Microbial contamination of mobile phones used by healthcare workers in a hospital

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***Abstract*—Aim: Microbes that cause nosocomial infections in patients, their families, and the community at large may be present in the mobile phones of medical personnel. The purpose of this study was to look at the microbiological contamination of cell phones in a medical facility.**

Method: Swab samples were collected from 50 different patients and workers at Mewar Hospital. All those samples were taken to the hospital microbiology laboratory. There, we cultured them on MacConkey agar, Blood agar, and SDA agar. After culturing, we observed Gram-positive bacteria, Gram-negative bacteria, and some opportunistic fungi. Then the colonies that appeared were tested for antibiotic sensitivity using the Kirby Bauer method.

Result: When we tested the swabs from all the mobile phones, we found 100% contamination, either with a single bacterial agent or mixed bacteria, along with some fungi. The most commonly found microorganisms were Staphylococcus aureus, E. coli, Bacillus, other bacteria, and the fungi Aspergillus and Candida.

Conclusions: This indicates that mobile phones can act as potential carriers of microbes and may contribute to the spread of infections. Therefore, regular cleaning and proper hygiene practices are important to reduce microbial contamination on mobile phones.

***Index Terms*—Cell phones, bacteria and fungi contamination, hand hygiene.**

I. INTRODUCTION

A mobile phone represents a widely accessible, user-friendly, long-range personal communication technology, designed to be both portable and economically affordable for individuals across diverse social contexts [1]. In today's era, mobile phones have become a very important device in all countries around the world. They are widely used by both professional and non-professional people because they are easily available at a low cost. Mobile phones are used extensively in hospitals by health workers as well as by normal people. While mobile phones have many benefits, they also have disadvantages. They can pose a serious risk to our health. [2] In hospitals, the continuous use of mobile phones has become a source for the spread of microorganisms and health-related infections. It commonly leads to skin infections because the moisture and temperature of the human body promote the growth of these microorganisms. [3] Due to all these reasons, bacteria and fungi can accumulate and reach dangerous levels of infection. When we touch mobile phones, the infection can transfer to our hands, and when we touch our body with the same hands, it can cause infections. [4] We can keep our hands free from microorganisms by using alcohol-based hand rubs or by washing our hands. These facilities are easily available in hospitals, laboratories, and other clinical settings. However, cleaning mobile phones is not easy, and it is difficult to make them completely free from microorganisms. As a result, mobile phones can contaminate other devices, instruments, or equipment [5].

Doctors, nurses, and other medical staff who work in important areas such as the ICU and operating units are in frequent contact with mobile phones. Because of this, they may unknowingly become carriers of infection. Wherever they go, they may spread the infection [6] and even transmit it to patients, even if the patient has not directly come into contact with the mobile phone. [7] These microorganisms can be harmful to the patient's health. Moreover, if these transferred organisms are drug-resistant, their treatment can become even more difficult [8].

II. MATERIAL AND METHOD

Study Design: This cross-sectional study was completed over a period of two months at Mewar Hospital. The study was conducted from December 2025 to January 2026. A total of 50 swab samples were collected from the mobile phones of patients and healthcare workers. These samples were sent to the microbiology laboratory for examination. The mobile phones included in the study belonged to laboratory health workers, ICU staff, nursing staff, patients, and receptionists (each department 10 sample collect).

Sample collection and processing: First, we will take a sterile cotton swab. After that, the swab will be moistened with normal saline because moistening helps microorganisms adhere to the swab easily. Then, samples will be collected from the surfaces of mobile phones, such as the screen, back, buttons, speaker, and cover. [9] After collecting the sample, the swab will be streaked onto culture plates. The culture media used will be MacConkey Agar, Blood Agar, and Sabouraud Dextrose Agar (SDA). The swab will be spread onto the plates using the Streak Plate method to allow well-isolated colonies to develop. [10] After inoculation, the plates will be incubated. The Blood Agar and MacConkey Agar plates will be incubated aerobically at 37 °C for 24 – 48 hours, while the Sabouraud Dextrose Agar plates will be incubated aerobically at 25 °C - 28 °C for 3–5 days. After incubation, observations will be made. Bacterial colonies will be examined for smooth and oval colony morphology, lactose fermentation or non-lactose fermentation, and Homolysis. Fungal colonies will be observed for fluffy or powdery growth. Finally, identification of microorganisms will be carried out using Gram Staining for bacteria and Lactophenol Cotton Blue Stain for fungi, with the help of a microscope. To identify bacteria, many biochemical tests are performed, such as: Sugar fermentation, Indole production, Urease test, Catalase test, Oxidase test, Citrate utilisation test, Phenylalanine deaminase test, Methyl red test, Voges Proskauer test, Mannitol, Coagulase test. [11] An antibiotic sensitivity test is performed using the Kirby Bauer method. This helps determine which bacteria are resistant, which are sensitive, and which show intermediate response to different antibiotics.

Antibiotic sensitivity test: The Clinical Laboratory Standards Institute recommendations, CLSI M100, were followed to conduct the test. This method of Kirby-Bauer disc diffusion. To put it briefly, a sterile tube holding 5 ml of regular normal saline was filled with the pure isolate (3 to 4 colonies) and gently stirred until an even suspension was formed. The bacterial suspension's turbidity was measured using 0.5 McFarland standards. To inoculate Muller-Hinton agar, a sterile cotton swab was dipped in the bacterial suspension. The agar was then permitted to dry at room temperature for 3 to 5 min. antimicrobial drug discs were then added to the Muller-Hinton agar using a disc dispenser, and the mixture was incubated for 18 to 24 hours at 37°C. The diameter zone of inhibition at the ending of the incubation period was measured with a antibiotic zone scale. Following comparison with conventional recommendations, the growth in the inhibition zone was classified as sensitive, intermediate, or resistant. [12]

Antifungal sensitivity test: The recommendations of the Clinical and Laboratory Standards Institute (CLSI), M44 for Candida and M51 for Aspergillus, were followed to conduct the test. This method is based on the disc diffusion technique. To put it briefly, a sterile tube containing 5 ml of sterile normal saline was inoculated with the pure fungal isolate (3 to 4 colonies) and gently mixed until a uniform suspension was formed. The turbidity of the suspension was adjusted according to the 0.5 McFarland standard. For inoculation, a sterile cotton swab was dipped into the fungal suspension and evenly spread over the surface of Muller-Hinton Agar supplemented with glucose and methylene blue (GMB). The inoculated plate was allowed to dry at room temperature for 3–5 minutes. Antifungal discs were then placed on the agar surface using a sterile disc dispenser. The plates were incubated at 35–37°C for 24–48 hours, depending on the fungal species. After incubation, the diameter of the zone of inhibition around each antifungal disc was measured using a zone scale. The results were interpreted as Sensitive (S), Intermediate (I), or Resistant (R) according to standard guidelines. [13]

Data Quality assurance: At Mewar Hospital, we tested 10% of the total samples collected over the entire month. All students who were involved in sample collection were properly instructed about the

standard rules and guidelines for correct sample collection procedures. After collection, all swab samples were properly inoculated onto culture media. The samples were cultured on MacConkey agar and Blood agar, which were incubated at 37°C, while Sabouraud Dextrose Agar (SDA) was incubated at 25–28°C in an aerobic incubator. For staining and sensitivity testing, standard strains of Staphylococcus aureus and Escherichia coli were used. The collected data was analysed twice to ensure accuracy and reliability.

Result: In this study, swab samples were collected from 50 mobile phones belonging to patients and healthcare workers. Samples were taken from five hospital departments.

In **Table 1:** Hospital Laboratory, reception, ICU, pharmacy, and nursing, with 10 samples collected from each department. A total of 50 participants were included in the study, consisting of 8 doctors, 10 workers, 8 technicians, 13 nurses, and 11 patients. Among the mobile phones studied, 60% were touchscreen devices and 40% were keypad phones.

This study showed that most of the samples contained a higher number of microorganisms. Among the departments sampled, the highest percentage of mixed microorganisms was found in the laboratory (100%), followed by pharmacy (90%), nursing (80%), ICU (70%), and reception (50%). In contrast, when observing single microorganisms, none were found in the laboratory 0%, the percentages were 10% in pharmacy, 20% in nursing, 30% in ICU, and 50% in reception.

According to healthcare workers and patients, mixed microorganisms were found in most cases. Among the 8 doctors, 2 (25%) had a single microorganism and 6 (75%) had more than one microorganism. Of 10 workers, 2 (20%) had a single microorganism, and 8 (80%) had multiple microorganisms. Among 8 technicians, 0 (0%) had a single microorganism, while all 8 (100%) had more than one microorganism. Among the nurses, 6 (46.10%) had a single microorganism and 7(53.90%) had more than one microorganism. Similarly, among the 11 patients, 5 (45.45%) had a single microorganism and 6 (54.55%) had more than one microorganism detected.

Table 2: In this table, we observed a large number of microorganisms in 50 swab samples. Among the Gram-positive bacteria, Staphylococcus aureus was found in 56%, Bacillus in 22%, Diphtheroid in 26%, Micrococci in 6%, and CONS (coagulase-negative staphylococci) in 60%. Similarly, among the Gram-negative bacteria, E. coli was found in 12%, Klebsiella in 4%, Enterobacter in 4%, Pseudomonas in 2%, and Proteus in 4%. Talking about fungi, Candida was found in 4% and Aspergillus in 2%.

Table 1: Number of isolated bacterial agents in relation to place, work, and hand hygiene practices

	Number of isolated bacterial agents									
	One Organism		More than one organism		Total		Mean	SD	Median	p- value
	No.	%	No.	%	No.	%				
Place										
Laboratory	0	0	10	100	10	100	6.67	4.71	10	
Reception	5	50	5	50	10	100	6.67	2.36	5	
Canteen	3	30	7	70	10	100	6.67	2.87	7	0.15
Pharmacy	1	10	9	90	10	100	6.67	4.03	9	
Nursing	2	20	8	80	10	100	6.67	3.4	8	
Work										
Doctor	2	25	6	75	8	100	5.33	2.49	6	
Worker	2	20	8	80	10	100	6.67	3.4	8	
Technician	0	0	8	100	8	100	5.33	3.77	8	0.2
Nurse	6	46.1	7	53.9	13	100	8.67	3.09	7	
Patient	5	45.55	6	54.55	11	100	7.33	2.63	6	
Hand Hygiene										
Yes	12	28.56	30	71.4	42	100	28	12.33	30	
No	4	50	4	50	8	100	5.33	1.89	4	0.22

Table 2: Types of isolates of Microorganism from the 50 mobile phones

Organism Type	No. n=50	%
Gram-positive bacteria		
Staphylococcus Aureus	28	56%
Bacillus	11	22%
Diphtheroid	13	26%
Micrococci	3	6%
CONS	30	60%
Gram-negative bacteria		
E. coli	6	12%
Klebsiella	2	4%
Enterobacter	2	4%
Pseudomonas	1	2%
Proteus	2	4%
Fungi		
Candida	2	4%
Aspergillus spec.	1	2%

Table 3: In this table, antibiotic sensitivity testing of Gram-positive bacteria was performed using the Kirby–Bauer disc diffusion method. With the help of antibiotics, we determined which bacteria were sensitive, intermediate, or resistant. The highest sensitivity was observed with Penicillin G (10 µg), Erythromycin (15 µg), Tetracycline (30 µg), and Ciprofloxacin (5 µg).

Table 3: Antibiotic sensitivity test Performance of Gram-positive bacteria

Antibiotic	Drug (µg/Dose)	S/I/R (mm)	Staphylococcus Aureus	Bacillus	Diphtheroid	Micrococci	CoNS
Penicillin G	10µg	S	≥26	≥28	≥30	≥32	≥25
		I	5	2	4	3	7
		R	≤30	≤29	≤31	≤30	≤28
Ampicillin	10µg	S	≥16	≥18	≥12	≥14	≥15
		I	15	15	15	15	15
		R	≤12	≤14	≤11	≤13	≤11
Amoxicillin	20µg	S	≥18	≥19	≥24	≥20	≥17
		I	15	16	16	14	14
		R	<15	<14	<17	<18	<15
Oxacillin	10µg	S	≥13	NA	NR	≥13	≥12
		I	10	NA	NR	11	9
		R	≤9	NA	NR	≤9	≤9
Erythromycin	15µg	S	≥23	≥24	≥25	≥22	≥22
		I	20	21	20	19	20
		R	≤12	≤14	≤16	≤14	≤12
Tetracycline	30µg	S	≥20	≥18	≥22	≥22	≥21
		I	15	17	18	20	15
		R	≤15	≤15	≤13	≤16	>17
Gentamicin	10µg	S	≥16	≥16	≥8	≥20	≥15
		I	12	12	5	14	11
		R	≤14	≤14	≤10	≤13	≤12
Ciprofloxacin	5µg	S	≥21	≥21	≥25	≥23	≥20
		I	15	20	20	25	15
		R	<15	<15	<19	<17	<15

Table 4: In this table, antibiotic sensitivity testing of Gram-negative bacteria was performed using the Kirby–Bauer disc diffusion method. With the help of antibiotics, we determined which bacteria were sensitive, intermediate, or resistant. The highest sensitivity was observed with ceftriaxone (30 µg), cefepime (30 µg), and chloramphenicol (10 µg).

Table 4: Antibiotic Sensitivity test performing of Gram - Negative bacteria

Antibiotic	Drug (µg/Dose)	S/I/R	E. coli	Klebsiella	Enterobacter	Pseudomonas	Proteus
Ampicillin	10µg	S	≥18	≥19	≥20	R	≥20
		I	15	13	12	R	14
		R	≤15	≤14	≤10	R	≤11
Ceftriaxone	30µg	S	≥26	≥28	≥23	NR	≥25
		I	20	18	19	NR	19
		R	≤20	≤20	≤17	NR	≤15
Cefepime	30µg	S	≥25	≥28	≥24	≥20	≥26
		I	20	19	19	16	19
		R	<19	<20	<10	11	<8
ofloxacin	5µg	S	≥16	≥19	≥18	≥17	≥16
		I	14	13	13	15	12
		R	≤13	≤12	≤10	≤9	≤10
Amikacin	30µg	S	≥18	≥20	≥19	≥18	≥19
		I	17	17	16	16	15
		R	≤13	≤12	≤14	≤11	≤13
Tetracycline	30µg	S	≥18	≥19	≥20	NA	≥19
		I	15	12	13	NA	11
		R	≤14	≤12	≤10	NA	≤9
Chloramphenicol	10µg	S	≥20	≥21	≥25	NA	≥19
		I	16	14	15	NA	16
		R	≤14	≤12	≤14	NA	≤14

Table 5: In this table, antifungal sensitivity testing of Fungi was performed using the Kirby–Bauer disc diffusion method. With the help of antifungal drugs, we determined Candida and Aspergillus fungi were sensitive, intermediate, or resistant. The candida highest sensitivity was observed with voriconazole (1µg), fluconazole (25 µg), and amphotericin B (10 µg) and the aspergillosis highest sensitivity was observed with voriconazole (1µg), Itraconazole (10 µg), and amphotericin B (10 µg).

Table 5: Antifungal Sensitivity Test Performance of Fungus

Antifungal	Drug (µg/Dose)	S/I/R(mm)	Candida	Aspergillosis
Fluconazole	25µg	S	≥22	≥4
		I	17	2
		R	≤14	98
Voriconazole	1µg	S	≥16	≥24
		I	15	15
		R	≤13	≤12
Amphotericin B	10µg	S	≥15	≥20
		I	10	9
		R	<15	<16
Itraconazole	10µg	S	≥10	≥16
		I	5	15
		R	≤9	≤12
Posaconazole	5µg	S	≥7	≥19
		I	6	13
		R	≤5	≤12

Discussion: An increasing issue in many healthcare facilities is hospital-acquired infections brought on by multidrug-resistant organisms [14], [15], and [16]. HCWs may use their hands, equipment, cell phones, or other inanimate hospital objects as vectors for the nosocomial spread of microorganisms [4], [17], [18], and [19]. Patients are more susceptible to hospital-acquired infections because mobile phones, unlike fixed phones, are often used in these settings [20], [21]. In the study, for healthcare monitoring, we collected swab samples from 50 mobile phones and examined the presence of bacterial and fungal contamination, in which 100% contamination was found. It was found that 97% of bacteria were present in samples from healthcare workers. In a study conducted by Tambe and Pai in 2012 [22], 83%

bacterial and fungal contamination was observed on the mobile phones of healthcare workers. In another study, it was also reported that mobile phones were contaminated with many types of bacteria, among which a large number were multidrug-resistant. It was also found that many types of microorganisms are transferred to mobile phones through the hands. In fact, about 30% of the bacteria found on mobile phones originated from the hands of their owners [23].

They analysed the microorganisms present on the screens of smart Android phones to determine whether there was a direct similarity with the microorganisms from the owners' skin. They found that bacteria present on the participants' fingers were also transferred to the mobile phones from the skin of the owners' hands [24]. All cell phones showed signs of bacterial contamination, according to Beckstrom et al. (2013) [25] in their investigation of bacterial contamination of the parents' cell phones in the NICU and the efficacy of an anti-microbial gel in lowering transmission to the hands. After using anti-microbial gel, 22% of people had no growth on their hands, and 90% of people had the same bacteria on both their cleaned hands and mobile phone. In hospitals, greater adherence to hand hygiene plays an important role in safeguarding the health of both patients and healthcare workers, while preventing the spread of hospital-acquired infections. Despite this fact, overall hand hygiene compliance among healthcare workers is very low, particularly in developing countries [26].

During our study period, the compliance rates among healthcare workers were observed to be 37% and 42%. This was consistent with the findings of previous studies, where compliance rates ranged between 5% and 89%, with an average of 39% [27]. Furthermore, in our study, hand hygiene compliance was found to be higher among nurses (67% and 78%). This was in agreement with the findings of Rosenthal et al., who reported similar results in 2005 [28] and again in 2013 [29], where compliance among nurses was higher compared to other healthcare workers. Kokate et al. (2012) [4] and Mark et al. (2014) [30] discovered lower rates of contamination, both reporting 60% contamination rates of mobile HCWs' phones.

Common bacteria found on the smartphones of healthcare workers, which can grow in various environments, include coagulase-negative Staphylococcus [31]. In addition, Staphylococcus aureus [32] and Bacillus species [33] can also be present on the screen and back surface of mobile phones, and Escherichia coli [34] is also found. In our study, it was found that the rate of contamination by Staphylococcus aureus was very high, reaching up to 56%, which was higher than that reported by other researchers [35]. Many studies have concluded that mobile phones of laboratory technicians have a higher level of microbial contamination [36], and reports have shown that, compared to other hospital departments, contamination on the phones of lab technicians is up to eight times higher [37]. A recent study observed that healthcare workers who did not wash their hands before patient care had more than a 13% higher likelihood of contamination on their mobile phones. In contrast, those who performed proper handwashing had lower levels of contamination on their phones. Therefore, handwashing is also an important preventive measure [38].

Conclusion: Our study concludes that mobile phones should be cleaned regularly to prevent the growth of microorganisms. If microorganisms grow, they can cause many diseases, whether due to bacteria or fungi. Healthcare workers should wash their hands or use a hand rub before and after examining a patient to prevent microorganisms from the patient from transferring to their mobile phones.

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