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Assessment of potentially pathogenic bacteria isolated from mobile phones of preclinical and hospital-based medical students and healthcare workers

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MAIN POINTS

- Mobile phones used in hospital settings showed a significantly higher contamination rate (65.9%) compared to those of preclinical students (25.7%).
- Potentially pathogenic bacteria, including Staphylococcus aureus, Pseudomonas spp., and Acinetobacter baumannii, were isolated only from hospital-exposed devices.
- Preclinical students' phones carried only commensal skin flora, emphasizing the role of hospital exposure in pathogen acquisition.
- Infection control measures and compliance with hand hygiene should be emphasized from the early years of medical education, and it must not be overlooked that mobile phones—devices used in every aspect of daily life—can also become contaminated in hospital environments.

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ABSTRACT

Aim: Healthcare-associated infections (HAIs) remain a major global problem, and contaminated personal devices may act as unnoticed vectors. This study aimed to evaluate the bacterial contamination of mobile phones among medical students and healthcare workers in hospital and non-hospital settings.

Materials and Methods: A cross-sectional study was conducted between February and March 2024. A total of 203 mobile phones were sampled: 94 from hospital-exposed participants (clinical students and healthcare workers) and 109 from non-hospital-exposed preclinical students. Surface swabs were inoculated into Mueller-Hinton broth, cultured, and isolates were identified using standard microbiological techniques.

Results: Among hospital-exposed participants, bacteria were cultivated from 62/94 phones (65.9%), with potentially pathogenic organisms detected in 13.8%. Among these bacteria were *Staphylococcus aureus* (n=4, none methicillin-resistant), *Pseudomonas spp.* (n=2), *Acinetobacter baumannii* (n=2), *Enterococcus faecalis* (n=1), *Stenotrophomonas maltophilia* (n=1), and *Bacillus spp.* (n=3). Commensals such as *Staphylococcus epidermidis* (n=36) and *Staphylococcus haemolyticus* (n=7) predominated. In contrast, only 28/109 samples (25.7%) from preclinical students showed growth, limited to skin flora without pathogenic isolates. The contamination rate was significantly higher in the hospital-exposed group ($p<0.001$).

Conclusion: Mobile phones used in hospital settings are more frequently contaminated with potentially pathogenic bacteria compared to those of preclinical students, highlighting their role as overlooked reservoirs of HAIs. Incorporating mobile device hygiene into infection prevention strategies, alongside routine hand hygiene, and reinforcing structured training for students and healthcare professionals are critical measures to reduce cross-contamination risks.

Keywords: Mobile phone contamination, Nosocomial infections, Hand hygiene, Healthcare workers, Medical students, Bacterial colonization

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INTRODUCTION

Healthcare-associated infections (HAIs) remain a major global health problem, contributing to significant morbidity, mortality, and economic burden. In addition to traditional risk factors, contaminated medical devices and personal items carried by healthcare professionals have been increasingly recognized as potential sources of nosocomial transmission.

Mobile phones are among the most frequently handled personal devices by both healthcare workers and medical students. Their continuous use, close contact with hands and faces, and rare cleaning practices make them ideal reservoirs for microorganisms. Evidence from different regions has highlighted the potential role of these devices in the spread of healthcare-associated pathogens.

In Uganda, Lubwama et al. [1] demonstrated that hands of medical students and mobile phones frequently carried bacteria associated with hospital-acquired infections, underlining their possible role as transmission vehicles. More recently, another study from Türkiye revealed that bacterial contamination was highly prevalent on mobile phones of medical students, especially among those with clinical exposure, with isolates including both commensal and pathogenic organisms [2]. Complementing these findings, a systematic review and meta-analysis from Africa reported a pooled prevalence of contamination exceeding 70% among mobile phones of healthcare workers, confirming that this issue represents a global concern [3].

Taken together, the literature strongly supports the view that mobile phones may serve as important but often overlooked vectors of infection, warranting attention in infection control policies. In our study, we aimed to address this issue by conducting a research project with a group of second-year medical students within the framework of evidence-based medicine practices. We evaluated the mobile phones of our faculty's students both before and after clinical exposure, and additionally included the mobile phones of healthcare workers outside the group of hospital-employed students.

MATERIALS AND METHODS

This cross-sectional study was conducted at İnönü University Faculty of Medicine (Malatya, Türkiye) between February and March 2024. The research was designed and implemented in collaboration with a group of second-year medical students within the framework of evidence-based medicine practices. The study was approved by the Inonu University Health Sciences Scientific Research Ethics Committee (Decision No: 2025/7105, Date: March 11, 2025).

Study population

Participants were divided into two groups:

- Hospital-exposed group (n = 94): clinical medical students in years 4–6 and healthcare workers with direct exposure to hospital wards.
- Non-hospital-exposed group (n = 109): preclinical medical students in years 1–3 without hospital exposure.

Sample vollection and processing

Sterile cotton swabs were used to collect surface samples from participants' mobile phones. Each swab was immediately inoculated into Mueller-Hinton broth and then cultured for bacterial growth.

Identification of isolates

Bacterial isolates were identified using standard microbiological techniques, including colony morphology, Gram staining, and conventional biochemical tests.

Statistical analysis

Descriptive statistics were used to summarize contamination rates and bacterial species distribution. The difference in the proportion of positive cultures between hospital-exposed and non-hospital-exposed participants was evaluated using the chi-square (χ^2) test. Statistical significance was defined as $p < 0.05$. All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 26.0 (IBM Corp., Armonk, NY, USA).

Since no a priori sample-size calculation was performed before data collection, a post-hoc power analysis was conducted based on the observed effect size. Using GPower (version 3.1), with $\alpha = 0.05$ and an effect size (w) of 0.40 obtained from the observed frequencies (62/94 vs. 28/109), the achieved power ($1 - \beta$) was calculated as 0.99, indicating that the sample size (n = 203) was adequate to detect a statistically significant difference between groups.

RESULTS

A total of 203 mobile phone surface swabs were analyzed. Among the hospital-exposed group (n = 94), 62 samples (65.9%) yielded bacterial growth, whereas in the non-hospital-exposed preclinical student group (n = 109), only 28 samples (25.7%) were positive (Table 1). The contamination rate was significantly higher among hospital-exposed participants compared with non-hospital-exposed preclinical students ($\chi^2 = 33.1$, $p<0.001$). The post-hoc power of this comparison was 0.99 ($\alpha = 0.05$, effect size w = 0.40). Pathogenic bacteria were more frequently isolated from hospital-exposed phones compared with non-hospital-exposed phones. Notably, *Staphylococcus aureus*, *Pseudomonas spp*., and *Acinetobacter baumannii* were identified only in the hospital-exposed group. In contrast, isolates from preclinical students' phones were predominantly commensal skin flora such as *Staphylococcus epidermidis* and *Staphylococcus haemolyticus* (Table 2).

DISCUSSION

Our findings demonstrate a significantly higher rate of bacterial contamination on mobile phones belonging to healthcare workers and clinical medical students compared with those of preclinical stages of their studies. Importantly, hospital-associated pathogens such as *Staphylococcus aureus*, *Pseudomonas spp.*, and *Acinetobacter baumannii* were exclusively isolated from the hospital-exposed group, whereas devices from the non-hospital exposed group carried only commensal skin flora. This observation strongly suggests that being in the hospital environment facilitates the acquisition and carriage of nosocomial microorganisms on personal devices.

These results are consistent with prior studies from both low- and high-income countries, which have reported contamination rates of over 70% among healthcare workers' mobile phones [3]. Lubwama et al. showed that final-year medical students in Uganda frequently harbored hospital-acquired bacteria on their phones and hands, highlighting the role of

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Table 1. Bacterial contamination rates according to study groups.

Group	Total phones (n)	Positive cultures, n (%)
Hospital-exposed (clinical students & HCWs)	94	62 (65.9)
Non-hospital-exposed (preclinical students)	109	28 (25.7)

Table 2. Distribution of bacterial isolates from contaminated mobile phones.

Bacterial species	Number of isolates (n)
Staphylococcus aureus (none MRSA)	4
Pseudomonas spp.	2
Acinetobacter baumannii	2
Enterococcus faecalis	1
Stenotrophomonas maltophilia	1
Bacillus spp.	3
Staphylococcus epidermidis	36
Staphylococcus haemolyticus	7

mobile devices as potential vectors of healthcare-associated infections (HAIs) [1]. Similarly, the systematic review and meta-analysis from Africa confirmed that mobile phone contamination is a widespread issue, with pathogenic species frequently isolated from devices used in clinical environments [3]. In Türkiye, Ünal et al. also reported that bacterial colonization was significantly higher in medical students with hospital exposure compared to their preclinical peers [2].

The absence of pathogenic isolates among preclinical students in our study further emphasizes the influence of hospital exposure on the microbial profile of mobile phones. This supports the notion that mobile phones act as reservoirs in the infection chain, enabling indirect transmission of hospital pathogens between patients, healthcare workers, and the community. Although hand hygiene remains the cornerstone of infection prevention, the continuous handling of contaminated devices can compromise infection control efforts if mobile phone hygiene is neglected.

From a public health perspective, this highlights the importance of not only strict adherence to hand hygiene protocols but also the integration of mobile phone decontamination into standard infection control policies. Regular cleaning of devices with approved disinfectants, coupled with educational interventions for both healthcare workers and students, is essential to minimize cross-contamination risks. Furthermore, reinforcing awareness of device hygiene during medical training may help reduce the silent spread of HAIs and protect both patients and healthcare providers. A study conducted in Southern Ethiopia found that health professionals whose mobile phones were cleaned after each use or at least once daily were significantly less likely to have contaminated devices. Conversely, lapses in handwashing before patient contact dramatically increased contamination risk—those who did not wash hands were nearly 13 times more prone to having contaminated phones [4].

Similarly, environmental contamination within hospitals is not restricted to mobile devices. In a study evaluating hospital public toilets, Altunışık Toplu et al. reported that 26% of 85 samples grew Gram-negative bacteria, although no carbapenem resistance was detected. Notably, 31% of individuals did not wash their hands at all after toilet use, and 27% practiced improper handwashing [5]. These findings emphasize that shared hospital environments, such as toilets, may also serve as reservoirs for nosocomial microorganisms if hand hygiene is neglected. Together with our results, this underscores the dual importance of both personal device hygiene and strict adherence to hand hygiene practices in mitigating the risk of cross-contamination and the spread of healthcare-associated infections.

Our findings highlight that mobile phones used in hospital settings are more likely to harbor potentially pathogenic microorganisms compared with those of preclinical students, supporting their role as overlooked reservoirs in the infection chain. This reinforces the importance of considering personal devices within infection prevention strategies.

It is important to implement infection control measures; however, broader reviews and evidence mappings have emphasized that despite the well-recognized potential of mobile phones to act as vectors of nosocomial pathogens, these devices are frequently overlooked in routine disinfection protocols. This gap in practice highlights the need for formal guidance and educational strategies to ensure mobile device cleanliness in clinical care areas [6].

Taken together, these findings underscore the necessity of integrating mobile phone decontamination into infection control policies, alongside strict hand hygiene compliance. Regular cleaning with approved disinfectants and educational interventions targeting both healthcare workers and students can substantially reduce cross-contamination risks. Practical recommendations include routine cleaning of mobile devices with 70% ethanol-based disinfectants or the use of UV sterilizers, both of which have been shown to effectively reduce mi-

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crobial contamination [7, 8]. Reinforcing awareness of device hygiene during medical training may further help prevent the silent spread of HAIs and protect both patients and healthcare providers.

Limitations

This study has some limitations. The study did not assess antibiotic susceptibility profiles, viral contamination, or fungal flora, which could provide a more comprehensive overview of the microbial spectrum. Furthermore, detailed data regarding the departments and duration of hospital exposure for participants with nosocomial pathogens were not collected, as the study design prioritized anonymity.

CONCLUSION

Our results indicate that mobile phones used in hospital environments serve as reservoirs for potentially pathogenic microorganisms and may contribute to the transmission of healthcare-associated infections. The absence of such pathogens among preclinical students emphasizes the role of hospital exposure in shaping device. Regular disinfection of mobile phones, strict compliance with hand hygiene, and the incorporation of device hygiene education into medical training are essential strategies to minimize cross-contamination risks and strengthen infection prevention efforts.

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