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Bacterial Contamination of Mobile Phones Healthcare Versus Non-Healthcare Workers at Mansoura City, Egypt

Mohamedin, A.*; A. Elsayed and Halima A. Nashnoush
Botany Department, Faculty of Science, Mansoura University, Egypt
***Corresponding Author: Attiya Mohamedin (amohamedin@hotmail.com) Tel: 01143525686**

ABSTRACT

The objective of this study was to identify the bacteria harbored by mobile phones of healthcare workers and non-healthcare workers from Mansoura City, Dakahlia Governorate and to determine their antibiotic resistance patterns. A total of 300 mobile phone samples, 150 samples from different Mansoura City Hospitals as healthcare workers (HCWs) and 150 samples from Mansoura University as non-healthcare workers (non-HCWs) used for isolation of bacteria on enriched, differential and selective media. Results of HCWs samples tested were 31(20.6%) samples no growth and 119(79.3%) showed bacterial contamination. Gram-positive isolates were 62(52.1%) samples Staphylococcus species, 58(48.7%) Staph.aureus, 71(59.6%) Bacillus species and 8(6.7%) were Micrococcus species. Also, 37(31.0%) mobile phones had only one genus and 82(68.9%) with two or more different genera. On the other hand 13(10.9%) isolates of Gram-negative bacilli were recorded. The results of non-HCWs samples indicated that 8(5.3%) samples showed no growth and 142(94.6%) samples were contaminated with bacteria. Gram-positive isolates were 86(60.6%) samples Staphylococcus species, 85(59.9%) Staph.aureus, 87(61.3%) Bacillus species and 24(16.9%) were Micrococcus species. Also, 20(14.1%) mobile phones had only one genus and 122(85.9%) with two or more different genera. On the other hand, 29(20.4%) isolates of Gram-negative bacilli were obtained and confirmed the results by BD PHOENIX Device. The Gram-negative bacterial isolates were resistant to Amikacin and Ampicillin, and sensitive to Ciprofloxacin, Trimethoprim sulfamethoxazole and Gentamicin. Also, some of isolates were resistant to Kanamycin, Nalidixic acid; Chloramphenicol and Tetracycline except Pseudomonas aeruginosa and Acinetobacter baumannii which are resistant to all antibiotics except Pseudomonas aeruginosa which was sensitive to Ciprofloxacin.Staphylococcus aureus of HCWs and non-HCWs 143(54.78%) were examined for nine antibiotics, the results were 99.30% were resistant to Oxacillin and Methicillin also, 89.5% were resistant to Ampicillin while 96.5% were sensitive to Ciprofloxacin, Kanamycin, and 98.6% to Trimethoprim sulfamethoxazole, Cefoxthin and Vancomycin. Also, 48(33.5%) Staph.aureus were resistant to penicillin-G. To reduce or prevent the contamination of the hands and mobile phones, healthcare workers should apply the standard hygienic precautions after using phones.

Keywords: Mobile phones, Bacterial contamination, Susceptibility to antibiotics, Mansoura City.

INTRODUCTION

Mobile telecommunication was established at 1982 in Europ, with a view of providing and improvement of communication network (El-Ashry *et al*., 2015). Today mobile phones have become one of the essential accessories of professional and social lives. Also, mobile phones are essential in daily life and are usually kept in a close contact with the body. Mobile phones are used in every place or situation including slaughter, toilet, hospital halls, laboratory, and/ or intensive care units. When dealing with severe illnesses, mobile phones are one of the sources that transmit pathogenic bacteria (Brady *et al*., 2006; Breves *et al*., 2015). They can harbor various pathogens and become sources of infection and health hazards for self and family members. Further, sharing of cell phones between HCWs and non-HCWs may directly facilitate the spread of pathogenic bacteria (Ramesh *et al*., 2008).

Nosocomial infection constitutes a major problem that increases morbidity and mortality of hospitalized patients (Sallam *et al*., 2005). The constant handling of mobile phones by users in hospitals makes it an open breeding place for transmission of pathogens, as well as health care-associated infections (Singh *et al*., 2012). Mobiles are associated with the skin providing the moisture and optimum temperature for contaminants growth (Uabol-Egbenni, 2003). Many studies in different parts of the world indicated that the medical equipment and mobile phones of health care workers are potential sources of nosocomial infections (Gunasekara *et al.,* 2015; Teng *et al.,* 2009) and so far they were found to be contaminated with different bacterial pathogens. However, they are seldom cleaned and are often touched during or after examination of patients and handling of specimens without proper hand washing (Jayalakshmi *et al.,* 2008).

Various pathogenic microbes associated with tuberculosis, meningitis, pneumonia, tonsillitis, peptic ulcer, genital tract infection, skin infection had been identified in mobile phones. The contaminated phones can play a potential role in spread of hospital infection microbes in the community (Sharma *et al.,* 2014).

On-porous surfaces such as toys, telephones, doorknobs, etc. facilitate a surface for transmission of pathogenic microorganisms (Orhue *et al.,* 2012; White *et al.,* 2007). Previous studies demonstrated that the decolonized hands of healthcare workers can become contaminated by bacteria from their mobile phones (Khivsara *et al.,* 2006; Jeske *et al.,* 2007). A number of studies have consistently reported that 5-21% of healthcare workers with mobile phones provide a reservoir of bacteria known to cause nosocomial infections (Brady *et al.,* 2006; Brady *et al.,* 2007; Brady *et al.,* 2009; Sadat-Ali *et al.,* 2010).

The warm environment surrounding mobile phones coupled with constant handling creates a prim breeding ground for growth of micro-organisms. Hence they are rightly called as "technological petri-dish" for thousands of warms (Tambe *et al.,* 2012). Globally hospital acquired infection is in increasing concern (Razine *et al.,* 2012) and in Ethiopia is also true caused a wide range of pathogens many of which becoming resistant to standard antimicrobial agents (Nyasulu *et al.,* 2012).

Staphylococcus aureus is one of the most common causes of both endemic and epidemic infections acquired in hospital, which result the substantial morbidity and mortality. In U.S. hospitals, *Staph.aureus* accounted for up to 13% of isolates recovered from patients with nosocomial infections from 1979-1995, and the percentage has increased in few years (Steinberg *et al.,* 1996; Boyce,

1998). The main reservoir of *Staph.aureus* is the hand from where it is introduced into food pathogen and a common cause of invasive and life their alarming infections. It is the most common cause of folliculitis, boils, furuncles and carbuncles, community associated cellulitis (Wendt *et al.,* 1997; Diekema *et al.,* 2001). Also, a common cause of bacteremia and *Staph.aureus* can cause postoperative wound infections, food poisoning and pneumonia in infants, debilitated individual and immune compromised patients (Diekema *et al.,* 2001; Javaloyas *et al.,* 2002). The extended duration of hospital admission and extra drugs or medical management may contribute to additional cost of patient care. These factors increase the emotional stress of the patients and their families and may lead to severe disability and reduce the patient's quality of life (Teng *et al.,* 2009). This study was carried out to screen and identify the mobile phone contaminants of HCWs and non-HCWs as well as to determine the pattern of antimicrobial susceptibility of the pathogenic bacterial isolates.

MATERIALS AND METHODS

Collection of Samples:

A total of 300 samples from Mansoura International Hospital (MIH), Mansoura University Hospital (MUH) and Mansoura University, were collected during 15/11/2015 to 14/11/2017. All samples obtained without prior notification, and the age between (18-80 years). Each sample needs two sterile cotton swabs therefor 300 swabs were collected from the 150 mobile phones samples of HCWs {physicians (50), nurses (50) and workers (50). Also, 300 swabs were collected from 150 samples mobile phones of non-HCWs (staff members (50), students (50) and workers 50)} randomly. Sterile cotton swabs were moistened with sterile physiological normal saline (8.5gm/L) then rubbed over the entire various surface of the mobile phones both sides, and brought to the microbiological laboratory of Botany Department, Faculty of Science, Mansoura University as soon as possible or preserved in refrigerator overnight.

Culturing of Samples:

All the swabs were plated onto the following media; Blood agar as enriched medium (OXOID), MacConkey agar as a selective and differential medium for Gram-negative (OXOID) and Mannitol Salt agar as a selective and differential medium for Gram-positive (OXOID). After streaking the samples the plates were incubated at 37°C for 24 to 48 hours.

Identification of Isolates:

The suspicious colonies were cultured on Nutrient agar (OXOID) and incubated at 37°C for 24 hours for identification. All isolated bacteria were identified by standard bacteriological procedures (Cowan *et al.,* 1974; Cheesbrough, 1984; Collee *et al.,* 1989; Holt *et al.,* 1994), Gram-positive coccid isolates (*Staphylococcus* and *Streptococcus*) were differentiated by catalase test. Also, Mannitol salt agar, DNase, Coagulase and Blood hemolysis were used for identification of *Staphylococcus* aureus. While Enterobacteriaceae and other non-fastidious Gram-negative rods isolates were differentiated by oxidase test and a variety of biochemical tests. These tests were carried out for the identification up to genus and species level by API 20E system bioMerieus sa 69280Marcy I'Etoile / France REF 20 100/20 160 (Shayegani *et al.,* 1978) or Integral system REF. 71714 (Burguet *et al.,* 2012). BD PHOENX Device was used for confirmation of some Gram-negative and Gram-positive at National Organ Transplant Program and Burns Central Hospital, Tripoli, Libya. The *Staph.aureus* and all Gram-negative isolates were studied for their antimicrobial susceptibility pattern test.

Antibiotic Susceptibility Test:

The isolates of *Staph.aureus* and the Gram-negative isolates were cultured on Mueller Hinton agar (OXOID) by swab and susceptibility of the isolates was tested by the disc diffusion method. The isolated bacterium was suspended in 5 ml sterile distilled water mixed by Vortex then compared with 0.5 % McFarland standard (Bauer *et al.,* 1966). After 10 minutes the antibiotic discs were gently pressed onto the inoculated Mueller Hinton agar to ensure intimate contact with the surface then the plates were incubated aerobically at 37°C for 18-24 hours (Cheesbrough, 1984; Baker *et al.,* 1991). The antibiotic discs: are Amikacin 25µg, Ampicillin 10µg, Tetracycline 30µg, Gentamycin10µg, Nalidixic acid 30µg, Kanamycin30µg, Trimethoprim-sulfamethoxazole 25µg, Chloramphenicol 30µg and Ciprofloxacin-Cip.5µg for Gram-negative. While Oxacillin 1µg, Vancomycin 5µg, Penicillin- 10µg, Methicillin 10µg, Cefoxthin 2µg, Ampicillin 10µg, Kanamycin 30µg, Trimethoprim-sulfamethoxazole 25µg and Ciprofloxacin 5µg were used for Gram-positive. The inhibition zone diameter was measured with a calibrated ruler and values interpreted to standard guidelines (Bauer *et al.,* 1966). All the isolated bacteria were preserved in semisolid media (SIM MEDIM, ScharIau) as stock culture for further work.

RESULTS AND DISCUSSION

Results

Distribution of Bacterial Contamination of Mobile Phones:

Out of the 150 mobile phones (Table 1) of HCWs, 31 samples (20.7%) recorded no growth and 119 exhibited bacterial growth (79.3%). The percentage of bacterial contamination of mobile phones from HCWs (physicians, nurses, workers) are (31.1%) from 37 samples containing one organism and (68.9%) from 82 samples contaminated with two or more bacterial isolates.

The types of mobile phones bacteria were Gram-positive (*Staphylococcus* spp., *Staph.aureus*, *Micrococcus* spp., *Bacillus* spp). Gram-negative (Table 2) (*Serratia marcescens, Pantoea agglomerans, Klebsiella oxytoca, Pseudomonas aeruginosa*).

The percentages of Gram-positive were (52.1%), (48.7%), (6.7%) and (59.6%) of *Staphylococcus* spp., *Staph.aureus*, *Micrococcus* spp., *Bacillus* spp. respectively and (10.9%) of Gram-negative.

Table 1.Sources, Types and Frequency (Fr.) of Bacterial Isolates from Mobile Phones in Mansoura City Hospitals

Sources	Physicians (50)		Nurses (50)		Workers (50)		Total (150)
Bacterial Isolates	Female (Fr., %)	Male (Fr., %)	Female (Fr., %)	Male (Fr., %)	Female (Fr., %)	Male (Fr., %)	(Fr., %)
Staphylococcus spp.	4(8)	15(68.1)	8(44.4)	7(31.8)	13(72.2)	15(68.1)	62(52.1)
Staph.aureus	11(64.7)	18(81.8)	10(55.5)	7(31.8)	5(27.7)	7(31.8)	58(48.7)
Micrococcus spp.	2(11.7)	1(4.5)	3(16.6)	2(9.0)	0(0.0)	0(0.0)	8(6.7)
Bacillus spp.	10(58.8)	14(63.6)	16(88.8)	11(50)	14(77.7)	6(27.2)	71(59.6)
Gram-negative	0(0)	0(0.0)	2(11.1)	9(40.9)	1(5.5)	1(18.1)	13(10.9)
Only one organism growth	5(22.7)	5(22.7)	7(38.8)	10(45.4)	5(27.7)	5(22.7)	37(31.O9)
Two or more organism growth	12(54.5)	17(77.2)	11(61.1)	12(54.5)	13(66.6)	17(77.2)	82(68.9)
No growth	8(32)	3(12)	7(28)	3(12)	7(28)	3(12)	31(20.6)

Table 2. Gram-negative Bacilli Isolate Types and Frequency (Fr.) from Healthcare Workers (HCWs) and non-Healthcare Workers (non-HCWs) Mobile Phones

Oxidase Test	HCWs	Fr.	Non-HCWs	Fr.
Oxidase Positive	*Pseud.aeruginosa*	1	*Aeromonas hydrophila*	1
			Aer. caviae	1
			Aer.sobria	1
			Pseud.aeruginosa	2
			Moraxella spp.	3
Oxidase Negative	*Serratia marcescens*	10	*Ser. Fonticola*	1
	Klebsiella oxytoca	1	*Klebsiella oxytoca*	5
	Pantoea agglumerans	1	*Enterobacter cloacae*	5
			Citrobacter farmeri	1
			Proteus mirabilis	1
			Proteus vulgaris	1
			Providencia rettgeri	2
			Pantoea agglumerans	2
			Morganella morganii	1
			Acinetobacter baumannii	2
Total		13		29

On the other hand, from 13 Gram-negative isolate frequency: 10 isolates were *Serratia marcescens* (8 from male nurses and 2 from female nurses) and one *Pantoea agglomerans* from female worker and one *Klebsiella oxytoca* from male worker while only one *Pseudomonas aeruginosa* from male nurse. Also the result of the HCWs mobile phones indicated that no isolates of Gram-negative from male and female physicians.

From 150 samples (Table 3) of non-HCWs, 8 samples (5.3%) had no growth and 142 were appeared with single and mixed bacterial growth (94.7%). The percentage of bacterial contamination of mobile phones from non-HCWs mobile phones (staff members, students, workers) recorded 20(14.1%) had a single type of colony, and 122(85.9%) with two or more organisms growth. The types of mobile phones bacteria were Gram-positive (*Staphylococcus* spp., *Staph.aureus*, *Micrococcus* spp., *Bacillus* spp.), Gram-negative isolates (Table 2) which were (*Pseud.aeruginosa*, *Aeromonas hydrophila*, *Aeromonas sobria*, *Aeromonas caviae*, *Klebsiella oxytoca*, *Enterobacter cloacae*, *Citrobacter farmeri*, *Proteus mirabilis*, *Proteus vulgaris*, *Providencia rettgerii*, *Morganella morganii*, *Pantoea agglomerans, Serratia fonticola, Moraxella* species and *Acinetobacter baumannii*).

The percentage of Gram-positive were (60.5%), (59.8%), (16.9%) and (61.2%) of *Staphylococcus* spp., *Staph.aureus*, *Micrococcus* spp., *Bacillus* spp. respectively.

On the other hand, from 29(20.4%) Gram-negative isolate frequency (Table 2): 5 *Klebsiella oxytoca*, 5 *Enterobacter cloacae*, 2 *Providencia rettgerii*, 2 *Pantoea agglomerans*, 2 *Acinetobacter baumannii*, and one of *Morganella morganii*, *Proteus vulgaris*, *Proteus mirabilis*, *Citrobacter farmeri*, *Serratia fonticola*, 3 *Aeromonas* spp., 2 *Pseud. aeruginosa*, and 3 *Moraxella* spp. Some of bacterial isolates of phones are known to cause nosocomial infections such as *Staph.aureus, Pseud. aeruginosa*, *Aeromonas* spp, *Acinetobacter baumannii*, *Proteus spp.*, *Providencia rettgerii*, *Enterobacter cloacae* and *Klebsiella oxytoca.* The bacterial isolates were confirmed with BD PHOENIX Device.

Table 3. Sources, Types and Frequency (Fr.) of Bacterial Isolates from Mobile Phones in Mansoura University

Sources	Faculty Members (50)		Students (50)		Workers (50)		Total (150)
Bacterial Isolates	Female (Fr., %)	Male (Fr., %)	Female (Fr., %)	Male (Fr., %)	Female (Fr., %)	Male (Fr., %)	(Fr., %)
Staphylococcus spp.	16(66.6)	14(63.6)	15(62.5)	13(54.1)	15(65,2)	13(52.0)	86(60.5)
Staph.aureus	17(70.8)	11(50,0)	14(58.3)	13(54.1)	15(65.2)	15(60.0)	85(59.8)
Micrococcus spp.	3(12.0)	3(13.6)	7(29.1)	5(20.8)	2(8.6)	4(16.0)	24(16.9)
Bacillus spp.	19(76)	12(54.5)	12(50.0)	8(33.3)	17(73.9)	19(76.0)	87(61.2)
Gram negative	7(28.0)	7(31.8)	1(4.1)	6(25.0)	5(21.7)	3(12.0)	29(20.4)
Only one organism growth	2(8.3)	4(18.1)	2(8.3)	6(25.0)	4(17.3)	2(8.0)	20(14.0)
Two or more organism growth	22(91.6)	18(81.8)	22(91.6)	18(75.0)	19(82.6)	23(92.0)	122(85.9)
No growth	1(4.0)	3(12.0)	1(4.0)	1(4.0)	2(8.0)	0(0.0)	8(5.3)

Biochemical Tests:

Biochemical tests (Table 4) showed 58(48.7%) and 85(59.8%) *Staph.aureus* isolates from HCWs and non-HCWs respectively. All isolated 143(54.7%) were fermenting Mannitol salt agar giving yellow colony on MSA and positive catalase named *Staph.aureus*. The 9 and11 of *Staph.aureus* isolates were revealed hemolysis on Blood agar, 10 and 15 giving golden yellow pigmentation on Nutrient agar plates, also 46 and 56 of isolated *Staph.aureus* were DNase positive, and 14 and 37 with positive slide coagulase, while tube coagulase giving 5 and 30 positive tubes.

Table 4. Sources, Frequency (Fr.) and Biochemical Tests of *Staph.aureus* of Mobile Phones from Mansoura University (non-HCWs) and Mansoura City Hospitals (HCWs)

Biochemical Test	B-Hemolysis	Pigmentation	D Nase Test	Coagulase (Fr., %)	
Staph.aureus Sources	(Fr., %)	Gold Yellow (Fr., %)	(Fr., %)	Slide	Tube
Non-HCWs (85)	11(12.9)	15 (17.6)	56 (65.9)	37 (43.5)	30 (35.3)
HCWs (58)	9 (15.5)	10 (17.2)	46 (79.3)	14 (24.1)	5 (8.6)
Total (143)	20 (13.9)	25 (17.5)	102 (71.3)	51(35.7)	35(24.5)

Antibiotics Susceptibility:

Bacterial species vary in their sensitivity to different antibiotic agents. This can be determined by disk diffusion method. Nine antibiotics were used for testing the antibiotic sensitivity of 58 Mansoura City Hospitals *Staph.aureus* bacteria (Table 5). Mansoura City Hospitals *Staph.aureus* from mobile phones 58(100%) was sensitive to Kanamycin and Trimethoprim sulphometoaxazole antibiotics, 57(98.2%) were sensitive to Ciprofloxacin, Cefoxthin and Vancomycin antibiotics, and 46(79.3%) sensitive to Penicillin-G antibiotic, Also, 57(98.2) *Staph.aureus* was resistant to Methicillin, Oxacillin and Ampicillin antibiotics, also, 12(20.6%) *Staph.aureus* was resistant to Penicillin-G., antibiotic. On the other hand one (1.70%) *Staph.aureus* from male worker was resistant to Ciprofloxacin antibiotic whereas another one of *Staph.aureus* (1.70%) was resistant to Cefoxthin antibiotic from female nurse and one (1.72%) resistant to Vancomycin antibiotic from male physician (Dentist).

From 85 Mansoura University Campus *Staph.aureus* (Table 5) were showed sensitive 85(100%) to Vancomycin and Cefoxthin antibiotics, while 85(100%) *Staph.aureus* was resistant to Methicillin and Oxacillin antibiotics. Also, *Staph.aureus* were 82(96.4%) sensitive to Trimethoprim sulfamethoxazole and 81(95.29%) sensitive to Ciprofloxacin while 4(4.7%) *Staph.aureus* was intermediated to Ciprofloxacin. On the other hand 84(98.8%) were sensitive to Kanamycin antibiotic, 70(82.3%) were sensitive to Ampicillin and 49(57.6%) were sensitive to Penicillin-G.

Nine antibiotics were used for testing the antibiotic sensitivity of 13 Gram-negative bacterial isolates from Mansoura City Hospitals (Table 6) revealed that the all isolates resistant to Ampicillin, Amikacin and sensitive to the remaining antibiotics except *Pseud.aeruginosa* was resistant to all antibiotics only Ciprofloxacin was sensitive.

The Gram-negative isolates from non-HCWs, (Table 6) indicated that The Gram-negative bacterial isolates 29(100%) were resistant to Ampicillin, and 28(96.5%) were resistant to Amikacin while 28(96.5%) were sensitive to Ciprofloxacin and 86.2%, to Trimethoprim sulfamethoxazole, also, 18(62%) were sensitive to Gentamicin and Tetracycline. Some of isolates were sensitive with 21(92.4%), 19(65.5%) and 71(58.6%) to Kanamycin, Nalidixic acid and chloramphenicol respectively, except *Pseudomonas aeruginosa* and *Acinetobacter baumannii* were resistance to all antibiotics except *Pseud.aeruginosa*. was sensitive to Ciprofloxacin antibiotic.

The isolates were confirmed by BD PHOENIX Device with of confidence value between 90 to 99% identification and multidrug index value between 0.0 for *Pantoea agglomerans* which giving sensitive to all the antibiotics and 0.53 for *Acinetobacter baumannii* which was resistance to all antibiotics.

Table 5. Sources, Frequency (Fr.) and Susceptibility Percentage of *Staph.aureus* Isolates to Commonly Used Antibiotics of Mansoura University (non-HCWs) and Mansoura City Hospitals (HCWs)

Staph.aureus	Non-HCWs (Fr., %)			HCWs (Fr., %)	
Antibiotics	Resistant	Intermediate	Sensitive	Resistant	Sensitive
Methicillin	85(100%)	0(0.0%)	0(0.0%)	57(98.3%)	1(1.7%)
Oxacillin	85(100%)	0(0.0%)	0(0.0%)	57(98.3%)	1(1.7%)
Penicillin-G	36(42.4%)	0(0.0%)	49(57.6%)	12(20.7%)	46(79.3%)
Vancomycin	0(0.0%)	0(0.0%)	85(100%)	1(1.7%)	57(98.3%)
Cefoxthin	0(0.0%)	0(0.0%)	85(100%)	1(1.7%)	57(98.3%)
Kanamycin	1(1.1%)	0(0.0%)	84(98.8%)	0(0.0%)	58(100%)
Ciprofloxacin	0(0.0%)	4(4.7%)	81(95.3%)	1(1.7%)	57(98.3%)
Trimethoprim sulpho- methimazole	2(2.3%)	1(1.2%)	82(96.5%)	0(0.0%)	58(100%)
Ampicillin	15(17.6%)	0(0.0%)	70(82.4%)	0(0.0%)	58(100%)

Table 6. Sources, Frequency (Fr.) and Susceptibility Percentage of Gram-negative Isolates to Commonly Used Antimicrobial of Mansoura University (non-HCWs) and Mansoura City Hospitals (HCWs).

Gram-negative	Non-HCWs (Fr., %)			HCWs (Fr., %)	
Antibiotic	Resistant	Intermediate	Sensitive	Resistant	Sensitive
Ampicillin	29(100%)	0(0.0%)	0(0.0%)	13(100%)	0(0.0%)
Amikacin	28(96.5%)	0(0.0%)	1(3.4%)	13(100%)	0(0.0%)
Gentamycin	8(27.5%)	3(10.3%)	18(62.0%)	0(0.0%)	13(100%)
Tetracycline	11(37.9%)	0(0.0%)	18(62.0%)	1(7.6%)	12(92.3%)
Nalidixic acid	7(24.1%)	3(10.3%)	19(65.5%)	1(7.6%)	12(92.3%)
Kanamycin	6(20.6%)	2(6.8%0	21(92.4%)	1(7.6%)	12(92.3%)
Ciprofloxacin	0(0.0%)	1(3.4%)	28(96.5%)	0(0.0%)	13(100%)
Trimethoprim sulpho methimazole	4(13.7%)	0(0.0%)	25(86.2%)	0(0.0%)	13(100%)
Chloramphenicol	11(37.9%)	1(3.4%)	17(58.6%)	1(7.6%)	12(92.3%)

Discussion

Strict attention is paid to changing cloths, removing jewelry, covering hair and under taking hand hygiene measuring to reduce the transfer of potentially harmful bacteria (Usha *et al.,* 2007). The constant handling of mobile phones or other tools by users in hospitals makes it an open breeding place for transmission of pathogens, as well as health care-associated infections (Singh *et al.,* 2012). The present study tries to define the role of mobile phones of healthcare workers and non-healthcare workers in transmission of antibiotic resistant bacteria. In this study, 79.3% and 94.6% of the mobile phones by healthcare workers and non-healthcare workers respectively were contaminated by bacteria. Methicillin resistant *Staph.aureus* MRSA recorded 99.3% of the isolates. The non-HCWs mobile phones were heavily contaminated with nosocomial pathogens *Staph.aureus* 85(59.8%) compared to HCWs 58(48.7). The possibility of transmission of nosocomial drug-resistant pathogens by mobile telephones reported by previous studies (Isaacs *et al.,* 1998; Bellamy *et al.,* 1998). Both authors recorded that coagulase-negative *Staphylococcus* was susceptible to methicillin/flucloxacillin. These results were dissimilar to our result that recognized resistant Methicillin and Oxacillin *Staph.aureus* in most samples 142(99.3%) and positive coagulases 86(60.1%) for both HCWs and non-HCWs. The *Staph.aureus* of frequency and percentage recorded 58(48.7%), and 85(59.8%) for HCWs and non-HCWs respectively. The positive results of coagulase and DNase were 86(60.1%) and 102(71.3%) respectively. Non-coagulase *Staphylococcus* but not *Staph.aureus* isolated by Karabay *et al.,*(2007).

The isolation of *Staph.aureus* in our study was 58, 85 from HCWs and non-HCWs respectively. The negative coagulase staphylococci (CNS) were 39(67.2%) and 18(21.2%) for HCWs and non-HCWs respectively. The result of HCWs is nearby the work of Kilic *et al., (*2009) but was dissimilar for non-HCWs.

Most of the studies have shown the presence of bacterial contamination of mobile phones of healthcare workers. Variable contamination rates of mobile phones were reported in different countries: 99% in USA (Goldblatt *et al.,* 2007) and 95% in Austria (Akinyemi *et al.,* 2009) also, 94.5% in Turkey (Ulger *et al.,* 2009), 96.5% in Cairo (Elkholy *et al.,* 2010), 84% in UK (Brady *et al.,* 2012), 98% contaminated mobile phones with bacteria was found in Ethiopia (Gashaw *et al.,* 2014).

However 90% in Alexandria Egypt (Gunasekara *et al*., 2015), India 72.5% (Hadir, 2017), and in Turkey 20%, by (Jeske *et al.,* 2007) were reported to be contaminated with bacteria.

Singh *et al.,* (2010) reported that over that 47% of mobile phones were contaminated with pathogenic microbes, other authors (Borer *et al*., 2005; Brady *et al*., 2006) showed that healthcare workers mobile phones were contaminated with nosocomial pathogens. Compared to our study that showed 79.3% and 94.6% bacterial contamination in Mansoura City Hospitals and in Mansoura University respectively, and 48.7% and 59.8% Staph.aureus also, 42(26.0%) Gram-negative bacilli most of isolated bacteria implicated of nosocomial infections such as Staph.aureus, Klebsiella oxytoca, Pseud. aeruginosa, Acinatobacter baumannii, Enterobacter cloacae, their percentage was quite low. This variation may be due to lack of awareness and difference in mobile phone handling and cleaning also, in hand washing practice and low hygiene standards also in different environment.

Results from our study revealed that 79.3% and 94.6% of mobile phones HCWs and non-HCWs respectively were contaminated with one or more bacteria, our result was opposite to (Nwankwo *et al.,* 2014) which indicated that HCWs (94.6%) phones were higher than non-HCWs (82%).

Previous studies in Iran showed that 99% (Sedighi *et al.,* 2015), from Coimbatora, India reported that 91.6% mobile phones were found to be contaminated and the efficacy of decontamination of mobile phones with 70% isopropyl alcohol was 98% (Usha *et al.,* 2007). In Ethiopia (Gashaw *et al.,* 2014) and Turkey (Tekerekoglu *et al.,* 2011), 98% contamination was recorded. All these reports of contaminated mobile phones were nearby our result from non-HCWs 94.6% while HCWs contamination percentage was quite lower. Some of our isolates were pathogenic, an alarming number of pathogens related to health association infections on surface of mobile phones were found.

This study showed that there was 98.3% *Staph.aureus* from HCWs sensitive to Ciprofloxacin while only one from male worker was resistance with a percentage 1.7%, while 95.3% sensitive and 4.7% intermediate to Ciprofloxacin with non-HCWs, no isolates of *Staph.aureus* from non-HCWs were resistant to Ciprofloxacin. This result was dissimilar to the result of Daka, (2014) however, 31.7% of the isolates from mobile phones and 30.9% of the hands of healthcare workers were resistant to Ciprofloxacin. This might indicate that there is graduate increase of antibiotic resistance pattern at hospitals therefore it is better to overcome this problem early.

Several isolations in our study are potential pathogens, and demonstrated resistance to antibiotics such as *Pseud.aeruginosa, Acinetobacter baumannii, Staph.aureus*. On the other hand Tambe *et al.,* (2012) showed that *Staph.aureus* isolates and very few cases (16.9%) isolates were resistant to Methicillin comparing to our results where, 99.3% were MRSA of the *Staph.aureus* isolates. This is a significant result and could reflect the differences in carries states of health care and non-healthcare personnel for *Staph.aureus* in different countries. The fact that several isolations are potential pathogens and demonstrated resistance to antibiotics high lights the need for even more stringent measures to be followed in hospitals and community to prevent the spread of such pathogenic bacterial strains.

The present study results showed 13(10.9%) from HCWs and 29(20.4%) from non-HCWs of Gram-negative bacilli, Less percentage of Gram-negative from HCWs also, no *Escherichia coli* isolated from HCWs and non-HCWs, it means contamination with fecal low than other reports and *no E.coli* such reports as Dr. Gerba, professor of microbiology at Arizona University and An Article in DAIL MAIL UK., stated that the average of cell phone is dirtier than either a toilet seat or the bottom of your shoes (Tambe *et al.,* 2012; Sharma *et al.,* 2015), it harbor *E.coli*

as well as influenza this may be due to the mausoleum religion and personnel hygiene, also habit for cleaning after going to the toilet.

The recording of high percentage of *Bacillus* spp. confirmed that the ubiquitous nature of *Bacillus* spp. giving it great colonization ability as well as the ability of its spores to resistant environment changes, without dry heat and certain chemical disinfectants for moderate's periods, *Bacillus* spp. can cause food poisoning through eating with infected hands (Tagoe *et al.,* 2011; Hill *et al.,* 2012). The result of the present study indicated that *Bacillu*s species were high level in Mansoura City Hospital and Mansoura University with frequency and percentage 71(59.6%) and 87(61.2%) respectively. Personal hygiene and environmental disinfection greatly minimize the contamination of mobile phones.

Enterobacter cloacae, *Klebsiella oxytoca*, *Proteus* spp., *Aeromonas* spp., *Pseudomonas* spp., *Acinatobacter baumannii* and *bacillus* spp., *Staphylococcus* spp. and *Staph.aureus* are the bacterial isolates from mobile phones of the present work. These organisms (Ekrakene *et al.,* 2007) get their way into phones through the skin and transmitted regular skin contact which is the isolated bacteria are normal flora of the skin. Frequently handling by many users with different hygiene profiles might cause the contamination by these pathogens.

In a study of Arora *et al.,* (2009), *Acinetobacter* spp. was isolated and also Isaacs *et al.,* (1998) identified multidrug resistant *Acinetobacter* spp. in the mobile phones and hands of healthcare workers and patients admitted to ICU. However, it interesting that no *Acinetobacter* spp. in our study from HCWs while only two isolates from non-HCWs were identified by BDPHOENX Device as multidrug resistant *Acinetobacter baumannii*.

Acinetobacter is clinically important pathogen with widespread resistance to various antibiotics Kulkarni *et al.,* (2017), Gupta *et al.,* (2015), personal hygiene, and not sharing phones are better ways to reduce the transmission of microorganisms.

In the present study, *Serratia marcescens Staph.aureus* and only one isolate of *Pseud.aeruginosa*, one *Klebsiella oxytoca* and one *Pantoea agglumerans* were the organisms isolated among HCWs phones, results that dissimilar to Famurewa *et al.,* (2009) in which the organisms recovered belonging to *Staph.aureus*, *Pseud.aeruginosa*, *Serratia* spp., *Proteus vulgaris* and *E.coli*. Hand washing is considered the single most important intervention to prevent transmission of bacteria and viruses from hands of healthcare workers Fendler *et al.,* (2002)).

According to these results it is obvious that, the training of healthcare personnel about strict infection control procedure, personal hygiene, and environmental disinfection and eventually, optimum disinfection methods are of great importance. There should be a recommendation by manufactures to provide clear guidelines for decontamination of mobile phones.

CONCLUSION

Our findings suggest that mobile phones of healthcare and non-healthcare people act as a disease carriers and may play an important role in spreading of nosocomial infection. We recommend regular cleaning of phones and hand hygiene and not to share phones to prevent transmission of bacteria. To reduce or prevent the contamination of the hands and mobile phones, HCWs and non-HCWs workers should take standard precautions after each use of the phones.

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الثلوث البكتيري للهواتف المحمولة للتابعين للرعاية الصحية وغير التابعين لها في مدينة المنصورة ـ مصر

عطية محمدين ، أشرف السيد و حليمة عبدالله نشنوش

قسم النبات ـ كلية العلوم ـ جامعة المنصورة ـ مصر

المؤلف المسؤل: عطيه محمدين (amohamedin@hotmail.com) Tel: 01143525686

أصبح جهاز الإتصال المحمول أداة للحياة اليومية ويعد إستخدام الهواتف المحمولة داخل المستشفيات موضعا للجدل لأنها قد تؤدي إلى المساعدة في العلاج في المستشفيات كما أنها قد تودي الى نقل العدوى بين العاملين. في هذا البحث تم دراسة الثلوث البكتيري لثلاثمائة عينة من الهواتف المحمولة. 150 عينة لعاملين تابعين للرعاية الصحية بمستشفيات بجامعة المنصورة ومستشفيات أخرى غير تابعة للجامعة في المنصورة من أطباء وممرضين وعاملين بالمستشفى وكذلك 150 عينة لعاملين في جامعة المنصورة غير تابعين للرعاية الصحية (أعضاء هيئة التدريس وطلبة وعاملين بالجامعة) وذلك في الفترة مابين 2015/11/15 - 2017/11/14 .اشارت نتائج العينات المأخودة من أجهزة التابعين للرعاية الصحية أن 31(20.6%) عينة بدون تلوث في حين 119 من 150(79.3%) عينة كانت ملوثه بالبكتيريا موجبة وسالبة جرام .وكانت البكتريا موجبة جرام كانت على النحو التالي:,(59.6%)71 .spp *Bacillus* *Staphylococcus* *Staph.aureus* (52.1%), 62 .spp *Micrococcus* 8(6.7%), *58*(48.7%) أوضحت النتائج أيضا أن 37(31.0 %) عينة بها نوع واحد فقط من البكتيريا في حين 82(68.9%) عينة بها أكثرمن نوع كما أوضحت النتائج أيضا أن 13(10.9%) عينة كانت سالبة جرام ,وهي كالتالي: 10 تابعة لبكتيريا *Serratia marcescens* (ثمانية منها عزلت من ممرضات و إثنان من ممرضين من مستشفى طلبة الجامعة), وعزلت واحدة فقط *Pantoea agglomerans* من عاملة و*Pseudomonas aeruginosa* من ممرض من نفس المستشفى بالجامعة , وواحدة فقط *Klebsiella oxytoca* من عامل بالمستشفى الدولي. ولم تعزل أي واحدة من بكتريا سالبة جرام من الاطباء. كما أشارت النتائج لغير التابعين للرعاية الصحية إلى أن 142 من 150(94.6%) عينة كانت ملوثه بالبكتيريا و 8(5.3%) غير ملوثة. وكذلك 20 (14.0%) عينة بها نوع واحد فقط من البكتريا و122(85.9%) عينة بها اكثرمن نوع . وكذلك أوضحت النتائج أن العينات الغير تابعة للرعاية الصحيه كانت ملوثه بالبكتريا موجبة جرام التالية: ,(61.2%)87 .spp *Staphylococcus* 86(60.5%), .spp *Bacillus* *Micrococcus* and (59.8%) 85 *Staph.aurous* 24(16.9%) .spp كذلك تم عزل بكتيريا سالبة جرام من الهواتف المحمولة للعاملين الغير تابعين للرعاية الصحية بالجامعة حيث كانت 29(20.4%) عينة ملوثة وهي كالتالي: *Aeromonas hydrophila*, *Aer.caviae*, *Aer.sobria*, *Pseudomonas aeruginosa,* *Moraxella* spp موجبة الاوكسيداز اما المعزولات سالبة الاوكسيداز فكانت كالتالي: *Acinetobacter baumannii, Klebsiella oxytoca, Serratia fonticola, Enterobacter cloacae, Pantoea agglomerans*, *Citrobacter farmeri*, *Morganella morganii*, *Proteus mirabilis*, *Proteus vulgaris*, *Providencia* rettgerii وكانت العزلات البكتيريا سالبة جرام مقاومة إلى Ampicillin ,Amikacin وحساسة إلى Ciprofloxacin ,Trimethoprim Sulfamethoxazole ولكن بعض منها كانت مقاومة إلى Nalidixic ,Kanamycin ,Chloramphenicol, Gentamycin وTetracycline بإستثناء *Pseudomonas aeruginosa* و*Acinetobacter baumannii* فكانت مقاومة لجميع المضادات الحيوية إلا *Pseud.aerugenosa* فكانت حساسة الى Ciprofloxacin. في حين أن العزلات البكتيريا العنقودية الذهبية كان أغلبها مقاومه الي Methicillin و Oxacillin 142 (99.3%) بينما اغلبها حساسة الي Ciprofloxacin وSulfamethoxazole Trimethoprim 142 (99.3%) وكذلك حساسة الي Kanamycin 142(99.3%) وكذلك وجد أن 128 عينه مقاومه اليPenicillin-G (89.5%)و 142 (99.3%) عينه حساسة الي Cefoxthin, Vancomycin بينما Penicillin-G كانت نسبه حساسية البكتيريا له (66.4%) بواقع 95 عينه من مجموع 143 .وعلى ضوء نتائج البحث نوصي بالاهتمام بالنطافة الشخصية وغسل اليدين خاصة بعد دخول الحمام لأقلال من ثلوث الهواتف المحمولة وحتى كل الأدوات الغير متحركة والتي نستخدمها بحياتنا اليومية للحد من انتقال العدوى بألكائنات الدقيقة.