

The practice of disinfection of finger oximeters performed by nursing professionals

A prática da desinfecção dos oxímetros de dedo realizada pelos profissionais de Enfermagem

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ABSTRACT

Objective: to analyze the practice of disinfection of finger oximeters by nursing professionals. **Methods:** a quantitative, descriptive, and cross-sectional study with nine professionals in a hospital clinical unit. Eighteen swab samples were collected, internally and externally from each equipment, isolating 51 bacterial colonies for antimicrobial susceptibility testing. **Results:** the professionals were not trained to disinfect the equipment. Eight carried the oximeters in their lab coats, and one carried them on a tray. They rarely disinfected the inside of the device fearing the 70% ethyl alcohol would damage the sensor. In 17 samples, different bacterial genera grew. 17.7% were multidrug-resistant to antimicrobials. **Conclusion:** it was observed that Nursing professionals don't disinfect finger oximeters correctly. The use of 70% isopropyl alcohol is recommended to disinfect the sensors, since it doesn't damage the equipment, and 70% ethyl alcohol to sanitize the patients' fingers before and after the tests.

Descriptors: Nursing; Disinfection; Drug Resistance, Bacterial; Equipment Contamination; Nurse Practitioners.

RESUMO

Objetivo: analisar a prática da desinfecção dos oxímetros de dedo realizada pelos profissionais de Enfermagem. **Métodos:** estudo quantitativo, descritivo e transversal com nove profissionais em unidade clínica hospitalar. Coletaram-se 18 amostras com *swab*, uma interna e uma externa de cada equipamento, isolando-se 51 colônias bacterianas para a testagem de suscetibilidade aos antimicrobianos. **Resultados:** os profissionais não recebiam capacitação para a desinfecção do aparelho. Oito transportavam os oxímetros nos jalecos e um, na bandeja. Raramente desinfetavam o interior do aparelho por receio do álcool etílico 70% danificar o sensor. Em 17 amostras, cresceram diferentes gêneros bacterianos. Foram multirresistentes aos antimicrobianos 17,7%. **Conclusão:** observou-se que os profissionais de Enfermagem não desinfetam corretamente os oxímetros de dedo. Recomendam-se o uso de álcool isopropílico 70% para desinfetar os sensores, por este não danificar o equipamento, e o uso de álcool etílico 70% na higienização dos dedos dos pacientes antes e após os testes.

Descritores: Enfermagem; Desinfecção; Farmacorresistência Bacteriana; Contaminação de Equipamentos; Profissionais de Enfermagem.

Introduction

Worldwide, multi-resistance of microorganisms to antimicrobials is complicating the treatment of nosocomial infections. Multidrug-resistant microorganisms are those resistant to three or more classes of antibiotics. In the United States of America, these microorganisms are responsible for approximately 23,000 deaths annually. And it is estimated that 11.0% of individuals examined in health care facilities are asymptomatic carriers of a transmissible and difficult-to-treat microorganism⁽¹⁾.

The spread of pathogens such as viruses, fungi, and multi-resistant bacteria in hospital environments is mainly the result of careless cleaning⁽²⁾. Nowadays, there is no lack of scientific evidence on the importance of the quality of cleaning in the hospital environment. However, the spread of multidrug-resistant pathogens is increased when portable equipment and materials (such as trays, especially) are exposed to high-contact surfaces⁽³⁾.

The chances of a patient becoming infected increase by 40.0% in a room previously occupied by an infected patient. This is because, after cleaning, 50.0% of the contact points remain contaminated. On mobile equipment, these pathogens can remain for a long time, such as the Gram-positive *Staphylococcus aureus*, including the methicillin-resistant ones. These remain from seven days to seven months, while *Streptococcus pneumoniae* remains between one and 20 days, *Streptococcus pyogenes* survives from three to 195 days, and *Enterococcus spp* persists between five days and four months. On inanimate surfaces, Gram-negatives such as *Acinetobacter spp.* survive from three days to five months and *Escherichia coli* survive from 90 minutes to 16 months⁽⁴⁾.

Thus, moving objects, such as finger and pulse oximeters, are among the main transmitting equipment. These are non-critical pieces of equipment because they come in contact with intact skin. However, these items can contribute to secondary transmission by contaminating the hands of health care workers,

or by contact with medical equipment that will later come into contact with patients⁽⁵⁾. Even in contaminated pulse oximeters, when disinfected, “neglected reservoirs” can form due to difficult access, regardless of the product’s commercial brand. In addition, some environmental conditions, such as high temperature, can keep the contamination level high⁽⁶⁾.

To decontaminate the oximeter sensors, it is recommended to use a swab with 70% isopropyl alcohol and then clean them with a chlorinated detergent. Isopropyl alcohol is used for cleaning the surfaces of electronic components and prevents oxidation by not having water in its composition. However, even after cleaning, different types of bacteria can remain, such as *Acinetobacter baumannii*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Staphylococcus aureus*. In this regard, tissues and gauze moistened with sodium hypochlorite (1:10) are more effective in removing vegetative bacteria and spores when used as pre-cleaning on the remaining parts of the oximeters. The presence of tallow reduces the cleaning efficiency of some commercially available wipes/swabs⁽⁷⁾.

In 2020, as a result of the COVID-19 pandemic, new criteria for the disinfection of objects and surfaces have been established. For electronic equipment such as computers, telephones, and mobile light sources, it is suggested to follow the manufacturers’ guidelines. In the absence of recommendations in the equipment manuals, the National Health Surveillance Agency recommends the use of cloths dampened with 70% isopropyl alcohol, especially to disinfect touchscreens. A list of alternative products to 70% ethyl alcohol is suggested for the disinfection of objects and surfaces, such as: 0.1% sodium hypochlorite; bleaches containing 0.1% hypochlorite (sodium, calcium); sodium dichloroisocyanurate (concentration of 1,000 parts per million of active chlorine); 1% povidone iodine; 0.5% hydrogen peroxide; the 0.5% peracetic acid; the quaternaries of ammonium, as, for example, the 0.05% Benzalkonium Chloride; the phenolic compounds and the disinfectants approved by the National Health Surveillance Agency⁽⁸⁾.

In contrast, in the disinfection of non-critical environmental surfaces and equipment in patient care, the Centers for Disease Control and Prevention does not recommend the use of liquid chemical sterilants or disinfectants such as glutaraldehyde, peracetic acid, ortho-phthalaldehyde, and the antiseptics chlorhexidine and iodophors. It also advises against the use of phenolics with high toxicity⁽⁹⁾. This recommendation needs to be adapted to the disinfection of finger oximeters. For the Centers for Disease Control and Prevention, the inappropriate use of some of these products poses risks to health professionals, especially when used too frequently, and recommends caution in mixing substances for disinfection⁽¹⁰⁾.

Unlike pulse oximeters, finger oximeters are widely used in emergency settings and clinical units and can be included as agents of pathogen dissemination, when sanitation performed by the nursing staff does not reach these neglected reservoirs.

It is in this context that the Nursing team needs to be trained so that it can draw on scientific evidence to improve the quality of disinfection. This is because there are still no evaluation methodologies that can ensure that these cleaning procedures reached the neglected reservoirs⁽²⁾. Having said this, it is evident the need for training of health professionals to replace old practices, minimizing occupational and patient risks⁽¹¹⁾.

This study aimed to analyze the practice of finger oximeter disinfection performed by nursing professionals.

Methods

This is a quantitative, descriptive study, which occurred in two stages, in February 2018, in a hospital in the west of Santa Catarina State, Brazil. The guiding question sought to know whether the procedures adopted in the hygienization routine of finger oximeters eliminated the biological risks to the health of the Nursing team and patients.

The inclusion criterion was free participation by signing the Free and Informed Consent Term. The approach was made through a formal invitation to the sector manager. The objectives of the study were presented to the 32 nursing professionals of the clinical unit. Of these, nine (28.1%) chose to participate in the research. The criteria for exclusion adopted were being on leave for health treatment or on vacation.

In the first stage, to facilitate the analysis of the results, with a questionnaire containing semi-structured questions, we tried to find out from the nursing professionals their level of education, how long they had been working, whether they were trained to disinfect mobile electronic equipment, where the oximeters came from, where they kept them between shifts, how they were transported during work, and what disinfectants were made available by the hospital.

In the second step, first, a free observation of the professionals was performed during the disinfection of the oximeters with products made available by the hospital, namely: alkyl dimethyl benzyl ammonium chloride (benzalkonium chloride) 5.2% and ethyl alcohol 70%. One of the professionals used chlorhexidine, however, this product was not available for use by all professionals.

Then, with sterile swabs dampened in saline solution, samples were collected from the external part of each oximeter, a region delimited in 12 and 13 mm², where the professional has contact, and from the internal part, delimited in 16 mm², where the patient comes in contact with the sensor. The samples were collected from the oximeters at the beginning of the morning and afternoon shifts, when, theoretically, the oximeters should be sanitized.

In the laboratory, the samples were seeded on Petri dishes containing Blood Agar medium and incubated at 37°C, in aerobiosis, for 18 to 24 hours. Two colonies with different morphological characteristics were isolated from each plate and again transferred to the plates containing Blood Agar medium (Oxoid)

and incubated under the previous conditions. The criterion for choosing the two samples per plate was the greater representativeness of each colony.

Presumptive identification occurred by morphology and Gram's method. And the isolation tests were performed by biochemical tests on Simmons Citrate, iron triple sugar, sulfite, indole and motility, methyl red and Voges-Proskauer⁽¹²⁾. For Gram-positive pathogens, the catalase, oxidase, coagulase, mannitol fermentation, and bile-soculin tests were used. The bacitracin and novobiocin tests were also employed. For the identification of Gram-negative microorganisms, the chromogenic urinary tract infection was used initially. These were subsequently submitted to the biochemical reagents rugai lysine, citrate and triple sugar iron.

In the control of the susceptibility test, the strains *E. faecalis* 29212, *E. coli* ATCC 25922, *S. aureus* ATCC 25923, *P. aeruginosa* ATCC 27853 and *E. coli* ATCC 35218 are used. Antimicrobial susceptibility testing was performed by the disc-diffusion technique, using Muller-Hinton medium (Oxoid) and antibiotic discs (Laborclin and BioRAD): ampicillin + sulfobactam (ASB- 10µg); aztreonam (ATM-30µg); azithromycin (AZI 5µg); ceftazidime (CAZ-30µg); chloramphenicol (CLO-30µg); amoxicillin + clavulanate (AMC- 20µg); ceftriaxone (CRO-30µg); cefotaxime (CTX- 30µg); doxycycline (DOX- 30µg); imipinem (IPM 10µg); meropenem (MER 10µg); nalidixic acid (NAL-10µg); ciprofloxacin (CIP-5 µg); norfloxacin (NOR-10 µg); tetracycline (TET 5µg); penicillin (PEN G 10µg); rifampicin (RIF 5µg); cefepime (COM 30µg); vancomycin (VAN 30µg); ofloxacin (OFX 5µg); bacitracin (BA 10µg); clindamycin (CLI 2µg) and erythromycin (ERI 15µg). Inoculation occurred by bacterial suspension. Halos diameters were read and interpreted according to the guidelines of the Clinical and Laboratory Standards Institute⁽¹³⁾. Pathogens that showed resistance to three or more classes of antimicrobials were considered as multidrug-resistant isolates⁽¹⁾.

In the analysis of the data obtained from the

questionnaire, observations regarding hand hygiene, growth of bacterial cultures on plates, and bacterial resistance to antimicrobials, the results were statistically analyzed as to absolute and percentage frequencies. Regarding bacterial growth on the plates, a phenomenon called contamination, the quantity of bacterial colonies was analyzed in an observational and presumptive manner. With this, the counting of colonies per plate was dispensed with, and the plates in which bacterial growth occurred were considered contaminated, regardless of the presumed quantity observed.

The research was approved by the Ethics Committee for Human Research, under Opinion no. 2,252,276/2017, and there is a commitment to return the results to the institution after publication.

Results

Of the nine Nursing professionals interviewed, three (33.3%) were nurses, three (33.3%) were technicians, and three (33.3%) were Nursing assistants. As for the time of professional practice in the hospital environment, one nurse had ten years and the others, five years or less. All said they had never received guidance on disinfection of oximeters.

These devices were for personal use and purchased by them in commerce. When asked to check them, it was noticed that some did not have the seal of the National Institute of Metrology, Quality and Technology. About the transportation of oximeters during the care, eight said they carried them in the pocket of their lab coats, and one said he carried them in his tray. Regarding the place where they kept the oximeters between shifts, all argued that they carried them to their homes because they belonged to them.

Among the nurses, one used alkyl dimethyl benzyl ammonium chloride to disinfect the oximeter; one used alkyl dimethyl benzyl ammonium chloride associated with 70% ethyl alcohol, and one applied only 70% ethyl alcohol. Both products were available

on site. The three technicians and the two nursing assistants used 70% ethyl alcohol. One nursing assistant used chlorhexidine for disinfection, but did not describe whether it was in aqueous, alcoholic or degerming solution. It is worth mentioning that chlorhexidine was not available for everyone.

The interviewees argued that ethyl alcohol 70% damaged the device, discoloring it and damaging the sensor, so they did not use it, as well as did not disinfect the sensor and the internal part of the oximeter. The participants recognized the existence of occupational and patient risks due to the contamination of their oximeters. They also admitted the importance of properly disinfecting this equipment.

Regarding the number of bacterial colonies and the genera that grew in the culture media, similar microbial growth was found among the oximeters carried in the jacket pockets or on trays. Of the 18 swab samples collected from the oximeters, in 17 (94.4%), bacterial growth occurred. In only one external sample plate, no growth occurred. This sample was obtained from the oximeter of the nursing professional who used chlorhexidine to disinfect it. However, the sample obtained from the internal part of the same oximeter presented contamination.

Among the 17 samples, 51 colonies were isolated at random, being 11 colonies of *Staphylococcus epidermidis* (three internal and eight external), three of *Staphylococcus saprophyticus* (three internal), five of *Staphylococcus aureus* (two internal and three external), three of *Streptococcus pyogenes* (two internal and one external), 21 of *Klebsiella pneumoniae* (ten internal and 11 external), four of *Enterococcus faecalis* (three internal and one external), four of *Proteus mirabilis* (three internal and one external), one of *Gonococcus sp* (external), one of *Providência sp* (external) and one of *Pseudomonas aeruginosa* (external).

All isolates were submitted to antimicrobial susceptibility testing, the results of which were classified into antimicrobial classes (Figure 1).

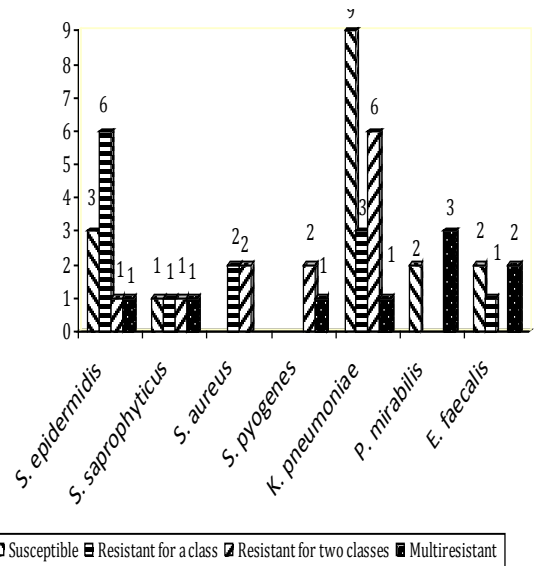


Figure 1 – Antimicrobial resistance profile of bacterial genera isolated from finger oximeters in a hospital in western Santa Catarina in absolute numbers. Chapecó, SC, Brazil, 2020

Of the 21 *Klebsiella pneumoniae* colonies identified in four oximeters, both the internal and external samples had the same antimicrobial resistance profile. They were all resistant to the betalactams (AMC, CAZ, CTX, ATM, CRO). No resistance was found for the third generation cephalosporins.

When analyzing the resistance by class of antimicrobials, in relation to multidrug-resistance, 17.7% were resistant to three or more classes, as shown in Figure 2.

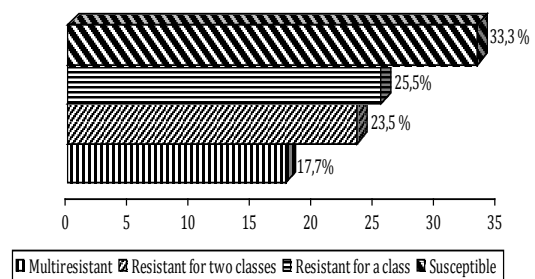


Figure 2 – Percentage of resistances to antimicrobial classes of bacterial isolates from a hospital clinical unit. Chapecó, SC, Brazil, 2020

Discussion

This study presents, as limitations, the lack of specific tests to identify the facilities or difficulties in disinfecting critical points in the different brands of oximeters. The lack of adherence of nursing professionals to the research was another factor that limited a more robust sample of oximeter swabs so that the profiles of antimicrobial resistance and the pathogens involved could be more expressive. The results found can be generalized to other realities and healthcare settings that involve the use of fixed and mobile electronic equipment or objects used in patient management because microorganisms on these surfaces tend to behave in a similar manner.

Among the answers provided by the interviewees regarding the disinfectants used, the technicians were the ones who came closest to the orientations recommended by Anvisa in Brazil, considering that they used 70% ethyl alcohol⁽⁸⁾. Although one of the interviewees affirmed using chlorhexidine, the Centers for Disease Control and Prevention does not recommend using this disinfectant for this purpose because it poses health risks to professionals when exposed too frequently⁽⁹⁾.

The lack of cleaning of the sensors by the nursing professionals, who were afraid of damaging them by using 70% ethyl alcohol, suggests that this is the reason for the contamination of the internal part of all devices. This lack of disinfection was verified in the microbiological results when a similar level of growth and the same bacterial genera were found with the samples collected from the outside. This fear is understandable, because the water present in the 70% ethyl alcohol, by oxidation, damages the electronic components, besides generating a personal cost to replace the equipment. To reduce this fear, 70% isopropyl alcohol, recommended in the cleaning of pulse oximeter sensors, may present itself as an alternative in the disinfection of internal parts⁽⁶⁾.

Hand disinfection with ethyl alcohol 70% before and after cleaning oximeters, as presented by the

professionals, helps in the efficiency of the processes. No publications were found to provide guidance on how to sanitize the fingers of patients before and after using this equipment. This recommendation was only found in manuals for the use of finger oximeters⁽¹⁴⁾, which suggest using 70% alcohol, but without specifying between ethyl or isopropyl.

Transporting contaminated equipment in a coat pocket during work or to their homes after work is a risky practice for professionals, their families and their own health⁽⁴⁾. These risks were evidenced by the presence of pathogens such as *Klebsiella pneumoniae*, which is multidrug resistant to the antimicrobials tested in the samples. Family members can become asymptomatic carriers⁽¹⁾ of these pathogens. It is also emphasized the possibility of increasing the level of contamination of this equipment due to the survival time of microorganisms on inanimate surfaces⁽⁴⁾. This contamination can also be increased by the body temperature of the professionals due to the transportation in the coat pocket. The fact that an interviewee carries the oximeter in the tray does not allow us to affirm that this equipment is free of contamination, because the samples collected proved to be contaminated internally and externally. It is worth noting that inadequately disinfected trays become potential sources of contamination of other fixed and movable objects such as finger oximeters⁽³⁾.

A significant difference was observed between the results of the oximeter samples of the nursing professionals who disinfected the equipment and sanitized their hands. However, those who disinfected the equipment and sanitized their hands with ethyl alcohol 70% before and after, had their samples less contaminated on the outside compared to those who disinfected the equipment and only sanitized their hands after the process.

Based on the analyses performed, it is recommended to disinfect finger oximeter sensors with 70% isopropyl alcohol because it does not damage them, and to use 70% ethyl alcohol before and after cleaning patients' fingers. However, it is important to empha-

size the role of hospital institutions in the training of nursing professionals for the disinfection of this equipment. It is also emphasized the responsibility of health institutions in the acquisition of equipment such as finger oximeters, thus ensuring the patient's safety by acquiring commercial brands with the certification seal.

In this study, regarding bacterial genera, similar results were found to those of researches that analyzed the contamination of pulse oximeters in intensive care units. All bacterial genera found are potentially pathogenic, such as *S. aureus* and *Klebsiella pneumoniae*, and affect mainly immunocompromised patients⁽⁶⁾. A large part of the pathogens isolated, such as *Staphylococcus spp*, the *Streptococcus spp*. and the *Enterococcus spp*, is part of the human microbiota, although it can acquire pathogenicity in the hospital environment. In the presence of *Enterococcus spp*, it is assumed the contamination by fecal route, originating from inadequate hygiene of the hands of patients or nursing professionals. Regarding the presence of *S. epidermidis*, the results of the samples showed that the hygienization performed by the professionals was unsatisfactory. This bacterium colonizes the human epidermis, but has the potential for dissemination of antimicrobial-resistant genes. The vast majority of microorganisms found in the study are compatible with those causing infections acquired in the hospital environment⁽¹⁵⁾.

The profile of antimicrobial resistance in the bacterial isolates of the samples can be considered low, as it does not exceed 20.0%. However, multi-resistance can be considered worrisome, especially those found in *Klebsiella pneumoniae*, since this bacterium causes severe pneumonia. By knowing the susceptibility profile to the antimicrobials prescribed, the patient will be able to receive adequate treatment and thereby reduce the risks of selecting microbial strains resistant to antimicrobials⁽¹²⁾.

Given the failures in the procedures for disinfecting oximeters, many occurring due to lack of knowledge of the possible risks, it was found to be

necessary to train nursing professionals to adopt best practices for disinfecting mobile devices. It is also indicated as urgent the review of protocols for use and disinfection of these devices in hospital environments.

Conclusion

It was observed that nursing professionals do not disinfect finger oximeters correctly. This behavior represents risks for the professionals, their families, and the patients. It is recommended to disinfect the sensors with 70% isopropyl alcohol and the patients' fingers with 70% ethyl alcohol before and after the tests.

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Collaborations

Korb A and Silveira AM contributed to the conception and design, analysis and interpretation of data, writing of the article, relevant critical review of the intellectual content, and final approval of the version to be published.

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