Effectiveness of Disinfection with 70% Isopropyl Alcohol to Reduce Bacterial Contamination of Mobile Phones Carried by Medical Personnel in Baghdad Teaching Hospital

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Abstract

Mobile phones, despite their importance in daily life, can disseminate pathogens due to their frequent contact with hands. The purpose of the present study is to determine the prevalence of bacterial contamination on the mobile phones of healthcare personnel at the Baghdad Teaching Hospital, to identify the contaminating microorganisms, and to determine the preventive efficacy of 70% isopropyl alcohol. Sixty mobile phones from 40 physicians and 20 nurses were analyzed for microbial contamination. After collecting samples from each phone, they were disinfected with 70% isopropyl alcohol wipes and samples were recollected. Twenty four hours of aerobic and anaerobic incubation of agar plates at 37 °C. The results indicated that 34 (56.7%) out of 60 samples were contaminated with bacteria. Approximately 57.5% of the mobile phones used by physicians and 45% of those used by nurses contained microorganisms. Before disinfection, the most common bacteria found in mobile phones were coagulase-negative staphylococci, followed by *Staphylococcus aureus*, hemolytic (3.33%) and non-hemolytic (3.33%) Streptococci. While, *E. coli* and fungi contaminates were also found on mobile phone surfaces in equal percentage (6.67%). Following disinfection with 70% isopropyl alcohol, the number of bacteria was reduced to nil in 83.3% of the colonized mobile phones. This investigation demonstrated that commercially available, affordable and device safe wipes containing 70% isopropyl alcohol can significantly reduce mobile phone contamination. As a result, it is crucial for medical professionals to sterilize their mobile phones on a regular basis, as this can limit the dissemination of pathogens to patients and reduce the incidence of hospital acquired infections.

Keywords: 70% alcohol; mobile phones; disinfection; bacterial contamination.

1. Introduction

Mobile phones (MPs) have become a fundamental piece of the lives of healthcare professionals and have enhanced communication, collaboration, and data sharing (Chang *et. al*., 2017). With all the advantages of the Mobile phones (MP), it is simple to overlook the potential health risks it poses to its handlers (Rahangdale *et. al*., 2014). Although MPs are routinely placed in bags or pockets, they are frequently carried and held near the face (Smith and Sheridan, 2006). Mobile phones are capable of transmitting infectious diseases through their frequent contact with hands (Kilic

et.al., 2009) and have been described as microorganism reservoirs (Brady *et. al.*,2006). Mobile phones are related to nosocomial infections, this is especially true for the infections associated with the skin because of the moisture and optimum temperature of the human body particularly the palms (Tagoe *et. al*., 2011). In addition to the heat generated by MPs, these factors contribute to alarming levels of bacterial growth on the device. Considering repeated contact with the face, mouth, ears and hands, the terrible health hazard associated with using germ-invaded mobile devices are evident (Singh and Purohit, 2012).

Some reports indicate that health professionals' disregard for regular hand disinfection and inadequate hand washing practices allow bacteria to colonize their mobile phones and those of other individuals (Chang *et. al.,* 2017; Sepehri, 2009). In fact, hand-to-hand or hand-to-objects contact can transmit 80% of infections (Al-Ghamdi *et.al*., 2011). Even in the absence of direct contact with contaminated MPs, healthcare workers' (HCWs) colonized devices can transmit microorganisms to patients (Kilic *et.al*.,2009). Hospital-acquired infection (HAI) is a significant problem in hospitals that can result in an increase in morbidity and mortality (Plowman *et. al*., 2011). Recent data (Hacek *et.al*., 1999) indicate that the proportion of hospitalized patients with HAI is on the rise, with estimates ranging from 5 to 10 percent. HAIs can propagate via hospital staff and the environment, equipment, and devices that hospital staff uses (Kolmos, 2007). In the United States, HAIs cause about 2 million infections and are responsible for 100,000 deaths each year (Sprague, 2009). The cost of HAIs in 2002 was reported to be $6.7 billion (Gura, 2004), and increased in recent years to cost $20 billion yearly (Sprague, 2009). Nosocomial infections are associated with the emergence of antimicrobial resistance, which is a serious public health concern. Antimicrobial medications played a key role in limiting diseases caused by susceptible organisms, but the emersion of antimicrobial resistance, which is a profound public health problem, is associated with nosocomial infections. Certain pathogens have developed resistance to multiple antimicrobial medications, and infections caused by resistant bacteria are now widespread (Solomon and Oliver, 2014). It is estimated that approximately 33 percent of these infections can be avoided by adhering to standard infection control guidelines (Tekerekoğlu *et. al*., 2011).

The present research is intended to study the prevalence of certain bacterial contamination of mobile phones of medical staff working at various departments in Baghdad Teaching Hospital, to identify the contaminating micro-organisms and to find the preventive potential of 70% isopropyl alcohol.

2. Methodology

2.1 Sample Collection

From 15 to 28 July 2019, a cross-sectional investigation was conducted at the Baghdad Teaching Hospital. Using the technique of convenience sampling, samples were collected. All volunteers who participated in the current study provided verbal consent. Those with recent bacterial skin or any recurrent bacterial infections, and in contact with other patients suffering from contagious infections were excluded from the study. Before collecting samples, medical personnel were questioned about the sterilization methods used. Before interacting with patients, the majority of them used the hospital ward disinfectant (chlorhexidine), while others used hand sanitizer containing 70% ethanol. The samples were collected from the mobile phones of 40 resident and permanent physicians, and 20 nurses. Sixty mobile phones were sampled by rotating antiseptic cotton swabs over the six surfaces of each mobile phone, including the touch screen, home button, back, and the four sides. Each mobile phone was then thoroughly disinfected using disposable swabs

containing 70% isopropyl alcohol that were commercially available. After 3 minutes, the same control smear technique was repeated with a new sterile swab (Koscova *et.al*.,2018) Aimes' transport medium was used to preserve and transport all samples until laboratory culturing and identification.

2.1.1. Isolation and Identification

Blood agar, MacConkey agar, (Salucea/ Netherlands) and Gram stain (AFco, Jordan) were prepared in accordance with (Finegold and Martin, 1982). Inverted agar plates were stored in the refrigerator until use.

For culture, swabs were streaked on blood agar and MacConkey agar plates. Twenty four hours needed of both aerobic and anaerobic (jar) incubation of plates at 37 °C. Growth characteristics (shape and color) of colonies, hemolytic characteristics on blood agar, and Gram stain were used to identify bacteria.

Gram staining was utilized to distinguish Gram-positive from Gram-negative bacteria. For selective isolation of Staphylococcal bacteria, Staph 110 agar (Salucea/ Netherlands) and coagulase test were used, in which both show negative results in case of *Staphylococcus epidermidis* and positive results in case of *Staphylococcus aureus*, fungal growth in blood agar O2 was further identified under the microscope by wet mount preparation.

2.2. Statistical Analysis

The obtained data were analyzed using SPSS 21.0 (SPSS Inc., Chicago, USA). Wilcoxon's signed-rank test was utilized to compare the data sets. Fisher's exact test was utilized to determine if two variables were associated. $P \leq 0.05$ was considered to be statistically significant.

3. Results

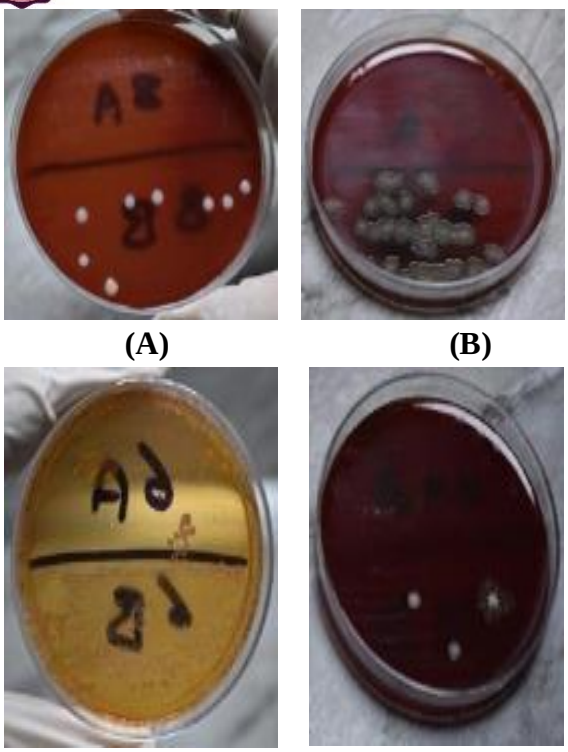
This investigation included the mobile phones of sixty health care professionals, including forty physicians and twenty nurses, 34 (56.7%) of the 60 samples were colonized. This difference was not statistically significant. The incidence of contamination fell within the range of 34% to 83% reported in the literature (Shakir *et.al.*, 2015; Soto *et.al.*, 2006).

The results as shown in Table-1 and Figure-1 revealed predominant Staphylococcal contamination. Before disinfection of mobile phases, coagulase negative *Staphylococci* (CoNS) were identified in (36.67 %) of the mobile phones whereas, *Staphylococcus aureus* was found to colonize (10%) the mobile phones surfaces, other Gram-positive bacteria were isolated included hemolytic (3.33%) and non-hemolytic (3.33%) Streptococci. While, both *E. coli* and fungi contaminates were also found on mobile phone surfaces in equal percentage (6.67%).

Table 1. Types of Bacteria Isolated from Mobile Phones under Study before and after Disinfection and Elimination of Contamination.

Type of organism	Before disinfection (n= 60), n (%)	After disinfection (n= 60), n (%)	Elimination of contamination (%)
CoNS	22 (36.67%)	2 (3.33%)	90.9%
Staphylococcus aureus	6 (10%)	2	66.6%
Streptococcus Spp.	4 (6.67%)	0 (0%)	100%
E. coli	2 (3.33%)	2 (3.33%)	0%
Fungi	2 (3.33%)	0 (0%)	100%

CoNS: Coagulase-negative Staphylococci



(A) **(B)**

(C) **(D)**

Figure 1. (A). Blood agar with CoNS isolated from mobile phone before (**lower**) and after (**upper**) Disinfection. **(B).** Blood agar with *Streptococcus* spp. isolated from mobile phone before (**lower**) and after (**upper**) disinfection. **(C).** MacConkey Agar with *E. coli* isolated from Mobile Phone before (**lower**) and after (**upper**) Disinfection. **(D).** Blood Agar Showing Fungal Growth with CoNS before (**lower**) and after (**upper**) Disinfection.

Following decontamination with 70% isopropyl alcohol wipes, the number of bacteria on (83.3%) of the colonized mobile phones was reduced to nil, a statistically significant difference ($p \leq 0.001$). The number of CoNS and *Staphylococcus aureus* was reduced by (90.9%) and (66.6%), respectively, after disinfection. Streptococcal and fungal contaminations were eliminated at the same rate (100%). In contrast, 70% isopropyl alcohol reduced, but did not completely eradicated *E. coli* colonies that contaminated mobile phones.

3. Discussion

The mobile phones became an essential device in people's everyday life. These phones are considered as a reservoir for potential pathogenic multidrug resistant microorganisms as any other object in hospitals and of medical staff. Mobile phones contamination may occur through un-sanitized hands of doctors and nurses after examination of patients and administration of medications to patients respectively. Soto *et. al.*, (2006) study showed that mobile phones of medical staff were contaminated by hands, bags, pockets, food and environment.

Coagulase-negative Staphylococci (CoNS) bacteria are a normal component of the skin's flora and the leading cause of nosocomial bacteremia and intravascular catheter infections (Mermel *et.al.*, 2009). Additionally, these bacteria were the most frequently isolated organisms in experiments conducted by (Koscova *et.al*., 2012; Murgier *et.al*.,2016; Chang *et.al*.,2017; Bodena *et.al*.,2019; Pal *et.al*.,2015) showed (80%), (81%), (65%), (58.7%) and (81%) incidence respectively of total isolates. Bacteria like *S. aureus* and CoNS are resistant to dry conditions and flourish in warm environments, such as mobile phones (Trivedi *et.al*., 2017). The high temperature and humidity produced by mobile phones promote the growth and formation of biofilm on the surface of the device. Biofilm bacteria can remain infectious for a couple of weeks (Hassan *et. al.*, 2004). Previous studies revealed similar results of isolated microbes varying in the percentage of total isolates. Study done by (Koscova *et.al*., 2008) showed *S. aureus* (4%), Streptococcus Spp. (12%), Enteric bacteria (64%), and moulds (12%) while (Murgier *et.al*.,2016) showed fungi (6%) and other types of bacteria that were inconsistent with the current study, (Chang *et.al*., 2017) showed *S. aureus* (7%), Streptococcus Spp. (13.8%), *E. coli* (0%) and fungi (0%), (Bodena *et.al.*, 2019) showed *S. aureus* (13.7%), Streptococcus

Spp. (5.7%), *E. coli* (6.19%) and fungi (0%).

In this study, isopropyl alcohol (70%) eliminated the vast majority of isolated bacteria (83.3%), with the exception of *E. coli*. The result is similar to (Singh *et. al.*, 2010), used 70% isopropyl alcohol wipes and exposed the mobile phones for 10 minutes before taking samples, which showed (87%) reduction of bacteria. On the other hand, use of Chlorhexidine and Triclosan by (Koscova *et. al.*, 2018), showed an overall (0%) elimination of microorganisms in (60.9%) of mobile phones in 5 minutes exposure.

In the current study, disinfecting mobile phones of medical staff using (70%) isopropyl alcohol showed (100%) elimination for Streptococcus Spp. and fungi and these outcomes agree with findings by (Koscova *et.al*., 2018) that showed complete elimination of these microorganisms isolated from computer key board using chlorhexidine digluconate and triclosan. Another study conducted by (Palaniswamy *et.al.*, 2018) revealed significant ($P \leq 0.0001$) reduction in microbial load of mobile phones of endodontist and general dentists using titanium dioxide nanoparticle spray. The present study, CoNS and *S. aureus* showed (90.9%) and (66%) elimination respectively. These results are similar to (Koscova et. al., 2018) showing (63.2%) and (60.0%) elimination for CoNS and *Staphylococcus aureus* respectively.

E. coli was not eliminated by the 70% isopropyl alcohol while enteric bacteria were (100%) eliminated by Chlorhexidine and Triclosan in a study done by (Koscova *et.al.*, 2018) which disagrees with our result. Isopropyl alcohol is known to be bactericidal for *Escherichia coli* with its germicidal effect starting from 10 seconds of disinfection (Rutala and Weber, 2008). Accordingly, in order to fully eliminate *Escherichia coli* colonies, the concentration and exposure time should be increased, but considering the special properties of isopropyl alcohol, concentration cannot be increased (Ribeiro *et.al.*, 2015). One limitation of the study is that the disinfection is subjected to many factors including size of inoculum and location of microorganisms, concentration and potency of disinfectants, inherent resistance of the organism, organic and inorganic material, physical and chemical elements, length of exposure and biofilms (Favero and Bond, 1991; Spaulding, 1968).

Conclusion

Mobile phones are widely used by HCWs. These devices may contribute to the spread of infectious diseases particularly HAIs. In this study, many types of microorganisms were found to contaminate MPs under study. The alcohol showed no obvious elimination effect after disinfection but, it may have reduced the bacterial count. However, as the samples were not quantified in this study, the number of bacteria reduced cannot be calculated.

This investigation demonstrated that commercially available, affordable and device safe wipes containing 70% isopropyl alcohol can significantly reduce mobile phone contamination. As a result, it is crucial for medical professionals to sterilize their mobile phones on a regular basis, as this can limit the dissemination of pathogens to patients and reduce the incidence of hospital acquired infections.

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فعالية التطهير بكحول الأيزوبروبيل ٧٠% في تقليل التلوث البكتيري للهواتف النقالة التي يحملها الطاقم الطبي في مستشفى بغداد التعليمي

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الخلاصة

الهواتف المحمولة، على الرغم من أهميتها في الحياة اليومية، يمكنها نشر مسببات الأمراض بسبب ملامستها المتكررة للأيدي.الغرض من هذه الدراسة هو تحديد مدى انتشار التلوث البكتيري على الهواتف المحمولة للعاملين في الرعاية الصحية في مستشفى بغداد التعليمي، وتحديد الكائنات الحية الدقيقة الملوثة، وتحديد الفعالية الوقائية لكحول الأيزوبروبيل ٧٠٪. تم تحليل ستين هاتفًا محمولًا لـ ٤٠ طبيبًا و٢٠ ممرضة بحثًا عن التلوث الميكروبي. بعد جمع العينات من كل هاتف، تم تطهيرها بمناديل كحول الأيزوبروبيل بنسبة ٧٠% وتم جمع العينات. أربع وعشرون ساعة من الحضانة الهوائية واللاهوائية للاطباق الزرعية عند ٣٧ درجة مئوية. أشارت النتائج إلى أن ٣٤ (٥٦,٧%) من أصل ٦٠ عينة كانت ملوثة بالبكتيريا. حوالي ٥٧,٥% من الهواتف المحمولة التي يستخدمها الأطباء و٤٥% من الهواتف المحمولة التي يستخدمها الممرضون تحتوي على كائنات دقيقة. قبل التطهير، كانت البكتيريا الأكثر شيوعًا الموجودة في الهواتف المحمولة هي المكورات العنقودية السلبية المخثرة، تليها المكورات العنقودية الذهبية، والمكورات الحالة للدم (٣,٣٣%)، والمكورات العقدية غير الحالة للدم (٣,٣٣%). بينما وجدت أيضاً ملوثات الإشريشيا كولاي والفطريات على أسطح الهواتف المحمولة بنسبة متساوية (٦,٦٧%). بعد التطهير. بكحول الأيزوبروبيل بنسبة ٧٠%، انخفض عدد البكتيريا إلى الصفر في ٨٣,٣% من الهواتف المحمولة الملوثة. أظهر هذا البحث أن المناديل المبللة المتوفرة تجاريًا وبأسعار معقولة وآمنة على الأجهزة والتي تحتوي على ٧٠% من كحول الأيزوبروبيل يمكن أن تقلل بشكل كبير من تلوث الهاتف المحمول. ونتيجة لذلك، فمن الأهمية بمكان أن يقوم العاملون في المجال الطبي بتعقيم هواتفهم المحمولة بشكل منتظم، لأن هذا يمكن أن يحد من انتشار مسببات الأمراض للمرضى ويقلل من حدوث العدوى المكتسبة من المستشفيات