Microbial Load of Touch Screen Mobile Phones Used by University Students and Healthcare Staff

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Abstract

Mobile phones have become an indispensable part of our lives. Though they offer plenty of advantages, they are prolific breeding grounds for infectious pathogens in communities and hospitals. The present study seeks to identify the counts and types of bacteria contaminating touch screen mobile phones (TSMP) used by students of the Islamic University-Gaza (IUG) and healthcare workers (HCWs) at Al-Shifa Hospital. It also tries to investigate the antimicrobial resistance profiles. A cross-sectional study was conducted from October 2013 to April 2014. Two hundred and fifty swab samples were collected: 100 IUG female students, 100 IUG male students and 50 from HCWs. Along with the questionnaire, swabs moistened with sterile normal saline were used to swab an area of 3cm2 over TSMP. Samples were cultured and processed by standard Microbiological procedures. The overall percentage of positive cultures was 71.6%. Staphylococcus aureus was the most predominant isolate (with 27%). HCWs results revealed higher positive cultures and counts of bacteria than those for IUG samples. The most common isolate in HCWs was S. aureus, but Coagulase Negative Staphylococcus (CNS) was particularly found in IUG students. Male phones exhibited higher positive culture and bacterial count than those for females at the target university. Meanwhile, S. aureus was the most common isolate in male phones compared to CNS in female phones. The data from the questionnaire showed that wipes were the most efficient method used by respondents to clean TSMP. The use of surface guards with rough type reduced contamination and bacterial counts. Antimicrobial susceptibility results of S. aureus in HCWs showed that 28.3% were methicillin-resistant Staphylococcus aureus (MRSA) and 73.6% were penicillin-resistant. Tested mobile phones were contaminated with potential pathogen, including MRSA. Therefore, an awareness campaign should be launched to educate the public and HCWs on the health hazards associated with improper use of mobile phones.

Keywords: *Mobile phones, contamination, Staphylococcus aureus, healthcare workers, Gaza Strip.*

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Introduction

Mobile phones have become widely spread accessories in today's life. In 2013, more than 1.6 billion smart phones were in use worldwide, and it is estimated that this number will approximately double within the next 4 years (Strategy Analytics, 2013). In addition to the standard voice function of a telephone, mobile phones can support many additional services such as SMS for text messaging, email, pocket switching for access to the Internet, and MMS for sending and receiving photos and video. With all the achievements and benefits of the mobile phone, it is easy to overlook the health hazard it might pose to its many users (Tagoe et al., 2011). In addition, mobile phones might act as fomites as they are carried with their owner to places such as toilets, hospitals and kitchens, which are loaded with microorganisms (Bhoonderowa et al., 2014)**.**

Unlike fixed phones, mobile phones serve as a perfect habitat for the microbes to breed– providing higher temperature and humid conditions (Srikanth et al., 2009). Mobile phone usage has increased dramatically. In such environments where the percentage presence of bacteria is likely high, such as in hospitals, abattoirs, market places and toilets, this could enhance pathogen transmission and intensify the difficulty of containing disease spread (Butcher and Ulaeto, 2005). Sources of infection may be exogenous such as air, medical equipment, hands of surgeons and other staff, or endogenous such as the skin flora in the operative site, or rarely from blood (Ducel et al., 2002). The human skin is constantly in contact with microorganisms and becomes readily colonized by certain microbial species. The adult human is covered with approximately $2m^2$ of skin, with surface area supporting about 10^{12} bacterial cells/person (Mackowiak, 1982).

During a phone call, the mobile phone comes into close contact with contaminated human body areas with hands to hands, and hands to other areas like mouth, nose and ears (Elkholy and Ewees, 2010). Moreover, physicians and paramedical staff, while attending patients, sometimes hold mobile phones close to their face, which facilitates the transmission of bacteria from mobile surfaces to hands, thus leading to the nosocomial spread of the bacteria (Elkholy and Ewees, 2010; Sowah, 2008). Despite the high possibility of being contaminated, mobile phones are seldom cleaned and are often touched during or after examination of patients and handling of specimens without proper hand washing. These phones can harbor various potential pathogens and become exogenous sources of infection for the patients and are also potential health hazard for self as well as family members (Arora et al., 2009; Kilic et al., 2009). Further, sharing of cell phones among health care workers (HCWs) and non-HCWs may directly facilitate the spread of potentially pathogenic bacteria to the community (Chawla et al., 2009).

There is growing evidence that contaminated fomites or surfaces play a key role in the spread of bacterial infections with antimicrobial resistance (Weinstein and Hota, 2004). Nosocomial infections caused by multi-drug resistant Gram-positive organisms such as *S. aureus* and enterococcal species are growing problems in many health care institutions (Singh et al., 1998; Kennedy et al., 2003; NNIS, 2000). The main reservoir of *S. aureus* is the hand from where it is introduced into food during preparation (Hui et al., 2001).The hand serves as a major vehicle for the transmission of various microbes, including the enteric species (Brande et al., 1981). Moreover, hand washing may not be performed often enough during the course of a working day and the possibility that mobile phones may act as a potential source of microbial transmission is considerable (schulz et al., 2003; Rafferty and Pancoast, 1984).

There is no data on the risk of contamination of personal mobile phones among university students and HCWs in Palestine. This study seeks to identify the most common bacteria that contaminate TSMPs of students at IUG in comparison to HCWs of Al-Shifa Hospital. It also examines the antibiotic resistance profile in HCWs samples.

Literature Review

Today, mobile phones have become indispensable accessories for professional and social life. Although they are usually stored in bags or pockets, mobile phones are handled frequently and held close to the face (Sowah, 2008; Brady et al., 2006). A mobile phone is a device that can make and receive telephone calls over a radio link whilst moving around a wide geographic area (Suganya and Sumathy, 2012). Modern smart phones are usually operated by a glass touch screen, with finger tapping. There is a great importance of the human hands for many aspects of personal, industrial, occupational, and clinical hygiene (Jumaa, 2005).

In 2000, World Health Organization (WHO) described the electromagnetic radiation emitted from phones and base stations as a threat to lives, as it damages the DNA producing sperm cells (Ilusanya et al., 2012). Mobile phones have also been reported to be a reservoir for microorganisms (Brady et al., 2006). Microorganisms can be transferred from a person to another or from inanimate objects to hands, and vice versa (Brady, 2007). A mobile phone can spread infectious diseases by its frequent contact with hands (Kilic et al., 2009). There is much evidence that contaminated fomites or surfaces play a key role in the spread of bacterial infections (Kawo and Rogo, 2008; Kawo et al., 2009; 2012; Enemuor et al., 2012a; b).

The sources of infection can be divided into two main groups: exogenous and endogenous (Butcher, 2005). Endogenous infections occur when the infectious agent comes from the patient's own body, usually from his/her own normal flora. Endogenous sources of infections are particularly important when the person's own immunity against his/her normal flora becomes compromised (e.g. the bacterial flora at a surgical site), (Ducel et al., 2002).The exogenous infection, on the other hand, develops from bacteria outside the body, which is the case most of the time. To be more specific, exogenous sources of infections can be human, animal, or environmental in origin. Humans can be a source of infection in three cases: when they are clinically infected (symptomatic infection), when they are asymptomatically infected or when they are carriers. Air, mobiles, toys; hands of surgeons are exogenous source of infections (Mandal et al., 1995).

Mobile phones could be contaminated via a source such as human skin or hand, bag, phone pouch, pockets, environment and food particles. These sources are links through which microorganisms colonize the phone, thus causing diseases that range from mild to chronic (Soto, 2006). The combination of constant handling and the heat generated by the phones create a prime breeding ground for all sorts of microorganisms. The human surface tissue is constantly in contact with environmental microorganisms and becomes readily colonized by certain microbial species (Prescott et al., 2005).

Hand washing is a process which removes soil and transient microorganisms off the hands. Hence, the simple process of hand washing has long been a mainstay of any control measure for reducing nosocomial infections (Chawla et al., 2009). A well-practiced infection control plan– that encompasses hand hygiene, environmental decontamination, surveillance and contact isolation– is effective for the prevention of such nosocomial infections (NNIS, 2000; Farr et al., 2001; Neely, 2002). Unfortunately, despite the simplicity of hand washing procedure, studies continue to report unacceptably low hand washing compliance rates amongst health workers (Alex-Hart and Opara, 2001).

The constant handling of a mobile phone by a user makes it a breeding place for transmission of microorganisms as well as hospital-associated infections (Glodblatt et al., 2007; Yusha'ul et al., 2010). The range of microorganisms can vary from one person to another, and HCWs may have different hand flora from ordinary members of the public. The hands, thus, are permanently colonized with pathogenic flora acquired from the hospital environment (Guenthner et al., 1987; Strausbaugh et al., 1994). Antimicrobial resistance is a global phenomenon that has resulted in high morbidity and mortality as a result of treatment failures and increased health care costs (Laxminarayan, and Malani, 2007).

MRSA contamination surrounding infected patients can be widespread, especially in hand-touch areas. One study found that 74% of surfaces in the rooms of infected or colonized patients were contaminated with MRSA (French et al., 2004). Another study found that microbial contamination of mobile phones of college students was 98%: Gram-positive bacillus (30%), Gram-negative bacillus (8%), Staphylococcus spp. (14%), Esherichia coli (16%), Enterococcus(18%), Coliform (8%), Micrococcus(1%) and aerobic spores (1%) (Jagadeesan et al., 2013).

The rate of bacterial contamination of personal mobile phone was 80.0% and public mobile phone was 100% in a study conducted on personal and public mobile phones in Bayero University, Nigeria: S. aureus (84%), Streptococcus spp. (16%), Aspergilles spp (32%), Candida spp (16%), Mucor spp (43%) and Rhizopus (4%) in public mobile phones. However, S. aureus (76%), Streptococcus spp. (48%), Candida spp. (12%) and Mucor s*pp*. (40%) were isolated from personal mobile phones (Yusha'ul et al., 2010). Another study conducted on HCWs mobile phones showed that 34% of the subjects were colonized with bacteria or fungi. Twenty percent of S. aureus was methicillin resistant Staphylococcus aureus (MRSA) (Mehta et al., 2013). In Nigeria, the rate of bacterial contamination of mobile phones of HCWs was 94.6%. Staphylococcus epidermidis (42.9%) was the most frequently isolated bacteria followed by Bacillus spp. (32.1%), S. aureus (25%), Pseudomonas aeruginosa (19.6%), E. coli (14.3%), Streptococcus spp. (14.3%), Proteus spp. (12.5%), Klebsiella spp. (7.1%), and Acinetobacter spp. (5.3%) (Nwankwo et al., 2014).

In another study conducted on HCWs mobile phones, bacteria were isolated from 90% of the examined mobile phones: CNS(69%), Bacilli (20.6%), Acinetobacter spp. (6%), Klebsiella pneumonia (1.8%), Pseudomonas aeruginosa (1.2%), S. aureus (1.2%) and E. coli (0.6%) (Parhizgaril et al., 2013). In an Indian study on mobile phones used by physicians and surgeons in a hospital, the presence of bacterial growth was positive with 65%. The various microorganisms detected were CNS (16%), S. aureus (18%), *E. Coli* (16%), *Klebsiella* spp. (19%), Micrococcus (16%), Citrobacter (4%), Pseudomonas spp. (4%), Candida (2%) and MRSA (5%) (Tankhiwale et al., 2012).

(Karabay et al., 2007) reported that E. coli, Bacillus spp. And CNS, which are agents of nosocomail infection, were isolated from mobile phones of healthcare staffs. The presence of E. coli in personal mobile phones for male suggests faecal contamination of these phones, which can result in community-acquired infections and disease outbreaks (Shahaby et al., 2012; Sepehri et al, 2009) concluded that Staphylococcus epidermidis was the most commonly cultured microorganism isolated from mobile phones. S. epidermidis and other CNS have emerged as major causative agents of nosocomial infections (Prasad et al., 2012).

Hypothesis

- TSMP are potentially contaminated with pathogen and in high numbers.
- TSMPs of HCWs are more contaminated with higher bacterial counts than TSMPs of IUG students.
- There is high antibiotic resistance to bacteria found in TSMPs of HCWs.

Methodology

Study Population

A cross-sectional study was conducted during the period from October 2013 to April 2014. Swab samples (250) from TSMP were randomly collected from IUG and Al-Shifa Hospital: 100 university female students, 100 university male students and 50 HCWs from Al-Shifa Hospital. After conducting a survey, we found that fifty percent of IUG students use touch mobile phones. According to IUG Deanship of Admission and Registration, there are 17,285 students in IUG. Using sample size calculator (http//www.surveysystem.com/sscalc.htm. Accessed in October 2013), 200 students are required for statistically valid results**.** The random sample from HCWs was for the purposes of comparison.

Ethical Approval

Approval was taken from IUG and the Palestinian Ministry of Health to allow for the collection of samples. Also, informed consents were obtained from all participants to collect the sample and fill in a structured questionnaire. A questionnaire was used to collect personal and socio-economical as well as behavioral data in Arabic language. The questionnaire was prepared based on previous studies and according to the authors own perception of possible factors that could contribute to the contamination of mobile phones**.** A pilot study was conducted on 20 students and the results of this study were used to evaluate and prepare the final copy of the questionnaire**.**

Sample Collection, Handling and Transport

The researchers used a cotton swab moistened with sterile normal saline for an area of 3 cm^2 of TSMP. The swab was placed in 1 ml sterile normal saline tube to maintain the viability of microorganisms. All samples were transported from collection area within one hour to the Medical Microbiology Laboratory, IUG for processing.

Bacterial Count, Culture and Identification

A 0.1 ml of the suspension was aseptically pipetted and transferred onto pre-labeled Nutrient Agar (HiMedia, India). Colonies were counted after 24 hours of incubation at 37 ^oC and expressed asa colony-forming unit per milliliter (CFU/ml) of the sample analyzed.

A loopful of the suspension was streaked on Blood Agar and MacConkey Agar (HiMedia, India)**.** The inoculated plates were incubated at 37±0.50C for 24 hours, after which their cultural characteristics were observed and recorded. Isolates from Blood and MacConkey agar were sub-cultured to obtain pure isolates. The isolates were then identified by colony morphology and characteristic growth, gram stain, and pattern of biochemical profile (catalase, oxidase, coagulase, citrate, indole and API 20E) in accordance with the standard methods.

Antimicrobial Susceptibility Testing (AST)

Antimicrobial susceptibility testing of isolates was performed by the modified Kirby-Bauer disks diffusion method under the CLSI protocol (CLSI, 2005). Small filter paper disks impregnated with a standard amount of antimicrobial agents were placed onto a Muller Hinton Agar (Himedia, India) to which bacteria were swabbed by a bacterial suspension using sterile normal saline comparable to 0.5 McFarland turbidity standard. The plates of Muller Hinton Agar were incubated overnight, and the zone of inhibition of bacterial growth was measured. The antibiotic discs used for S. aureus were penicillin (10µg), oxacillin (1µg), vancomycin (30µg), cefuroxim (30µg) and clindamycine (10µg). Methicillin sensitivity of S. aureus was detected using oxacillin disk (CLSI, 2005).

Statistical Analysis

Data entry and analysis were done using SPSS. Cross tabulation and chi square tests were performed. A p-value of less than 0.05 was considered indicative of statistically significant.

Results

A total of 310 isolates were obtained from 250 swabs of TSMPs collected from IUG students and HCWs from Al-Shifa Hospital. Around 71.6% of the sample showed growth of at least one type of bacteria. Of the 50 swabs collected from Al-Shifa, 96% were found positive, compared to 65.5% in IUG. Mobile phones used by male students showed higher positivity rates (79%) than those used by female students (52%). These differences were obviously statistically significant.

The results of bacterial counts (Table 1) showed statistically significant gender and source differences (higher counts in male and HCWs samples).

Table 1: Bacterial counts distribution – by gender and source

Bacterial count (CFU/ml)	IUG			HCW	P value
	Male	Female	Total		
No growth	21(21%)	48(48%)	69(34.5%)	2(4%)	P <0.0001
1-100	71(71%)	50(50%)	121(60.5%)	38(76%)	
101-1000	4(4%)	0(0%)	4(2%)	5(10%)	
Over 1000	4(4%)	2(2%)	6(3%)	5(10%)	

Both Gram-positive and Gram-negative bacteria were isolated from mobile phones swab (IUG and HCW) samples. The most common isolates were S. aureus (27%) and CNS (25%), as shown in Figure 1 (Figure 1: Distribution of bacterial isolates).

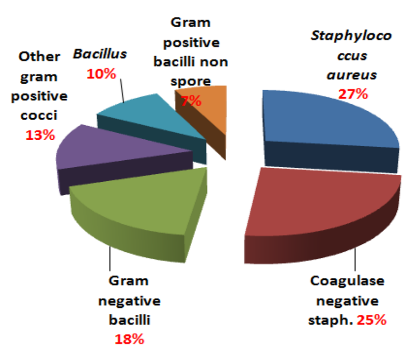

Figure 1: Distribution of bacterial isolates

Regarding the number of isolates, mobiles of male students produced 152 (49.0%) isolates compared to 58 (18.7%) isolates for mobiles of female students, while HCWs were 100 (32.3%) isolates. Unlike findings for students (males and females), the most common isolates in HCWs were *S.* aureus (37%) and Gram-negative bacilli (33%). This was different from students results, where the predominant isolates were CNS (34%) and *S. aureus* (22%) See Table 2.

Table 2: Distribution of isolates– by source and gender

Isolate	**Total**	**IUG**			HCW
		Total	**Male**	**Female**	
S. aureus	84 (27%)	47 (22%)	41 (27%)	6 (11%)	37(37%)
CNS	79 (25%)	72 (34%)	37 (25%)	35 (60%)	7 (7%)
Bacillus spp.	31 (10%)	25 (12%)	17(11%)	8 (14%)	6 (6%)
Gram negative bacilli	55 (18%)	22 (11%)	20 (13%)	1 (2%)	33(33%)
*Other gram positive cocci	39 (13%)	23 (11%)	17 (11%)	6 (11%)	16(16%)
Gram positive bacilli non spore forming	22 (7%)	21 (10%)	20 (13%)	1 (2%)	1(1%)
Total isolates	310	210	152	58	100

*** (*Micrococcus* and Streptococcus)**

In an attempt to explore the likelihood of transmitting MRSA in HCWs isolates, *S. aureus* isolates were tested for common antibiotics, including oxacillin, to detect methicillin resistance. Results revealed28.3% of MRSA and 3.8% of vancomycin resistance (See Table 3).

Table 3: Antibiotic susceptibility profile of *S. aureus* isolates

Antibiotic	**Potency**	**Resistant %**	**Intermediate %**	**Sensitive %**
Penicillin	P (10mcg)	73.6	73. 6	22.6
Oxacilin	Ox (1mcg)	28.3	1.9	69.8
Vancomycin	VA (30mcg)	3.8	0	96.2
Cefuroxime	CXM (30mcg)	7.5	9.4	83
Clindamycin	CD (10mcg)	7.5	0	92.5

Data obtained from interviewing TSMP users was analyzed using SPSS. The results are shown in Table 4.

Table 4: Study sample characteristics

Variable		No. (%)	(%)Positive	P
Gender	Male	133(46.8%)	61.2	0.001
	Female	117(53.2%)	38.8	
Mobile brand name	Samsung	141(56.4%)	57.9	0.566
	Nokia	78(31.2%)	30.9	
	i-phone	23(9.2%)	9	
	Others	8(3.2%)	2.2	
Most common use of mobile phones	Call	50(20%)	88	0.04
	Messages	10(4%)	80	
	Call & messages	38(15.2%)	71.1	
	Applications (apps)	105(42%)	67.6	
	Call, massages, apps	47(18.8%)	61.7	
Phone Lock Code	No code	106(42.4%)	46	0.201
	Symbols	62(24.8%)	24.2	
	Numbers and letters	82(32.8%)	29.8	
Cover use	Yes	118(47.2)	48.9	0.176
	No	110(44%)	44.4	
	Sometimes	22(8.8%)	6.7	
Screen guard	Yes	158(63.2%)	68.5	0.004
	No	92(36.8%)	31.5	
Screen guard type	Smooth	141(56.4%)	60.7	0.024
	Rough	22(8.8%)	9.6	
	Not present	87(34.8%)	29.8	
Screen guard replacement	Yes	38(15.2%)	16.3	0.038
	No	73(29.2%)	32.6	
	Sometimes	52(20.8%)	21.3	
	Not have	87(34.8%)	29.8	
Number of daily uses	1-15	45(18%)	16.9	0.181
	16-30	89(35.6%)	39.3	
	More than 30	116(46.4%)	34.8	
Time spent using mobile in one day (minutes)	1-10	129(51.6%)	56.2	0.033
	11-20	48(19.2%)	15.2	
	21-30	27(10.8%)	10.1	
	More than 30	46(18.4%)	18.5	
Hand washing (times/day)	1-10	105(42%)	41	0.284
	11-20	84(33.6%)	36.5	
	21-30	38(15.2%)	12.9	
	>31	23(9.2%)	9.6	
Using mobile while in bathroom	Yes	148(59.2%)	59.6	0.768
	No	102(40.8%)	40.4	
Mobile clean	Daily	64(25.6%)	77.5	0.481
	Not daily	186(74.4%)	22.5	
Method of cleaning	Alcohol	44(17.6%)	90.9	0.002
	Water	21(8.4%)	76.2	
	Wipes	114(45.6%)	61.4	
	Dry paper	39(15.6%)	89.2	
	Others	32(12.8%)	78.1	
Hand Hygiene products use	Yes	188(75.2%)	75.3	0.899
	No	62(24.8%)	24.7	
Using mobile during dining	Yes	146(58.4%)	59	0.895
	No	104(41.6%)	41	
Do children use your mobile at home	Yes	141(56.4%)	59.4	0.087
	No	109(43.6%)	40.4	

Discussion

The overall percentage of positive cultures from TSMPs was 71.6%, compared with 28.4% for negative cultures. This is somewhat lower than the figures reached by studies conducted in Nigeria (100%) (Ilusanya et al., 2012), Turkey (94.5%) (Ulger et al., 2009), India (99%) (Bhat et al., 2011) and Ethiopia (98%) (Gashaw et al., 2014), but well higher than the findings of another study from India, with only 34% of positive cultures (Mehta et al., 2013). The level of contamination in HCWs mobile phones was higher than that for IUG students, with statistically significant differences. The results are by far dissimilar to findings reported by a Nigerian study (Akinyemi et al., 2009), which revealed higher mobile contamination of university student mobiles (30.6%) than HCWs mobile phones (15.3%). This might be attributed to poor hygiene and hand washing practice in HCWs. Another Nigerian study detected higher rate of bacterial contamination of mobile phones of HCWs (94.6%) (Nwankwo et al., 2014). The incidence of IUG male's mobile phones contamination (79%) is much higher than that with the female counterparts (52%), with males also reporting higher count range of bacteria. These results are consistent with findings in an Iraqi study, which showed that the rate of bacterial contamination of personal mobile phones for males was 85%, compared with80% for females (Auhim, 2013).

With 27 percent, S. aureus was the most common isolate (Figure 1). This is compatible with the results of a study performed in Nigeria, with *S. aureus* (50%) found as the most common isolate (Ilusanya et al., 2012). Another study concluded that *S. aureus* was the most frequently encountered bacterial agent, probably because this type of bacteria propagates in optimum temperatures, as phones are kept warm in pockets, handbags and brief cases (Akinyemi et al., 2009). In addition, the high occurrence rate of *S. aureus* could be estimated to contribute 40-50% to nasal carriers in humans (Uabol-Egbenni, 2003).

In the present study, IUG predominant isolate was CNS (34%), ahead of *S. aureus* (22%) (See Table 2). This is consistent with the findings of a Nigerian study (Akinyemi et al., 2009), but inconsistent with another study carried out in Nigeria for university students. The latter showed that with 53.6 percent, *S. aureus* was the most predominant isolate, followed by gram-negative bacilli (with46.4%) (Kawo and Musa, 2013).

The most common isolate among HCWs mobiles was *S. aureus* (37%) (Table 2), which is very much similar to the findings in an Indian study (Mehta et al., 2013) and a Nigerian study (Akinyemi et al., 2009). By contrast, a study carried out in Ethiopia (Gashaw et al., 2014) found CNS the most predominant isolate (47.5%), ahead of *S. aureus* (27.1%). Most organisms die within hours due to dehydration, but bacteria such as *S. aureus* and *Acinetobacter* can survive for weeks and multiply rapidly in a warm environment (Kramer et al., 2006; Hirai, 1991; Wendt et al., 1997; Oie, and Kamiya, 1996). Two studies (Borer et al., 2005; Brady et al., 2006) reported that HCWs' mobile phones were contaminated with nosocomial pathogen and gram-negative bacteria. Hand hygiene is an important mechanism in preventing the nosocomial infections.

However, we observed a relatively high resistance rate to some of the commonly used antimicrobials for *S. aureus* isolated from HCWs (Table 3). MRSA in the present study was 28.3%, which is lower than the results reported by a study conducted in Turkey (37.7%) (Ulger et al., 2009), but higher than the findings of an Indian research (20%) (Chawla et al., 2009) and another study in India which reported no MRSA (Singh, et al., 2010).

These pathogens that proliferate in hospitals may have been transmitted from patients to HCW hands to other patients during examination. This result has serious implications, with likelihood of patients who attend the hospital catching nosocomial infections.

Several variables representing possible risks of contamination of mobile phones were investigated: gender, mobile brand, cover use and guard use etc, (Table 4). In a study conducted in Ethiopia, the efficacy of decontamination with 70% isopropyl alcohol was found to be 98% (Arora et al., 2009). The authors found wet wipes the most common and efficient cleaning method. Yet, it would be appropriate at this point to suggest further investigation to empirically identify the most efficient procedures to disinfect mobile surfaces. Wet wipes are effective, probably because of their antimicrobial properties. The antimicrobial composition may include a single hydrophobic antimicrobial agent or a combination of two or more hydrophobic antimicrobial agents. Desirably, the hydrophobic antimicrobial agent is a broad spectrum antimicrobial one (Chodosh, 1997).

We found in this study that using screen guards resulted in significant reduction of bacterial contamination and counts. Soft type of guards showed higher bacterial contamination and counts with significant value. Many variables listed in Table 4 were in stark contradiction to expectations (hand washing, for instance). This could be attributed to the complex and multifactorial nature of bacterial contamination. The high microbial load of bacteria on mobile phones could be attributed to several factors, which contribute to contamination in different ways (poor personal hygiene, frequency of hand washing, educational level, extent of mobile use and environmental pollution, among other factors).

Conclusion

High percentage of TSMPs harbored potentially pathogenic bacteria, which pose a serious health hazard. MRSA was isolated from the TSMPs of HCWs. The result was alarming. People should be very cautious about their personal hygiene when they use TSMPs. It is critical not to allow children, who are naturally immunecompromised, to use mobile phones. Mobile phone users are advised to use screen guards and regularly replace them to reduce the microbial contamination. Regular cleaning of mobile phones with wet wipes and frequent hands washing should be encouraged to reduce any transmission of diseases.

Recommendations

- The results of this study would provide a baseline data that could be used as a basis for any public awareness programs on the health hazards of contaminated mobile phones.
- Concerned authorities should organize educational sessions, where specialists show people the proper methods of cleaning mobile phones.
- HCWs should consider the fact that mobile phones are potential sources for transmitting pathogen. Part of the effort should be focused on a "NO MOBILE PHONE IN HOSPITALS' policy.
- Mobile phone companies are advised to make use of antimicrobials surfaces technologies that inhibit (or kill) bacteria transmitted by direct contact.
- Equipping mobile phones for bacterial load and type detection that enables proper detecting and cleaning of TSMPs.
- The findings of the study highlight the need for further research into the infectious diseases transmitted via mobile phones.

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الحمل الميكروبي لشاشات الهواتف النقالة بنظام اللمس والمستخدمة من قبل طلبة الجامعة والعاملين في المجال الصحي

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ملخص

الخلفية: لقد أصبحت الهواتف النقالة جزء لا يتجزأ من حياتنا كونها تمتلك العديد من المزايا والفوائد، لكن ربما تكون سببًا في نقل وانتشار مسببات الأمراض المعدية في المجتمعات والمستشفيات.

الهدف: تحديد أعداد وأنواع البكتيريا الملوثة لشاشات الهواتف النقالة التي تعمل باللمس من طلاب الجامعة الإسلامية-غزة والعاملين في الرعاية الصحية من مستشفى الشفاء، والتحقق من مقاومة البكتيريا للمضادات الحيوية.

المنهجية: أجريت دراسة مقطعية في أكتوبر 2013 وحتى ابريل 2014 تم خلالها تعبئة الاستبانات من المشاركين وجمع (250) عينة على النحو التالي: (100) طالبات الجامعة الإسلامية، (100) طلاب الجامعة الاسلامية و(50) من العاملين في الرعاية الصحية. أخذت المسحات مبللة بمحلول ملحي معقم من مساحة 3سم^2 من شاشات الهواتف النقالة التي تعمل باللمس وعولجت العينات المستزرعة بواسطة الإجراءات المكروبيولوجية القياسية.

النتائج: كانت النسبة الإجمالية للمزارع الموجبة (71,6٪). وقد كانت المكورات العنقودية الذهبية المعزولة هي السائدة بنسبة (27٪). وأظهرت النتائج بأن المزارع الموجبة وأعداد البكتيريا للعاملين في الرعاية الصحية أعلى من طلاب الجامعة الاسلامية. وكان عزل المكورات العنقودية الذهبية الأكثر شيوعاً للعاملين في الرعاية الصحية، بينما المكورات العنقودية سالبة التخثر هي الأكثر شيوعاً لدى طلبة الجامعة الاسلامية. هذا وقد كانت المزارع الموجبة وأعداد البكتيريا عند الطلاب الذكور أعلى من الإناث. وشكلت المكورات العنقودية الذهبية الأكثر عزلاً عند الطلاب الذكور بينما المكورات العنقودية سالبة التخثر أعلى عند الطالبات الإناث. وأظهرت بيانات الاستبيان بأن استخدام الورق المعطر هو الطريقة الأكثر كفاءة لتنظيف شاشات الهواتف النقالة، وأن استخدام اللاصق لشاشة الهاتف النقال ومن النوع الخشن قلل التلوث وعدد البكتيريا بشكل ملحوظ. وأظهرت نتائج الحساسية للمكورات العنقودية الذهبية بأن ما نسبته (28,3٪) كانت مقاومة للميثيسيلين و (73,6٪) للبنسلين.

الخلاصة: كانت الهواتف النقالة التي تم اختبارها ملوثة بمسببات الأمراض المحتملة بما في ذلك المكورات العنقودية الذهبية المقاومة للميثيسلين، لذا ينبغي إطلاق حملة توعية لتثقيف الجمهور والعاملين في الرعاية الصحية حول المخاطر الصحية المرتبطة بالاستخدام غير السليم للهواتف النقالة.

كلمات دالة: الهواتف النقالة، التلوث، المكورات العنقودية الذهبية، العاملين في الرعاية الصحية، قطاع غزة.