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# Microbial contamination of cell phones of nursing department students in Technical Institute of Baqubah, Iraq

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**This study was aimed to investigate microbiological colonization of cell phones used by nursing students of Baqubah Technical Institute, from June to August 2018. In 150 randomly collected cell phones, 133 bacterial and 74 fungal species were isolated using sterile swabs from cell phones surface. The microbe were identified using conventional methods, bacterial species isolated were: *Staphylococcus aureus* (48%), *Staphylococcus epidermidis* (25.2), *Pseudomonas aeruginosa* (14.1), *Bacillus subtilis* (7%), *Escherichia coli* (2.3), *Streptococcus viridians* (2%) and Proteus spp. (1.2%) whereas, the fungal species isolated were Cladosporium spp. (36.1%), Alternaria spp. (17%), Penicillium (9%), *Aspergillus fumigates* (6.3%), and *Aspergillus niger* (32%). The bacterial isolates were tested by antibiotic disks diffusion method. High percentage of bacterial isolates was found resistance to erythromycin, cefoxitin, ciprofloxacin and clindamycin. Several *S. aureus* and *S. epidermides* isolates were resistant to erythromycin and cefoxitin. The Proteus spp. and *E. coli* were found highly sensitive to ampicilin, amikacin, cefepime, cefroxain and imipenem. However, the *P. aeruginoae* spp. showed two different antibiotics sensitivity profiles for the similar antibiotics. This study confirmed that the students cell phones were contaminated with several pathogenic bacterial and fungal species thus might act as an important source of cross-transmission of human and antibiotics resistant.**

**Key words:** Cell phones, microbial contamination, nursing students, fungal species, *Staphylococcus aureus*.

## INTRODUCTION

A cell phone is an important device for private telecommunication in daily life and is frequently kept in close contact with the human body. In most countries, mobile phones became more than landline telephones, since most adults and many teenagers currently own mobile phones. At present, Middle East geographic area has the fastest growth rate of cellular phone subscribers in the world (Ibrahim et al., 2014). Persistent handling of cell phones by different users exposes it to many species of microbes; thus, making phones perfect carrier for microorganisms. Particularly, those related to the skin resulting in the spread of different microorganisms from

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user to user (Al-Abdalall, 2010).

The problem of cell phones contamination with microbes is aggravated from the fact that several cell phone users neglects their personal hygiene (Roy et al., 2013). Continuous usage of cell phones in almost every place and occasions exposed it to a large number of microorganisms. It can be an important source for variety of zoonotic pathogens, which lead to infections and may be a potential health hazard for users and their family (Gurang et al., 2008). Handling of mobile phones by lectures and teachers makes it a good vehicle to spread many pathogenic microbe (Ibrahim et al., 2014; Brady et al., 2006). Various species and genera of bacteria, including *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella* spp., *Enterococcus* spp. and *Proteus* spp. are known as the etiologic pathogenic agents.

In addition, the normal Microflora is harmless and may be useful when they found in the normal sites in host. However, it can also produce disease if replaced into another locations or a compromise host (Roy et al., 2013; Amadi et al., 2013). Fungal species like *Trichophyton mentagrophytes, Aspergillus niger*, *Pencillium* sp. have the ability to grow on cell phones when exposed to mobile waves for 20 min (Fawole and Ose, 2001).

Hand washing may not be usually performed enough thus, personal mobile phones may be used in work all of the day. Thus, mobile phones are considered as a potential source for transmission of microbe (Ibrahim et al., 2014; Suganya and Sumathy, 2012).

Over the last decade, the use of mobile has increased rapidly from being rare and priced items of device used primarily by the wealthy category, to a common cheap personal asset. According to many Microbiologists the warmth generated by continuous handling of phones make it a perfect ground for the normal flora of the skin which may be resistant to some antibiotics (Dave and Shende, 2015; Zakai et al., 2016).

This research investigates microbial contamination of cell phones used by the students at the Nursing department in Baqubah Technical institute. This research also identifies the microorganisms that are regularly associated with mobile phones. This research also studies the sensitivity of bacterial isolates to some antibiotics.

## MATERIALS AND METHODS

### Sampling

This study was performed during summer training from June to August 2018, at the laboratory of Medical Microbiology, Baqubah Institute, Middle Technical University (MTU), Diyala, Iraq. One hundred and fifty randomly collected cell phones of second year nursing department students were examined by taking swabs for isolation of bacteria and fungi.

The surface of cell phones were swabbed with sterile cotton swab immersed in sterile saline. Each cell phones were sampled and inoculated separately into tubes containing 3 ml Luria - Bertani broth (LB broth) and Sabouraud dextrose broth.

### Bacterial isolation

The inoculated LB broth were incubated overnight and streaked into blood agar and MacConkey's agar. The culture plates were incubated aerobically at 37°C for 24 h. The identification of isolated bacteria were based on standard protocol beginning with morphology of colonies, gram stain, and observed for growth as well as colonial description of the isolates (Roy et al., 2013; Arora et al., 2009). Mobility tests, biochemical tests and Microorganisms plates were identified grown on with conventional techniques. A slide coagulase test (Microgen Staph, Microgen Bioproducts, Camberley, UK) was used to differentiate *S. aureus* from other coagulase-negative Staphylococci (Zakai et al., 2016; Brooks et al., 2013).

### Biochemical analysis

Following purification, single colonies of bacteria were subjected to biochemical tests according to standard procedures, which include carbohydrate fermentation test, mannitol motility test, IMViC tests (Methyl Red test, Indole test, Voges Proskauer test and Citrate test), urease test, nitrate reduction test, growth in triple sugar iron agar (TSI) (Brooks et al., 2013; Kumar and Aswathy, 2014).

### Antibiotic susceptibility test

The antibiotic susceptibility test was conducted on 0.5 McFarland (is a chemical solution of 1% barium chloride $BaCl_2$ and 1% sulfuric acid $H_2SO_4$ Solution in appropriate proportion), using the Kirby-Bauer disk diffusion method according to NCCLs recommendation M100-S25(2015). The bacterial suspension (0.5 MaFarland) was streaked over Muller-Hinton agar surface (Shahlol et al., 2015); then available suitable antibiotic disks were placed onto the surface of medium and incubated for 18 h at 35°C. The zones of inhibitions were measured and interpreted according to the Clinical and Laboratory Standards Institute (Wayne, 2011). The antibiotics disks used include: Tetracycline, erythromycin, cefoxitin, ciprofloxacin and clindamycin for Gram positive bacteria, ampicillin, amikacin, cefepime, ceftriaxone and imipenem for Gram negative bacteria were used and the results were indicated by sensitive or resistant test according to standard measure (Zakai et al., 2016; Julian et al., 2012).

### Fungal isolation

After incubation for 24 h at room temperature, swabs were streaked on the Sabouraud dextrose agar and potato dextrose agar. The samples were cultured for the growth of isolated colonies on potato dextrose agar. Then the plates were incubated at 37°C for 24 h, the colonies grown on two media were examined for their morphology and staining. The isolated fungal species further identified and characterized by using standard microbiology method (Kampf and Kramer, 2004).

## RESULTS AND DISCUSSION

An inanimate object as mobile phone, may pose as a potential for survival of microorganisms. Some viruses such as corona, coxakie and influenza can survive few days and herpes virus for a week, while bacteria can persist for months (Kampf and Kramer, 2004). Many studies conducted around the world show that there is a

**Table 1.** Grouping of microbial content of cell phones.

| Number of isolated microorganisms | Bacteria | | Fungal | |
|---|---|---|---|---|
| | Number | % | Number | % |
| 0 | 17 | 11.3 | 76 | 28 |
| 1 | 33 | 22.0 | 24 | 17.3 |
| 2 | 47 | 31.3 | 33 | 30 |
| 3 or more | 53 | 35.3 | 17 | 24.7 |

**Table 2.** Bacterial species isolates from cell phones.

| Isolates of bacterial | Number | % |
|---|---|---|
| *Staphylococcus aureus* | 264 | 48 |
| *Staphylococcus epidermidis* | 137 | 25.2 |
| *Pseudomonas aeruginosa* | 77 | 14.1 |
| *Bacillus subtilis* | 36 | 7 |
| *Escherichia .coli* | 13 | 2.3 |
| *streptococcus viridians* | 9 | 2 |
| *Proteus* spp | 7 | 1.2 |

high prevalence of microbial contamination in cell phones (Karabay et al., 2007).

The results in Table 1 refers to the highest rate which belongs to cell phone contaminated with 3 or more types of bacteria (35.5%), while the non-contaminated cell phone recorded as lowest rate (11,3%). These results approximate Chawla et al. (2009) with his findings, which included the total number of cell phones that showed no growth of bacteria, the contaminated phones with 2 types of bacteria reported as the highest rate. Cell phones, which show no fungal growth, recorded the highest rate 76%, while those that appear in the lowest rate 17% show growing of 3 or more fungal types. Many researches carried the entire world refers to high propagation of contaminated cell phones (Karabay et al., 2007).

The rate and number of isolated bacterial types (spp.) are summarized in Table 2. *S. aureus* and *S. epidermidis* were the predominant bacteria in rate of 48 and 25.5%. These results were parallel with Akinyemi et al. (2009) and with Datta et al. (2009) in their study reporting that coagulase-negative staphylococci were the most prevalent bacterial agents isolated from mobile phones, followed by *Staphylococcus aureus* (Chawla et al., 2009) in which *S. aureus* were the predominant bacterial spp. In rate of (48%), among other species including 7 types of bacteria were isolated from totally 150 cell phones which are in accordance with frequency as follows: *S. epidermidis* (25.2%), *P. aeruginosa* (14.1%), *B. subtilis* (7%), *E. coli* (2.3%), *S. viridians* (2%) *and Proteus* spp. (1.2%) sequently.

*S. aureus* is carried by healthy people on the skin and nose. It can cause mild to serious infections if it enters the body through cuts, wounds, etc. (Angadi et al., 2014). *S. aureus* mainly introduced from hands which is the main reservoir for this bacteria and introduced to food while preparation. (Suganya and Sumathy, 2012; Morubagal et al., 2017).Many pathogens like *S. epidermidis* can transfer by cell phones to the body by contacting with other plastic surface such as catheters or prostheses. The most prevalent cause of sepsis and the etiologic agent of most cases of urinary tract infection is *S. epidermidis* (Al-Abdalall, 2010; Akinyemi et al., 2009; Jalalmanesh et al., 2017). *P. aeruginosa*. was observed at the rate of 14.1%. This is close to Famurewa and David (2009) who observed that 22.6% of the investigated cell phones owned by volunteers in the university premises were contaminated with *P. aeruginosa*.

The contamination of hospital device and food products with species of bacteria is a major concern (Gurang et al., 2008; Julian et al., 2012) since the cell phones can play a role as a vector. The prevalence of other bacterial spp. isolated from student's cell phones were *B. subtilis* (7%), *E. coli* (2.3%), *S. viridance* (2%) and the lower percentage (1.2%) was Proteus spp. The prevalence of Bacillus species according to previous researches processed in Iran, were 60 and 26.3%, respectively (Karabay et al., 2007; Jalalmanesh et al., 2017). These results do not agree with another study performed by Sedihgi et al. isolates *Bacillus* spp. By about (0.8%) from the cell phone of Health Care Providers in a Teaching Hospital in Hamadan Province, Iran (Sedighi et al., 2015).

*E. coli*, *S. viridians* and *Proteus* spp. were isolated by a small percentage compared with other isolates mentioned.

**Table 3.** Fungal species isolates from phones.

| Isolates of Fungal | Number | % |
|---|---|---|
| *Cladosporium* spp. | 17 | 36.1 |
| *Alternaria* sps. | 15 | 32 |
| *Penicillium* | 8 | 17 |
| *Aspergillus fumigates* | 4 | 9 |
| *Aspergillus niger* | 3 | 6.3 |

**Table** 4**.** Pattern of antibiotic sensitivity for Gram-positive bacterial isolates.

| Antibiotics | Bacteria | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | ***S. aureus*** | | ***S. epidermidis*** | | ***Bacillus subtilis*** | | ***S. viridians*** | |
| | **S** | **R** | **S** | **R** | **S** | **R** | **S** | **R** |
| TE | 232 | 32 | 95 | 42 | 26 | 10 | 7 | 2 |
| E | 193 | 71 | 83 | 54 | 21 | 15 | 5 | 4 |
| CX | 213 | 51 | 76 | 61 | 17 | 19 | 9 | - |
| CIP | 231 | 33 | 104 | 33 | 27 | 9 | 6 | 3 |
| CD | 217 | 47 | 97 | 40 | 29 | 7 | 8 | 1 |

TE, tetracycline; E, erythromycin; CX, cefoxitin; CIP, ciprofloxacin; CD, clindamycin.

Significance of fecal contamination of hands can be confirmed by presence of *E.coli* through bed pans or poor personal hygiene (Amadi et al., 2013). Ibrahim et al. (2014) observed that 9.77% of examined cell phones were contaminated with *E. coli* and *Proteus* spp. in a rate of (7.47%) with many other bacterial species in different rates. The results were also close the findings of Zakai et al. (2016) in regards to total isolation of bacteria which was about (20%).

Cell phones are likely to be a soruce of microbial transmission, inculding human pathogens and that can increase the incidence for bacterial and fungal infections. Recently many rersearches researched the contamination of cell phones surfaces with bacteria and fungi (Nowakowicz-Dębek et al., 2013).

Table 3 shows the pathogenic fungi isolated based on mycelia, colour and spores from swabs taken from the cell mobile device with different values started from *Cladosporium spp.* at a higher rate (36.1%) to *A. niger* which was in the lower percentage (6.3%). Many of recent studies Confirmed high contamination with mycotic agents, especially of Aspergillus and *Penicillium* (Nowakowicz-Dębek et al., 2013).

Present research also is in parallel with Coutinho et al. (2007) who analyzed the incidence of fungal contamination of mobiles in high level when he isolate 34 species of fungal from public telephones in Brazil.

These isolates influence food infectious and cause food spoilage by producing toxins. Filamentous fungi, have strong allergenic properties, and can induce dermal mycoses, which is considered as opportunistic human pathogens (Nowakowicz-Dębek et al., 2013). The results are consistent with isolation of *cladosporium spp*. In a rate of 20.9% and *Aspergillus fumigates* at a rate 2.3% among fungal isolates including *A. niger* 20.7%, and other pathogenic species from mobile phones in eastern Saudi Arabia (Al-Abdalall, 2010).

Dave and Shende (2015) pointed out to the isolation of a group of pathogenic fungi in similar proportion to the same rates obtained by us but differ with the isolation rate of *A. niger* (32.0%) which was reported as a high percentage.

The sensitivity tests for bacterial isolates were presented according to Gram positive and Gram negative in Tables 4 and 5, respectively. Generally antibiotic sensitivity test results revealed that all bacterial strains were sensitive to the studies antibiotics but at different rates.

Most of *S. aureus*, *S. epidermidis*, *B. subtilis* and *S. viridians* isolates were sensitive to tetracycline, erythromycin, cefoxitin, ciprofloxacin and clindamycin. *P. aeruginosa, E. coli* and *Proteus* spp. were moderately sensitive to the following antibiotics ampicillin, amikacin, cefepime, ceftriaxone and imipenem. *Proteus* spp. did not show any resistance to amikacin and imipenem same as *E. coli* to cefepime and was to imipenem .This agree with Roy et al. (2013) findings according to *E. coli* and *Proteus* spp. isolates that showed highly sensitivity to ciprofloxacin, erythromycin, amikacin.

There is increase in the use of mobile devices without awareness of the risks that it may cause; especially the contamination of these devices with microbes may lead

**Table 5.** Pattern of antibiotic sensitivity for Gram-negative bacterial isolates.

| Antibiotics | Bacteria | | | | | |
|---|---|---|---|---|---|---|
| | *P. aeruginosa* | | *E. coli* | | *Proteus spp.* | |
| | S | R | S | R | S | R |
| A | 49 | 28 | 10 | 3 | 6 | 1 |
| AK | 46 | 31 | 12 | 1 | 7 | - |
| CPM | 32 | 45 | 13 | - | 5 | 2 |
| CTR | 55 | 22 | 9 | 4 | 6 | 1 |
| IPM | 37 | 40 | 13 | - | 7 | - |

A, ampicillin; AK, amikacin; CPM, cefepime; CTR, ceftriaxone; IPM, imipenem.

to serious health problems especially when it is used without caring heygin precautions (Martínez-Gonzáles et al., 2017).

Recent research included contamination of 133 out of 150 mobile devices with bacterial and among of 150 total examined cell phones only 74 devices were contaminated with fungal spp. The ability of pathogens to grow on the surface of cell phones, survival time, and the risk of transmitting these pathogens to patients should be taken into account. This study aimed to isolate and identify microorganisms and create awareness that mobile could also serve as a vector for transfer pathogenic agents from one individual to another, and causes of infections. Therefore, it is important to take care of personal hygiene and mobile decontaminations by regular cleaning of mobile phones with methylated spirit or alcohol to eradicate and reduce growth of pathogenic micro-organisms.

## Conclusion

This study reveals that there is colonization of pathogenic bacteria and fungal agents on the mobile phones, in which it may act as disease - producing and help in transforming microbes among the students of 2nd year Nursing department especially when they start training in health center during summer. These contaminated phones may be an important facility in the spreading of drug-resistant bacterial isolates. In order to reduce this potential risk, everyone should have an education about hygiene, comprehensive guidelines and strict hand wash, and regular decontamination of mobile phones by appropriate cleaning of the device.

## CONFLICT OF INTERESTS

The author has not declared any conflict of interests.

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