Vol. 11, No. 2 (2025), pp.37–45

CHITKARA UNIVERSITY

Journal of Multidisciplinary Research in Healthcare

The Role of Mobile Phones in Spreading MRSA and Multidrug-Resistant Microorganisms: From Hands to Wards

Mukul Mudgal[1], Mahesh Kumar Seth[2], Rituparna Saha[3], Akriti Sharma[4] and Sandhya Khunger[2*]

[1]*Department of Medical Laboratory Technology,Faculty of Allied Health Sciences (FAHS), SGT University, Gurugram, Haryana, India-122505.*

[2]*Department of Life Sciences,Faculty of Allied Health Sciences (FAHS), SGT University, Gurugram, Haryana, India-122505.*

[3]*Department of Microbiology,Faculty of Allied Health Sciences (FAHS), SGT University, Gurugram, Haryana, India-122505.*

[4]*Department of ENT, Faculty of Allied Health Sciences (FAHS), SGT University, Gurugram, Haryana, India-122505.*

[*]sandhya.khunger@gmail.com (Corresponding Author)

RESEARCH ARTICLE **Open Access**

ARTICLE INFORMATION

Received: July 17, 2025
Accepted: October 08, 2025
Published Online: October 30, 2025

Keywords:
Mobile phones, Healthcare workers, MRSA, Multidrug-resistant bacteria, Nosocomial infections

DOI: 10.15415/jmrh.2025.112005

ABSTRACT

Background: Mobile phones are essential tools for healthcare workers (HCWs) but may act as reservoirs of multidrug-resistant (MDR) bacteria, contributing to hospital-acquired infections (HAIs).

Purpose: This study investigates bacterial contamination on HCWs' mobile phones, their resistance patterns, and associated usage practices.

Methods: A six-month cross-sectional study was conducted at SGT Hospital, Gurugram. A total of 120 mobile phones (100 HCWs, 20 non-HCWs) were swabbed from commonly touched areas. Samples were cultured on standard media, and isolates were identified by morphological and biochemical methods. Antibiotic susceptibility testing of Staphylococcus aureus was performed using the Kirby-Bauer disc diffusion method. PCR assays targeting 16S rRNA and mecA genes were used for molecular confirmation of bacterial isolates and methicillin-resistant S. aureus (MRSA). A structured questionnaire assessed participants' mobile phone usage and hygiene practices.

Results: Of the 120 phones, 95 (79.1%) showed bacterial contamination. Predominant isolates included diphtheroids (37.5%), S. aureus (27.5%), Micrococcus (26.6%), Bacillus (13.3%), and Acinetobacter (5.8%). Among 33 S. aureus isolates, 16 (48.5%) were MRSA by culture, while PCR confirmed 14 as mecA-positive. Resistance was highest to penicillin, erythromycin, and cefoxitin. Contamination correlated significantly with risk behaviors such as phone use in washrooms and lack of cleaning practices ($p < 0.05$).

Conclusion: Mobile phones of HCWs are major reservoirs of MDR bacteria, particularly MRSA, posing a hidden risk of nosocomial transmission. Implementation of standardized phone-cleaning protocols and behavioral guidelines is essential to reduce device-mediated infection spread.

1. Introduction

Mobile phones have become indispensable tools for social, professional, and personal communication (Mushabati *et al.*, 2021). According to the State of Mobile 2023 report, Indian users spend an average of 4.9 hours per day on their smartphones, placing India eighth globally in terms of mobile device usage (Ahaskar, 2023). Studies further indicate that individuals check their phones an average of 58 times daily (Akbari *et al.*, 2024). Within healthcare organizations, mobile phones enhance communication speed and efficiency, improve service delivery, and enable healthcare workers (HCWs) to access pharmaceutical information and medical literature. However, their potential health risks are often overlooked (Mushabati *et al.*, 2021). The human skin, with an approximate surface area of 2 m^2 and harboring nearly 10^{12} bacterial cells per individual, is constantly exposed to and colonized by environmental microorganisms. Mobile phones may act as significant vectors

for transferring diverse microflora between the environment and human skin, thereby contributing to potential health hazards. Microbiologists emphasize that constant handling combined with the heat generated by mobile phones creates an optimal environment for the proliferation of common skin flora (Brady *et al.*, 2006). During use, phones come into frequent contact with multiple body sites through hand-to-hand transmission and hand-to-face contact (ears, nose, and mouth), increasing the likelihood of colonization by skin-surface pathogens (Morubagal *et al.*, 2017).

It was reported that 78% of HCWs believed doctors could use mobile phones in medical settings, compared with 56% of nurses and 49% of patients (Morubagal *et al.*, 2017). In hospitals, where nosocomial infections remain a major concern, research indicates that poor hand hygiene and inadequate disinfection among healthcare professionals can facilitate bacterial colonization of mobile phones (Chang *et al.*, 2017). Patients are at heightened risk of acquiring nosocomial infections due to frequent mobile phone use in clinical areas. Contaminated hands and devices of healthcare professionals may act as transmission sources, spreading infections to themselves, their families, patients, and the wider community (Angadi *et al.*, 2014). Several screening studies have demonstrated that mobile phones harbor pathogenic organisms such as Staphylococcus aureus, Escherichia coli, Pseudomonas, Acinetobacter, and Candida species. Previous investigations have shown that healthcare personnel's mobile phones are frequently contaminated with bacterial microorganisms (Punj *et al.*, 2022).

Although studies in other regions have documented the role of mobile phones in microorganism transmission, no such evidence has been reported from Haryana. Since contamination rates vary geographically and across different communities, it is essential to determine the extent of mobile phone contamination in Gurugram. Despite these concerns, limited literature is available regarding the degree of contamination and the diversity of microorganisms present on mobile phone surfaces. The present research, therefore, aims to analyze bacterial contamination on healthcare workers' mobile phones, investigate the prevalence of antibiotic-resistant bacteria, and correlate these findings with device-handling practices.

2. Materials and Methods

2.1. Study Design and Setting

This study was a cross-sectional observational study that was conducted between February and August 2023 at SGT University, Gurugram, to assess bacterial contamination of mobile phones among healthcare workers (HCWs) and non-healthcare workers (non-HCWs). This study received an exemption from the Institutional Ethics Committee of SGT University, Gurugram, Haryana, India, since it was a non-interventional study. Nevertheless, all procedures were conducted in strict accordance with the principles outlined in the Declaration of Helsinki.

2.2. Study Population

Mobile phones were randomly selected from two groups: HCWs, including doctors, nurses, residents, laboratory staff, and radiology technicians (n=100), and non-HCWs, including non-medical students from B.Tech, B.Com, BCA, BA, LLB, BJMC, and B.Des programs (n=20). The ratio of 1:5 was chosen to ensure adequate representation of healthcare workers, who were the primary focus of the study. Non-HCWs were included only as a small comparison group to highlight differences. Simple random sampling was employed using a lottery method within the respective groups.

2.3. Inclusion and Exclusion Criteria

Consenting participants who owned and regularly used a mobile phone were included in the study. The device provided had to be the participant's most frequently used phone. Exclusion criteria included (i) individuals who did not own or use a mobile phone, (ii) participants who reported cleaning or disinfecting their devices after learning about the study, and (iii) samples that were found to be contaminated during collection or transport.

2.4. Questionnaire

The questionnaire was pilot tested on 10 participants (not included in the final study) for clarity and reliability. Necessary modifications were made before final administration. Participants completed a pre-tested questionnaire covering demographics, socioeconomic status, phone use in specific settings (bathroom, kitchen, while eating), cleaning practices, average daily use, and device sharing. Comparisons between groups were analyzed using the chi-square test.

2.5. Sample Collection and Processing

Swabs were taken from touchscreens, mouthpieces, earpieces, and buttons using sterile cotton swabs with transport medium. Samples were cultured on blood agar and MacConkey agar and incubated at 37°C for 24 hours. Colonies were subcultured, and isolates were identified by standard morphological and biochemical methods.

2.6. Antibiotic Susceptibility Testing

Antimicrobial susceptibility was assessed by the Kirby–Bauer disc diffusion method on Mueller–Hinton agar, interpreted according to CLSI guidelines. The following

discs were used for *Staphylococcus* species (HiMedia Laboratories Pvt. Ltd, Mumbai, India): Penicillin (10 U), Cefoxitin (30 µg), Gentamicin (10 µg), Erythromycin (15 µg), Clindamycin (2 µg), Minocycline (30 µg), Tetracycline (30 µg), Ciprofloxacin (5 µg), Cotrimoxazole (1.25/23.75 µg), Chloramphenicol (30 µg), Linezolid (30 µg), and Vancomycin (30 µg).

2.7. Molecular Detection

2.7.1. MRSA DNA Extraction

DNA from culture-confirmed MRSA (Methicillin-resistant Staphylococcus aureus) isolates was extracted using the QIAamp DNA Micro Kit (Qiagen GmbH, Hilden, Germany) with minor modifications. Extracted DNA was stored at −20°C.

2.7.2. 16S rRNA PCR

Universal primers 27F (5′-AGAGTTTGATCCTGGCTCAG-3′) and 1492R (5′-GGTTACCTTGTTACGACTT-3′) were used for 16S rRNA gene amplification. PCR conditions included initial denaturation at 94°C for 5 min; 35 cycles of denaturation (94°C, 30 s), annealing (60°C, 30 s), and extension (72°C, 60 s); and a final extension at 72°C for 5 min. Products were with ethidium bromide.

2.7.3. mecA Gene Detection

Confirmed isolates were screened for the *mecA* gene using primers mecA-F (5′-AGAAGATGGTATGTGGAAGTTAG-3′) and mecA-R (5′-ATGTATGTGCGATTGTATTGC-3′). [19] PCR reactions (25 µL) contained 200 µM dNTPs (0.4 µL), primers (0.6 µL each), $MgCl_2$ (1 µL, 5 mM), Taq polymerase (0.2 µL, 0.5 U; Thermo Scientific Pvt. Ltd), Taq buffer (2 µL, 1×), and DNA template (5 µL, 1:5 dilution). Amplified products were visualized on 1.2% agarose gels with ethidium bromide.

2.8. Statistical Analysis

Data collected was entered into Microsoft Excel and analyzed using SPSS version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages [n]. The chi-square test and Fisher's exact test were applied to assess associations between categorical variables. A p-value of <0.05 was considered statistically significant.

3. Results

Among the control group (n=20), 60% were male and 40% female, while in the HCW group (n=100), 43% were male and 57% female. The difference was not statistically significant (p=0.164). With respect to residency, 60% of controls were from urban areas compared to only 24% of HCWs, whereas 76% of HCWs were from peri-urban/rural regions. This difference was statistically significant (p=0.001), indicating a higher representation of peri-urban residents among HCWs. Regarding mobile phone usage frequency, 40% of controls and 37% of HCWs used their phones ≤25 times/day, 15% of controls and 26% of HCWs used them 26–50 times/day, and 45% of controls and 36% of HCWs used them >50 times/day. The differences were not statistically significant (p=0.543) (Table 1). Owning pets or cattle was reported by 30% of controls and 25% of HCWs, with no significant association (p=0.639). A significantly higher proportion of controls (75%) reported using their phones while eating compared to HCWs (47%) (p=0.022). Similarly, phone use in washrooms/toilets was significantly more common among controls (70%) compared to HCWs (39%) (p=0.011). Phone cleaning or sanitization practices were more frequent among HCWs (55%) compared to controls (25%), and this difference was statistically significant (p=0.014). Phone sharing within the family was common in both groups, reported by 60% of controls and 63% of HCWs, with no significant difference (p=0.806). No participants in either group reported any inflammatory disease (Table 1).

Table 1: Questionnaire-Based Comparison of Mobile Phone Usage Habits and Related Factors between Healthcare Workers (N=100) And Controls (N=20)

Variable	Domain	Control (n=20)	Healthcare Workers (n=100)	p-value
Gender	Male	12 (60%)	43 (43%)	0.164
	Female	8 (40%)	57 (57%)	0.164
Residency	Urban	12 (60%)	24 (24%)	0.001*
	Rural	8 (40%)	76 (76%)	0.001*
Use the phone per day	≤25 times	8 (40%)	37 (37%)	0.543
	26–50 times	3 (15%)	26 (26%)	
	>50 times	9 (45%)	36 (36%)	

Have any pets/cattle	Yes	6 (30%)	25 (25%)	0.639
Use of phone while eating	Yes	15 (75%)	47 (47%)	0.022*
Use of phone in the kitchen	Yes	9 (45%)	45 (45%)	0.999
Use of phone in the washroom/toilet	Yes	14 (70%)	39 (39%)	0.011*
Clean or sanitize phone after work	Yes	5 (25%)	55 (55%)	0.014*
Use of phone by another person in family	Yes	12 (60%)	63 (63%)	0.806
Any inflammatory disease	Yes	0	0	NA

*Significant differences were observed for residency, phone use while eating, use in washrooms/toilets, and phone cleaning/sanitization practices (p<0.05).

The overall contamination rate of mobile phones among all participants was 79.1% (95/120). The highest contamination was observed among MBBS interns (95%), followed closely by nurses (90%) and housekeeping staff (85%). Medical students (80%) and technicians (75%) also demonstrated high contamination levels. In contrast, the control group showed significantly lower contamination (50%). These findings indicate that healthcare-related personnel, particularly those with frequent patient contact, had markedly higher rates of mobile phone contamination compared to controls (Table 2).

Table 2: Mobile Phone Contamination Rates among Different Categories of Healthcare Workers (N=100) and Controls (N=20)

Personnel	**Number of Mobile Phones Contaminated With Microbes (n=20)**
Control	10 (50%)
MBBS Interns	19 (95%)
Nurses	18 (90%)
Housekeeping	17 (85%)
Technician	15 (75%)
Medical Student	16 (80%)
Total	95 (79.1%)

The prevalence of contamination was substantially higher among healthcare workers compared to controls.

Among the control group, 35% of mobile phones carried only one bacterial contaminant, while 15% carried more than one. In contrast, MBBS interns showed the highest rate of multiple bacterial contamination (80%), indicating heavy microbial load. Nurses and medical students had higher proportions of single bacterial contaminants (60% each), while housekeeping staff and technicians demonstrated intermediate levels, with 40–45% single and 35–45% multiple contaminants. Overall, healthcare workers were more likely than controls to harbor multiple bacterial species on their mobile phones (Table 3).

Table 3: Distribution of Single And Multiple Bacterial Contaminants Isolated from Mobile Phones among Healthcare Workers and Control Group

Group	**Only 1 Bacteria**	**More than 1 Bacteria**
Control (n=20)	7 (35%)	3 (15%)
MBBS Interns (n=20)	3 (15%)	16 (80%)
Nurses (n=20)	12 (60%)	5 (10%)
Housekeeping (n=20)	8 (40%)	9 (45%)
Technician (n=20)	8 (40%)	7 (35%)
Medical Student (n=20)	11 (60%)	5 (25%)

Multiple bacterial contaminations were most prevalent among MBBS interns.

The analysis revealed that diphtheroids (37.5%) and S. aureus (27.5%) were the most frequently isolated bacteria from mobile phones across healthcare workers and students. Micrococcus spp. (26.6%) was also commonly detected. Among the groups, MBBS interns (65%), nurses (35%), and technicians (30%) showed high contamination with S. aureus, while medical students (65%) had the highest prevalence of diphtheroids. Acinetobacter spp. (35%) was notably isolated only from the housekeeping group. In contrast, the control group showed minimal contamination, with diphtheroids (30%) and CONS (25%) being the most common. Overall, the findings emphasize that healthcare-related personnel had a significantly higher bacterial burden on their mobile phones compared to controls (Table 4).

Table 4: Distribution of Bacterial Isolates from Mobile Phones among Healthcare Workers and Control Group

Bacterial Isolates	**Control (n=20)**	**MBBS Interns (n=20)**	**Nurses (n=20)**	**Housekeeping (n=20)**	**Technician (n=20)**	**Medical Student (n=20)**	**Total (n=120)**
S. aureus	0	13 (65%)	7 (35%)	2 (10%)	6 (30%)	5 (25%)	33 (27.5%)

CONS	5 (25%)	3 (15%)	2 (10%)	4 (20%)	1 (5%)	1 (5%)	16 (13.3%)
Micrococcus	2 (10%)	9 (45%)	7 (35%)	6 (30%)	6 (30%)	2 (10%)	32 (26.6%)
Diphtheroids	6 (30%)	10 (50%)	3 (15%)	4 (20%)	9 (45%)	13 (65%)	45 (37.5%)
Enterococcus	0	0	0	1 (5%)	0	0	1 (0.83%)
Bacillus spp.	0	6 (30%)	5 (25%)	3 (15%)	2 (10%)	0	16 (13.3%)
Acinetobacter spp.	0	0	0	7 (35%)	0	0	7 (5.8%)

Diphtheroids, *S. aureus*, and *Micrococcus* were the predominant contaminants, highlighting the potential role of mobile phones as reservoirs for pathogenic bacteria in hospital environments.

Out of 33 S. aureus isolates, 16 (48.48%) were resistant (MRSA), while 17 (51.52%) were sensitive. The highest proportion of resistant strains was observed among nurses (71.4%) and MBBS interns (69.2%), followed by medical students (20%) and technicians (14.3%). In contrast, the housekeeping group and control group showed no resistance (0%). These isolates showed the highest resistance to penicillin (10 ug), erythromycin (15 ug), cefoxitin (30 ug), clindamycin (2 ug), and ciprofloxacin (5 ug). This indicates that healthcare workers, particularly nurses and interns, harbor a higher burden of MRSA carriage compared to non-clinical staff, likely due to increased and repeated exposure to patients and hospital environments (Table 5).

Table 5: Distribution of *Staphylococcus Aureus* Isolates Showing Sensitivity and Resistance Patterns among Different Study Groups (N = 33)

Group	**Sensitive n (%)**	**Resistant n (%)**	**Total**
Control	0	0	0
House keeping	1 (100.0%)	0	1
Technicians	6 (85.7%)	1 (14.3%)	7
Nurses	2 (28.6%)	5 (71.4%)	7
Medical students	4 (80.0%)	1 (20.0%)	5
MBBS interns	4 (30.8%)	9 (69.2%)	13
Total	17 (51.52%)	16 (48.48%)	33

DNA from all 120 study samples was subjected to 16S rRNA gene amplification, followed by agarose gel electrophoresis to visualize the amplified products. No band was observed in the control samples (S8 and S9), confirming negative results for the 16S rRNA gene. In contrast, a distinct band of approximately 1500 bp was detected in the study samples (lanes S1 to S6), indicating the presence of the 16S rRNA gene. All 120 samples consistently showed a positive band for 16S rRNA gene amplification. The amplification was performed using 16S rRNA-specific primers by conventional PCR (Figure 1).

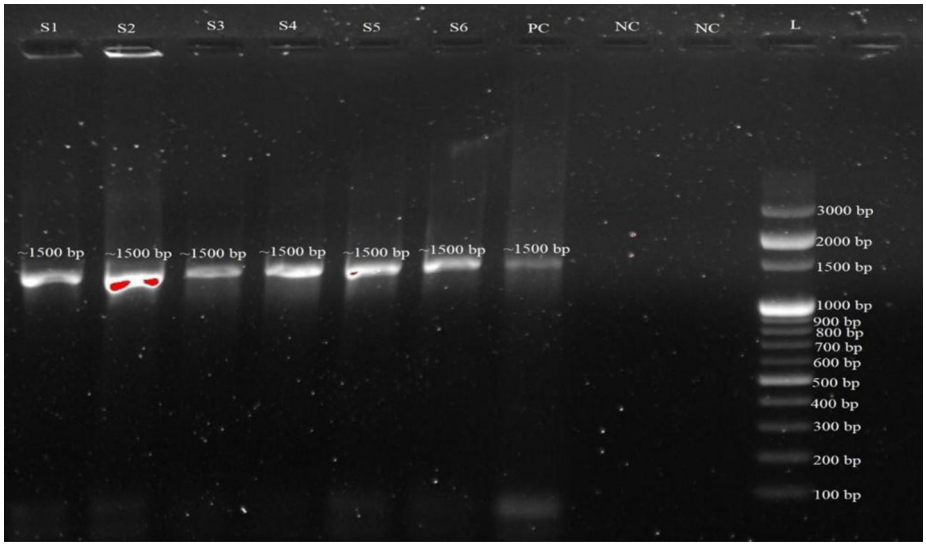

Figure 1: Gel Electrophoresis (1.2%) of 16S Rrna Gene Amplification by PCR from Mobile Phone Swabs (N = 120)

No band was observed in the negative control samples (S8 and S9), indicating the absence of the 16S rRNA gene. A distinct ~1500 bp band was detected in the study samples (lanes S1 to S6), confirming positive amplification of the 16S rRNA gene.

PCR targeting the mecA gene (583 bp) was performed to detect MRSA in the study samples. The PCR products were electrophoresed on a 1.2% agarose gel, with the ATCC strain (29213) used as a positive control (lane PC). Positive amplification was observed in study samples loaded in lanes S1, S2, and S5 to S7, whereas the negative control (lane NC) and samples in lanes S3 and S4 showed no amplification. Among the 16 MRSA strains confirmed by culture-based methods, molecular detection using PCR successfully identified 14 strains, while 2 strains were PCR-negative (Figure 2).

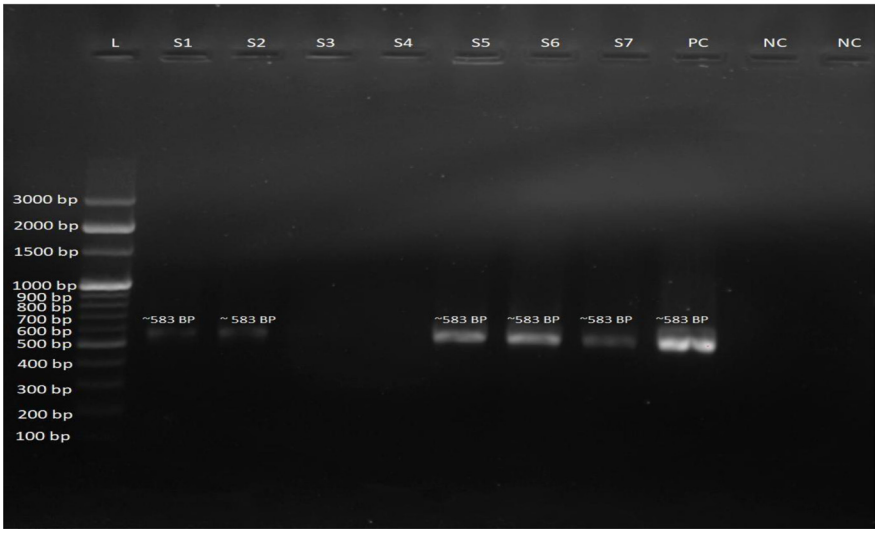

Figure 2: Agarose Gel Electrophoresis (1.2%) of PCR Products for *Meca* Gene Detection (583 Bp) from Mobile Phone Surface Swabs (N = 120)

No band was observed in the negative control (lane NC), indicating absence of the *mecA* gene. Distinct 583 bp bands were detected in study samples (lanes S1, S2, and S5–S7), consistent with the positive control (lane PC), confirming the presence of the *mecA* gene.

4. Discussion

Daily routine activities are almost impossible without a means of communication, and mobile phones have become indispensable in today's world. However, the way mobile phones are used is of concern, as their surfaces act as important sources of pathogen transmission to humans. Since individuals frequently touch mobile phone screens to check notifications, this creates repeated opportunities for microbial transfer. Such frequent contact provides significant potential for aerosol-mediated transmission of infectious diseases via phones. The situation worsens when mobile phones are carried into toilets or washrooms. A previous report by TechRepublic ("The Dirty Truth") highlighted this issue (Balkrishna *et al*., 2022). Similarly, a study from the University of Arizona showed that approximately 17,032 bacterial isolates were detected on mobile phone screens of high school students—about ten times more than those typically found on toilet seats (Kõljalg *et al*., 2017).

In the present healthcare-based study, culture techniques revealed that the majority of organisms retrieved from mobile phones of HCWs were cefoxitin-resistant S. aureus (MRSA, 48.48%) and cefoxitin-sensitive S. aureus (MSSA, 51.51%), followed by diphtheroids (~37.5%), Micrococcus (26.6%), Enterococcus (0.83%), and Acinetobacter spp. (5.8%). Findings of the present study regarding Staphylococcus spp. detected from mobile phone surfaces are in concordance with a recent report from an urban community in Mexico (Campista-León *et al*., 2022; Czekaj *et al*., 2015). As in the present study, screening of S. aureus isolates exhibited cefoxitin resistance, raising a serious concern since Staphylococcus spp. are routinely encountered in healthcare settings, with the potential for transmission to immunocompromised patients and consequent healthcare-associated (nosocomial) infections (Sharaf *et al*., 2011). By correlating survey responses with antibiotic resistance profiles of isolates, we found that HCWs' mobile phone usage practices were associated with colonization of antibiotic-resistant isolates on phone surfaces. In this investigation, approximately 79.1% of HCW mobile phones displayed microbial growth, consistent with many published

studies highlighting mobile phones as important vectors of microbial transmission. The systematic analysis emphasized the importance of mobile phones in microbial transmission in both healthcare and community environments, reporting contamination rates ranging from 68% to 98% (Datta *et al.*, 2009). In this study, risky phone-using habits (e.g., using mobile phones in washrooms/toilets or while eating) showed a significant association with colonization ($p \leq 0.05$). Inadequate cleaning and sanitization of mobile phones were also significantly associated with bacterial colonization ($p = 0.05$) (Qadi *et al.*, 2021).

Besides the microbiological implications, mobile phone use also carries psychological and behavioral consequences for healthcare workers. Excessive reliance on mobile phones has been associated with increased stress and anxiety, as users remain in a constant state of expectancy for notifications. Continuous exposure to social media and digital communication may further reduce attention spans and distract HCWs from patient care responsibilities. In addition, mobile phone overuse has been linked to phantom vibration and phantom ringing syndromes, where individuals perceive phone vibrations or ringing sounds in the absence of any actual stimulus. These phenomena highlight the broader psychological impact of mobile phone dependence, underscoring the need for mindful usage policies in healthcare environments (Goyal, 2015; Goyal & Saini, 2019). It is therefore mandatory to design and implement guidelines for appropriate mobile phone use and regular cleaning in healthcare environments. It is important to note that, to date, there are no standardized protocols for routine cleaning or restrictions on the use of mobile phones in healthcare settings.

In the present study, out of 16 MRSA strains confirmed by culture, 14 were detected on mobile phone surfaces by conventional PCR, while 2 were negative by PCR. This may be explained by possible mutations in MRSA strains, DNA quantities below the detection threshold of PCR, or false positives in culture due to technical error (e.g., thick smear during AST leading to false inhibition zones). Molecular techniques such as PCR therefore demonstrated greater specificity (compared to culture, which showed ~40% specificity) (Olsen *et al.*, 2020). The present study has several strengths. It is among the first from the Haryana region (India) to combine both culture-based methods and molecular confirmation (16S rRNA and mecA PCR) for the detection of bacterial contamination on mobile phones of healthcare workers. The inclusion of multiple categories of healthcare personnel, along with a control group, enhances the generalizability of the findings within hospital settings.

However, some limitations must be acknowledged. This was a single-center study with a relatively small sample size, which may not fully represent the burden of contamination across different hospitals. Viral, fungal, and parasitic organisms were not included in the scope of this research, which might have provided a more comprehensive overview of mobile phone contamination. Additionally, the cross-sectional design limits causal inference between phone-handling practices and microbial colonization. Future studies should be conducted on a larger scale across multiple healthcare facilities to validate these findings. Inclusion of other personal electronic devices such as tablets, smartwatches, and stethoscopes could provide deeper insights into gadget-mediated infection risks. Longitudinal interventional studies assessing the effect of standardized cleaning protocols and behavioral modifications are also recommended to generate evidence-based guidelines for infection control.

5. Conclusion

As this was a pilot-scale study, it provides preliminary insight into the malpractice of mobile phone use and inadequate cleaning, which may significantly contribute to the nosocomial spread of multidrug-resistant (MDR) microorganisms from HCWs to patients. Mobile phones are particularly problematic in this context, as they can facilitate intra-ward, inter-ward, and even inter-hospital transmission of pathogens. Since complete restriction of mobile phone use in healthcare settings is nearly impossible, it is essential to develop evidence-based guidelines aimed at preventing microbial colonization and transmission via mobile phones. Such policies should incorporate behavioral modifications among personnel, alongside safe and effective mobile phone cleaning practices that do not damage sensitive electronic devices. Furthermore, inclusion of other commonly used personal gadgets in future studies will provide more comprehensive information on the prevalence of resistant bacteria on device surfaces, thereby offering better insight into their potential role in patient-to-environment and environment-to-patient transmission.

Acknowledgments

The authors declare that there are no acknowledgements for this research article.

Authors Contribution

Mukul Mudgal, Mahesh Kumar Seth, Rituparna Saha, Akriti Sharma, and Sandhya Khunger were involved in the designing of the study, enrollment of the subjects, collection of data, statistical analysis, and drafting of the manuscript. All authors have approved the submitted version and

have agreed both to be personally accountable for their own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution documented in the literature.

Funding

The work in this manuscript is supported by funds provided by the host institute and the researchers themselves. Participants were not imposed with any additional financial burden because of this study.

Ethics Approval

This study received an exemption from the Institutional Ethics Committee of SGT University, Gurugram, Haryana, India. Nevertheless, all procedures were conducted in strict accordance with the principles outlined in the Declaration of Helsinki.

Declarations

The authors declare that they have followed all ethical standards in conducting this research. All data supporting the findings are available within the manuscript.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

Ahaskar, A. (2023). Indians binge on mobile phone use. *Live Mint.*

Akbari, M., Seydavi, M., Sheikhi, S., & Wright, P. J. (2024). Exploring differences in four types of online activities across individuals with and without problematic smartphone use. *Psychiatric Quarterly, 95*(4), 579–597.

Angadi, K. M., Misra, R., Gupta, U., Jadhav, S., & Sardar, M. (2014). Study of the role of mobile phones in the transmission of hospital-acquired infections. *Medical Journal of Dr. D. Y. Patil University, 7*(4), 435–438.

Balkrishna, A., Singh, K., Haldar, S., & Varshney, A. (2022). Germi-X herbal-based spray disinfects smartphone surfaces: Implication on fomite-mediated infection spread. *AMB Express, 12*(1), 30.

Brady, R., Wasson, A., Stirling, I., McAllister, C., & Damani, N. (2006). Is your phone bugged? The incidence of bacteria known to cause nosocomial infection on healthcare workers' mobile phones. *Journal of Hospital Infection, 62*(1), 123–125.

Campista-León, S., López-Espinoza, J. U., Garcia-Guerrero, J. T., Alfonso-Corrado, C., Clark-Tapia, R., & Peinado-Guevara, L. I. (2022). Determination of drug-resistant bacteria in palmar surface and touchscreen cell phones from bystanders in an urban community. *Microbiological Research, 256,* 126958.

Chang, C.-H., Chen, S.-Y., Lu, J.-J., Chang, C.-J., Chang, Y., & Hsieh, P.-H. (2017). Nasal colonization and bacterial contamination of mobile phones carried by medical staff in the operating room. *PLOS ONE, 12*(5), e0175811.

Czekaj, T., Ciszewski, M., & Szewczyk, E. M. (2015). *Staphylococcus haemolyticus*—An emerging threat in the twilight of the antibiotics age. *Microbiology, 161*(11), 2061–2068.

Datta, P., Rani, H., Chander, J., & Gupta, V. (2009). Bacterial contamination of mobile phones of health care workers. *Indian Journal of Medical Microbiology, 27*(3), 279–281.

Goyal, A. K. (2015). Studies on phantom vibration and ringing syndrome among postgraduate students. *Indian Journal of Community Health, 27*(1), 35–40.

Goyal, A. K., & Saini, J. (2019). The phantom syndrome. *Indian Journal of Social Psychiatry, 35*(2), 102–107.

Kõljalg, S., Mändar, R., Sõber, T., Rööp, T., & Mändar, R. (2017). High level bacterial contamination of secondary school students' mobile phones. *Germs, 7*(2), 73–77.

Morubagal, R. R., Shivappa, S. G., Mahale, R. P., & Neelambike, S. M. (2017). Study of bacterial flora associated with mobile phones of healthcare workers and non-healthcare workers. *Iranian Journal of Microbiology, 9*(3), 143–151.

Mushabati, N., Samutela, M., Yamba, K., Ngulube, J., Nakazwe, R., Nkhoma, P., & Kalonda, A. (2021). Bacterial contamination of mobile phones of healthcare workers at the University Teaching Hospital, Lusaka, Zambia. *Infection Prevention in Practice, 3*(2), 100126.

Olsen, M., Campos, M., Lohning, A., Jones, P., Legget, J., Bannach-Brown, A., McKirdy, S., Alghafri, R., & Tajouri, L. (2020). Mobile phones represent a pathway for microbial transmission: A scoping review. *Travel Medicine and Infectious Disease, 35,* 101704.

Punj, J., Chaudhry, R., Sagar, T., & Chandran, D. (2022). Aerobic and anaerobic contamination of mobile

phones of health personnel with probable transfer of bacterial microbes to their hands at a tertiary care hospital of India. *Journal of Anaesthesiology Clinical Pharmacology, 38*(3), 405–410.

Qadi, M., Khayyat, R., AlHajhamad, M. A., Naji, Y. I., Maraqa, B., Abuzaitoun, K., Mousa, A., & Daqqa, M. (2021). Microbes on the mobile phones of healthcare workers in Palestine: Identification, characterization, and comparison. *Canadian Journal of Infectious Diseases and Medical Microbiology, 2021,* 8845879.

Sharaf, E. J., Senok, A. C., Udo, E. E., & Botta, G. A. (2011). Trafficking of methicillin-resistant staphylococci and co-colonization with vancomycin-resistant enterococci. *Medical Principles and Practice, 20*(3), 253–258.