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Review article

Prevalence and inherent factors in the bacterial contamination of the mobile phones of health workers: Literature review

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ABSTRACT

Background: Bacterial contamination of mobile devices could be a major problem for global health systems. The objective of the present study is to describe the factors inherent in the process of bacterial contamination of mobile phones of healthcare workers. Our research is a literature review based on the common results of studies carried out between 2009 and 2019. Its global vision resulting from analyzes of isolation of bacteria according to standard microbiological methods. The bibliographic analysis showed a contamination rate, of mobile phones of healthcare workers, varies between 36% up to 100%. The most common isolate was coagulase negative *staphylococcus* (CNS) (29%), followed by *staphylococcus aureus* (SA) (25%), *Bacillus* (14%), methicillin resistant *staphylococcus aureus* (MRSA) (12%), *streptococcus* (10%) and others (10%). Cell phones are rarely cleaned and are always in contact with the hands and different parts of the face as well as work benches, which facilitates the transmission of infections in and out of the hospital. Therefore, it is difficult to prevent the use of mobile phones but with the danger that involves their uses, it is necessary to inform health personnel about the means of prevention and to make them aware of this danger and to explain the interest in modifying their behavior towards these devices.

Introduction

Despite improvements in modern therapies, infections associated with health care remain a critical and costly problem in health systems. Globally, the source is defined by the transfer of microorganisms between clinicians, patients, devices and general surfaces. In contrast, innovation in mobile communication technology has provided new approaches for the delivery of health care as well as improvement in the speed and quality of routine medical communication.

However, bacterial contamination of mobile devices could be a significant problem affecting the implementation of effective infection control measures and could impact efforts [1].

Indeed, according to studies by **Bodena et al.** and **Nwankwo et al.**, the mobile phones of healthcare workers could be colonized by potential pathogenic bacteria [2,3]. The prevalence of bacterial contamination of phones among healthcare professionals ranges from 94.5% to 100%. They

shared their phones with other colleagues and answered calls while looking after patients.

The cell phone represents a major and essential tool for the flow of medical information in hospitals. A tool is considered one of the most indispensable accessories in professional and social life, and an important means of communication worldwide, easily accessible, economical and user-friendly [4,5,6]. It is widely used by health workers in all departments. With all these achievements and benefits, it is easy to ignore its health hazard [7]. Almost all healthcare workers use cell phones and the majority of them use them for calls, while others use them to send messages or do research. Most clinicians have admitted that they use their cell phones all the time as pathogens from patients can be transmitted to their cell phones during use which increases the risk of infection [8].

The use of cell phones by healthcare workers increases the risk of repetitive cyclic contamination in the hands and face (e.g. nose, ears, and lips) [9,10,11]. A difference in personal hygiene and behavior can further contribute to the increased risk [12]. Their use in hospital settings serves as a potential vehicle for the spread of nosocomial pathogens, including multidrug-resistant pathogens like methicillin-resistant *Staphylococcus aureus* [3,13,14]. The 2015 study by **Ulger et al.** suggested that in daily routines, the hands of health workers are often contaminated with pathogens. In hospital settings, microorganisms can be transferred from person to person or from the environment to people and vice versa. Several studies have shown that certain tools that are commonly used by health workers, namely keyboards, computers, pens, patient records, mobile phones, thermometers and stethoscopes are a source of transmission of nosocomial infections [15,16,17]. Consequently, these nosocomial infections not only lead to morbidity and mortality, but beyond that, to an increase in health costs. According to several studies, inadequate hand hygiene can allow hand transfer [11,18].

This problem was confirmed during a study carried out in Morocco on the bacterial flora contaminating the mobile phones of health workers in the laboratory of the Mohammed V Military training hospital in Rabat [11]. The study on the comparison between the bacterial flora in health personnel and a control population, revealed that the rate of bacterial contamination of all mobile phones

was 100% among health personnel. The bacteria isolated were coagulase negative *staphylococcus* (CNS) at 50.7%, *S. aureus* (18.1%), *Corynebacterium* species (18.8%), *Bacillus* species (3.1%) and others accounted for 2.2% [11].

Some bacteria can be commensal, opportunistic or pathogenic. In humans, the symptoms of a bacterial infection are expressed by a rash, cough, runny nose, tearing, fatigue, nausea, fever and muscle pain. Sometimes they are fatal. These infections can be treated with the use of antibiotics. We can distinguish two large groups of bacteria according to the result of the Gram staining, of which there are Gram positive bacteria and Gram negative bacteria [19].

This issue has been identified during our professional experiences in laboratories in Marrakech (Morocco) which prompts us to ask the following question: What are the factors inherent in the bacterial contamination of cell phones by health personnel in hospitals?

To answer this question, bibliographical research was carried out, sifting all the articles published between 2009 and 2019 on contamination of cell phones by health personnel, by using

Prevalence of contamination of mobile phones used by healthcare personnel

A series of studies including the terms mobile phones, bacterial contamination and hospital environment are included. Thus, according to several studies carried out between 2009 and 2019 to examine bacterial contamination of healthcare personnel's mobile phones. The contamination rate was between 30% to 100% by different bacteria which can cause nosocomial infections. The results varied depending on the services, hospitals and regions where the studies were carried out (**Table 1**).

However, cell phones, which can be a potential source of contamination, have been little studied in Morocco but their use has not been subjected to recommendations (one study). An analysis of the literature on this subject confirmed the high rate of contaminated cell phones, of which it represented 91.7% in the study by **Bhoonderowa et al.** [20], 94.5% was demonstrated by **Ulger et al.** [12], 98% by **Singh et al.** [21] and **Shakir et al.** [22], and even 100% was confirmed by the work of **Selim et al.** [13], which is comparable to the results of a study carried out in Morocco representing the same 100% contamination rate [11].

Germs identification on mobile phones used by healthcare personnel

An identification of the most responded isolated bacteria identified according to the analysis of the studies taking into consideration the year of study, the country, the rate of bacterial contamination.

It should be noted that the most common isolate was coagulase negative *Staphylococcus* (CNS) followed by *Staphylococcus aureus*, Methicillin resistant *Staphylococcus aureus* (MRSA) and *Bacillus sp* (Table 1).

It is also well known that microorganisms like *S. aureus* and CNS are drought tolerant and thus can survive and multiply rapidly in hot environments like cell phones [23]. This pathogen is of greatest concern because of its virulence, its ability to cause a variety of life-threatening infections, adapt to different environmental conditions [24]. According to studies by Centers for Disease Control and Prevention (2013) and **Daoudi et al.**, resistance to one or more antimicrobials is the most serious for the health of patients [25,26]. The study by **Uwingabiye et al.** showed that for the eradication of coagulase-negative *Staphylococci*, the highest rate of resistance was detected to oxacillin [11]. Thus, a rapid assessment of this problem can prevent the spread of these agents which prove their health dangers.

Factors associated with cell phone contamination in hospitals

The most studies investigated the relationship between age, gender, frequency of phone use, and type of phone; however. The observed variation (30% -100%) was due according to several studies to the difference in the training concerning the prevention of infections, the frequency of cleaning mobile phones during working hours, the practice of hand washing, the model and the policy on the use of mobile telephones in hospitals, as well as sensitization of health personnel on the role of mobile telephones in the transmission of infections (Figure 1).

Studies have shown the correlation between germs on cell phones and on their owner's hands [21,27]. Indeed, It was reported that in 94.3% of study staff for whom bacteria were detected on their cell phones the same bacteria were detected in the nostrils or hand of which *Staphylococcus aureus* (SA) was the most commonly encountered clinical pathogen, which results in colonization of the nasal

nostrils of medical personnel being transmitted to parliamentarians through the hands. Hand washing is important as long as healthcare professionals are in contact with contaminated areas and cell phones. 45% of HCWs said they never washed their hands before and after using their devices [28], while 38% responded occasionally and 17% said they "always" wash their hands before and after using cell phones [29]. The duration of hand washing is also important, 30 seconds allowing the elimination of transient flora, but not five seconds [30].

The study of **Bodena et al.** showed that half of the participants in his study had no training in infection prevention; 69% of them did not have an infection prevention manual in their work area [2]. **Mark et al.** showed that some health workers no longer knew that cell phones were contaminated, 65% of people questioned in a study believed that there would be contamination on their phone, 10% were convinced that their phones would not carry bacteria, so that 25% are uncertain [29]. From these results, it is evident that training of healthcare personnel in strict infection control procedures, hand hygiene, environmental disinfection and ultimately, optimal disinfection methods is of great importance [12]. The product used for disinfection of cell phones must reduce the bacterial load without affecting the latter. **Singh et al.** used wipes with a concentration of 70% isopropyl and let the device sit for 10 minutes before taking samples [21]. They obtained a reduction in the bacterial load of about 87% but without information on the safety of the device. Likewise, **Shakir et al.**, used towels with an alcohol concentration of 32% combined with local detergents [22]. This towel, which is not likely to damage cell phones, was passed over the device and significantly reduced the bacteria rate from 83% to 8%. With a higher rate in the study of **Uwingabiye et al.** [11]. Disinfection of the telephone covers with a hydro-alcoholic solution reduced the number of colonies to 99.5%. It was active on all of the bacteria isolated, with a rate of colony reduction after decontamination which is slightly high (99.6%).

It is difficult to conclude on the ideal decontamination protocol but it is interesting to note in the study by **Shakir et al.** [22]. that the contamination rate rose to around 75% one week after decontamination, hence the benefit of performing this procedure very regularly (several times a week and why per day).

Occupation is one of the factors associated with contamination depending on the work area, the

sensitivity of this area and the way healthcare workers work. Laboratory technicians have the highest risk of contamination since they are in direct contact with bacteria, with neglect of this danger, regular decontamination and use of cell phones in the laboratory has been confirmed [2]. And who find that all these devices worn by laboratory personnel were contaminated by bacterial agents, but he does not deny medicines and other health care providers, The distribution of cell phones contamination according to the departments was significant in some studies and not in some others. The Moroccan study demonstrated that there was no significant difference between the prevalence of bacteria isolated according to clinical services and the function of health personnel, but there is a difference in the rate of isolation of bacteria depending on the type of the phone cover (metal + plastic) [11].

At the same time, the mixed infection was found more among laboratory technicians followed by doctors and nurses. Laboratory technicians are often exposed to a wide variety of pathogenic and multi-resistant microorganisms when handling different types of specimens in their work. In the study by **Tambe et al.** the isolation of bacterial flora was seen to a greater extent among laboratory technicians compared to nurses and physicians [31].

The cell phones of male health professionals were more contaminated. This is similar to a study conducted in Ethiopia and in Iran [2,32]. However, this contrasts with the findings of **Pal et al.**, and **Shooriabi et al.** who reported no such sexual association [8,33]. The difference could be due to a woman's habit of keeping her mobile phone in a purse and using it frequently in the hospital. This is also what **Bodena et al.** in their study where most women (66.7%) did not use their mobile phone in a hospital environment [2]. Otherwise, age is

considered an inherent factor in contamination. In fact, the proportion of contamination by cell phones was higher in the 25-29 age group (47.4%), although the 20-24 group had the lowest rate (16.8%) [2].

Recommendations

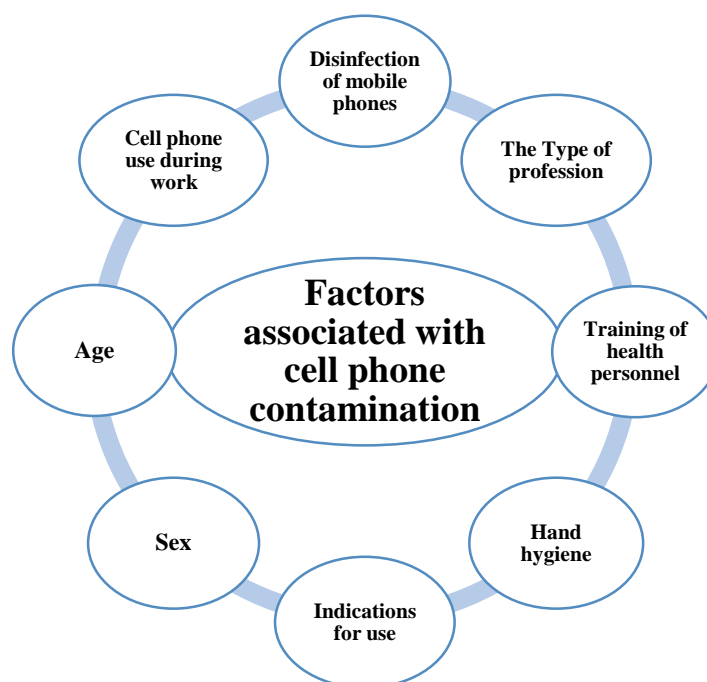
In the light of the results of this study, we offer recommendations for all stakeholders in the process of contamination of cell phones of health workers. These recommendations can be successful if they are part of a movement and dynamic of change, with the mobilization of all those responsible, whether they are individuals or institutions.

Several recommendations are possible, but we have cited those that are priority, practical and achievable:

- Inform health personnel about means of infection prevention in the hospital, especially at the level of infectious disease departments.
- Advise to make a manual of disinfection of devices susceptible to contamination.
- Advise to ensure cleaning before and after using mobile phones on a daily basis.
- Control the sharing of mobile phones between staff and departments.
- Show that the transport of mobile phones with the materials used for patient care is a risk of sharing pathogens.
- Require staff to use alcohol-based antiseptics for cleaning.
- Reinforce staff to disinfect their phones before leaving the hospital environment.
- Improve and enforce usage and cleaning processes by the managers of each service.

Table 1. Contamination of mobile phones by health workers in the literature (2009-2019).

Reference	Service or Hospital	Country	Prevalence (%)	Bacteria isolated
Gallazi et al. [34]	Tertiary-level intensive care unit	Italy	100	Methicillin-resistant staphylococcus aureus (MRSA), Bacillus, staphylococcus (CNS)
Bodena et al. [2]	Hiwot Fana Specialized University Hospital	Ethiopia	94.2	staphylococcus (CNS), S. aureus, streptococcus
Chang et al. [27]	Operating room	Taiwan	94,3	S.aureus
Kanishtha et al. [35]	Government Medical College, Jammu	India	60	S.aureus, staphylococcus (CNS), Pseudomonas, E.coli
Murgier et al. [36]	Orthopedic surgery room	Kuwait	94	staphylococcus (CNS), Corynebacterium, Bacillus
Shadi z et al. [37]	King Abdulaziz University, Jeddah	Saudi Arabia	96,2	staphylococcus (CNS), S.aureus, Bacillus,
Pal et al. [38]	Tertiary care centre of eastern India	India	82	Methicillin-resistant staphylococcus aureus (MRSA), S. aureus, staphylococcus (CNS), E. coli
Uwingabiye et al. [11]	Military Hospital Mohammed V in Rabat	Morocco	100	Streptococcus (Streptocoque), Proteus, Staphylococcus epidermidis
Chao et al. [39]	Regional Australian hospital	Australia	92,4	staphylococcus (CNS), Bacillus
Bhoonderowa et al. [20]	Volunteers in the community	USA	91,7	staphylococcus (CNS), Micrococcus, klebsiella
Mark et al. [29]	Surgical wards	UK	60	Streptococcus (Streptocoque), staphylococcus (CNS)
Nwankwo et al. [3]	Hospital in Anyigba, Kogi state	Nigeria	94,6	S.aureus, staphylococcus(CNS), Corynebacterium
Rana et al. [7]	Alexandria University Students' Hospital	India	30	S.aureus, staphylococcus (CNS), E.coli
Lee et al. [40]	Three teaching hospitals in South Korea	Kouria	100	staphylococcus (CNS), Acinetobacter, Enterobacter
Tambe et al. [31]	Health care personnel	India	82,5	S. aureus, Micrococcus
Trivedi et al. [23]	Operating room (OT), in the intensive care unit	India	46,6	S. aureus, methicillin-resistant staphylococcus aureus (SARM), staphylococcus (CNS)
Tagoe et al. [41]	Campus of University of Cape Coast	Ghano	100	Bacillus, S. aureus
Al Abdalall et al. [42]	Dammam city, Eastern Saudi Arabia	Saudi Arabia	100	Staphylococcus aureus, Staphylococcus epidermidis
Ustun et al. [10]	Secondary referral hospital	Turkish	97,8	S. aureus, methicillin-resistant staphylococcus aureus (MRSA)
Singh et al. [21]	Clinics of an Indian dental school	India	98	Streptococcus faecium (Entérocoque), Pseudomonas, methicillin-resistant staphylococcus aureus (MRSA)
Ulger et al. [12]	Operating room and intensive care unit	Turkish	94,5	S. aureus, staphylococcus (CNS)
Sepehri et al. [43]	Three teaching hospitals in Kerman, Iran	Iran	32	S. epidermidis, S. aureus

Figure 1. Factors associated with cell phone contamination in hospitals

Conclusion

Mobile devices will always be part of clinical medicine and healthcare facilities, but there will always be a risk of cross-contamination of the latter. The use of mobile phones in hospitals presents a risk of transmission of around ten microorganisms, thus presenting a risk of infection for health personnel, even for their colleagues in the services, their family members and in particular hospitalized patients.

The present study was intended to show that several factors are linked to cell phone contamination including the habit of cleaning phones and hands, cell phone sharing and lack of training are implicit in bacterial contamination. Better awareness of health personnel on the value of modifying their behavior towards these telephone devices and adequate training on preventive means will be desirable to reduce the risks of bacterial contamination.

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