

MICROBIOLOGICAL ASSESSMENT OF COMPUTERS AND SIMILAR DEVICES, ILLUSTRATE SOME THREADS AGAINST HUMAN HEALTH

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Abstract

Introduction: now a days, electronical devices such as Laptops and computers due to their well-functional usage, may have a major roll and effect on human health. So it is important to be more attentive to their cleanliness. **Material & methods:** in this descriptive cross-sectional study some electronical devices such as Laptops, Tablets, Printer sets, Scanners and multiple part of computers including monitors, mouses, keyboards and cases were assessed by some scientific bacteriological methods like Gram staining and cellular morphology. **Results:** generally 9410 electronic samples is collected while 7128 cases (75.74%) were polluted

significantly. The highest rate of contamination is due to *Staphylococcus epidermidis*. Almost all the keyboards are extremely contaminated.

Conclusion: accordingly, the proper disinfection of such devices in a regular manner recommended to avoid many complexities confront to human health.

Keywords: Computers – microbial contamination – bacteria – printer set – scanner machine – personal health

INTRODUCTION

Personal health is an essential issue. Disregarding to it can lead to infectious diseases and even fatality, according to studies conducted several years ago estimated that annually 2 million people suffer from diseases caused by insufficient health care [1, 2]. Actually about 90,000 people would be face with the death by the current situation, and this statistic may have been increased [3].

One of the devices that need health care observance is the computer. Owing to its usage, the computer has influenced many aspects of human's lives, such as household, work environments, and entertainment, etc. which has caused almost everyone to deal with it.

According to studies performed on students' daily activities, it is clarified that nearly all of the students have access to the computer and related equipment [4].

Moreover, as a result of much direct hand contact as well as infrequent disinfection, Keyboards and mice can be presented as a major source of contamination. In addition, researchers have pointed out that keyboards and mice are highly contaminated, particularly if they have been used by multiple users and must be adequately disinfected [5-7].

In addition, cleaning and disinfecting of the computers existed in hospitals, clinics and other medical centers should be regarded seriously which If not properly disinfected, it can be the main source of many nosocomial diseases.

According to the research of Movahed et al., 70% of these computers will be cleaned weekly with window cleaners, 4.5% of them by deconex, and the rest will not be wiped at all [8].

Beside them, some studies have pointed out vast bacterial isolations for the computers Such as: *E. coli*, *S. aureus*, and *Bacillus cereus* [9]. Overall, the pollution caused by multi-user computers is far more than the pollution caused by single-user [10]. As a result, the use of computers can transmit a variety of microorganisms in such a way that 80% of infections are spread through hand-to-hand or hand-to-object contact [11].

When these surfaces become infected with bacterial isolations, also depending on the environmental conditions, at least they can survive for several weeks [12]. Therefore, these devices must be disinfected frequently. Late researches reveal that these microorganisms lived on different electronic devices, can be lead to a variety of diseases [13].

In this way, our research has been done to investigate the different types of electrical devices, including laptops, tablets, and computers, because these devices have involved almost everyone's life. As long as humanity did not observe hygiene, we will face serious risks of a new disease as well as increasing fatality in a short period. Also we have provided a comprehensive observation so as to compare the different type of electronic devices to give a better vision; so we collect many samples to make the judge easier for the scientific society.

MATERIAL AND METHODS

The principal aim of this article is to determine the cleanliness of many electronic devices which may have some essential application in human life such as Laptops, Tablets, Printer sets, Scanners and multiple part of computers including monitors, mice, keyboards and cases. This study is conducted in

Tehran, Iran on February 2021. In order to collect the samples, we have used some sterile cotton swabs soaked with deionized water and put inside test tubes. After a while the samples were passaged on transport culture medias and transferred to laboratory for further procedures. Previously some culture medias such as Nutrient agar, Blood agar, MacConkey agar and EMB were being provided and kept in refrigerator. So the samples were transferred to main agars and incubated on 37°C for 24-48 hours. Afterward the samples were precisely checked for bacterial growth and colony forming with some scientific bacteriological methods like Gram staining and cellular morphology.

RESULTS

In this descriptive cross- sectional study 9410 electronic samples is collected from

Laptops, Tablets, Printer sets, Scanners and multiple part of public and personal computers which amongst 7128 cases (75.74%) were polluted significantly. According to the table 2, the highest rate of contamination is due to *Staphylococcus epidermidis* (26.29%, 1874 out of 7128) and the least one is due to *Pseudomonas* (0.56%). Among different part of computers such as monitors, computer cases, keyboards and mice, almost all the keyboards are extremely contaminated (99.80%) followed by mice (98.83%), monitors (49.64%) and computer cases (44.25%). In other hand, in comparing Laptops and Tablets, the most bacterial load is detected on tablets with 98.71% against laptops with 82.08%. Probably this is related on much direct hand contact with the tablets due to their well functional system and accessibility.

Table 1: Absolute and relative frequency table of contaminated and non-contaminated cases:

	Contaminated	Non-Contaminated	Total
Computer Case	1093 (11.61%)	859 (9.12%)	1541 (16.37%)
Monitor	765 (8.12%)	776 (8.24%)	1541 (16.37%)
Keyboard	1538 (16.18%)	3 (0.03%)	1541 (16.37%)
Mice	1523 (16.18%)	18 (0.19%)	1541 (16.37%)
Printer	286 (3.03%)	299 (3.17%)	585 (6.21%)
Scanner	224 (2.38%)	88 (0.93%)	312 (3.31%)
Laptop	1031 (10.95%)	225 (2.39%)	1256 (12.34%)
Tablet	1079 (11.46%)	14 (0.14%)	1093 (11.61%)
Total	7128 (75.74%)	2282 (24.26%)	9410 (100%)

Figure 1: Rectangular chart illustrating comparative microbial depiction of contaminated and non-contaminated cases:

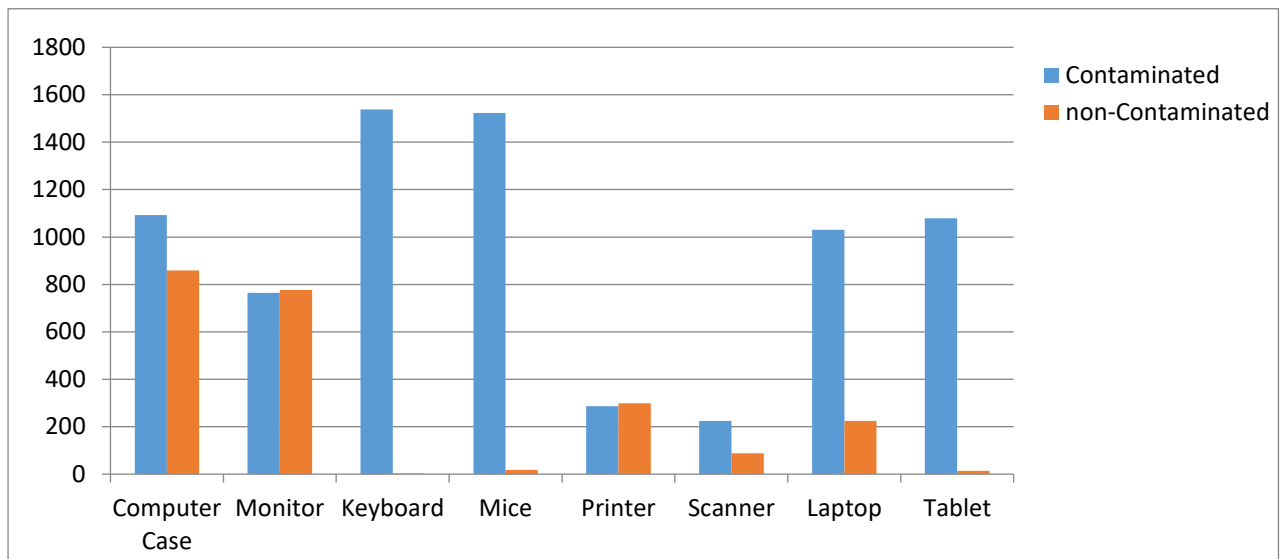
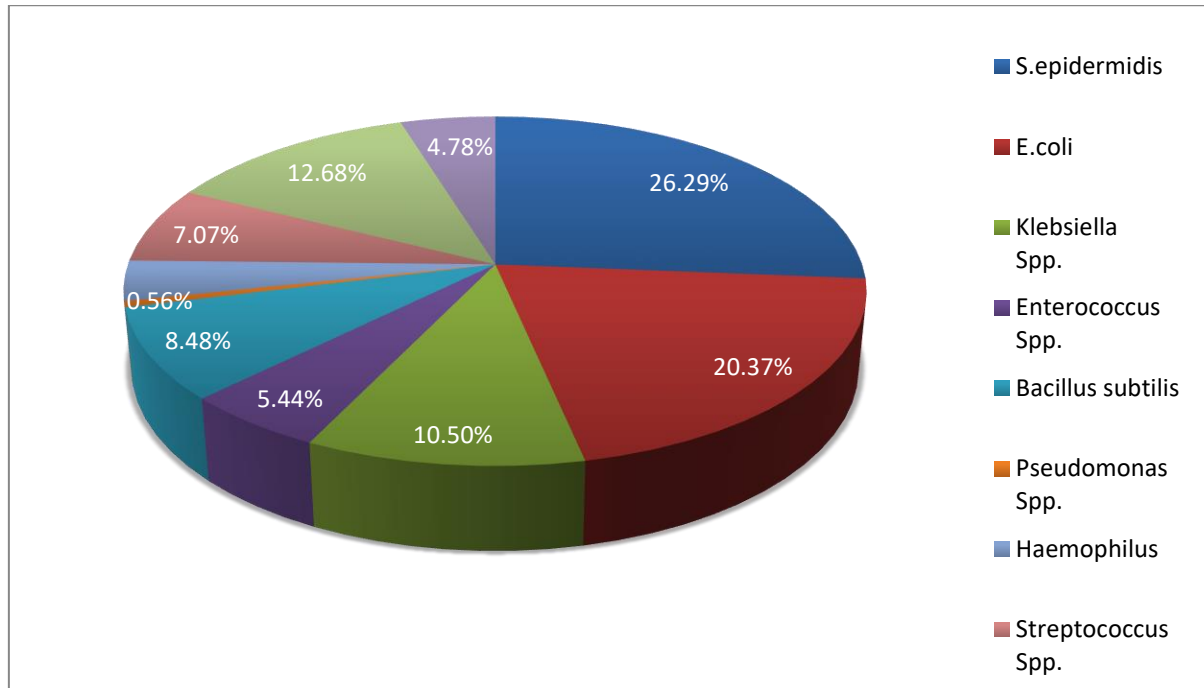


Table 2: Absolute and relative frequency table of microorganisms isolated from computers and similar devices:

<i>Bacteri</i> <i>Sample</i>	<i>S.aureus</i>	<i>S.epidermidis</i>	<i>E.coli</i>	<i>Klebsiella</i> <i>Spp.</i>	<i>Enterococcus</i> <i>Spp.</i>	<i>Bacillus</i> <i>subtilis</i>	<i>Pseudomonas</i> <i>Spp.</i>	<i>Haemophilus</i>	<i>Streptococcus</i> <i>Spp.</i>	<i>Mix</i>	<i>Total</i>
<i>Computer</i> <i>Case</i>	72	189	128	87	31	85	–	8	36	46	682
<i>Monitor</i>	91	199	132	78	56	36	9	44	98	23	765
<i>Keyboard</i>	254	382	298	188	78	107	15	56	103	57	1538
<i>Mice</i>	248	385	297	169	86	110	10	51	101	66	1523
<i>Printer</i>	45	80	53	36	20	38	–	–	–	14	286
<i>Scanner</i>	12	68	49	22	19	36	–	–	–	18	224
<i>Laptop</i>	84	285	234	87	56	96	–	52	82	55	1031
<i>Tablet</i>	105	286	261	82	42	97	6	54	84	62	1079
<i>Total</i>	911	1874	1452	749	388	605	40	264	504	341	7128

Figure 2: Relative frequency of each Bacterial isolation demonstrated by Percent ratio.

DISCUSSION

As mentioned earlier, nowadays, computers, laptops, and tablets because of their features and benefits, have many applications in human life, so it can be said that almost everyone deals with them. Among many studies that have been done to measure the level of computer's keyboard contamination, we can mention a study from India. The results of the survey indicate that about 88% of samples, out of 25 keyboards surveyed have infected with coagulase-negative Staphylococci (CoNS). So we can say that the mentioned pathogen is more prevalent than the others. Similarly, in our experiments which 1538 keyboards are examined, *S. epidermidis* has the highest rate of bacterial contamination among them (with 24.83%), so it can be concluded that the most common infection is caused by *S. epidermidis* [14]. also *E. coli* and *Staphylococcus aureus* became more widespread, respectively and it is interesting to know that *Pseudomonas* was also

found on the keyboard, which has an innate and acquired resistance to common antibiotics, which fortunately has the lowest prevalence among other pathogens. The critical point to consider is that humans, as a result of working with the keyboard, reciprocal transfer takes place between the microorganisms in hand and the keyboard. In other words, pathogens and bacterial organisms are transmitted from hand to keyboard and vice versa. In addition, in another experiment conducted by Yen Hsu Chen et al., about 282 samples of computers, keyboard and the mouse was also examined [15]. *Staphylococcus aureus* and *Pseudomonas* were the two common bacteria isolated in our experiments and theirs. It is true that this bacterium is not normally pathogenic but with regard to its resistance to antibiotics, it has the ability to cause infection in people with immunodeficiency, therefore it should be noted.

By assessing 1523 samples of mice, we realized that similar to the keyboards,

generally they were polluted by *S. epidermidis* bacteria, although, this bacterium is not capable of causing serious diseases and actually considered as normal flora. However, the person will become sick quickly if he/she has predisposing factors like a weakened immune system. Moreover, this bacterium has a high drug resistance, and it is not easily treated with drugs and even antibiotics. Accordingly, in the last decade, the third factor of nosocomial infection and one of the most common cause of septicemia (blood infection) have been devoted to this bacteria, so by washing our hands after using the mouse, or even disinfecting the mouse, we can easily prevent the disease caused by this bacterium. Also, during a study that took place in Iran in June 2018, it was found that *S. epidermidis* is the most common bacterial species on the computers exist in dental clinics which discovered that 88% of computers are infected [8].

We suppose that the uneven serrated surface of the keyboard is one of the main causes of keyboard contamination; as well as in any other device that has an uneven surface. We all somehow experience or know that how to clean the unevenness surface of electronics such as keyboards is too difficult due to their high probability of damage. However, in our studies, infected keyboards account for about 21.57% of the total contaminated samples.

Today, many students and professors complete their educations and work studies using electronic tools. Glen Anderson, in his research on student computers, reported that the pathogen *S. aureus* is one of the most common bacterial isolation. However, this pathogen is ranked third in our studies with a ratio of 12.78%.

In addition to computers, laptops and tablets were also subject to significant contamination. As mentioned earlier, the reciprocal touch contact causes the rapid spread of infection, but we must also keep in mind that by using these tools for a long time, with indication of eye fatigue, the impurities would be able to come into contact with the eyes and giving rise to some optical problems. It should be noted that *S. aureus* is abundantly found on laptops

and tablets. Absolutely the most common place for this bacterium in the body is a nostrils. Furthermore, *S. aureus* and *S. epidermidis* are well-known for their resistance to disinfectants and cleansers. In addition, our studies showed that about 27.06% of tablets and laptops are infected with these two species. The presence of some soil originated bacteria on the samples may be due to dust. For example, the presence *Bacillus* spores on computer devices can be caused by dust deposits on them [8].

According to figure 1, we found that computer cases, scanners, and monitors were much less bacterially infected than other computer-related devices, also one of the main reasons is that the consumer or user does not have direct contact with these items.

According to above statements, proper disinfection of such devices should be regarded as an important matter, especially disinfecting of the space between the keyboard's buttons which helps germs survive and spread.

Jana Kaskova et al. suggested some disinfecting methods, including: 1) Using wipes containing disinfectants that include triclosan and chlorhexidine-digluconate 2) Use of phenol-based wipes with alkaline detergent or isopropyl alcohol 70% [16].

CONCLUSION

According to the results obtained in this article, the electronic devices may play an important role in spreading bacteria and impurities which could be harmful for human health. Substantially we proffer the people to wipe such devices up regularly and if it is possible, wash their hand before and after utilizing these instruments with alcohol 70% or other hand cleaners, etc.

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