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Article

Mobile Phones as Reservoirs of Antimicrobial-Resistant Pathogens in Healthcare Settings: Roles of *Staphylococcus aureus* and *Acinetobacter baumannii*

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SUMMARY

Mobile phones used by healthcare workers are increasingly recognised as potential reservoirs of antimicrobial-resistant pathogens in clinical settings. This review discusses the existing evidence on antimicrobial-resistant bacteria on mobile phones of healthcare professionals, with reference to *Staphylococcus aureus* and *Acinetobacter baumannii*. The recovery of methicillin resistant *S. aureus* (MRSA) and multidrug resistant *A. baumannii* from mobile phones highlights the possible significance of these devices in the spread of antibiotic resistance organisms in health care settings. Poor hand hygiene, inadequate device cleaning, and unrestricted phone use in healthcare settings are among the factors that contribute to contamination and transmission of these AMR pathogens. Routine cleaning, staff education, surveillance, and institutional policies embedding mobile phone hygiene into current infection prevention and control programs may help reduce contamination and limit the spread of healthcare-associated infections.

Keywords: Mobile phones; Antimicrobial resistance; Healthcare-associated infections; *Staphylococcus aureus*; *Acinetobacter baumannii*

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INTRODUCTION

Mobile phones have become essential tools in modern healthcare, supporting communication among medical professionals, access to clinical information, telemedicine, clinical decision-making, and patient follow-up [1,2]. Their portability and constant availability make them valuable in fast paced clinical environments such as hospital wards, emergency departments, outpatient clinics, and intensive care units. However, frequent handling raises concerns about their role as fomites and secondary reservoirs for antimicrobial-resistant pathogens, especially since they are not consistently included in routine decontamination protocols [3].

Healthcare-associated infections remain a major cause of morbidity, mortality, prolonged hospital stay, and increased healthcare costs worldwide [4]. Their control has become more difficult in the era of antimicrobial resistance (AMR), in which multidrug-resistant organisms can persist in healthcare settings and limit available treatment options. In this context, attention has increasingly shifted toward overlooked reservoirs and transmission routes that may support the persistence and spread of resistant pathogens in hospitals. Mobile phones are particularly relevant because they are repeatedly touched during patient care, often with limited hand hygiene between phone handling and clinical contact and may therefore serve as bridge fomites linking healthcare workers' hands, contaminated hospital surfaces, and susceptible [5].

Evidence from hospital-based studies and systematic reviews shows that bacterial contamination of healthcare workers' mobile phones is common, with *Staphylococcus aureus*, coagulase-negative staphylococci, *Escherichia coli*, *Klebsiella* spp., *Pseudomonas* spp., and *Acinetobacter* spp. among the organisms frequently recovered [6,7]. The presence of antimicrobial-resistant organisms on these devices is of particular concern because mobile phones are personal items that may escape routine infection prevention and control oversight while remaining in constant circulation within clinical environments. Although direct evidence that contaminated phones independently cause healthcare-associated infections remains limited, current evidence supports their role as potential secondary reservoirs and contributors to microbial transmission networks in healthcare settings, rather than as harmless personal accessories [8].

Among the pathogens recovered from healthcare workers' mobile phones, *Staphylococcus aureus* and *Acinetobacter baumannii* are of particular importance because of their clinical relevance, persistence in hospital environments, and association with antimicrobial resistance. *Staphylococcus aureus*, especially methicillin-resistant *S. aureus* (MRSA), remains one of the most important causes of healthcare-associated infections and is readily transferred to frequently handled devices because of its close association with human skin and nasal carriage [9]. In contrast, *A. baumannii* is less strongly associated with normal human carriage but is notable for its ability to survive on abiotic surfaces, persist in dry hospital conditions, and accumulate multidrug resistance determinants, particularly in high-risk units such as intensive care units. These differences in ecological behaviour make the two organism's useful models for understanding how mobile phones may participate in both direct contact-mediated and environmentally mediated transmission of antimicrobial-resistant pathogens in healthcare settings [10].

This review examines the contribution of healthcare workers' mobile phones to the contamination, persistence, and dissemination of antimicrobial-resistant pathogens in healthcare environments, with particular emphasis on *Staphylococcus aureus* and *Acinetobacter baumannii*. It synthesises current evidence on the prevalence and routes of contamination, the biological and resistance-related traits that support persistence, and the implications of mobile phone contamination for infection prevention and control in healthcare settings.

Mobile Phone Contamination in Healthcare Settings

Prevalence, microbial burden, and determinants of contamination

Bacterial contamination of healthcare workers' phones has been consistently reported across hospitals and healthcare centres around the world [10–12]. Recent systematic reviews and meta-analyses report that bacterial contamination of healthcare workers' phones is widespread, with pooled prevalence estimates often exceeding 80%, although individual studies show considerable variation depending on clinical setting, sampling strategy, culture methods, and definitions of contamination [3,6,8,13]. Findings across hospital-based studies support the conclusion that microbial contamination of mobile phones is a recurrent feature of device use in healthcare environments, rather than an isolated or region-specific issue [14–16].

The frequently recovered microorganisms from healthcare workers' phones include normal flora of the skin, other opportunistic pathogens and clinically relevant multidrug-resistant organisms [17]. This composition is often influenced by the healthcare environment, the population of patients, antimicrobial prescribing practices in the facilities and the closeness or intensity of patient contact. Several studies conducted in higher risk clinical certain, like ICUs, emergency wards report a higher recovery of healthcare associated pathogens than other lower risk areas within the hospitals. This demonstrates the greater environmental burden of this pathogen in relation to the frequency and occurrence around the hospital environment [18]. Common isolates from healthcare workers' phones include MRSA, extended spectrum B-lactamase producing enterobacterales, multidrug-resistant acinetobacter and other resistant bacteria on healthcare worker's phones [19]. The repeated detection of these organisms indicates that mobile phones can accumulate microbial communities originating from both the user's skin flora and the clinical environment [20].

Several connecting factors determine the level of contamination observed on mobile phones. These include the frequent handling during patient care, failure to adhere to hand hygiene regulations, the use of phones while wearing gloves, storage of phones in contaminated workspaces, the absence of the practice of disinfecting the phones regularly, and the movevent between multiple clinal environments. All of this increases the chances of microorganisms to accumulate on the phone surfaces [21].

Mobile phones as secondary reservoirs within healthcare transmission networks

Evidence consistently shows that the primary route of mobile phone contamination in healthcare settings is repeated contact between the device and healthcare workers' hands. During routine clinical activities, phones are often handled before, during, or shortly after contact, frequently without intervening hand hygiene or device decontamination [22]. This creates a bidirectional pathway, allowing microorganisms to transfer from colonised or contaminated hands to mobile phone surfaces and then back to hands, with the potential to reach patients, equipment, or environmental surfaces. In effect, mobile phones function as extensions of the hands: when hand hygiene is inadequate, device contamination is highly likely; if the device is not cleaned, it can serve as a source of repeated recontamination even after handwashing [23,24].

Contamination of the environment also contributes substantially, especially in high-contact and high-acuity settings such as intensive care units, emergency departments and surgical wards. In these places, healthworkers frequently move between patients, equipment and other shared surfaces [25]. In these environments, mobile phones may acquire microorganisms not only from the user's hands but also indirectly from contaminated fomites within the care setting. However, behavioural factors remain central to the persistence of contamination, as it has been found that most healthcare workers do not exactly adhere to recommendations for hand hygiene developed by the World Health Organisation guidelines on disease prevention [26].

The epidemiological importance of mobile phone contamination also encompasses the role that phones may play in connecting various components of the hospital microenvironment. They are not like stationary environmental surfaces, mobile phones accompany healthcare workers as they move about, across wards, nursing stations, laboratories (including lab benches with patient samples), and staff-only spaces. This movement increases the chances that organisms picked up from one location are transported to another, potentially acting like a bridge between colonized hands, contaminated surfaces and susceptible patients within the same transmission network [27]. Mobile phones should therefore be regarded not as isolated contaminated objects, but as portable bridge fomites capable of facilitating repeated cycles of microbial transfer.

Staphylococcus aureus and Mobile Phones

Colonisation, contamination, and clinical significance

Staphylococcus aureus is one of the organisms most consistently recovered from healthcare workers' mobile phones, and its frequent detection is biologically unsurprising because it is closely linked to human carriage. The organism commonly colonises the anterior nares, skin, and hands, allowing healthcare workers and colonised patients to act as continuous sources of contamination within clinical environments [28]. In hospitals, repeated contact between colonised healthcare workers, patients and shared clinical environments speeds up the deposition of S. aureus onto mobile phone surfaces during routine patient care. Recovery of the organism from healthcare workers' phones has been reported consistently across hospitals globally [29].

S. aureus is an important pathogen to be considered in any discussion around nosocomial infections, because it's still one of the leading causes. It is responsible for a wide spectrum of diseases, ranging from skin and soft tissue infections to surgical site infections, pneumonia, and bloodstream infections, and is frequently associated with infections involving medical implants [30–32]. In the context of mobile phone contamination, the significance of *S. aureus* lies in its ecology, which favours repeated transfer among colonised individuals, hands, and fomites during patient care. Mobile phones, therefore, represent a plausible extension of the established hand-mediated transmission pathway of *S. aureus*, especially where hand hygiene and phone disinfection are inconsistent [33].

Persistence of *S. aureus* on mobile phone surfaces

S. aureus can survive on mobile phones for extended periods because of several biological characteristics that help it persist on dry, frequently touched surfaces. It can tolerate desiccation, allowing it to persist on inanimate surfaces for extended periods. This increases the likelihood of continuous contamination of frequently handled devices [34]. This characteristic is particularly relevant in hospital environments, where phones are repeatedly handled, stored in pockets or at workstations, and may not be disinfected as regularly as standard medical equipment. Another trait of *S. aureus* is that it readily forms biofilms on abiotic surfaces, including plastics and glass, which are components of mobile phones. Research conducted in 2025 found that biofilm formation enhances the environmental persistence of *S. aureus* on surfaces. This is achieved by reduced susceptibility to cleaning agents and increased tolerance to antimicrobials [35].

The infection prevention implications become even more significant when the recovered isolates are methicillin resistant. MRSA possesses the same environmental survival characteristics as methicillin-susceptible *S. aureus* while exhibiting resistance to β-lactam antibiotics through acquisition of the *mecA* or *mecC* genes, often accompanied by resistance to multiple additional antimicrobial classes [26]. Numerous studies have reported MRSA on healthcare workers' mobile phones, indicating that these devices may harbour clinically important resistant strains rather than only susceptible commensal isolates [6,36].

Transmission of *S. aureus* mostly involves contact-based dissemination. Mostly *S. Aureus* spreads from patients who have *S. Aureus* to the hands of healthcare workers to their mobile phones and then back to their hands or to other patients [21]. Even though some molecular studies have identified genetic connections between S. aureus isolates from hospital equipment and from patients, most of those studies have been cross-sectional. As a result, phones are considered potential contributors to S. Aureus spread but are not necessarily the primary source of infection [37].

Acinetobacter baumannii as a mobile phone-associated pathogen

Clinical relevance, environmental persistence, and contamination of mobile phones

Acinetobacter baumannii is an aerobic Gram-negative coccus that has become one of the most problematic pathogens in modern hospital practice since its discovery in the 1980s [38]. It causes opportunistic infections of the skin, urinary tract, lungs, and bloodstream [39]. *Acinetobacter baumanii* has also been implicated as a harmful nosocomial pathogen and is a cause of concern, especially for critically ill patients and those with weakened immunity. It’s frequently involved in hospital outbreaks. Carbapenem-resistant *A. baumannii* is a particularly important infectious agent, and it was considered as a priority 1 (critical) in the WHO priority pathogens list for research and development of new antibiotics [40].

Compared with *Staphylococcus aureus*, *A. baumannii* is recovered less frequently from healthcare workers' mobile phones, but its presence is often more concerning from an epidemiological standpoint. Whereas *S. aureus* contamination commonly reflects transfer from colonised skin or hands, *A. baumannii* contamination more often points to environmental contamination within high-risk clinical settings [41]. Several studies have recovered *Acinetobacter baumannii* from the phones of health care personnel, especially in units or wards with high patient populations, such as ICUs and emergency departments [42]. In most cases, its presence on phones is thought to reflect contamination from the hospital environment rather than direct transfer from the worker's own microbiota. That distinction matters. It suggests that mobile phones function less as personal microbial reservoirs and more as extensions of contaminated clinical surfaces.

Survival mechanisms, antimicrobial resistance, and transmission relevance

Acinetobacter baumanni has emerged as a successful and troublesome pathogen due to its ability to endure adverse conditions. Unlike many hospital-associated bacteria, *A. baumannii* can tolerate desiccation and remain viable on dry abiotic surfaces for prolonged periods. This explains why *A. baumanii* can persist on plastics, bed rails, monitors, chairs, tables and other frequently touched equipment within healthcare settings [43]. This survival characteristic is a very good contributor to mobile phone contamination because phones are handled repeatedly between patient-care spaces. Once introduced onto the surface of the phone, *A. baumanii* may persist long enough to contribute to repeated contamination cycles. This is very pronounced in wards where the environmental burden is already high. Persistence is further strengthened by the organism's ability to form biofilms and also to accumulate multiple resistance determinants [44].

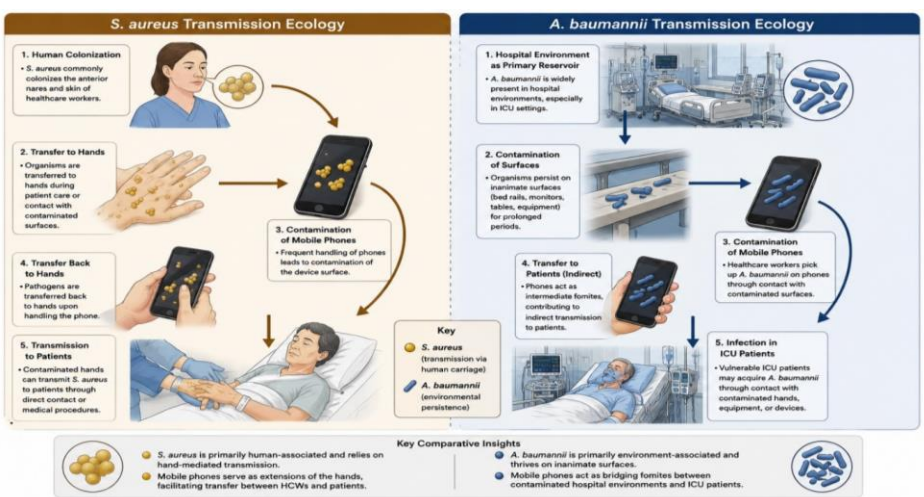

Figure 1: Comparative Transmission Ecology of Pathogens on Mobile Phones

A. baumannii is one of the notorious ESKAPE organisms (*Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *A. baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter spp.*), that currently threaten global health and pose a big therapeutic challenge due to their increasing resistance. Since 2018, the WHO has listed Carbapenem resistant *A. baumannii* (CRAB) as number one priority for antibiotic agent research and development of drugs, including alternative therapies [45]. *A. baumannii* acquires resistance to antibiotics through several mechanisms such as altering the antibiotic target site, efflux pump overexpression, reduced membrane permeability or rendering them neutralized by enzymatic modification of the antibiotics amongst others [46]. These mechanisms have contributed to cases of persistent hospital outbreaks and limited therapeutic options associated with *A. baumanii* [45]. The fundamental concern is that once introduced into clinical settings, resistant bacteria are difficult to eradicate and may persist in environmental reservoirs, including regularly used equipment.

Transmission of *A. baumannii* in hospital settings is predominantly environmental and contact based. The pathogen spreads via contaminated surfaces, medical equipment, healthcare workers' hands, and hospital fomites. Mobile phones may contribute to this cycle by serving as temporary reservoirs that facilitate persistence between cleaning cycles in the hospital environment [44]. Mobile phones should be regarded as bridge fomites (Figure 1), allowing the transfer of organisms between contaminated hospital surfaces and patient-care activities, especially in ICUs where the environmental load is high.

Infection Prevention and Control Considerations

Integrating mobile phone hygiene into routine infection prevention practice

The widespread use of mobile phones in healthcare settings presents a practical challenge for infection prevention because mobile phones are essential for work in the healthcare space and while also serving as frequently handled personal items. Given the role they play in modern healthcare, complete restriction is impracticable. Instead, infection prevention efforts should focus on reducing the opportunites for transfer of microorganisms by incorporating mobile phone hygiene into existing infection prevention protocols in the hospitals [47].

Effective hand hygiene remains the biggest means for tackling contact-mediated transmission cycle of microorganisms and should be extended to the use of mobile phones in hospitals and other health care facilities [48]. In healthcare settings, mobile phones basically behave as extensions of the hands; thus, poor hand hygiene before or after phone use could reintroduce organisms into patient-care workflows even when other environmental cleaning measures are in place. This makes gadget hygiene difficult to differentiate from hand hygiene in practice. The most effective treatment is therefore likely to be an integrated approach in which mobile phone use is deliberately incorporated into standard hand hygiene. In practical terms, this means encouraging hand hygiene after phone handling in patient-care areas and reinforcing the idea that mobile devices, like stethoscopes or ID badges, can act as transient fomites when used during clinical care. This is part of the recent WHO guidelines for infection prevention and control in hospitals [26].

Routine decontamination of mobile phones provides an additional opportunity to reduce microbial burden. Some studies have shown that cleaning mobile phones can really reduce the number of bacteria and other pathogens on them. Although, the durability of this effect depends on how soon they're exposed again during routine use by the health workers. In a study done in 2024 they used 70% isopropyl alcohol wipes and ultraviolet-C light. Both ways worked well to reduce bacteria on the phones. The phones got contaminated again, due to exposure after a few hours. This shows that there's need to clean them not just once [49]. In another study more recently, a pre–post trial demonstrated a significant decrease in microbiological contamination after cleaning with 70% isopropanol. This suggests that alcohol-based wiping can be a practicable intervention in hospital settings, including hospitals located in low- and middle-income countries [50].

Policy considerations for healthcare facilities

Not every area of the hospital environment has the same level of risk. In high-acuity settings such as intensive care units, operating theatres, neonatal units and transplant wards have vulnerable patients and MDR organisms are common. the institutional policy should limit the non-essential phone handling during direct patient contact should be avoided [48]. In these situations' hospital staffers using their cell phones without control can accidentally spread germs. This does not mean that mobile phones should be completely banned, especially if they are important for communication and work. It could also require healthcare workers to routinely clean their mobile phones and wash their hands before and after using their phones in such high-risk locations within the hospital environment.

Institutional policies should also support staff education on appropriate mobile phone use within clinical environments. Although healthcare workers are generally aware of the importance of hand hygiene, awareness of mobile phone contamination and appropriate device cleaning practices is often less consistent. Incorporating mobile phone hygiene into infection prevention training, routine audits, and antimicrobial resistance programmes may improve compliance while reinforcing the concept that phones should be managed alongside other frequently handled non-critical equipment [8].

Routine microbiological monitoring of phones for germs is not the usual practice in hospitals or other health care facilities. Tailored monitoring and tracking may be effective in epidemic investigations. For example, if there is a disease outbreak situation, checking things that people touch a lot, like phones, might help find out where the germs are coming from. Mobile phones can be reservoirs of pathogens that we might not know about. Checking phones might help us understand how germs are spreading in a particular area [10].

CONCLUSION

Mobile phones used by healthcare workers are often laden with clinically important bacteria and other pathogens. Among the most common and are *Staphylococcus aureus* and rarely but worrisome, *Acinetobacter baumannii.* Current evidence supports the role of these phones as secondary reservoirs in hospital environments; as this phones from research, are part of the transmission cycle of these nosocomial pathogens, rather than direct cause. Because the use of these devices is now imperative to everyday health worker-patient care routines, mobile phone hygiene should be included in infection prevention and control strategies. These strategies can include hand hygiene reinforcement, routine cleaning of the devices, staff education, and strict institutional policies in the health centres. There's also need for further longitudinal and molecular epidemiological research, as most available research is cross-sectional. This is required to understand the extent to which mobile phone contamination contributes to transmission in clinical settings.

Authors Contribution

JME and ENE conceptualized the study. JME, ENE, and UYA designed the study. JME prepared the first draft of the manuscript, reviewed by ENE, UYA, MGL and KSU. All authors contributed to the development of the final manuscript and approved its submission.

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