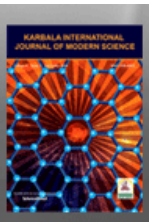

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Isolation, identification and antibiotic-resistance profiling of bacteria isolated from mobile phone surfaces in Karbala.

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Isolation, identification and antibiotic-resistance profiling of bacteria isolated from mobile phone surfaces in Karbala.

Abstract

Due to the diverse environments that mobile phones are exposed to via human handling they become reservoirs of microorganisms. The objective of the current study was to determine the level and character of bacterial contamination on mobile phones by identifying bacterial strains, and the degree of antimicrobial susceptibility. A cross-sectional study was conducted from April to July 2025 where phones belonging to 115 individuals were randomly chosen from various departments and units at Kerbala University and swabbed. The VITEK 2 automated system was used to identify bacterial taxa and test for antimicrobial susceptibility, and 50 of the swabs exhibited bacterial growth. This confirms that mobile phones serve as reservoirs for bacteria, including commensal skin flora, opportunistic pathogens, and environmental isolates. Species of *Staphylococcus* (*Staphylococcus warneri, Staphylococcus epidermidis*, and *Staphylococcus aureus*) dominated, which reflects frequent contact with human skin. Clinically significant pathogens such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli* were also detected, which raises concerns about their role in hospital-acquired infections and antibiotic resistance. The detection of environmental and waterborne bacteria (*Aeromonas hydrophila*, *Pseudomonas stutzeri*, and *Brevundimonas diminuta*) and uncommon isolates (*Ewingella americana*, *Kocuria kristinae*, and *Enterococcus columbae*) also confirms that contamination is potentially occurring via poor hygiene practice. Antibiotic resistance was determined against multiple antibiotics. Among those tested, all isolates were resistant against benzylpenicillin, while no resistance was observed against tigecycline.

Keywords

Mobile phones contamination, Antibiotic resistance, Kerbala University

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RESEARCH PAPER

Isolation, Identification and Antibiotic-resistance Profiling of Bacteria Isolated From Mobile Phone Surfaces in Karbala

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Abstract

Due to the diverse environments that mobile phones are exposed to via human handling they become reservoirs of microorganisms. The objective of the current study was to determine the level and character of bacterial contamination on mobile phones by identifying bacterial strains, and the degree of antimicrobial susceptibility. A cross-sectional study was conducted from April to July 2025 where phones belonging to 115 individuals were randomly chosen from various departments and units at Kerbala University and swabbed. The VITEK 2 automated system was used to identify bacterial taxa and test for antimicrobial susceptibility, and 50 of the swabs exhibited bacterial growth. This confirms that mobile phones serve as reservoirs for bacteria, including commensal skin flora, opportunistic pathogens, and environmental isolates. Species of *Staphylococcus* (*Staphylococcus warneri*, *Staphylococcus epidermidis*, and *Staphylococcus aureus*) dominated, which reflects frequent contact with human skin. Clinically significant pathogens such as *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli* were also detected, which raises concerns about their role in hospital-acquired infections and antibiotic resistance. The detection of environmental and water-borne bacteria (*Aeromonas hydrophila*, *Pseudomonas stutzeri*, and *Brevundimonas diminuta*) and uncommon isolates (*Ewingella americana*, *Kocuria kristinae*, and *Enterococcus columbae*) also confirms that contamination is potentially occurring via poor hygiene practice. Antibiotic resistance was determined against multiple antibiotics. Among those tested, all isolates were resistant against benzylpenicillin, while no resistance was observed against tigecycline.

Keywords: Mobile phones contamination, Antibiotic resistance, Kerbala University

1. Introduction

Bacteria that cause opportunistic infections can be cultured and maintained on mobile phone surfaces due to the accumulation of oily residues from human contact, then transferred back to human hands that lead to contamination of the mouth, eyes, or wounds [1]. Earlier studies identified that bacteria such as *Staphylococcus aureus*, *Escherichia coli*, and *Pseudomonas spp*. can persist on phone surfaces and are considered as a barrier to the fight against nosocomial and community-acquired infections [2]. Because cell phones are widely used for quick community communication [3], this problem will persist.

The presence of antibiotic-resistant strains on human skin further complicates the issue [4]. Antibiotic therapy has faced a unique problem because in the past it selected for multidrug resistant strains of bacteria and these are now prevalent on human skin [5].

Antimicrobial Resistance (AMR) develops when microorganisms avoid the special effects of medications designed to combat them, AMR is a stark universal risk to both human health and the existence of present medications. An estimated 4.71

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million Mortalities worldwide were associated with bacterial AMR in 2021; by 2050, this The number is likely to increase to 8.22 million. AMR has direct effects on an individual basis as well, affecting the length of hospital stays since it increases the threat of treatment failure and is connected to longer hospital stays, re-consultations, and increased the rate of mortality. The antibiotics overuse and misuse are among the factors that hasten the emergence of AMR. The World The health organization modified the Global Action Plan in 2015 in order to combat AMR. These include raising awareness and understanding of antibiotic use, enhanced research and investigation, better infection prevention and control, optimizing antibiotic use and continuing investment in diagnostics and cures [6].

To help with initiatives aimed at controlling the spread of resistant microbes, it is important to understand the microbial ecosystem of mobile phones, particularly in densely populated and high-contact areas like Karbala. Hence, this research constitutes a bridge between microbiology and public health by offering insights into the silent role of mobile phones in facilitation of bacterial routes through the community.

In the modern digital age, mobile phones have become an irreplaceable tool for use in daily life. They are now a requirement for communication, work, banking, safety, and entertainment. Due to the potential risk that they pose as carriers of pathogenic microbes, regular disinfection of mobile phones and hand hygiene are critical to alleviate this potential threat, in particular, to limit the spread of antibiotic-resistant bacteria [7].

The city of Karbala is known for its high population density and significance in the space of religious tourism. The traffic of people within and via the city makes it a unique environment for studying microbial contamination, including microbes of global distribution. This study therefore aims to isolate and identify bacterial species on the surface of mobile phones used by residents of Karbala and further assess their antibiotic resistance profiles. The findings are expected to contribute to our scientific understanding of health implications to the public and may inform strategies to mitigate the spread of antibiotic-resistant bacteria, particularly in high-risk areas or among high-risk groups of people.

2. Materials and methods

2.1. Ethical considerations

Informed consent was obtained from all participants prior to sample collection. The study protocol was reviewed and approved by the institutional ethics committee of the University of Kerbala [8].

2.2. Study design

A Cross-sectional study was done from April to July of 2025. A total of 115 participants were randomly selected from different departments and units within Kerbala University.

2.3. Sample collection

Sterile cotton-tipped swabs that were pre-packaged with transport medium (non-growth) were used for sample collection. These swabs are specifically designed to preserve microbial viability during transport and storage prior to analysis. The samples were collected aseptically to avoid environmental contamination. After swabbing the mobile phone surfaces, the swabs were placed into the transport tubes immediately and stored at 4 °C until microbiological processing [9].

2.4. Sample culture

The collected samples were streaked onto suitable media like nutrient agar, blood agar, MacConkey agar and mannitol salt agar. The inoculated plates were incubated aerobically in an inverted position at 37 °C for 48 h. The plates were then observed for the presence of single colonies.

2.5. Bacterial identification

Bacterial identification was performed using the Vitek 2 Compact ID/AST system (bioMérieux), which reduces hands-on time and automates incubation and reading of bacterial growth [10].

2.6. Antibiotic sensitivity

The antibiotic susceptibility of bacterial isolates was assessed using the Vitek 2 Compact system, which is an automated microbiology platform that utilizes advanced optical technology to determine microbial resistance profiles. Bacterial suspensions were prepared according to the manufacture's guidelines and loaded into specialized AST (Antimicrobial Susceptibility Testing) cards. The results were interpreted in accordance with the Clinical and Laboratory Standard Institute (CLSI) guidelines. The system performed real-time analysis and provided precise MIC (Minimum Inhibitory Concentration) values for a broad range of antibiotics.

The result was given as Sensitive (S), Intermediate (I) and Resistant (R) to the chosen antibiotic.

2.7. Statistical analysis

The collected data were analyzed using SPSS and Microsoft Excel. Descriptive statistics such as frequencies and percentages were applied. Excel was also used for graphical representations such as bar charts and pie charts, to help visually illustrate distribution patterns and categorical variables.

3. Results

Out of 115 mobile phone swab samples collected at University of Kerbala, 50 were positive for bacteria (Table 1). Among these, 40 samples yielded a single bacterial species, whereas 10 samples included two distinct bacterial species. No bacteria were isolated from the remaining 65 samples (Fig. 1).

This means that 43.5% of mobile phone surfaces tested were contaminated with bacteria, reinforcing the hypothesis that mobile devices can be reservoirs for microbes and responsible for transmission. From the majority (80%) of the contaminated samples, only a single bacterial species was isolated, which was a species that is either related to skin flora or environmental contact. Some of bacterial cultures isolated from mobile phone surfaces were illustrated in Fig. 2. The bacterial colonies exhibited differences in size, shape, and color.

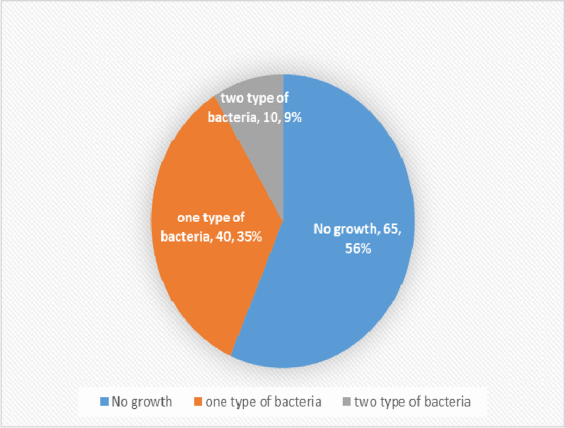

Fig. 1. Bacterial growth pattern in 115 mobile phone swab samples.

Table 1. Distribution of bacterial isolates from mobile phones.

Bacteria	Number of isolates	Percentage
Staphylococcus warneri	9	15.3%
Staphylococcus epidermidis	8	13.6%
Staphylococcus hominis subspecies hominis	6	10.2%
Staphylococcus haemolyticus	6	10.2%
Staphylococcus aureus	5	8.5%
Staphylococcus capitis	4	6.8%
Pseudomonas oryzihabitans	2	3.4%
Bacillius spp.	2	3.4%
Staphylococcus xylosus	1	1.7%
Staphylococcus vitulinus	1	1.7%
Staphylococcus lentus	1	1.7%
Serratia liquefaciens	1	1.7%
Pseudomonas stutzeri	1	1.7%
Pseudomonas aeruginosa	1	1.7%
proteus mirabilis	1	1.7%
Pantoea spp.	1	1.7%
Kocuria kristinae	1	1.7%
Ewingella americana	1	1.7%
Escherichia coli	1	1.7%
Enterococcus columbae	1	1.7%
Enterobacter cloacae complex	1	1.7%
Brevundimonas diminuta/vesicularis	1	1.7%
Aeromonas hydrophila	1	1.7%
Acintetobacter baumannii	1	1.7%
Acinetobacter lwoffii	1	1.7%

The species listed in Table 1 include mostly those associated with skin flora, particularly species from the genus *Staphylococcus*, such as *Staphylococcus warneri*, *Staphylococcus epidermidis* and *Staphylococcus aureus*. This is consistent with the frequent contact between mobile phones and human skin. While these organisms are part of the normal dermal microbiome, they can become pathogenic, particularly in immunocompromised individuals.

Species that have the potential to become pathogenic include *Staphylococcus aureus*, *Pseudomonas aeruginosa*, and *Escherichia coli*. These species are at the forefront of antibiotic resistance, frequently being responsible for hospital-acquired infections. This raises concerns about mobile phones as potential reservoirs for nosocomial pathogens.

Table 1 also lists environmental and waterborne species, such as *Aeromonas hydrophila*, *Pseudomonas stutzeri* and *Brevundimonas diminuta*, suggesting exposure to contaminated water sources or other environments. Their persistence on the phones may be due to poor hygiene practices or the use of phones in moist environments [7]. Finally, rare, or unusual species were isolated, like *Ewingella americana*, *Kocuria kristinae* and *Enterococcus columbae*, which emphasizes how globalized an individual's handset truly is.

Due to the wide range of isolates, including both commensals and potential pathogens, and the importance of regular disinfection of mobile devices, we decided to explore potential sociological factors in relation to contaminated versus sanitary devices. One variable investigated was the gender of the device's owner. Out of the total 50 mobile

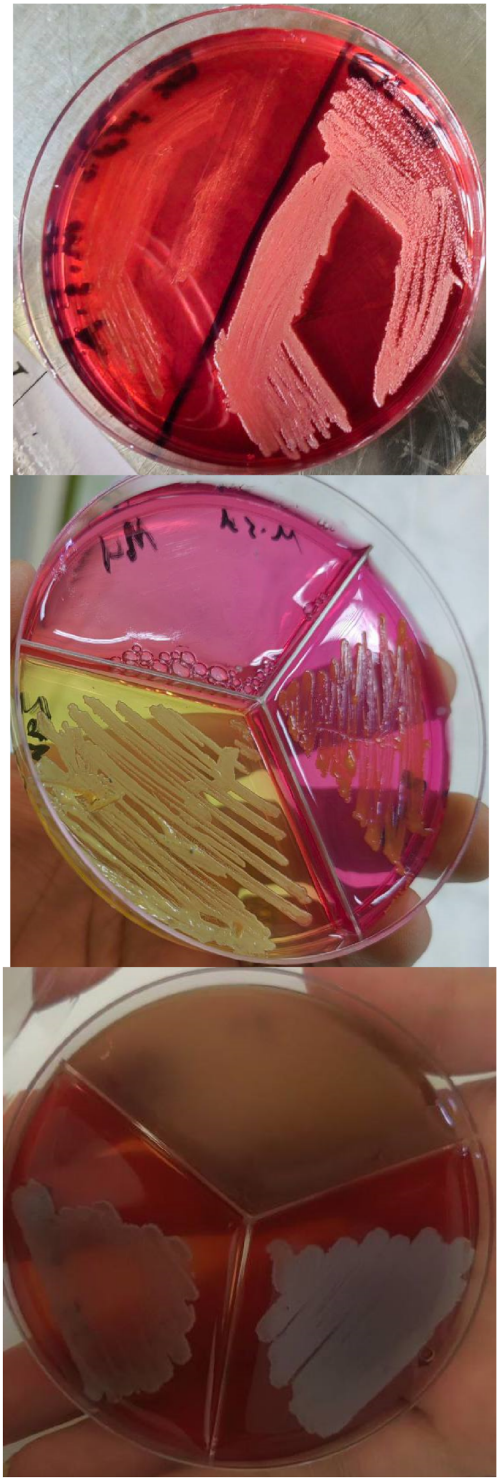

Fig. 2. Selected culture plate photographs of bacterial isolates.

phone found to be contaminated with bacteria, 40 (80%) were owned by female users, leaving 10 (20%) from male users (Table 2).

This indicates a significant correlation according to gender. However, because 72% of the device owners in this study were female, this figure needs to be normalized to negate bias in candidate selection. If this figure is normalized, 31% of devices owned by males were contaminated, compared to 48% of devices owned by females. Although the gender gap appears to be narrowing, the whole data still suggests a gender-based disparity, where a further investigation is demanded.

Table 2. Microorganisms isolated from mobile phones according to gender.

		No growth	One type of bacteria	Two types of bacteria	
Gender	Female	43	30	10	83
	Male	22	10	0	32
Total		65	40	10	115

We also investigated contaminated devices according to the age of the device owner (Table 3). The 18–33 years age range accounted for the highest number of contaminated devices at 62% of the total. The 34–49 years group accounted for 22%, and the 50–65 years group accounted for 16% of contaminated devices. While this trend may reflect higher social activity and more frequent phone handling among younger individuals, increasing exposure to diverse microbial environments [11], these values need to be adjusted according to the number of sanitary phones within those same age groups. By comparing contaminated versus sanitary devices within those age groups, 50% of devices were contaminated in the 18–33 years age range, compared to 34% in the 34–49 age range, and 38% in the 50–65 years old age range. This conveys that, even after adjustment, the younger aged device owners tended to be more likely to own a contaminated mobile phone.

We then investigated the antibiotic susceptibility profile of 42 Gram-positive isolates. These included *S. aureus, S. warneri, S. epidermidis, S. hominis, S. haemolyticus, S. capitis, S. xylosus, S. vitulinus, S. lentus*, and *E. columbae*. There was notable variation among these isolates. Among these, 31 isolates tested positive for resistance in the cefoxitin screen test, a widely accepted method for detecting methicillin resistance, while 11 isolates tested negative. In contrast, the results for inducible

Table 3. Distribution of bacterial isolates according to age groups.

		No growth	One type of bacteria	Two types of bacteria	Total
Age categories	(18–33)	31	23	8	62
	(34–49)	21	10	1	32
	(50–65)	13	7	1	21
Total		65	40	10	115

clindamycin resistance showed that only 6 isolates were positive, whereas the majority remainder, being 36 isolates, were determined to be negative, as depicted in Fig. 3.

All isolates were resistant to benzylpenicillin. This was followed by resistance to linezolid (39 isolates), oxacillin (31), fusidic acid (28), clindamycin (27), erythromycin (25), tetracycline (18), gentamicin (16), vancomycin (8), ciprofloxacin (6), moxifloxacin (6), rifampicin (5), and trimethoprim/sulfamethoxazole (1). None of the isolates were resistant to tigecycline, representing the lowest rate observed. Refer to Fig. 3 for detailed data.

Fig. 4 conveys how the isolates responded to gentamicin, ciprofloxacin, and trimethoprim/sulfamethoxazole. Gentamycin has the highest resistance rate of the three, reaching 35.2% (19) of the isolates tested. This was followed by ciprofloxacin, at 18.5% (10), then trimethoprim/sulfamethoxazole, at 11.1% (6).

Fig. 5 presents the antimicrobial susceptibility of the Gram-negative bacterial isolates. Hence, 11 isolates were tested for resistance against a panel of commonly used antibiotics. These included ceftazidime, cefepime, ciprofloxacin and trimethoprim/sulfamethoxazole resistance, where 4 out 11 isolates

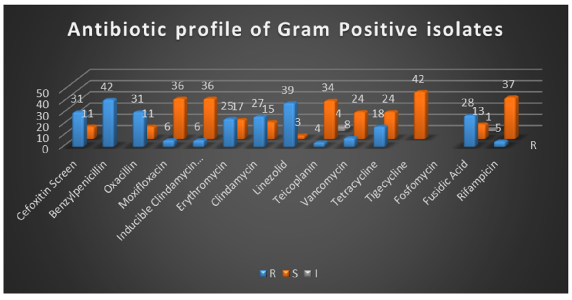

Fig. 3. Antibiotic Sensitivity profiles of the Gram-positive bacterial isolates. R = resistant, S = susceptible, and I = Intermediate.

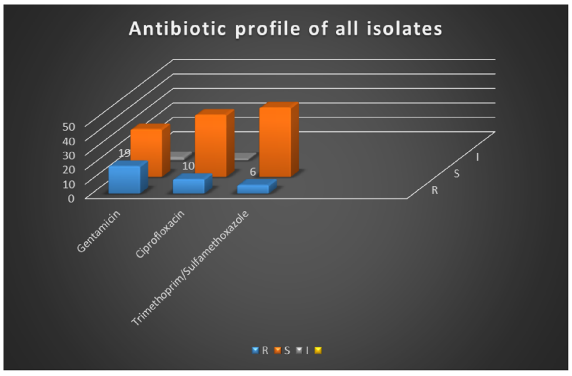

Fig. 4. Antibiotic profile of Gram positive and Gram-negative isolates against gentamicin, ciprofloxacin and trimethoprim/sulfamethoxazole.

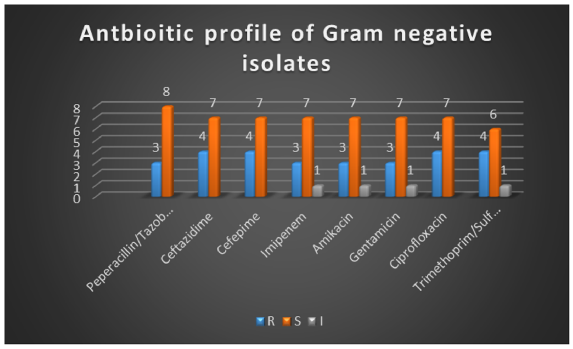

Fig. 5. Antibiotic Sensitivity profiles of the Gram-negative bacterial isolates. R = resistant, S = susceptible, and I = Intermediate.

(36.4%) were resistant for each antibiotic tested. Imipenem, amikacin, and gentamycin resistance was observed in 3 out 11 isolates (27.3%). Hence, the data indicate moderate levels of resistance among the Gram-negative isolates that were tested.

4. Discussion

While it is well known that bacterial pathogens are commonly isolated from human hosts or inanimate objects, most people fail to realize the high potential of mobile phones as carriers of bacteria [12]. Mobile phones accumulate oily residues from human interfacing and become pseudo-cultures for various environmental and human sourced bacteria.

Mobile phones are indispensable communication tools that are used both at home and at work. They are placed down, picked up, dropped or pocketed; exposing them to multiple warm or humid environments. This has the potential to both acquire microbes from the handlers/environment and nurture their growth. It has been shown that mobile phones can acquire and retain viable microorganisms, with some bacteria surviving for months, whereas viruses such as corona or influenza can persist for few days, and the herpes virus can persist for a week [13].

The presence of two or more bacterial species on 10 of mobile phones (20% of the contaminated group) may reflect either poor hygiene practices, shared device usage, or exposure to high-risk environments such as in healthcare settings, on public transport, or in public bathrooms. Alternatively, the absence of bacteria on 56.5% of the mobile phones could be attributed to regular cleaning habits, transferal of antiseptics from hands to phones, use of antimicrobial covers, or environmental factors that inhibit microbial survival such as exposure to UV radiation.

Nevertheless, these findings of potentially pathogenic microbes on a significant number of phones conveys the importance of routine disinfection of these devices, especially if they are exposed indirectly or directly to high-risk environments. This also corroborates the growing body of evidence that personal electronics can act as inorganic vectors of microbial transmission, potentially spreading opportunistic pathogens.

The moderate rate of bacterial colonization of mobile phones belonging to students and staff suggests that they are regularly exposed to environmental sources of bacteria. This may involve direct contact with infected materials, or it may reflect the individual's level of personal hygiene [14].

In our study we measured a moderate prevalence rate (43.5%) bacterial retention on mobile phones. This prevalence might be because students deal more directly with contaminated aerosols created in laboratories. In addition, when their mobile phones make contact with the laboratory benches there is potential for the transfer of lab-sourced microbes to their devices, which might account for the moderate prevalence rate. The current study agrees with another study that was done in India which showed a similar percentage of contaminated mobile phones, at 34% [15]. Alternatively, one study by authors from Baghdad and Yeman demonstrated higher values at 100%. Nevertheless, the results of the current study are consistent with another study [10], in which several microorganisms were isolated, some of them pathogenic such as *S. aureus*, while the others were normal opportunistic flora.

When the types of organisms that were isolated are considered, despite the difference in the isolation rate, most studies have reported similar type of organisms [16]. Species in the genus *Staphylococcus* were the most frequently isolated in our study. Furthermore, the isolated Gram-positive and Gram-negative bacteria of the current study are consistent with those isolated in other studies. While our results demonstrated a general trend that the frequency of contamination mobile phones of females was higher than in males, even after correction for the numbers of females versus males in the study overall, age range was also a factor. Hence, this data requires further examination to determine if higher numbers of females in the younger age range creates the apparent gender disparity as an artifact, and if age range is the true predictor of mobile phone contamination.

In the analysis of the antibiotic susceptibility profile, the 42 Gram-positive isolates demonstrated widespread resistance patterns with notable variation across agents. Methicillin resistance was confirmed in 31 of those isolates through the cefoxitin screen test, while 11 remained susceptible. Inducible clindamycin resistance was relatively uncommon, detected in only six isolates out of the 42 in total. Benzylpenicillin screening showed universal resistance (100%), underscoring its limited efficacy. There were also high resistance rates of the isolates to linezolid (93%), oxacillin (74%), fusidic acid (67%), clindamycin (64%), and erythromycin (60%). Moderate resistance was observed for tetracycline (43%) and gentamicin (38%), whereas lower levels were recorded for vancomycin (19%), ciprofloxacin and moxifloxacin (14%), rifampicin (12%), and trimethoprim/sulfamethoxazole (2%). Tigecycline stood out as the only agent with complete susceptibility across all isolates. Detailed data further highlighted resistance to gentamicin (35.2%), ciprofloxacin (18.5%), and trimethoprim/sulfamethoxazole (11.1%), reflecting the overall trend of multidrug resistance with tigecycline as the most promising therapeutic option.

Among the 11 Gram-negative bacterial isolates, resistance was found in four (36.4%) to ceftazidime, cefepime, ciprofloxacin and trimethoprime/sulfamethoxazole, and in 3 isolates (27.3%) to imipenem, amikacin and gentamycin. These results highlight moderate resistance levels and emphasize the need for ongoing antimicrobial monitoring.

The study of antibiotic resistance in environmental sites, such as universities, is vital because these environments perform as reservoirs for genes encoding antibiotic resistance and contribute to their spreading, even if the bacteria are not directly isolated from medical patients. Bacterial antibiotic resistance evolution and its distribution are considered one of the biggest threats to humans. AMR poses a severe alarm to human health, such as prolonged infection and increased morbidity and mortality, as it can spread from environmental parts to drinking water sources as a key method of contact [17].

5. Conclusion

A ubiquitous personal electronic, the mobile phone, serves as a vector for microbial transmission. This means that proactive hygiene practices and institutional policies are essential in mitigating the risk and preventing the spread of opportunistic pathogens. Routine disinfection may require establishment of regular cleaning protocols for mobile devices using alcohol-based wipes or UV sanitizers, particularly in healthcare and high-risk environments.

Another strategy to improve overall hygienic practice in relation to mobile phones may include awareness programs to educate the public and healthcare workers about the role of mobile phones in microbial transmission and the importance of hygiene practices. A mandate approach may be involved as a strategy to mitigate the cross-contamination within the institutions. This could be achieved by incorporating the protocol of mobile device decontamination into infection control guidelines in hospitals, clinics, and workplaces. It may also be necessary to limit mobile phone use in moist or contaminated environments to reduce exposure to waterborne bacteria, as an environmental precaution. Lastly, further research is necessary, particularly on the effectiveness of antimicrobial covers, coatings, and novel disinfection technologies in reducing microbial load.

6. Limitations

Limitation of the study include the relatively small sample size, the exclusive reliance on the VITEK 2 automated system and the restriction to a single geographical area which might affect the overall application of the results. Future research should include larger sample size and apply multiple methods to enhance detection of resistance patterns.

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Conflicts of interest

The authors declare that they have no conflicts of interest, financial or otherwise.

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