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## INTEGRATIVE REVIEW ARTICLE

### AREAS OF HOSPITAL ENVIRONMENT: A POSSIBLE UNDERESTIMATED MICROBES RESERVOIR? – INTEGRATIVE REVIEW

#### SUPERFÍCIES DO AMBIENTE HOSPITALAR: UM POSSÍVEL RESERVATÓRIO DE MICRO-ORGANISMOS SUBESTIMADO? – REVISÃO INTEGRATIVA

#### SUPERFICIES INANIMADAS DEL AMBIENTE HOSPITALARIO: UN POSIBLE RESERVATORIO DE MICROORGANISMOS SUBSTIMADO? – REVISIÓN INTEGRADORA

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#### ABSTRACT

**Objective:** characterizing Brazilian researches on the contamination of hospital environment areas. **Method:** Integrative review of literature in order to answer the question: *What has been investigated in Brazil regarding the participation of inanimate areas in microbial borne in the hospital environment?* Research conducted in December 2011, using the following data bases: Latin American and Caribbean Literature on Health Sciences (LILACS) and Nursing Data Base (BDENF). A form of data collection including the article ID, year, sample studied, objective, main results and conclusion was used by the authors. **Results:** we have found publications describing 19 different areas, including mattresses, stethoscopes, and toys; alcohol at 70% showed to be more efficient to perform disinfection. **Conclusion:** the subject is incipient and does not provide consistent subsidies to establish appropriate protocol on the cleaning and disinfection of areas. **Descriptors:** Equipment Contamination; Hospital Infection; Disinfection.

#### RESUMO

**Objetivo:** caracterizar e descrever pesquisas brasileiras acerca da contaminação de superfícies em ambiente hospitalar. **Método:** revisão integrativa da literatura com o propósito de responder ao questionamento: *O que tem sido investigado, no Brasil, acerca da participação de superfícies inanimadas na veiculação microbiana em ambiente hospitalar?* Busca realizada em dezembro de 2011 utilizando-se as bases de dados Literatura Latino-Americana e do Caribe em Ciências da Saúde e Banco de Dados em Enfermagem. Um formulário de coleta de dados contemplando identificação do artigo, ano, amostra em estudo, objetivo, principais resultados e conclusão foi utilizado pelos autores. **Resultados:** evidenciaram-se publicações que descreveram 19 superfícies diferentes, dentre elas, colchão, estetoscópio, e brinquedos; o álcool 70% se mostrou mais eficiente para a realização da desinfecção. **Conclusão:** o tema é incipiente e não fornece subsídios consistentes para estabelecer protocolos apropriados de limpeza e desinfecção de superfícies. **Descritores:** Contaminação de Equipamentos; Infecção Hospitalar; Desinfecção.

#### RESUMEN

**Objetivo:** caracterizar y describir investigaciones brasileñas acerca de la contaminación de superficies en entornos hospitalarios. **Método:** revisión integradora del literatura con fin de responder la pregunta: *¿Lo ue ha sido investigado, en Brasil, acerca de la participación de superficies inanimadas en vinculación microbiana en ambiente hospitalario?* Busca realizada en mes de diciembre de 2011 utilizando las bases de datos de Literatura Latino Americana y del Caribe en Ciencias de Salud y Bancos de Datos en Enfermería. Un formulario de cosecha de datos contemplando identificación del artículo, año, muestra del estudio, objetivo, principales resultados y conclusión fue utilizado por los autores. **Resultados:** se evidenciaron publicaciones que describieron 19 tipos de superficies, incluyendo colchones, estetoscopio y juguetes. Alcohol de 70% resultó más eficiente para la desinfeción. **Conclusión:** nota que el tema es aún incipiente y no fornecen soporte consistente para establecer protocolos de limpieza y desinfeción de superficies. **Descriptores:** Contaminación de Equipos; Infección Hospitalaria; Desinfeción.

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## INTRODUCTION

Many factors influence the risk of microbial transmission in health services, including characteristic conditions of the individual, intensity of care, presence of invasive procedures, as well exposure to environmental sources. Thus, the maintenance of a biologically safe environment is a priority in preventing cross contamination. The hands of health professionals are the most common transfer means of pathogens. Generally, the environment occupied by colonized and infected patients may become contaminated and, therefore, inanimate areas and equipment are potential reservoirs for bacteria, especially those resistant to antimicrobial agents.<sup>1-3</sup>

Literature provides valuable information on the role of the area in the dissemination of microorganisms, including those resistant to various drugs, since the contamination of inanimate areas is frequent, thus making them possible reservoirs for microorganisms<sup>4-6</sup>. In addition, the presence of multiresistant bacteria increases the risk of infections related to health care (IRAS), considering the different contacts of the patient with the stethoscope, mattress, table, clothes, pillows, toys, thermometer, among others<sup>7</sup>. Although we cannot say that contaminated areas and equipment may be the responsible for disseminating IRAS, there is evidence that these items work as secondary reservoirs that may lead to cross contamination.<sup>7-8</sup> Knowing the possibility of contaminated environmental areas having a prominent role in the transmission chain of microorganisms, the accuracy of cleaning and disinfection procedures is required to minimize the incidence of colonization or infection.<sup>9-10</sup>

Currently, the identification of potential reservoirs in order to prevent the dissemination of microorganisms causing infections in health facilities is an important strategy to control the resistance of bacteria and IRAS, as it enhances the review and preparation of preventive measures<sup>5,7-8,11</sup>.

In a recent review article<sup>6</sup>, it is clear that there aren't studies on the bacteria dissemination environment and acquisition of IRAS in Brazil, since authors used various data bases and not a single Brazilian study has been included. Another review article<sup>12</sup> widely discussed the role of contaminated areas in the transmission of microorganisms and did not include any Brazilian study. We highlight

that only recently ANVISA (*Agência Nacional de Vigilância Sanitária*) released a manual discussing the subject more comprehensively, i.e., it approaches subjects ranging from the importance of the environment and areas of transmission of infections, human resources, sanitizing products, equipment and material used to clean and disinfect areas, to biosafety measures, among other subjects.<sup>3</sup>

These considerations justify our interest in developing an integrative review on the scientific production on the contamination of areas in the hospital environment, in Brazilian literature, in order to interpret the knowledge produced in the area and purposed to help in the development of further studies. Thus, the study is aimed at characterizing Brazilian studies on the contamination of inanimate areas in hospital health facilities.

## METHODOLOGY

The integrative review of literature was the method adopted by us, as it enables analyzing and summarizing existing studies. We used the following steps: Selection of research question, sampling, data extraction, analysis and synthesis of results and presentation of review.<sup>13</sup>

The research question was: what has been investigated in Brazil regarding the participation of inanimate areas in microbial borne in the hospital environment?

The bibliographic survey was conducted in December 2011 through electronic research in the data bases of Latin American and Caribbean Health Science Literature (LILACS) and Nursing Data Base (BDENF), considered the major ones in the Brazilian health area. It is worth mentioning that we also performed a reverse search in references of articles selected. The period of search in these data bases was not delimited.

The search was performed according to Health Science Descriptors (DeCS), crossing in the advance Data Bases forms the following controlled descriptors: Contamination of equipment and hospital contamination; hospital cleaning and disinfection service; contamination of equipment and disinfection; contamination and hospitalization; hospital infection and contamination; contamination and control of infections; hospital infection and fungi; resistance to drugs and contamination; transmission of infectious disease from professionals to patients and hospital infection.

We elected as inclusion criteria: full original articles, published in national or

international journals, in Portuguese, English and Spanish, on the participation of contamination of areas in microbial borne in hospital health care services. Publications of narrative reviews of literature, editorials, letters to the reader and experts' opinions were excluded.

A data collection form was prepared by the authors and used to fill each sample article. Data extracted from articles were presented descriptively, on tables providing information

on the year and sample studied, objective, main results and conclusion.

RESULTS

Of the 39 publications selected, 18 articles were used, according to the inclusion and exclusion criteria. Below, we present the synthesis of studies that were part of the research. In order to do so, we followed the chronological order of publication (Figure 1).

| Authors                        | Characteristics of Studies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
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| Dias et al. <sup>14</sup>      | Year: 1989.<br>Sample: sphygmomanometer<br>Objective: Evaluating the presence of pathogenic microorganisms in cuffs of sphygmomanometers used in hospital environment.<br>Main results: Predominance of agents with low virulence, of which the most frequent was the negative coagulase <i>Staphylococcus</i> ; however, presenting increasing genesis of nosocomial infections.<br>Conclusion: Although cuffs are considered non-critical items, they should be kept clean and disinfected.                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Marconcin et al. <sup>15</sup> | Year: 1991.<br>Sample: Blanket.<br>Objective: Determine the potential of contamination of blankets in hospital environment.<br>Main results: 100% (n=30) of contamination. In a total of 57 bacteria, the most frequent was coagulase negative <i>Staphylococcus</i> (35%).<br>Conclusion: There is no standard routine to clean and take general care of blankets, thus evidencing a source of hospital infection. They suggest defining a routine for handling blankets within the hospital environment.                                                                                                                                                                                                                                                                                                                                                                                                           |
| Novaes et al. <sup>16</sup>    | Year: 1997.<br>Sample: Toys.<br>Objective: Identify the bacterial flora in toys used by children, furniture and hands of professionals in the leisure room at a university hospital.<br>Main results: There was no significant growth of microorganisms in culture media. Prevalence of Gram positive <i>Micrococcus</i> and <i>Staphylococcus epidermidis</i> .<br>Conclusion: Routines adopted were efficient, i.e., cleaning is performed daily in the room before the commencement of activities, the floor is washed with water and ammonia-based detergent, tables and stools are cleaned with alcohol at 70%, and toys are washed with water and mild soap. The room is totally cleaned once a month.                                                                                                                                                                                                         |
| Brioschi et al. <sup>17</sup>  | Year: 1999.<br>Sample: Stethoscope.<br>Objective: Check through microbiological analyses the incidence of contamination by <i>Staphylococcus aureus</i> oxacillin and methicillin-sensitive and resistant.<br>Main results: Of the 150 stethoscopes, 137 (91.3%) of diaphragm cultures and 132 (89.2%) of indentations were infectious reservoirs, of which 11 (7.3%) were methicillin-sensitive and 3 (2%) were methicillin-resistant. As for indentations, 8 (5.3%) and 2 (1.3%) were methicillin-sensitive and methicillin-resistant, respectively.<br>Conclusion: Authors suggest the disinfection of diaphragms with alcohol at 70% prior to treating each patient.                                                                                                                                                                                                                                             |
| Araujo et al. <sup>18</sup>    | Year: 2000.<br>Sample: Stethoscope.<br>Objective: Determining the level of contamination in stethoscopes, identifying bacteria valuing the presence of <i>Staphylococcus aureus</i> and proposing decontamination measures.<br>Main results: 96 bacterial samples were isolated; 19/96 (19.8%) <i>Staphylococcus aureus</i> , 72/96 (75%) <i>Staphylococcus epidermidis</i> and 05/96 (5.2%) of other species. In some cases there was the association of both bacteria in a single sample collected. Among the samples of <i>Staphylococcus aureus</i> isolated, there was the determination of 05/19 (26.3%) of lines resistant to methicillin (MRSA).<br>Conclusion: Stethoscopes analyzed were characterized as a potential source of infection and dissemination of multiresistant microorganisms. One recommends to regularly clean stethoscopes with isopropyl alcohol (70%) or chlorhexidine based products. |
| Andrade et al. <sup>19</sup>   | Year: 2000.<br>Sample: Mattress.<br>Objective: Evaluating microbiological conditions of hospital mattresses prior to and after cleaning them.<br>Main results: 52 mattresses were studied, totaling 520 plates of which 514 (98.8%) resulted in positive cultures; 259 prior to cleaning and 255 after cleaning. There was the remarkable presence of fungi prior to and after cleaning.<br>Conclusion: Results showed that the routine of cleaning with phenol causes the movement of microbial load instead of decreasing it and showed to be inefficient against fungi.                                                                                                                                                                                                                                                                                                                                           |
| Brito et al. <sup>20</sup>     | Year: 2002.<br>Sample: Immobilizing splint for venipuncture.<br>Objective: Showing what happens to a immobilizing splint made by the nursing team and used by a children after being incubated into the same incubator.<br>Main results: Fungi grew and spread until almost fully covering the splint.<br>Conclusion: The splint is a potential source and its use needs to be reconsidered by the nursing team.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Mundim et al. <sup>21</sup>    | Year: 2003.<br>Sample: Mattress.<br>Objective: Evaluating the presence and position of <i>Staphylococcus aureus</i> colonies in beds at the intensive care unit of a school hospital prior to and after cleaning.<br>Main results: 50 mattresses were investigated, totalizing 600 culture plates with growth of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |

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| Martins-Diniz et al. <sup>22</sup> | <p><i>Staphylococcus aureus</i> in 94 (15.6%), 82 (87.2%) prior to and 12 (12.8%) after cleaning and disinfection. Conclusion: The process of cleaning with water and soap and disinfection with alcohol at 70% in mattresses should be performed according to the need and not according to predetermined criteria.</p> <p>Year: 2005.</p> <p>Sample: Bed, knob, telephone.</p> <p>Objective: Monitoring and characterizing airborne fungi and yeasts from biotic and abiotic sources in a hospital.</p> <p>Main results: Yeasts were found in 44% of samples, there was the prevalence of the gender <i>Candida</i> 70%, followed by <i>Trichosporon</i> spp.; <i>Candida guilliermondii</i> prevailed in knobs (52%).</p> <p>Conclusion: We observed a significant number of yeasts in abiotic sources. The environmental microbiological monitoring should be performed mainly in special rooms with immunocompromised patients.</p>                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Binatti et al. <sup>23</sup>       | <p>Year: 2006.</p> <p>Sample: Computer keyboard.</p> <p>Objective: Evaluating the microbial contamination level in computer keyboards at various sectors of a general, private hospital.</p> <p>Main results: Aerobic mesophilic organisms were detected in 82% of keyboards studied; coagulase positive <i>Staphylococcus</i> sp. with 50% resistance profile on drugs tested (12/24); however, these profiles were different from each other. Among them, 75% (3/4) were resistant to penicillin and 25% (1/4) were also resistant to oxacillin (MRSA). Enterococci were resistant to cefoxitin, ceftazidime and carbenicillin. No sample of <i>Enterococcus</i> sp. resistant to vancomycin was isolated.</p> <p>Conclusion: We recommend the use of transparent cover on keyboards of hospital computers, made of material resistant to products that should be used in their period disinfection, gloves before typing, washing the hands after using the keyboard and definition of protocol of use for computers.</p>                                                                                                                                                                                                                                                                                                                                          |
| Freitas et al. <sup>24</sup>       | <p>Year: 2007.</p> <p>Sample: Toys.</p> <p>Objective: Evaluate the presence of bacteria in toys used in a hospital and their drug resistance profile.</p> <p>Main results: In the evaluation of bacterial contamination of 10 toys studied, 06 genders and 22 species were recovered, totalizing 121 positive samples belonging to the environment and human microbiota, such as <i>Bacillus</i> sp., <i>Acinetobacter</i> sp., <i>Enterobacter</i> sp. and <i>Staphylococcus</i> sp. 90% of bacteria were resistant to only one or two antimicrobial agents. Conclusion: It is clear the risk of toys to cause cross infection. They suggest a daily routine of cleaning and disinfection without, however, describing when, how and with which such procedures should be performed.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Zanconato et al. <sup>25</sup>     | <p>Year: 2007.</p> <p>Sample: Mattresses.</p> <p>Objective: Evaluating the microbiological conditions of hospital mattresses prior to and before cleaning them with a white, clean cloth moistened with water and later disinfection with alcohol at 70% using the same cloth.</p> <p>Main results: The microbiological analysis performed in 14 mattresses with nutrient agar, prior to and after cleaning and disinfecting mattresses, showed that only 4 (28.5%) of mattresses studied had reduced Colony Forming Units (CFU). With BHI agar, 5 (35.7%) were reduced. The CFU average accounted per mattress sampled using nutrient agar prior to the disinfection was of 121 CFU, while after the average was 96 CFU. Using BHI agar, the average of CFU achieved after the disinfection was of 61 CFU and 16 CFU after disinfection. This reduction of total CFU in mattresses studied was not statistically significant for the nutrient agar; however, it was statistically significant for the BHI agar.</p> <p>Conclusion: Considering that sampling were performed in different parts of mattresses, the results achieved point out that the disinfection procedure is only replacing the microbial load to other points instead of reducing it. Changes in disinfection activity are suggested based on the recommendations by the Ministry of Health.</p> |
| Xavier et al. <sup>26</sup>        | <p>Year: 2009.</p> <p>Sample: Stethoscope.</p> <p>Objective: Comparing the action of alcohol at 70%, iodinated alcohol and sodium hypochlorite (100ppm) in the disinfection of stethoscopes in different pediatric units.</p> <p>Main results: 33 (86.8%) of stethoscopes had diaphragms contaminated prior to the disinfection, where negative coagulase <i>Staphylococcus</i> was the most frequent microorganism. After the disinfection there was the elimination of microorganisms from stethoscopes in two units, while the other had statistically significant reduction of contamination. However, approximately 95% of <i>Staphylococcus</i> spp. and 70% of <i>Streptococcus</i> spp. were sensitive to oxacillin; one and two strains of <i>Staphylococcus</i> were intermediary sensible to vancomycin and teicoplanin, respectively.</p> <p>Conclusion: The resistance to antibiotics shows that the stethoscope should be considered as an important mean for resistant bacteria. Disinfectants; sodium hypochlorite, iodine alcohol and alcohol at 70% were efficient in disinfection. However, they did not describe the concentration of iodinated alcohol.</p>                                                                                                                                                                                      |
| Melo et al. <sup>27</sup>          | <p>Year: 2009.</p> <p>Sample: Beds, incubators, windows, air conditioners, telephone, stethoscopes, doors and knobs.</p> <p>Objective: Perform the survey of fungi flora in Pediatric and Neonatal Intensive Care Units (ICU) at hospital das Clínicas, in order to identify the presence of potentially pathogenic and opportunistic fungi.</p> <p>Main results: The quantitative analysis of colonies showed the presence of 11 genders. They verified that more than 40% of colonies correspond to the <i>Penicillium</i> spp. gender, followed by <i>Cladosporium</i> spp. and <i>Chrysosporium</i> spp.</p> <p>Conclusion: Fungi found may present great potential of pathogenicity, especially in immunodepressed patients. It is important to adopt environmental control measures, such as asepsis of equipment, control of visitors presence, hands washing by professional and exchange of air conditioner filters.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| Ferreira et al. <sup>28</sup>      | <p>Year: 2011.</p> <p>Sample: Egg box-type mattresses.</p> <p>Objective: Evaluating the microbiological conditions of egg box-type mattresses of hospital use in order to identify the presence of <i>Staphylococcus aureus</i> and its phenotype of methicillin resistance (MRSA) prior to and after washing mattresses.</p> <p>Main results: There was a total of 180 plates collected from 15 mattresses, of which 139 (72.2%) were positive for <i>Staphylococcus aureus</i>. From this total, 77 (55.4%) and 62 (44.6%) corresponded, respectively, to the collection prior to and after washing mattresses. They evidenced significant reduction (p=0.023) of CFU; however, for the profile of resistance they found 8 (53.3%) mattresses with MRSA, where for two mattresses, MRSA was recovered after washing.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

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| Ilva et al. <sup>29</sup>     | <p>Conclusion: Egg box-type mattresses may become critical by contamination of fluids, secretions and excretions and, thus, represent a secondary reservoir for <i>Staphylococcus aureus</i> and MRSA, therefore contaminating hands and clothes of health professionals, equipment and contribute to the increase of infection levels.</p> <p>Year: 2011.</p> <p>Sample: Mattresses.</p> <p>Objective: Comparing two techniques of disinfection of hospital mattress using alcohol at 70%, in order to test their efficiency in reducing microorganisms.</p> <p>Main results: Of the six beds studied in technique 01 (unidirectional cleaning, from the cleaner to the most contaminated area), four were contaminated prior to cleaning, and contamination was reduced in two (50%) of contaminated mattresses. As for technique 02 (independent circular movements of the contamination degree) there was microbial reduction in all six (100%) mattresses evaluated. <i>Staphylococcus aureus</i> was found both prior to and after disinfection.</p> <p>Conclusion: Although technique 2 provided greater reduction of microbial count, it is necessary to perform further studies using a greater number of mattresses and also related to products and to the improvement of new techniques.</p> |
| Ferreira et al. <sup>10</sup> | <p>Year: 2011.</p> <p>Sample: Bed rails, bed crank, table, infusion pump buttons and cotton aprons.</p> <p>Objective: Evaluating the presence of <i>Staphylococcus aureus</i> resistant to methicillin (MRSA) in areas close to patients hospitalized in General ICU.</p> <p>Main results: of total 63 samples collected, 48 were positive for <i>Staphylococcus aureus</i>, of which 29 (60.4%) were resistant to methicillin. The incidence in bed rails and cranks, table, infusion pump buttons and aprons was respectively 55.5%, 57.1%, 57.1%, 60.0% and 75.0%.</p> <p>Conclusion: Results suggest that the areas surrounding the patient are an important treat, as they represent secondary MRSA reservoirs.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Ferreira et al. <sup>9</sup>  | <p>Year: 2011.</p> <p>Sample: Bed rails, crank, bedside table, infusion pump buttons.</p> <p>Objective: Describing the cleaning/disinfection conditions of four areas close to patients hospitalized in a ICU.</p> <p>Main results: 100 evaluations of areas were performed after cleaning. Three methods were used to evaluate cleaning: Visual inspection, adenosine triphosphate (ATP) bioluminescence and presence of <i>Staphylococcus aureus</i>/MSRA. Respectively, 20, 80 and 16% of evaluations by visual methods, ATP and presence of <i>Staphylococcus aureus</i>/MSRA were considered disapproved. There were statistically significant differences (p&lt;0.05) among the disapproval rates for cleaning using methods ATP, compared to the visual and microbiological methods.</p> <p>Conclusion: Visual inspection was not enough to evaluate the cleaning of areas. Results showed that the routine of cleaning adopted needs to be reviewed.</p>                                                                                                                                                                                                                                                                                                                                         |

**Figure 1.** Summary of studies performed by Brazilian researchers on the contamination of areas sorted by year, sample, objective, main results and conclusion.

Considering the first author of each article, we found an author with three publications on the subject; however, authors were distinct for the other studies.

The publications analyzed studied 19 types of areas, including mattresses (05), stethoscopes (03), toys (02), immobilizing splint for upper limbs (01), blanket (01), sphymomanometer (01), computer keyboard (01). In four articles author have researched other areas along with those, they are: Bed, knob and telephone; bed, incubators, windows, air conditioners, telephone, stethoscopes, doors and knobs; bed rails, bed crank, bedhead table, infusion pump buttons and cotton aprons; and bed rails, bed crank, bedhead table and infusion pump buttons.

The subject of contamination of areas was prevalent in publications in medical journals (nine articles), followed by nursing journals (five articles), between 2000 and 2011, and most publications are dated 2011 (four articles). Generally, we observed increased interest in this subject for the last 10 years.

Regarding the titration of the main author of each article, most of them are students (six articles), and the other authors are: Professor (four articles), Biologist, Pharmacist and Resident in General Surgery (one article each). The other five articles do not indicate

the professional category of authors.

Most studies (twelve articles) were performed in the Southeast of Brazil (São Paulo, Rio de Janeiro, Minas Gerais), followed by South (Rio Grande do Sul and Paraná) and only one publication was performed in the Midwest (Mato Grosso do Sol) and, finally, one from the Northeast (Paraíba).

DISCUSSION

Although it is difficult to associate the transmission of microorganisms from areas to patients and the consequent acquisition of IRA, studies have been evidencing that such areas have been housing resistant microorganisms, making them a potential reservoir. It is worth warning on the evidence that environmental control reduces the risk of serious fungal infections in immunocompromised patients, leading to the creation of a protective environment. We still add the continuous increase of incidence of infections by multiresistant microorganisms in all treatment situations, related to an increased knowledge of transmission of these agents, leading to the need of specific recommendations for surveillance and control of these pathogens in inanimate media.<sup>14,17-8</sup>

Studies<sup>21,25,29</sup> performed to evaluate the microbiological conditions of mattresses used

alcohol at 70% to disinfect mattresses. The results of these studies showed that the procedure was not being effective. There are many evidences that the cleaning and disinfection of equipment and areas are needed; however, although essential in health treatment, they hardly remove all existing microorganisms. Thus, the high contamination levels of surfaces suggests that the current cleaning and disinfection method used by the studied institutions was not satisfactory. We should also consider that the techniques used in cleaning and disinfection of mattresses used in the studied are not clearly described, or they differ considerably, since there are no conclusive studies on the variables that may interfere the effectiveness of disinfection of areas by using alcohol.<sup>10</sup>

Another study<sup>28</sup> approached the cleaning and disinfection of egg box-type mattresses and found that the process was not efficient, showing that these mattresses may work as a reservoir for *Staphylococcus aureus* and *Staphylococcus aureus* microorganisms resistant to oxacillin. In the study, mattresses (uncoated foam) were rolled and tied and later processed in an automatized washing machine in the laundry sector, with the cycle of blanked using sodium hypochlorite at 10%, that even in high concentration could not eliminate contamination.

The use of Phenol in the disinfection of hospital mattresses coated with tissue or plastic cover showed the ineffectiveness of the product against fungi and bacteria, because the number of positive plates after cleaning was relevant and the microbial load in both types of mattresses was kept after cleaning. The authors highlight the need of changes in the cleaning activity of this object<sup>19</sup>. In this study there are further details in addition to indicate that cleaning was performed by nursing professionals, through manual friction using detergent-synthetic phenol disinfectant solution, and therefore, the way of cleaning and concentration of product are not mentioned.

It is worth highlighting that the results of studies involving mattresses reflect the need of an accurate reevaluation of cleaning and disinfection procedures currently used within these institutions. It should be noted that the studies diverge or fail in detailing the aspects of these processes, whether in the type of cloths used, the frequency of exchange of cloths, and the contact time of products, the friction method, the concentrations of types of detergents and/or soaps used, microbiological collection methods; or the

process of samples and culture media used.

The most indicated products to perform the disinfection of areas and equipment in health premises are alcohol and sodium hypochlorite. Alcohol is indicate at 70% in weight, in three applications by friction. Waiting for the drying between each procedure. It may be used in concurrent disinfection, i.e., daily disinfection. However, the product may damage plastic and rubber. As for sodium hypochlorite used to decontaminate areas, its recommended concentration is of 1% active chlorine (10:000 ppm) for ten minutes. It may cause corrosion in metallic objects; however, it is a good choice for floors.<sup>3</sup>

Although it is recommended to use alcohol on areas, there are no parameters of contact time, type of friction and material to be used (cotton cloth, microfibers, disposable wipes with disinfectant) to friction the product over the areas. It should be considered that alcohol at 70% loses some of its effectiveness in the presence of organic matter; however, it is recommended to previously clean the area prior to disinfection<sup>3</sup>, and this was not performed in any study.<sup>29</sup>

In addition to the cleaning and disinfection of areas and equipment in hospital environment, hand hygiene stands out in order to provide safe care. The hands of health professionals and of people within the sector are an important mean of dissemination of pathogens among patients and the environment and vice-versa. However, it was found that hand hygiene does not have sufficient adhesion among health professionals, probably due to their multiple tasks, skin irritation, access to the sink, products, level of knowledge, motivation, beliefs, among other factors.<sup>3,6</sup>

Thus, hand hygiene with water and mild soap and/or alcohol gel at 70% is recommended; however, keeping direct contact with contaminated areas and patients may result in the transport of various microorganisms.<sup>6-7,11</sup> Even when hands are duly washed, there is the possibility of transferring microorganisms from hands to patients and areas that are touched by the professional during treatment; this probably occurs as the areas close to patients could be contaminated, thus generating cross infections.<sup>6-7,11, 28</sup> Therefore, the monitoring of horizontal surface such as furniture and equipment has been currently the focus of studies.<sup>1-2,4-8,11</sup>

Currently there are various equipment,

artifacts and objects used in health care, which may have their areas contaminated by microorganisms of epidemiological importance.

The sphygmomanometer is a non-critical artifact used in health services collectively among patients, and a study showed that the amount of microorganisms in cuffs was higher in the general surgery facility, an interesting result since that facility had the highest number of infections<sup>14</sup>. However, the study design did not allow this correlation to be performed.

The study showed the effectiveness<sup>26</sup> of the disinfection of stethoscopes, for the following disinfecting agents: Sodium hypochlorite (100ppm) (pp=0.0005), iodinate alcohol (p=0.0007) and alcohol at 70% (p=0.0010). However, it is worth highlighting that authors did not describe how disinfection was performed, considering the time and the method of application of disinfectants. From the epidemiological point of view, identifying multiresistant samples such as *Staphylococcus aureus* methicillin resistant (MRSA) in diaphragm, bell and indentations of stethoscopes denotes an alarming fact, as the treatment is of high cost and drugs are potentially toxic.<sup>17-8</sup> However, disinfection by alcohol-based products, according to the authors, effectively reduced the amount of bacteria in this equipment.<sup>26</sup> On the other hand, there are recommendations<sup>17-8</sup> of friction with alcohol at 70% or chlorexidine<sup>18</sup> both in the diaphragm and indentations using swab to clean as a supplement, because in indentations there may be a higher accumulation of organic substance, thus enabling bacterial growth.<sup>17</sup> It is worth highlighting that the recommendations by authors do not detail the timing, inputs and methods used to perform the procedure.

It is recommended that equipment that gets in contact only intact skin, like thermometers and stethoscopes, generally require only cleaning followed by low level disinfection that will result in the elimination of vegetative bacterial forms; however, not spores, and thus usually ethyl or isopropyl alcohol is used at 60% and 90% (v/v).<sup>3</sup> However, this recommendation does not describe how to perform disinfection and the contact time needed between the disinfecting agent and the area.

The cleaning of the patient facility is purposed to remove dirt using germicide substances and friction, thus preventing the dispersion of microorganisms found on furniture. However, it was observed that the

way it has been performed, particularly, the cleaning and disinfection of various areas, only displace dirt from one point to another, as microorganisms such as *Staphylococcus aureus*, MRSA and fungi sometimes have been found after cleaning and disinfection of various áreas studied.<sup>9-10,19,21,25,28-9</sup>

Environments such as Intensive Care Unit (ICU) and surgical center need attention with microorganisms present on areas, as they are conditioned, indoor facilities with immunocompromised patients. A study showed samples of fungi on the furniture of such facilities. The most prevalent microorganisms were yeasts and *Candida guilliermondii* on beds and telephones, and mainly on door knobs of ICUs. The emergence of fungi such as *Cândida lusitaniae* was worrisome because of its potential strength. The displacement from one place to another of yeasts was suggested, as an isolated sample found in the knob of the neonatal ICU was found one week later in the knob of the adult ICU. However, genotyping studies were not performed to confirm the similarity of strains. Authors suggest the monitoring of the environment and areas thus enabling the identification of control measures and the improvement of therapy to be provided.<sup>22</sup>

Another study<sup>27</sup> was aimed at surveying the fungi microbiota of Pediatric and Neonatal ICUs in a hospital. Thirteen samples were collected using swab; two were collected from air conditioners, one from the telephone, four from stethoscopes and another five from doors and knobs. They verified that more than 40% of colonies correspond to the *Penicillium* spp. gender, followed by *Cladosporium* spp. and *Chrysosporium* spp. Among the most prevalent genders, *Cladosporium* spp. was isolated in all sites studied, while *Penicillium* spp. and *Chrysosporium* spp. were not found only in telephones. The only place that there was no growth of yeasts was the internal part of a door.

Currently, objects such as toys and books in the hospital leisure room daily contact hospitalized children in the pediatric ward thus becoming a potential means of transmission of pathogens. In studies analyzed, we found the prevalence of environmental bacteria; however, resistant bacteria were found only in a study involving toys.<sup>24</sup> Test results on drug susceptibility showed that 90% of bacteria were resistant to only one or two antimicrobial agents. *Staphylococcus* sp. bacteria isolated in this study showed to be resistant to penicillin G

and oxacillin. Among the negative Gram bacilli found (*Enterobacter cloacae* and *Enterobacter sakazakii*), all of them showed sensitivity to amikacin and imipenem. Some species were resistant to ceftazidime and cefuroxime. *Acinetobacter lwoffii* was resistant to antimicrobial agents such as penicillin G and aztreonam.<sup>24</sup> On the other hand, a routine of daily cleaning of the hospital leisure room was efficient, thus making this environment a low risk area for transmissions (Table 1).<sup>16</sup>

With the advancement of technology, computers and peripherals have been part of fixed materials in hospital facilities and are daily handled by the health professionals, thus becoming fomites. One study<sup>23</sup> analyzed 50 computers in 09 sectors of a particular hospital in the city of Rio de Janeiro and showed 82%(41/50) of keyboards with aerobic mesophilic microorganisms, a result compatible with that found in other areas. The most recovered microorganisms were fungi in 84%(42/50). A low amount of enterococci were found in 24%(12/50) of samples, of which only 20% (10/50) grew in qualitative tests. Staphylococci were detected in 28% (14/50) of the keyboards, and 28.5%(4/14) isolates of coagulase-positive staphylococci. No *Enterobacteriaceae* bacteria were found in samples collected from keyboards. Only 6%(3/50) of keyboards did not have microbial growth. A worrying finding were multiresistant bacteria such as *Staphylococcus coagulase positive* (12/24) that were resistant to many drugs. It is worth highlighting that one of the strategies suggest to difficult the dissemination of microorganisms was the use of procedure gloves<sup>23</sup> every time professionals used the keyboard. However, such measure seems to be impracticable from a cost-benefit point of view, as the time professionals use the computer is short and frequent.

The immobilizing splint for upper limbs was also highlighted as fomite. It is an equipment usually made by the nursing team using porous materials and used and reused in children to stabilize venous infusion. It was found that this equipment is a potential means of spreading microorganisms, as it became clear that the splint after 30 days in an environment similar to gases, covered in mold, indicating the presence of fungi. The authors suggest, for a better quality of nursing care, a review of techniques grounded in scientific research<sup>20</sup>, without, however, suggesting alternative possibilities in stabilizing or intravenous methods of cleaning and disinfection.

Inadequate care with storage and cleaning of blankets has been making them sources of microorganisms, as confirmed in the study<sup>15</sup> that shows 100% of contamination of samples, including those used by teams of physicians, as most bacteria were multiresistant and the most prevalent microorganism was negative coagulase *Staphylococcus*. Authors suggest the need to define a routine of treatment of hospital blankets in order to prevent the proliferation and dissemination of such multiresistant microorganisms. Additionally, once again, they did not indicate or tested cleaning, disinfection or storage routines, in order to control the situation evidenced.

Considering studies analyzed, we noticed that some recommendations to decrease or prevent contamination of areas are evasive and contribute little to the use in clinical practice, thus showing the need to better outline cleaning and disinfection procedures, in order to achieve evidence on their effectiveness in reducing the microbial load on environmental areas and thus the dissemination of microorganisms.

The microorganisms commonly found in the surfaces of objects, items and equipment, were *Staphylococcus aureus* followed by coagulase-negative *Staphylococcus*. *Staphylococcus aureus* can be considered as the main causative agent of infections acquired in the hospital community and environment, in addition to be one of the most prevalent causes of infections related to health care, such as pneumonia related to mechanical ventilation and bacteremia related to catheter.<sup>9-10,28</sup> The second coagulase negative *Staphylococcus* microorganism constitutes the skin normal microbiota, being considered as low virulence bacteria, despite causing risks of infection for immunocompromised patients.<sup>14,26</sup> The presence of fungi in various areas also stood out.<sup>19-20,22-3,25,27</sup>

The detection of such microorganisms of epidemiological importance in the areas reinforces the assumption that the environment close to the patient becomes contaminated, thus forming a potential reservoir for the dissemination of pathogens.<sup>1</sup> Therefore, the proper cleaning and disinfection of areas may contribute to the reduction of contamination and dissemination of resistant bacteria within the environment, patients and professionals.<sup>6</sup>

Although this study was not designed to demonstrate the relationship between microbial contamination of surfaces and the incidence of infections acquired in health

establishments assistance hospital, it was found that all items surveyed, at some point, were contaminated by microorganisms from the skin microbiota and other sites, which may pose a risk to vulnerable patients, especially in hospitalized patients, debilitated and undergoing invasive procedures.

The IRAS control is a challenge with several casualties, thus placing enormous difficulties to implement an effective prevention and control program, in a way that challenging IRAS requires an increasing effort for health professionals. The barriers range from the adoption of simple every day, as the act of hand hygiene, to the complex dynamics of the organizational structure of normalizing institutions, providers and executors.<sup>30</sup>

## CONCLUSION

This study on the contamination of areas in hospital health services enabled us to identify that there was the prevalence of descriptive transversal studies; areas studied were: mattresses, toys and stethoscopes, respectively, there was predominance of publications in medical journals followed by nursing titration of the first author of each article was students, followed by faculty; prevailed in the southeastern publications, the alcoholic solution at 70% was more to achieve efficient disinfection, and *Staphylococcus aureus* was the microorganism most frequently followed by coagulase-negative *Staphylococcus* among certain types of fungi.

Finally, there is the need of greater investment in the Brazilian scientific production on the contamination of hospital areas, regarding sanitizing products and inputs used, cleaning and disinfection procedures, and likewise establishing the clonal relation of strains found on areas, as well as those present in patients and health professionals, in order to demonstrate the dispersion of microorganisms and the importance of cleaning and disinfection to control dissemination.

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