Microbial Contamination Associated with Computer Keyboards and Mouse Devices in Diyala University

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Abstract

Background: Surface contamination of public user interface systems such as computer keyboards and mouse devices may play a role in community-acquired outbreaks by acting as an environmental vehicle in transmission of potential hazardous microorganisms. There is no economical way to test all keyboards and mice out there, but there is a common-sense way to prevent bacterial contamination or eliminate it if it exists.

Objectives: To explore the bacterial contamination rates in multi-user and single-user computer accessories (keyboards and mouse devices) in certain colleges of the Diyala University.

Materials and methods: This study was conducted in Bacteriology laboratory- Colleges of Veterinary Medicine- Diyala University for the period from October 2012 to April 2013. A total of 155 swabs were collected aseptically from 60 computers in 4 colleges, namely, College of Medicine, Veterinary Medicine, Science, and Education- Pure Science. Swabs were streaked on blood and MacConkey's agar plates then incubated for 24 hours at 37 ˚ C. Final identification of bacterial species was based on standard bacteriological and biochemical criteria.

Results: The results showed that the overall contamination rate in the four colleges was (54.8%). The highest isolation rate of bacterial contaminant was *Staphylococcus epidermidis* (30.6%), followed by *Escherichia coli* (29.4%). Fungi constitute (17.6 %) of isolates. The College of Veterinary Medicine rank at the top with significant highest contamination rate (52.7%), followed by the College of Medicine with a contamination rate (21.2). Computers of the internet centers harbor the significant highest contamination rate compared to administrative units (71.8% and 28.2%) respectively. The contamination rate was higher in mouse devices compared to keyboards (57.6% *vs* 42.3%).

Conclusion: The study concluded that continuous education of students and employees about the risk of bacterial contamination arise from using the computers, beside the periodic disinfection of computer accessories may aid the fight against transmission and spreading of infectious pathogens.

Keywords: Computer keyboards, Computer mouse devices, Microbial contamination, surface contamination.

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Introduction

People believe that microbes are only present in hospital settings and research laboratories; therefore, they have a misleading feeling of security in other places. Contamination occurs everywhere including environment and all its objects [1]. Surface bio-contamination is a problem that has been shown to aid outbreaks of community-acquired and nosocomial infections either by fomites transmission of diseases or by acting as reservoirs [2].

Public user interfaces like computer keyboard and mouse (because of frequent dermal contact with hands) may serve as fomites reservoirs for transmission of microorganisms. The ability of computer to act as fomites has been previously documented in healthcare [3]. And hospital environment [4]. Some investigators have suggested that computer keyboards may contribute to cross-transmission because of acquisition of transient hand carriage by healthcare personnel during contact with the contaminated computer keyboard surface [4, 5]. In work place, contamination of the office environment (including the computer and mouse) with bacteria is also recognized [6]. Of increasing concern, is the role of keyboards in the non-hospital environment as pathogen reservoirs [7]. Since the keyboard is constantly in contact with human hands there will constantly be a stream of things leaving the hands and entering the keyboards, or of course, leaving the keyboards and entering the hands. Because of a symptomatic carriage of some bacteria like MRSA in humans is increasing alongside other pathogenic organisms [8, 9, 10]. The ubiquitous sharing of public computers might facilitate increased transmission and occurrence of community-associated infections [11, 12, 13]. According to work of Malik,(2014), Nwankiti *et al*, (2012) and Chimezie *et al*, (2013) *Staphylococcus aureus*, *E. coli* and *Bacillus* are common contaminants of computer keyboards [1, 2, 14]. Bures *et al*,(2000) and Wilson *et al*, (2006) documented that computer keyboards harbor MRSA [4, 15].

On the other hand, *Trychophyton spp.*, *Aspergilus spp. Rhizopus spp. Penicillium spp.*, *Mucor spp.* and *Candida albicans* were isolated from computer keyboards and mouse devices [2, 6].

Surprisingly, scientific information about the occurrence of bacteria on various objects outside the healthcare facilities is very little and needs to be enriched in order to educate people on the necessity of improving the habit of hand washing, to reduce microbial transmission. So, this study aims to explore the bacterial contamination rates in multi-user and single-user computer accessories (keyboard and mouse) in some colleges in University of Diyala

Materials and Methods

Samples collection:

Sterile cotton swabs were used to collect samples from keyboards and mice of 60 computers. A total of 155 swabs were collected from keyboards (95 swabs) and mouse devices (60 swabs) at administrative units and internet centers of the following colleges: Colleges of Medicine, Veterinary Medicine, Science, and Education- Pure Science, during the period from October 2012 to April 2013. After collection, the swabs were immersed in about 1 ml of nutrient broth to keep them wet while delivered to the laboratory.

Sample processing and identification:

Each swab was streaked on blood and MacConkey's agar plates, labeled and incubated at 37 ℃ for 24 hrs. The identification of bacterial isolates was performed according to the standard microbiological and biochemical techniques at bacteriology lab in the College of Veterinary.

Determination of fungal growth:

To detect fungal hyphae, a few drops of 10 % KOH was mixed with fungal growth on clean slide and incubated for 5 min. at 37 ℃ and then examined under low and high power lenses [16].

Statistical analysis:

The results accumulated during study period were transformed into computerized database. The SPSS (Statistical Package of Social Science) version 18 was used. Chai square was used for paired and group comparison. Differences were considered significant whenever p-value less than 0.05.

Results

Out of 155 samples examined, a total of 85(54.8%) bacterial isolates were isolated from computer keyboards and mouse devices, out of which *Staphylococcus epidermidis* recorded the highest contamination rate 26 (30.6%) with insignificant difference compared by *E. coli* 25 (29.4%), (p-value > 0.05). *S. aureus* and *Bacillus spp* had comparable percent, (10.6% and 9.4%) respectively. *Enterobacter aeroginosa* had lowest percent (2.3%) than others. On the other hand fungi constitute 17.6 % of isolates, table (1).

Table (1): Contamination rate according to bacterial species.

Bacterial species	No. of isolates	%
Staphylococcus epidermidis	26	(30.6)
Staphylococcus aureus	9	(10.6)
Escherichia coli	25	(29.4)
Enterobacteraerogenes	2	(2.3)
Bacillus spp.	8	(9.4)
Fungi	15	(17.6)
Total	85	(100)

***P- value >0.05**

According to table (2) the present study revealed the differences in the contamination rate among the colleges included in this study. The College of Veterinary Medicine rank at the top with the highest contamination rate (52.7%), followed by the College of Medicine with a contamination rate (21.2%), and the College of Science with a contamination rate (14.1%), while the least contamination rate was found in the College of Education (11.8%). The difference was significantly higher in college of Veterinary Medicine compared to other colleges (P-value <0.05).

Table (2): Contamination rate according to colleges.

Settings	No. swab tested	No. swab positive (%)	No. swab negative (%)
College of Veterinary Medicine	74	45 (52.9)	29 (41.4)
College of Medicine	26	18 (21.2)	8 (11.4)
College of Science	25	12 (14.1)	13 (18.6)
College of Education- pure Science	30	10 (11.8)	20 (28.6)
Total	155	85 (54.8)	70 (45.2)

***P-value <0.05**

Regarding to the setting, the contamination rate revealed that out of 67 swabs collected from the administrative units (as single-user), 24 (28.2%) were positive by culture, while, 61 (71.8%) of 88 swabs that collected from internet centers (as multi-user) were positive by culture, table (3). The contamination rate was significantly higher in internet centers compared to administrative units (p-value <0.05).

Table (3): Contamination rate according to settings.

Settings	No. of swabs	No. positive (%)	No. negative (%)
Administrative units	67	24 (28.2)	43 (61.4)
Internet centers	88	61 (71.8)	27 (38.6)
Total	155	85 (100)	70 (100)

***P-value <0.05**

On the other hand, table (4) revealed the contamination rate according to accessories. 36 (42.3%) of the swabs collected from computer keyboards were culture positive. Whereas, 49 (57.6%) of the swabs collected from mouse devices were culture positive. The difference between the two groups was failed to reach the levels of statistical significant (p-value >0.05).

Table (4): Contamination rate according to computer accessories.

Accessories	No. of swabs	No. positive (%)	No. negative (%)
Keyboards	95	36 (42.3)	59 (84.3)
mouse devices	60	49 (57.6)	11 (15.7)
Total	155	85 (100)	70 (100)

***P- value >0.05**

Discussion

Numerous studies have indicated that computer keyboards and mouse devices can become contaminated with pathogenic bacteria [4, 12, 17,18,19]. In healthcare setting, it is perhaps not unexpected that such microorganisms would contaminate these common work surfaces. The present work highlights the bacterial contamination of computers keyboards and mouse devices in four colleges at University of Diyala. The results obtained are clearly point out to the high contamination rate (54.8%) of computer keyboards and mouse devices by different bacterial species. The current results actually not surprising since there were any personal or official precautions govern the use of computers whether in the administrative units (single-user) or internet centers (multi-user) in colleges.

Throughout the study, a total of 85 bacterial isolates were recovered, table (1).The present results were almost similar to the results obtained by other workers [20, 21]. As these bacteria are highly prevalent in the environments including soil, dust, object surfaces and human hands, so it is not unusual to detect these bacteria on computer accessories, since computers becomes widely used in domestic life as well as academic institution.

Other study done by Rutala *et al*.(2006) reported that potential pathogens cultured from more than 50% of the computers included coagulase-negative staphylococci

(100% of keyboards), diphtheroids (80%), Micrococcus species (72%), and Bacillus species (64%). Other pathogens cultured included oxacillin resistant *S. aureus* (4% of keyboards), oxacillin sensitive *S. aureus* (4%), vancomycin-susceptible Enterococcus species (12%), and non-fermentative gram-negative rods (36%) [17]. The ecologic niche for *S. aureus* in humans is in the anterior nares [22]. Of note, previous studies conducted in Iraq have reported a rate of MRSA carriage among healthcare workers of around 28% [10]. Which can easily by transferred to hand by simply rubbing the nose. In Diyala province, it has been found that 26.3% of the general population carries the *S. aureus* on their hands [23]. On the other hand, enteric Gram's negative bacilli in general and *E. coli* in particular constitute the major normal flora of the intestine of human and animals. These bacteria are sheded in the feces in large numbers and contaminate the environment including the hands of individuals with bad personal hygiene [24]. The Gram's positive bacillus species including the B. subtilis are highly prevalent in nature in soil, dust, water and vegetation, and since these are spore-forming, it can survive in under different environmental conditions [25].

The present study table (2) demonstrated that the highest rate of isolation occurs in College of Veterinary Medicine followed by the College of Medicine. The most acceptable explanation is that the students in these colleges were in direct contact with diseased humans or animals and contamination of hands during clinical examination is frequent. Additionally, further contamination of student's hands comes through handling and manipulation of animal specimens in the diagnostic laboratories. In a study in veterinary college teaching hospital to characterize the frequency of recovery of Staphylococcus species from computer keyboards and to evaluate the effect of daily cleaning. Of the 25 Staphylococcus recovered 13 were *Staphylococcus* species, 7 *S. pseudintermedius*, 4 S. aureus and 1 mixed colony of both Staphylococcus species and S. pseudintermedius, recommending the value of routine cleaning of keyboards and the need for on-going and regular education of staff and students about good hand hygiene [26].

In concern to setting, the results in table (3) clearly showed that the isolation rate of multiple users' computers (internet centers) is much higher than that of the single user computers (administrative units) (71.8% *vs* 28.2%). In a similar study conducted in Environment and Biotechnology Centre, Swinburne University of Technology, Melbourne - Australia, It has been reported that the average number of microorganisms present on multiple-user computer keyboards was significantly greater than on single-user keyboards, and the number of keyboards harboring potential pathogens was also greater for multiple-user computers. It is recommended that regular cleaning and disinfection of computers be used to reduce the microbial load, especially for multiple-user workstations [21]. On the other hand, the results according to accessories indicate that the isolation rate of mouse devices is higher than that of the keyboards (57.6% *vs* 42.3%). These results seems logical probably due to the fact that computer's users usually accustom to keep their hands on computer mouse more time than on the keyboards. Additionally, the surface area of the user's hand that is in direct contact with the mouse is much larger than the hands area touching the keyboard. These two factors enable the microbes on the user's hand to be transferred to the surface of the mouse devices much easier than keyboards [17].

In conclusion, it was found that there was a higher contamination rate of computer keyboards and mouse devices. On the basis of this finding, it suggested that periodic decontamination of computer accessories with any available disinfectant or whenever there is a gross contamination may aid the fight against infections in various communities. Also continuous education of students and employees about the risk of transmitted bacteria from mouse devices and keyboards of computers in addition to hand washing before and after contact with keyboards and mice should significantly reduce the risk of contamination and cross transmission.

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