Abstract

The present study was carried out with the aim to investigate the microbial colonization of computer keyboards and mice in our medical school computer center.

In total, 56 samples were collected from surfaces of multiple-user computers in daily open-access, student computer center of School of Medicine. Two samples were taken by sterile swab from each computer keyboard and mouse and were put in trypticase soy broth. The specimens were subcultured onto blood agar and MacConkey agar after initial incubation at 37 °C. The confirmatory standard biochemical tests were then performed to identify the grown bacteria on the culture media.

All the keyboards and 26 (96.29%) out of total tested computer mice were contaminated with at least two kinds of bacteria. CoNS was the most common contaminated bacteria recovered from computer keyboards (36.5%) and mice (38.8%). Other isolated bacteria were Diphtheroids, Bacillus spp., and Enterobacteriaceae as the least isolates bacteria. S. aureus was detected on the 5 keyboards and 4 mice.

In conclusion, this study has shown the multiple-user computer keyboards and mice as potential reservoir for microbial contamination, some of which are of importance in transmission the nosocomial infections between medical students and patients in hospital wards.

Key words: keyboard, mouse, multiple-user computer, bacterial contamination

Introduction

Computers have been commonly used for multiple purposes in our occupational, recreational and residential environments. In the university environment, students have been used the computers for regular access to Internet, and use of e-mail and ordinary word processing. Most universities have developed multiple-user “computer laboratories” for general student access. As the popularity of such facilities increases, there is a need to recognize that computer equipment may act as a reservoir for the transmission of potentially hazardous or pathogenic microorganisms (Anderson and Palombo, 2009).

The transmission of nosocomial infections through hospital and medical and dentistry school computer users have been documented in previous studies (Man et al., 2002; Schultz et al., 2003; Palenik and Hughes, 2005).

The surfaces of computer keyboards and mice are often contaminated with nosocomial pathogens and when those are coming into contact with hands can serve as vehicles for infection transmission (Kramer et al., 2006).

The common bacteria that are commonly present on keyboards are coagulase-negative staphylococci (CoNS), diphtheroids and Bacillus spp (Fukada et al., 2008), however, meticillin resistant Staphylococcus aureus (MRSA) is also reported in some studies (Rutala et al., 2006). Several investigations have been done on contamination of computer keyboards in various hospital wards due to importance of nosocomial infections (Bures et al. 2000; Hartmann et al., 2004), since some harmful bacteria can survive for >24 h on computer keyboards and keyboards in hospitals may therefore contribute to cross-transmission of bacteria (Devine et al., 2001; Wilson et al., 2005). However little work is done on computers in use by students in medical schools computer centers located outside the hospital environment. The pre-
The study therefore was carried out with the aim to investigate the microbial colonization of computer keyboards and mice in our medical school.

**Methods**

In this study, 56 samples were collected from surfaces of multiple-user computers (28 keyboards and 28 mice) in daily open-access, student computer center of School of Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran. All computers had been in use for a period of 1 to 5 years. Sample collection was performed in the afternoon and at least 6 hours after the commencement of computer operating hours. For sampling cotton swabs inserted in sterile trypticase soy broth tubes were used.

Two samples were taken by direct contact of swabs and moving over each computer keyboard especially space bar, enter keys and mouse and were put in trypticase soy broth and immediately transferred to the microbiology department. A control, ‘field blank’ swab that was briefly exposed to the air in computer center was also collected.

The specimens were incubated at 37°C for 18-24 hours and were subcultured onto blood agar and MacConkey agar on the consecutive day. The culture media were examined after 24 hours of incubation. Colony characteristics were studied and Gram’s staining, microscopic examination and confirmatory biochemical tests were performed to identify the grown bacteria (Forbes et al., 2007).

**Results**

All the computer keyboards and mice in the center showed bacterial contamination. All the keyboards and 26 (96.29%) out of total tested computer mice were contaminated with at least two kinds of bacteria. The total number of bacteria recovered from computer keyboards and mice was 74 and 67 respectively. On the surface of majority of computer keyboards two (27%) and three (60.8%) species of the bacterial normal flora were grown. The rate of bacterial growth on computer mice were 37.8% for two species and 44.5% for 3 species (Table 1).

The isolated bacteria from computer keyboards and mice and the bacterial total count are shown in Table 2. CoNS was the most common contaminated bacteria recovered from computer keyboards (36.5%) and mice (38.8%). Other isolated bacteria were Diphtheroids, Bacillus spp., and Enterobacteriaceae as the least isolates bacteria. S. aureus was detected on the 5 keyboards and 4 mice and is a well known bacterium to cause nosocomial infections. The recovered bacteria from control blank swab was the same as sample tests except for lower bacterial count and none detection of S. aureus strain.

**Table 1. Type and total count of bacteria isolated from computers.**

<table>
<thead>
<tr>
<th>Type of isolates</th>
<th>Keyboard</th>
<th>mouse</th>
</tr>
</thead>
<tbody>
<tr>
<td>one bacterium</td>
<td>0 × 1 = 0</td>
<td>1 × 1 = 1</td>
</tr>
<tr>
<td>two bacteria</td>
<td>10 × 2 = 20</td>
<td>14 × 2 = 28</td>
</tr>
<tr>
<td>three bacteria</td>
<td>15 × 3 = 45</td>
<td>11 × 3 = 33</td>
</tr>
<tr>
<td>four bacteria</td>
<td>3 × 4 = 12</td>
<td>2 × 4 = 8</td>
</tr>
<tr>
<td>Total</td>
<td>74</td>
<td>67</td>
</tr>
</tbody>
</table>

**Table 2. Microorganisms identified on computer keyboards and mice**

<table>
<thead>
<tr>
<th>Microorganisms</th>
<th>keyboard, No. (%)</th>
<th>mouse, No. (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>CoNS</td>
<td>27 (36.5%)</td>
<td>26 (38.8%)</td>
<td>53</td>
</tr>
<tr>
<td>Diphtheroids</td>
<td>18 (24.3%)</td>
<td>17 (25.4%)</td>
<td>35</td>
</tr>
<tr>
<td><em>Bacillus</em> species</td>
<td>15 (20.3%)</td>
<td>14 (20.9%)</td>
<td>29</td>
</tr>
<tr>
<td>Micrococcus species</td>
<td>6 (8.1%)</td>
<td>5 (7.4%)</td>
<td>11</td>
</tr>
<tr>
<td>Staphylococcus aureus</td>
<td>5 (6.75%)</td>
<td>4 (6%)</td>
<td>9</td>
</tr>
<tr>
<td>Enterobacteriaceae</td>
<td>3 (4.05%)</td>
<td>1 (1.5%)</td>
<td>4</td>
</tr>
<tr>
<td>Total</td>
<td>74 (100%)</td>
<td>67 (100%)</td>
<td>141</td>
</tr>
</tbody>
</table>

* Coagulase-Negative Staphylococci
Discussion

Medical students are in close contact with patients in clinical wards in teaching hospitals, so they may act as a reservoir of microorganisms gains from computer keyboards and mice and transmit the organisms to patients. Besides the computer keyboard and mouse represent a high contact area for all staff, who may spread the organism without direct patient contact (Neely and Sittig, 2002).

In this study, we investigated the number and nature of contaminating microorganisms on the keyboards and mice of multiple-user computers located in computer center of School of Medicine. Several studies have indicated the contamination of computer keyboards and mice with pathogenic bacteria in hospitals and health care settings. In these investigations apart from normal flora, there are reports of detecting MRSA as potential pathogen in nosocomial infections (Kassem et al., 2007; Bures et al., 2000).

In our study the contamination rate of keyboard was high and this shows that microbial contamination also occurs on computer equipments located outside the hospitals and in an environment that is not directly connected to hospital. However most of isolated bacteria in our study was normal flora with CoNS as the most common isolated bacteria. In similar studies conducted in a tertiary care center and in a hospital, CoNS was reported as the major isolated organism at the rate of 100% and 96.7% respectively (Rutala et al., 2006; Dogan et al. 2008) which was higher than our findings. This may be due to existence of higher rate of bacterial contamination in hospital environment. Although, the rate of isolated S. aureus in our study was in concordant to their results as 6% which was lower than 17.4% reported rate of S. aureus isolation in another recent study (Lu et al., 2009). In the only investigation we have found on literature review which was conducted on computers in a university setting, the high bacterial contamination rate in multiple-user computers was reported which was similar to our findings (Anderson and Palombo, 2009). Further study is needed to compare the bacterial contamination of multiple-user computers with the academic staff single-user computers in point of view of bacterial count and nature.

The ideal way for elimination or minimizing the risk of transmission from contaminated keyboards and mice would be performance of hand hygiene before and after use of computers, however this may be impractical and can not be checked for a great number of daily users. So the desired way might be use of a suitable disinfection on a regular basis as has been suggested by other investigations (Rutala et al., 2006).

In conclusion, this study has shown the multiple-user computer keyboards and mice as potential reservoir for microbial contamination, some of which are of importance in transmission the nosocomial infections between medical students and patients in hospital wards.

Acknowledgements

We are grateful to the staff of computer center of School of Medicine, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran, for their collaboration in sample collection.

References


Corresponding Author
Azar D. Khosravi,
Dept. of Microbiology,
School of Medicine,
Ahvaz Jundishapur University of Medical Sciences,
Ahvaz,
Iran,
E-mail: khosraviaz@yahoo.com