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Efficacy of Disinfectant to Reduce Bacterial Contamination with Computer Keyboards and Mouse Devices

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ABSTRACT

Computers are ubiquitous in the universities and the keyboard and mouse devices of several users (students) and single user (staff) computers and have been shown to be contaminated with potentially pathogenic microorganisms. This study was carried out to isolate and identify microorganisms related with computer keyboard and mouse devices positioned at administrative units and internet centers of the medical colleges in Duhok university and to assess the efficacy of Ethanol (70%v/v) as disinfectant on the computer keyboards and mouse devices.A total number of 200 bacteriological swabs were taken before and after disinfection with disinfectant ethanol (70%) from two different objects, 100 samples from the keyboards and 100 samples from the mouse devices. Nutrient agar, Nutrient broth, Blood agar and Mannitol Salt agar were used to inoculate the collected samples. The incidence and type of microorganisms isolated before and after disinfection was evaluated.Our results showed the high degree of surface contamination with bacteria. Before disinfection with ethanol, computer keyboards and mouse devices, a total of 205 isolates comprising six bacterial species were recovered from these samples, the most frequencies of occurrence of the species were; *Bacillus spp*., *Staphylococcus epidermidis* and *Escherichia coli*. Cultivation of swabs performed 10 min after disinfection have shown that ethanol (70%) as antibacterial disinfectant wipe led to a significant reduction of microbial contamination of surfaces.The present study concluded that computer accessories might act as ecological vehicles for the transportation of possibly pathogenic bacteria in our environments. In addition, the need for increasing attention among computer handlers on cleaning of such surfaces and sufficient handwashing hygiene is strongly recommended by the authors. Keyboards and mouse devices may be successfully decontaminated with disinfectants; therefore they should be disinfected daily.

INTRODUCTION:

Microbial requirements in hygiene are essential for a healthy life. People usually think that microbes only exist in hospitals or in clinics and research laboratories; hence they have deceptive feelings of safety in other places. The reason for health issues could be the lack of information about the place where germs occur (1).

Computers are extensively used in every element of our leisure, residential and occupational surroundings. In colleges, students have 100% access to computers, 92.1% frequently use the internet and 73% usually access e-mails (2). Most universities have developed multiple user computer laboratories on campus for regular student access to accommodate the widespread use of computer technology. As the prevalence of such services rises, there is a need to understand that computer apparatus might act as a reservoir for the spread of possibly harmful or pathogenic microbes (3).

Several researches have confirmed the microbial contamination of computer equipment. William (4) stated plausible pathogens such as *Micrococcus*, *Staphylococcus*, *Bacillus and Diphtheria* species in greater than 50% of the computer systems (4,5,6).

The capability of computer to be fomites have been earlier documented in health care on hospital surroundings (7,8). Previously, the role of keyboards in non-hospital surroundings as infectious agent reservoirs has been proven (9). Since the keyboard is continuously in contact with human hands there will frequently be a move of things leaving the hands and entering the keyboards, or vice versa, because of a symptomatic presence of various bacteria such as Methicillin-resistant *Staphylococcus aureus* (MRSA) in people are rising together with different pathogenic microbes (10,11).

Unfortunately, scientific data regarding the prevalence of bacteria on a variety of items outside the healthcare services is really limited and it must be enhanced to aware individuals on the need of improving the habit of handwashing to decrease microbial transmission (9). Even though our perception about the omnipresence of microbes in the surroundings is evolving, the threat of contamination posed by using the computer keyboard and mouse devices is until now not completely comprehended (12).

Because most medical students in university in Duhok are studying in both university campus and teaching hospitals in Duhok city, this mean that they are in the danger of transmitting pathogen between these two locations. Therefore, the current study aimed to inspect the quantity and nature of contaminating bacteria on the keyboards and mouse devices of computers presented at administrative units and internet centers of the medical colleges in Duhok University. Since ethanol is available as a common and inexpensive disinfectant, evaluating the efficacy of ethanol (70%v/v) in removing or inactivating the studied organisms on the keyboards and mouse devices is another objective of this study, in order to present a suitable strategy for removing this contamination to prevent incidence of nosocomial infections.

MATERIAL AND METHODS:

Collection of samples:

This study was carried out in the Department of Microbiology at the Nursing College, University of Duhok, Iraq, from March to August 2019. A total of 100 swabs were obtained from computer keyboards (50 swabs) and computer mouse devices (50 swabs) at administrative units and internet centers of the following medical colleges in university of Duhok, Colleges of Medicine, Dentistry, Pharmacy and Nursing.

A single sterile cotton swab per component (keyboard or mouse) was moistened by dipping it in sterile normal saline. Moistened swabs were wiped firmly over the entire surface of the specific object. To enhance the growth of microorganisms, the swab was immediately inoculated into a tube containing nutrient broth and incubated at 37°c /24 hours in an aerobic atmosphere.

Subsequently, the entire locations were disinfected using commercially available disinfectant with active ingredients ethanol (70% v/v), and after 10 minutes, Another 100 Swabs from the keyboards (50) and mouse (50) were carried out the same way.

Isolation of samples:

Samples were sub-cultured on solid media such as: Nutrient agar medium, Blood base agar (for growth of fastidious bacteria), and Mannitol Salt agar (for Staphylococci), then were labeled and put inside the incubator for 24 hours at 37℃. In addition to the culture examinations, pure

bacterial cultures were diagnosed by means of microscopic examination. Gram staining was used for differentiation between Gram-positive and Gram-negative bacteria, and also for determination of the size, shape, and specific arrangement of observed pure solitary colonies.

Identification of microorganisms:

Isolated bacteria were confirmed depending on colonies features, Gram stain, followed by the pattern of biochemical reactions. In this research, the number of isolated microorganisms was determined before disinfection and compared with the number of microorganisms isolated after disinfection: the difference was expressed as a percentage of contamination reduction on tested surfaces after disinfection.

RESULTS:

Before disinfection, a total of 100 swabs (50 from computer keyboards and 50 from mouse devices) were collected and examined for the presence of bacteria. All the samples collected (100%) yielded growth; however, the extent of contamination varied. Six bacterial isolates were detected including *Bacillus spp*. which recorded the highest contamination rate (29.92%) in keyboards and (33.33%) in mouse devices, while *Streptococcus spp*. had a lowest percentage (0.79%) in keyboard and (0.0%) in mouse devices. The numbers and frequency of each isolated bacteria on keyboard and mouse devices are presented in Table Number 1.

Table No. 1: Frequency of bacterial occurrence in computer keyboards and mouse devices

Microorganisms	**Keyboard No. (n=50)**		**Mouse No. (n=50)**	
	No.	%	**No.**	%
Bacillus spp.	38	29.92	26	33.33
Staphylococcus epidermidis	36	28.35	20	25.64
Staphylococcus aureus	25	19.69	11	14.10
Escherichia coli	16	12.60	17	21.79
Klebsiella spp.	11	8.66	4	5.13
Streptococcus spp.	1	0.79	0	0.00
Total No. of bacterial isolates	127	100	78	100

After disinfection, in all isolated bacteria taken from keyboard and mouse surfaces, a reduction of microbial contamination was observed. Simple disinfection using antimicrobial wipe was followed by elimination of the number of bacteria to zero in (84.39%) of both keyboards and mouse devices, which is a statistically significant difference ($p<0.005$). The numbers and frequency of each isolated bacteria on both keyboard and mouse are presented in Table Number 2.

Table No. 2: Percentage evaluation of bacteria isolated from keyboard and mouse surfaces before and after disinfection and reduction of contamination.

Type of Isolated Bacteria	Before Disinfection (N.100)	After Disinfection (N.100)	Reduction of the Contamination
Bacillus spp.	64 (31.22%)	14 (43.75%)	78.13%
Staphylococcus epidermidis	56 (27.32%)	9 (28.13%)	83.93%
Staphylococcus aureus	36 (17.56%)	6 (18.75%)	83.33%
Escherichia coli	33 (16.10%)	3 (9.38%)	90.91%
Klebsiella spp.	15 (7.32%)	0 (0.00%)	100%
Streptococcus spp.	1 (0.49%)	0 (0.00%)	100%
Total	205 (100%)	32 (100 %)	84.39%

Post disinfection, the numbers of bacteria on computer equipment surfaces decreased radically by (78.13%) in the case of *Bacillus spp*. and almost identically by (83.93% and 83.33%) in the case of *Staphylococcus epidermidis* and *Staphylococcus aureus* respectively, the decrease in *Escherichia coli* was (90.91%). In the case of *Klebsiella spp* and *Streptococcus spp*. microbial contamination of keyboards and mouse devices was reduced after disinfection by 100%.

Our results confirmed the efficacy of a simple cleaning with disinfectant wet wipe with ethanol 70% in reduction of bacterial contamination.

DISCUSSION:

The increased multiple and single use of computer accessories among students and administration staff in the university is playing an important role in our life and could help in spreading the potential pathogenic organisms in the university surroundings.

In the current study, (100%) of examined computer keyboards and mouse devices were contaminated by bacterial agent. All of them were having one or more organisms. Similar studies have been done by Alemu (13) and Amer (14) showed that (100%) of the tested computer keyboards and mouse devices were contaminated with mixed growth.

Our data represent that *Bacillus spp.* had the highest incident with a percentage frequency of occurrence of (31.22%). This result is compatible with the results received by Rhman R.H.A (7) who reported *Bacillus spp*. as the highest bacteria isolated from his study. The isolation of *Bacillus spp*. proves the abundant nature of this bacteria giving it the capability of its spores to withstand climate alterations and increased colonization ability (15). Therefore, on the basis of present and previous studies, it can be concluded that *Bacillus spp*. are the major flora of computer accessories.

Generally, *Bacillus species* were the predominant isolate. The second most frequent bacterial growth in all samples was *Staphylococcus epidermidis* (27.32%) which is a usual inhabitant of the epidermis *however it could* sometimes anticipate an opportunistic infectious agent function in producing inflammations to people, like endocarditis (16).

Potential pathogenic such as *Staphylococcus aureus* were also isolated but in lower frequencies (17.56%), in Saudi Arabia, a study published by Al-Ghamdi (1) has nearly similar results. There is every risk of presenting *Staphylococcus aureus* on to the interface since computer users continuously touch the interface and frequently sneeze (17). This bacterium has the greater concern because of its virulence, and it is able to cause various types of life-threatening infections.

In the present study, the percentages of gram-negative bacilli such as *Escherichia coli* and *Klebsiella spp*. were (16.10%) and (7.32%); respectively. This bacterium is one of the most prevalent organisms in human faces, and consider as indicator of fecal contamination (15). Also,

the present of these enteric bacteria is a direct indicator that other Enterobacteriaceae could be carried on computer accessories.

Additional possibly pathogenic bacteria were also isolated from keyboards of the multiple users (students) and single user administration units (staff) computers, which were not noticed on the mouse devices of the same workplaces. Of specific interest was the isolation of *Streptococcus species* (0.49%) which point out the probability of mouth contamination (18).

Moreover, the greater reduction in the number of all isolated bacteria after disinfection in both keyboards and mouse devices was notable. Many studies have indicated that computer equipment are ponderously bacterial contaminated and serve as a recurrent cause of infection in colleges and hospitals (19, 20).

Our study reveals that microbial pollution of computer keyboards and mouse devices is repeated and the most common organisms are skin commensalism. The existence of potentially pathogenic bacteria such *Escherichia coli*, *Staphylococcus aureus* and *Bacillus spp*. represent a threat of infection particularly for immunocompromised individuals (21).

In a study published by Neely (22) they showed that computer accessories have been also implicated as a potential reservoir for infectious agents. Since computers are not routinely disinfected, the possibility for the transmission of contaminating microbes is probably great. Inadequately performed hand hygiene and not disinfected surfaces are two causes why the computer keys could be the sources of microbial contamination, consequently resulting in indirect transmission of potential pathogens (23).

Subsequent standardly performed disinfection with sterilization wipes that contain active ingredient such as Ethanol (70% v/v). The disinfectant tested was highly effective deactivating or removing pathogens, including the six examined bacterial isolates, in 10 min application with a wipe. According to our results, the reduction of contamination to zero was achieved in computer keyboards and mouse devices for both *Klebsiella spp. and streptococcus spp.* which is the highest contamination reduction (100%), Followed by *Escherichia coli* with contamination reduction (90.91%), while *staphylococcus epidermidis* and *staphylococcus aureus* have almost similar contamination reduction with (83.93% and 83.33%) respectively. On the other hand, the

lowest contamination reduction was for *Bacillus spp*. (78.13%). Bacterial response to disinfectant might vary depending on the specific disinfectant together with that of the specific organism (24).

The most commonly used disinfectant in microbiology laboratory is Ethanol, chlorhexidine, Dettol and soap (25,26). Ethanol, as a dehydrating agent causes cell membrane damage, denaturalization of protein and cell lyses (25,27).

The current study was undertaken to assess the bacteriological contamination of computer equipment and their susceptibility patterns to commonly used disinfectant wipes with active ingredient Ethanol (70%v/v). Adequate hand-washing as well as using disinfectant wipes once daily for computers hardware can decrease the possibility of contamination and spreading of bacterial pathogens through these devices (22).

According to current study, we confirmed that all collected samples from multiple and single user computer keyboards and mouse devices show countless bacteria which is similar to other studies (14,4). These microorganisms are related with many diseases such as nosocomial, gastrointestinal and urinary tract infections (2).

In addition, this study confirmed the efficacy of a simple cleaning with disinfectant wet wipe with Ethanol 70% in reduction of bacterial contamination which is compatible with other studies (21,28).

CONCLUSION:

In summary, this study has revealed that the bacterial contamination of computer accessories might be a regular mechanism of transmission of possibly pathogenic bacteria among users. The degree of knowledge among computer users about the existence of microorganisms on computer equipment and their sanitation is really poor. Public awareness programs must be motivated and hand hygiene before and after the use of computers should be performed by college students. This study confirmed that using commercially available disinfectant wet wipes can decrease the existence of microbes on devices of daily use like computer hardware.

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REFERENCES:

1. Al-Ghamdi A, Ashshi S., Faidah, H, Shukri H, Jiman-Fatani A. Bacterial contamination of computer keyboards and mice, elevator buttons and shopping carts. African Journal of Microbiology Research. 2011;5(23):3998-4003.
2. Burki Z, Hassan M, Naseer F, Ahmad S, Burki S, Saleem M. Isolation and Characterization of Microbial Contamination from Computer Accessories used in Different Department of Hazara University and Diagnostic Laboratories of District Mansehra, Pakistan. American Journal of Infectious Diseases. 2015;3(3):112-124.
3. Anderson, G. and Palombo, E.A. Microbial contamination of computer keyboards in a university setting. American journal of infection control. 2009;37(6):507-509.
4. Hasan A, Al-Azawi Z, Asa'd R. Microbial Contamination Associated with Computer Keyboards and Mouse Devices in Diyala University. Diyala Journal of Medicine. 2015;8(1):66-72.
5. Rutala W, White M, Gergen M, Weber D. Bacterial contamination of keyboards: efficacy and functional impact of disinfectants. Infection Control & Hospital Epidemiology. 2006;27(4):372-377.
6. Cataño J, Echeverri L, Szela C. Bacterial contamination of clothes and environmental items in a third-level hospital in Colombia. Interdisciplinary perspectives on infectious diseases, 2012.
7. Rahman R. Bacterial contamination of computer keyboards and mouse. Tikrit Journal of Pure Science. 2014;19(5):18-22.
8. Enemuor S, Apeh T, Oguntibeju O. Microorganisms associated with computer keyboards and mice in a university environment. African journal of microbiology research. 2012;6(20):4424-4426.
9. Eguia J, Chambers H. Community-acquired methicillin-resistant Staphylococcus aureus: epidemiology and potential virulence factors. Current infectious disease reports. 2003;5(6):459.
10. Creech C, Kernodle D, Alsentzer A, Wilson C, Edwards K. Increasing rates of nasal carriage of methicillin-resistant Staphylococcus aureus in healthy children. The Pediatric infectious disease journal. 2005;24(7):617-621.
11. Hidron A, Kourbatova E, Halvosa J, Terrell B, McDougal L, Tenover F, Blumberg H, King M. Risk factors for colonization with methicillin-resistant Staphylococcus aureus (MRSA) in patients admitted to an urban hospital: emergence of community-associated MRSA nasal carriage. Clinical infectious diseases. 2005;41(2):159-166.
12. Kumar A, Srivastava M. Computer components in college and its surroundings encompass the pathogenic bacteria. J. Appl. Sci. Environ. Sanitation. 2012;7(1):43-47.
13. Alemu A, Misganaw D. Wondimeneh Y. Bacterial profile and their antimicrobial susceptibility patterns of computer keyboards and mice at Gondar University Hospital, Northwest Ethiopia. Biomed Biotechnol. 2015;3(1):1-7
14. Amer H, Atia A, Tawil K. Bacterial Contamination of Computer Keyboards and Mice in University and Hospital Settings. DJ International Journal of Medical Research. 2017;2(1):1-7.
15. Tagoe D, Kumi-Ansah F.Computer keyboard and mice: Potential sources of disease transmission and infections. Internet J. Public Health. 2011;1(2):1-3.

16. Muhammad R, Yaro C, Musa B, Safiyya S. Isolation and Identification of Bacteria Associated with Computer Keyboards and Mouse at Various Business Centres in Dutse Metropolis Jigawa State, Nigeria. Int. J. Curr. Microbiol. App. Sci. 2016;5(8):811-817.
17. Oluduro A, Ubani E, Ofoezie I. Bacterial assessment of electronic hardware user interfaces in Ile-Ife, Nigeria. J. Basic Appl. Pharmaceutical Sci. 2011;32(3):323-334
18. Ubani E, Oluduro A, Ofoezie I. A survey of common habits of computer users as indicators of possible environmental contamination and cross infection source. African Journal of Biotechnology. 2012;11(9):2241-2247.
19. Bures S, Fishbain J, Uyehara C, Parker J, Berg B. Computer keyboards and faucet handles as reservoirs of nosocomial pathogens in the intensive care unit. American journal of infection control. 2000;28(6):465-471.
20. Centers for Disease Control and Prevention (CDC). Norovirus outbreak in an elementary school--District of Columbia, February 2007. MMWR. Morbidity and mortality weekly report. 2008;56(51-52):1340.
21. Koscova J, Hurnikova Z, Pistl J. Degree of bacterial contamination of mobile phone and computer keyboard surfaces and efficacy of disinfection with chlorhexidine digluconate and triclosan to its reduction. International journal of environmental research and public health. 2018;15(10):2238.
22. Neely A, Weber J, Daviau P, MacGregor A, Miranda C, Nell M, Bush P, Lighter D. Computer equipment used in patient care within a multihospital system: recommendations for cleaning and disinfection. American journal of infection control. 2005;33(4):233-237.
23. Siegmund K, Hübner N, Heidecke C, Brandenburg R, Rackow K, Benkhai H, Schnaak V, Below H, Dornquast T, Assadian O, Kramer A. Are laptop ventilation-blowers a potential source of nosocomial infections for patients?. GMS Krankenhaushygiene interdisziplinär. 2010;5(2).
24. Russell A. Bacterial resistance to disinfectants: present knowledge and future problems. Journal of Hospital infection. 1999;43:57-68.
25. Al-Dabbagh S, Ali H, Khalil I, Hamad M. A study of some antibiotics; disinfectants and antiseptics efficacy against some species of pathogenic bacteria. Assiut Vet. Med. J. 2015;61(147):210-217.
26. Jang H, Ann S, Kim M, Kim C. Removed: Use of hydrogen peroxide as an effective disinfectant to Actinobacillus ureae. Process Biochemistry. 2008;43(3):225-228.
27. Larson E, Morton H. Alcohols. In: Philadelphia, Pa:Lea Febiger . 199;191-203.
28. Elzain A, Elsanousi S, Ibrahim M. Effectiveness of ethanol and methanol alcohols on different isolates of staphylococcus species. J Bacteriol Mycol Open Access. 2019;7(4):71-73.