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**Research Article**

# BACTERIOLOGICAL PROFILE ON MOBILE PHONES, DOMINANT HAND AND NARES OF HEALTHCARE PERSONNEL WORKING IN AN ICU SETTING OF A TERTIARY CARE HOSPITAL

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**A R T I C L E I N F O**

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**A B S T R A C T**

**Background:** Hands of healthcare workers, and medical surfaces with high-contact chances like mobiles, keyboard, and medical charts are reported to be contaminated by multi-drug resistant bacteria resulting in ICU-acquired infections, a major cause of morbidity and mortality.
**Objective:** This study was proposed to investigate the bacterial profile on mobile phones, dominant hand, and nares of healthcare workers in intensive care units.
**Methodology:** Samples were collected from healthcare staff from different intensive care units of Govt Medical College Hospital in Central Kerala. Three samples were collected from each of participants' mobile phones, dominant hand, and nares. The swabs were transferred to a culture media for isolation and identification.
**Results:** Out of the total 303 samples analyzed, methicillin-susceptible coagulase-negative staphylococci, methicillin-resistant coagulase-negative staphylococci, methicillin-susceptible Staphylococcus aureus, methicillin-resistant Staphylococcus aureus and diphtheroids were the most common species. Nares were the most common site of colonization by clinical pathogens (64/64; 100%) followed by hands (17/64; 26.1%) and mobile phones (13/64; 20.38%). In 68.3% of samples the bacteria were possible clinical pathogens. MRSA was identified from 31.1% (n=61) of the samples from nares, while 15.8% and 12.9% of samples each from mobile phones and hands also showed the presence of possible clinical pathogens.
**Conclusion:** High rate of bacterial colonization was noted in nares of healthcare workers suggesting that it may act as a reservoir for pathogen contamination in an ICU setting. Explicit guidelines on the use of phones and infection control practices in the hospital may be of help in controlling infection in a hospital setting



## INTRODUCTION

Healthcare associated infections form a major public health threat across the globe affecting millions of people with a tremendous economic burden on healthcare system.These infections lead to considerable morbidity and mortality and is thus a major threat to patient safety. Prevalence of healthcare associated infections especially in adult intensive-care units is reported to be much higher in developing countries as compared to developed countries.[1]Close and frequent interaction between source, host and microorganisms especially drug resistant bacteria in the hospital environment result in hospital-associated infections. Source of these infections is more often exogenous comprising contaminated hands of healthcare workersand high touch surfaces like mobiles, handrails etc.[2]. Studies have shown that one-third of all hospital-associated infections can be prevented.[3]

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Patients in intensive care unit (ICU) have a poor health status when compared to other patients and are susceptible to healthcare-associated infections. Contaminated hands of healthcare workers and devices can be a potential source of infections in such a setting. Mobile phones are very popular among healthcare workers and patients alike, and it is known that more than 90% of the healthcare workers bring and use it during work every day. Thoughmobile phones have become indispensable in a hospital setting for communication and information sharing, they can serve as reservoirs of pathogenic bacteria leading to cross-transmission and outbreaks especially in ICU settings.[4]Contemporary mobile phones and other devices used in the hospital setting are conducive for bacterial contamination.[5]Recently some studies have reported the role of hands and mobile phones of healthcare workers as well as inpatients in the transmission of infectious pathogens.[3] Absence of hygiene in healthcare workers may result in contamination of not only phones, but also nares and hands and any other part of the body acting as a source of infection

for the patients. Sharing of mobile phones between healthcare and non-healthcare workers also can spread potentially pathogenic bacteria among the workers as well as patients.

Another cause of concern for the healthcare community worldwide is the increase in drug-resistant bacteria. Patients in intensive care units have impaired immune response, and ruptured anatomical integrity due to interventions, prolonged hospital stay, high use of antibiotics,all of which increase the risk of nosocomial infections by these drug resistant organisms. *Staphylococcus aureus*, especially methicillin resistant strains (MRSA), have become an important nosocomial pathogen by colonising nasal cavity of healthcare workers.[6]These organisms are soon developing into multidrug resistant strains and this increases the risk of nosocomial infections due to their decreased susceptibility to many of the commonly used antibiotics.[7]

In a developing country like India, the burden of nosocomial infection is high mainly due to lack of surveillance among the healthcare workers as well as lack of awareness. Understanding the contamination rate among the different healthcare workers in ICU setting is important in laying out the most appropriate control methods for nosocomial infections. The present study was conducted to evaluate the bacterial profile of mobile phones, dominant hand and nares of healthcare workers in an ICU setting of a tertiary care hospital. Knowledge of the bacterial contamination rate can further help to assess the effectiveness of infection control measures followed in ICUs of the hospital. It will also help clinicians to modify empirical antibiotic policy.

***Objectives***

***Primary Objective:*** To determine the bacterial profile on mobile phones, dominant hand, and nares of healthcare workers' in Intensive care unit of a tertiary care hospital

***Secondary objective:*** To estimate MRSA colonization rate among healthcare workers

## MATERIALS AND METHODS

The present cross-sectional study was performed from May to June 2019 in a tertiary care centre in Central Kerala. Study subjects included randomly selected health care workers such as doctors, residents, nurses, cleaners, and nursing assistants working in intensive care units after getting the informed consent. The departments included were general medicine, paediatrics, neonatology, general surgery, neurosurgery, orthopaedics, Obstetrics, gynaecology, and cardiovascular and thoracic surgery.

Participant demographics, including age, gender, and occupation was collected in addition to the type of mobile phone used. Both hands of the swab collector were cleaned using appropriate sanitizer and sterile disposable gloves worn before collection of swab to prevent cross contamination.One sample each from anterior nares, dominant hands and mobile phones were collected from healthcare workers using sterile swabs moistened with normal saline. The swabs were immediately transported to microbiology lab and processed within an hour. These were inoculated on sheep blood agar, MacConkey agar and mannitol salt agar. The plates were incubated at 35°C–37°C for 48hours.Plates showing growth were reported as positive while those showing no growth were reported as negative. Identification and antibiotic sensitivity testing of the bacterial isolates were performed as per Clinical laboratory standards institute (CLSI) guidelines. Screening of Methicillin resistance among *Staphylococcus aureus* isolates (MRSA) was identified using Cefoxitin disk (30 µg) by Kirby–Bauer disk diffusion method and confirmed using oxacillin screen agar plates.

Data were entered and analysed using Microsoft Excel &SPSS Info statistical tools. Demographic characteristics of the participants, contamination of the phones, nares and dominant hands, and the organisms isolated were analysed using descriptive statistics. Data obtained from these were presented as frequencies, tables and graphs. Chi-square test and Fischer's exact test were used to analyse the differences between categorical variables. Pooled prevalence of MRSA colonisation was calculated by dividing the number of MRSA-colonised subjects by the total number of subjects for whom culture results were reported. Carriage rates were described by 95% confidence intervals of proportions.

Ethical approval for the study was obtained from institutional ethics committee. Informed consent was obtained from all study participants..Privacy and confidentiality of the participants were ensured.

## RESULTS

The study was conducted in 101 healthcare workers from different intensive care units of a tertiary care hospital. Among the participants, 45 (44%) were doctors, 38 (37.6%) were nursing staff, 10 (9.9%) were cleaning staff and 8 (7.92%) were nursing assistants. Majority of them were working in surgical intensive care units (68.3%, n=69). Mean age of the participants was 33.63 ± 9.02 yrs (mean±SD). Twenty one participants (20.8%) were males and 80 (79.2%) were females. One sample each from anterior nares, hands and mobile phones was collected using sterile swabs making a total of 303 samples. Baseline characteristics of the staff under study are shown in **Table1**

**Table 1** Baseline characteristics of participants in the study

| Characteristics | Groups | Number | Percentage |
|---|---|---|---|
| Sex | Males | 21 | 20.8 |
| | Females | 80 | 79.2 |
| Age (Mean±SD)yrs | | 33.63±9.02 | |
| Profession | Doctor | 45 | 44.6 |
| | Nurse | 38 | 37.6 |
| | Nursing assistants | 8 | 7.9 |
| | Cleaners | 10 | 9.9 |
| Location (Departments) | Neurosurgery | 10 | 9.9 |
| | Anaesthesia | 11 | 10.9 |
| | Obstetrics & Gynaecology | 21 | 20.8 |
| | Surgery | 10 | 9.9 |
| | Orthopaedics | 7 | 6.93 |
| | Cardiothoracic &Vascular surgery | 10 | 9.9 |
| | Medicine | 11 | 10.9 |
| | Paediatrics | 10 | 9.9 |
| | Neonatology | 11 | 10.9 |
| Type of mobile phones | Touch phone | 95 | 94.05 |
| | Keypad | 6 | 5.94 |

The total culture positivity rate from all 3 sites was 51.48% (n=156). Isolation rate was highest in anterior nasal nares (100%, n=101), followed by mobile phones (29.7%, n=30) and dominant hands (24.75%, n=25). The distribution of isolated bacteria in anterior nares, mobile phones and dominant hands is shown in **Table2**.

No significant association was found between the phones with conventional keypads and those with touch pads with respect to contamination (r=0.111, *p*=0.266). A significant positive association is seen between the presence of bacteria on mobile phones and in dominant hands of healthcare workers (r=69.75, *p*=0.02). This was true for the presence of bacteria in any of the hands and on the mobile phones used by healthcare workers (r=7.68, *p*=0.006).

**Table 2** Distribution of bacterial isolates among samples

| | Bacteria | Nose | Mobile phone | Hands | Total |
|---|---|---|---|---|---|
| | Isolation rate | 101 (100%) | 30 (29.7%) | 25 (24.75 %) | 156 (51.48%) |
| | Potential clinical pathogens | 40(39.6%) | 16 (15.8%) | 13 (12.9%) | 69(22.8%) |
| | **Gram positive bacteria** | | | | |
| 1 | *Staphylococcus aureus* | 40 (39.6%) | 10 (9.9%) | 11 (10.8%) | 61 (60.39%) |
| 2 | Coagulase Negative Staphylococci | 59 (58.42%) | 16 (15.84%) | 12 (11.88%) | 87 (86.13%) |
| 3 | Diphtheroids | 3 (2.97%) | 0 | 1 (0.9%) | 4 (3.96%) |
| 4 | *Streptococcus spp* | 2 (1.98%) | 0 | 0 | 2 (1.98%) |
| 5 | *Bacillus sp.* | 0 | 1(0.9%) | 1 (0.9%) | 2 (1.98%) |
| | **Gram negative bacilli** | | | | |
| 6 | *E.coli* | 0 | 3 (2.97%) | 1 (0.9%) | 4 (3.96%) |
| 7 | *Klebsiella pneumoniae* | 0 | 3(2.97%) | 1 (0.9%) | 4 (3.96%) |
| | Total isolates | 104 | 33 | 27 | **164** |

A total of 164 isolates were recovered from 303 samples. The contamination rate was more with Gram positive bacteria than Gram negative bacteria. The predominant isolate was coagulase negative staphylococci as they form an important group of colonisers in nose and hands. Potential clinical pathogens (*Staphylococcus aureus*and gram negative bacilli) were isolated from 69 samples (22.8 %,69/303). Isolation rate of pathogens were 39.6% from nares, 15.8% from mobile phones, and 12.9% from dominant hand.The most common potential clinical pathogen was *Staphylococcus aureus* which constituted 37.2% of the total isolates (61/164). Nineteen isolates out of these 61(31.1%) were methicillin resistant (MRSA),and was distributed predominantly in anterior nares (n=17,16.8%) followed by dominant hands (n=2,1.9%). Other pathogens were *E.coli* (n=4) and *Klebsiella pneumoniae* (n=4). All mobile phones were free of MRSA contamination. Contamination with gram negative bacilli was seen predominantly in mobile phones followed by hands.Among the other factors studied, occupation (type of healthcare work) was not associated with the presence of *S aureus* in phones or hands of the workers (r=1.52, p=0.676).

**Table 3** Distribution characters of MRSA (MRSA – methicillin resistant Staphylococcus aureus; MSSA – methicillin sensitive Staphylococcus aureus)

| | | MRSA | MSSA |
|---|---|---|---|
| **Site** | Nose | 17 (42.5%) | 23(57.5%) |
| | Mobile phones | 0 | 10(100%) |
| | Hands | 2 (18.2%) | 9 (81.8%) |
| **Occupation** | Doctors | 11 (24.4%) | 16 (35.56%) |
| | Nurses | 5 (13.16%) | 16 (42.1%) |
| | NA | 2 (0.25%) | 2 (0.25%) |
| | Cleaners | 1(0.1%) | 3(0.3%) |

Among staff with contaminated mobile phones (29.7%, n=30), 4 have methicillin sensitive *Staphylococcus aureus* (MSSA) both on mobile phones and nares. One has both on mobile phone and hands.

**Table 3** shows the distribution of MSSA and MRSA in different groups. A total of 40participants (39.6%) were found to have nasal carriage of *S. aureus* and among them 17(16.8%) were MRSA carriers.Two of the participants in the study were having MRSA contaminated hands. MRSA colonisation rate was highest among doctors, 24.4% (n=11) followed by 16.7% (n=3) among other supporting staff and13.15% (n=5) among nurses. Occupation (type of healthcare work) did not have a significant correlation with the presence of MRSA among the different participants (r=3.35, *p*=0.34). Gender of the participant also did not have an association with the presence of MRSA in nose or hands of the participants (r=3.01, *p*= 0.082).

MRSA colonisation was identified in 19 of the healthcare workers swabbed, corresponding to a pooled prevalence of 1.8% (95% CI, 1.34%-2.50%).

## DISCUSSION

The burden of hospital acquired infections, especially in critical care settings is high in lower-middle income countries when compared to those of higher-middle income countries. Sources of the potential infectious organisms are varied and some of the most common ones include the inanimate objects that are in the close vicinity of the patients. This study aimed to investigate the contamination of hands, nares and mobile phones of healthcare workers in an ICU setting of a hospital. Hospital environment plays a major role in the transmission of a number of infections, put together as healthcare-associated infections (HAIs). The infectious organisms can be transferred through direct contact between people or through inanimate objects including mobile phones, computer keyboards, pens, stethoscopes, etc. Mobile phones are one of the most commonly used non-medical device in any healthcare facility. Transmission of nosocomial infections through these devices, including mobile phones and personal digital assistants, have been reported in earlier studies.[8-11]

This study showed that the rate of contamination in the three sites to be 58%, with maximum positivity rate from anterior nares (100%) followed by mobile phones (29.7%). Anterior nares were found to be the most common site of colonization by clinical pathogens in a study conducted byChang*et al*.[12]The highest isolation rate was found in anterior nares in the present study also and this may be due to the moist and warm environmental conditions present in the nares that is conducive for the growth of bacteria.

Contamination rates of mobile phones varied from 62-90% in other studies.[9,13-15]Differences in sampling methods and also the mobile phone owning healthcare workers may be one of the reasons for the high variation seen among the positivity rate. A significant positive association is seen between the presence of bacteria on mobile phones and in dominant hands of healthcare workers (r=69.75, *p*=0.02). Mobile phones are not cleaned so often leading to the higher rate observed in them when compared to dominant hands which is cleaned periodically while being in a hospital. Thus, constant use of these devices without proper disinfection make them the potential source of transmission of pathogens. It can also act as a reservoir of pathogens, especially skin colonizing bacteria, as the moisture and temperature of the human body are conducive

for bacterial growth. Moreover, these pathogens are known to survive on inanimate surfaces like mobile phones for a longerdurationforming a very important source of cross contamination in healthcare field.

Mobile phones of healthcare workers was contaminated in 29.7% of the cases with coagulase negative staphylococci being the most common isolate which is in concordance with the study conducted by Bhat *et al*.[15]Tagoe*et al* had reported a very high rate of contamination on mobile phones (100%).[16]With respect to contamination, the type of mobile phone (keypad vs touchpads) had no significant association unlike that reported by Pal *et al*[17]. Contamination rate was not different between male and female doctors as against the report in a study by Kokate*et al*where male doctors showed more proportion of contamination of mobile phones when compared to female doctors.[18] Studies shows that many healthcare workers do not clean their mobile phones after receiving a call and before touching a patient.[9,15,17] Healthcare workers reported that lack of an effective disinfection method that does not damage the device as the most common reasons for the same.[17]

Coagulase negative *Staphylococcus* was the most predominant (58.42%) organism isolated during the study, reflecting that the common fauna of the skin can be easily transferred to hands and even objects that are in contact with the skin surface. As mobile phones are constantly handled and the heat generated during the calls may provide a favourableenvironment for the growth of these commensals on the device. And these may emerge as a pathogen in the hospital settings. The other organisms isolated during the study including *E coli,Klebsiella*, *Bacillus*, and Diphtheroids are all known nosocomial pathogens too. One of the earlier studies had shown the presence of these organisms in the currency circulating in a tertiary care hospital.[19]This may be an added method for the contamination of mobile phones and hands of healthcare workers.

The most common clinical pathogen collected from the isolates was *Staphylococcus aureus* constituting 37.2% of the total isolates. The colonization rate was highest in anterior nares (39%) followed by dominant hand (10.89%) and mobile phones (9.9%). Colonization of *S aureus* increases the risk of infection by 2-9 fold.[20]A very high colonization rate of *S aureus*among patients was reported from hospitals across Uttarakhand valley by Talwar*et al*and clearly shows the importance of transmission control to reduce the rate of infection among patients.[21]In a study conducted by Chang *et al*, for 8 positive samples of *S aureus*isolated from the mobile phones of medical professionals, 7 samples from nares had *S aureus*, indicating a high level of transmission.[12]High colonization of nares by *S aureus* was reported by Hadley et al in 2010.[22]About 31% of the *S aureus* isolates in this study were methicillin resistant (MRSA) which is in lieu with other studies.[8,12,21,23-25]High prevalence of resistant *S aureus*in the nares points to the need for additional measures to control transmission to patients.

MRSA contamination was found to be highest among doctors (24.4%) and this was higher than the carriage rate among doctors in another study conducted in Northern Ethiopia.[26]Category-wise contamination rate was not significantly associated with the presence of resistant *S aureus* unlike that presented by Trivedi *et al*, Pal *et al* and Tambe*et al*.[17,27-28] Lab technicians who possibly had direct contact with body fluids and tissues had a higher carriage rate in the study reported by Arora *et al* and Panchal *et al*.[29,30]Nasal and hand carriage of MRSA was high in our study as is seen in the study conducted by Gebreyesus *et al*.[26]Infection control teams in a hospital should discuss in detail the methods to be followed in a hospital environment that will help in preventing transmission of pathogens from healthcare workers to patients, especially in a critical care setting.

One of the major limitations of the study is that genotyping of *S aureus* was not performed to confirm the transmission from anterior nares to dominant hands or mobile phones. This would have also helped to tracethe connection between colonization and presence of the same organisms in patients too. Additionally, other potential sources of infection including stethoscopes, computer keyboards and other devices were not studied. This would help to rule out the role of other devices in the cycle of hospital associated infections.

## CONCLUSION

A high culture positivity rate including some drug resistant strains isolated from the hands, nares and mobile phones of healthcare workers in this study points to a potential reservoir for nosocomial infections in ICU setting. This clearly indicates the need for restricting/limiting the use of devices like mobile phones or to switch to alternative method like use of headphones while in hospital to reduce the epidemiological risk associated with its use. It also shows that infection control practices and proper hand hygiene practice have to be followed strictly. It is equally important to spread awareness among healthcare workers regarding the potential role of mobile phones, nares and hands in transmission of infectious agents. Explicit guidelines on the use of phones and infection control practices in the hospital may be of help in controlling infection in a hospital setting.

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