Assessment of Aerobic Bacterial Contamination of Computer Keyboards in a Tropical Setting

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Abstract

Background: Computers are widely used in healthcare for improved and effective care. Previous published reports have shown microorganisms colonising computer keyboards in some clinical areas.

Objectives: This study was undertaken to measure, compare and characterize the aerobic microorganisms in computer keyboards of hospital and non-hospital settings.

Methodology: Samples were collected from commonly used keys of computers in hospital and non-hospital settings using moistened sterile swabs, inoculated in liquid and solid media, and incubated aerobically at 37°C for 24-48 h. Growth was identified as per standard microbiological procedures. Antibiotic susceptibility was determined for pathogenic strains by Kirby-Bauer method.

Results: Growth was seen in all 80 samples (40 from each setting). Staphylococcus aureus was isolated from both settings (hospital: 6 MRSA, 11 MSSA; non-hospital: 4 MRSA, 9 MSSA). Gram-negative bacilli were isolated more frequently from hospital (33%). Statistical analysis showed homogeneity among isolates from computer keyboards in both settings, except for Pseudomonas.

Conclusion: Isolation of microorganisms from “high-touch” surfaces such as computer keyboards is indicative of the need for awareness on cleaning of such surfaces or disinfection and adequate hand hygiene.

Introduction

Technological advancement has changed the environment of the healthcare facilities. Computers have become a vital component of healthcare delivery for improved and effective care. Valuable patient related information is available in computers at the click of a button. Healthcare providers move back and forth, between computers and patients while delivering healthcare, as a part of the daily routine. There are some reports on the microorganisms colonising computer keyboards in different locations of hospital environment, including clinical areas.¹⁻⁵ There is, however, paucity of data on the extent and nature of contamination, and microbial profile of computer keyboards in healthcare facilities especially in the context of developing countries in tropical region, since the environmental conditions differ.

This study was undertaken to measure, compare and characterize the aerobic microorganisms in computer keyboards of both hospital and non-hospital settings. In order to ascertain whether the hospital milieu contributes to the colonisation of microorganisms and the type of organisms recovered on computer keyboards, sampling was undertaken in non-hospital setting (banking facility and a computer laboratory).

Materials and Methods

Surface samples were taken from computer keyboards in hospital (clinical areas and administrative section of a healthcare facility) and non-hospital (a banking facility and a computer laboratory) environments in June – December 2008 after obtaining permission. Sampling of only the computer keyboards were included in the study protocol. Samples were collected from frequently used computer keys using sterile swabs moistened with sterile saline. Sampled swabs were streaked over Blood agar and MacConkey agar plates, and inoculated in thioglycollate medium (Hi-Media Company Limited, India) for aerobic growth. Anaerobic / fungal cultures were not undertaken. Plates were incubated aerobically at 37 °C for 24 - 48 h.

Gram-positive and Gram-negative bacteria were identified as per standard microbiological procedures.⁶ Bacterial colonies were differentiated based on the colony morphology and colour, Gram staining, haemolysis patterns, catalase and coagulase tests [for Staphylococci], and catalase and oxidase tests [for Gram-negative bacterial]. Suitable biochemical tests were done for further identification of the bacterial isolates. Antibiotic susceptibility test was done for pathogenic strains by Kirby-Bauer Disc diffusion method. Data was statistically analysed to determine if the variation in the microbial growth obtained in the two settings was significant.

Results

A total of 80 samples (40 from each location) were collected, from which 150 microorganisms were isolated. All the samples collected yielded growth; however the extent of contamination varied (Table 1). Majority of the isolates obtained were microorganisms considered to be pathogenic or probable pathogen (n = 90; 60%), where the nature and extent varied. Gram-positive cocci (GPC) (n = 72; 80%) were more predominant than Gram-negative bacilli (GNB) (n = 18; 20%). GPC were more frequently isolated than GNB irrespective of the location. However, more isolates of GNB were obtained from computer keyboards of hospital setting (33%) than from non-hospital setting (13%).

Hospital settings: Among GPC, CNS was predominant (n=22; 55%). Staphylococcus aureus was also isolated (n=17; 43%), of which 11 (28%) were sensitive to methicillin and six (15%) were methicillin resistant. A total of 13 GNB were isolated, of which Pseudomonas spp. (23%) was the predominant. Other GNB isolated include Acinetobacter spp. (n = 2), Escherichia coli (n = 1) and Klebsiella pneumoniae (n = 1).

Non-hospital settings: Of the GPC isolated, CNS (50%) was the most frequently isolated. Among the S. aureus isolates (n = 13;
was cultured most frequently, and no methicillin resistant spp. *Bacillus* (MRsA) was isolated. Another study from Japan reported *aureus* spp. *Pseudomonas* Gram-Negative Bacteria staphylococci negative Coagulase- *aureus* Staphylococcus sensitive Methicillin *aureus* Staphylococcus Resistant Methicillin Gram-Positive Bacteria *Pseudomonas* when analysed for isolates from both the settings. any significance. The test was, however, found to be significant, from the two settings under study, and the test did not show in non-hospital keyboards).

and aerobic spore bearers (42% in hospital keyboards and 58% respectively), while non-pathogenic strains included micrococci from both the hospital and non-hospital settings (55% and 50% comprising of coagulase-negative staphylococci were obtained computer laboratory) (Figure 1). Isolates of probable pathogens strains isolated (n=48), 30 (63%) were healthcare in origin, probable pathogen and non-pathogenic. Among the pathogenic isolates have been grouped as known pathogenic, probable pathogen and non-pathogenic. Among the pathogenic strains isolated (n=48), 30 (63%) were healthcare in origin, while 18 (37%) were from non-hospital environment (office and computer laboratory) (Figure 1). Isolates of probable pathogens comprising of coagulase-negative *Staphylococcus* were obtained from both the hospital and non-hospital settings (55% and 50% respectively), while non-pathogenic strains included micrococci and aerobic spore bearers (42% in hospital keyboards and 58% in non-hospital keyboards).

Chi-square test for homogeneity was used to analyse the data to determine the homogeneity of the microbial pattern obtained from the two settings under study, and the test did not show any significance. The test was, however, found to be significant, when analysed for *Pseudomonas* isolates from both the settings.

### Discussion

Studies published earlier have documented colonisation of computer keyboards in healthcare settings. However, to our knowledge, there are no reports from developing countries on the nature and extent of colonisation of micro-organisms on computer keyboards. Non-hospital settings such as banking facility and computer laboratory were also studied to determine if difference in the environment has an impact on the extent of colonisation. Our study has documented the presence of microorganisms in computer keyboards irrespective of the location, though there were differences in the type of organisms isolated.

A study from Turkey documented skin flora to be the predominant isolates from computer keyboards; *Bacillus* spp. was cultured most frequently, and no methicillin resistant *S aureus* (MRSA) was isolated. Another study from Japan reported

### Table 1: Microbiological profile of pathogenic isolates from computer keyboards of hospital and non-hospital settings

<table>
<thead>
<tr>
<th>Organisms isolated</th>
<th>Keyboards from hospital setting (N = 40)</th>
<th>Keyboards from non-hospital setting (N = 40)</th>
<th>Statistical Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gram-Positive Bacteria</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Methicillin Resistant <em>Staphylococcus aureus</em></td>
<td>6 (15%)</td>
<td>4 (10%)</td>
<td>0.499</td>
</tr>
<tr>
<td>Methicillin Sensitive <em>Staphylococcus aureus</em></td>
<td>11 (28%)</td>
<td>9 (23%)</td>
<td>0.606</td>
</tr>
<tr>
<td>Coagulase-negative staphylococci</td>
<td>22 (55%)</td>
<td>20 (50%)</td>
<td>0.654</td>
</tr>
<tr>
<td><strong>Gram-Negative Bacteria</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Pseudomonas</em> spp.</td>
<td>9 (23%)</td>
<td>0</td>
<td>0.001*</td>
</tr>
<tr>
<td><em>Acinetobacter</em> spp.</td>
<td>2 (5%)</td>
<td>0</td>
<td>0.152</td>
</tr>
<tr>
<td><em>Escherichia coli</em></td>
<td>1 (3%)</td>
<td>0</td>
<td>0.314</td>
</tr>
<tr>
<td><em>Klebsiella pneumonia</em></td>
<td>1 (3%)</td>
<td>5 (13%)</td>
<td>0.09</td>
</tr>
</tbody>
</table>

*Statistically significant

33%), nine (23%) were sensitive to methicillin and four (10%) were methicillin resistant. *K. pneumoniae* (n = 5) was the only GNB isolated from non-hospital setting.

The isolates have been grouped as known pathogenic, probable pathogen and non-pathogenic. Among the pathogenic strains isolated (n=48), 30 (63%) were healthcare in origin, while 18 (37%) were from non-hospital environment (office and computer laboratory) (Figure 1). Isolates of probable pathogens comprising of coagulase-negative *Staphylococcus* were obtained from both the hospital and non-hospital settings (55% and 50% respectively), while non-pathogenic strains included micrococci and aerobic spore bearers (42% in hospital keyboards and 58% in non-hospital keyboards).

Chi-square test for homogeneity was used to analyse the data to determine the homogeneity of the microbial pattern obtained from the two settings under study, and the test did not show any significance. The test was, however, found to be significant, when analysed for *Pseudomonas* isolates from both the settings.

CNS and *Bacillus* spp, including MRSA from keyboards of computers used by anaesthetists for entry of patients related data. In our study, CNS was the predominant isolate. These are known to be present in the hospital environment, and can be a source of cross infection, causing Hospital Acquired Infections (HAI) especially in immuno-compromised hosts. MRSA were isolated in small percentage (12%) of computer keyboards. Thus, there appears to be an additional source for colonisation of MRSA in the hospital environment; infection control guidelines for control of MRSA must consider disinfection of computer keyboards to prevent inadvertent transmission.

In addition, nosocomially significant pathogens such as *Pseudomonas* spp., *Acinetobacter* spp., *E. coli*, and *K. pneumoniae* were also isolated. Multi-drug resistance was not observed among GNB, and *Bacillus* spp was not isolated.

Chi-square test for homogeneity was not significant for the isolates from both the settings, thus indicating that the proportion of microbial pattern obtained from computer keyboards in the hospital setting is homogenous with that of the microbial pattern in non-hospital setting. However the variation in case of *Pseudomonas* isolated from the hospital setting was significant when compared to those from non-hospital setting.

Computer keyboards offer a surface for colonisation of microorganisms including nosocomially significant pathogens. What are the possible sources of microorganisms? Hands may have pathogenic organisms as transient flora, which may cause contamination of high-touch areas such as computer keyboards. Furthermore, air may be a source of contamination of computer keyboards; it is also possible that GNB can be airborne due to the prevailing environmental conditions, as previously described.

If air is the source of contamination, then aerobic spore bearers and micrococci, which are known to be airborne, should be more frequently isolated. If hands are the source, CNS, which are part of skin flora, may be isolated. In our study, we documented GNB in addition to CNS and MRSA, which are known to survive in the presence of moisture. In an air-conditioned environment, if the ambient temperature is not well maintained, this will allow for moisture condensates which may trap microorganisms. Environmental factors that allow GNB to survive and be airborne include temperature and relative humidity; thus it is essential that standards for indoor air quality be followed, especially in healthcare facilities to prevent aerosolisation. Furthermore, hands may have moisture due to sweat in humid conditions,
which may allow for colonization of gram negatives and get readily transmitted to inanimate surfaces and high-touch areas. Humid conditions appear to enhance the persistence of *E coli* and *Pseudomonas aeruginosa*.

Microorganisms may survive on dry surfaces including computer keyboards for varying time periods as previously described; for example, *S aureus* were found to survive for seven days to seven months, while *Pseudomonas* spp. were observed to be viable for up to five weeks. However, the current study was a one-time sampling.

Studies earlier have found that contamination rates with potentially pathogenic microorganisms on computer keyboards or mouse devices were higher than on other (non-porous) surfaces. Use of plastic covers and simple cleaning of computers with 70% isopropyl alcohol may decrease the bacterial load. Cleaning or routine use of surface disinfection is often not followed due to lack of sufficient evidence to support the use of appropriate disinfectants that are suitable for clinical applications as well as compatibility with the surface materials.

Compliance rates with hand hygiene have been found to vary between 16-50%, which may allow for cross transmission of nosocomial pathogens. It is therefore essential to create awareness among healthcare personnel on the possibility of transmission of microorganisms from computer keyboards to patients and thus the need for proper hand hygiene practices.

The limitation of the study is that the data presented is based on one-time sampling. Further studies may be carried out to determine the persistence of the microorganisms on computer keyboards over time, and simultaneous sampling of hands of the personnel.

**Conclusion**

Computer keyboards in both hospital and non-hospital settings harboured microorganisms such as *Staphylococcus aureus* and *Klebsiella* sp. Statistical analysis revealed a homogeneity in the isolation of microorganisms; there was however significant difference in isolation of *Pseudomonas* sp. from the computer keyboards in hospital setting as against those in non-hospital setting. Thus presence of pathogenic microorganisms on computer keyboards is a cause of concern. Since computer keyboards are providing a surface for colonisation, infection control guidelines must target appropriate surface disinfection and adequate hand hygiene, and awareness on cleaning of such surfaces or disinfection needs to be addressed.

**Acknowledgement**

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**References**