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Prevalence of nasal carriage of methicillin-resistant Staphylococcus aureus among health care workers at a tertiary care hospital: A prospective cross-sectional study.

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Abstract

Background

Nasal carriage of Staphylococcus aureus among health care workers is an important reservoir for hospital transmission, particularly when methicillin-resistant strains are present. Screening of anterior nares helps identify silent carriers and supports targeted infection-control measures.

Objectives

To estimate the prevalence of nasal carriage of methicillin-resistant Staphylococcus aureus among health care workers in a tertiary care hospital and to describe the antimicrobial susceptibility profile of MRSA isolates, including inducible clindamycin resistance.

Methods

This hospital-based prospective cross-sectional study was conducted in the Department of Microbiology, S.P.V. Government Medical College, Machilipatnam, Andhra Pradesh, India, from July to September 2025. Using consecutive sampling, 230 health care workers involved in direct or indirect patient-care services were enrolled. Anterior nasal swabs were collected and processed by conventional culture methods; Staphylococcus aureus isolates were tested phenotypically for methicillin resistance, and MRSA isolates were evaluated for inducible clindamycin resistance.

Results

The 230 participants represented multiple occupational groups: laboratory technicians/assistants 71 (30.9%), staff nurses 68 (29.6%), doctors 61 (26.5%), MNO/FNO personnel 20 (8.7%), and other clinical/support staff 10 (4.3%). Coagulase-negative Staphylococcus was isolated from 204 (88.7%) samples. Staphylococcus aureus was isolated from 17 participants (7.4%); five isolates were methicillin resistant, giving an MRSA carriage prevalence of 2.2% among all health care workers and 29.4% among Staphylococcus aureus carriers. One MRSA isolate showed inducible clindamycin resistance.

Conclusion

The study demonstrated a low overall MRSA nasal carriage rate among health care workers, but nearly one-third of Staphylococcus aureus carriers harboured methicillin-resistant strains. Periodic screening remains useful for strengthening hospital infection-prevention practices.

Recommendations

Hospitals should conduct periodic MRSA surveillance among high-contact staff, reinforce hand hygiene, and ensure laboratory reporting of inducible clindamycin resistance before clinical use of clindamycin.

Keywords: *Methicillin-resistant Staphylococcus aureus; nasal carriage; health care workers; hospital infection; antimicrobial susceptibility; clindamycin resistance.*
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Introduction

Staphylococcus aureus is a major human bacterial pathogen and a frequent colonizer of the skin and anterior nares. The organism has a wide clinical spectrum, ranging from superficial skin and soft-tissue infections to pneumonia, bloodstream infection, endocarditis, osteomyelitis and device-associated sepsis [1-4]. Its ability to persist as a commensal organism, while retaining the capacity to cause invasive disease, makes carriage studies clinically relevant in hospital settings. The anterior nares are recognised as a principal ecological niche for S. aureus, and persistent or intermittent nasal carriage increases the risk of subsequent endogenous infection and onward transmission [1-3,6].

Methicillin-resistant Staphylococcus aureus (MRSA) has remained a major challenge for infection prevention because resistance to beta-lactam agents limits empirical treatment options and is frequently associated with additional resistance mechanisms [4,5]. MRSA strains are resistant to penicillins, antistaphylococcal penicillins and several related beta-lactam agents because of altered penicillin-binding protein activity mediated through mec gene mechanisms [5]. Compared with methicillin-susceptible isolates, MRSA infections are associated with longer hospital stay, higher treatment cost, restricted antimicrobial choice and greater risk of adverse clinical outcomes [4,5]. In this background, identifying reservoirs of MRSA within health-care environments is a practical public health priority.

Health care workers occupy a unique position in the epidemiology of MRSA. They work in close proximity to patients, contaminated surfaces and clinical devices; therefore, they can acquire S. aureus from the hospital environment and can also transmit colonizing strains through hands or respiratory contact [7-11]. Nasal carriage does not indicate active disease, but it provides an important reservoir from which transient hand contamination and patient transmission can occur. Studies from different regions have reported variable carriage rates because of differences in hospital type, ward exposure, staff category, sampling strategy, laboratory method and infection-control adherence [7-11]. Hence, local surveillance is necessary rather than relying only on external prevalence figures.

Laboratory detection of MRSA carriage usually begins with culture of anterior nasal swabs, followed by identification of S. aureus and phenotypic screening for methicillin resistance. Cefoxitin-based phenotypic methods are widely accepted as useful surrogate methods for mecA-mediated resistance detection, while testing for inducible clindamycin resistance remains important because routine clindamycin susceptibility can be misleading in erythromycin-resistant isolates [12]. Local data on nasal MRSA carriage among hospital workers support targeted education, decolonization policy discussions and rational antimicrobial use.

The present study was conducted with the objectives of estimating the prevalence of nasal carriage of MRSA among health care workers at a tertiary care hospital, describing the distribution of screened participants by work category, identifying the spectrum of organisms isolated from anterior nasal swabs, and assessing the antimicrobial susceptibility pattern of MRSA isolates with special reference to inducible clindamycin resistance.

Methodology

Study design and setting

This was a hospital-based prospective cross-sectional study conducted in the Department of Microbiology, S.P.V. Government Medical College, Machilipatnam, Andhra Pradesh, India, from 1 July 2025 to 30 September 2025. The college is linked to Government General Hospital, Machilipatnam, a 553-bed tertiary teaching hospital that provides services to residents of Krishna district and surrounding mandals, including neighbouring-district catchment areas. The hospital provides outpatient and inpatient care across major medical and surgical specialties, including general medicine, general surgery, obstetrics and gynaecology, paediatrics, orthopaedics, dermatology, ENT, psychiatry, pulmonology, radiology, anaesthesiology and emergency medicine, supported by intensive-care areas, operation theatres, diagnostic laboratories, blood-bank services and hospital infection-control activities.

Study population

The source population comprised health care workers involved in direct patient care or in services supporting patient care. These included doctors, staff nurses, laboratory technicians/laboratory assistants, multipurpose nursing orderlies, female nursing orderlies, pharmacists, microbiology staff, dialysis-related staff, ward security personnel, sanitization staff and administrative support staff working in hospital care areas.

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Eligibility criteria

Health care workers engaged in direct or indirect patient-care services during the study period were eligible. Workers with recent nasal surgery, current use of nasal medication, recent antimicrobial therapy or symptoms of upper respiratory tract infection were excluded. Patients and students were outside the defined study population. Willingness to participate was not treated as an eligibility criterion; written informed consent was addressed separately under ethical considerations.

Study size and sampling technique

The minimum sample size was estimated using the single-population proportion formula $n = Z^2p(1 - p)/d^2$. An anticipated nasal Staphylococcus aureus carriage prevalence of 16.8% from published health-care-worker literature [8], a 95% confidence level ($Z = 1.96$) and 5% absolute precision were used. Thus, $n = (1.96)^2 \times 0.168 \times 0.832/(0.05)^2 = 214.8$, rounded to 215. Allowing 7% for non-response or an inadequate specimen gave $215 \times 1.07 = 230.05$; therefore, the target sample was 230 health care workers. Consecutive sampling was used, with each participant sampled once, until the target was reached. Basic participant information, including designation and work category, was recorded using the study questionnaire.

Bias

Potential selection bias was reduced by consecutively enrolling eligible health care workers from multiple clinical, nursing, laboratory and support cadres rather than restricting recruitment to a single occupational group. Measurement bias was minimized by applying the same anterior-nares sampling technique and laboratory workflow to all participants, including standard culture identification, phenotypic cefoxitin-based screening for methicillin resistance and D-test assessment when indicated. Each participant contributed only one nasal specimen, reducing duplicate observations. Excluding workers with recent antimicrobial therapy, current nasal medication, recent nasal surgery or active upper-respiratory symptoms also reduced transient factors that could alter culture yield. Outcomes were defined before analysis and summarized uniformly using frequencies and percentages.

Sample collection and laboratory processing

Nasal swabs were collected from the anterior nares using pre-sterilized cotton swabs. The swab was inserted gently and rotated against the mucosal surface to ensure adequate contact with the anterior nasal epithelium. Samples were transported promptly to the microbiology laboratory and processed by conventional culture methods. Bacterial growth was identified using colony morphology, Gram staining and relevant biochemical tests. Isolates suggestive of Staphylococcus aureus were confirmed by standard procedures such as catalase and coagulase testing. Automated culture or identification support available in the laboratory was used when required for confirmation.

Detection of methicillin resistance and inducible clindamycin resistance

Confirmed Staphylococcus aureus isolates were screened for methicillin resistance using laboratory antimicrobial susceptibility methods consistent with accepted phenotypic approaches for MRSA detection [12,13]. Cefoxitin resistance was considered a practical phenotypic marker for methicillin resistance because it provides clear induction of mecA-mediated resistance and improves recognition of resistant isolates [13]. MRSA isolates were further assessed for inducible clindamycin resistance using the D-test approach where erythromycin and clindamycin testing patterns indicated the need for evaluation [14].

Statistical analysis

Data were entered into a structured spreadsheet and summarized using descriptive statistics. Frequencies and percentages were calculated for designation categories, culture outcomes, Staphylococcus aureus carriage, MRSA carriage and inducible clindamycin resistance. The primary outcome was the prevalence of nasal MRSA carriage among screened health care workers. Secondary outcomes included overall Staphylococcus aureus carriage and inducible clindamycin resistance among MRSA isolates. No comparative risk-factor analysis was performed because designation-wise MRSA distribution and individual risk-factor data were not available in the final dataset.

Ethical considerations

The study protocol was approved by the Institutional Ethics Committee, Government Medical College, Machilipatnam, with IEC application number GMCM/IEC/030/2025. Approval was issued on 02 July 2025 after full committee review, and the decision was recorded as approved. Written informed consent was obtained from all participating health care workers before sample collection. Participation was voluntary, and participants were informed about the purpose of the study, sample collection

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procedure, expected benefits, and their right to withdraw at any stage without any consequences. Confidentiality of participant identity and questionnaire responses was strictly maintained by using coded data. Nasal swab collection was performed using aseptic precautions, and all microbiological procedures were carried out according to standard laboratory biosafety practices. Participants found to be MRSA carriers were advised regarding hand hygiene, infection prevention measures, and appropriate follow-up as per institutional policy.

Results

Participant flow

During the three-month study period, 230 eligible and consenting health care workers were enrolled and underwent anterior nasal swab collection. All 230 specimens yielded evaluable culture results and were retained in the final analysis; no post-enrolment samples were excluded. A separate count of health care workers who were approached but declined participation or were excluded before enrolment was not retained in the final study dataset. The documented participant flow is shown in Figure 1.

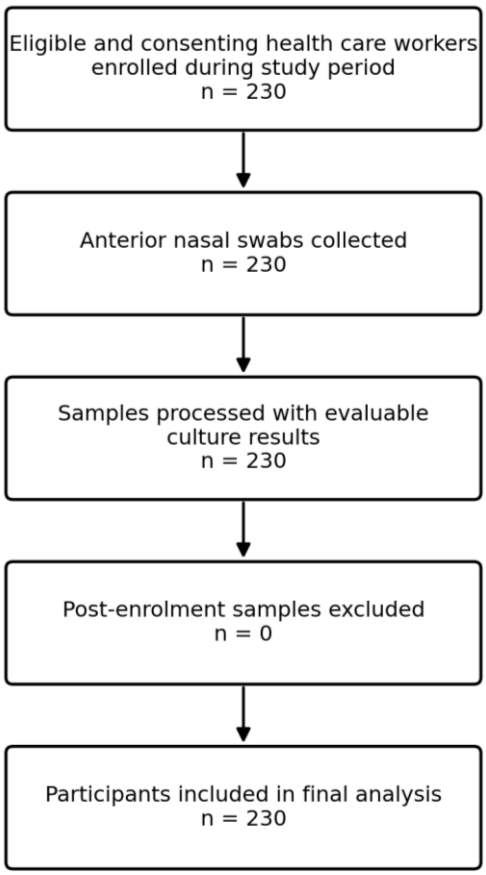

Figure 1. Participant flow through the study

Descriptive data: Among the 230 participants, laboratory technicians/laboratory assistants constituted the largest occupational group (71; 30.9%), followed by staff nurses (68; 29.6%) and doctors (61; 26.5%). MNO/FNO personnel accounted for 20 (8.7%), while the remaining 10 (4.3%) comprised a microbiologist, pharmacists, dialysis-related staff, ward security, sanitization and Arogyasri support staff. Participant-level age and sex data were not available in the final analyzable dataset; therefore, occupational category is presented as the principal available demographic/workforce characteristic.

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Table 1: *Occupational Characteristics of Participating Health Care Workers*

Designation	Frequency	Percentage
Doctors	61	26.5
Staff nurses	68	29.6
Laboratory technicians/laboratory assistants	71	30.9
MNO/FNO	20	8.7
Microbiologist	1	0.4
Pharmacists	4	1.7
Dialysis manager	1	0.4
Dialysis data entry operator	1	0.4
Male medical ward security	1	0.4
Sanitization staff	1	0.4
Arogyasri staff	1	0.4
Total	230	100.0

Note. MNO = multipurpose nursing orderly; FNO = female nursing orderly.

Culture of anterior nasal swabs showed that coagulase-negative Staphylococcus was the predominant isolate. Staphylococcus aureus was isolated from 17 participants, while a small proportion showed no growth or yielded other commensal organisms such as diphtheroids and Micrococci. The overall culture distribution is shown in Table 2.

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Table 2: *Culture Profile of Anterior Nasal Swab Samples*

Culture result	Frequency	Percentage
Coagulase-negative Staphylococcus	204	88.7
Staphylococcus aureus	17	7.4
No growth	6	2.6
Diphtheroids	2	0.9
Micrococci	1	0.4
Total	230	100.0

Note. Percentages are based on the total sample of 230 health care workers.

Among the 17 Staphylococcus aureus isolates, five were identified as methicillin-resistant Staphylococcus aureus and 12 were methicillin-susceptible Staphylococcus aureus.

The overall MRSA carriage rate among all screened health care workers was 2.2%, whereas MRSA constituted 29.4% of all Staphylococcus aureus isolates. One of the five MRSA isolates showed inducible clindamycin resistance. These findings are summarized in Table 3.

Table 3: *Staphylococcus aureus Carriage, MRSA Carriage, and Inducible Clindamycin Resistance*

Parameter	Frequency	Percentage / interpretation
Total nasal samples screened	230	100.0 of screened participants
Staphylococcus aureus isolates	17	7.4 of screened participants
Methicillin-susceptible Staphylococcus aureus	12	70.6 of Staphylococcus aureus isolates
Methicillin-resistant Staphylococcus aureus	5	29.4 of Staphylococcus aureus isolates; 2.2 of screened participants
Inducible clindamycin-resistant MRSA	1	20.0 of MRSA isolates; 0.4 of screened participants

Note. MRSA = methicillin-resistant Staphylococcus aureus; MSSA = methicillin-susceptible Staphylococcus aureus.

Overall, the findings indicate that MRSA carriage was uncommon in the screened population, but methicillin resistance was present in a substantial fraction of S. aureus carriers. This pattern supports continued surveillance because even a small number of colonized workers can act as a reservoir in high-contact clinical settings.

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Discussion

The present study evaluated nasal carriage of MRSA among 230 health care workers in a tertiary care hospital and found an overall MRSA carriage rate of 2.2%. Staphylococcus aureus was isolated from 7.4% of participants, and 29.4% of these S. aureus isolates were methicillin resistant. These findings show that overall colonization with MRSA was low in the screened workforce, yet methicillin resistance among S. aureus carriers remained microbiologically important. Nasal carriage is a well-recognised reservoir for future infection and cross-transmission, particularly in hospitals where patient turnover, invasive procedures and antibiotic pressure are high [1-6].

The S. aureus carriage rate in this study was lower than several published reports among health care workers. Genc and Arikan reported S. aureus carriage in 20.1% of 269 health care workers, with only one MRSA carrier [7]. Rongpharpi et al. described nasal S. aureus carriage among health care workers in a tertiary care hospital in Assam with special reference to MRSA, highlighting the need for region-specific screening [8]. Rai et al. also emphasized the value of evaluating both nasal and hand carriage, as recolonization can occur after decolonization in hospital staff [9]. Differences across studies are expected because carriage is influenced by sampling method, infection-control practices, occupational category, recent antibiotic exposure and ward-level MRSA burden.

The finding that coagulase-negative Staphylococcus was the predominant isolate is consistent with the usual commensal flora of the anterior nares and surrounding skin. Although coagulase-negative staphylococci were not the primary outcome of this study, their high frequency supports adequate sampling of the nasal vestibule. The presence of five MRSA carriers is epidemiologically significant because even asymptomatic colonization can contribute to patient exposure through hand contamination or environmental shedding. Genomic and epidemiological studies have shown that health care workers, patients and the environment form an interconnected transmission network, although the relative contribution of each source varies by setting [10,11].

The detection of inducible clindamycin resistance in one MRSA isolate has direct therapeutic relevance. Clindamycin is useful for skin and soft-tissue infections, but inducible resistance can lead to clinical failure when it is not detected by routine testing. The D-test remains a simple laboratory method for recognizing this phenotype and should be incorporated into reporting workflows for erythromycin-resistant, clindamycin-susceptible staphylococcal isolates [14]. Similarly, phenotypic MRSA detection must be performed carefully because accurate recognition of methicillin resistance guides infection-control action and antimicrobial choice [12,13].

Generalizability

These findings are most applicable to tertiary care hospitals with similar staff categories, microbiology facilities and infection-control practices. The low MRSA carriage rate suggests that comparable institutions can expect limited but meaningful colonization among health care workers. However, differences in ward crowding, antibiotic use, screening frequency, hand hygiene compliance and local MRSA prevalence influence external validity. The study supports institutional surveillance rather than a universal prevalence estimate for all hospitals.

Conclusion

This prospective cross-sectional study found that nasal carriage of MRSA among health care workers at the tertiary care hospital was 2.2%, while overall Staphylococcus aureus carriage was 7.4%. Although the absolute number of MRSA carriers was small, methicillin resistance was detected in nearly one-third of S. aureus isolates, indicating a relevant reservoir within the hospital workforce. One MRSA isolate also showed inducible clindamycin resistance, reinforcing the need for complete antimicrobial susceptibility reporting. Periodic screening, strict hand hygiene, staff education and targeted infection-control interventions can reduce the risk of silent transmission from colonized workers to vulnerable patients and support safer routine clinical service delivery across departments.

Limitations

This single-centre study included only one screening episode over three months, so persistent and intermittent carriage could not be differentiated. Molecular confirmation of mecA or strain typing was not performed. Risk-factor analysis by ward exposure, antibiotic use, hand hygiene behaviour and designation-wise MRSA distribution was not available. Participant-level age and sex data, as well as counts of health care workers approached but not enrolled before consent/eligibility assessment, were not retained in the final analyzable dataset. Post-screening decolonization outcomes were also not assessed; therefore, the findings represent a single-period prevalence estimate in the participating workforce.

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Recommendations

Hospitals should introduce periodic MRSA carriage screening for health care workers posted in intensive care units, operation theatres, dialysis units and high-risk wards. Staff education must focus on hand hygiene, glove change between patient contacts, rational antibiotic use and early reporting of skin or nasal infections. Laboratory protocols should include cefoxitin-based MRSA screening and D-test reporting for relevant isolates. MRSA-positive staff should receive confidential counselling, targeted decolonization according to institutional policy and follow-up culture after completion of treatment. Hospital infection-control committees should review surveillance data regularly and link findings with environmental cleaning audits and antibiotic stewardship review meetings.

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Abbreviations

CONS: Coagulase-negative Staphylococcus.
FNO: Female nursing orderly.
HCW: Health care worker.
IEC: Institutional Ethics Committee.
MNO: Multipurpose nursing orderly.
MRSA: Methicillin-resistant Staphylococcus aureus.
MSSA: Methicillin-susceptible Staphylococcus aureus.
OT: Operation theatre.

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Conflict of interest

The authors declare no conflict of interest.

Author contributions

MHVS-Concept and design of the study, results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript **VAL-** design of the study, results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript. **MA-** Results interpretation, review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript. **ADR-** Review of literature and preparing first draft of manuscript. Statistical analysis and interpretation, revision of manuscript

Data availability

Data available on request

Author Biography

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