Microbial Contamination of Some Computer Keyboards and Mice in National Center for Radiation Research and Technology (NCRRT)

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Abstract: Computers are ubiquitous in everywhere and have been shown to be contaminated with potentially pathogenic microorganisms. There is no economical way to test all the keyboards out there, but there are common-sense ways to prevent bacterial contamination or eliminate it if it exists. In this study, it was found that all the tested 24 computer keyboards and mice, were positive for microbial contamination. The percentage of pathogenic bacteria, non pathogenic bacteria and mould was 3.0%, 0%; 66.3%; 66.6%; 30.6% and 33.3% for computer keyboards and mice, respectively. The isolated pathogens which included *Bacillus cereus* (60% susceptible and 10% resistant); *Pseudomonas putida* (90% susceptible and 10% resistant) and *Escherichia tarda* (90% susceptible and 0% resistant) were tested against the 10 different antibiotics. The disinfectant dettol wipes were highly effective at removing or inactivating microbial contamination.

Key words: Microbial contamination • Disinfectant • Pseudomonas putida • Escherichia tarda • Gamma ray

INTRODUCTION

Microorganisms are everywhere, bacteria and fungi contaminate our body, our houses, workplaces, pets and the whole environment. Fortunately, among many billions of bacteria, only 1,500 can be dangerous for our health, causing different diseases such as pneumonia or skin infections. The real problem is that the number of bacterial strains which develop resistances towards disinfectants and especially antibiotics is increasing very fast. Some of these resistant microorganisms are difficult to destroy and can survive for a longer time on the floor and other surfaces. Resistant bacterial strains are now spreading to our houses and other places where people live or work [1].

ECCMID [1] reported that there are no safe objects. Tables, utensils, computers, door knobs, gym equipments and other objects were shown to be contaminated with potentially dangerous pathogens. Bacterial presence has been revealed also on mobile phones and even on the mouse and keyboard of personal computers. All these items and surfaces can be potential source for cross infections, transmitting microorganisms. Therefore, we should promote regular decontamination of daily use

objects as part of an effective strategy to prevent the spread of multiresistant pathogens and the occurrence of consequent infections.

The prevalence of bacterial infections in humans is increasing and has been shown to result in part from transmission of pathogens from the hospital setting to the community and vice versa [2, 3, 4, 5]. Because of frequentdermal contact by numerous users, one reservoir of interest is computer keyboards, which have been shown to harbor methicillin resistant Staphylococcus aureus (MRSA) in the hospital setting [6, 7]. Of increasing concern, however, is the role of keyboard in the non-hospital environment as pathogen reservoirs. Because the asymptomatic carriage of MRSA in humans is increasing [3] along with the occurrence of community associated MRSA infections [8], it follows that the ubiquitous sharing of public computers by a broad user base might facilitate increased transmission and prevalence of MRSA throughout the community.

The main cause of bacterial contamination of keyboards is eating lunch while working so crumbs and spills can wind up on and between the keys; the food deposits encourage the growth of millions of bacteria.

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Another cause is thought to be poor personal hygiene such as neglecting to wash hands after going to the bathroom. Dust, also which can trap moisture and enable any bacteria that are already on your keyboard to flourish. One potential cause of a keyboard that can make a person sick, is sharing it among other workers. One of whom may have coughed or sneezed into his hand [9].

This study was undertaken to evaluate the extent of microbial contamination of some computer keyboards and mice at National Center for Radiation Research and Technology (NCRRT). The efficacy of dettol wipes as a cheap and available disinfectant was tested.

MATERIALS AND METHODS

Sampling: This study was conducted at NCRRT, where there are microbiological labs, irradiation units, operative rooms and staff rooms. Samples were collected from 24 computers (Keyboards and mice). To determine the level of microbial contamination, a single sterile swab moistened with sterile saline solution was moved over the surfaces being tested (keyboard and mouse). After the collection, swabs were squeezed in 1 ml sterile saline solution.

Microbiological Analysis: The suspension was spread onto nutrient agar (for total bacterial count); MacConkey agar (for gram negative bacteria) and Sabouraud dextrose agar (for total mould count). Cultures were incubated at 37°C for 48 hr for nutrient and MacConkey agar and at 28°C for 4 days for Sabouraud dextrose agar then microbiological counts were taken. Isolated bacterial organisms were identified using gram stain and standard biochemical procedures [10].

Antimicrobial Susceptibility Test: It was performed to all pathogenic bacterial isolates against 10 ready made antibiotics (representing different classes of antibiotics) by disc diffusion method. Zones of inhibition were measured after 24 h incubation at 37°C to the nearest millimeter with a slide gauge.

Irradiation: Determination of D₁₀.values (a dose which kill 90% of total bacterial count) for the three pathogenic bacterial isolates were carried out to evaluate their radiation sensitivity.

Bacterial cultures in test tubes (10 ml each) of 16 h incubation were exposed to different doses of gamma radiation from 1-15 kGy in ambient temperature using "Indian Gamma Chamber 4000 A" with a ⁶⁰Co source at dose rate of 2.6kGy/h at irradiation facility of NCRRT.

Dilutions for plate counts were then made in saline solution. Petri dishes were incubated for at 35°C for 24 h before counting. The log number of survivors was plotted against the absorbed radiation doses in kGy. Linear regression was applied using Excel program to produce the best fitting line from which the D_{10} value was calculated as the reciprocal of the absolute value of the regression line [11].

Cleaning of Computer: To get rid of crumbs and dust that may have found their way between the keys, first unplug the keyboard, turned it upside down and gently shaked. Afterward, to remove any remaining debris, vacuum between the keys using a hand-held vacuum cleaner, or wipe between the keys with a computer brush.

To rid the surface of the keys common grease and grime, unplug the keyboard, gently wiped off with a cloth slightly dampened with water followed by a wipe with a dry cloth.

To rid the keys of bacteria and viruses, was gently rubbed the keyboard with a dettol wipe (purchased from local pharmacies) that are alcohol free which help to prevent the fading of the letters and other markings on the keys.

Finally, the mice were kept clean as well with both ball-type and optical mice by a dettol wipe and compressed air. The efficacy of the disinfectant (dettol wipes) was determined by calculating the percent reduction achieved (number of colony forming units on nutrient, MacConkey and Sabouraud dextrose agar) by using a sterile swabs as done before.

RESULTS AND DISCUSSION

A total of 24 computer keyboards and mice were tested for microbial contamination. The percentage of non pathogenic, pathogenic bacteria and mould isolates were represented in Table 1 and Fig. 1-3. It was found that all the tested computer keyboards and mice were positive for microbial contamination. Most of these isolates were traditional skin flora. In addition other organisms such as gram positive rods, cocci and mould, revealed a general level of contamination of this widely used equipments.

In this study the contamination rate of keyboards and mice was 99.9% and 100%, respectively. The sampled potentially pathogenic microorganisms contained 3.0% of *Bacillus cereus*, *Pseudomonas putida* and *Escherichia tarda* on computer keyboards when compared with that on mice (0.0%). It was revealed by Hartmann *et al.* [12]

Table 1: Microbial contamination of computer (keyboards and mice) before disinfection

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|------------------------------|--|---|
| Microorganisms | No. (%) of keyboards positive for contamination (n=24) | No. (%) of mice positive for contamination (n=24) |
| Non pathogenic bacteria | | |
| Bacillus circulans | 22 (91.6%) | 16 (66.6%) |
| Bacillus brevis | 19 (79.2%) | 13 (54.2%) |
| Bacillus sphaericus | 18 (75.0%) | 16 (66.6%) |
| Micrococcus luteus | 4 (16.6%) | 1 (4.2%) |
| Micrococcus varians | 1 (4.2%) | 0 (0.0%) |
| Staphylococcus epidermidis | 1 (4.2%) | 0 (0.0%) |
| Pathogenic bacteria | | |
| Bacillus cereus | 1 (4.2%) | 0 (0.0%) |
| Pseudomonas putida | 1 (4.2%) | 0 (0.0%) |
| Escherichia tarda | 1 (4.2%) | 0 (0.0%) |
| Mould | | |
| Aspergillus flavus | 11 (45.9%) | 9 (37.5%) |
| Aspergillus niger | 12 (50.0%) | 7 (29.2%) |
| Penicillium sp. | 2 (8.3%) | 1 (4.2%) |
| Mucor sp. 2 (8.3%) | 1 (4.2%) | |
| Rhizopus sp. | 3 (12.5%) | 5 (8.3%) |
| Total bacteria and mould | 98.0 | 69.0 |
| % of non pathogenic bacteria | 66.3% | 66.6% |
| % of pathogenic bacteria | 3.0% | 0.0% |
| % of mould | 30.6% | 33.3% |

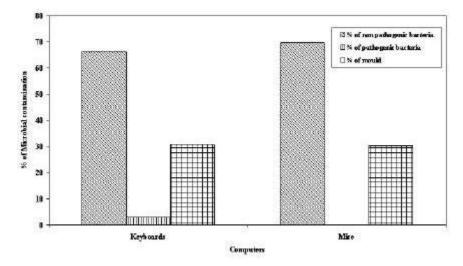


Fig. 1: Total percent of microbial contamination of computers (keyboards and mice)

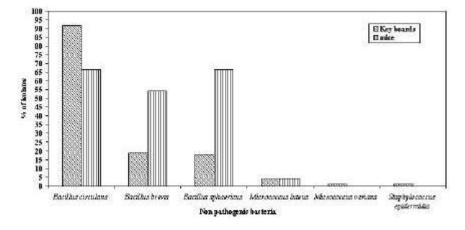


Fig. 2: Percentage of non pathogenic bacterial isolates contaminating keyboards and mice

Table 2: Antimicrobial susceptibility test for pathogenic bacterial isolates

| Antibiotics | Bacillus cereus | Pseudomonas putida | Escherichia tarda |
|--|-----------------|--------------------|-------------------|
| 1-Amikacin (AK) | I | S | I |
| 2- Augmentin (AG) | S | S | S |
| 3-Cephradine (CH) | S | S | S |
| 4-Ciprofloxacin (Cip) | I | S | S |
| 5-Colifuran (F) | I | R | S |
| 6-Gentamycin (GM) | S | S | S |
| 7-Nalidixic acid (NA) | S | S | S |
| 8- Penicillin (P) | R | S | S |
| 9-Sulphamethoxazole trimethoprim (SXT) | S | S | S |
| 10-Tetracycline (Te) | S | S | S |
| Total % of antibiotic susceptibility | 60% S | 90%S | 90% S |
| • • | 30% I | 0%I | 10%I |
| | 10% R | 10%R | 0%R |

S: susceptible I: intermediate R: resistant

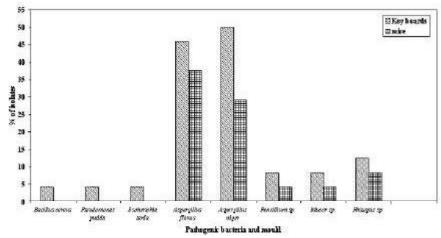


Fig. 3: Percentage of pathogenic bacteria and mould contaminating keyboards and mice

that the highest rate of contamination in patients rooms was found on keyboards (with 5.4% *Enterococcus* sp). and mice (with 5.9% *Staphylococcus aureus*). Gram negative rods were isolated in only 2 samples taken from keyboard and one from ventilator in patient room. Schultz *et al.* [13] found that the tested 100 keyboards in 29 clinical areas for bacterial contamination, 95 from them were positive for *Streptococcus, Clostridium perfringens, Enterococcus, Staphylococcus aureus* and gram negative organisms.

Among the non-pathogenic microorganisms found on keyboards and mice included *Bacillus circulans*, *Bacillus brevis*, *Bacillus sphaericus*, *Micrococcus luteus*, *Micrococcus varians* and *Staphylococcus epidermidis* being part of the normal skin flora (Table 1 and Fig. 2). These results agreed with that of Hartmann *et al.* [12], who isolated *Staphylococcus epidermidis* from keyboards in intensive care units. Rutala *et al.* [14] also showed that the tested 25 computer keyboards contained 72% *Micrococcus* sp. and 64% *Bacillus* sp.

The percentage of mould isolates in this work was 30.6% and 30.3% for keyboards and mice respectively. These isolates included *Aspergillus flavus*, *Aspergillus niger*, *Penicillium* sp. *Mucor* sp. and *Rhizopus* sp. (Table 1 and Fig. 2). Rutala *et al.* [14] also isolated *Aspergillus flavus* and *Aspergillus niger* from computer keyboards.

Susceptibility testing was performed on *Bacillus cereus*, *Pseudomonas putida* and *Escherichia tarda* (isolated from the 24 tested computer keyboards) against 10 different types of antibiotics (Table 2 and Fig. 4). It was found that *Bacillus cereus* was 60% susceptible and 10% resistant; *Pseudomonas putida* was 90% susceptible and 10% resistant while *Escherichia tarda* was 90% susceptible and 0% resistant. It was found by Rutala *et al.* (2006) that *Staphylococcus aureus* was 4% oxacillin resistant and 4% oxacillin sensitive in comparison with *Enterococcus* sp. which was 12% vancomycin susceptible.

The disinfectant dettol wipes were found to be highly effective at removing or inactivating pathogens including

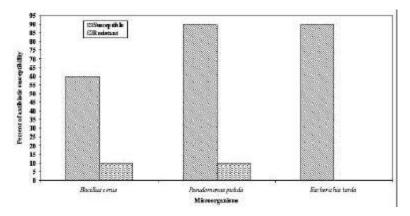


Fig. 4: Percentage of antibiotics susceptibility of the isolated pathogenic bacteria against 10 tested antibiotics

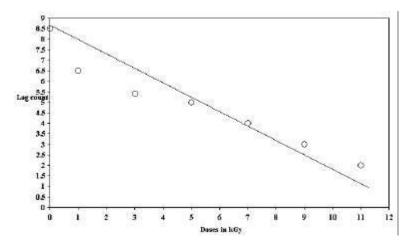


Fig. 5: Radiation-dose response curve for isolated Bacillus cereus

Bacillus cereus, Pseudomonas putida and Escherichia tarda after 5-second application with a wipe. So that risk of transmission from contaminated keyboards and mice could be eliminated if staff performed hand hygiene after contact with inanimate objects.

To determine the radiation resistance of the three isolated pathogenic strains. Bacillus cereus. Pseudomonas putida and Escherichia tarda suspensions were exposed to different doses of gamma radiation. It was found that Pseudomonas putida and Escherichia tarda were highly sensitive to gamma radiation (since there was no growth at 1.0 kGy), Whereas, Bacillus cereus was moderate radiation resistance. Its estimated D₁₀ value was 0.9 kGy. Christensen and Ringertz [15] found that ordinary strains of Bacillus cereus, have moderate radiation resistance. The D₁₀ values calculated for 99% of total number of spores of bacilli isolated from dust were found to be 0.9 kGy [16].

CONCLUSION

In this study, it was found that there was a higher contamination rate of computer user interfaces, like keyboard and mouse. The contamination rates of non pathogenic bacteria were higher than pathogenic bacteria and mould.

On the basis of these findings, it was suggested that routine cleaning of keyboards and mice or transparent plastic covers may aid the fight against infection. Also, hand washing before contact with keyboards and mice should significantly reduce the risk of contamination and cross transmission.

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