of their failure in treatment and therefore brings a need for a broader class of antibiotics, which can be more expensive (10). This has triggered alarms in the medical community as *S. aureus* strains cause life-threatening infections in hospitalized and non-hospitalized patients (11). Examination of colonization strains is therefore key to understanding the epidemiology of *S. aureus* infection and diseases.

There is increasing interest in the role of hospital janitors in managing HAI (12), because their direct contact with biological hazards may pose a potential threat to their health, patients' health, the health of health care providers, and the health of individuals related to them. Moreover, hospital janitors have been linked to a high rate of HAI, including MRSA infection (13). Studies have shown that the nasal MRSA carriage rate among hospital janitors is 5.0–7.8%, which is significantly higher than that for the general population which is 3.8% (14). In addition, Chang et al,(2015) in their study reported the nasal carriage rate of *S. aureus* as 15.3% and MRSA as 3.6% among janitors working in hospitals in Taiwan (2). Studies conducted in Ethiopia showed that the colonization rate of MRSA was 8.1% among janitors working in hospitals and 1.4% among non-hospital janitors (15), and a colonization rate of 6.25% was reported among janitors working at Makerere University (16).

Tanzania was classified as having a low MRSA prevalence in African continent between 2001 and 2009, ranging from 6-16% (17). However, the prevalence appears to have increased in the last decade (17). Studies in Tanzania have reported the prevalence of MRSA contamination, carriage, colonization, and infection in different population groups. One study reported the prevalence of MRSA colonization among hospitalized patients as 11.83% (18), while that of healthcare workers was 2.1% (18). Moreover, the prevalence of MRSA infection among patients admitted in medical and surgical departments was 33.3% (19). In the case of MRSA carriage, a prevalence of 24% was reported among patients during admission (20), whereas a prevalence of 19.5% was reported to contaminate the patient's care environment within the national hospital (21). Considering the risk of hospital janitors transmitting MRSA, it was important to determine their MRSA colonization rate in Tanzania since the detection of the risk groups, the infection sources, and the routes of transmission of infections are important measures for the prevention of HAI. Furthermore, the rise in MRSA prevalence in Tanzania must be taken more seriously, with research efforts focused on understanding and preventing further spread of these strains.

Methodology

Study design, settings and study population

This study reports the baseline results only from the quasi-experimental study that was conducted from January 2021 to March 2021 in central zone Tanzania involving three regional hospitals, Dodoma Regional Referral Hospital (DRRH) located in Dodoma region, Singida Regional Referral Hospital (SRRH) located in Singida region, and Iringa Regional Referral Hospital (IRRH) located in Iringa region. The study population was all hospital

janitors in the three hospitals. At the time of the study, there were a total of 160 hospital janitors of whom 70 were from DRRH, 50 from SRRH and 40 from IRRH. The minimum sample size calculated for this study was 126 participants, calculated using the probability of type 1 error as 0.05, power of 80%, mean difference of 0.5, and population variance of 1. Proportionate stratified sampling was then used to select study representatives from each hospital based on the size of the study population in each hospital, whereby 51, 39, and 32 participants were selected from DRRH, SRRH, and IRRH, respectively. Within each hospital, a systematic random sampling technique was used to get the study respondents, and the k^{th} interval was calculated using the formula $k^{th} = N/n$ (22), whereby N is the sampling frame, which is the total number of janitors in that particular hospital, and n is the required sample in each hospital.

Data collection procedure

An interviewer-administered questionnaire was used to collect background information from the study participants. The data were collected for one day in each hospital, whereby the principal investigator started by collecting the background characteristics followed by sample collection by the laboratory technicians.

Sample Collection, Transportation and Handling

Two laboratory technicians working in DRRH were involved in specimen collection. Standard operating procedure guidelines established by the Dodoma Regional Referral Hospital Laboratory (DRRHL) of 2019 and The Textbook of Diagnostic Microbiology of 2018 (23) were followed during sample collection, transportation, and handling of the sample to the processing area. Using aseptic techniques, a nasal swab specimen was collected from both anterior nares of each subject with a moist, sterile swab (Rabex, China). Each swab was rubbed against the anterior 1 cm of the nasal vestibular wall of both nares and immediately placed into tubes containing tryptose soy broth for enrichment (Oxoid Ltd., Basingstoke, UK). Tubes were labelled with the specimen source, the hospital name, the date, and time of collection. The specimens were then transported to DRRHL in a cool box with ice packs within 6 hours of collection. A thermometer was located inside the cool box to measuring the temperature.

Sample culture

All samples were processed in the DRRH microbiology laboratory. Methods of processing, culture reading, and bacterial identification were done as per standard operating procedure guidelines established by the DRRHL of 2019 and Diagnostic Microbiology textbook of 2018 (23). There, the swab specimens were inoculated into Mannitol salt agar plates (Oxoid, Basingstoke, United Kingdom) and streaked on 5% blood agar plates (BD Diagnostics, Sparks, MD), where they were incubated aerobically at 37°C and examined for growth after 24 hours and then 48 hours if no growth was observed. Using macroscopic examination of the plates, the isolates were identified as *S. aureus* in Mannitol salt agar by golden yellowish round colonies, (23), and Isolates that presented with β-hemolysis in blood agar were sub cultured into Mueller–Hinton agar (Oxoid, UK), and *S. aureus* were identified based on colonial morphology, gram staining, catalase test and the coagulase .

Gram staining and a biochemical test using tube coagulase were done to confirm the identification of the *S. aureus*. In the tube test method, 0.5 ml of rabbit's plasma was added to a 12 x 75 mm test tube, and several colonies of the test organism were inoculated in the tube. The tube was then incubated at 35˚C for up to 4 hours, with hourly clot formation observed. The tube was not allowed to be agitated; instead, the clot was observed by gently tipping the tube. If the test was negative after 4 hours, the tube continued to be incubated for another 24 hours. After a 24-hour incubation period, observation for clot formation was done, and the results were recorded. Complete clot formation or any degree of clot formation was recorded as positive, while lack of clot formation was recorded as negative, thus, *S. aureus* was reported if the tube test was positive.

Screening for MRSA was done by testing for cefoxitin resistance using the Kirby-Bauer disc diffusion method as per the guidelines of the Clinical and Laboratory Standards Institute (CLSI) (24). Cefoxitin disks (30 µg, Liofilchem™Italy) were incubated aerobically at 35 °C for 24 hours on Mueller–Hinton agar (Oxoid, UK). All S. *aureus* isolates with a zone of inhibition on the cefoxitin (30 µg) disk of ≤21 mm were phenotypically considered MRSA. *S. aureus* (ATCC 25923) was used as a control.

Drug susceptibility testing

Bacterial isolates were checked for antimicrobial susceptibilities using the Kirby–Bauer disc diffusion method on Muller-Hinton agar as per the DRRHL of 2019 and as indicated in CLSI (23), (24). A loop full of bacteria was taken from a pure culture colony and transferred to a tube containing 5 ml of saline (sterile 0.9% w/v NaCl solution) and mixed gently until it

formed a homogenous suspension. The turbidity of the 0.5 McFarland standard was used to adjust the turbidity of a tube suspension swabbed on Muller-Hinton medium (23), (24). The following concentrations of antimicrobials were used; gentamicin (10 µg), erythromycin (15 µg), ciprofloxacin (5 µg), clindamycin (2 µg), and cefoxitin (30 µg) according to Clinical and Laboratory Standards Institute (CLSI) (21). The results were reported as sensitive, intermediate, and resistant as described by the CLSI guideline. Besides, MRSA strains were differentiated from Methicillin-Sensitive *Staphylococcus aureus* (MSSA) strains using a cefoxitin (30 µg) disc. Multidrug resistance (MDR) was also observed. Multidrug resistance for *S. aureus* was defined as acquired nonsusceptibility to at least one agent in three or more antimicrobial classes (25).

Results

Demographic characteristics of study participants

In this study, 122 hospital janitors participated, making the response rate 95%. The mean age of respondents was 32.3(SD=9.9) years, majority of study participants were female 80(65.6%), and less than half had a primary education level 60(49.2%). The slight majority 72(59%) were working in hospital wards, and 68(57.9%) had working experience of two years or more. Only 48(39.3%) had received training on Health Care Waste Management (HCWM), among them, majority 37(77.1%) received this training from the hospital where they are working (Table 1).

Colonization of nasal S. aureus and MRSA among study participants

Results of this study showed that among the 122 samples taken to the laboratory for culture, 97.5% (119/122) samples showed bacterial growth. Among the 119 grown samples, 21% (25/119) were identified as *S. aureus*. Of the 25 *S. aureus* isolates, 44% (11/25) were MRSA, making the overall prevalence of MRSA among all study participants 9.2% (11/119). Further analysis showed that, of the 25/119 *S. aureus* and 11/25 MRSA isolates, the small majority (48% (12/25) *S. aureus* and 45.5% (5/11) MRSA) were isolated from Dodoma regional referral hospital, followed by Iringa regional referral hospital (28% (7/25), *S. aureus* and 36.4% (4/11) MRSA), and Singida regional referral hospital (24% (6/25), 18.2% (2) MRSA).

Published by OJS
Doi: 10.4314/tmj.v33i4.547.g309

Table 1: Demographic characteristics of study participants (N = 122)

Variables	Number	Percent
Working Hospital		
Dodoma General Referral Hospital	51	41.8
Singida General Referral Hospital	39	32.0
Iringa General Referral Hospital	32	26.2
Sex		
Male	42	34.4
Female	80	65.6
Age groups (years)		
18-25	38	31.1
26-35	45	36.9
36-45	24	19.7
46-68	15	12.3
Education Level		
No formal education	12	9.8
Primary education	60	49.2
Secondary Education	40	32.8
Certificates and above	10	8.2
Cleaning area		
Wards	72	59.0
Office	21	17.2
Laboratory	7	5.7
Courtyard	22	18.0
Other areas ever worked		
Wards	4	33.3
Office	7	58.3
Courtyard	1	8.3
Working Experience		
One year and less	51	42.9
Two years and above	68	57.1
Given working contract	43	35.2
Received training on HCWM	48	39.3
Training institution		
From the hired company	11	22.9
From working hospital	37	77.1

Published by OJS
Doi: 10.4314/tmj.v33i4.547.g309

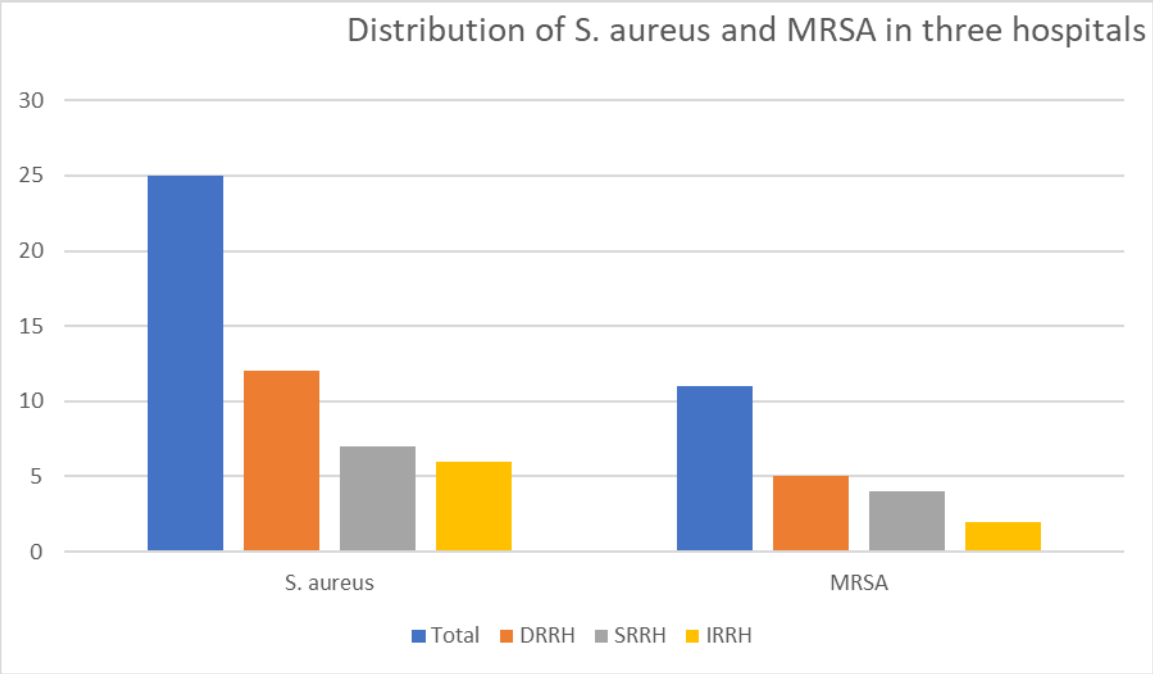

Figure 1. Distribution of *S. aureus* and MRSA among janitors in three hospitals

Distribution of nasal *S. aureus* and MRSA within demographic characteristics of study participants

A cross-tabulation was conducted, and a chi square test was used to compare the distribution of *S. aureus* and MRSA among different groups of demographic characteristics. The results showed that the colonization of *S. aureus* was more common among female janitors 18(23.1%) compared to male 7(17.1%)among those with low education level 15(25%) compared to those with secondary education level 7(17.5%), who were cleaning in the laboratory 2(28.6%)compared to those cleaning in the office 3(14.3%), and with working experience of two years and above 18(26.5%) compared to those with working experience of starting one year and less 7 (13.7%).However there was no enough evidence to suggest the statistical significance difference among the groups (p>0.05). The colonization of MRSA was also common among the same groups as observed for *S. aureus,* however, the statistical significance difference was observed in the cleaning area, whereby MRSA was more common among those who were cleaning in the laboratory 2(28.6%), followed by those cleaning in the courtyard 4(18.2%), those cleaning in the wards 4(5.8%), and those cleaning in the offices 1(4.8%) (p=0.03),(Table 2).

Table 2: Distribution of Nasal *S. aureus* and MRSA colonization within demographic characteristics of study participants (N=119) *

Variables	Total	*S. aureus* Colonization n (%)	**p-value	MRSA Colonization n (%)	**p-value
Sex					
Male	41	7(17.1)	0.4	2(4.9)	0.2
Female	78	18(23.1)		9(11.5)	
Education Level					
No formal education	12	3(25.0)	0.2	1(8.3)	0.5
Primary education	57	15(25.0)		8(14)	
Secondary education	40	7(17.5)		2(5.0)	
Certificate and above	10	0(0.0)		0(0.0)	
Cleaning Area					
Wards	69	15(21.7)	0.8	4(5.8)	**0.03**
Office	21	3(14.3)		1(4.8)	
Courtyard	22	5(22.7)		4(18.2)	
Laboratory	7	2(28.6)		2(28.6)	
Years of Working Experience					
One year and less	51	7(13.7)	0.09	4(7.8)	1.0
Two years and above	38	18(26.5)		6(8.8)	
Training					
Received Training	47	10(21.3)	0.9***	2(4.3)	0.3
Not received Training	72	15(20.8)		9(12.5)	

**Only sample that had bacteria growth were taken*

***Fisher exact test*

****Pearson Chi square test*

Antimicrobial sensitivity/resistance pattern

All 25 *S. aureus* isolates were subjected to antimicrobial susceptibility testing against five agents. The majority of *S. aureus* isolates were sensitive to clindamycin 80% (20/25) followed by gentamycin 64% (16/25) and the least were sensitive to ciprofloxacin 44% (11/25) (Table 3).

Published by OJS
Doi: 10.4314/tmj.v33i4.547.g309

Table 3: Antimicrobial sensitivity/resistance of *S. aureus* isolates (N= 25)

Drugs	Sensitivity/resistance pattern		
	Sensitive	Intermediate	Resistant
	n (%)	n (%)	n (%)
Gentamycin	16(64)	1(4)	8(32)
Erythromycin	13(52)	2(8)	10(40)
Clindamycin	20(80)	2(8)	3(12)
Ciprofloxacin	11(44)	3(12)	11(44)
Cefoxitin	14(56)	0(0.0)	11(44)

Comparison of antimicrobial resistance/sensitivity pattern between MRSA and MSSA

When the antimicrobial resistance pattern was compared between the MRSA and MSSA using a chi square test, results showed that the proportion of isolates that were resistant to many of the antimicrobials tested in this study was higher among the MRSA isolates as compared to the MSSA isolates, and this difference was significant (p <0.001) (Table 4).

Table 4: Antimicrobial resistance/sensitivity pattern among MRSA and MSSA (N= 25)

Antimicrobial drug	MRSA (n=11)	MSSA (n=14)	p-value
	n (%)	n (%)	
Gentamycin			<0.001
Resistance	6(54.5)	2(14.3)	
Sensitive	5(45.5)	12(85.7)	
Erythromycin			<0.001
Resistance	6(54.5)	4(28.6)	
Sensitive	5(45.5)	10(71.4)	
Clindamycin			<0.001
Resistance	3(27.3)	0(0.0)	
Sensitive	8(72.7)	14(100)	
Ciprofloxacin			<0.001
Resistance	9(81.8)	2(14.3)	
Sensitive	2(18.2)	12(85.7)	

Multidrug resistance (MDR) isolates of *S. aureus*

Antimicrobial resistance to at least one drug in three or more antibiotic classes was assessed as MDR. Of the 25 isolates of *S. aureus*, 36% (9/25) showed MDR. Results showed that two isolates were resistant to at least one antimicrobial from three antimicrobial classes (Gentamycin, Ciprofloxacin, and Cefoxitin), and six isolates were resistant to at least one antimicrobial in four antimicrobial classes (e.g. Gentamycin, Erythromycin, Ciprofloxacin, and Cefoxitin). Most MDR isolates were resistant to Ciprofloxacin, and the MDR was higher among the MRSA isolates 9(81.8%) compared to the MSSA isolates, 1(7.1%) (<0.001), (Table 5).

Table 5: Multidrug resistance isolates of *S. aureus* among hospital janitors (N= 25)

Number of antimicrobial resistances	MDR pattern (n =9 (36%))	Number of Isolates n (%)
Three	Gentamycin, Ciprofloxacin, Cefoxitin	2(8)
Four	Erythromycin, Kanamycin, Ciprofloxacin, Cefoxitin	1(4)
	Clindamycin, Kanamycin, Ciprofloxacin, Cefoxitin	1(4)
	Gentamycin, Erythromycin, Ciprofloxacin, Cefoxitin	3(12)
	Gentamycin, Clindamycin, Ciprofloxacin, Cefoxitin	1(4)
	Erythromycin, Clindamycin, Ciprofloxacin, Cefoxitin	1(4)

Discussion

Methicillin-resistant *Staphylococcus aureus* is an important causative agent of HAI worldwide, and it is more difficult to treat (5). Contamination of the inanimate environment around patients, including the hospital janitors, constitutes an important reservoir of MRSA (21). In that notion, this study determined the colonization rate of *S. aureus* and MRSA together with their antibiotic sensitivity among hospital janitors in central zone, Tanzania.

The current study is a preliminary study on the epidemiology of *S. aureus* and MRSA among janitors working in hospitals in Tanzania. It was found in this study that the nasal colonization rate of *S. aureus* among hospital janitors is (21%), among them MRSA is (11%). The MRSA

prevalence among hospital janitors is unexpectedly as high as that of the known high risk group of hospitalized patients whose MRSA prevalence ranges from 11% to 33% in Tanzania (18)–(20). The reason for the high prevalence among hospital cleaners is high chance of exposure to contaminants and to the higher selective pressure in hospital areas (15). If this is coupled with non-adherence to the correct procedures for medical waste disposal, Infection Prevention and Control (IPC) un-adherence, and poor hand hygiene, can explain the higher prevalence of colonization in this population (15). Moreover, these poor unhygienic practices could be due to a lack of awareness or knowledge about IPC and/or unfavorable attitude towards IPC practices. Nevertheless, shortage or lack of Personal Protective Equipment (PPE), unavailability of guidelines or policies guiding healthcare waste management practices, and IPC practices could also contribute to the high colonization rate among hospital janitors (15). If left undetected, these asymptomatic colonized hospital janitors become risky to hospitalized patients, health care workers, the hospital environment, or the community by contributing to the spread of MRSA.

The prevalence of *S. aureus* and MRSA found in this study is comparable to what was reported in Ethiopia among hospital janitors, where the colonization of *S. aureus* was (25.2%) and that of MRSA was (9.7%) (16). Moreover, the results are also comparable with what was recently reported in Ethiopia, where *S. aureus* colonization among hospital janitors was (29.4%) and that of MRSA was (8.1%) (15). However, our reported prevalence is higher compared to what was reported in Taiwan, where the colonization of *S. aureus* was only (15.3%) and MRSA (3.6%) among hospital janitors (2). This difference can be explained by the difference in the degree of adhering to IPC practice, as it was reported that janitors working in hospitals in Taiwan were well-equipped with suitable personal protective equipment, and have a high rate of wearing gloves and surgical masks while working (2).

The results of this study showed that the majority of *S. aureus* isolates were most sensitive to clindamycin, while the least were sensitive to ciprofloxacin. So, the full sensitivity to clindamycin indicates that these medications can work perfectly against *S. aureus* infections in our settings. The sensitivity pattern observed in this study is different from what has been reported in the study of Kahsay et al. in Ethiopia, in which the majority of the isolates of *S. aureus* were sensitive to ciprofloxacin (16). The sensitivity pattern of certain antimicrobial agents is reduced if there is excessive use and misuse of medication. Further studies should

be conducted to assess the sensitivity pattern of *S. aureus* in our settings and confirm the conflicting findings.

On the other hand, MRSA and MSSA isolates were resistant to different antimicrobials, however, the resistance to ciprofloxacin, gentamycin, erythromycin, and clindamycin were significantly higher in MRSA than MSSA. This indicates the pattern of treatment failure for MRSA, which poses challenges in treating HAI. Moreover, *S. aureus* isolates showed multidrug resistance against a wide range of currently available antimicrobial agents (26). In the present study, the MDR is 36%, and it is higher among the MRSA (81.8%) isolates. The most common MDR isolate resistance pattern is gentamycin, /ciprofloxacin, /erythromycin, /cefoxitin (12%). More like similar findings were reported in the studies of Nafi & Eldaif and Shebabew et al. (9), (27). The higher resistance of the isolates against these commonly used antibiotics might be due to the mutation or gene transfer of the strain due to misuse and/or overuse of antibiotics, and a lack of standardized antimicrobial susceptibility testing before the prescription of drugs (27). This may compromise the treatment options and increase the likelihood of inadequate antimicrobial therapy, increasing treatment costs, and increasing morbidity and mortality (28).

In this study, the colonization of *S. aureus* and MRSA was more common among females, those with lower education levels, those with more years of working experience, and those who did not receive training on HCWM. Despite showing a non-statistically significant difference between the groups, a similar pattern has been reported in other studies (2), (15). Lack of statistically significant results could be explained by a relatively small sample size in this study, population characteristics, or the presence of outside variables that were not controlled in this study. Besides, there was a statistically significant association between MRSA colonization and cleaning areas, whereby those janitors who are cleaning in the laboratory and in the courtyard are at greater risk of MRSA colonization. This result is comparable to what was reported previously among hospital janitors (2), (16),(29). It has also been reported elsewhere that laboratory staff with *S. aureus* colonization might contaminate the surfaces of their working environment and consequently spread the pathogen (30).

Study Limitations

In this study, only single cross-sectional sampling was reported; hence, more evidence is needed for disclosure of the long-term colonization status of MRSA among hospital janitors.

The sample taking was also compromised by the current status of the COVID-19 eruption, as some participants were reluctant to participate, thinking it was a COVID- 19 test. Despite its limitations, this study can still provide an epidemiologic feature of *S. aureus* and MRSA colonization in this population.

Conclusion

The present study indicates a high prevalence of nasal colonization with *S. aureus* and MRSA among hospital janitors. Most *S. aureus* isolates were sensitive to clindamycin and gentamycin, while the least were sensitive to ciprofloxacin. The MRSA isolates showed resistance to a wide range of commonly used antimicrobial agents compared to the MSSA, and the MDR was slightly less than half. The findings suggest that janitors working in hospitals may continue to work while colonized (unless clinical infection develops), and thus may contribute to the spread of MRSA if hygienic practices and/or IPC are not followed. Therefore, efforts should be made to ensure hospital janitors are adhering to IPC principles, along with providing adequate PPE to facilitate the adherence.

Ethical consideration

The ethical clearance was granted by the Vice Chancellor of the University of Dodoma in a letter referenced: MA.84/261/02/191, using his power as indicated in the government circular letter Referenced No. MPEC/R/10/1 dated 4th July 1980 which empowered Vice Chancellor of the University to issue research clearances to staff of the university on behalf of the government and the Tanzania Commission for Science and Technology (COSTECH). Written informed consent was obtained from participants.

Acknowledgments

The authors thank all the participants, laboratory technicians Mr. Rwanda Adam Pius and Dr. Abdallah Ramadhan Baja for their technical support.

Authors contribution

SAS conceived the study, SAS and AAJ designed the study, AAJ did the data collection, SAS analyzed the data and wrote the manuscript text. AAJ proofread the manuscript and all authors agreed on the final draft of manuscript for submission.

Published by OJS
Doi: 10.4314/tmj.v33i4.547.g309

Abbreviations

CLSI	Clinical and Laboratory Standards Institute
DRRH	Dodoma Regional Referral Hospital
DRRHL	Dodoma Regional Referral Hospital Laboratory
HAI	HealthCare Associated Infection
HCWM	Health Care Waste Management
IRRH	Iringa Regional Referral Hospital
IPC	Infection Prevention and Control
MRSA	Methicillin-Resistant Staphylococcus aureus
MSSA	Methicillin-Sensitive Staphylococcus aureus
MDR	Multidrug Resistance
PBP2a	Penicillin-Binding Protein 2a
PPE	Personal Protective Equipment
S.aureus	Staphylococcus aureus
SD	Standard Deviation
SRRH	Singida Regional Referral Hospital

References

1. A. Revelas, **"Healthcare - associated infections: A public health problem,"** *Niger. Med. J.*, vol. 53, no. 2, p. 59, 2012, doi: 10.4103/0300-1652.103543.
2. C. J. Chang, N. C. Chen, C. K. Lao, and Y. C. Huang, **"Nasal Staphylococcus aureus and methicillin-resistant S. aureus carriage among janitors working in hospitals in northern Taiwan,"** *PLoS One*, vol. 10, no. 9, pp. 1–11, 2015, doi: 10.1371/journal.pone.0138971.
3. Han J H, Sullivan N, Leas BF, Pegues DA, Kaczmarek JL, Umscheid CA. **Cleaning hospital room surfaces to prevent health care-associated infections: A technical brief.** Annals of Internal Medicine." https://www.bing.com/search?q=10.%09Han+J+H%2C+Sullivan+N%2C+Leas+BF%2C+Pegues+DA%2C+Kaczmarek+JL%2C+Umscheid+CA.+Cleaning+hospital+room+surfaces+to+prevent+health+care+associated+infections%3A+A+technical+brief.+Annals+of+Internal+Medicine.&go=Search&qs=ds&form=QBRE (accessed Nov. 05, 2021).
4. Bethesda, **"Phenhyltoloxamine,"** *LiverTox Clin. Res. Inf. Drug-Induced Liver Inj.*, p. Bookshelf ID: NBK547852, 2012, Accessed: Nov. 05, 2021. (Online). Available: http://www.ncbi.nlm.nih.gov/pubmed/31643176.
5. Staff H. **Methicillin-Resistant Staphylococcus Aureus (MRSA). 2020."** https://www.bing.com/search?q=4.%09Staff+H.+Methicillin-Resistant+Staphylococcus+Aureus+%28MRSA%29.+2020.&go=Search&qs=ds&form=QBRE (accessed Nov. 05, 2021).
6. Rogers K. **Methicillin. Encyclopedia Britannica. 2019;**" https://www.bing.com/search?q=5.%09Rogers+K.+Methicillin.+Encyclopedia+Britannica.+2019%3B+&go=Search&qs=ds&form=QBRE (accessed Nov. 05, 2021).
7. M. Z. David and R. S. Daum, **"Community-associated methicillin-resistant Staphylococcus aureus: Epidemiology and clinical consequences of an emerging epidemic,"** *Clin. Microbiol. Rev.*, vol. 23, no. 3, pp. 616–687, 2010, doi: 10.1128/CMR.00081-09.
8. Felson S. **Understanding MRSA Infection -- the Basics Medically. 2021;**" https://www.bing.com/search?q=6.%09Felson+S.+Understanding+MRSA+Infection++the+Basics+Medically.+2021%3B+&qs=n&form=QBRE&sp=1&pq=6.+felson+s.+understaning+mrsa+infection+--+the+basics+medically.+2021%3B+&sc=0-73&sk=&cvid=AC053E09C48649368FC8CBB24F0319BE (accessed Nov. 05, 2021).
9. Nafi M, Eldaif W. V**ancomycin Resistance among Methicillin Resistant**

Staphylococcus Aureus Isolates in Khartoum-Sudan. Gene. 2013; 29: 37-2." https://www.bing.com/search?q=23.%09Nafi+M%2C+Eldaif+W.+Vancomycin+Resistance+among+Methicillin+Resistant+Staphylococcus+Aureus+Isolates+in+Khartoum-Sudan.+Gene.+2013%3B+29%3A+37-2.&qs=n&form=QBRE&sp=1&pq=23.+nafi+m%2C+eldaif+w.+vancomycin+resistance+among+methicillin+resistant+staphylococcus+aureus+isolates+in+khartoum-sudan.+gene.+2013%3B+29%3A+37-2.&sc=0-143&sk=&cvid=229C833E950848B989D6F1B2F5A586AB (accessed Nov. 05, 2021).

10. Schweizer M, Herwaldt L. **Gram positive bacteria – Staphylococcus aureus. 2017**;" https://www.bing.com/search?q=7.%09Schweizer+M%2C++Herwaldt+L.+Gram+positive+bacteria+–+Staphylococcus+aureus.+2017%3B++&go=Search&qs=ds&form=QBRE (accessed Nov. 05, 2021).
11. T. Mzee *et al.*, **"Prevalence, antimicrobial susceptibility and genotypic characteristics of Staphylococcus aureus in Tanzania: a systematic review,"** 2020, doi: 10.21203/RS.3.RS-16889/V1.
12. Dancer SJ, Kramer A. **Four steps to clean hospitals: LOOK, PLAN, CLEAN and DRY.** Journal of Hospital Infection. 2019;" https://www.bing.com/search?q=12.%09Dancer+SJ%2C+Kramer+A.+Four+steps+to+clean+hospitals%3A+LOOK%2C+PLAN%2C+CLEAN+and+DRY.+Journal+of+Hospital+Infection.+2019%3B+&go=Search&qs=ds&form=QBRE (accessed Nov. 05, 2021).
13. Litwin AS, Avgar AC, Becker ER. **Superbugs versus outsourced cleaners: Employment arrangements and the spread of health care-associated infections.** Industrial and Labor Relations Review. 2017; 70(3), 610–641." https://www.bing.com/search?q=13.%09Litwin+AS%2C+Avgar+AC%2C+Becker+ER.+Superbugs+versus+outsourced+cleaners%3A+Employment+arrangements+and+the+spread+of+health+care+associated+infections.+Industrial+and+Labor+Relations+Review.+2017%3B+70%283%29%2C+610–641&go=Search&qs=ds&form=QBRE (accessed Nov. 05, 2021).
14. Y. C. Huang, L. H. Su, C. J. Chen, and T. Y. Lin, **"Nasal carriage of methicillin-resistant Staphylococcus aureus in school children without identifiable risk factors in northern Taiwan,"** *Pediatr. Infect. Dis. J.*, vol. 24, no. 3, pp. 276–278, Mar. 2005, doi: 10.1097/01.INF.0000154333.46032.0F.
15. S. Abie, M. Tiruneh, and W. Abebe, **"Methicillin-resistant Staphylococcus aureus nasal carriage among janitors working in hospital and non-hospital areas: a**

comparative cross-sectional study," *Ann. Clin. Microbiol. Antimicrob.*, vol. 19, no. 1, Dec. 2020, doi: 10.1186/S12941-020-00391-X.

16. A. G. Kahsay, D. G. Hagos, G. K. Abay, and T. A. Mezgebo, **"Prevalence and antimicrobial susceptibility patterns of methicillin-resistant Staphylococcus aureus among janitors of Mekelle University, North Ethiopia,"** *BMC Res. Notes*, vol. 11, no. 1, May 2018, doi: 10.1186/S13104-018-3399-1.
17. S. M. Abdulgader, A. O. Shittu, M. P. Nicol, and M. Kaba, **"Molecular epidemiology of Methicillin-resistant Staphylococcus aureus in Africa: A systematic review,"** *Front. Microbiol.*, vol. 6, no. APR, 2015, doi: 10.3389/FMICB.2015.00348/FULL.
18. A. Geofrey, A. Abade, and S. Aboud, **"Methicillin-resistant staphylococcus aureus (MRSA) colonization among Intensive Care Unit (ICU) patients and health care workers at Muhimbili national hospital, Dar Es Salaam, Tanzania, 2012,**" *Pan Afr. Med. J.*, vol. 21, p. 211, 2015, doi: 10.11604/PAMJ.2015.21.211.4207.
19. Kumburu HH, Sonda T, Leekitcharoenphon P, Van Zwetselaar M, Lukjancenko O, Alifrangis M, Aarestrup FM. **Hospital epidemiology of methicillin-resistant Staphylococcus aureus in a tertiary Care Hospital in Moshi, Tanzania, as determined by whole genome sequencing.** BioMed research international." https://www.bing.com/search?q=17.%09Kumburu+HH%2C+Sonda+T%2C+Leekitcharoenphon+P%2C+Van+Zwetselaar+M%2C+Lukjancenko+O%2C+Alifrangis+M%2C+Aarestrup+FM.+Hospital+epidemiology+of+methicillin+resistant+Staphylococcus+aureus+in+a+tertiary+Care+Hospital+in+Moshi%2C+Tanzania%2C+as+determined+by+whole+genome+sequencing.+BioMed+research+international.+&go=Search&qs=ds&form=QBRE (accessed Nov. 05, 2021).
20. A. Joachim *et al.*, **"Prevalence of methicillin-resistant Staphylococcus aureus carriage on admission among patients attending regional hospitals in Dar es Salaam, Tanzania,**" *BMC Res. Notes*, vol. 10, no. 1, Aug. 2017, doi: 10.1186/S13104-017-2668-8.
21. E. J. Nkuwi, F. Kabanangi, A. Joachim, S. Rugarabamu, and M. Majigo, **"Methicillin-resistant Staphylococcus aureus contamination and distribution in patient's care environment at Muhimbili National Hospital, Dar es Salaam-Tanzania,"** *BMC Res. Notes*, vol. 11, no. 1, Jul. 2018, doi: 10.1186/S13104-018-3602-4.
22. R. Iachan, "**Systematic Sampling: A Critical Review,"** *Int. Stat. Rev. / Rev. Int. Stat.*, vol. 50, no. 3, p. 293, Dec. 1982, doi: 10.2307/1402499.
23. C. R. Mahon, D. C. Lehman, and G. Manuselis, ***Textbook of diagnostic microbiology*.**

2015.

24. (CLSI) Clinical and Laboratory Standards Institute, **"Performance Standards for Antimicrobial Susceptibility Testing; 20th Informational Supplement.** CLSI document M100-S19," *Replace. M100, 28th ed., Wayne, Pennsylvania, USA.*, p. 282, 2019.
25. A. P. Magiorakos *et al.*, **"Multidrug-resistant, extensively drug-resistant and pandrug-resistant bacteria: an international expert proposal for interim standard definitions for acquired resistance,"** *Clin. Microbiol. Infect.*, vol. 18, no. 3, pp. 268–281, 2012, doi: 10.1111/J.1469-0691.2011.03570.X.
26. (P. C. Appelbaum, "**Reduced glycopeptide susceptibility in methicillin-resistant Staphylococcus aureus (MRSA)**," *Int. J. Antimicrob. Agents*, vol. 30, no. 5, pp. 398–408, Nov. 2007.
27. A. Shibabaw, T. Abebe, and A. Mihret, **"Antimicrobial susceptibility pattern of nasal Staphylococcus aureus among Dessie Referral Hospital health care workers, Dessie, Northeast Ethiopia,"** *Int. J. Infect. Dis.*, vol. 25, pp. 22–25, 2014.
28. Hogi CW, Gambel JM, Sirijan A, Pitrangsi C, Echeverria P. **Trends in antibiotic resistance among diarrheal pathogens isolated in Thailand over 15 years.** Clin Infect Dis 1998;26:341–5." https://www.bing.com/search?q=30.%09Hogi+CW%2C+Gambel+JM%2C+Sirijan+A%2C+Pitrangsi+C%2C+Echeverria+P.+Trends+in+antibiotic+resistance+among+diarrheal+pathogens+isolated+in+Thailand+over+15+years.+Clin+Infect+Dis+1998%3B26%3A341–5.+&go=Search&qs=ds&form=QBRE (accessed Nov. 05, 2021).
29. M. M. de J. Silva, D. A. Nogueira, M. J. Clapis, and E. P. R. C. Leite, **"Anxiety in pregnancy: Prevalence and associated factors,"** *Rev. da Esc. Enferm.*, vol. 51, Aug. 2017, doi: 10.1590/S1980-220X2016048003253.
30. M. Schmidlin, M. Alt, G. Vogel, U. Voegeli, P. Brodmann, and C. Bagutti, **"Contaminations of laboratory surfaces with Staphylococcus aureus are affected by the carrier status of laboratory staff,"** *J. Appl. Microbiol.*, vol. 109, no. 4, pp. 1284–1293, Oct. 2010, doi: 10.1111/J.1365-2672.2010.04749.X.