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Bacterial contamination of mobile phones and computers in microbiological laboratories

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Abstract
Cellphones are increasingly used by researches for communication. These can harbor various potential bacterial isolates and become an exogenous source of nosocomial infections. A total of 12 swabs collected from various sources like mobile phones, keypads, screens and mice were used for isolation. Among the samples, touchpads were more contaminated with the bacterial population Gram positive rods were observed in most of the samples.

Keywords: bacteria, microbiology

Introduction
Mobile phones are long range, portable electronic devices for personal telecommunication. Mobile phones have become integral and indispensable accessories of professional and social daily life. They are increasingly becoming an important means of conversation worldwide being easily accessible, economical and user friendly (Selim and Inama, 2012) [16]. In many countries, mobile phones outnumber landline telephones. Most adult and many children now own mobile phones. At present, Asia has the fastest growth rate of cellular phone subscribers in the world. The Telecom and regulatory Authority of India (TRAI, 2013-14) reported that the share of mobile phone users in India stood at 784.32 million as compared to 591.76 million a year before. Computer technology in research laboratories has become an essential part of all aspects of modern laboratories.

Due to these benefits of mobile phones and computers, their hazard to human health is often overlooked. The constant handling of mobile phones and other electronic gadgets by different users exposes to an array of microorganisms and thus makes a good carrier for microbes (Singh and Purohit, 2014) [17]. This is especially so with skin due to the moisture and optimum temperature of human body especially our palms. Along with these factors, heat generated by mobile phones contributes to harbouring bacteria and their transmission on the devices at alarming rate (Rana *et al*. 2013) [18].

Hence, it can be envisaged beyond doubt that mobiles and computers act as potential reservoirs of pathogenic microbes and could led to severe infections. Cell phones can harbor various potential pathogens and serves as an exogenous source of nosocomial infection among hospitalized patients (Tagoe *et al*., 2011) [19].

Bacterial pathogens are colonized on human host and inanimate objects like many common objects in the microbiological research laboratories. The common objects include; mobile phones, keyboards, office desks, computer keyboards, computer mice, and elevator buttons. A persons in contact with these inanimate objects in the working place, harbor microbes especially contact with computer keyboards and mice than other inanimate objects.

Computers continue to have an increased presence in as Mobile phones and laptops being independent accessories are frequently used by researchers at the laboratories. These mobile phones and laptops may act as major carriers for transmission of pathogens in laboratories. During every phone call the mobile phone come into close contact with strongly contaminated human body areas with hands to hands, and hands to other areas like mouth, nose and ears. As mobile phones act as perfect habitat for microbes to breed, especially in high temperature and humid conditions, it serves as a major reservoir of pathogenic microbes.

An article in *DAILY MAIL*, UK stated that 'Mobilephones harbor more micro-organisms than toilet seat'.The warm environment surrounding mobile phones coupled with its constant handling creates a prime breeding ground for growth of microorganisms. Hence they are rightly called as 'technological Petri-dish for thousands of worms.'

Mobile phones are often touched during activities related to sample collection, sample processing, culturing of the microorganisms, etc. Hence mobile phones are likely to get contaminated by various micro-organisms, some of which could very well be pathogenic in nature. Despite being used on a continuous basis, these mobile phones are seldom cleaned. They can also act as fomites for transmission of pathogenic organisms like *Staphylococcus aureus, Escherichia coli, Pseudomonas, Acinetobacter, Candida,*etc.

Therefore, the purpose of this article is to review current literature to determine the potential for transmission of pathogens via computer hardware and to review basic microbiologic and infection control procedures that might be used to determine and diminish the risk of microbial transfer and contamination in microbiological laboratories.

Thus, in this study, we investigated bacterial contamination of the mobile phones and laptops of the researchers working in Department of Applied Microbiology, SPMVV, Tirupati, Andhra Pradesh, India.

Materials and Procedures

A total of three mobile phones, three mobile touch pads, 4 computer touch pads and four screens from laptops and mobile phones were used in this study. From each mobile phone two swabs were collected with help of sterile cotton swabs by rotating it on overallsurface of the mobile phone. Swab was collected after proper cleaning of hands before collection. The swab was collected in sterile saline. (Before decontamination swab). The mobile phone was thoroughly cleaned with 70% isopropyl alcohol swab for 5 to 7 minutes. Another swab was collected in sterile saline. (After decontamination swab). Samples were collected in the same manner from computers also.

Isolation & Identification of pathogens

The swabs collected were immediately transported to the microbiology laboratory and inoculated on a Nutrient agar. In the culture plates after incubation at 37^0C for 24 to 48 hrs, growth of bacteria was identified by studying colony characteristics, gram staining and by different biochemical tests as per standard text book procedures.

Colony Morphology

Isolated bacterial colonies obtained on the media were selected for characterization of colony morphology following Aneja (2012). Size, shape, color, pigmentation, elevation, margin, hemolytic activity etc were determined under cultural identification. Pure cultures were maintained on nutrient agar slants at 40C and used for further analysis.

Staining techniques

Morphological features of the bacterial isolates were analysed by gram staining, spore staining and motility tests (Ramos, 2004).

Biochemical identification

Each bacterial culture was identified according to the standard microbiological methods described by Bergey's Manual of Systematic Bacteriology (1973) to the genus level by different biochemical tests. They are carbohydrate fermentation test, IMViC tests (Indole, Methyl Red, Voges Proskeur and Citrate utilization test), oxidase test, catalase test, nitrate reduction tests, urease test and triple sugar iron (TSI) test.

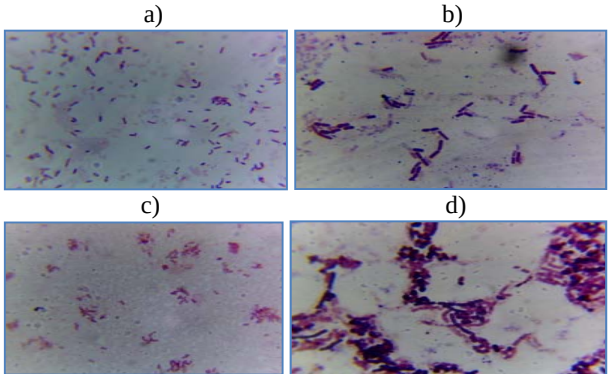
Results and Discussion

After overnight culture, all inoculated samples (30) became turbid which indicated the presence of bacteria in the respective samples. Several colonies appeared on the agar plates which differ in their size and shape (Table 1 and Fig 1). Majority of isolated bacterial contaminants were mixed with more than one organism suggestive of mixed infection and morphologically different organisms. Non touch pads of mobiles were highly contaminated compared to other objects, followed by laptop screens, keypads and mobile phones. Based on the sources, samples were designated as S1TP, MTP, BTP, SKP, MKP, BKP, SS, MS, BS, SM, MM, BM, S2TP. Majority are gram positive rods. Among 13 isolates, only BS and S2TP isolates were spore forming bacteria.

Biochemical properties of the isolates were given in tables 2, 3 and figure 2. Based on morphological and biochemical characterization, the isolates were tentatively identified as species of Bacillus, *Staphylococcus, Escherischia, Enterobacter* etc

Table 1: Gram staining of isolates from mobiles and laptops

S.No	Source of sample	Gram Staining	Shape	Arrangement
a	S1 touch pad	+Ve	Rods	Singles
b	M1 touch pad	+Ve	Rods	Chains
c	B1 touch pad	-Ve	Rods	Singles
d	S1 key pad	-Ve,+Ve	Rods	Chains
e	M1 key pad	+VE	Cocci	Clusters
f	B1 key pad	+VE,-Ve	Rods	Chains
g	S1 screen	-VE	Rods	Clusters
h	M1 screen	+VE	Rods	Chains
i	B1 screen	+VE	Rods	Singles, Chains
j	S1 mobile	+VE	Cocci	Clusters
k	M1 mobile	+VE	Rods	Clusters
l	B1 mobile	+VE	Cocci	Paired
m	S2 touch pad	+Ve	Rods	Singles



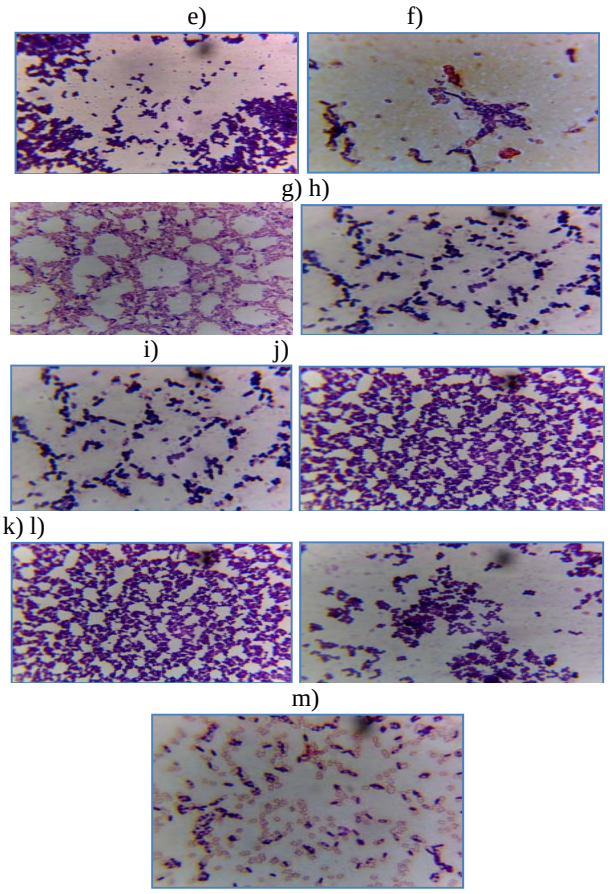


Fig 1: Gram staining images of isolates from mobiles and laptops

Fig 2: Biochemical identification of the bacterial isolates

Table 2: Biochemical characterization of computer bacterial flora

Name of the test	S1TP	MTP	BTP	SKP	MKP	BKP	SS	MS	BS	S2TP
Citrate	-	-	-	+	-	+	-	+	-	-
Urease	-	-	-	+	-	-	+	-	+	-
Indole	-	+	-	-	-	-	-	-	-	+
H_2S	-	-	-	+	-	-	-	-	+	-
Glucosefermentation	+	+	+	+	+	+	+	+	-	-
Nitrate reduction	+	-	+	+	-	-	+	+	+	-
Methyl Red	+	-	-	-	-	-	+	-	-	-
VogesProskauer	+	-	-	+	-	-	-	-	+	-
OxidativeReduction	+	-	-	+	-	-	+	-	-	-
Coagulase	-	+	-	-	-	+	-	-	-	-
Oxidase	-	-	-	-	+	-	+	+	-	+
Catalase	+	+	+	+	+	+	_	+	-	+

Tab 3: Biochemical characterization of mobile bacterial flora

Name of the test	SM	MM	BM
Citrate	-	-	-
Urease	-	-	-
Indole	+	+	-
H_2S	-	-	-
Glucose fermentation	+	+	+
Nitrate reduction	-	-	+
Methyl Red	-	+	-
VogesProskauer	-	-	-
OxidativeReduction	-	-	-
Coagulase	+	-	-
Oxidase	-	+	-
Catalase	+	+	+

Discussion

Bacterial pathogens are colonized on human host and inanimate objects but most people do not realize that microbes are found on many common objects in the outdoors, in their offices, and even in their homes (Ghamdi *et al*., 2011) [1]. Today India has 287 million mobile phone users and these accounts for 85% of all the telecommunication users (Kapdi *et al*., 2008) [8]. Computer technology in research laboratories has become an essential part of all aspects of modern laboratories. Consequently, computers, including bedside components, point-of-care testing equipment, and handheld computer devices, are present in laboratory rooms. Recent articles have indicated that computer hardware, just as other medical equipment, may act as a reservoir for microorganisms and contribute to the transfer of pathogens to patients (Anandi *et al*., 2009) [3].

This article presents basic microbiological concepts relative to infection, croos contamination, between computer contamination and nosocomial colonizations and infections.

.Among 12 samples collected from mobiles and laptops, mostly are Gram positive organisms. This poses a potential risk factor, as many researchers carry their mobile devices with them. Both clinical and non-clinical staff harbor bacteria, but the phones of clinical staff was more contaminated (21%) than the non-clinical staff (8%). The high level of contamination might be due to the job specification and also many users may have no regard for personal hygiene after attending the jobs. Sharing of phones amongst colleagues which is a common practice might also be a reason for the high contamination rate observed within researchers.

Before decontamination, all devices were contaminated with bacteria. But a second culture after decontamination yielded no bacteria growth which shows the efficacy of the decontaminant. The most widely used disinfecting agent for bacterial contamination of cell phones is 70% isopropyl alcohol, which works by damaging the bacterial cell (Venkatesan *et al*., 2015) [4]

The introduction of computers into critical care environments is a relatively new event. Consequently, the possible impact of the presence of these devices in patient care areas has not been well-studied. However, results from the first early studies presented above clearly demonstrate that the keyboards of computers, as of other bedside inanimate objects can be reservoirs for microorganisms associated with colonized or infected patients (Brady *et al*., 2006) [5]. Whether other computer hardware, such as computer mice, rollerballs, touchscreens, joysticks or even portable handheld devices, might be a factor in the dissemination of microbe's remains to be determined.

Gram positive bacteria were the leading isolates, which was also found in studies conducted by others. CoNS was the most prevalent and frequent bacterial agent isolated from mobile phones in this study (Fatma ulger *et al*., 2009) [6]. Though gram positive bacteria are normal skin inhabitants, these organisms have the potential to harbour and transfer drug resistance gene among their genera or beyond. The issue may become more serious, if HCWs become a potential source for transfer of these organisms during invasive procedures and may lead to nosocomial infections.

Conclusion

Mobile phones are likely to remain a part of the communications arsenal of modern life style and is of great concern when it comes to health care practice. They can however, act as a mobile reservoir for nosocomial infection. We need to minimize the risk posed by these devices.

Developing active preventive strategies like routine decontamination of mobile phones with alcohol containing disinfectant materials might reduce cross infection. Another way of reducing bacterial contamination on mobile phones might be the use of antimicrobial additive materials.

Proper cleanliness of hands and limiting use of mobile phones in working areas may limit the spread of pathogens significantly which are the frequent cause of nosocomial infection.

In the future, mobile phones could be produced by using protective material against the bacterial contamination.

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