Full Length Research Paper

Bacterial contamination of healthcare workers' mobile phones and efficacy of surface decolonization techniques

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This study was performed to determine the rate of bacterial contamination of mobile phones of healthcare workers and the efficacy of 70% Ethyl alcohol and 70% Isopropyl alcohol as disinfectant agents. 150 mobile phones of healthcare workers in Esfahan's hospital were included. Samples were collected by sterile, moistened swabs and were cultured on blood agar and EMB and then isolates were identified. In separate studies, we assessed the effectiveness of Ethyl and Isopropyl alcohol against mobile phone surface contamination with S*taphylococcus aureus* (ATCC: 25923), *E.coli* (ATCC: 25922), *Pseudomonas aeroginosa* (ATCC: 27853) and *Enterococcus faecalis* (ATCC: 9854).In total, 94% of mobile phones demonstrated evidence of bacterial contamination including *Coagulase-negative Staphylococcus*, *Staphylococcus aureus*, *Enterococcus faecalis*, *Escherichia coli*, *Pseudomonas aeroginosa* and non-fermentative Gram negative bacilli. Both Ethyl and Isopropyl alcohol were effective at decontaminating mobile phones of test bacteria. Healthcare workers' mobile phones were contaminated in the hospital environment and therefore may potentially serve as vehicles of transmission of pathogenic bacteria. Strict adherence to infection control, such as hand washing and mobile decontamination is advocated. Ethyl and Isopropyl alcohol were highly effective at removing or inactivating pathogenic bacteria on surface of mobile phones.

Key words: Bacterial contamination, healthcare workers, mobile phone, nosocomial infection.

INTRODUCTION

The global system for mobile telecommunication was established in 1982 in Europe and quickly spread all around world. Mobile phones have become one of the most essential accessories in our social and professional life. Mobile phones increase the speed of communication and contact within healthcare institutions, making healthcare delivery more efficient (Ramesh et al., 2008; Soto et al., 2006). Increasing technological applications of mobile phones have led to increased use of these portable electronic devices to provide better communication between healthcare workers (HCWs) and patients. For example management of diabetes, asthma and improving vaccination rate in travelers (Vilella et al., 2004; Ferrer-Roca et al., 2004; Neville et al., 2002). Despite increasing popularity of mobile phones, noise and distractions in clinical environment, data security (Mole et al., 2006) and bacterial contamination increase patient (Brady et al., 2006a).

Nosocomial infections rates are increasing and cause significant mortality and morbidity. Nosocomial infection is an important problem in all hospital. Each year more than 2 million patients acquire healthcare associated infections, resulting in 90 000 deaths (Burke, 2003). The

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hands of HCWs play an important role in transmission of this infection. Jeske et al. found that bacteria on HCWs hands match that on phones (Iijima and Ohzeki, 2006, Jeske et al., 2007). In recent study Brady et al. showed the bacteria on phones matches that in the subjects anterior nares/nose (Brady et al., 2011). The mobile phones of HCWs provide a reservoir of potentially pathogenic bacteria within healthcare environment (Karabay et al., 2007). On the other hand, a team of researchers from the Department of Medical Microbiology at Inonu University in Malatya, Turkey collected swab 200 samples from three parts of cell phones—the keypad, microphone and ear piece. The researchers found that 39.6% of the patient group phones and 20.6% of HCW phones tested positive for pathogens. Additionally, seven patient phones contained multidrug resistant (MDR) pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA) and multiply resistant Gram-negative organisms, while no HCW phones tested positive for MDR pathogens (Tekerekolu et al., 2011).

The purpose of this study was investigated the rate of bacterial contamination of HCWs mobile phones employed in hospital of Esfahan, Iran. In addition, functional effects of Ethyl alcohol and Isopropyl alcohol on decontamination of keypads of mobile phones were studied.

MATERIALS AND METHODS

The present study was a descriptive-analytical study, which was carried out in 2010 at Islamic Azad university- Falavarjan branch, Esfahan, Iran. 150 HCWs randomly were included in the study.

Sample collection and bacteriological analysis

A sterile swab moistened with sterile demineralised water was rotated on the surface of the mobile phone keypad by aseptic technique. The swab was immediately inoculated into tubes containing 5 ml Brain Heart infusion broth medium (BHI). These tubes were transported within 1 to 2 h to the bacteriology laboratory and incubated aerobically at 37°C for 24 h. Further su bcultures were made on blood agar (Merck-Germany) supplemented with 5% defibrinated sheep blood and Eosin Methylene blue agar (Merck-Germany) plates, and were incubated aerobically at 37°C for 48 h. All plates were examined for visible growth (Kabir et al., 2009). The isolates were stained and were tested for the presence of catalase and oxidase enzyme. Isolated bacteria were identified on the basis of colony morphology, Gram's stain findings, detection of hemolysis on blood agar, catalase reaction, oxidase reaction and colony pigmentation, as well as results of coagulase production test and anaerobic manitol fermentation (for *Staphylococcus* spp.), growth in medium containing 6.5% NaCl and results of the bile esculin test (for *Enterococcus faecalis*), results of TSI, IMViC test (for Enterobacteriaceae) oxidative- fermentation test and growth at 40°C (for nonfermantative Gram-negative bacilli). Oxacil lin sensitivity of *Staphylococcus aureus* was carried out by using oxacilin and methicillin disk test.

Efficacy of disinfectants

Two mobile phones were used to evaluate the effectiveness of 70% Ethyl alcohol and 70% Isopropyl alcohol. Before experiments, mobile phones were decontaminated by sterile wipe moistened with hypochlorite solution. To remove the effects of residual hypochlorite, the keypads were washed 3 time by sterile wipe moistened with sterile demineralised water (Rutala et al., 2006).

Four bacterial strains were tested for efficacy of alcohol. The following strains of test organisms were obtained from Iranian research organization for science and technology: *Staphylococcus aureus* (ATCC: 25923), *Enterococcus faecalis* (ATCC: 9854), *Pseudomonas aeroginosa* (ATCC: 27853) and *Escherichia coli* (ATCC: 25922). These organisms were inoculated in BHI broth medium and incubated at 37°C for 24 h. Test keys of mobile phones keypads were contaminated with 10 µl of one test suspen-sion organism (10^6 cell/ml). After drying, each mobile phone was wiped with its disinfectant (70% Ethyl alcohol or 70% Isopropyl alcohol) for 10 s and allowed to air dry. Once dry, the test keys were swabbed using a sterile swab moistened with BHI broth. The swab was cultured on sheep blood agar plate. These plates were incubated at 37°C for 24 h and colony-forming units (cfu/ml) were counted. The efficacy of the alcohol against bacteria was calculated by the difference between cfu/ml of control positive key and cfu/ml of test key. Each alcohol examination repeated for five times. Then mean of cfu/ml was calculated (Rutala et al., 2006). For control of experiments a contaminated key without exposure to alcohol and a decontaminated key were cultured as a positive control and negative control respectively.

Statistical analysis

The data were analyzed using SPSS ver.14 software. The selected threshold level for statistical significance was p-value less than 0.05.

RESULTS

Age of HCWs that participate in this study varied from 23 to 66 with means age of 34.7 (SD 8.07) years. About 43.7% were women and other was men (52.7%).

In total, 150 HCWs, 41 doctors, 5 resident, 20 interns, 52 nurses and 32 other workers in hospital were included. All of HCWs sampled used their mobile phones at work at least once every day. 85.3% of 150 HCWs never washed their hands before using the device. The rate of routine cleaning of HCWs mobile phones was 31.3%. Which means 68.7% of the HCWs never cleaned their mobile phones. Alcohol was used by 87% of those who clean their mobile phones; the rest used a dry wipe. Only 10.9% of HCWs cleaned their phones daily, 10.9% weekly and 78.3% cleaned their mobile phones occasionally.

Out of 150 samples evaluated, growth was observed in the most of samples. Bacteriological analysis revealed 141 (94.0 %) of mobile phones demonstrated evidence of bacterial contamination and 50 (33.3 %) of the mobile phones sampled grew bacteria such as *S. aureus, MRSA,*

Table 1. Types of bacteria isolated from mobile phones of HCWs.

Bacterial agents identified	Number of bacteria isolated	%
Gram positive bacteria		
Coagulase-negative Staphylococcus	79	28.9
Staphyloccus aureus	29	10.6
Methicillin-resistant Staphyloccus aureus (MRSA)	3	1.1
Enterococcus faecalis	9	3.3
Other Streptococci	19	7.0
Micrococcus spp.	4	1.5
Bacillus spp.	93	34.0
Diptheroids	6	2.2
Gram negative bacteria		
Escherichia coli	1	0.4
Enterobacter spp.	3	1.1
Proteus spp.	1	0.4
Klebsiella spp.	4	1.5
Other Enterobacteriaceae	10	3.7
Pseudomonas aeroginosa	1	0.4
Pseudomonas spp.	8	2.9
Non fermentative Gram negative bacilli	3	1.1
Total	273	100

P. aeroginosa, E. coli, Klebsiella, Enterobacter, Enterococcus feacalis are known to cause nosocomial infection. Details of the number and type of bacteria obtained from mobile phones are shown in Table 1.

It was found that 22.7% of phones grew one bacterial species, 61.0% grew two different species and 16.3% grew three or more different species resulting in 273 organisms grown in total. Numbers of Gram-positive bacteria were higher than Gram-negative. The majority of Gram-negative organisms grown were non-fermentative Gram-negative bacilli and coliforms. The most Gram-positive bacteria were belonging to staphylococcus genera. There was no significant difference ($p < 0/05$) in the incidence of specific type of bacterial growth isolated in HCWs group.

No bacterial growth was seen after decontamination with 70% Ethyl alcohol or 70% Isopropyl alcohol for 10 seconds. The negative control plates showed no growth and cfu/ml of positive control plates were over 10^5. There was no significant difference ($p < 0.05$) in effect of two alcohol for decontamination of mobile phones and two agents were equally effective.

DISCUSSION

This study highlights mobile phones as a potential threat in infection control practices and could exaggerate the rate of healthcare associated infections. In this study, bacteria contaminated 94.0% of mobile phones of HCWs. Isolation of bacterial agents from mobile communicate devices such as mobile phones and pagers has shown these devices to be possible modes of transmission of nosocomial pathogens (Bures et al., 2000). In a study conducted in Queen Elizabeth hospital in Barbados, west Indies, 46% of mobile phones of 266 medical staff and students were culture positive that 15% of them were Gram negative pathogens (Ramesh et al., 2008). Ulger et al. reported that 94.5% of 200 phones of HCWs were contaminated with various bacteria and Gram-negative strains were isolated from 31.3% of phones. Their research demonstrated that distribution of the isolated microorganisms from mobile phones were similar to hands isolates (Ulger et al., 2009). Brady et al. showed that, 96.2% of phones of HCWs demonstrated evidence of bacterial contamination, and 14.3% of the mobile phones sampled grow nosocomial infection agents (Brady et al., 2007; 2009a; 2009b). In a similar study from Turkey hospital only 9% of mobile phones sampled showed contamination by bacteria associated with nosocomial infections (Karabay et al., 2007).This study demonstrated a high rate of mobile phone contamination by bacteria known to cause nosocomial infection (33.3%). *Staphylococcus aureus* was isolated from 21.3% of

HCWs mobile phones which three (2.0%) of them exhibited meticillin resistance. Khivsara et al. (2006) reported 40% contamination of mobile phones by *Staphylococcus* and MRSA from HCWs working in a Mangalore. These results are higher as compared to the results of our study (p>0.05). In other study, this rate was 25%, which is similar to our results.

Two disinfectants tested (70% Ethyl alcohol and 70% Isopropyl alcohol) were highly effective at removing or inactivating pathogens, including *Staphylococcus aureus* and *Pseudomonas aeroginosa* in 10 s application with a wipe.

Mobile phones are ideal breeding sites for growth of microbes as they are kept warm in our pockets and handbag (Brady et al., 2006b). On the other hand, there are not guidelines for the care, cleaning and restriction of mobile phones in our health care settings.

Conclusion

This study has confirmed that mobile phones of HCWs are contaminated with potentially and important pathogenic bacteria. The risk of transmission from conta-minated mobile phones would be eliminated if HCWs performed hard hygiene after contact with inanimate objects in the hospital environment.

Unfortunately, there are no recommendations for cleaning mobile phones of HCWs and other people. (Brady et al., 2006b; Jeske et al., 2007). Therefore, this study suggested that routine daily disinfection of mobile phones by 70% alcohol. In an effort to prevent conta-mination of mobile phones, HCWs should not touch the devices with contaminated hands. Our data demonstrate that mobile phones can be safely and successfully decontaminated with disinfectants, such as 70% ethyl alcohol and 70% isopropyl alcohol.

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