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Bacterial contamination of computer keyboards in hospitals in Isfahan in Iran

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Abstract

Introduction: Because of the increased use of computers in hospitals, computer keyboards may become reservoirs for pathogens. This study was performed to determine the degree of bacterial contamination and to assess the efficacy of ethanol (70%v/v) as disinfectant on the computer keyboards. Methods: Sampling was conducted using sterile swab from 65 keyboards in the medical wards at a number of hospitals. The bacterial isolates were examined for identification using biochemical tests, and their antibiotic resistance pattern was determined by disk diffusion method. In the study assessed the effectiveness of Ethanol (70% v/v) against three potential bacterial pathogen organisms. Results: 98.5% of the computers have been found to be colonized by potential pathogens including Bacillus species (69% of keyboards), coagulase- negative Staphylococci (24%), *Staphylococcus aureus* (23%), Enterococcus species (9%), Micrococcus species (7%), gram negative bacilli (21%), methicillin- resistant *Staphylococcus aureus* (15%) and vancomycin- resistant Enterococci (1.5%). Ethanol (70%v/v) was effective at removing more than 93% of the test bacteria. Conclusions: According to the data obtained from this study the computer keyboards are being the source of potential bacterial contamination in the development of nosocomial infections. Therefore the computers should be cleaned daily with disinfectants such as ethanol and hand washing procedures should be obeyed after the use of computers before handling the patients.

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Introduction

Conducted investigations throughout the world show that, nosocomial infections are the main cause of morbidity and mortality (June *et al.*, 2000). Some patient care systems and hospital environment may facilitate the transmission of microorganisms among patients. Recently, computer use is very common in hospitals, and today the computers are considered as a source of nosocomial infection pathogens (Ducel and Fabry, 2001). Since, this technology is also used in many hospitals and medical centers of Iran, therefore, investigating the bacterial contamination of this equipment in hospitals can indicate a potential risk which may occur for the prevalence of nosocomial infections. . 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 is another objective of this study, in order to present a suitable strategy for removing these contaminations to prevent incidence of nosocomial infections.

Computers are ubiquitous in the healthcare setting and have been shown to be contaminated with potentially pathogenic microorganisms. This study was performed to determine the degree of microbial contamination, the efficacy of different disinfectants, and the cosmetic and functional effects of the disinfectants on the computer keyboards.

The aim of this research is study of bacterial contamination of computer keyboards in hospitals in Isfahan (central section of Iran).

Materials and methods

Materials

In a descriptive method since autumn 2011 till spring 2012, the keyboards of computers in number of hospitals in Isfahan city were studied.

Methods

Given the sample volume equation and with confidence level of 95% and a precision of 0.1, 65 keyboards were selected by systematic randomized sampling method.

In order to determine the degree of microbial contamination of the keyboards, a sterile swab which has been dampened by Trypticase soy agar, was applied on the entire keyboard.

Then, swab was put inside the pipe containing 2mm of Trypticase soy broth, and was sent to the laboratory. Swab made vortex for 1 minute at the highest speed. 10 microliter of the sample was incubated into the blood agar medium. The plates were put under 37 ^{0}C for 48 hours (Rutala *et al.*, 2006).

After incubation, the number of colonies formed on the plate was counted to determine the number of colony forming units (cfu) in each keyboard. Then, the strains were isolated based on colony morphology and Gram reaction. After obtaining pure cultures from isolates, diagnostic tests for bacterial identification were performed.

Antibiotic resistant of bacterial strains which were important in nosocomial infections was determined using disk diffusion method.

In order to investigate the effect of ethanol (70%v/v) in contaminating the keyboards, five keys including Q, F, M, ENTER and ESC were incubated by 10 microliter of three bacterial species, *Staphylococcus aureus* ,*Pseudomonas aeruginos* and Vancomycin - resistant Enterococci which had a turbidity by 0.5 McFarland. After 45 minutes, all the tested keys except ESC (which here is the control key) were rubbed by wipes impregnated with 15 ml of 70% ethanol (Rutala *et al.*, 2006). Once the keys were dried, the keys (Q, F, M and ENTER) were tested and sampled using sterile wet by TSB medium. Then, swab was put inside a pipe containing TSB and was vortexed. 100 microliter of medium was inoculated into two culture mediums containing Tripticase soy agar and blood, and the plates were incubated at 37^{0}C for 48 hours. Then the number of colonies was counted.

Using a swab wetted by TSB, a sample was taken also

from the control key (ESC). Swap was wortexed in TSB and 100 microliter was incubated to the plate containing blood and TSA. The colonies were counted, and percentage of ethanol efficiency in removing the bacteria was calculated using the equation [3].

Results

Contamination percentage of keyboards

Fig.1 shows the 5% of the 65 studied keywords were contaminated. Fig.1 shows the percentage of the contaminated keyboards based on the number of bacterial species isolated from any keyboard.

Efficiency of ethanol in removing microorganisms

Table 1. Shows the percentage of the pollution of keyboards based on the bacterial species. Among the studied keyboards, 10 keyboards were in the intensive care unit of which 6 keyboards were contaminated by potential pathogens such as methicillin resistant *Staphylococcus aureus, Klebsiella pneumoniae* and enterococcus species.

Evaluation of antibiotic-resistance of isolates showed that, 17% of vancomycin-resistant enterococcus and 50% of *K. pneumoniae* were resistant to gentamicin. Frequency of methicillin, novobiocin resistant *S.aureus* strains was 67 and 33% respectively, and none of the strains were resistant to vancomycin.

Table 2. Shows the efficiency of ethanol (70%v/v) in removing the examined organisms on the keyboards (in 5 seconds and 60 seconds in disinfection).

Discussion and conclusion

Present study was conducted to study bacterial contamination of the keyboards in the hospitals and, ethanol efficiency in removing bacterial pollution. In this study, 98.5% of the studied keyboards had bacterial contamination. Contaminant bacteria included organism's potentially pathogenic and saprophytic bacteria. In a study conducted by Namaei *et al.* in one of the hospitals of Birjand, bacterial pollution percentage was determined by 100%. Schultz *et al.* reported the pollution percentage by 95% (Schultz *et al.*, 2003; Namaei *et al.*, 2012). Also, conducted study by Rutala *et al.* showed that, 50% of the keyboards were contaminated by potential pathogens (Rutala *et al.*, 2006). Difference in the amount of keyboards pollution can be considered as a result of differences in the frequency and methods of decontamination of keyboards.

Table 1. Bacterial contamination of computers keyboard.

Bacterial isolate	Contaminated keyboard (%)	Mean of cfu per keyboard
Bacillus sp.	45(69)	480
Staphylococcus aureus	15(23)	280
[£]CONS	16(24)	356
Micrococcus	5(7)	60
Enterococcus sp. K.pneumoniae	147(9)	80
Escherichia coli	1(1.5)	200
Citrobacter sp	2(3)	90
Acinetobacter baumannii	3(4)	45
Enterobacter sp.	1(1.5)	30
Actinomycet sp.	1(1.5)	40

[*]cfu, colony forming unit; [£]CONS, Coagulase Negative Staphylococci

In the present study, 60% of the studied computers in ICU were contaminated by potential pathogens. This finding is consistent with the study conducted by Hartmann *et al.* (Hartmann *et al.*, 2004). According to the present study, it was found that, the keyboards contamination is common and the contaminant bacteria mostly included Bacillus or normal skin flora such as *Staphylococcus aureus* and coagulase-negative staphylococci which are widely dispersed in the air or soil. Moreover, the percentage of contaminated keyboards by potential pathogens including MRSA and VRE was 15 and 1.5% respectively. While, percentage of keyboards contamination was less in an investigation conducted by Rutala. In the conducted study by Namaei, the most frequent isolated bacterial factors belonged to Enterobacteriaceae family (Namaei *et al.*, 2012). The differences in findings refer to the level of sanitation measures when working with computers. In the present study also, gram-negative rod bacteria such as *Escherichia coli*, *K. pneumoniae* and Enterobacter sp. were isolated from the studied keyboards. These findings were the same with the results of similar study conducted by Dogan *et al.* and Namaei, in terms of the isolates type (Dogan *et al.*, 2008).

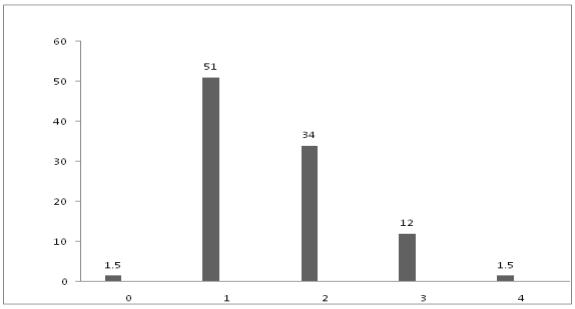

Fig. 1. Contamination percentage of keyboards as the number of isolated bacteria types.

In this research, 4% of the keyboards were contaminated by one of the important pathogens causing nosocomial infections, *Acinetobacter baumannii*; in the conducted study by Nili, the computers' keyboards have been as a reservoir for this pathogen in burn hospitals (Neely and Maley, 1999). In terms of antibiotic susceptibility of isolates, a high percentage of *S.aureus* strains showed resistance to methicillin, while in other studies percentage of resistant *S.aureus* strains to methicillin and oxacillin was lower (Rutala *et al.*, 2006). Such findings were consistent with conducted study by Kassem *et al.* (Kassem *et al.*, 2007).

Table 2. Efficiency of ethanol (70%) in removing microorganisms from the keyboard.

The mean reduction in the number of CFU after disinfection (%).		
	Time	
Organism	5 seconds	60 seconds
VRE	42	96.6
PA	64	99.7
MRSA	90	93

CFU = colony-forming units, PA= *Pseudomonas areuginosa,* VRE= Vancomycin-resistant *Enterococcus* species, MRSA= Methicillin resistant *Staphylococcus aureus.*

Existence of a higher percentage of antibiotic-resistant *Staphylococcus aureus* requires more attention to the health measures. Also, contact with the mouth or nose while working with keyboard keypad can contribute to contaminate with this pathogen since, the nose is able to transport Staphylococcus. However, degree of bacterial spread to humans and its survival on the keyboard is unknown.

In the present study, a strain of vancomycin-resistant enterococcus was also isolated from the keyboard, while, in the study conducted by Rutala, isolated enterococcus strains were all sensitive to vancomycin. The efficiency of ethanol (70%) was high in removing or deactivating the studied pathogens after 60 seconds disinfection but, in 5 seconds disinfection, eliminating of the strains was lower. In a same study by Rutala, the efficiency of ethanol was high in removing the pathogen organisms even in 5 seconds (Rutala *et al.*, 2006). This difference can be due to the difference in the type of alcohol applied in the two investigations.

It is concluded that, nowadays, the use of communication devices such as computers and mobile health systems increases the risk of infection transmission in the hospital setting and transferring it to the community (Mohammadi-Sichani and Karbasizadeh, 2011). Therefore, it is suggested to use new smart keyboards which control infection and state their cleaning and health status.

If there is no access to such keyboards, the risk of transmission from keyboard can be eliminated by considering the following items; washing hands before and after using the computer, cleaning and disinfecting the keyboard by a disinfectant such as ethanol (70%) on a daily basis, and if the keyboard has plastic cover, the same disinfectant should be used to clean them. According to the present study, it was proved that, common disinfectants such as ethanol can be effective in removing pathogenic organisms from computers' keyboard.

Study limitations

Anaerobic bacteria were not investigated in this study.

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