Shared Computer Keyboards as Pathogenic Microorganisms Contamination Sources
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INTRODUCTION
Humans get in contact everyday with several kinds of threats. Bacteria are widely distributed through the environment, in animals, plants and over inanimate surfaces, and the contact with pathogens can trigger an infection. The normal or resident microbiota is compound by microorganisms which are present in the host that, under normal conditions, are not able of causing damage, since there is an ecological equilibrium relation between the human organism and the microorganisms of this microbiota, without no negative effects. However, in cases of immunodepression of immunsupresion these microorganisms may become pathogenic [1, 2]. There is also a transient microbiota, which often enters in contact with the human body and colonizes various tissues, being pathogenic and causing infections. The transient microbiota can be acquired through the contact with several environments and devices, such as computer keyboards [3]. The development of an infectious process depends on four factors. The first is related to the amount of infecting microorganisms, the second depends on the pathogenic potential of these microorganisms, the third is associated with the ability of the host to fight against the invading microorganisms and, finally, for an infection installs, the microorganism should contact the host in certain specific conditions. The contact of the microorganism with the hosts can occur directly or through fomites or vectors. These microorganisms may colonize their hosts without causing damage, or this colonization can trigger an infectious process [4, 5].

Most environments are susceptible to contamination by pathogenic microorganisms and this fact is directly related to the hygienic situation of these...
places. Therefore, objects of daily use with inadequate hygiene may become a locus of contamination and infection to susceptible hosts [2, 6]. The survival of microorganisms in the environment varies according to different types of surfaces, from a few minutes to an undetermined long time. The greater time a microorganism persists viable on a surface, the longer it will remain as a source of contamination, increasing the chance of transfer to a host [4, 7, 8]. With the propagation of new technologies, computers are widely used by people of the all age groups and socioeconomic conditions. Many computer components are made of plastic material. Studies shows that this kind of material allows the permanence of bacteria and fungi for days to weeks [9, 10]. Moreover, these devices, by their physical characteristics, are difficult to clean and therefore facilitate the permanence of microorganisms which can causes infectious diseases [4].

Inanimate surfaces and contaminated devices are considered as secondary reservoirs of microorganisms for infectious transmission processes. Then, it is necessary to identify these reservoirs with the purpose of preventing microorganisms dissemination that cause infections and take prophylactic actions [11]. This research have the objective to evaluate bacterial and fungal contamination in shared computer keyboards of an University and propose prophylaxis measures to avoid recontamination.

MATERIALS AND METHODS
This research has an observational, descriptive, perspective and cross-sectional design. The examined objects were the shared keyboards used by teachers, students and the administrative staff of the University. Keyboards of 60 shared computers were randomly selected as sample units. The research was conducted at a private university in the city or Rio de Janeiro, Brazil. All samples were analysed in the Bacteriology Laboratory of the Souza Marques Medicine School and Microbiology Laboratory of the Brazilian Army Biology Institute. Samples were collected using sterile swabs moistened in 0.9% NaCl solution. The swabs were rubbed against the surface of computer keyboard, stored in Stuart's transportation medium and sent to the laboratories. Afterward, the material was seeded in blood agar, hypertonic-mannitol-agar, Teague agar, Sabouraud-dextrose-agar and Micosel medium. Culture media were incubated at 37°C for 24 to 48 hours and those intended for mycology were kept at room temperature (±30°C). The bacterial colonies were identified by morphotinorial characters, stained by the Gram method, and through biological and biochemical tests. Colonies of yeasturiform fungi were identified through biochemical tests and filamentous fungi by morphological and cultural characteristics.

RESULTS

computer keyboards: Bacillus spp 18 (30%), Enterococcus spp 5 (8.3%), Streptococcusfae-
haemolyticus 8 (13.3%), Escherichia coli 4 (6.67), Enterobacter spp 6 (10%), Klebsiella spp 2 (3.33%), Proteus spp 1 (1.67%), Neisseria spp 3 (5%), Staphylococcus coagulase-negative 32 (53.3%), Staphylococcus aureus 5 (8.33) (Graph-1). Nine different fungi species were isolated: Candidaalbicans 3 (5%), Penicillin spp 5 (25%), Aspergillusniger 8 (13.3%), Aspergillusfumigatus 2 (3.33%), Alternaria spp 4 (6.67%), Cladosporium spp 2 (3.33%), Fusarium spp 7 (11.67%), Epidermorphotonflocosum 2 (3.33%), Rhodotorulaspp 10 (16.67%) (Graph 2).

Graph-1: Bacteria isolated from 60 shared computers keyboards in a University in Rio de Janeiro city, Brazil
DISCUSSION

Several studies on the biology of microorganisms indicate that the survival of these elements in fomites and inanimate objects is an important factor to evaluate the potential of exposure to people who attend to specific environments. A few species of microorganisms in the environment are pathogens, but these can survive after large periods on inanimate surfaces, such as telephones, door knobs, and other objects [12-14].

Rodrigues et al. investigated bacteria contamination in computer keyboards used at the Professor Alberto Antunes Hospital of the Federal University of Alagoas. The research inspected computers from various hospital clinics. The authors isolated several bacteria species considered potentially pathogenic, among them Enterococcus spp [15], also found in our research. This bacterium indicates faecal contamination and suggests that other entero bacteria, enteroviruses or potentially pathogenic parasitic elements could be found as contaminants with possibility of transmission to computer users.

The contamination of computer keyboards in three computer laboratories at the Swinburne University of Technology, Australia was reported by Anderson et al. The result of the research revealed the contamination by S. aureus and enterobacteria, being Enterococcus faecalis colonizing all keyboards of a laboratory which has computers with 1 to 3 years of use [16]. The bacteria cited by these authors were also found in our research, however both S. aureus and Enterococcus spp were found in only 5 of the 60 examined keyboards in our research.

Bacteria of the genus Enterobacter colonizes the human intestine as normal flora, but become pathogenic in other sites of the organism, and was reported by Garazzino et al., as a frequent cause of nosocomial infections in the United States of America. This trend has been confirmed throughout Europe in recent years, corresponding to 8% of the microorganisms isolated from intensive care units [17]. Our research revealed that this bacterium was also found on the shared keyboards of six computers, which may be a source of contamination for the users.

A research to determine the prevalence of Staphylococcus aureus in computer keyboards and mice in an intensive care unit was performed by Anastasiades et al. The result shows a high rate of contamination by S. aureus (35%), and also a high contamination by coagulase negative Staphylococcus was verified. The research also revealed contamination by Gram positive bacilli of the genus Bacillus [18]. All of these microorganisms were found in our research in shared computers keyboards at a University in Rio de Janeiro.

Lima et al., investigated the occurrence of bacteria in computer keyboards in a private University in the city of Recife, Province of Pernambuco, Brazil. The authors analysed the surface of five computer keyboards. The collected material was seeded in agar Teague and agar chromogenic medium. After the incubation, the colonies were identified by morphotinorial characters and traditional microbiological identification techniques. The results showed a diversity of 22 species: Bacillus spp (36%), Staphylococcus coagulase negativa (23%), Staphylococcus epidermidis (18%), Enterococcus spp (10%), Staphylococcus aureus (4%), Escherichia coli (4%), non-fermenters Gram negative bacilli (4%) [2]. The bacterial diversity found by these authors is similar to the results of our research and confirm the need of a hygiene protocol to minimize the contamination of the
computer keyboards and the regular and correct hands cleaning.

The contamination of shared computer keyboards and mice in clinical areas of a hospital in India was investigated by Patankar&Samant. Shared computers presented a higher bacterial contamination than that observed in single-user equipment, although the spectrum of pathogenic microorganisms observed in the two groups was quite similar. The reduction of microbial load in keyboards and mice was quite significant after disinfection (P = 0.001). In equipment used by several people, the persistence of MRSA and other bacteria was observed even after disinfection. The authors concluded that the microbial load on shared equipment is greater than that observed in single-user devices, and they recommend frequent disinfection of these devices and an intensive protocol of hand cleaning after the use of these equipments and before contact with patients in order to prevent nosocomial infections. These authors isolated the following pathogens: Staphylococcus aureus (including MRSA), Pseudomonas spp, Proteus spp, Klebsiella spp and Aspergillus spp [19]. We found in our research all the microorganisms isolated by Patankar&Samant, besides other species of pathogens that were not found by these authors.

Das et al., compared bacterial colonization on keyboards before and after their use in a hospital environment, and the use of covers on these keyboards. The researchers examined the material collected from the surface of new keyboards and after six months of use in the clinical area. In the first culture, non-pathogenic bacteria were isolated, but after six months of use the researchers found contamination with pathogenic bacteria, especially coagulase-negative Staphylococcus. Colonization rates by pathogenic bacteria were higher in keyboards with covers (22% vs 16%) [20]. Our results also reveal the prevalence of coagulase-negative Staphylococcus contaminating keyboards, with a rate of 53%.

CONCLUSION

The keyboards of shared computers of the studied University were contaminated with bacterial and fungal elements, among them Escherichia coli, indicative of faecal contamination. This contamination occurs due to the high turnover of users with different hygiene habits. These results highlight the requirement of a hygiene protocol to minimize the contamination of computers, in order to avoid the possible transmission of pathogens between users.

REFERENCES

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