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SHORT ARTICLE

Microbiological analysis of mobile devices of surgical personnel working at a health care institution in Pereira, Colombia, 2018

Evaluación microbiológica de dispositivos móviles en personal quirúrgico de una institución de salud, Pereira, Colombia, 2018

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Resumen

Introducción: El uso del teléfono celular se ha vuelto común en áreas del hospital, incluida la sala de operaciones, aumentando el riesgo de contaminación cruzada y las altas tasas de infecciones del sitio quirúrgico. **Objetivo:** Determinar la contaminación microbiana en dispositivos móviles del personal quirúrgico de una Institución de Salud de Pereira, Colombia en el primer semestre del año 2018. **Materiales y métodos:** Estudio descriptivo observacional, transversal. Se tomaron 10 dispositivos móviles del personal del área de quirófano al azar y a cada uno se le realizó frotis con hisopo estéril al estuche o cobertura del celular. Las muestras se transportaron en tubos de ensayo con agua peptonada al 1% hasta el momento de la siembra; las muestras se analizaron por técnica microbiológica recuento en placa profunda. **Resultados:** En las muestras se encontró un promedio de 93 UFC (Unidades Formadoras de Colonias) de mesófilos aerobios, 13 UFC de coliformes totales, 22 UFC de mohos y levaduras. **Conclusiones:** El análisis microbiológico permitió detectar la presencia de elevadas cantidades de unidades formadoras de colonias que podrían contribuir de manera significativa a incrementar las tasas en infecciones asociadas a la atención en salud.

Palabras clave: Teléfono celular; infección de la herida quirúrgica; análisis microbiológico; infección hospitalaria; desinfección. (Fuente: DeCS, Bireme).

Abstract

Introduction: Cell phone use in hospital areas such as surgery rooms has become a common practice, which has increased both the risk of cross-contamination and the rates of surgical site infections. **Objective:** To determine microbial contamination of mobile devices belonging to surgical staff of a Health Care Institution in Pereira, Colombia during the first semester of 2018. **Materials and methods:** An observational, cross-sectional, descriptive study was conducted with a sample of ten mobile devices randomly chosen from health personnel working in the surgical room. Surface samples were collected from cell phone cases and bags using sterile swabs that were were kept in a 1% peptone salt solution until a deep plate count assay was performed on them. **Results:** The plate count confirmed the presence of mesophilic aerobes (93 CFUs), total coliforms (13 CFUs) as well as yeasts and molds (22 CFUs). **Conclusions:** The microbiological analysis showed elevated numbers of colony-forming units that could significantly increase the rates of infections associated with health care settings.

Key words: Cell phone; surgical wound infection; microbiological analysis; cross infection; disinfection. (Source: DeCS, Bireme).

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Introduction

Mobile devices have become one of the most essential technological tools in professional and social life. They have turned into the most important means of communication worldwide, easily accessible, affordable, and easy-to-use. Although mobile devices are widely used by health care workers, their benefits are overshadowed by the health risks to patients in hospitals when appropriate aseptic measures are not taken into account[1].

Contact with mobile devices by all hospital users such as patients, visitors and clinical staff is a frequent event, constituting an open and critical fomite for the transmission of microorganisms as well as health care-associated infections (HAIs) which are a product of cross infections and are associated with the humidity and skin temperature conditions of the human body, especially those which in the palms. These factors, together with heat generated by mobile phones, contribute to the harboring of bacteria on the device at alarming levels[2]. Unlike hands that are commonly disinfected in health care institutions, mobile devices are not subjected to this exhaustive control, disinfection or cleaning procedures.

Several studies have demonstrated that almost 90% of mobile devices belonging to clinical staff are bacterial reservoirs that can cause intrahospital infections[3,4]. A literature review of 30 articles published from 2004 to 2014 revealed variable levels between 40% and 100% of bacterial contamination in mobile devices more frequently associated with the presence of *coagulase-negative Staphylococcus aureus* and *Staphylococcus aureus*, of which nearly 95.3% were methicillin resistant[5].

The operating room is an aseptic environment and the fundamental pillar for safe care of surgical patients. Unlike multiple factors that increase the risk of infections at the surgical site, environmental contamination was not considered a priority during many years. However, scientific evidence has demonstrated that controlling key factors of the surgical environment and establishing a strong aseptic barrier that separate it from non-restricted areas play an important role in mitigating the transmission of microorganisms[6,7].

It is important to highlight that surfaces of mobile devices are made of plastic or metal due to their cost and durability. However, bacteria have a high capacity of adherence to inert materials, allowing the formation of biofilms that metabolize plastic and release bacterial nutrients, as previously reported for *S. aureus*, *Escherichia coli, Pseudomonas aeruginosa* and *S. epidermidis*, the latter surviving long periods and being considered a source of infection[6,8].

Studies about microbial contamination by mobile devices agree that it is necessary to isolate *S. aureus,* especially multi-resistant strains, and Gram-negative bacilli because they can resist desiccation conditions and multiply in warm environments such as the surfaces of these devices[9].

The risk posed by the uncontrolled use of mobile devices in restricted and aseptically-controlled areas[10] due to the lack of restrictions for the usage and cleaning/disinfection of mobile devices by the surgical staff raises the need to carry out this study in the participating institution.

Therefore, this study was aimed at determining microbial contamination in mobile devices of surgical staff working at a Health Institution from Pereira, Colombia during the first semester of 2018. Our ultimate goal was to generate strategies to reduce the risk of cross contamination associated with their use.

Materials and methods

A descriptive, cross-sectional study was conducted with mobile devices of health caregivers working at a surgery facility of a hospital institution from Pereira, Colombia. This surgery unit was comprised of 25 employees, including surgeons, physician assistants, surgical instrument technicians, nurses, and nursing assistants. Ten people who carried cell phones were randomly selected to perform microbiological analyses on their devices.

The selection criteria of the institution were its acceptance to participate in the study and having health care workers with functions within surgical rooms (surgeon, physician assistant, surgical instrument technician, anesthesiologist, and nursing assistant) at the moment of sample collection. Samples were taken from the surfaces of 10 mobile devices and their cases or covers with a sterile swab, and they were assigned a number from 1 to 10 as a sample code to be kept during the process.

Samples were carried within test tubes containing 1% peptone water until their analysis. Four groups of microorganisms were microbiologically analyzed through the deep plate count technique[11] as follows. Samples were inoculated in Plate Count agar plates and incubated at 37°C for 24 hours for the total count of aerobic mesophilic bacteria. Total and fecal coliform count was carried out in both *Brillance E. coli*/coliform and *Petrifilm E. coli*/Coliform selective agar media at 37°C for 24 hours. Finally, yeasts and molds were analyzed in *Sabouraud dextrose* agar medium incubated at 25°C for 5 days. All these assays had appropriate previous microbiological controls and were performed at the basic science laboratories from the Andean Region University Foundation.

Microbiological controls for culture media were conducted as follows:

Positive control: ATCC microbiological strains were used to verify media performance. *Staphylococcus aureus* ATCC 25923 (aerobic mesophiles) for deep plate count; *Enterobacter aerogenes* ATCC 13048 (total coliforms) and *Escherichia coli* ATCC 25922 (fecal coliforms) for surface plate method; and *Candida albicans* ATCC 60193 and *Aspergillus brasiliensis* ATCC 16404 (yeasts and molds) for deep plate count.

Negative controls for all media were incubated for 48 hours after their preparation. A vial containing Plate Count agar was inoculated with peptone water and incubated simultaneously with the samples to ensure its purity.

Samples were collected with disposable sterile rayon swabs that were wrapped individually to guarantee the innocuity of the procedure.

Counting method

In reference to the counting and identification of bacteria, given the fact that a selective culture medium was used for the identification of *E. coli* and its differentiation from total coliforms, it was unnecessary to carry out confirmatory tests.

The data was collected through Microsoft Excel 2015® and analyzed by SPSS v. 23. Absolute and relative frequencies were used for qualitative variables. Quantitative variables were expressed as central tendency measures (Mean) and standard deviation (SE). A qualitative bivariate analysis was conducted using Fisher's exact test with a significance level of ≤0.05.

Ethical considerations

This research was approved by the Research Committee of the Health Department of the Andean Region University Foundation, which was classified as a minimum risk study according to Resolution No. 008430 of 1993 that establishes scientific, technical and administrative standards for research in the health sciences. In addition, the study obtained the approval of the Health Institution where it was conducted. Finally, mobile devises were provided and analyzed after the signing of the informed consent by the surgical staff.

All microbiological procedures were carried out following the policies of the NTC 4092 technical standard that establishes the general requirements and guidelines for microbiological analyses. All participating personnel made proper use of the biosafety equipment and samples were processed inside a laminar flow cabinet (properly calibrated) to ensure accurate recovery of microorganisms and avoid contamination from researchers. Once a procedure was finished, cultures were autoclaved to guarantee proper elimination of biological material.

Results

In order to avoid gender-related biases, 5 mobile devices were collected from male participants and 5 mobile devices were collected from female participants. 40% of the devices belonged to specialist surgeons, 20% to anesthesiologists, and the remaining 40% to surgical instrument technicians, nursing assistants and resident physicians.

Microbiological cultures were successfully obtained from all samples taken from surfaces and cases of mobile devices that contain microorganisms which may cause intrahospital cross infections. The average colony-forming unit (CFU) counts were as follows: 76.3 CFUs/cell phone (SD=62) for aerobic mesophiles; 15.2 CFUs/cell phone (SD=15.2) for yeasts and molds; and 7.1 CFUs/cell phone (SD=5.3) for total coliforms. The average count reported for total coliforms was lower than 10 CFUs/cell phone in all collected samples. No missing data were recorded during either the processing or collection of data.

Based on the acceptance criteria of the 1418 resolution of 2011 by the National Institute of Food and Drug Surveillance (in Spanish: INVIMA), the elevated number of mesophilic microorganisms can be considered as a high risk for surgical infections associated with deficient disinfection processes of those devices.

The adjusted average of CFUs, which was corrected after the elimination of extreme values, was 92.87 CFUs/cell phone (SD=12.8) for aerobic mesophiles; 22.37 CFUs/cell phone (SD=6.3) for yeasts and molds; and 13.5 CFUs/cell phone (SD=5.5) for total coliforms. No variation patterns in fecal coliforms were found.

The analysis of statistical associations between gender-related qualitative variables and the presence of microorganisms did not reveal any statistically significant differences for any of the microorganisms assessed: aerobic mesophiles (p=0.5), yeasts and molds (p=0.08). The institution does not have current protocols to mitigate the risk of cross contamination associated with mobile devices entering aseptically controlled areas, and no restrictions for their use were observed.

Discussion

This study revealed the presence of at least 70 CFUs/cell phone aerobic mesophiles, which is similar to previously reported counts[3-5].

Health care-associated infections continue to pose a significant risk for increased morbidity and mortality of patients and the diverse etiological agents responsible for such infections vary from hospital to hospital and according to different geographical regions[7]. Despite the fact that mobile phones have become an essential element of medical care, it has been demonstrated that they represent critical and potential fomites for the transmission of nosocomial infections[4].

Currently, the importance of cell phones is recognized due to their advantages for the solution of technical and job-related problems as well as an easy form of communication. In the health care field, these elements facilitate the diagnosis and focusing of the management of diseases in different scenarios. Consequently, the use of these devices has disseminated at all social levels and current data from the World Health Organization (WHO) shows that there are nearly 6,900 million users worldwide[12]. However, populations are now exposed to health risks and biological hazards associated with their use[12].

A study conducted by Pérez *et al.*[13] on 71 cell phones of medical personnel found coagulase-negative staphylococci (50%), *Staphylococcus aureus* (32.4%), enterobacteria (4.2%), and actinomycetes (4.2%). It is important to highlight that the Enterobacteriaceae is a large family that includes microorganisms such as *Escherichia, Shigella, Salmonella, Klebsiella, Serratia, Hafnia, Proteus, Morganella, Providencia, Yersinia, Edwarsiella, Citrobacter* and *Erwinia*. These researchers observed that only 9.8% of the devices tested negative, which is similar to our findings. Pérez *et al.,* also emphasize the importance of establishing a strict cell phone cleaning routine and raising public awareness of maintaining these hygiene practices. Similarly, a study carried out by Ustun and Cihangiroglu on mobile phones revealed 179 samples that tested positive for bacterial growth, including methicillin-resistant *Staphylococcus aureus* (17.9; 9.5%) and ESBL-producing *Escherichia coli* (20; 11.2%), which can cause intrahospital infections[14].

Dorost *et al*[15], analyzed phones used in a hospital from Iran and found that bacterial contamination of touchtone devices used by research groups was lower than that of keyboard devices. They also found that cell phone contamination was higher in hospital employees than in visitors and that cell phones of women have higher levels of colonization. The predominant microorganisms in hospital personnel were *Enterobacteriaceae* and *Bacillus* spp., especially sporulated Gram-positive and coagulase-negative staphylococci.

Murgier *et al.,* performed a microbiological analysis before and after the disinfection of 52 cell phones belonging to individuals who entered into the operating room of the orthopedic surgery department of the Toulouse University Hospital Center (France). Before decontamination, the average number of CFUs was 258 per phone (0-1,664 range), whereas the number decreased to 127 after decontamination (0-800 range) (p=0.0001). 49 cell phones (94%) had CFUs before decontamination and 39 afterwards (75%) (p=0.02)[16]. They did not find a statistical association with gender, which is similar to our results.

Pillet *et al.,* demonstrated that more than a third of sampled mobile phones were contaminated with RNA from viruses commonly found in clinical environments. Rotavirus (RV) RNA was largely identified in health care workers, especially in pediatric personnel[17]. Therefore, it is evident that the magnitude of the problem related to cross-transmission of microorganisms between different hospital areas begins to increase which could be aggravated by fomites such as mobile devices.

Our research team revealed the potential role of mobile devices as sources of cross-intrahospital infections that is similar to what has been reported[3-5]. The are no regulations restricting the use of mobile devices within surgical rooms. In 2016, the WHO in collaboration with the LANCET journal published 16 recommendations to prevent infections within operating rooms, highlighting measures such as proper air circulation, use of adherent films impregnated with antibiotics, temperature control, and adequate post-operative care[18]. However, these recommendations omitted data regarding cell phone use.

In reference to the problems associated with the use of cell phones and intrahospital cross-contamination, a 2009 review by Brady *et al.,* emphasized measures such as training of health care staff, serial assessment of intrahospital contamination, following protocols to control infections, and restricting the use of cell phones within locations that require asepsis (e.g., operating rooms and intensive care units). These are important guidelines that are considered cost effective at the moment of restricting cross infections[19].

Our study had an appropriate sample size for the operating room area of the institution under study and our results underscore the need to establish preventive measures in order to prevent infections associated with health care. The selection of a level four complexity institution from Pereira with high local and regional impact supports our conclusions as it is an important hallmark of the city and region. Despite these advantages, there are limitations that must be considered when interpreting our results. Given the fact that this was a cross-sectional descriptive study, it is not possible to structure causal associations between the presence of the characterized microorganisms and the presence of mobile phones in the operating room. However, according to Hill criteria[20] it is evident that this study meets the temporal sequence, biological plausibility, experimental evidence, and consistency to come close to statistical causal associations in future studies.

Conclusions

There is a high prevalence of microorganisms isolated and characterized from mobile devices belonging to surgical staff of a Health institution from the municipality of Pereira, which poses a significant risk associated with HAIs. Therefore, it is recommended to have exhaustive disinfection and restriction controls of the use of these devices within surgical areas.

Recommendations

Our study provides a new perspective on an overlooked source of infection due to the continuous and almost mandatory use of mobile devices. Thus, it is recommended to establish aseptic principles to regulate their use.

Our results reveal the presence of potentially pathogenic microorganisms (*E. coli, Klebsiella, Proteus, Enterobacter, Citrobacter*) on the surfaces of mobile phones used in hospital areas where extreme aseptic measures are required. Additional research studies are needed to assess associated risk factors as well as confusing and interacting variables. It is also important to analyze the strength of associations between the presence of microorganisms in mobile devices with cross-contamination in operating rooms, a reason for which new multicenter studies are recommended in order to establish correlations between microorganisms present in mobile devices and surgical wound infections.

Conflict of interests

None declared by the authors.

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