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ORIGINAL ARTICLE

Evaluation of Extrinsic Contamination of Liquid Soap Used for Handwashing in a Philanthropic Hospital

Avaliação da Contaminação Extrínseca de Sabonete Líquido Utilizado para Lavagem das Mãos em um Hospital Filantrópico

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ABSTRACT

Introduction: Health Care Infections are a public health problem, and are caused by a number of microorganisms. As a way of preventing the hygiene of the hands is shown as a great measure, however, the soaps and antiseptics used during this process can be an important vehicle of contamination, which may occur during the manufacturing process or during its use. **Objective:** To evaluate the extrinsic contamination by pathogenic bacteria of liquid soaps used by health professionals in a philanthropic hospital. **Materials and Methods:** Sixty-four samples of 32 soap dispensing push buttons were collected through sterile Swabs and 32 liquid soaps. The samples were inoculated in BHI broth, incubated for 24/48 hours in an aerobic oven at 35ºC. They were spiked in MacConkey Agar and Blood Agar and incubated for 24/48 hours in aerobiosis at 35 ± 1ºC. The colonies present in the culture media were identified by biochemical and physiological tests and submitted to the antimicrobial susceptibility test. **Results:** Of the 64 samples collected, in 25 (39.06%) there was a growth of bacteria, 14 (21.87%) were dispensed and 11 (17.19%) in soaps, 28 strains were identified with a prevalence of 12 (42.85%) of *Acinetobacter spp*, 4 (14.28%) of *Enterobacter cloacae*, 3 (10.72%) of *Klebsiella oxytoca*, 3 (10.72%) of *Pantoea spp.*, 3 (10,72 %) of *Pseudomonas spp.*, 2 (7.14%) of *Escherichia coli*, and 1 (3.57%) of *Klebsiella pneumoniae*. **Conclusion:** There was extrinsic contamination of liquid soaps by pathogenic bacteria.

Keywords: Hand hygiene, Soaps, Contamination, Health Care-Related Infections.

RESUMO

Introdução: As Infecções Relacionadas à Assistência à Saúde representam um problema de saúde pública, e são causadas por diversos microrganismos. Como forma de prevenção a de higienizar das mãos se mostra como uma grande medida, porém os sabonetes e anti-sépticos utilizados durante esse processo podem ser um importante veículo de contaminação, que pode ocorrer durante o processo de fabricação ou durante seu uso. **Objetivo:** Avaliar a contaminação extrínseca por bactérias patogênicas de sabonetes líquidos utilizados por profissionais de saúde em um hospital filantrópico. **Materiais e Métodos:** Foram coletadas 64 amostras, 32 pushs de dispensação do sabonete, através de Swabs estéreis e 32 sabonetes líquidos. As amostras foram inoculadas em caldo BHI, incubadas por 24/48 horas, em estufa de aerobiose, à 35ºC. Foram repicadas em Ágar MacConkey e Ágar Sangue e incubadas por 24/48 horas, em aerobiose, a 35º ± 1ºC. As colônias presentes nos meios de cultura foram identificadas por provas bioquímicas e fisiológicas e submetidas ao teste de sensibilidade aos antimicrobianos. **Resultados:** Das 64 amostras coletadas, em 25 (39,06%) houve crescimento de bactérias, sendo 14 (21,87%) pushs de dispensação e 11 (17,19%) em sabonetes, 28 cepas foram identificadas com prevalência de 12 cepas (42,85%) de *Acinetobacter spp*, 4 (14,28%) de *Enterobacter cloacae*, 3 (10,72%) de *Klebsiella oxytoca*, 3 (10,72%) de *Pantoea spp.*, 3 (10,72%) de *Pseudomonas spp.*, 2 (7,14%) de *Escherichia coli*, e 1 (3,57%) de *Klebsiella pneumoniae*. **Conclusão:** Houve contaminação extrínseca dos sabonetes líquidos por bactérias patogênicas.

Palavras-chave: Higienização das mãos, Sabões, Contaminação, Infecções Relacionadas à Assistência à Saúde.

INTRODUCTION

Health Care-Related Infections (HCRI) refer to those acquired during health care delivery, after patient admission, during hospitalization or after discharge[1]. They represent an important public health problem, both in developed and developing countries, as they increase morbidity and mortality rates, extend hospitalization and raise hospital costs[1,2].

Despite important advances in infection control, studies have demonstrated the emergence of the problem globally, with a marked increase in the frequency and severity of cases of HCRI[3,4]. In the United States, more than 70% of the bacteria isolated in hospitals are resistant to at least one antimicrobial commonly used in the treatment of infection[5]. The acquisition of resistant microorganisms usually occurs due to the non-adherence of the professionals to biosafety measures, the work overload, sometimes the reduced number of human resources and the direct contact of the patient with environment or contaminated material[4,5].

Currently, it is believed that a considerable proportion of HCRI can be avoided, and hand hygiene is still very important in this context because it is a measure of unquestionable effectiveness and low cost, since the microorganisms most associated with the occurrence of such infections belong to the transient microbiota (acquired through contacts established with persons colonized or infected and/or with contaminated objects). These microorganisms can be eliminated through hand hygiene, which, when not performed or performed inadequately, is a basic premise for the occurrence of cross-transmission[6,7].

Hand hygiene along with correct technique should be part of the routine of health professionals. Well-performed studies have shown the importance of this practice in the reduction of HCRI rates and the majority of specialists in infection control affirm that this procedure is the simplest and most effective means of preventing the transmission of microorganisms in the care environment[8,9].

Hand-washing with soap and water eliminates transient microorganisms and reduces residents and, most of the time, disrupts the disease transmission chain. As a way to prevent infections the action of hand hygiene is shown as a great measure, but it is important to remember that the soaps and antiseptics used during this process can be an important vehicle of contamination, which contamination can occur during the process (intrinsic contamination) or during its use (extrinsic contamination)[10,11].

Considering the above mentioned, this study aimed to evaluate the extrinsic contamination by pathogenic bacteria of liquid soaps used during the handwashing process of health professionals in a philanthropic hospital.

METHODS

The design adopted in this study was cross-sectional descriptive, where we evaluated the presence of extrinsic contamination of liquid soaps used in a philanthropic hospital.

The samples were collected in the months of August and September 2016, of plastic soap holders, fixed to the wall, with refill for replenishment and soap dispenser. With sterile swab with Stuart medium (Labor® Swab) the sample was collected from the push and 1 ml of the liquid soap was collected in the test tube. After the

collection, the samples were sent to the microbiology laboratory of the Faculty of Medical Sciences and Health of Juiz de Fora.

The samples were inoculated in BHI broth (Mbiolog diagnostics Ltda. ®), incubated for 48 hours in an aerobiose oven (Fanem® 502 São Paulo - Brazil), at 35ºC ± 1. After this incubation period, they were spiked in Blood Agar 5 (RenyLab®, Química e Farmacêutica) and incubated for 24-48 hours in aerobiosis at 35° ± 1°C and biochemical tests were performed to identify each species[12,13]. For the identification of Gram-negative rods, OF, IAL, citrate, arginine, ornithine, lysine, motility, oxidase and resistance to polymyxin B were used[12,13].

The bacteria identified underwent antimicrobial susceptibility test (AST) by the Disk Diffusion Agar method, according to the standardization of the CLSI 2016 - Clinical Laboratory Standards Institute[14].

For the *Enterobacteriaceae* family, the following antimicrobials were tested: amoxicillin + clavulanate, ceftazidime, ceftriaxone, cefepime, aztreonam, ertapenem, meropenem, imipenem, gentamicin, amikacin, sulfamethoxazole + trimethoprim, ciprofloxacin and levofloxacin.

For *Acinetobacter spp.*, ceftazidime, ceftriaxone, cefepime, meropenem, imipenem, gentamicin, amikacin, sulfamethoxazole + trimetoprin, levofloxacin, ciprofloxacin, ampicillin + sulbactam and tetracycline were tested. And for *pseudomonas spp.*, piperacillin + tazobactam, caftazidime, cefepime, aztreonam, gentamycin, imipenem, meropenem, amikacin, levofloxacin, ciprofloxacin were tested.

RESULTS

32 soap dispensers were analyzed, totalizing 64 samples, 32 soap dispenser pushbuttons and 32 liquid soaps used in different sectors of the hospital, being divided into Intensive Care Unit 1 - ICU1 (14 samples), Neonatal Intensive Care Unit - NICU (10 samples), Intensive Care Unit 2 - ICU2 (12 samples), Intensive Care Unit Reception Room 1 - ICURR1 (4 samples), Surgical Center - SC (4 samples), Normal Delivery Center - NDC (4 samples), Inpatient Unit 5 - INPU5 (4 samples), Inpatient Unit 6 -INPU6 (8 samples) and in the Canteen - CAN (4 samples).

Of the 64 samples collected, in 25 (39.09%) there was growth of bacteria, 14 (21.87%) in the dispensing push buttons and 11 (17.19%) in soaps. The percentage of microbial growth according to the sampled site is described in figure 1. In 4.68% of the samples there was growth of more than one bacterial species.

In relation to the microorganisms found, of the 25 positive samples of dispensing push buttons and soaps, 28 strains were identified, being 12 strains (42.85%) of *Acinetobacter spp*, 4 (14,28%) of *Enterobacter cloacae*, 3 10.72%) of *Klebsiella oxytoca*, 3 (10.72%) of *Pantoea spp.*, 3 (10.72%) of *Pseudomonas spp.*, 2 (7.14%) *Escherichia coli*, and 1 (3.57 %) of *Klebsiella pneumoniae* as described in figure 2.

In the ICU1, 60.0% of the positive samples were *Acinetobacter spp.* and 40.0% *E. coli*. In NICU the prevalence was 50.0% of *Acinetobacter spp.*, 33.33% of *Pantoea spp*. and 16.67% of *K. pneumoniae*. In ICU2 the growth was 100.0% of *Acinetobacter spp.*, and in the NDC it was 50.0% of *Pseudomonas spp.* and 50.0% *E. cloacae*. In ICURR1 it was 100.0% of *Acinetobacter spp*. and in the CAN it was 100.0% of *Pseudomonas spp*. In INPU5 it was 50.0% of *K. oxytoca* and 50.0% of *E. cloacae*, and in INPU6 it was 50.0% of *Acinetobacter spp.* and 50% of *Pantoa spp*. In SC it was 50.0% of *E. cloacae* and 50.0% of *K. oxytoca*, according to table 1.

The Antimicrobial Sensitivity Test (TSA) was performed to evaluate the resistance profile of the bacteria found. The antimicrobials tested were in accordance with the CLSI 2016 standardization, and the observed resistance profile is reported in table 2.

By means of phenotypic tests, *E. coli strains* (2), *K. oxytoca* (1), *K. pneumoniae* (1) and *E. cloacae* (1) were found to be extended-spectrum beta-lactamase (ESBL) producers, and the *Pseudomonas sp.* strains (3) were AmpC beta-lactamase producing agents.

DISCUSSION

Most environments are susceptible to contamination by microorganisms directly related to the local hygienic situation. Consequently, objects of routine use and with inadequate hygiene may become

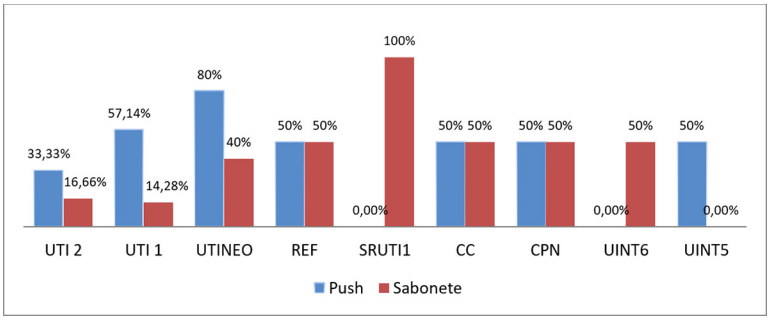

Figure 1. Percentage of microbial growth in dispensing push buttons and liquid soaps, distributed by hospital sectors.

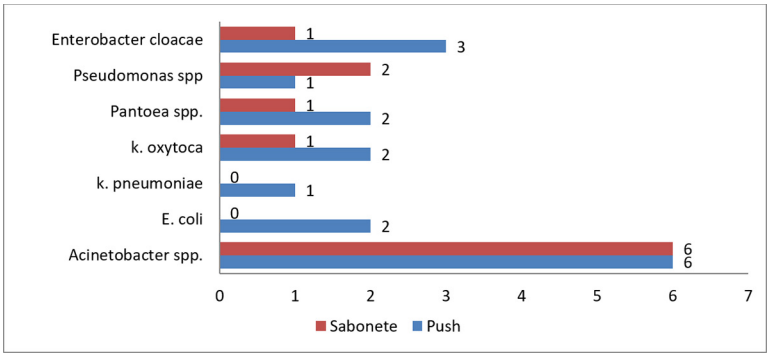

Figure 2. Distribution of the number of bacterial species found in the dispensing push buttons and soaps of a philanthropic hospital.

Table 1. *Distribution of bacterial strains by hospital sectors.*

	ICU1	ICU2	NEOICU	CAN	ICURR1	SC	NDC	INPU5	INPU6
E. cloacae	-	-	-	-	-	50.0%	50.0%	50.0%	
Pantoea spp	-	-	33.33%	-	-	-	-	-	50.0%
Acinetobacter spp	60.0%	100.0%	50.0%	-	100.0%	-	-	-	50.0%
Pseudomonas spp.	-	-	-	100.0%	-	-	50.0%	-	-
K. oxytoca	-	-	-	-	-	50.0%	-	50.0%	-
K. pneumoniae	-	-	16.67%	-	-	-	-	-	-
E. coli	40.0%	-	-	-	-	-	-	-	-

Table 2. *Resistance profile of the bacterial strains isolated from the dispensing push buttons and soaps, compared to the tested antimicrobials.*

Bacteria	Observed resistance	Rate	
		nº	%
Klebsiella pneumoniae (1)	CAZ, CRO, AMC, ATM, CPM, GEN, SUT	1	100
Klebsiella oxytoca (3)	CAZ, CRO, AMC	3	100
	CPM, ATM , GEN, AMI	1	33.33
Escherichia coli (2)	CAZ, CRO, AMC, ATM, CPM, GEN, SUT, CIP	2	100
	LVX	1	50
Enterobacter cloacae (3)	CAZ, CRO, AMC, ATM, CPM, GEN, SUT, CIP, LVX	1	33.33
Pseudomonas spp. (3)	CAZ, CPM	3	100
Acinetobacter spp. (12)	CAZ, TET, CRO , CIP, CPM, LVX, IMP, MER	12	100
	GEN, AMI	3	25

CAZ, Ceftazidime; CRO, Ceftriaxone; CPM, Cefepime; ATM, Aztreonam; PPT, Piperacillin + Tazobactan; ASB, Ampicillin+Sulbactan; AMI, Amikacin; GEN, Gentamycin; LVX, Levofloxacin; SUT, Sulfamethoxazole + Trimethoprim; AMC, Amoxicillin + Clavulanate.

foci of contamination and infection in susceptible hosts. The survival of microorganisms in the environment varies on different types of surfaces, varying from a few minutes to months. The longer a microorganism persists viable on a surface, the longer it remains as a source of transmission, thus increasing the chance of transfer to a host[15].

A central issue in the prevention and control of infections is the importance of handwashing as the primary effort of health professionals to prevent and spread infectious diseases in the clinical setting[16,17]. However, liquid soap can become contaminated with bacteria and represent a recognized health risk in health care settings[16,18]. In particular, reusable soap dispensers are prone to bacterial contamination and several outbreaks associated with the use of contaminated soap in health care settings have been reported[10,16,18-21].

Manufacturers provide instructions for handwashing, but typically do not provide instructions for recharging dispensers. Such instructions would be beneficial because liquid soaps are purchased in gal-

lons to recharge the dispensers[18]. In addition, when reusable pumps are supplied and transferred into several bottles, cross-contamination is a concern. Regular observation of expiration dates is important because active or preservatives agents may degrade over time, which may reduce the effectiveness of soap against microorganisms[18, 22].

Open dispensing systems, according to the practice used in the institution of the present study, and the manipulation of liquid soaps in the hospital environment are known risk factors for the microbial contamination of these products[10]. Some studies make recommendations to prevent soap from becoming a source of infection, such as buying disposable dispensers, using soap bottles with smaller volumes, limiting the use of liquid soap, providing individual soap to patients, and increasing disinfection with alcohol gel[10,23].

Although facilities may have documented cleaning protocols for liquid soap dispensers, noncompliance may be a problem that leads to contamination. Several studies have investigated the microbial contamination of liquid soaps in hospital and community settings. A number of opportunistic bacterial pathogens were recovered from liquid soaps, including *Klebsiella pneumoniae*, *Serratia marcescens*, *methicillin-resistant Staphylococcus aureus* (MRSA), *Pseudomonas sp.* and *Enterobacter spp*.[16,20].

In the present study, it was found that 39.06% of the samples were contaminated. Twelve strains of *Acinetobacter spp*., the main pathogen identified, were found. *Acinetobacter spp*. has been responsible for causing different types of infections, such as pneumonia, septicemia, urinary infections and meningitis, especially in immunocompromised patients, and is considered an opportunistic pathogen of great importance in HCRI[24]. During the last decade, the treatment of these infections has become critical due to the emergence of multiresistant strains whose dissemination has been associated with the contamination of hospital equipment (respirators, air conditioning, imaging equipment, etc.) and/or through contaminated hands of the care team[24,25].

Pseudomonas spp. is a ubiquitous microorganism found easily in any hospital setting and is an important agent of HCRI frequently identified as a causal agent of infection due to its ability to survive in places of high humidity such as sinks and breathing apparatus as ventilation masks[26]. Almost all hospital equipment and materials, mainly with liquid components, can serve as reservoirs for *Pseudomonas spp.* including respiratory ventilation equipment, intravenous therapy and even some germicides such as liquid soap and disinfectants[10,26]. Intrinsic resistance to multiple antimicrobials contributes to the opportunistic nature of this pathogen[26,27]. It was found in this study that 100% (3) of the strains of *Pseudomonas sp*. were AmpC beta-lactamase producing agents, an enzyme that confers resistance to cephalosporins and penicillins.

It was observed the growth of *Enterobacteriaceae* strains, 5 were ESBL producers, being *E. coli* (2), *K. oxytoca* (1), *K. pneumoniae* (1) and *E. cloacae* (1). The production of ESBL by enterobacteria has an important impact on the morbidity and mortality rates as well as the costs of hospital and community treatment[28-30]. The production of ESBL is an important mechanism of resistance in enterobacteria[29]. The treatment of infections caused by ESBL-producing strains presents a substantial challenge to antimicrobial therapy since ESBLs are able to hydrolyze penicillins, cephalosporins of all generations and monobacchaeam, minimizing the therapeutic options[29-33]. In addition, the continuous and often inadequate use of antimicrobial agents may induce the selection of multiresistant strains[29,34].

In this study, we observed the growth of *Pantoea spp*. in dispensers and soap, with prevalence of 3 strains, which did not present resistance to the tested antimicrobials. *Pantoea spp*. is an important plant pathogen that can cause disease in rare cases and has already been found in wounds, blood and urine as an opportunistic pathogen and has been responsible for several national sepsis outbreaks in the US[12,35]. In the mid-1960s *Pantoea agglomerans* were identified in HCRI, being the most frequent species associated with human infections[36,37]. Hospital outbreaks due to contamination of anesthetic propofol, blood products, parenteral nutrition, and transfer tubes used for intravenous hydration have been reported[35-38].

P. agglomerans is a causative agent of infection in children and the elderly and can cause bacteremia, often in association with more conventional pathogens, and is also responsible for outbreaks in NEOICU[35,36,38,39]. In recent years a remarkable increase in HCRI has been reported, especially in the NEOICU, intensive care units and oncology. Baseline diseases, low birth weight, immunocompromised immune system, chemotherapy, and the use of invasive devices may be predisposing factors in infections caused by unusual microorganisms, including *P. agglomerans*[36,37].

Based on these considerations, this study evaluated the extrinsic contamination of liquid soaps used in a philanthropic hospital, since, in our view, studies of this nature help prevent infection and, consequently, reduce their rates and costs. Thus, they have benefits for the institution and for the patient who will not have his health condition compromised nor his prolonged stay in the hospital due to an HCRI. Although it cannot be stated herein that they have influenced infection rates, since the causal relationship has not been established, some bacteria are known agents of HCRI. The confirmed presence of pathogenic bacteria in soaps of hospital use awakens to the necessity of more rigid measures of disinfection of the hospital area.

CONCLUSION

There were extrinsic contamination of the liquid soaps used for handwashing in different sectors of the hospital by pathogenic bac-

teria such as *Acinetobacter spp*, *Enterobacter cloacae*, *Klebsiella oxytoca*, *Pantoea spp.*, *Pseudomonas spp.*, Escherichia coli and *Klebsiella pneumoniae*.

The isolated bacterial strains showed high bacterial resistance, and resistance mechanisms such as ESBL and AmpC were observed.

Thus, considering all the possibilities of microorganisms isolated in this study to demonstrate resistance to antimicrobials, favoring infection in immunocompromised patients, it is of the utmost importance that the participants of the hospital infection commission also include among the materials inspected during their inspections the products used mainly for the prevention of infections, such as soaps and antiseptics.

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