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Use of Smartphones in Hospital Environment. Evaluation of Bacterial Flora in Three Sectors of the Hospital

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1. Abstract

1.1. Introduction: Smartphones are items of great handling during the hospital workday. Biosafety is compromised by its use, since they come into frequent contact with the hands of professionals. Often, they are left on surfaces of different sectors in the same day, being able to transfer microorganisms. The hypothesis formulated for the work was that the evaluation of the microbiota found in the culture coming from the surface of smartphones belonging to professionals in these sectors could reveal pathogenic potential.

1.2. Method: Observational, cross-sectional study, based on the collection of biological material from the smartphones surface of employees from sectors with influence on the infection rate of surgical patients. It was performed in the operating room, ICU and CME of Hospital de Clínicas de São Bernardo do Campo. RODAC plates filled with TSA (Triplice Sugar Agar) medium were used to collect the specimen from the surfaces. Data analysis was performed with Microsoft Excel 2016 and Prism 8.2.1 (GraphPad Software, Inc. 2019). Prevalence data were described in absolute numbers and percentages. The analysis of bacterial types in each hospital sector and by profession was performed using the chi-square test.

1.3. Results: 56 samples were collected, covering different professions. The contamination rate of smartphones was 94.6%. Eighteen microorganisms have been isolated and some of them are potentially opportunistic pathogens. A potentially pathogenic opportunistic bacterium was isolated in 25% of electronic devices. The difference in the microbiota found in the CC, ICU and CME had a p-value=0.57. The assessment of the professionals most likely to contaminate surgical patients had a p-value=0.72.

1.4. Conclusion: The use of smartphones by health professionals working in the perioperative sectors demonstrated a high rate of contamination with opportunistic pathogens, with no nosocomial germs being found. Among the microorganisms found, 3 of them were not part of the human microbiota. Indication that the greatest contamination is due to poor personal hygiene when compared to that carried out after handling patients colonized by pathogenic germs. The professional classes and the different sectors did not seem to influence the spread rate of the microorganisms. However, personal hygiene represented a probable need for improvement.

2. Introduction

Nosocomial infections have always been a serious problem in hospitals and health centers [1]. The handling of contaminated personal objects often contributes to the perpetuation of this situation. Sem-

melweis in 1861 had already observed the transmission of bacteria to patients through the contaminated hands of health professionals [2]. Smartphones are projected as items of great handling during the workday of employees in any hospital environment: today, research is carried out on bases for conduct, information sharing, calculations, online case discussions with multidisciplinary teams from others centers and even from other countries or, simply, to facilitate personal communication [3, 4].

In hospitals, this widespread use of cell phones was configured as an important aid in conducting conduct; since a wide variety of data, images and results are available in real time, becoming a tool in healthcare professionals' hospitals. Disadvantages of the continuous use of cell phones include the volatility of information, dispersion of professionals in tasks that require concentration, dependence on devices to perform tasks that previously did not need these to be performed. This way, health professionals spend much more time handling these devices and transporting them to different hospital environments throughout the day.

Biosafety is another area compromised by the use of cell phones, since they come into frequent contact with the hands of professionals and are not always sanitized. In addition, they are left on surfaces in different sectors in the same day, allowing the transfer, from one place to another, of microorganisms that can lead to the development of infections in patients or the contamination of materials and supplies [3, 5].

The Surgical Center (SC) is seen as one of the places with the highest standard of hygiene within the hospital. Thus, it is assumed that the same requirements cover the workers who attend it and the equipment used in the sector [6]. Despite the high potential for transmitting possible pathogens through the handling of smartphones, there is still no consensus on the development of hygiene protocols for these devices in order to meet biosafety requirements in each hospital unit [7]. In a study carried out in an English teaching hospital, it showed that cell phones were used by 64% of doctors working in high-risk hospital areas, such as operating rooms and Intensive Care Units (ICU) [5].

The risk of infection involved in the use of electronic devices in operating rooms and other places related to perioperative care has not yet been determined, but it is known that the bacterial flora that inhabits its surface is diverse. Several types of microorganisms have been isolated by culture [7].

The main objective of this study was to analyze the cell phone flora of the professional teams of a hospital of Brazilian Health System (SUS) through the identification of microorganisms in three environments: SC, ICU, and Sterile Materials Center (SMC). The secondary objective was to identify the sector to which the devices with the greatest potential for patient contamination belong and whether the microbiota found could reveal pathogenic potential for patients.

3. Methods

This study was carried out in accordance with the Research Norms involving Human Beings (Rs. CNS 196/96) of the National Health Council, after being registered at Plataforma Brasil and approved by the Research Ethics Committee, and signing the Free and Informed Consent Form.

This is an observational, cross-sectional study, based on the collection and microbiological analysis of material from the surface of smartphones of employees from sectors involved in perioperative care and that, therefore, could directly or indirectly influence the infection rate of surgical patients.

The study was carried out by collecting samples of the surface of smartphones belonging to employees of the sectors of the Surgical Center (SC), Intensive Care Unit (ICU) and Sterile Material Center (SMC) of the Hospital of Brazilian Health System (SUS) recently accredited by the Canadian company Qmentum. Among the professionals, there were doctors, nursing technicians, nurses, radiology technicians, electronic technicians, officers, instructors, physiotherapists, nutritionists, pharmacists and cleaning assistants.

To calculate the sample size, the value of $\propto = 0.05$ was fixed and an estimate error of approximately $\varepsilon = 0.10$. Assuming that the number of employees per day is approximately 150 individuals of all specialties, the sample size of 59 people was obtained. So we added one more professional and 20 professionals from each sector were studied, being 20 SC, 20 ICU, and 20 SMC. The subjects were not randomized due to the unavailability of a previous list of professionals from the three sectors. In each of the three sectors studied, cell phone collections were carried out in an entire afternoon, in order to respect the sample size on the same day.

The exclusion criterion was only the refusal of the employee to participate in the research. The respondent's profession was taken into consideration to subdivide the research findings.

The sample collection of the microbiology of the surface of the smartphones was pressed directly to the previous region of the cell phones where the owner made greater handling in RODAC plates filled with Triplice Sugar Agar (TSA) medium were used to collect the specimen, being pressed directly to the region before. Each RODAC plate was 25 cm2 and allowed the counting of colonies of each isolated microorganism, the examination being carried out by the hospital´s laboratory, without knowing the origin from which it came. Subsequently, they were placed for incubation in an at 36º C for 18 to 24 hours. The bacterial groups were grouped into opportunistic pathogenic microbiota and non-pathogeni microbiota.

Data analysis was performed with Microsoft Excel 2016 and Prism 8.2.1 (GraphPad Software, Inc. 2019). Prevalence data were described in absolute numbers and percentages. The analysis of bacterial tyes in each hospital sector and by profession was performed using the chi-square test.

4. Results

Of the total of 60 employees from the three sectors, four from SMC refused to participate in the study. The 20 from SC and 20 from ICU participate in the study. The list of the varios professionals in each sector is shown in (Table 1). No physician was found at SMC.

The rate of bacterial or fungal contamination of cell phones was 94.6%. Three cells did not show colony growth during culture. Eighteen microorganisms were isolate (Table 2) and some of them are described as potentially opportunistic pathogens (Figure 1), although most are present in the human microbiota in the airways and oral, intestinal or urethral mucous membranes. The same potentially pathogenic opportunistic bacteria were isolated in 25% of electronic devices (Figure 1).

Among the microorganisms found in this study, three bacterias had a higher prevalence in the number of smartphones studied (Figure 2), as well as in each sector individually researched (Figure 3). The Chi-square test suggests that there are no differences between the prevalence of types of pathogens between different sectors (SC, ICU, SMC), with a p-value equal to 0.05 (Figure 3).

The professional classes with the greatest representativeness in the research were nursing technicians and doctors. The evaluation of the professionals most likely to contaminate surgical patients is shown in (Figure 4), and there is no significant difference (p-value = 0.2801).

Table 1: Professionals participating in the study

PROFESSIONALS	SC = 20	IUC = 20	SMC = 16
Physician	9	5	0
Nurse	2	3	0
Nursing Technician	4	7	9
Pharmacist	2	1	0
Radiology Technician	1	0	0
Physiotherapist	0	2	0
Instrumentation	0	0	4
Nutritionist	0	1	0
Official Secretary	1	1	0
Electronic Technician	1	0	0
Cleaning Assistant	0	0	3

SC=Surgical Center
ICU=Intensive Care Unit
SMC= Sterile Material Center

Table 2: Microorganisms isolated on the surface of smartphones

1	Staphylococcus epidermidis
2	Bacillus sp.
3	Corynebacterium sp. (not diphteriae)
4	Demabacter hominis
5	Kytococcus sp
6	Kocuria sp.
7	Macrococcus sp.
8	Micrococcus luteus
9	Neisseria sp. (not meningitidis)
10	Penicillium sp
11	Staphylococcus haemolyticus
12	Staphylococcus capitis
13	Staphylococcus sp (non-lugdunensis coagulase-negative)
14	Rhodotorula sp.
15	Streptococcus sp. grupo viridans
16	Staphylococcus hominis
17	Streptococcus sp. Group D (not Enterococcus)
18	Moraxella sp

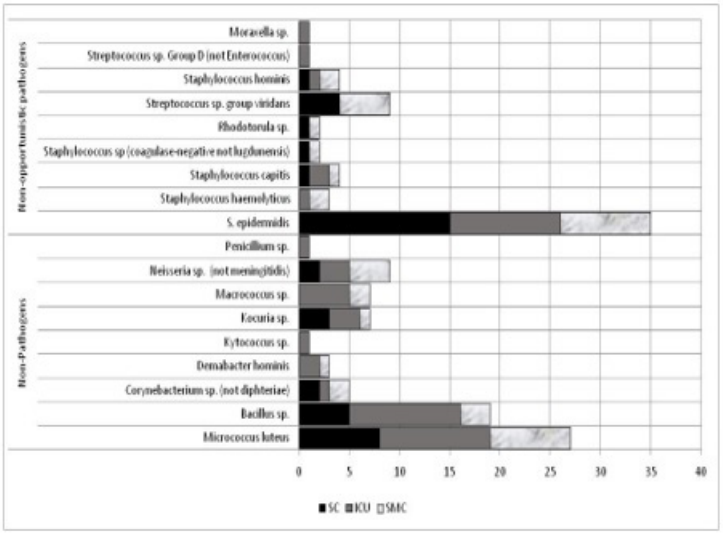


Figure 1: Microorganisms, their prevalence and classification regarding their pathogenicity.

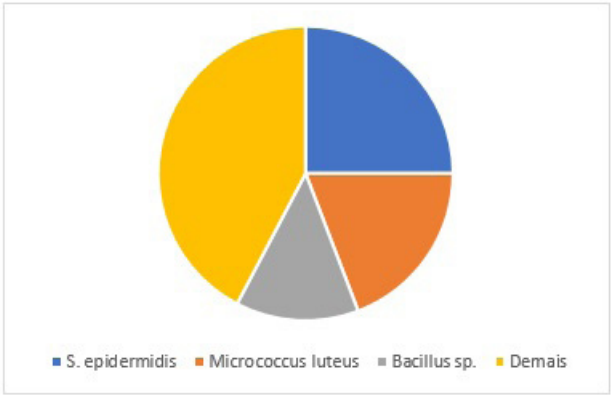
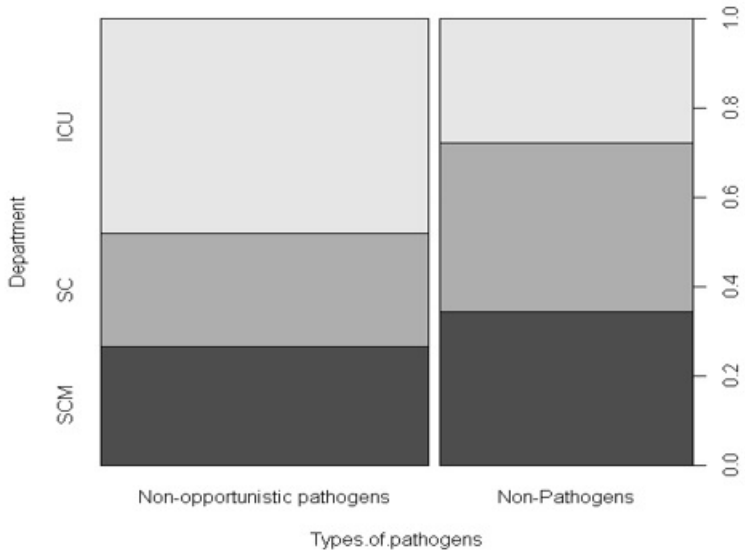
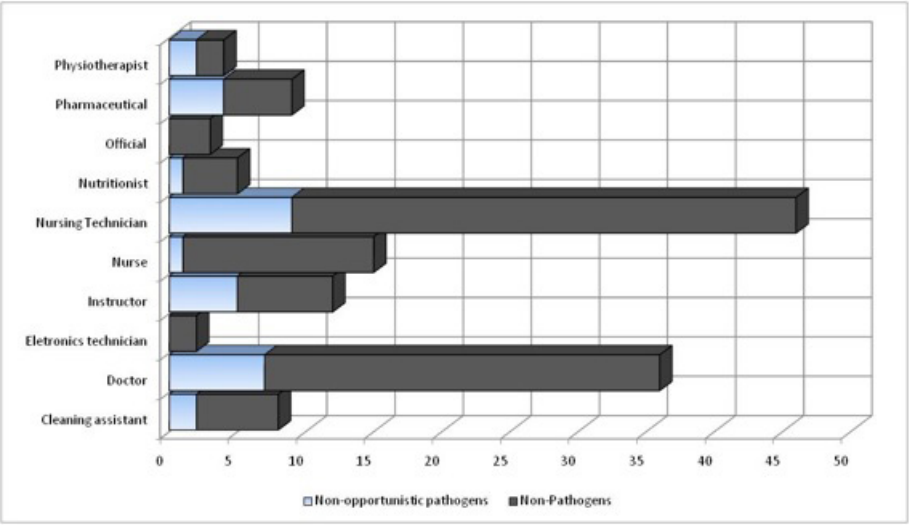


Figure 2: Three bacteria had a higher prevalence in the number of smartphones studied



The Chi-square test suggests that there are no differences between the prevalence of types of pathogens between the different sectors (SC, ICU and SCM,), returning a p value equal to 0.05.

Figure 3: Microorganisms and incidence in the three sectors studied.



(The Chi-square test showed p-value = 0.2801)

Figure 4: Various professionals and types of pathogens.

5. Discussion

In this study, it was found that the smartphones of health professionals working in sectors related to perioperative care (SC, ICU, and SMC) had a high rate of contamination with opportunistic pathogenic microorganisms, however, no nosocomial germs were found. The high rate of contamination of cell phones is worrying due to the increasingly widespread use of these devices inside and outside hospital environments, and the possibility of transmission of pathogens through these electronic tools, since previous epidemiological studies have even reported contamination by multi-resistant bacteria through personal items [1 ,8, 9]. There was no statistical difference when comparing the existing microbiota on smartphones belonging to employees in the SC, ICU and SMC sectors (p-value = 0.57%). Thus, there was no sector that represented a greater risk of contamination of surgical patients when compared.

Smartphones have improved the quality of patient care; improving techniques, however, bringing a greater possibility of contamination between environments, given its proximity to handling with the sick [8]. It can be said, therefore, justification for the need to elaborate hygiene protocols for devices inside hospitals and health establishments. And the comparison between the pathogenic and non-pathogenic microbiota found on smartphones of the different professional classes (p = 0.72) did not show a statistical difference in the probability of greater transmission of diseases by a given labor group.

Among the 18 microorganisms found, only three of them were not part of the human microbiota (Bacillus sp., Penicillium sp. and Rhodotorula sp.), Making us infer that the greatest contamination would occur due to poor personal hygiene when compared to that performed after handling patients colonized by pathogenic germs. This finding differs from other published articles [1, 6]. A recent review of the medical literature showed that cyclic contamination between hands and face (such as nose, lips and ear) and the difference between personal hygiene can contribute to the risk of further spread of pathogens [3]. Among the three bacterias with the highest prevalence in the three sectors (S. Epidermidis, Micrococcus luteus and Bacillus sp.), Only the bacterium Bacillus sp. originates from environmental contamination. The other two are part of the human microbiota and the bacterium Penicillium sp is the only one with potential opportunistic pathogenicity. This result supports other findings on the contribution of the use of smartphones to the bacterial spread in the hospital environment [1, 3, 7].

The comparison between the pathogenic and non-pathogenic microbiota found on smartphones of the different professional classes (p = 0.72) did not show a statistical difference in the probability of greater transmission of diseases by a given labor group.

Cell phone use has become common in areas of the hospital, including the operating room, intensive care units, and sterile materials center. On the basis of the high percentage of cell phone contamination found in this study, we would recommend periodic cell phone cleaning with appropriate materials used in other studies [10, 11]. It seems prudent to routinely disinfect cell phones in three main areas studied in this article and related to the surgical patient. Cell phones are challenging to disinfect without damaging the device. Apple and Samsung recommend cleaning their devices with a lint-free cloth, yet it is rarely done [12, 13]. We are aware of no universally accepted guidelines for the disinfection of cell phones.

6. Conclusion

Results of this study suggest the presence of an extensive microbiota on the surface of smartphones belonging to employees from environments involved in perioperative care (SC, ICU and SMC), demonstrating that smartphones are a potential source of contamination by opportunistic pathogenic microorganisms. In this accredited hospital, the presence of nosocomial germs was not observed in samples from the professionals' cell phones.

The professional classes and the different sectors did not seem to influence the spread rate of the microorganisms. However, considering the high contamination rate of smartphones found, it can be inferred that there is a need to reinforce personal hygiene protocols (such as hand washing after contact with the face) before and after contact with patients. Thus, the findings support the need to create an in-hospital hygiene protocol for professionals' smartphones.

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