

RESEARCH PAPER

Bacterial contamination associated with mobile phones used by students at Basrah Medical College, Basrah, Iraq

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Abstract

Background: Cell phones are increasingly becoming an important vector for pathogens, especially when they are combined with unhealthy behaviours that speed up the spread of nosocomial infections.

Objectives: This study was conducted to investigate microbial contamination of mobile phones belonging to students of Basrah Medical College, located in the southern region of Iraq.

Methods: Samples were collected aseptically with sterile swabs moistened with sterile normal saline solution over a period of four weeks. One hundred mobile devices were included in this study. The wet swab was rolled over the exposed surfaces of the mobile phones.

Results: Of 100 swabs samples, 137 isolates were identified. Of these, *Staphylococcus aureus*, *Staphylococcus epidermidis*, and *Pseudomonas aeruginosa* were the most frequently identified microorganisms, in addition to other important pathogens.

Conclusion: This study showed that mobile phones are potential carriers for the spread of many pathogens, and a measure of cleanliness must be introduced to prevent the possibility of cross contamination. It was also revealed that bacteria colonized mobile phones of medical students and the contaminated mobile phones are able to transport microbes that may be able to produce serious disease.

Key words: Basrah, Medical students, Mobile phone, *Staphylococcus* spp.

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Introduction

Human skin is in constant contact with microorganisms and becomes easily colonized by certain microbial species. Almost every surface of adult human skin is covered with several microflora and sometimes exposed to pathogenic microbes. During a phone call, the

mobile phone comes into close contact with contaminated human body areas, hand to hand, and hand to other areas such as mouth, nose and ears.^{1,2} This connection may result in the transfer of potential pathogens found on the human skin to mobile phones. It was suggested that infection may be caused by telephone contact and that fears come from the device itself as a source of infection. The fact is that the phone is being used more and more in a global world.³ As well, mobile phones have also become an external source of infection, not only for patients in hospitals, but also for potential health risks for workers and family members.⁴

Moreover, sharing mobile phones among friends may directly facilitate the spread of pathogenic bacteria in society.⁵ The microorganisms in the skin may differ from one person to another. Each person may have different hand flora among the public; it may represent the community environment (for example, the health community may have a different commensal that is different from society in the general environment). Methicillin-resistant *Staphylococcus aureus* (MRSA) has been identified from the surface of the mobile phone and door handles, chairs and handrails. This organism is a real pathogen and its spread causes a lot of health risks.^{6, 7} In many countries, the number of mobile phones exceeds the number of landlines, replacing land phones, as most adults, many young people and children now own mobile phones. At present, Asia enjoys the fastest rate of growth for mobile subscribers in the world. Many users may not care about the health risks of a mobile phone. Different users may use the same phone, which may increase the chance of spread of a group of microorganisms and make them a good carrier of microbes. Therefore, this study was aimed to identify microbial contamination of mobile phones among students of Basrah Medical College in southern Iraq and to determine the microbial species associated with these phones.

Subjects and methods

Sample collection:

After getting the ethical approval from the committee board of the Iraqi health and higher education authority. The samples were collected aseptically with sterile swabs moistened with sterile normal saline solution over a period of four weeks from 7 April to 30 April 2019. One hundred mobile devices were included in this study. The wet swab was rolled over the

exposed surfaces of the mobile phones. Care was taken to ensure that all keyboard, screen, mouth, earpiece, side, and back of cell phones were properly swabbed because these areas are the most frequent locations when touching fingers and skin. All participants were declared consent and were taken prior of collecting the samples.

Sample inoculation and bacterial identification:

After the collection, the samples were immediately transferred to the laboratory (Department of Microbiology, College of Medicine) and were inoculated on plates of nutrient agar, blood agar, MacConkey agar and mannitol salt agar. The plates were incubated aerobically at 37°C for 24-48 hours. After incubation, plates were examined for growth and for description of colonial morphology of the isolates.^{8,9} Gram-positive and Gram-negative bacteria were determined according to standard microbiological procedures. Pure cultures from all the isolates were prepared and subjected to Gram staining. Then for the primary identification, various biochemical tests such as oxidase test, indole test, urease test, citrate test, triple sugar iron test, catalase, and coagulase test were performed as previously described.⁹ Standard kits of API 20E biochemical test (HiMedia Laboratories, Mumbai, India) were also used to confirm identity of the isolates.

Results

One hundred mobile phones used by Basrah medical college students were examined: 75 were from students entering clinic sessions and 25 were from students studying basic science. From the 100 mobile phone swabs, pure cultures were detected on most of the inoculated plates and mixed isolates appeared in a small number of plates. A total of 137 isolates were recognized: 37 *Staphylococcus aureus*, 33 *Staphylococcus epidermidis*, 21 *Pseudomonas aeruginosa*, 12 *Proteus spp.*, 17 *Escherichia coli*, 4 *Neisseria sicca*, 7 *Acinetobacter spp.*, 3 *Bacillus subtilis*, 1 *Enterobacter aerogenes*, and 2 *Candida spp.* (Table-1; Figure 1A & B).

Table 1. Microorganisms isolated from students' mobile phones.

Isolated Microorganism	No. of isolated organism N=137	%
<i>Staphylococcus aureus</i>		
<i>Staphylococcus epidermidis</i>		
<i>Pseudomonas aeruginosa</i>	37	27.0
<i>Bacillus subtilis</i>	33	24.1
<i>Escherichia coli</i>	21	15.3
<i>Proteus spp.</i>	03	2.2
<i>Neisseria sicca</i>	17	12.4
<i>Acinetobacter baumannii</i>	12	8.8
<i>Enterobacter aerogenes</i>	04	2.9
<i>Candida spp.</i>	07	5.1
Total	01	0.7
	02	1.5
	137	100



Fig 1A

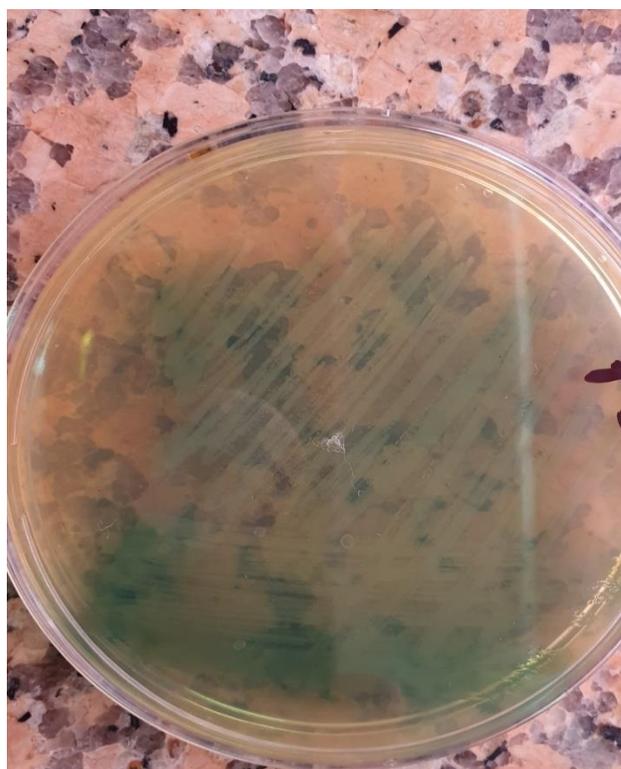


Fig 1B

A total of 75 mobile phones samples from students attending clinical sessions (Group 1) and 25 samples from students mobile attending only sessions for basics science (Group 2) were cultured, out of which, 30 isolates of *Staphylococcus aureus* was the predominant organism isolated from the mobiles of first

group of students whereas, *Staphylococcus epidermidis* (11 isolates) was the predominant organism isolated from the second group of students mobile. The distribution of bacterial isolates among those groups is shown in (Table-2)

Table 2. Number and type of microorganisms isolated from mobile phones of students attending different sessions at the college.

Source type	No. of sample collected	No. of isolates	Isolated organism	No. of isolated organism	%
Students attending clinical sessions	75	108	<i>Staphylococcus aureus</i>	30	27.7
			<i>Staphylococcus epidermidis</i>	22	20.4
			<i>Pseudomonas aeruginosa</i>	19	17.6
			<i>Bacillus subtilis</i>	01	0.9
			<i>Escherichia coli</i>	13	12.1
			<i>Proteus spp.</i>	12	11.1
			<i>Neisseria sicca</i>	01	0.9
			<i>Acinetobacter baumannii</i>	07	6.5
			<i>Enterobacter aerogenes</i>	01	0.9
			<i>Candida spp.</i>	02	1.9
Students attending basic sciences session	25	29	<i>Staphylococcus aureus</i>	07	24.2
			<i>Staphylococcus epidermidis</i>	11	37.9
			<i>Pseudomonas aeruginosa</i>	02	6.9
			<i>Bacillus subtilis</i>	02	6.9
			<i>Escherichia coli</i>	04	13.8
			<i>Proteus spp.</i>	0.0	0.0
			<i>Neisseria sicca</i>	03	10.3
			<i>Acinetobacter baumannii</i>	0.0	0.0
			<i>Enterobacter aerogenes</i>	0.0	0.0
			<i>Candida spp.</i>	0.0	0.0
Total	100	137		137	

Discussions

A variety of microorganisms were found on the mobile phones. However, the standard hygiene is very important issues for the people in contact with mobile. In this study, several microorganisms were isolated, some were real pathogens and others were a normal flora and commensal at the skin. These pathogens may

become disease-prone when they have the opportunity to do so. *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa* and others (Table-1) were the main bacterial isolates frequently associated with mobile phones. These organisms may have found their way to the phone through the skin

and from hand to hand contact. These organisms are the normal microflora resides on the skin which was mentioned earlier.¹⁰ The various hygiene profiles are followed and recognized among people in the community. Therefore, dealing with a mobile phone by many users results in regular skin contact with the phone and may result in the frequency of the variance, and the degree of population of the isolates. This might have many health concerns. On the other hand, the environment of the hospital plays a very important role in the transfer of microorganisms, where it was observed that the students of the first group who contacted patients or devices or things such as speakers, or bronchoscope, pens, computer keyboards, Obtain pathogenic bacteria and symbiosis on their mobile phones colonized by these bacteria, this finding is in agreement with other studies,^{11,12} which reported the same findings from the mobile phones of health care workers (HCWs) and non-HCWs. It has been also reported that the HCWs workers had a heavy mobile phone contamination as compared with non-HCWs.^{4,13} The reasons for obtaining more isolates from HCWs may be the result of direct contact with the patients. Monitoring hospital standards for infection prevention may also contribute to the detection of high bacterial contamination. Personal behavior and mobile phone style may also affect the amount of pollution in mobile phones.¹⁴

In one study, researchers discovered that cell phones are usually dirtier than a toilet seat or shoe bottom.¹⁵ The continuous processing of mobile phones by different users reveals a range of microorganisms, making them a good carrier of microbes This is especially recognizable with the skin, due to the moisture and optimum temperature of the human body especially the palm as well as the heat generated by cell

phones and prefer colonization and reproduction of microorganisms. These devices can contain many potential pathogens and act as an external source of nosocomial infections among patients in hospitals.¹⁶ *Staphylococcus aureus* is known to cause many diseases ranging from minor skin infections to more serious diseases, including pneumonia, bacteremia, septicemia, meningitis. MRSA is particularly important in the medical community, as it has developed resistance to β -lactam antibiotics.¹⁷ The present study found that *Staphylococcus aureus* was the predominant microorganism isolated; this bacterium is very important pathogen and can be transferred through the mobile phone to the public community. This finding is in agreements with other researchers.¹⁷⁻¹⁹ High rate of *Staphylococcus epidermidis* were also reported in this study. This organism is normally found on skin as normal flora, and this might be the reason for their high rate of growth from the mobile phones in the present study. The presence of a Gram-negative rod, *Enterobacter aerogenes*, a member of the coliform group, indicates the potential for contamination of faeces on the mobile phone. Gram-negative sepsis is most commonly due to *E. coli*, *Enterobacter* spp, and *Pseudomonas aeruginosa*,²⁰ which have been also isolated in high rate in this study. Isolation of *Bacillus subtilis* was also determined frequency of occurrence as a vital organism in the spoilage of food.²¹ Undoubtedly, this contributes greatly to food damage and food contamination if food is prepared or eaten with infected hands. *Acinetobacter baumannii* is a pathogenic organism that can cause healthcare-associated infections (HAI). This organism has recently emerged as a major cause of HAIs due to its resistance to antimicrobials and its tendency to cause large nosocomial outbreaks.²² *Neisseria*

sicca is a gram-negative diplococcus found as normal human oral and upper respiratory tract flora; it is considered one of the commensal *Neisseria* species. This organism has the ability to decompose hydrogen peroxide, live as a commensal in the oropharynx with commensal producing hydrogen peroxide and dissolved oral flora of hydrogen peroxide in salivary deposits and plaque.^{23, 24} Simple control measures are very important to reduce potential contamination of the device. Cleaning of the phone and computers with 70% alcohol may reduce bacterial load.^{25, 26} Some of these measures can make portable surfaces pollution-free. Hand washing and wearing gloves by the staff are also good preventive procedures.^{7, 25, 27} In fact, such simple control measures can reduce morbidity and mortality and thus reduce the cost of medical care for hospitals and other caregivers.

CONCLUSION

The study revealed that bacteria colonized mobile phones of medical students and the contaminated mobile phones are able to transport microbes that may be able to produce serious disease. There is a need for preventive care to reduce the impact of contaminated mobile phones on the spread of microbes and control measures should be applicable for this reason. Further investigations are recommended to provide evidence that better mobile phone hygiene will protect the spread of nosocomial infections.

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التلوث الجرثومي المرتبط بالهواتف المحمولة التي يستخدمها الطلاب في كلية طب البصرة، البصرة، العراق

الخلفيه: أصبحت الهواتف المحمولة بشكل متزايد ناقلاً مهمًا لمسببات الأمراض، خاصة عندما تم دمجها مع السلوكيات غير الصحية التي تسرع من انتشار عدوى المستشفيات.

الاهداف: أجريت هذه الدراسة للتحقيق في التلوث الميكروبي للهواتف المحمولة الخاصة بمجموعه من طلبة كلية الطب في جامعة البصرة الواقعة في المنطقة الجنوبية من العراق .

الطرائق: تم جمع العينات باستخدام مسحات معقمة مبللة بمحلول ملحي طبيعي معقم على مدى أربعة أسابيع. تم تضمين مائة جهاز محمول في هذه الدراسة. ثم تم مسح المسحة الرطبة فوق الأسطح المكشوفة للهواتف المحمولة.

النتائج: تم تحديد 137 عزله من مجموع 100 عينه مفحوصه ومن بين هذه العزلات كانت المكورات العنقودية الذهبية والجلديه وتليها الزوائف الارجونزبه من أكثر العزلات تحديدا اضافه الى عزلات ممرضه مهمه اخرى.

الاستنتاجات: أظهرت هذه الدراسة أن الهواتف المحمولة هي حاملات محتملة لانتشار العديد من مسببات الأمراض ، ويجب إتباع مقاييس للنظافة لمنع احتمال التلوث المتبادل كما تم الكشف عن أن البكتريا التي استعمرت الهواتف المحمولة لطلاب الطب والهواتف المحمولة الملوثة قادرة على نقل الميكروبات التي قد تكون قادرة على إنتاج أمراض خطيرة ناهيك عن وصولها إلى المجتمع من خلال الهواتف المحمولة.