

# Nasal Carriers of *Staphylococcus aureus* and Its Recolonisation Rate After Mupirocin Treatment Among Medical Students in Nepal

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## Abstract

**Introduction:** Healthy carriers harboring methicillin resistant *Staphylococcus aureus* (MRSA) strains are responsible for nosocomial and community outbreaks as they interface between the healthcare centers and the community. MRSA is a threat to clinicians as they are resistant to many antibiotics. Besides antibiotics, a mupirocin intervention is done to minimize the transmission of these strains. However, the rise in mupirocin resistance has been increasing. Hence, this study determined the frequency of *S. aureus* carriers among medical students and the recolonization rate after using 2% topical mupirocin.

**Methods:** Nasal swabs from 200 medical students of a tertiary care hospital in Nepal were collected and *S. aureus* isolates were identified and antibiotic sensitivity were performed using standard microbiological procedures. *S. aureus* carriers were topically decolonized using 2% mupirocin ointment and recolonization of the carriers was further assessed monthly for the next 3 months.

**Results:** A total of 39 *S. aureus* were recovered from the anterior nares of the participants. Of these, 25 (64.1%) were methicillin-sensitive strains and 14 were MRSA strains (35.89%). 100% decolonization was achieved after nasal decontamination with 2% mupirocin ointment. However, 6 and 13 *S. aureus* recolonization cases were noted in the second and third month respectively, out of which, there were only one and four MRSA strains.

**Conclusion:** This study exhibits higher rate of recolonization of *S. aureus* strains after effective decolonization with mupirocin treatment. Therefore, regular identification and alternate decolonization strategies must be implemented to mitigate infection as well as their transmission.

**Keywords:** Decontamination, methicillin resistant *Staphylococcus aureus*, mupirocin resistance, recolonization

## Introduction

"*Staphylococcus aureus*" is a known commensal of both human skin and mucosae including anterior nares.<sup>1</sup> Methicillin-resistant *Staphylococcus aureus* (MRSA) is perhaps the most common cause of skin and wound infections and causes a plethora of invasive diseases that may be both community or hospital-acquired.<sup>2,3</sup> Increasing MRSA infection represents a serious concern due to its broad level of antibiotic resistance, high economic burden and clinical manifestations with an attributable mortality rate approaching 30%.<sup>4,5</sup>

Asymptomatic colonized patients and healthcare workers

(HCWs) are the major reservoirs of MRSA that may lead to its dissemination both at the hospital and community level via direct contact, through colonized hands and sneezing.<sup>6,7</sup> Furthermore, the MRSA carriers are at a high risk of developing endogenous infections with serious complications.<sup>8</sup>

MRSA strains display blanket resistance to almost all available  $\beta$ -lactams, often offering resistance to several other classes of antibiotics constringing the therapeutic options. Consequently, as the infection prevention strategy, topical nasal decolonization is employed to reduce the occurrence of staphylococcal infection along with decrement of risk of transmission within hospital settings.<sup>9</sup> Mupirocin, a topical glycopeptide for

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nasal decontamination is used as an intervention to prevent transmission of MRSA owing to the fact that *S. aureus* carriage is a risk factor for staphylococcal disease. Additionally adopting hand hygiene and routine nasal screening can be valuable to lessen MRSA infections in healthcare settings.<sup>9,10</sup> Unfortunately, unjustified and unrestricted usage of mupirocin has led to relapses within a few months and the emergence of mupirocin-resistant strains making MRSA outbreak management difficult, subsequently owing to high morbidity and mortality.<sup>11</sup>

Therefore, this study was conducted to assess the nasal carriage rate of *S. aureus* and MRSA among medical students, mupirocin susceptibility profile and their relapse after topical application of mupirocin. Also, this study aimed to determine the risk factors for nasal carriage MRSA.

## Methods

An interventional study among medical students was carried out in the Microbiology Department of Gandaki Medical College Teaching Hospital and Research Centre (GMCTH-RC), Nepal from July to December 2022. The Institutional Review Committee in GMCTH-RC approved the study with Ref. no. 249/079/80. A convenient sampling method was adopted to collect the specimens from the study participants. Sample size of 196 was calculated assuming the population proportion as 50% for maximum coverage with 95% confidence interval and 7% margin of error. Overall, 200 students above 18 years were recruited for the study. Students presenting with wound and upper respiratory tract infection in one month were excluded from the study.

Pre-sterilized cotton swabs were inserted 1-2 cm into the nasal vestibule and rotated four times both clockwise and anticlockwise. The swabs were immediately transported to the laboratory on peptone water and proceeded further in the bacteriology laboratory in the Department of Microbiology. Swabs were immediately inoculated on mannitol salt agar (MSA) and incubated aerobically at 37°C. Yellow colonies yielded on MSA were preliminarily identified as the colonies of *S. aureus* and further subcultured on nutrient agar (NA). Golden yellow colonies on NA exhibiting Gram-positive cocci in clusters on microscopy, producing catalase and coagulase enzymes were identified as *S. aureus*. ATCC 25923 of *S. aureus* was used as quality control.

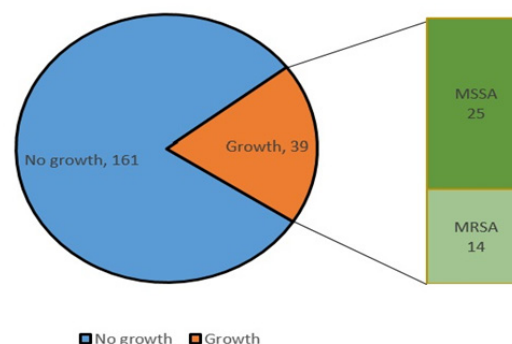
All confirmed *S. aureus* isolates were subjected to an antibiotic susceptibility test by the Kirby Bauer disc diffusion method for the detection of methicillin resistance by using Cefoxitin (30µg) and Mupirocin (5µg and 200µg) for mupirocin resistance. The zone size was interpreted as per Clinical and Laboratory Standards Institute (CLSI 2021) guidelines.<sup>12</sup>

All identified *S. aureus* carriers were topically decontaminated with 2% mupirocin ointment for five days. Nasal swabs were collected from all the carriers on the seventh day to identify the efficacy of mupirocin ointment. Nasal swabs were collected in every three months from the nasal carriers. The identification process of *S. aureus* and the antimicrobial susceptibility test for mupirocin and methicillin were repeated. All the data were recorded in MS Excel 2016 and analyzed using International Business Machine Statistical Package for the Social Sciences

(IBM SPSS) version 21. The point estimate was calculated at 95% confidence interval.

## Results

A total of 200 nasal swabs were collected from the participants aged 18-25 years. Of which, 112 were males and 88 were females. A total of 39 (19.5%) participants were found to be carriers of *S. aureus*, and among them, 25 (64.1%) were methicillin-sensitive strains (MSSA). Overall, the distribution of MRSA was 14 (35.89%). (Figure 1)



**Fig 1:** Distribution of *S. aureus* as nasal carriers among participants

Females were predominantly seen to harbor *S. aureus* as nasal carriers (51.28%) and eight of them were MRSA strains. Among 39 isolated *S. aureus*, none of them were found to exhibit both low-level and high level mupirocin resistance in antibiotic susceptibility tests.

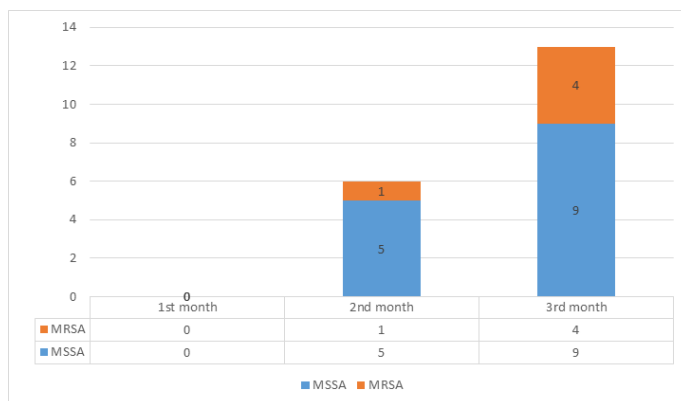
Participants with nose-picking habits and inadequate handwashing techniques were more prone to *S. aureus* colonization. (Table 1) 100% mupirocin efficacy was achieved with the application of 2% mupirocin ointment. Mupirocin sensitivity was 100% when antibiotic susceptibility testing was done.

**Table 1:** Risk factors related with *S. aureus* carriage in anterior nares

Associated risk factors	Total participants with risk factors	Participants with risk factors and positive <i>S. aureus</i>	
		MSSA	MRSA
Nose picking habit	25	11	7
Inadequate handwashing technique	17	8	4
Both nose picking habit and inadequate handwashing	8	3	3
Recent history of infection (>1 month)	3	2	0
Recent history of hospital admission (>1month)	3	1	0
<b>Total</b>	<b>56</b>	<b>25</b>	<b>14</b>

Recolonization of *S. aureus* among carriers was found to be (48.71 %, 19/39). No recolonization was noted in the first

month. However, 6 and 13 *S.aureus* recolonization cases were noted in the second and third month respectively. (Figure 2)



**Fig 2:** Recolonization of *S.aureus* after decontamination with 2% mupirocin

Of which, only one MRSA strain (1/6) was noted in the second month whereas four (4/13) MRSA strains were isolated in the third month. *S.aureus* recolonization was more frequently observed in females (57.89%). In general, the rate of recolonization was higher in MSSA strains (73.68%) than in MRSA strains (26.31%). (Table 2) No mupirocin resistance was noted on the recontamination isolates. Those carriers having nose-picking habit (10/39, 25.64%) and participants not following standard handwashing technique (7/39, 17.94%) showed more recolonization. (Table 2)

**Table 2:** Distribution of *S.aureus* recolonization among carriers (n=39)

Factors affecting recolonization	Positive recolonization (%)	Negative recolonization (%)
Staphylococcus aureus		
MRSA	5 (12.82%)	9 (23.07%)
MSSA	14 (35.89%)	11(28.20)
Gender		
Males	8 (20.51%)	11(28.20%)
Females	11 (28.20%)	9(23.07%)
Risk factors		
Nose picking habit	10 (25.64%)	29(74.39%)
Improper handwashing technique	7 (17.94%)	32(82.05%)

## Discussion

Although *S. aureus* are part of the human commensal flora, opportunistic invasion following breakdown of the epithelial layers can lead to heaps of infections at both local and distant sites. Because of their high drug resistance traits, treatment remains a severe challenge for the clinicians. Despite advancements in treatment and the adoption of infection prevention practices, MRSA remains a targeted pathogen that is correlated with paramount morbidity and mortality. The participants in this study were medical students who are among the high-risk group as they are continuously being exposed to this notorious pathogen. These students who are at the interface between the hospital and the community may serve as a reservoir and potential agents of cross-contamination. The overall nasal carriage of *S.aureus* in participants was 19.5%.

This finding was fairly similar to the study findings of Rai, et al. 13 Other published data on nasal carriage of *S.aureus* among medical students presented the higher carrier rate.<sup>14</sup>

In the present study, MSSA predominated over MRSA. The overall magnitude of MRSA in this study was 33.3%. This study finding was more or less in parity with the study conducted by Emaneini, et al.<sup>15</sup> However, it was reported lower in some studies.<sup>16,17</sup> Our study finding exhibited lower results in comparison to the study conducted by Pant, et al. which showed 54% MRSA in the anterior nares.<sup>18</sup> There are some possible explanations for these inconsistencies that include frequency of hospital exposures, hospital infection control and prevention policies and adoption of standard precautions. The isolation of *S.aureus* was more frequent in females in this study. This result was more or less similar to a couple of other studies.<sup>6,19</sup> However, male preponderance was seen in some other studies.<sup>20</sup>

Different behavioral factors were considered to explore the spread of nasal carriage of *S.aureus* among medical students in the present study. Of these, nose-picking habits and inappropriate handwashing techniques were highly responsible for harboring *S.aureus* in the anterior nares. These findings agree with the study results of Rai, et al.<sup>13</sup> The prolonged carrier state of MRSA complies with proper hand hygiene and some behavioral factors like nose-picking habit as the hand is supposed to be the main vector for transmission of the bacteria. Even a small breach in handwashing technique increases the potential for nosocomial transmission of MRSA. Antibiotic susceptibility test revealed 100% sensitivity to mupirocin. Similar results were documented in some studies conducted in India and Nepal.<sup>21,22</sup> On the contrary, mupirocin resistance has been demonstrated in some studies.<sup>23,24</sup> Unfortunately, swoopstake use of mupirocin has been associated with increased reports of mupirocin resistance.

One of the frequently attempted decontamination strategies to eradicate nasal carriage of MRSA is the use of topical 2% mupirocin ointment which showed excellent results. The rate of decolonization among *S.aureus* carriers after nasal application with 2% mupirocin was 100%, this outcome synchronized with the findings of Allport, et al.<sup>25</sup> This explains the efficacy of mupirocin as a short-term agent for nasal decolonization. However, nasal cultures obtained in the second and third month demonstrated 6 and 13 cases of recolonization with *S.aureus* respectively. The recolonization of *S.aureus* after several weeks of decontamination was noted in the study findings of Roghmann, et al.<sup>26</sup> Relapse with MSSA was more significant than MRSA, it might suggest that MSSA has more advantage over MRSA when competing for the same niche. Relapses were more commonly seen in participants who had one of the aforementioned predisposing factors. These higher relapses raise concern and urge the development of novel antibiotics and alternative strategies for prevention to achieve long-term decolonization.

## Strengths And Limitations

There are only a handful of studies that exhibit MRSA carrier state among medical students and the efficacy of mupirocin as a decolonization agent along with the duration of relapse

rate. The findings engendered from this study will provide a nifty reference for infection control committee as well as to the clinicians managing MRSA infections. The limitation of the study lies in the accurate identification of *S.aureus* and the drug resistant strains that is usually done genetically via amplification of *mecA*, *mupA* and *mupB* genes. Precise identification of *S.aureus* with detailed molecular characterization was beyond the scope of the study.

## Conclusion

This study highlights the increasing proportion of nasal *S. aureus* carriers along with the possibility of recolonization even after 100% decolonization. Tackling MRSA requires a multifarious approach, including stringent infection control practices and adequate education for healthcare workers as well as patients. The significant rise in mupirocin resistance and early recolonization emphasizes the need for judicious use of mupirocin. As recolonization is inevitable in some carriers, the strict practice of handwashing and refraining from the nose-picking habit might be fruitful in curtailing the dissemination of bacteria.

## Data Availability

The data obtained from the study are available from the corresponding author upon request.

## Ethical Approval

Ethical approval was obtained from Institutional Review Committee (IRC) of Gandaki Medical College, Pokhara, Nepal (Code no. 249/079/80).

## Consent

Informed written consent was obtained from each patient.

## Conflicts of Interest

The authors declare that they have no conflicts of interest.

## Authors' Contributions

KG, SP were responsible for the conceptualization of this study. KG investigated the study. SMR and KG were responsible for resources. SMR, SP and GG supervised the study. KG wrote the original draft. SMR, SP and GG reviewed and edited the article. All authors read and approved the final manuscript.

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