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Mobile Phones as a Source of Bacterial Infection

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A B S T R A C T

Background: The wide spread of mobile phones in recent years inevitably raises the question of whether they are an exogenous source of infections.

Design: A cross-sectional study was carried out among some teachers, educational staff, doctors, and nurses selected using the multi-stage stratified random sampling technique. 100 samples were collected from some teachers, educational staff, doctors, and nurses in some hospitals in Benghazi.

Results: The organisms sequentially isolated in this study, based on colonial, morphological, and biochemical characteristics, were coagulase-negative Staphylococci (58%), *Staphylococcus aureus* (12%), *Corynebacterium urealyticum* (6%), *Bacillus cereus* (5%), *Tatumella ptyseos* (3%), *Leuconostoc lactis*, *Pseudomonas aeruginosa*, All isolates were resistant to more than one antibiotic. This revealed that mobile phones may have a notable role in the transmission of multidrug-resistant nosocomial pathogens.

Conclusions: This study showed microbial contamination on personal mobile phones and hands. Some of the contaminated mobile phone microorganisms (such as *Staphylococcus aureus*) were epidemiologically important nosocomial drug-resistant pathogens. These isolates of bacteria were resistant to commonly used antimicrobials such as amoxicillin, gentamicin, and ciprofloxacin. These results showed that mobile phones and personal's hands were contaminated with various types of bacteria, which suggested that mobile phones (used by people in daily practice) may be a source of nosocomial infections.

1. Introduction

Mobile phones have become an integral part of modern social life and are in the hands of billions of users worldwide every day. Between 2011- 2018 the adoption rate of mobile phones within the community skyrocketed from 10 to 60 percent while the upward trend reaches 79% by 2025 (Tiron *et al.*, 2020). The real problem is that the number of bacterial strains that develop resistance to disinfectants and especially antibiotics is increasing very quickly. Some of these resistant microorganisms (bacteria) are difficult to destroy and can survive for a longer time on the floor and other surfaces. Resistant bacterial strains are now spreading to our houses and other places where people live or work (Eltablawy and Elhifnawi, 2009).

National Center for Radiation Research and Technology (NCRRT) (Eltablawy and Elhifnawi, 2009) reported that there are no safe objects. Tables, utensils, computers, doorknobs, gym equipment, and other objects were shown to be contaminated with potentially dangerous pathogens. Bacterial contamination has been discovered on cell phones as well as the mouse and keyboard of personal computers. All these items and surfaces can be potential sources for cross-infections and transmitting microorganisms.

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In fact, microorganisms are found almost everywhere in air, water, soil, food, plants and animals, including humans and may be transmitted, either directly, through hand-to- hand contact, or indirectly via food or other inanimate objects such as cell phones, money and coins (Angelakis *et al*., 2014) without enough washing performed and using personal cell phone in the course of a working day give the potential act of cell phones as a source of microbial transmission is considerable (Schultz *et al*., 2003, and Rafferty & Pancoast, 1984).

Additionally, infectious individuals who use their hands when covering a cough divert infective pathogens from the droplet route to the hand-fomite route, which has the potential to increase fomite transmission from highly touched devices (Zhao *et al*., 2012). Recently, the COVID-19 virus is rapidly transmitted from person to person via respiratory droplets that come out of the infected person when they cough, sneeze, breathe or talk.

Mobile phones are widely used by most adults and many children in many countries, including Libya. Therefore, cell phones have become one of the indispensable accessories of professional and social life, which makes them a good pathogenic carrier or reservoir. The reservoir of any organism, which may be animate or inanimate objects, in the epidemiology of any bacterial disease is very important (Haydon *et al*. 2002).The pathogens live and/or multiply in the reservoir on which their survival depends, such as flies. Many epidemiological studies have confirmed that contaminated surfaces play a major role in the spread of infectious diseases (Hendley, Wenzel, and Gwaltney, 1973).

These pathogens pass from the contaminated hand and skin of the user to another user, through which there is exchange of flora between the users (Famurewa and David, 2009). The adult human is covered with approximately $2m^2$ of skin, with a surface area supporting about 10^{12} bacteria (Mackowiak, 1982).The normal microbes of the skin include other; coagulase negative staphylococci, Diphtheroids, staphylococcus aureus, streptococci(various species), Bacillus spp (Joanne and Christopher, 2008).

The increased use of mobile phones is seen against a background of rising nosocomial infection rates reported by ecological findings (Brady *et al*., 2006). Mobile phones can harbor various potential pathogens and become an exogenous source of nosocomial infections among hospitalized patients and also a potential health hazard for themselves and family members (Gurang *et al*., 2008).

In view of the above, knowing the types of bacteria spread among the health and education sectors in Benghazi is important. This will provide programs that encourage Keep the mobile phone away from our children and pay attention to personal hygiene.

2. Materials and Methods

2.1 Collection of samples:

Random samples were collected from cell phones and the hands of the user using sterile cotton swabs. For each person, a sterile swab was rotated over the surface of both sides of his or her cell phone. A second swab was rubbed over the entire ventral surface of the hands, including the ventral surface of the thumb and the fingers. Both swabs were immediately sent to the laboratory at the Benghazi Center for Infectious Diseases and Immunology, the Al-Jalaa Hospital for Surgery and Accidents, and the Central Reference Laboratory.

Sub-culture: Samples were inoculated into Brain Heart Infusion (BHI) broth as a transport medium and incubated at 37°C for 24 hours aerobically. This was to ensure that any microbes present in the cotton swab diffused into the broth. Brain Heart Infusion is a general-purpose liquid medium used in the cultivation of fastidious and non-fastidious microorganisms, including aerobic and anaerobic bacteria, from a variety of clinical and nonclinical materials. It is used for the cultivation of microorganisms, including bacteria, yeasts, and molds.

For isolation and purification, organisms were sub-cultured on blood agar, MacConkey agar, and nutrient agar plates. Petri plates were incubated at 37°C for 24–48 hours aerobically. Plates were observed for growth and colonial morphology of the isolates and used for identification tests for more accurate biochemical tests.

2. 2 Identification of bacteria:

Bacteria were identified in culture by conventional methods such as microscopic examination and morphological analysis, with the help of the Phoenix fully automated identification system, the analytical profile index (API) system, and biochemical methods to confirm the identification.

2. 3 Gram Technique:

This is the most important staining method in bacteriology and the first step in the identification procedure. In this study, it was employed for the diagnostic identification of various organisms as Gram-positive or Gram-negative due to differences in their cell wall structure.

2. 4 Biochemical methods:

Different biochemical tests were carried out for bacterial identification using the medical laboratory manual (Mukhtar and Tukur, 2019).

2. 5 Antibiotic sensitivity tests:

Bacterial species vary in their sensitivity to different chemotherapeutic and antibiotic agents. These variations and the continuously increasing number of antimicrobial agents necessitate the selection of the proper agent for each organism to be used for therapeutic purposes. The antibiotic sensitivity pattern of the selected isolate was studied by the disc diffusion method (Bauer, 1966). All isolated strains were streaked on Mueller-Hinton agar plates. The tested antibiotics on Gram negative and Gram positive bacteria were amoxicillin-clavulanic acid, amoxicillin, ampicillin ,penicillin, ceftriaxone, ciprofloxacin, chloramphenicol, erythromycin, gentamicin, imipenem, levofloxacin, sulfamethoxazole /trimethoprim, Kanamycin and tetracycline . After 24 hours of incubation at 37°C, the zones of inhibition were measured and compared to the manufacturer's instructions and the criteria of the National Committee for Clinical Laboratory Standards (Wikler, 2006).

2.6. Analysis of results:

The data was analyzed using SPSS 8.0. Tests of significance were done using the Chi square test.

3. Results

3.1. Bacterial Identification:

A total of 100 hands and mobile phones screened in this study showed bacterial growth. These bacteria were identified using Bergey's Manual of Determinative Bacteriology (Holt *et al*., 1994). The organisms recovered are from sixteen different genera, including Coagulase-negative Staphylococci (CNS), *Staphylococcus aureus*, *Corynebacterium urealyticum*, *Bacillus cereus*, *Tatumella ptyseo*s, *Leuconostoc lactis*, *Pseudomonas aeruginosa*, *Citrobacter youngae*, Gaffkya *tetragena*, *Kocuria kristinae*, *Aeromonas hydrophila*, *Chryseobacterium meningosepticum*, *Enterobacter cloacae*, *Aerococcus viridans*, *Gardnerella vaginalis*, and *Leclercia adecarboxylata*. The recovery rate ranges between 1% and 58% **(Table 1)**.The organisms were consistently isolated from the mobile phone and human hands.

Table 1: Bacterial agents isolated from mobile phones and hands.

Bacterial types	Number of isolation	Percent
coagulase-negative staphylococci	58	58%
Staphylococcus aureus	12	12%
Corynebacterium urealyticum	06	6%
Bacillus cereus	05	5%
Tatumella ptyseos	03	3%
Leuconostoc lactis	02	2%
pseudomonas aeruginosa	02	2%
Citrobacter youngae	02	2%
Gaffkya tetragena	02	2%
Kocuria kristinae	02	2%
Aeromonas hydrophila	01	1%
Chryseobacterium meningosepticum	01	1%
Enterobacter cloacae	01	1%
Aerococcus viridans	01	1%
Gardnerella vaginalis	01	1%
Leclercia adecarboxylata	01	1%
Total	**100**	**100**

3.2 Level of Contamination:

The results showed that isolated organisms from individuals' hands and mobile phones, which included coagulase-negative staphylococcus (CNS), were the most common, followed by *S. aureus*, *C. urealyticum*, *B. cereus*, and *T. ptyseos*. While *G. vaginalis*, *A. viridans*, *E. cloacae*, *L. adecarboxylata*, *C. meningosepticum*, and *A. hydrophila* were the less commonly isolated from individuals' hands and mobile phones. In this study, the contamination rate of mobile phones and hands was 100% **(table 2)**. The percentage of gram-positive bacteria in mobile phones was higher (90%) than in hands (88%)**,** while the percentage of gram-negative bacteria in mobile phones was lower (10%) than that in hands (12%).

Table 2: Distribution of gram-positive and gram-negative bacteria isolated from people's phones and hands.

Bacteria: Gram positive (GP)	**Phones N=50%**	**Hands N=50%**
Staphylococcus epidermidis	10 (20%)	10 (20%)
Staphylococcus haemolyticus	3 (6%)	3 (6%)
Staphylococcus warneri	1 (2%)	4 (8%)
Staphylococcus sciuri	3 (6%)	1 (2%)
Staphylococcus pasteuri	1 (2%)	0
Staphylococcus capitis	1(2%)	0
Staphylococcus cohnii	2 (4%)	2 (4%)
Staphylococcus lentus	2 (4%)	2 (4%)
Staphylococcus simulans	1 (2%)	0
Staphylococcus hominis	6 (12%)	6 (12%)
Staphylococcus aureus	5 (10%)	7 (14%)
Gardnerella vaginalis	1 (2%)	0
Bacillus cereus	3 (6%)	2 (4%)
Corynebacterium urealyticum	3 (6%)	3 (6%)
Gaffkya tetragena	1 (2%)	1 (2%)
Kocuria kristinae	1 (2%)	1 (2%)
Aerococcus viridans	0	1 (2%)
Leuconostoc lactis	1 (2%)	1 (2%)
Total	**90%**	**88%**
Bacteria: Gram negative (GN)	**Phones N=50%**	**Hands N=50%**
Tatumella ptyseos	2 (4%)	1 (2%)
Citrobacter youngae	1 (2%)	1 (2%)
Enterobacter cloacae	1 (2%)	0
Leclercia adecarboxylata	0	1 (2%)
pseudomonas aeruginosa	1 (2%)	1 (2%)
Chryseobacterium meningosepticum	0	1 (2%)
Aeromonas hydrophila	0	1 (2%)
Total	**10 %**	**12 %**
Total bacteria GN &GP	**100 %**	**100 %**

S. epidermidis was the most commonly isolated microorganism from mobile phones (20%) and hands (20%), followed by *S. hominis*, which had the same incidence (12%) in the mobile phones and hands, the presence of *S. aureus* (14%) in the hands was higher than in the mobile phones (10%). While *C. urealyticum* and *S. haemolyticus* are represented by (6%) in both mobile phones and the hands. Some isolated bacteria were more prevalent in the hands than on mobile phones, such as *B. cereus* (6%) in the mobile phones and (4%) in the hands; *S. warneri* (2%) in the mobile phones and (8%) in the hands; and *S. cohnii* and *S. lentus*, both represented by 4% in the mobile phones and hands. *S. sciuri*r is represented by 6 percent of mobile phones and (2%) of the hand. However, the percentage (2%) of isolated bacteria was equal in both mobile phones and person hands, as in the case of *S. pasteuri*, *S. capitis, S. simulans, L. lactis* and *G. vaginalis*. *K. kristinae* and *G. tetragena* were both (2%) in mobile phones and hands, and *A. viridans* was (2%) only in hands. In gram- negative bacteria, *T. ptyseos* is represented by (4%) in mobile phones and by (2%) in the hands. *P. aeruginosa, C. youngae* were both (2%) in the mobile phones and hands. *A. hydrophila, L. adecarboxylata* and *C. meningosepticum* were represented by (2%) only in the hand. *E. cloacae* was (2%) on mobile phones only.

3.3. Antimicrobial susceptibility testing:

For gram-negative bacteria, antibiotics which included 8 antibiotics were used show in **(Table 3)**. Most of the organisms isolated in the study were sensitive to most of the antibiotics that were used. For gram-positive bacteria of 13 antibiotics were used **(Table 4)**.

Table 3: Antimicrobial susceptibility patterns of gram-negative bacterial identified.

Antibiotic	*T. ptyseos*				*C. youngae*				*P. aeruginosa*			
	Phones n = 2		Hands n = 1		Phones n = 1		Hands n = 1		Phones n = 1		Hands n = 1	
	S	R	S	R	S	R	S	R	S	R	S	R
CHL	2	-	1	-	1	-	1	-	-	1	-	1
KAN	2	-	1	-	1	-	1	-	1	-	-	1
IPM	2	-	1	-	1	-	1	-	1	-	1	-
AMP	2	-	1	-	-	1	-	1	1	-	1	-
TET	1	1	1	-	1	-	1	-	-	1	-	1
GEN	2	-	1	-	1	-	1	-	1	-	-	1
CIP	2	-	1	-	1	-	1	-	1	-	1	-
SXT	2	-	1	-	1	-	1	-	-	1	-	1

CHL→ Chloramphenicol. KAN →Kanamycin. IPM → Imipenem. AMP → Ampicillin. TET →Tetracycline. GEN→ Gentamicin. CIP → Ciprofloxacin. SXT→ Sulfamethoxazole /trimethoprim. S; sensitive, R; resistant.

Table 4: Antimicrobial susceptibility patterns of gram-positive bacterial identified.

Antibiotic	***S.haemolyticus***				***S. warneri***				***S. sciurir***				***S. cohnii***				***S. lentus***			
	Phones n = 3		Hands n = 3		Phones n = 1		Hands n = 4		Phones n = 3		Hands n = 1		Phones n = 2		Hands n = 2		Phones n = 2		Hands n = 2	
	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R
AMC	-	3	1	2	1	-	4	-	2	1	-	1	2	-	2	-	-	2	2	-
AMX	2	1	2	1	1	-	3	1	3	-	1	-	1	1	2	-	1	1	2	-
AMP	-	3	-	3	-	1	-	4	-	3	-	1	-	2	2	-	-	2	-	2
P	-	3	-	3	-	1	-	4	-	3	-	1	-	2	1	1	-	2	-	2
CRO	1	2	1	2	1	-	4	-	1	2	-	1	1	1	-	2	1	1	2	-
CIP	3	-	3	-	1	-	4	-	1	2	1	-	1	1	2	-	2	-	2	-
CHL	2	1	3	-	1	-	4	-	1	2	1	-	2	-	1	1	2	-	2	-
ERY	-	3	-	3	1	-	3	1	1	2	1	-	2	-	2	-	-	2	2	-
GEN	3	-	3	-	1	-	4	-	1	2	1	-	2	-	2	-	2	-	2	-
SXT	2	1	3	-	1	-	4	-	1	2	1	-	2	-	1	1	1	1	2	-
LVX	3	-	3	-	1	-	4	-	1	2	1	-	2	-	2	-	2	-	1	1
TET	2	1	2	1	1	-	4	-	2	1	1	-	2	-	2	-	2	-	2	-
IPM	3	-	1	2	1	-	4	-	1	2	-	1	2	-	1	1	-	2	2	-

Antibiotic	*B. cereus,*				*C. urealyticum*				*K. kristinae*				*G. tetragena*				*L. lactis*			
	Phones n = 3		Hands n =2		Phones n =3		Hands n = 3		Phones n = 1		Hands n = 1		Phones n = 1		Hands n = 1		Phones n =1		Hands n =1	
	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R	S	R
AMC	-	3	1	1	-	3	-	3	1	-	1	-	1	-	1	-	1	-	1	-
AMX	-	3	-	2	-	3	-	3	1	-	1	-	1	-	1	-	1	-	1	-
AMP	-	3	-	2	3	-	-	3	1	-	1	-	1	-	1	-	1	-	1	-
P	-	3	-	2	2	1	-	3	1	-	1	-	1	-	1	-	1	-	1	-
CRO	-	3	-	2	-	3	-	3	-	1	-	1	-	1	-	1	1	-	1	-
CIP	3	-	2	-	1	2	1	2	1	-	1	-	1	-	1	-	-	1	-	1
CHL	3	-	2	-	3	-	3	-	1	-	1	-	1	-	1	-	1	-	1	-
ERY	3	-	2	-	-	3	-	3	-	1	-	1	1	-	1	-	1	-	1	-
GEN	3	-	2	-	-	3	2	1	1	-	1	-	1	-	1	-	1	-	1	-
SXT	1	2	-	2	-	3	-	3	1	-	1	-	1	-	1	-	1	-	1	-
LVX	3	-	2	-	-	3	-	3	1	-	1	-	1	-	1	-	1	-	1	-
TET	1	2	-	2	2	1	-	3	1	-	1	-	1	-	1	-	1	-	1	-
IPM	3	-	2	-	-	3	-	3	1	-	1	-	1	-	1	-	1	-	1	-

AMC →Amoxicillin- clavulanic acid. AMX →Amoxicillin. AMP → Ampicillin. P→ Penicillin. CRO → Ceftriaxone. CIP → Ciprofloxacin. CHL→ Chloramphenicol. ERY→ Erythromycin. GEN→ Gentamicin. SXT→ Sulfamethoxazole /trimethoprim. LVX →Levofloxacin. TET →Tetracycline. IPM → Imipenem.

All *S. aureus* isolates from hands and mobile phones were sensitive to imipenem and sulfamethoxazole/trimethoprim. They are also sensitive to amoxicillin-clavulanic acid, amoxicillin, and gentamicin, except one isolate was resistant in each case. The incidence of resistance strains of *S. aureus* to chloramphenicol and erythromycin was higher in samples of mobile phones and hands. Most isolated *S. aureus* were sensitive to ampicillin, penicillin, ciprofloxacin and levofloxacin except one isolate on a mobile phone and two at the hands and also sensitive to ceftriaxone and tetracycline except two and one isolate respectively on the hands. **(Table 5).**

Table 5: Antibiotic sensitivity patterns of *S. aureus* isolated from mobile phones and hands.

Antibiotic	Mobile phones (n=5)		Hands (n=7)	
	S	R	S	R
Amoxicillin-clavulanic acid	4	1	6	1
Amoxicillin	4	1	6	1
Ampicillin	4	1	5	2
Penicillin	4	1	5	2
Ceftriaxone	5	-	5	2
Ciprofloxacin	4	1	5	2
Chloramphenicol	1	4	5	2
Erythromycin	1	4	4	3
Gentamicin	4	1	6	1
Sulfamethoxazole /trimethoprim	5	-	7	-
Levofloxacin	4	1	5	2
Tetracycline	5	-	6	1
Imipenem	5	-	7	-

All isolates of *S. epidermidis* from mobile phones and hands were sensitive to ciprofloxacin and levofloxacin. Also, they were sensitive to amoxicillin- clavulanic acid amoxicillin, chloramphenicol, and sulfamethoxazole /trimethoprim except one strain was resistant in each case and two on the last. They were susceptible to erythromycin and imipenem except for two resistant strains on the mobile phones and one on the hands. There were many *S. epidermidis* isolates that resistant to penicillin, ampicillin and ceftriaxone with different incidence. Sensitive to gentamicin and tetracycline but resistant only one in each case for mobile phone only. The highest incidence of resistant strains was ceftriaxone resistant bacteria from personal hands and ampicillin resistant once isolated from a mobile phone. Twenty-five resistance *S. epidermidis* strains were that isolated from the mobile phones and twenty-three that isolated from the hands most of them were ampicillin, penicillin, and ceftriaxone higher than other antibiotics resistant **(Table 6)**.

Table 6: Antibiotic sensitivity patterns of *S. epidermidis* isolated from mobile phones and hands.

Antibiotic	Mobile phones (n=10)		Hands (n=10)	
	S	R	S	R
Amoxicillin- clavulanic acid	9	1	9	1
Amoxicillin	10	-	9	1
Ampicillin	3	7	5	5
Penicillin	5	5	7	3
Ceftriaxone	4	6	1	9
Ciprofloxacin	10	-	10	-
Chloramphenicol	10	-	9	1
Erythromycin	8	2	9	1
Gentamicin	9	1	10	-
Sulfamethoxazole /trimethoprim	10	-	8	2
Levofloxacin	10	-	10	-
Tetracycline	9	1	10	-
Imipenem	8	2	10	-

The isolates of *S. hominis* from hands and mobile phones were sensitive to ceftriaxone, ciprofloxacin, chloramphenicol, gentamicin and levofloxacin. Where are sensitive to amoxicillin- clavulanic acid and imipenem but was resisted on the hands only. The number of resistant strains of *S. hominis* was higher in samples isolates from mobile phones 17 than in samples isolates from the hands was equal 15. In both samples, data revealed that isolated six samples had resistance activity more than one antibiotic or sensitive to all tested antibiotics **(Table 7)**.

Table 7: Antibiotic sensitivity patterns of *S. hominis* isolated from mobile phones and hands.

Antibiotic	Mobile phones(n=6)		Hands (n=6)	
	S	R	S	R
Amoxicillin- clavulanic acid	6	-	5	1
Amoxicillin	4	2	6	-
Ampicillin	-	6	-	6
Penicillin	-	6	-	6
Ceftriaxone	6	-	6	-
Ciprofloxacin	6	-	6	-
Chloramphenicol	6	-	6	-
Erythromycin	5	1	5	1
Gentamicin	6	-	6	-
Sulfamethoxazole /trimethoprim	5	1	6	-
Levofloxacin	6	-	6	-
Tetracycline	5	1	6	-
Imipenem	6	-	5	1

4. Discussion

In this study, mobile phone use by many people have not only shown a high rate of bacterial contamination, but also, more importantly, contamination by nosocomial pathogens. The results showed that about 100% of individual's hands and 100% of their mobile phones had bacterial contamination, these result are similar with Ilusanya *et al.*, 2012 mention that the rate of bacterial contamination of food vendor's mobile phones was 100% and with Angadi *et al.*, 2014 90% of the mobile phones and hands of all 100% the health care workers were contaminated with organisms known to cause hospital acquired infections.

Coagulate-negative staphylococcus (CNS) most prevalent bacterial agent isolated from 100 (58%) mobiles and hands in this study, may account for high levels of bacterial pathogen contamination observed. This result agree with Karabay *et al.*, 2007 in which CNS was the most frequently encountered bacterial agent isolated from 68.4% of the subjects evaluated. Brady *et al.*, 2006 had shown that the combination of constant handling and heat generated by the phones creates a prime breeding ground for microorganisms that are normally found on our skin. This may be because the increase incidence of bacterial agents isolated from hands and mobile phones was attributed to the poor hygiene and the body temperature that is a suitable environment for these organisms.

This research has shown that CNS (58%) it was the highest percentage among types specifically *S. epidermidis* and *S. hominis*. This result is similar to Banawas *et al.*, 2018 who reported coagulase-negative staphylococci were the most frequently isolate bacteria among healthcare workers (60.5%), particularly *S. epidermidis* and *S. hominis*. It was determined that coagulase-negative staphylococci are responsible for blood infections, of which *S. epidermidis* causes 67% of infections and other coagulase-negative staphylococci cause 33% (Gatermann, Koschinski, and Friedrich, 2007). Also various sub-species of *S. hominis* had been implicated for nosocomial outbreaks causing bloodstream infections in patients with underlying malignancies (Roy *et al.*, 2014).

In the present study, *S. aureus* was isolated from mobile phones 5 (10%) and hands 7 (14%) These results converge to study carried out at King Abdul-Aziz University in Saudi Arabia, out of 105 cell phones screened, 17 (16.2%) mobile phones were found to harbor *S. aureus* (Zakai *et al*., 2016). *S. aureus* is an opportunistic bacteria, responsible for nosocomial and community infections (Lalaouna *et al.*, 2018). In addition, *S. aureus* can invade tissues and cause infections such as cutaneous abscesses, endocarditis, and septic shock (Lalaouna *et al.*, 2018).

As shown in **Table 4**, our antimicrobial susceptibility results indicate that most of the coagulase-negative staphylococci isolate from mobile phones and hands were resistant to erythromycin, ampicillin and penicillin was observed in *S. hominis, S. haemolyticus, S. warneri, S. sciuri*r, and *S. lentus.* Similarly, Morad et *al.*, 2016 reported that coagulate-negative staphylococci isolates from nosocomial bloodstream infections in Najran -Saudi Arabia- were highly resistant to penicillin and erythromycin. It has been believed that coagulase-negative staphylococci are important reservoirs of antimicrobial resistance genes and resistance-associated mobile genetic elements, which can be transferred between staphylococcal species. *S. hominis, S. epidermidis,* and *S. haemolyticus* are reported to be multiple drug resistant coagulase- negative staphylococci (Bouchami *et al*., 2011, Becker, Heilmann, and Peters, 2014).

In the present study, we showed some of the *S. aureus* strain sensitive to ampicillin this differ with a previous study in Nigeria revealed that 42% of *S. aureus* isolated from mobile phones of non-health care workers was resistant to ampicillin (Nwankwo, Ekwunife, and Mofolorunsho, 2014). The study also showed some strains of *S. aureus* sensitive to penicillin this contradicts with Chambers *et al.*, 2009 reported that penicillin developing resistance to *S. aureus* since the 1960 and some strains resistant to ciprofloxacin this differ with Deyno *et al.*, 2017 who reported the pooled prevalence of *S. aureus* resistance to ciprofloxacin was 19%.

5. Conclusions

This study showed microbial contamination on personal mobile phones and hands. Some of the contaminated mobile phones microorganisms (such as *S. aureus*) were epidemiologically important nosocomial drug resistant pathogens. These isolates of bacteria were resistant to commonly used antimicrobials such as chloramphenicol, erythromycin, and ciprofloxacin. These results showed that mobile phones and personal's hands were contaminated with various types of bacteria, which suggested that mobile phones (used by people in daily practice) may be a source of nosocomial infections. Users of mobile phone are hence advised to use antibacterial wipes to make their mobile phones germ free at all times.

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