

ISOLATION AND IDENTIFICATION OF BACTERIA ASSOCIATED WITH MOBILE PHONES IN SULAIMANI CITY

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ABSTRACT

Background

Mobile phones are one of common inanimate objects that come in contact with human hands and hence host several types of bacteria.

Objectives

The aim of this study was to identify the types of bacteria present on the surfaces of mobile phones in a sample of people from Sulaimani city.

Materials and Methods

This is a cross sectional study on bacterial isolation from mobile phones surfaces. After collecting data concerning the phones and their users, swab samples were obtained from phone surfaces and immediately streaked on bacteriological media. Isolated microorganisms were identified based on culture and colony characteristics, biochemical activity and Vitek® 2 identification system.

Results

Out of 400 mobile phone samples, 272 (68%) swabs showed growth of one or more microorganisms. A total of 322 microorganisms were identified, the most common isolated bacteria was Coagulase Negative Staphylococcus (CoNS) species followed by Bacillus and Micrococcus species. Few pathogenic bacteria such as *Streptococcus pneumoniae*, *Streptococcus pyogenes*, *Staphylococcus aureus* and enteric microorganisms were also isolated.

Conclusion

Mobile phones are one of the frequently used gadgets that are contaminated by many types of bacteria from human contact. The types of the bacteria on their surface reflect those on human hand which can vary according to the hand hygiene.

Keywords: *Mobile phones surface bacteria, Contamination of mobile phones, Sulaimani city.*

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INTRODUCTION

Mobile or cell phones have become one of the most indispensable accessories of professional and social life. At the end of 2012, there were 6.8 billion mobile subscriptions estimates ⁽¹⁾. This is equivalent to 96 % of the world population (7.1 billion according to The International Telecommunication Union). While this figure does not represent the actual number of mobile phone user but indicate the growing usage of the phones and its levelling with global population which was expected to rise to 6,915 billion subscriptions by the end of 2014 and from these, 2,315 billion will be active subscriptions ⁽¹⁾.

The spread of infectious agents in human populations is thought to have occurred primarily through close contact that probably included droplet transmission and direct contact or fomite transmission ⁽²⁾. Using mobile phone will lead to contamination of the gadgets with many bacterial species that live with human and sharing these devices may lead to transmission of the bacteria to the users. Several researches have indicated the potential colonisation of inanimate surfaces and their ability to transmit diseases of which the mobile phone is no exception ^(3,4). Health care workers (HCWs) hands and their mobile phones were found to be contaminated with various types of microorganisms and mobile phones used by HCWs in daily practice may be a source of nosocomial infections in hospitals ^(5,6).

Different microorganisms were isolated from mobile phones in different studies involving various people. The main bacteria were Gram-positive organisms and to less extent Gram-negative bacteria ^(4, 5, 7). Contamination of mobile phone by fecal flora may raise the interest of daily news as reported that a study from U.K. found that 16% of both hands and phones were contaminated with *Escherichia coli* from faecal origin, the likely reason for that to be because people don't wash their hands after using the toilet ⁽⁸⁾ and even they may exaggerate the dirtiness of mobile phone "Mobile Phones 18 Times Dirtier Than Toilet Handles" as they may be contaminated with faecal flora ⁽⁹⁾.

This study aims to determine bacterial contamination of mobile phones from different users in Sulaimani city and identifying the bacterial species associated with these phones.

MATERIALS AND METHODS

After agreement to participate in the study, data concerning the users and their phones were collected. Sterile swabs (CITOTEST®) soaked with sterile normal physiological saline solution (0.89% NaCl) was used to swab the key bottoms and the screen of the phone. The swab was streaked immediately on blood agar, mannitol salt agar and MacConkey agar. The plates were incubated later aerobically at 37°C for 18-24 hours. The number and the types of isolated bacterial colonies were reported and any sample failed to produce visible growth after 72 hours was labelled as no growth.

Identification of isolated bacteria was based on colony morphology, Gram stain characteristic and response to various biochemical tests ^(10, 11). Doubtful isolates were confirmed by Vitek 2 ® (bioMérieux, France) identification system. Data were analysed with IBM Statistical Package for the Social Sciences (SPSS) package version 19 ⁽¹²⁾.

RESULTS

Four hundred mobile phones (cell phones) were included in this study over a period from November 2013 to June 2014. The owners were 230 (57.5%) males and 170 (42.5%) females. The age of the owners ranged from 16-65 years with mean of 31.348 years ±11.05 SD. The users were from different age groups and occupations including university students, university teaching staff, university cleaning staff, HCWs and food vendors, Table 1.

The mobile phones were from different manufactures. Two hundred fifty phones (62.5%) were smart phones while the remaining 150 phones were phones with digit keys (37.5%). Two hundred fifty nine (64.75%) phones were without cover (encase) while 141 (35.25%) were with covers made either from plastic, leather or cloth, Table 2.

Three hundred eighteen owners were using their phones by themselves (79.5%) while 82 (20.5%) admitted their phones were used by their family members regularly, Table 2. The mobile phones were used occasionally (few times) by 151 (39.11%) of the owners, 88 (22.79 %) were using it for up to an hour daily, 67 (17.35%) were using it for up to 2 hours while 80 (20.72 %) admitted using their phones for more than 2 hours, while 13 persons did not answered this question.

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Inquiry about cleaning the mobile phones revealed that 231 (59.38%) were not cleaning their phones, 149 (38.30%) were cleaning their phones irregularly by a tissue while 9 (2.32%) were cleaning their phone regularly (wiping it with a wet tissue) and 11 persons did not answered this part, Table 2.

Following cultivation of swab samples on bacteriological media, 272 (68%) swabs resulted in growth of one or more microorganisms while from the remaining 128 (32%) swabs no growth were observed. Among the 272 bacterial growth detected, one microorganism species was isolated from 221 (81.25%) phones, two species isolated from 44 (16.17%) while from 6 (2.2%) swabs three species of bacteria were isolated and one swab resulted in isolation of four different microorganisms.

Isolation of microorganisms were more among mobile phones from males than females (76.5% vs. 56.47%)

and more bacteria were isolated among food vendors (91%) followed by the university cleaning staff workers (75%), university students (59%), HCWs (57%) and university teaching staff (53%).

Table 3 shows the microorganism species isolated from the mobile phones. From 272 swabs, 332 microorganisms were isolated and Coagulase Negative Staphylococci (CoNS) were the most frequent isolated bacteria (222 or 66.66% of isolates). The next most frequent isolated bacteria were *Bacillus* spp. and *Micrococcus* spp. with 24 and 17 isolates respectively. Pathogenic microorganisms such as *Staphylococcus aureus* and *Pseudomonas aeruginosa* were also isolated. Few enteric microorganisms were isolated and three *Candida albicans* were also isolated, Table 3.

Table 1. The characteristic of the mobile owners and the results of swab cultivation from mobile phones on bacteriological media.

Owner variables	Growth No. (%) n = 272	No Growth No. (%) n = 168	Total (%)	p Value
Gender				
Male	176 (76.52)	54 (23.48)	230 (100)	< 0.001
Female	96 (56.47)	74 (43.53)	170 (100)	
Occupation				
HCWs*	57 (57)	43 (43)	100 (100)	<0.001
Students	58 (59.18)	40 (40.82)	98 (100)	
University Staff	36 (75)	12(25)	48 (100)	
University Teaching Staff	29 (53.7)	25 (46.3)	54 (100)	
Food Vendors	91 (91)	9 (9)	100 (100)	
Age				
≤ 19	42 (67.74)	20 (32.26)	62 (100)	0.7916
20-29	89 (65.44)	47 (34.56)	136 (100)	
30-39	71 (73.96)	25 (26.04)	96 (100)	
40-49	52 (65)	28 (35)	80 (100)	
50-59	15 (68.19)	7 (31.81)	22 (100)	
≥ 60	3 (75)	1 (25)	4 (100)	

* HCWs: health care workers

Table 2. The characteristic of the mobile phones and the result of swab cultivation from mobile phones on bacteriological media.

Mobile phone variable	Growth No. (%) n = 272	No Growth No. (%) n = 168	Total (%)	p Value
Phone type				
Smart	166 (66.4)	84 (33.6)	250 (100)	0.3758
Digit Keys	106 (70.67)	44 (29.33)	150 (100)	
Sharing phone				
Yes	57 (69.51)	25 (30.49)	82 (100)	0.8442
No	215 (67.61)	103 (22.39)	318 (100)	
Phone cover				
Yes	99 (70.21)	42 (29.79)	141 (100)	0.5567
No	173 (66.8)	86 (33.2)	259 (100)	
Cleaning phone n =389				
Yes	96 (64.43)	53 (35.57)	149 (100)	0.0928
Regular	4 (44.44)	5 (55.56)	9 (100)	
No	166 (71.86)	65 (28.13)	231 (100)	
No answer	6 (54.55)	5 (45.45)	11 (100)	
Daily phone use class * n = 387				
I	118 (78.15)	33 (21.85)	151 (100)	0.003
II	59 (66.29)	30 (33.71)	89 (100)	
III	43 (64.18)	24 (35.82)	67 (100)	
IV	44 (55)	36 (45)	80 (100)	
No answer	8 (61.54)	5 (38.46)	13 (100)	

*** Daily phone use; Class I using phone occasionally (few times), Class II using phone for up to an hour, Class III using phone for up to 2 hours, Class IV using phones for more than 2 hours.**

Table 3. The types of isolated microorganisms from mobile phone surface.

Microorganism	Total isolates <i>n</i> = 332	Percentage of isolates
Coagulase negative Staphylococci	222	66.8
Bacillus spp.	24	7.22
Micrococcus spp.	17	5.12
<i>Streptococcus pneumoniae</i>	15	4.51
<i>Viridans streptococci</i>	13	3.91
<i>Streptococcus pyogenes</i>	11	3.31
<i>Nonpathogenic Neisseria</i>	6	1.8
<i>Pseudomonas aeruginosa</i>	5	1.5
<i>Staphylococcus aureus</i>	4	1.2
<i>Pseudomonas stutzeri</i>	4	1.2
<i>Klebsiella pneumoniae</i>	3	0.9
<i>Candida albicans</i>	3	0.9
<i>Diphtheroids</i>	2	0.6
<i>Escherichia coli</i>	1	0.3
Enterococcus spp.	1	0.3
<i>Kocuria rosea</i>	1	0.3

DISCUSSION

Infectious diseases are common medical problems in many communities. Many infectious agents are transmitted by direct contact between individuals and the agents persist constantly in the community. Interrupting the pathway between different hosts limits the spread of the infectious agents. Proper hand hygiene was found to be an effective measure in limitation of the spread of methicillin resistant *Staphylococcus aureus* (MRSA) and other bacteria⁽¹³⁻¹⁵⁾.

Infectious agents can also exploit inanimate objects to circulate between hosts. Indirect contact transmission occurs when pathogens are spread from one host to another by fomites which are inanimate objects that are inadvertently used to transfer pathogens to new host⁽¹⁶⁾. Mobile phones nowadays are indispensable tools in our life and their use has increased dramatically since their

introduction and keep growing every year⁽¹⁾. Billions of handsets are introduced each year and people spend a lot of time using their phones either for communication or for the many applications which smart phones offers.

Many studies were conducted on the role of mobile phones on human brain through the electromagnetic effects⁽¹⁷⁻¹⁹⁾ and many other studies were performed on mobile phone bacterial contamination^(3, 20-22) but these have not add a limit to the use of the mobile phones.

In this study data were collected on the mobile phones and their usage and isolated bacteria from the phones surfaces were identified. The results showed that 60% of the users used their phone at a daily average of one hour to several hours. Prolonged hand contact with the phone increases the chances of bacteria transferred into and from the phone. The number and types of bacteria on the hand (pathogenic or flora) is in a dynamic state

and can vary with daily activities such as hand washing, contact with body parts or other persons so the types and number of the bacteria on the mobile phone will change accordingly.

Although mobile phones are indicated for personal uses, bacteria may spread to others when there are multiple users. Our results showed that 20.5% of the users admitted that their phones are used by others (usually a family member), this sharing increases the chance of bacterial transmission between users via the phone. Cleaning the handset with a tissue was questioned; the majority reported not to clean their phones while few users were persistent on cleaning their mobile regularly while others clean it just to remove the screen fingerprints. The use of antiseptics is usually not recommended by mobile phone manufactures and none of the users reported using antiseptic wipes and all this will increase the chance of persistence of the bacteria on the phones. In our study there was no significant evidence that fewer bacteria were isolated from cleaned phones versus non cleaned ones or from mobile phones with covers in comparison with phones without covers.

Among the 400 swabs obtained from the phone surfaces, 272 (67%) swabs resulted in growth of one or more microorganisms. This will conclude that two third of the phones were carrying different types of bacteria.

A high isolation rates (94.5 to 97.8%) from HCWs mobile phone were reported^(5, 23) while others reported less figures (43.6%)⁽²⁴⁾. In our study and among the HCWs, growth was observed in 57% of phones. Difference in isolation rate may be attributed to factors such as the frequency of phone use and daily activity. In our study significantly high isolation were observed among food vendors (91%) in comparison to other occupations. A statistically significant evidence for isolation were observed among the males in comparison to the females which may be due to that 94 % of the food vendor were males, Table1. The food vendors were having more contact with other persons during their works; working in a warmer environment with less frequent hand washing all which may be factors for the increased growth from their phones.

In comparison of bacterial growth from smart phones, shared phones, phones with cover and cleaned phones to non-smart type phones, non-shared phones, phones without cover and non-cleaned phones respectively, our results showed no significant difference while a positive relation was observed between the daily usage

time and bacterial isolation as seen from class III and IV users, Table 2.

The growth of microorganisms ranged from a single colony to a heavy growth. The majority of the isolated bacteria (66.7%) were CoNS species which is a human skin flora. others were non- pathogenic bacteria like neisseriae, micrococcus spp., viridians streptococci and Bacillus spp. Pathogenic bacteria such *Staphylococcus aureus*, *Streptococcus pneumoniae* and *Streptococcus pyogenes* were also found on some phones. These pathogens are less likely to inhabit skin but it is likely to contaminate hands from different body microbial flora and then seeded on the mobile phones.

The isolation of few other pathogenic microorganisms such as *Pseudomonas aeruginosa*, *Pseudomonas stutzeri*, *Klebsiella pneumoniae* and *E. coli* shows the possibility of the contamination by enteric flora. Unlike some reports quoting “1 in 6 Cell Phones Contaminated With Fecal Matter”⁽⁸⁾, we could not find such observation. It is obvious that mobile phones collect bacteria from the user’s hands and therefore the frequency of hand washing, contact with body parts and other persons will change the bacterial cells resident on the hands and then consequently on the mobile phones.

Since the cleaning of mobile phone is not effective and not practical then to reduce the chance of getting bacteria from mobile phone it is recommended not to use other phones and hand hygiene is essential to reduce bacterial contamination of mobile phones.

In conclusion, mobile phones are one the daily used gadget that is contaminated by many types of bacteria from human contact. The types of the bacteria on their surface reflect those on human hand and these bacteria can spread from one person to another. Hand hygiene and not sharing mobile phones can reduce the spread of bacteria and acquiring pathogenic bacteria from phones.

REFERENCES

1. The International Telecommunication Union. ITC Facts and Figures. Switzerland 2013. Available from: <http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2013-e.pdf>
2. Osterholm MT, Hedberg CW. Epidemiologic Principles. In: Mandell GL, Bennett JE, Dolin R, editors. Mandell, Douglas, and Bennett’s principles and practice of infectious diseases. 7 ed. Edinburg: Churchill Livingstone; 2010. p. 179-92.

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3. Tagoe DN, Gyande VK, Ansah EO. Bacterial Contamination of Mobile Phones: When Your Mobile Phone Could Transmit More Than Just a Call. *WebmedCentral Microbiology* 2011;2(10).
4. Akinyemi KO, Atapu AD, Adetona OO, Coker AO. The potential role of mobile phones in the spread of bacterial infections. *Journal of infection in developing countries*. 2009;3(8):628-32.
5. Ulger F, Esen S, Dilek A, Yanik K, Gunaydin M, Leblebicioglu H. Are we aware how contaminated our mobile phones with nosocomial pathogens? *Annals of clinical microbiology and antimicrobials*. 2009;8:7.
6. Datta P, Rani H, Chander J, Gupta V. Bacterial contamination of mobile phones of health care workers. *Indian journal of medical microbiology*. 2009;27(3):279-81.
7. Morioka I, Tabuchi Y, Takahashi Y, Oda Y, Nakai M, Yanase A, et al. [Bacterial contamination of mobile phones shared in hospital wards and the consciousness and behavior of nurses about biological cleanliness]. *Nihon eiseigaku zasshi Japanese journal of hygiene*. 2011;66(1):115-21.
8. Song S. Study: 1 in 6 Cell Phones Contaminated With Fecal Matter. *TIME*. 2011 17/10/2011. Available from <http://healthland.time.com/2011/10/17/study-1-in-6-cell-phones-contaminated-with-fecal-matter/print/>.
9. Foxnews.com. Mobile Phones 18 Times Dirtier Than Toilet Handles 2010 [16/10/2014]. Available from: <http://www.foxnews.com/story/2010/07/30/mobile-phones-18-times-dirtier-than-toilet-handles/>.
10. Colaninno PM. Identification of Gram-Positive Organisms. In: Goldman E, H. GL, editors. *Practical Handbook of Microbiology*. Second ed. Boca Raton CRC Press; 2009. p. 53-66.
11. Kohlerschmidt Dj, Musser KA, Dumas NB. Identification of Aerobic Gram-Negative Bacteria. In: Goldman E, H. GL, editors. *Practical Handbook of Microbiology*. Second ed. Boca Raton: CRC Press; 2009. p. 67-79.
12. SPSS for Windows. version 19. Chicago: SPSS Inc.; 2010.
13. Pittet D. Improving compliance with hand hygiene in hospitals. *Infection control and hospital epidemiology : the official journal of the Society of Hospital Epidemiologists of America*. 2000;21(6):381-6.
14. Lederer JW, Jr., Best D, Hendrix V. A comprehensive hand hygiene approach to reducing MRSA health care-associated infections. *Jt Comm J Qual Patient Saf*. 2009;35(4):180-5.
15. Boyce JM, Pittet D. Guideline for hand hygiene in health-care settings. Recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. *CDC*, 2002.
16. Bauma RW. *Infection, Infectious Diseases, and Epidemiology*. In: Bauma RW, editor. *Microbiology With Diseases by Body System*. Boston Perason; 2015. p. 415-47.
17. Davis DL, Miller AB, Philips A. Association of mobile phone use with adult brain cancer remains plausible. *BMJ (Clinical research ed)*. 2012;344:e3083; author reply e8.
18. Yamaguchi N. [The IARC carcinogenicity evaluation of radio-frequency electromagnetic field: with special reference to epidemiology of mobile phone use and brain tumor risk]. *Nihon eiseigaku zasshi Japanese journal of hygiene*. 2013;68(2):78-82.
19. de Vocht F, Burstyn I, Cherrie JW. Time trends (1998-2007) in brain cancer incidence rates in relation to mobile phone use in England. *Bioelectromagnetics*. 2011;32(5):334-9.
20. Jeske HC, Tiefenthaler W, Hohlrieder M, Hinterberger G, Benzer A. Bacterial contamination of anaesthetists' hands by personal mobile phone and fixed phone use in the operating theatre. *Anaesthesia*. 2007;62(9):904-6.
21. Brady RR, Wasson A, Stirling I, McAllister C, Damani NN. Is your phone bugged? The incidence of bacteria known to cause nosocomial infection on healthcare workers' mobile phones. *The Journal of hospital infection*. 2006;62(1):123-5.
22. Brady RR, Hunt AC, Visvanathan A, Rodrigues MA, Graham C, Rae C, et al. Mobile phone technology and hospitalized patients: a cross-sectional surveillance study of bacterial colonization, and patient opinions and behaviours. *Clinical microbiology and infection : the official publication of the European Society of Clinical Microbiology and Infectious Diseases*. 2011;17(6):830-5.
23. Ustun C, Cihangiroglu M. Health care workers' mobile phones: a potential cause of microbial cross-contamination between hospitals and community. *Journal of occupational and environmental hygiene*. 2012;9(9):538-42.
24. Sadat-Ali M, Al-Omran AK, Azam Q, Bukari H, Al-Zahrani AJ, Al-Turki RA, et al. Bacterial flora on cell phones of health care providers in a teaching institution. *American journal of infection control*. 2010;38(5):404-5.