Saudi Journal of Pathology and Microbiology (SJPM) **ISSN 2518-3362 (Print)**
Scholars Middle East Publishers **ISSN 2518-3370 (Online)**
Dubai, United Arab Emirates
Website: http://scholarsmepub.com/

Shared Computer Keyboards as Pathogenic Microorganisms Contamination Sources

Gabriel Priolli Bettamio Andrade[1], Paula Amaral Silva Perini Fiorot[1], Thaís Sales Amendola[1], Antonio Neres Norberg[2*]
[1]Medicine Under Graduation Members of the Scientific Trainee Program of Souza Marques Medicine School – FTESM, Rio de Janeiro, Brazil
[2]Souza Marques Medicine School – FTESM, UNIABEU University Center, São Carlos Metropolitan School – FAMESC, Rio de Janeiro, Brazil

Original Research Article

***Corresponding author**
Antonio NeresNorberg

Article History
Received: 16.09.2018
Accepted: 26.09.2018
Published: 30.09.2018

DOI:
10.21276/sjpm.2018.3.9.11

Abstract: Computer keyboards can contribute to the spread of microorganisms, mainly when shared by multiple users. Evaluate bacterial and fungal contamination in shared computers keyboards used in a University and propose preventing measures. This research has an investigative, descriptive and transversal design. Keyboards from 60 computers of collective use were randomly selected. Surface samples were collected with sterile swabs and moistened in 0.9% NaCl solution. The swabs were rubbed against the surface of the keyboards and then stored in Stuart's transport medium and sent to the Bacteriology Research Laboratory of the Souza Marques Medicine School. The material was seeded in the culture medias blood agar, hypertonic-mannitol-agar, Sabouraud-dextrose-agar and Micosel. Bacterial colonies were identified through morphotinorial characters, biological and biochemical tests. Yeasturiform fungi were identified by biochemical tests and the filamentous fungi through morphotinorial and cultural characters. From the 60 examined samples, 10 different bacteria species were isolated: *Bacillus*spp 18 (30%), *Enterococcus*spp 5 (8.33%), *Streptococcus alfa-haemolyticus* 8 (13.33%), *Escherichia coli* 4 (67%), *Klebsiella*spp 2 (3.33%), *Enterobacter*spp 6 (10%), *Proteus*spp 1 (1.67%), *Neisseria* spp 3 (4%), *Staphylococcus aureus* 5 (8.33%), Coagulase negative *Staphylococcus* 32 (53.3%). Isolated fungi: *Candida albicans* 3 (5%), *Penicillium*spp 15 (25%), *Aspergillusniger* 8 (13,33%), *Aspergillusfumigatus* 2 (3,33%), *Alternaria*spp 4 (6,67%), *Epidermophytonfloccosum* 2 (3.33%), *Fusarium*spp 7 (11.67%), *Rhodotorula*spp 10 (16.67%). The keyboards of the shared computers were contaminated with fungal and bacterial elements, and among them *E.coli*, evidence of faecal contamination. This contamination occurs due to the high turnover of users with different hygiene habits. Thus, a hygiene protocol is required to minimize contamination of computer's keyboards.

Keywords: Computers, keyboard, device contamination, fungi, bacteria.

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 immunodepresion of immunosupresion 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].

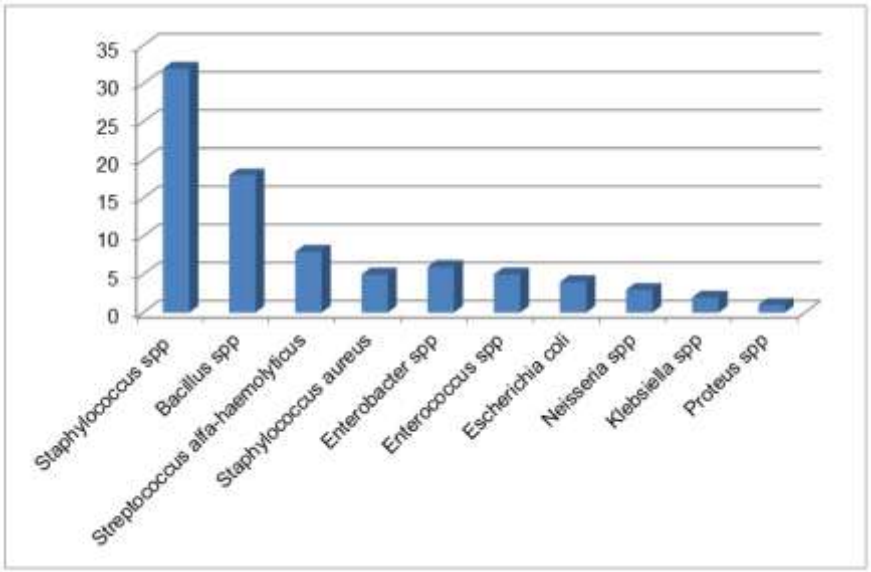
Inanimate surfaces and contaminated devices are considered as secondary reservoirs of microorganisms for infectious transmission processes. Then, it is necessary to identify these reservoirs with the purpose of preventing microorganisms dissemination that cause infections and take prophylactic actions [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

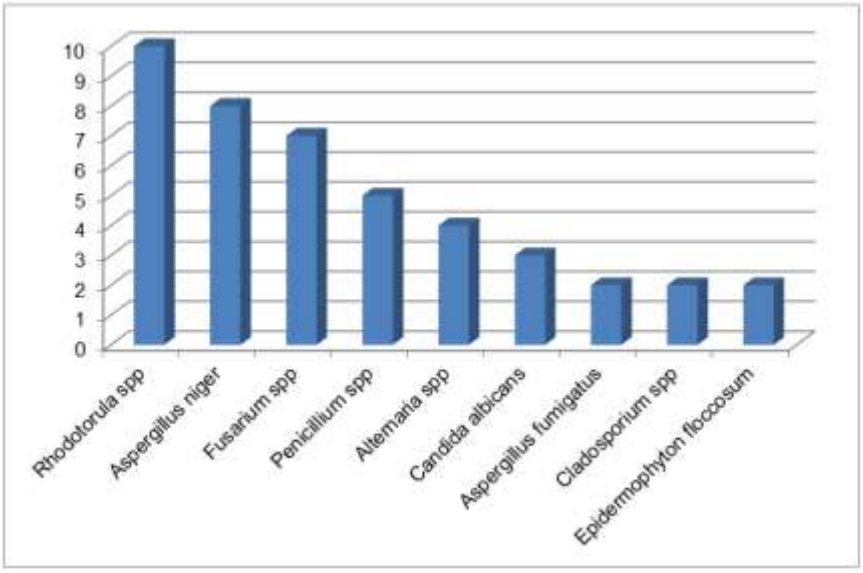
This research has an observational, descriptive, perspective and cross-sectional design. The examined objects were the shared keyboards used by teachers, students and the administrative staff of the University. Keyboards of 60 shared computers were randomly selected as sample units. The research was 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%), *Streptococcusalfa-haemolyticus* 8 (13,33%), *Escherichia coli* 4 (6,67), *Enterobacter* app 6 (10%), *Klebsiella*spp 2 (3,33%), *Proteus*spp 1 (1,67%), *Neisseria* spp 3 (5%), *Staphylococcus* coagulase-negative 32 (53,3%), *Staphylococcusaureus* 5 (8,33) (Graph-1). Nine different fungi species were isolated: *Candidaalbicans* 3 (5%), *Penicillium*spp 5 (25%), *Aspergillusniger* 8 (13,33%), *Aspergillusfumigatus* 2 (3,33%), *Alternaria*spp 4 (6,67%),*Cladosporium*spp 2 (33,3%), *Fusarium*spp 7 (11,67%), *Epidermophytonfloccosum* 2 (3,33%), *Rhodotorula*spp 10 (16,67%) (Graph 2).



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



Graph-2: Fungi 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 enterobacteria, 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%), *Staphylococcusepidermidis* (18%), *Enterococcus*spp (10%), *Staphylococcus aureus* (4%), *Escherichiacoli* (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

1. Júnior, F. B. P., Sousa, C. F., Rocha, T. J. M., Reys, J. R. M., & Rodrigues, M. M. L. (2011). Frequência de bactérias patogênicas nos computadores de uma instituição privada de ensino superior de maceió-AL. *Biofar-Revista de Biologia Farmacia*, *6*, 100-107.
2. Lima, B. A. (2017). Avaliação bacteriológica de teclados de computadores de uma instituição privada de ensino superior campus saúde de recife-pe. *Caderno de Graduação-Ciências Biológicas e da Saúde-FACIPE*, *2*(3), 25.
3. Rosa, C. M., Nogueira, I. A., & Chain, R. (2009). Manual para Redução de Riscos Inerentes à Terapia Renal Substitutiva. Secretaria de Estado de Saúde de Rio de Janeiro.
4. Alves, J. L. B., Costa, R. M., & Braoios, A. (2014). Teclados de computadores como reservatórios de micro-organismos patogênicos. *J. Health Sci. Inst.[Internet]*.
5. Jackson, M. M., &Tweeten, S. M. (2000). General principles of epidemiology. In Pfeiffer JA (et): APIC Text of infection control and epidemiology. Washington, DC: Association for Professionals In Infection Control and Epidemiology.
6. Devine, J., Cooke, R. P. D., & Wright, E. P. (2001). Is methicillin-resistant Staphylococcus aureus (MRSA) contamination of ward-based computer terminals a surrogate marker for nococomial MRSA transmission and handwashing compliance?. *Journal of Hospital Infection*, *48*(1), 72-75.
7. Rossi, D., Devienne, K. F., & Raddi, M. S. G. (2008). Influência de fluídos biológicos na sobrevivência de Staphylococcus aureus sobre diferentes superfícies secas. *Revista de Ciências Farmacêuticas Básica e Aplicada*.
8. Hartmann, B., Benson, M., Junger, A., Quinzio, L., Röhrig, R., Fengler, B., ... & Hempelmann, G. (2004). Computer keyboard and mouse as a reservoir of pathogens in an intensive care unit. *Journal of clinical monitoring and computing*, *18*(1), 7-12.
9. Neely, A. N., & Maley, M. P. (2000). Survival of enterococci and staphylococci on hospital fabrics and plastic. *Journal of clinical microbiology*, *38*(2), 724-726.
10. Neely, A. N. (2000). A survey of gram-negative bacteria survival on hospital fabrics and plastics. *The Journal of burn care & rehabilitation*, *21*(6), 523-527.
11. Ferreira, A. M., Barcelos, L. S., Rigotti, M. A., Andrade, D., Andreotti, J. T., & Almeida, M. G. (2013). Superfícies do ambiente hospitalar: um possível reservatório de micro-organismos subestimado? Revisão integrativa. *Rev enferm UFPE on line*, *7*, 4171-82.
12. Noskin, G. A., Stosor, V., Cooper, I., & Peterson, L. R. (1995). Recovery of vancomycin-resistant enterococci on fingertips and environmental surfaces. *Infection Control & Hospital Epidemiology*, *16*(10), 577-581.
13. Barker, J., Stevens, D., & Bloomfield, S. F. (2001). Spread and prevention of some common viral infections in community facilities and domestic homes. *Journal of Applied Microbiology*, *91*(1), 7-21.

14. da Silva, M. H. R., Barreto Gotardi, A. H., de Barros, A. A. S., Barcelos Blini, R. C., Bernardes, L. G., Machado, R., ... & Machado, A. M. (2014). Isolamento e identificação de microrganismos presentes em superfícies de teclados e mouses de uma universidade de três lagoas, MS. In *Colloquium vitae*(Vol. 6, No. 3).
15. Rodrigues, A. G., Viveiros, M. A., Barroso, I. M., Cavalcante, A. P., & Lopez, A. M. (2012). Contaminação bacteriana em teclados de computadores utilizados em hospital universitário do nordeste do Brasil. *Medicina (Ribeirao Preto. Online)*, *45*(1), 39-48.
16. Anderson, G., & Palombo, E. A. (2009). Microbial contamination of computer keyboards in a university setting. *American journal of infection control*, *37*(6), 507-509.
17. Garazzino, S., Aprato, A., Maiello, A., Massé, A., Biasibetti, A., De Rosa, F. G., & Di Perri, G. (2005). Osteomyelitis caused by Enterobacter cancerogenus infection following a traumatic injury: case report and review of the literature. *Journal of clinical microbiology*, *43*(3), 1459-1461.
18. Anastasiades, P., Pratt, T. L., Rousseau, L. H., Steinberg, W. H., & Joubert, G. (2009). Staphylococcus aureus on computer mice and keyboards in intensive care units of the Universitas Academic Hospital, Bloemfontein, and ICU staff's knowledge of its hazards and cleaning practices. *Southern African Journal of Epidemiology and Infection*, *24*(2), 22-26.
19. Patankar, A. R., & Samant, S. (2018). Shared Computer Keyboards And Input Devices In Clinical Areas: Source Of Nosocomial Infections. *International Journal Of Scientific Research*, *7*(5).
20. Das, A., Conti, J., Hanrahan, J., & Kaelber, D. C. (2018). Comparison of keyboard colonization before and after use in an inpatient setting and the effect of keyboard covers. *American journal of infection control*, *46*(4), 474-476.