International Journal of Infection Control
www.ijic.info ISSN 1996-9783

ORIGINAL ARTICLE

Bacterial contamination of mobile phones of healthcare workers at Jimma University Specialized Hospital, Jimma, South West Ethiopia

Girma Mulisa Misgana[1], Ketema Abdissa[2], Gemeda Abebe[2]
1. Adama Hospital Medical College, Department of Biomedical Science, Adama, Ethiopia
2. Jimma University, Department of Medical Laboratory Science and Pathology, Jimma, Ethiopia

doi: 10.3396/IJIC.v11i1.007.15

Abstract

Millions of people worldwide are suffering from infections acquired in hospitals. Contaminated equipment and hospital environments are known sources of infection. Mobile phones are used in hospitals without restrictions, regardless of their unknown microbial load. This study aimed to determine the level of bacterial contamination of mobile phones of health care workers at Jimma University Specialized Hospital in comparison with non health care workers' mobile phones.

A cross-sectional comparative study was used to conduct this study. The pattern of mobile phone use and cleaning practice of study participants were assessed using a questionnaire. Swab specimens were collected from known exposed areas of mobile phones and eluted in sterile normal saline. Colonies were counted using calibrated wire loop technique and growths were identified following standard bacteriological technique. Kirby-Bauer disc diffusion method was used to determine the antimicrobial sensitivity tests of the isolates. Data analysis was performed using SPSS version 16.

A total of 71.2% (94/132) of mobile phones showed evidence of bacterial contamination from which 61.7% (58/94) were contaminated with >5 colony forming units/cm^2. The degree of bacterial contamination was higher among health care workers mobile phones (OR= 4.50; 95% CI 1.85-10.98). A total of 112 bacterial organisms were isolated with 33 *Staphylococcus aureus*, 61 coagulase negative staphylococci, 12 *Bacillus* species, 4 *Micrococcus* species, 1 *Serratia* species and 1 *Klebsiella pneumoniae*. Thirty nine percent (5/13) of meticillin resistant *S. aureus* were vancomycin resistant. Health care workers mobile phones were more likely contaminated with meticillin resistant *S. aureus* than non health care workers' mobile phones (OR=12.83; 95% CI 2.15-37.45). All of the study participants never wash their hands after mobile phone use and 75.5%

Corresponding Author
Girma Mulisa Misgana
Adama Hospital Medical College, Department of Biomedical Science, P.O. Box 84, Adama, Ethiopia
Email: girmamulisa30@gmail.com

(50/66) of health care workers answered that they used their mobile phones while attending patients.

Health care workers mobile phones were more contaminated than non health care works' mobile phones. The majority of the resistant isolates were from health care workers' mobile phones.

Keywords: Cell phones; Equipment contamination; Bacterial infections; Health personnel; Cross infection

Introduction

Globally, hospital acquired infection is an increasing concern[1-3] and it is also true in Ethiopia.[4-6] It is caused by a wide range of pathogens, many of which are becoming increasingly resistant to standard antimicrobial agents.[7-8] At least 90% of hospital acquired infections diagnosed in hospitals were caused by bacteria.[9] The source of these infectious agents could be either from endogenous[10] or exogenous sources.[11] Health care equipment[12-13] and health care environments[14-15] are a significant source of hospital acquired infections.

Hand hygiene is promoted for prevention of hospital acquired infections and it is simple to implement in developing countries where resources are limited.[16] However, the potential transmission of diseases via contaminated devices or other items that are not considered in routine cleaning schedules is often overlooked[17] and they are a possible source of microbes in the health care environment.[7] Gowns, gloves, bedside stethoscopes, neck ties, bed rails, sheets, telephones, horizontal surfaces, door knobs, thermometers, nurse's clothing and personal bags are contaminated by pathogenic bacteria.[18-19] The hands and gloves of healthcare workers readily acquire the pathogens after contact with contaminated hospital surfaces and equipment, then transfer these organisms to subsequently touched patients.[2]

There is the standard that identification of an indicator organism of potential high-risk to patients in any amount and, the finding of total aerobic colony count >5 colony forming units/cm^2 from a hand contact surface, whatever the identity of the organisms, indicates that there might be an increased risk of infection for the patient in that environment.[20] A personal mobile phone is a frequently touched device in health care environments, but it is not usually included in routine cleaning schedules. It can be contaminated by resistant nosocomial pathogens and health care workers (HCWs) use it during patient examination.[21-22] Studies also demonstrate incidences of infectious diseases are greater in those people who use contaminated mobile phones.[23]

Although most personal objects are stored in changing rooms, mobile phones often accompany the staff into the operation room, intensive care unit and wards where calls are made or answered while attending patients.[24] Mobile phones are used in the hospital without restriction and the majority of HCWs neither clean their mobile phones regularly nor wash hands after using their mobile phones.[25] Further sharing of mobile phones between HCWs and non HCWs may distinctly facilitate the spread of potentially pathogenic bacteria to the community.[26]

Mobile phones are potential threats in infection control practices and could exaggerate the rate of hospital acquired infections. The hygiene risk involved in using mobile phones in the hospital setting and in the community has not yet been determined in Ethiopia. Thus, the purpose of this study was to determine the degree of bacterial contamination and resistance against commonly used antimicrobials found on the HCWs mobile phones at Jimma University Specialized Hospital in comparison to mobile phone of non HCWs.

Methods

A cross-sectional comparative study was conducted from June 15, 2011 to October 21, 2011. Healthcare worker study participants were randomly selected and proportionally allocated from the following hospital units; from the Operation Room (OR) 21 HCWs, Surgical wards - 10, Gynaecology and Obstetrics wards - 10, Intensive Care Unit (ICU) - 6, Paediatrics ward - 11 and Laboratory - 8. For non HCWs participants, 31 Jimma college instructors and 35 administrative staffs were selected after stratification based on their occupation and simple random sampling was applied

to each stratum. Using a predesigned and piloted questionnaire, the pattern of mobile phone use and cleaning practice of the randomly selected study participants were assessed.

To determine the degree of bacterial contamination and type of isolates, a sterile cotton swab moistened with sterile normal saline was rolled over a measured area of exposed outer surfaces of the mobile phones. Included were the most frequent areas of contact with the fingers: the buttons of the keypad, earpiece, back side and lateral side of the phone. After gentle mixing, the eluted specimen was inoculated on 5% defibrinated sheep blood agar (Oxoid UK) using a calibrated wire loop and incubated at 37°C for 24 to 48 hours. Growth was checked every 24 hours and colonies were counted using a colony counter and multiplied by the correction factor in order to obtain colony forming unit/ ml. Finally degree of contamination was calculated by: total colony forming unit/ total area sampled. Growths were identified to genus and species level following standard bacteriological technique.

The antimicrobial sensitivity tests of the isolates were determined using the Modified Kirby-Bauer disc diffusion method. The isolates susceptibility was tested for antibiotics listed in the national guideline for standard treatment. Data analysis was performed using SPSS version 16.0.

Results

A total of 66 HCWs and 66 non HCWs who had a mobile phone were included in the study. Bacteriological analysis of swab samples from the mobile phones showed that 86.37% (57/66) of HCWs and 56.06% (37/66) of non HCWs mobile phones had evidence of bacterial contamination. Sixty two percent (58/94) of the contaminated mobile phones showed growth of >5 CFUs/cm^2 of which HCWs mobile phones accounts 74.1% (43/58). HCWs mobile phones were more contaminated compared to the non HCWs mobile phones (OR= 4.96; 95% CI 2.11-11.67). More over the degree of bacterial contamination was also higher among HCWs mobile phones than non HCWs mobile phones (OR= 4.50; 95% CI 1.85-10.98). Totally 112 bacterial organisms were isolated (Table I).

Thirty nine percent (5/13) of meticillin resistant *S. aureus* (MRSA) and 29.60% (8/27) of meticillin resistant coagulase negative staphylococci (MRCoNS) were

Table I. Type of bacterial isolate from mobile phones of HCWs and non HCWs at JUSH and Jimma Teachers College, Jimma, Ethiopia, 2011

Isolates	Group of study participants		P- Value	OR (95%CI)
	Healthcare workers	Non healthcare workers		
S. aureus	17	16	0.137	0.518 (0.218-1.234)
CoNS	40	21	0.295	1.587 (0.668-3.770)
Bacillus species	9	3	0.318	2.020 (0.509-8.024)
Micrococcus species	2	2	0.626	0.607 (0.082-4.512)
K. pneumoniae	0	1		
Serratia species	1	0		

Table II. Susceptibility of *S. aureus* isolates to commonly used antimicrobials at JUSH and Jimma Teachers College, Jimma, Ethiopia, 2011

Antimicrobials	Study participants	Phenotypic results of antimicrobial susceptibility		Total	P value	OR (95%CI)
		Sen	Res			
Cefoxitin	HCWs	6	11	17	0.005	12.833 (2.154-76.446)
	Non HCWs	14	2	16		
Oxacillin	HCWs	6	11	17	0.005	12.833 (2.154-76.446)
	Non HCWs	14	2	16		
Penicillin	HCWs	2	15	17	0.052	5.833 (0.988-34.436)
	Non HCWs	7	9	16		
Ampicillin	HCWs	2	15	17	0.026	7.500 (1.276-44.085)
	Non HCWs	8	8	16		
Ceftriazone	HCWs	1	16	17	0.001	69.333 (6.426-748.059)
	Non HCWs	13	3	16		
Ciprofloxacin	HCWs	7	10	17	0.007	21.429 (2.275-201.865)
	Non HCWs	15	1	16		
Gentamycin	HCWs	10	7	17		
	Non HCWs	16	0	16		
Tetracyclin	HCWs	15	2	17	0.026	0.133 (0.023-0.784)
	Non HCWs	8	8	16		
Clindamycin	HCWs	15	2	17	0.948	0.933 (0.115-7.553)
	Non HCWs	14	2	16		
Erythromycin	HCWs	8	9	17	0.049	4.875 (1.008-23.568)
	Non HCWs	13	3	16		

vancomycin resistant. HCWs mobile phones were more likely contaminated with MRSA than non HCWs mobile phones (Table II). *Klebsiella pneumoniae* and *Serratia* species were resistant to all the beta-lactam antimicrobials used including cefotaxime. MRSA was isolated on the mobile phones of study participants from all wards, except the gynaecology and obstetrics wards. Multiple bacterial species were isolated from single mobile phones of HCWs and non HCWs (Table III).

None of the study participants washed their hands after mobile phone use and 75.50% (50/66) of HCWs answered that they used their mobile phones while attending patients. Fifty percent (50%) of HCWs do not wash their hands, before attending their patients. All of the participants used the same phone at home and in the work place. In addition, 95.50% of HCWs and 77.30% of non HCWs stated that they shared their mobile phones with their colleagues at work place and home.

Table III. Number of bacterial species isolated per specimen from mobile phones of HCWs and non HCWs at JUSH and Jimma Teachers College, Jimma, Ethiopia, 2011

Number of bacterial species per specimen	Study participants: Health care workers	Study participants: Non health care workers	P-value	OR (95%CI)
Single	43	33	0.024	0.169 (0.036-0.789)
Two	13	4	0.174	2.311 (0.690-7.741)
Three	1	0		

Discussions

Mobile phones are multipurpose non medical devices used in the health care facility and in the community. It has increasingly become an important means of communication in the community and in the health care facility for collecting epidemiological data and monitoring chronic diseases.[27] In Ethiopia, mobile phones are used without restriction in health care facilities, including specific, sensitive areas like the operation room and the intensive care units, regardless of their unknown microbial load. Outside of Ethiopia, a number of investigations were conducted[22-29] to determine bacterial contamination of mobile phones of HCWs. However, they did not determine the degree of contamination in reference to the acceptable bacterial load on frequently hand touched equipment in health care environments.[20]

A total of 71.20% mobile phones showed evidence of bacterial contamination in our study. Comparable results were reported in India by Datta *et al.*[28] and Chawla *et al.*[24] The rate of contamination of mobile phones was reported to be higher in the following studies: Ulger *et al.*[29] reported 95%, Famurewa *et al.*[30] reported 91% and Karabay *et al.* reported 83%.[31] Studies that reported findings of lower bacterial contamination of mobile phones were published by Sepehri *et al.*[32] at 33% and Arora *et al.*[33] with 41%. The difference in the contamination rate may be due to the variation of the study participants in adherence to infection prevention, the pattern of mobile phone use, mobile phone keeping habits and personal behaviour, like nose picking for example.

In this current study, HCWs mobile phones were more contaminated compared to non HCWs mobile phones (OR= 4.96; 95% CI 2.11-11.67). Sixty two percent (58/94) of the contaminated mobile phones showed growth of >5 CFU/cm^2 of which HCWs mobile phones accounted for 74.10% (43/58). This indicates that HCWs mobile phones were heavily contaminated compared to non HCWs mobile phones (OR=4.51; 95% CI 1.85-10.98). The reasons for getting a larger number of isolates from HCWs mobile phones may be due to the fact that HCWs have direct contact with patients. Usually HCWs keep their mobile phone in their pocket with other items. Non compliance of hospital standards for infection prevention may also contribute to the finding of high bacterial contamination.

Gram positive bacteria were the leading isolates, which was also found in studies conducted by others outside of Ethiopia.[34-35] CoNS was the most prevalent and frequent bacterial agent isolated from mobile phones in this study 54.50% (61/112). This result was similar to the findings of other studies.[36-38] Though gram positive bacteria are normal skin inhabitants, these organisms have the potential to harbour and transfer drug resistance gene among their genera or beyond. The issue may become more serious, if HCWs become a potential source for transfer of these organisms during invasive procedures.[36] CoNS are increasingly the causative agents of nosocomial infections.[37]

The second predominant isolate was *S. aureus,* which accounted for 29.40% (33/112) of all isolates. More than half of the *S. aureus* isolates were from HCWs mobile phones. The findings in the studies conducted by Chawla *et al.*[25] and Arora *et al.*[33] were similar with the findings in this study; *S. aureus* as was the second dominant bacterial isolate. Studies conducted by Data

et al.[28] and Sadat *et al.*[38] showed *S. aureus* was their leading isolate.

Few Gram negatives bacteria one *K. pneumoniae* and one *Serratia* species, were isolated from HCWs and non HCWs mobile phones. Other–study results by Karabay *et al*.[31] and Chawla *et al*.[24] were in agreement with this finding. The reason for getting low isolates of gram negative organisms may be due to the fact that they do not tolerate desiccation.

Eighty one percent (81%) (78/96) of the isolates tested for antimicrobial susceptibility were resistant to at least one antimicrobial. The antimicrobial susceptibility profile revealed 44.30% (27/61) of the CoNS were meticillin resistant and 29.60% (8/27) of them were vancomycin resistant. *S. aureus* was one of the most frequently encountered strict pathogen both in a community and in a health care facility.[39] In the current study 39.40% (13/33) of *S. aureus* isolates were meticillin resistant of which 38.50% (5/13) were vancomycin resistant. A higher number of MRSA isolates were found on the mobile phones of HCWs compared to non HCWs mobile phone (OR=12.83; 95% CI, 2.15-76.45) with 6 MRSA from nurses, 2 MRSA from doctors, 2 MRSA from scrub nurses and 1 MRSA from laboratory technologist's mobile phones. All isolates of *S. aureus* from surgical wards and more than half of the isolates of *S. aureus* from ICU, OR and pediatrics wards were MRSA. The majority of vancomycin resistant *S. aureus* isolates were from the mobile phones of HCWs.

Mobile phones of HCWs were more contaminated with MRSA and MRCoNS than non HCWs mobile phones (OR= 3.71; 95%CI 1.48-9.25). This may indicate that the hospital environment is a habitat for drug resistant pathogens, including MRSA and MRCoNS.[40] Bacteria viable through multiple environments are likely to give a crucial contribution to the spreading of bacterial resistance towards antimicrobial compounds.[41] Thus this result calls for the decontamination of mobile phones that harbour MRSA and MRCoNS in health care settings and the community to prevent the spread of resistant organisms.

The principal mode of transmission of MRSA within the hospital is via the colonized hands of HCWs, who acquire the organism after close contact with colonized patients, contaminated equipment, or their own flora. As mobile phones harboured MRSA, HCWs acquire it during phone use and transfer to the subsequently touched individuals and materials, since they do not wash their hands after mobile phone use. Thus the contaminated mobile phones of HCWs are a strong risk factor for the prevalence of MRSA in the hospitalized patients, visitors, and hospital staff with potential risk of spreading to the community. For these reasons, the results of this study recommend that mobile phone hygiene should be considered in the control strategy of MRSA.

None of the study participants washed their hands after mobile phone use and 75.80% (50/66) of the HCWs answered that they used their mobile phones while attending patients. Fifty percent (50%) of HCWs did not wash their hands before attending to their patients. Only 51.50% (34/66) of HCWs and 37.90% (25/66) non HCWs cleaned their mobile phones. The study conducted by Chawla *et al.* in India[24] showed that 48% of HCWs use mobile phones while attending patients and the majority neither cleaned their mobile phones regularly nor wash hands after using mobile phones. Majority of the mobile phone users neither clean their mobile phones regularly nor wash hands after using mobile phones.[24]

Other studies demonstrated similar nosocomial pathogens were isolated from HCWs hands and their mobile phones.[40,42] Thus the combination of HCWs non adherence to infection prevention like hand washing, the high contamination rate of their mobile phones, the pattern of using mobile phones in the health care setting with its low cleaning practice make this device a vehicle for transmission of pathogenic bacteria that is a potential danger to patient safety.

In this study, it was revealed that all the study participants use the same mobile phones at home and in the work place, while 86.40% of them share their mobile phone with their colleagues at work. These conditions enhanced the cross contamination of the mobile phone and spread bacterial pathogens among the users, which may also contribute to the spread of bacterial pathogens among the health care facility and the community. In addition, users of contaminated

phones may acquire infections, because infectious doses of pathogens may be transferred to the mouth after handling contaminated mobile phones.[43]

Conclusion

We conclude that 61.7% (58/94) of mobile phones were contaminated with >5 colony forming units/cm^2 which is not acceptable in health care environments. More resistant bacteria were isolated from HCWs mobile phones than from non HCWs mobile phones. HCWs used their mobile phones without restriction in the hospital and they answer that they used their mobile phones while attending patients. The use of contaminated mobile phones in specific areas such as the operation room and the intensive care units in the study hospital was a potential risk for patient safety.

Acknowledgement

We are heartily thankful to Jimma University for funding and Ethiopian Health and Nutrition Research Institute for provision of control strains.

References

1. Palmore T, Henderson D, Bonten M, *et al*. Enhancing patient safety by reducing healthcare-associated infections: the role of discovery and dissemination. *Infect Control Hospital Epidemiology* 2010; **31(2):** 118-123. http://dx.doi.org/10.1086/650198
2. Allegranzi B, Pittet D. Role of hand hygiene in health care associated infection prevention. *Journal of Hospital Infection*. 2009; **73(4):** 305-315. http://dx.doi.org/10.1016/j.jhin.2009.04.019
3. Razine R, Azzouzi A, Barkat A, *et al*. Prevalence of hospital-acquired infections in the university medical center of Rabat, Morocco. *International Archives of Medicine* 2012; **5(26):** 1-8.
4. Endalafer N, Gebre-Selassie S, Kotiso B. Nosocomial bacterial infections in a tertiary hospital in Ethiopia. *Journal of Infection Prevention 2010;* **11(6):** 1757-1774.
5. Mikyas D, Sileshi L. The prevalence of nosocomial infections and associated risk factors in pediatric patients in Tikur Anbessa Hospital. *Ethiopian Journal of Pediatrics and Child Health* 2009; **5(5):** 1-4.
6. Tesfahunegn Z, Asrat D, Woldeamanuel Y, Estifanos K. Bacteriology of surgical site and catheter related urinary tract infections among patients admitted in Mekelle Hospital, Mekelle, Tigray, Ethiopia. *Ethiopian Medical Journal* 2009; **47(2):** 117-127.
7. Borkow G, Monk A. Fighting nosocomial infections with biocidal non-intrusive hard and soft surfaces. *World Journal of Clinical Infectious Disease* 2012; **2(4):** 77-90. http://dx.doi.org/10.5495/wjcid.v2.i4.77
8. Nyasulu P, Murray J, Perovic O, Koornhof H. Antimicrobial resistance surveillance among nosocomial pathogens in South Africa: Systematic review of published literature. *Journal of Experimental & Clinical Medicine* 2012; **4(1):** 8e13.
9. Jain A, Singh K. Recent advances in the management of nosocomial infections. *Journal of Medical Education and Research* 2007; **9(1):** 1-8.
10. von Eiff C, Becker K, Machka K, Stammer H, Peters G. Nasal carriage as a source of *Staphylococcus aureus* bacteremia. *N Engl J Med* 2001; **344:** 11-16. http://dx.doi.org/10.1056/NEJM200101043440102
11. Horan C, Dudeck A. CDC/NHSN surveillance definition of health care–associated infection and criteria for specific types of infections in the acute care setting. *American Journal of Infection Control* 2008; **36(5):** 309-332. http://dx.doi.org/10.1016/j.ajic.2008.03.002
12. Schabrun S, Chipchase L. Healthcare equipment as a source of nosocomial infection: a systematic review. *Journal of Hospital Infection* 2006; **63(1):** 239-245. http://dx.doi.org/10.1016/j.jhin.2005.10.013
13. Eze JC, Ekpo EU, Nzotta CC, Asogwa NC, Egbe NO. X-ray equipments and accessories as possible vectors of nosocomial bacteria in Anambra State, Nigeria. *Journal of Association of Radiographers of Nigeria* 2012; **26:** 18–27.
14. Otter J, Yezli S, French G. The role played by contaminated surfaces in the transmission of nosocomial pathogens. *Infect Control Hospital Epidemiology* 2011; **32(7):** 687-699. http://dx.doi.org/10.1086/660363
15. Tagoe D, Baidoo S, Dadzie I, Tengey D, Agede C. Potential sources of transmission of hospital acquired infections in the Volta regional hospital in Ghana. *Ghana Medical Journal* 2011; **45(1):** 1-5. http://dx.doi.org/10.4314/gmj.v45i1.68918
16. Edem EN, Onwuezobe IA, Ochang EA, Etok CA, James IS. Antibiogram of bacterial isolates from the anterior nares and hands of health care workers in University of Uyo Teaching Hospital (UUTH) Uyo, Akwalbom State, Nigeria. *Journal of Bacteriol Parasitol* 2013; **4(2):** 1-5.
17. Marcham Ch. Coats, ties, stethoscopes, cell phones, and id badges: potential sources of healthcare-associated infections? *Environmental health and safety* 2009; **16(1):** 1-4.
18. Snyder M, Thom A, Furuno P. Detection of Methicillin resistant *Staphylococcus aureus* and vancomycin-resistant enterococci by healthcare workers on infection control gown and gloves. *Infection Control Hospital Epidemiology* 2008; **29(7):** 583–589. http://dx.doi.org/10.1086/588701
19. Harika G, Prashanth K, Amana A. Bacteriological study of microorganisms on mobiles and stethoscopes used by health care workers in emergency and ICU's. *International Journal of pharmacy and biological sciences* 2013; **2(3):** 290-297.
20. Dancer J. How do we assess hospital cleaning? A proposal for microbiological standards for surface hygiene in hospitals. *Journal of Hospital Infection* 2004; **56:** 10-15. http://dx.doi.org/10.1016/j.jhin.2003.09.017
21. Rana R, Joshi S, Lakhani S, Kaur M, Patel P. Cell phones – homes for microbes. *International Journal of Biological and Medical Research* 2013; **4(3):** 3403-3406.
22. Muzslay M, Lee E, Alder S, *et al*. Key pad mobile phones are associated with a significant increased risk of microbial contamination compared to touch screen phones. *Journal of Infection Prevention* 2013; **14(2):** 65-68. http://dx.doi.org/10.1177/1757177413475903
23. Khan S, Shaikh AA. Mobile phones: reservoir of infectious diseases in university premises. *NED University Journal of Research* 2012; **9(1):** 35-43.
24. Chawl K, Mukhopadhayay C, Gurung B, Bhate P, Bairy I. Bacterial '*cell*' phones: Do cell phones carry potential pathogens? *Online Journal of Health Allied Science* 2009; **8(1):** 1-5.
25. Jagadeesan Y, Deepa M, Kannagi M. Mobile phones as fomites in miocrobial dissemination. *International Journal of Current Science* 2013; **5(1):** 6-14.

26. Trivedi HR, Desai KJ, Trivedi LP, Malek SS, Javdekar TB. Role of mobile phone in spreading hospital acquired infection: a study in different group of health care workers. *National Journal of Integrated Research in Medicine* 2011; **2(3):** 61-66.
27. Waruingi M, Underdahl L. Opportunity in delivery of health care over mobile phone in developing countries. *African Journal of Food, Agriculture, Nutrition and Development* 2009; **9(5):** 1-11.
28. 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):** 13. http://dx.doi.org/10.4103/0255-0857.53222
29. Ulger F, Esen S, Dilek A, *et al*. Are we aware how contaminated our mobile phones with nosocomial pathogens? *Annals of Clinical Microbiology and Antimicrobials* 2009; **8(7):** 1476-1480.
30. Akinyemi O, Atapu D, Adetona O, Coker O. The potential role of mobile phones in the spread of bacterial infections. *Journal of Infection Development Ctries* 2009; **3(8):** 628-632.
31. Karabay O, Koçoglu E, Tahtaci M. The role of mobile phones in the spread of bacteria associated with nosocomial infections. *Journal of Infection in Developing Countries* 2007; **1(1):** 72-73.
32. Sepehri G, Talebizadeh N, Mirzazadeh A, Mir-shekari T, Sepehri E. Bacterial contamination and resistance to commonly used antimicrobials of healthcare workers' mobile phones in teaching hospitals, Kerman, Iran. *American Journal of Applied Sciences* 2009; **6(5):** 806-810. http://dx.doi.org/10.3844/ajassp.2009.806.810
33. Arora U, Devi P, Chadha A, Malhotra S. Cell phones a modern stay house for bacterial pathogens. *Journal of Medical Education and Research* 2009; **11(3):** 127-130.
34. Verran J. The microbial contamination of mobile communication devices. *Journal of Microbiology & Biology Education* 2012; **13(1):** 59-61. http://dx.doi.org/10.1128/jmbe.v13i1.351
35. Auhim HS. Bacterial contamination of personal mobile phones in Iraq. *Journal of Chemical, Biological and Physical Sciences* 2013; **3(4):** 2652-2656.
36. Griffith J, Malik R, Cooper A, *et al*. Environmental surface cleanliness and the potential for contamination during hand washing. *American Journal of Infection Control*. 2003; **31:** 93-96. http://dx.doi.org/10.1067/mic.2003.62
37. John JF, Harvin AM. History and evolution of antibiotic resistance in coagulase-negative staphylococci: Susceptibility profiles of new anti-staphylococcal agents. *Therapeutics and Clinical Risk Management*. 2007; **3(6):** 1143–1152.
38. Sadat-Ali M, Al-Omran K, Azam Q, *et al*. Bacterial flora on cell phones of health care providers in a teaching institution. *American Journal of Infect Control* 2010; **38(5):** 404-405. http://dx.doi.org/10.1016/j.ajic.2009.08.007
39. Skov L, Jensen S. Community-associated meticillin-resistant *Staphylococcus aureus* as a cause of hospital-acquired infections. *Journal of Hospital Infection* 2009; **73(1):** 364-370. http://dx.doi.org/10.1016/j.jhin.2009.07.004
40. Abed El-Jalil H, Jallad M, Thwaini A. Nasal carriage of methicillin resistant *Staphylococcus aureus* in individuals exposed and not exposed to hospital environments. *European Journal of Scientific Research* 2008; **22(4):** 570-574.
41. Fondi M, Fani R. The horizontal flow of the plasmid resistome: clues from inter-generic similarity net work. *Environmental Microbiology* 2010; **12(12):** 3228–3242. http://dx.doi.org/10.1111/j.1462-2920.2010.02295.x
42. Singh V, Chauhan PK, Kanta R, Puri A, Singh Saini J. Are we aware how contaminated our mobile phones with pathogenic bacteria. *International Journal of Pharmacy and Pharmaceutical Sciences* 2011; **3(4):** 275-276.
43. Chandra J, Prasanna L, Rao V. A study on isolation and identification of bacteria causing nosocomial infections on mobile phones of health care workers. *Calicut Medical Journal* 2011; **9(1):** 1-6.