

## **MOBILE PHONES AS RESERVOIRS OF BACTERIA: A REVIEW**

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### **ABSTRACT**

Mobile phones culminate the features of many devices such as cameras and laptops, into a single device, which is probably the reason for their widespread popularity. These devices have made immense contributions to the field of communication.

Mobile phones have recently come under scrutiny as they may act as ‘Trojan Horses’ and serve as vectors of disease causing organisms. The issue of mobile phones harboring pathogenic bacteria is even more pronounced in the healthcare setup as these devices may play an active role in the dissemination of nosocomial or hospital acquired infections.

It is suggested that people, especially those working in sensitive areas such as hospitals, should follow good hygienic practice and try to wash their hands after using mobile phones. It is also recommended that mobile phones should be decontaminated regularly.

Mobile phone manufacturers should provide a procedure to decontaminate mobile phones and also create awareness among the public.

**KEYWORDS:** Bacteria, Disease, Hospital, Mobile Phones

### **INTRODUCTION**

With rapid advancement in technology, mobile phones have become commonplace and are indispensable accessories in the present day scenario. Mobile phones culminate the features of many devices such as cameras and laptops, into a single device, which is probably the reason for their widespread popularity. These devices have made immense contributions to the field of communication, thereby improving accessibility even in remote areas. Mobile phones have also led to improvement in healthcare, education, industrial and many other sectors, where information is now available at the press of a button.

But in spite of the many positive effects on the society, mobile phones have recently come under scrutiny as they may act as ‘Trojan Horses’ and serve as vectors of disease causing organisms. As mobile phones are used in close proximity to the body and are often in direct contact with the skin, it is but natural for them to harbor the normal flora of the skin, some of which may be opportunistic pathogens. But the constant handling of mobile phones also exposes them to an array of microorganisms present in the environment and as mobile phones are oft warm and rarely cleansed, they can serve as active breeding ground for bacteria, as has been shown in previous studies, with population densities of up to 10,000 microbes per square inch.<sup>1,2</sup>

The issue of mobile phones harboring pathogenic bacteria is even more pronounced in the healthcare setup as

these devices may play an active role in the dissemination of nosocomial or hospital acquired infections. Studies have shown that the hospital environment serves as a reservoir of nosocomial pathogens as these pathogens can survive on environmental surfaces for months.<sup>3</sup> The bioburden of pathogens may vary with different activities of patients such as coughing and sneezing, which expels pathogens into the hospital environment. These pathogens might get adhered onto the mobile phones of doctors as well as other patients and can lead to the dissemination of nosocomial infections among their family members as well as other people who might be using the phones. These infections may be severe in sensitive areas such as Intensive Care Units (ICUs) and other wards due to the immunocompromised status of the patients. The pathogenic organisms may also be multi drug resistant, referred to as 'superbugs', and the infections caused by these organisms may be recalcitrant.<sup>4</sup>

Many studies have been conducted in the recent years to study the growth of bacteria on mobile phones:

In a study conducted by H.-C. Jeske, et al in 2007, consisting of 40 subjects, regarding the contamination of anesthetists' hands by personal mobile phone and fixed phone use and found that the hands of 38 subjects were contaminated with bacteria after a short phone call. In case of fixed phones, 33 physicians' hands were contaminated. In both cases, 10% of the physicians showed bacterial contamination with human pathogenic bacteria, raising questions about the potential benefit of using mobile phones in the Operating Room or in the ICU.<sup>5</sup>

The bacterial contamination of mobile phones of healthcare workers had growth in 111 out of 122 samples. Bacteria that might be associated with hospital infection were isolated in only ten (9.0%) samples. Oguz Karabay et al (2007) concluded that mobile phones may serve as a vehicle for the spread of nosocomial pathogens. Since the same mobile phones are used both outside and inside of hospitals, these contaminated phones may play some role in the spread of hospital acquired infections in the community. They suggested that healthcare workers should practice increased adherence to precautions such as hand hygiene and should be informed that these devices could serve as a source for transmission of hospital-acquired infections.<sup>6</sup>

The hands and mobile phones of 150 randomly selected healthcare workers (HCWs) in three teaching hospitals in Iran were examined for the presence of organisms and it was found that a total of 48 (32.0%) mobile phones and 59 (39.3%) dominant hands had bacterial contamination. The kind of isolated microorganisms and their susceptibility to commonly used antimicrobials from dominant hands were almost similar with those from phones. Gholamreza Sepehri et al (2007) concluded that mobile phones could be an important source for the spread of antibiotic resistance bacteria.<sup>7</sup>

Brady et al (2007) found that 89.7% of the mobile phones included in their study were contaminated with bacteria. Such high rates of bacterial contamination of mobile communication devices in the operative environment is a cause of serious concern.<sup>8</sup>

Ramesh J et al (2008), in a study of 101 mobile phones of medical staff found that 45% were culture-positive and 15% grew Gram-negative pathogens. They also noted that only 3% of the subjects reported washing their hands after use of mobile phones and 53% reported never cleaning their phone. Mobile phones are used widely by staff and are considered by most participants as a more efficient means of communication. However, microbial contamination is a risk associated with the infrequent cleaning of phones and could lead to nosocomial infections. They recommended that hospitals should develop policies to address the hygiene of mobile phones.<sup>9</sup>

DH Tambekar et al (2008) analyzed 75 doctors' mobile phones and observed growth of organisms from 71

subjects. They isolated a total of 90 bacterial pathogens from these 71 mobile phones. They also noted that the male doctor's mobile phones were more (69%) contaminated as compared to female doctor's phones (31%). The study demonstrated that mobile phones, in a clinical setting, may become contaminated by contact with healthcare workers' hands and can thus act as a potential source to spread infection.<sup>10</sup>

In a study by Fatma Ulger et al (2009) to determine the contamination rate of HCWs mobile phones, it was found that 94.5% of mobile phones demonstrated evidence of bacterial contamination with different types of bacteria. The distributions of isolated microorganisms from mobile phones were similar to hand isolates. They also found that some mobile phones were contaminated with nosocomial virulent pathogens. Mobile phones used by HCWs may be a source of nosocomial infections.<sup>11</sup>

A high percentage (62.0%) of bacterial contamination from the mobile phones of 400 individuals was found by Kabir O. Akinyemi et al, in their study conducted in 2009. They formed groups categorized by the owners of the phones as follows: Group A was comprised of 100 food vendors; Group B, 104 lecturers/students; Group C, 106 public servants; and Group D, 90 health workers and found that mobile phones in Group A had the highest rate of contamination (92; 37%), followed by Group B (76; 30.6%), Group C (42; 16.9%), and Group D (38; 15.3%).

This suggests that mobile phones may serve as vehicles of transmission of both hospital and community-acquired bacterial diseases and strict adherence to infection control such as hand washing is recommended. The study shows that bacterial contamination of mobile phones is significant both in the healthcare setup as well as in other areas.<sup>12</sup>

Padma Srikanth, et al, (2009) conducted a study on the potential for mobile phones to harbor microorganisms in both hospital and non-hospital settings. They sampled mobile phones of 51 healthcare workers (HCW) and 36 corporate users and detected polymicrobial growth in 71% HCW and 78% corporate mobile phones respectively. The high level of contamination of mobile phones irrespective of the environment indicates the potential threat of mobile phones in spreading infections. The isolation of Methicillin Resistant Staphylococcus Aureus (MRSA) from HCWs mobile phones is also a cause for concern in the spread of nosocomial infections. It was observed that even though 38 (75%) HCWs and 11 (37%) of corporate users were aware that mobile phones harbor microorganisms and transmit infectious agents, of these only 12 % HCWs used disinfectants to wipe their mobile phones.<sup>13</sup>

By comparing the nature of the growth of pathogens on cell phones in both the hospital and community, Kiran Chawla et al (2009) found that 75% cell phones from both the categories grew at least one potentially pathogenic organism. However, the samples of mobile phones of healthcare workers grew significantly more potential pathogens. They also noted that 97.5% healthcare workers included in the study used their mobile phones in the hospital and moreover 57.5% of them never cleaned their phone. It was noted that healthcare workers were lacking awareness of the safety measures as a significant number of them neither clean their hands before and after seeing a patient nor cleaned the mobile phone after using in the hospital set up. They also noted that the awareness at the community level, with rickshaw drivers, food handlers, clerical staff and medical students was much better as majority of them (57.5%) had the idea that microbes can colonize their mobile phones and 32.5% of them cleaned their mobile phones regularly.<sup>14</sup>

Mohamad T Elkholy et al (2010) conducted a study to evaluate the role of mobile phones in relation to the transmission of bacteria from the mobile phones to the health care workers' hands and found that 96.5% of mobile phones were contaminated by bacteria and other microorganisms. The microorganisms isolated from mobile phones and hands

were similar and many of them were known to cause nosocomial infections. It was advised that active preventive policies and strategies must be developed to reduce cross-infection caused by mobile phones.<sup>15</sup>

Anita Pandey et al (2010) carried out a study to investigate the contamination of accessories used by the physicians working in a tertiary care hospital and found that 66% of the pens, 55% of the stethoscopes, 47.61% of the cell phones and 28.46% of the white coats belonging to the physicians were contaminated with bacteria. They noted that *Staphylococcus aureus* (27.5%) was the predominant isolate from the stethoscope, Coagulase Negative *Staphylococcus* (CONS) from the pens and cell phones (26%) and *Escherichia coli* from the white coats (10.77%). The Cross-transmission of these microorganisms by the hands of healthcare personnel from various accessories could be a serious risk to immunocompromised patients.<sup>16</sup>

Sadat Ali et al (2010) found that 109 (43.6%) mobile phones of the 288 healthcare providers included in the study carried infective organisms. These organisms could cause infections in the healthcare workers as well as the patients and thus mobile phones should be cleaned regularly.<sup>17</sup>

Hundred % contamination of all the mobile phone surfaces and high antibiotic resistances to commonly used antibiotics were observed in a study by Daniel N Tagoe et al (2011). They concluded that mobile phones can be heavily colonized by large quantities of pathogenic bacteria and can thus act as potential sources of disease transmission. Periodic cleaning of mobile phones with disinfectants or hand cleaning detergents was recommended.<sup>18</sup>

The analysis of the mobile phones of 50 resident doctors for the growth of microorganisms showed that 30 of them (60%) were contaminated. Coagulase negative *Staphylococci* (71.87%) was the dominant organism, followed by *Diphtheroids* (21.87%). Also in this study by Sandeep B. Kokate, et al (2012), the comparison of mobile phones of male and female resident doctors showed that the proportion of contamination of mobile phones of male resident doctors was more. This might be due to the reason that females keep their mobiles in purses and use less frequently during their duties. On the other hand, male doctors keep their mobiles in their pockets and use them frequently.<sup>19</sup>

In a study conducted by Rawia Ibrahim Badr, et al (2012) on 32 healthcare personnel (12 neurosurgeons, 8 anesthetists and 12 nurses), it was observed that after the use of a mobile phones, the rate of bacterial contamination on the hands increased to 30 (93.7%) same as that found from the mobile phones (93.7%), leading to the conclusion that mobile phones may act as a reservoir of microorganisms that can be transmit infections into the operating environment.<sup>20</sup>

Yazhini Jagadeesan et al (2013) analyzed the rate of microbial contamination of mobile phones of college students and observed that of the 100 mobile phones included in the study, 98% demonstrated evidence of bacterial contamination. They noticed that 85% of the students did not clean their mobile phones regularly.<sup>21</sup>

P.D. Shah et al (2013) investigated the rate of microbial contamination of mobile phones and hands of health professionals in a tertiary care hospital and observed that out 160 samples, 70.62% mobile phones and 64.37% hands demonstrated evidence of microbial contamination. They also noted that the organisms isolated from hands were almost similar to those isolated from the mobile phones. They suggested that the use of mobile phones in hospital setting should be limited to emergency calls only and that awareness should be created among healthcare workers regarding the role of mobile phones as fomites in transmission of diseases.<sup>22</sup>

In a study conducted by Najmeh Parhizgari, et al (2013) in three medical and teaching hospitals in Ahvaz, bacteria were isolated from 90% of the mobile phones of 170 healthcare workers. The number of pathogenic bacteria isolated from

the mobile phones of healthcare staff was significantly more than that from the phones of administrative staff. Coagulase negative Staphylococci (69%) was the dominant species, followed by Bacilli (20.6%) and Acinetobacter spp. (6%). It appears that the microbial flora of clinical staff's mobile phones that are associated more closely with the patients and infectious agents is different from those who are not working in these departments.<sup>23</sup>

Muktar Gashaw, et al (2014) conducted a study on the prevalence of bacteria on the mobile phones of health care professionals in Gondar Town Health Centers which showed that a very high percentage of mobile phones (98% of 58 healthcare professionals) were contaminated with bacteria. Moreover, of the organisms isolated, over 17% were resistant to two drugs. Decontamination of the mobile phones with 70% alcohol significantly decreased the rate of contamination.<sup>24</sup>

Prof. Saurajit Pattnaik, et al (2014) screened the mobile phones of general surgeons for the presence of microorganisms and found that of the 40 mobile phones analyzed, 26 (65%) were contaminated with microorganisms, with Coagulase negative Staphylococci (69.23%) being the dominant organism. As surgeons are often exposed to pathogenic microorganisms during hospital work, their mobile phones may act as a carrier of infection to others.<sup>25</sup>

A study of bacterial contamination of cellular telephone of dental care personnel by Satinder S. Walia et al in 2014 showed 100 (33%) mobile phones were devoid of any growth, while 67% of the mobile phones were found to harbor potential pathogens. The study suggested that fomites such as cellular telephones can potentially act as "Trojan horses" in causing Hospital acquired infections in the dental setting. They recommended staff education, use of dental gloves, hand washing, use of alcohol disinfectant wipes, use of alcohol- chlorhexidine wipes, and consideration of the restrictions regarding the use of cellular telephones in certain high risk areas to reduce bacterial colonization on the cellular telephones of dental care personnel.<sup>26</sup>

Saeedeh Haghbin, et al (2015) investigated the bacterial contamination of cell phones and pens of HCWs employed in pediatric and neonatal ICUs. Growth of microorganisms was observed in 77.11% of the cell phone and 84.34% of pen samples. The most common isolated Gram-positive bacteria were Coagulase-Negative Staphylococci (CoNS) and Gram-negative ones were Pseudomonas species. Their questionnaire revealed that none of participants routinely cleaned their phones or pens before entering the ward, and only 23% washed their hands before using the devices.<sup>27</sup>

In a study of 300 mobile phones of healthcare professionals by S. E. Amala and I. F. Ejikema, (2015) it was seen that the percentage prevalence of isolated bacteria was 80.60%, which was significantly higher than those from the mobile phones of non-medical personnel (25%), suggesting that healthcare workers were more prone to exposure to bacteria. The analysis of the percentage prevalence rate of bacteria on mobile phones by gender revealed that the mobile phones of the males harbored more bacteria (88.6%) than those of their female counterparts (72.6%) for health personnel, which was probably because most women keep their mobile phones in their purses or hand bags, protected from contaminants. It was also found that decontamination of 50 mobile phones that showed heavy growth, with 70% isopropyl alcohol rendered the phones bacteria free on repeat culture.<sup>28</sup> Is isopropyl alcohol the right chemical to disinfect mobile phones?

Heba Sayed Selim et al (2015) conducted a study of 40 mobile phones of patients and health care workers from a hospital and found that all of the tested mobile phones (100%) were contaminated with either single or mixed bacterial agents. It was concluded that mobile phone usage in hospital settings poses a risk of transmission of pathogens.<sup>29</sup>

In a study conducted by Mohammed Heyba et al in 2015 to study the prevalence of microbiological contamination

of mobile phones in intensive care units, it was found that out of 213 mobile phones, 157 (73.7%) showed the growth of microorganisms. Intensive care units are regarded as high risk healthcare settings and the isolation of potential pathogens from mobile phones in these areas is of a major concern. Only 68(33.5 %) of the clinicians who were included in the study reported that they have ever disinfected their mobile phones.<sup>30</sup>

Whether mobile phones of healthcare workers harbor microorganisms of pathological significance was studied by Marwa A. El-Ashry et al in 2015, who found that out of the 200 mobile phone samples collected, 92.5% samples were contaminated. They also noted that 96.5 % participants had never disinfected their phones and 85.5 % were unaware that their phones could carry bacteria.<sup>31</sup>

Shekhar Pal et al (2015) aimed to investigate the rate of bacterial contamination of mobile phones among HCWs in a tertiary care hospital and to compare it with personal mobile phones of non-healthcare workers. The growth of bacterial pathogen was found on 316 mobile phones (81.8%) as compared to 309 hand swab samples (80%), with pathogenic organisms such as *Staphylococcus* species, *Acinetobacter* species, *Escherichia coli* and *Klebsiella pneumoniae* being prominent. They suggested that use of mobile phones in health care setup should be restricted only for emergency calls as these can be a source of hospital acquired infections.<sup>32</sup>

Priyanka W. Deshmukh (2016) isolated a total of 174 colonies belonging to 10 different genera of both Gram positive and Gram negative bacteria from 10 mobiles phones. This study showed that all mobile phones under consideration were infected by several microbes and although most of them belonged to the natural flora of the human body, mobile phones could also serve as a carrier of infections, thereby necessitating the sterilization of hands after contact with phones.<sup>33</sup>

To examine the presence of pathogenic bacteria on the surfaces of cell phones that are used frequently by preclinical medical students, Shadi Zakai et al conducted a study in 2016 and found that out of 105 cell phones screened, 101 (96.2%) were contaminated with bacteria, which indicates that cell phones can act as reservoirs of both pathogenic and nonpathogenic organisms. Coagulase-negative staphylococci were the most abundant isolates (68%). Seventeen (16.2%) cell phones were found to harbor *Staphylococcus aureus*. Gram-positive bacilli were isolated from 20 (19%) samples. Full guidelines about restricting the use of cell phones in clinical environments, hand hygiene, and frequent decontamination of mobile devices were recommended to limit the risk of cross-contamination and healthcare-associated infections caused by cell phones.<sup>34</sup>

As is evident from these studies, it has been found that mobile phones are indeed capable of harboring bacteria. Most of the studies focused on mobile phones in the healthcare setup, probably because the hospital environment is considered to be more contaminated with pathogenic organisms. However, the few studies which also included non-healthcare workers in the sample group, also found evidence of the growth of organisms from mobile phones in relatively high numbers. More studies need to be undertaken to study the growth of organisms on the mobile phones of the non-healthcare workers.

Many of the subjects included in the studies were unaware that mobile phones could lead to the dissemination of infections and those who were aware did not cleanse their phones regularly, possibly because they were unaware of effective decontamination measures. Many studies have found that decontamination of the mobile phones with 70% alcohol significantly decreased the rate of bacterial contamination. However, further study needs to be conducted to know

whether alcohol can be safely used to decontaminate mobile phones without any adverse effects as many mobile phone manufacturers warn against the use of such chemicals for cleansing of mobile phones. Also, people should be made aware that their mobile phones can harbor bacteria and lead to dissemination of diseases.

Many studies also reported the isolation of multi drug resistant organisms, which is of great concern as an antibiotic resistant epidemic may be lurking on the horizon. It will be very difficult to treat the infections caused by these organisms, especially in immunocompromised patients.

It is suggested that people, especially those working in sensitive areas such as hospitals, should follow good hygienic practice and try to wash their hands regularly after using mobile phones. It is also recommended that mobile phones should be decontaminated regularly to prevent the possibility of mobile phones serving as carriers of diseases and those mobile phone manufacturers should provide a procedure to decontaminate mobile phones.

Albeit it may be impractical to set up regulations on the use of mobile phones, their use, especially in sensitive areas should be reconsidered.

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