



## Modern Day Gadgets, are they the New Covert Reservoirs of Pathogens in Dental Settings? An *in vitro* Study

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### Authors' contributions

This work was carried out in collaboration between all authors. Author NN designed the study, wrote the protocol and wrote the first draft of the manuscript. Author CB managed the literature searches, acquisition of data, analysis of data and author NN managed the experimental process and manuscript review. Author MV identified the species. All authors read and approved the final manuscript.

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### ABSTRACT

**Introduction:** Nosocomial infections are a major concern to both clinicians and health care seekers. Investigations have suggested that laptops & mobile phones may contribute to cross-contamination and can serve as vehicles for infection transmission.

**Methodology:** The samples were collected from 25 laptops and 25 mobile phones from dentists working in a dental college in Bangalore city. The samples were collected aseptically using sterile cotton swabs dipped in sterile saline by rotating the swabs on the keyboard surfaces of laptops and mobile phones, inoculated into Brain Heart Infusion broth, vortexed for 1 minute in Fischer Vortex Genie 2 on highest setting & streaked immediately on 5% sheep blood agar plates and were incubated at 37°C for 24 hours aerobically. The isolates were identified based on the colony morphology, colony characteristics and biochemical reactions.

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**Statistical Analysis:** Descriptive statistics and Spearman correlation were done for the colony forming units and microbial organisms present in various departments.

**Results:** The bacterial species isolated were *Staphylococcus aureus*, *Coagulase negative Staphylococcus*, *Bacillus species*, *Enterococci*, *Micrococci*, *Pseudomonas* etc. Predominant species isolated was *Staphylococcus aureus* and least was *Micrococci*. The microbial contamination was more for the department of Orthodontics (18.08%) followed by Oral surgery (15.96%) and least was from Endodontics (14.57%).

**Conclusion:** Laptops and mobile phones act as vehicles for transfer of potential pathogens associated with dental hospitals. Disinfecting the hands prior to examination of patients and disinfection of laptops and mobiles with alcohol wipes should be done to prevent nosocomial infections.

**Keywords:** Disinfection; infection; microbial contamination; pathogenic organism.

## 1. INTRODUCTION

Healthcare-associated infections are an important cause of morbidity and mortality in hospitals. Each year more than 2 million patients acquire healthcare-associated infections, resulting in 90,000 deaths and healthcare costs are estimated to exceed \$5 billion. Health care-associated infection (HCAI), also referred to as “nosocomial” or “hospital” infection, is defined as: “An infection occurring in a patient during the process of care in a health-care facility which was not present or incubating at the time of admission” [1]. Some studies have demonstrated that the mean rate of compliance with the Centers for Disease Control and Prevention guidelines on hand hygiene is approximately 40% among healthcare workers [2], which is a likely explanation for the frequent contamination of computer keyboards and mobile phones.

With the advent of technology, mobile phones, laptops used by health care professionals are on the rise especially in the clinical set ups. The laptops and mobile phones of health care workers harbor many harmful pathogens which serve as a reservoir for nosocomial infections and may contribute to cross – contamination, which serve as vehicles for infection transmission [3-6]. Studies have revealed that mobile phones and laptops have a great potential for dissemination of disease and the incidence of such cross contamination diseases to be 4.8% in U S A, 7.1% in European countries, 10-30% in India and 17.1 % in Iran [7-10].

Some investigators have suggested that computer keyboards may contribute to cross-transmission because of acquisition of transient hand carriage by healthcare personnel during contact with the contaminated computer keyboard surface [11,12]. Technical support

systems have acted as a boon for health care providers in the past few decades. The burden of data recording, data maintenance & analysis of data have become very easy with the introduction of multiple softwares in health care sector. The usage of these has been very simple & can be operated through laptops & mobile phones. This in turn acts as reservoir for health care associated infections. Since laptops and mobile phones have become an essential means of communication, their usage in clinical set up is unavoidable [13].

As mobile phones act as perfect habitat for microbes to breed, especially in high temperature and humid conditions, Health care workers (HCWs’) mobile phones may serve as reservoirs of microorganisms that could be easily transmitted from the mobile phones to the HCWs’ hands and therefore facilitate the transmission of bacterial isolates from one patient to another in different hospital wards [14]. Dental clinics are common place for the bacterial aerosols generated by high speed dental hand pieces with water supplies which has the capacity to settle over long distance. Aerosols and spatter produced during many dental procedures are a potential source of transmission of various diseases [15-17]. The usage of laptops, desktops and mobile phones have become an integral part of dental practice. There are no studies that were conducted to determine if both mobile phones and laptops of dentists/dental set ups are the vehicles of bacterial associated nosocomial infections.

Hence, the aim of the study was to investigate and compare the microbial contamination found on laptops and mobile phones in clinical settings of various departments of a dental college in Bangalore city.

## 2. MATERIALS AND METHODS

A cross sectional study was done to assess the microbial contamination of laptops and mobile phones used by dentists in clinical settings of a dental college in Bangalore city, Karnataka, India. The duration of the study was for a period of 3 months from July 1<sup>st</sup> to September 31<sup>st</sup> 2014. Ethical clearance was obtained from the Institutional Ethical Committee before the start of the study. Necessary permission was obtained from the institution prior to the study. Informed consent was obtained from the dentists before the start of the study.

Inclusion criteria were the laptops and mobile phones which were in use for a minimum period of one year and near clinical settings were taken for the study. Dentists who did not give consent to participate were excluded from the study. A pilot study was conducted by collecting the samples from 5 participants.

Before starting the study, the training and calibration of the examiner was done for collection of samples and streaking on agar plates. Intraexaminer reliability was 0.80 estimated based on kappa statistics.

A sample of 25 laptops and 25 mobile phones which satisfied eligibility criteria were considered for the study. The laptops and mobile phones were randomly selected using a simple random sampling technique.

The samples were collected aseptically using sterile cotton swabs dipped in sterile saline by rotating the swabs on the keys of laptops and mobile phones during operating hours using a method in which the investigator had received training in advance. The swabs were then transported immediately to the laboratory for inoculation. The samples were then inoculated into Brain Heart Infusion (BHI) broth. The sample was vortexed for 1 minute in Fischer vortex genie 2 on highest setting. The samples were then streaked immediately on 5% sheep blood agar plates and were incubated at 37°C for 24 hours aerobically. The organisms isolated were stained, identified and speciated based on the morphology (shape, arrangement of the organisms), colony characteristics (size, shape of the colony, opacity, pigmentation, haemolysis, elevation etc.) and biochemical reactions (catalase test, coagulase test, sugar fermentation, heat test, citrate utilization test, urease test, triple sugar iron test, oxidase,

mannitol motility test etc). The colonies were counted and colony forming unit was estimated.

### 2.1 Statistical Analysis

The data analysis was done using the statistical software SPSS version 19. Descriptive statistics was done for the colony forming units and microbial organisms present on laptops and mobile phones of various departments. Pearson correlation was computed for comparing the microbial contamination of laptops & mobile phones with respect to various departments. All the analysis was computed based on 95% confidence interval with a p value of  $p < .05$ .

## 3. RESULTS

The normal flora like *Micrococci* was isolated from 66.67% of laptops and 33.34% of mobile phones, *Diphtheroids* from 77.78% of laptops and 22.23% of mobile phones.

*Coagulase -ve Staphylococci* which is frequently found in keyboard surfaces of laptops and mobiles was isolated from all laptops and 88.89% of mobile phones.

Among the *Bacillus species* which is most commonly found in the environment, *Bacillus anthracis* was found in 66.67% laptops and 11.12% mobile phones, *Bacillus subtilis* was found in 88.89% laptops and 77.78% mobile phones.

Among the pathogenic organisms isolated, *Acenetobacter* was isolated from 62.50% laptops and 22.23% mobile phones. *Pseudomonas species* was isolated from 66.67% laptops and 33.34% mobile phones and *Staphylococcus aureus* was isolated from 88.89% laptops and 77.78% mobile phones.

Out of 25 laptops, 16.66% of laptops from the Department of Endodontics, 14.76% from Department of Orthodontics, 14.6% from Department of Oral surgery were contaminated. Among mobiles, 25.48% of mobiles from the Department of Periodontics, 24.29% from Orthodontics, 18.51% from Oral surgery were contaminated (Table 1).

*Staphylococcus aureus* was present in 29.2% of mobiles from Periodontics, 20.8% from Orthodontics and 16.7% from Endodontics and 16.6% from Oral surgery. *Staphylococcus coagulase negative* was present in 29.63% of mobiles from Public Health Dentistry, 17.28%

from Prosthodontics and 12.3% from Oral medicine (Table 2).

*Staphylococcus aureus* was present in all the laptops (88.89%) and (77.78%) of mobiles (Table 3).

Statistically significant and positive correlation was obtained for department of Prosthodontics (r=0.809), Oral pathology (r=0.894) and Endodontics (r=0.860) (Table 4).

#### 4. DISCUSSION

This study shows that a proportion of around two third of all the laptops and mobile phones near clinical setup and almost half of those sampled immediately after use were contaminated with microorganisms, which can lead to nosocomial infections. The microbial contamination was more for the departments of Orthodontics (18.05%) followed by Oral surgery (15.95%) and least was from Endodontics (14.55%).

In this study, the use of mobile phones and laptops by the dental faculty and postgraduate students involved in direct patient care not only demonstrated a high contamination rate with bacteria but also were contaminated with nosocomial pathogens. The organisms isolated were *Staphylococcus aureus*, *Micrococci*, *Acinetobacter*, *Bacillus species*, *Diphtheroids*, *Enterococci* and *Pseudomonas*. Among these *staphylococcus aureus* and *Acinetobacter* are resistant to drying and can survive for weeks in a dry environment and is capable of multiplying rapidly.

The microbial contamination in the present study among laptops for *Staphylococcus aureus* was 25% from department of Periodontics followed by

22.5% from the department of Endodontics, which is in line to a study by Shakeel Anjum et al. [5] where 26% laptops from Periodontics, 24% from Prosthodontics and 23.5% laptops from Endodontics were contaminated which could be due to the lack of disinfection of laptops on a periodic basis. In the present study, *Staphylococcus coagulase negative* was found to be 25.6% from the department of Endodontics which is contradictory to a study by Anastasiades et al. [18] where 68.5% of laptops showed contamination with *Staphylococcus coagulase negative*.

The microbial contamination was due to the constant contact of their gadgets with gloved hands used immediately after a dental procedure.

In the present study, the overall rate of contamination of laptops with potentially pathogenic organisms like *Acinetobacter* was 62.50% which is similar to a study by William A et al. [19] where multidrug resistant *Acetobacter Baumannii* was found on the hands, cell phones of health care workers and patients admitted to the ICU (60%) and contradictory to a study by Sweta Singh et al. [20] which showed lower rates of contamination ranging from 7-14.3%. The lower rates of contamination show that the gadgets were routinely decontaminated. The higher rates of contamination of laptops and mobile phones among departments in this present study might be due to the influence of various factors like lack of hand washing after examination/treatments, use of gadgets with gloved hands, disinfection practices followed in the hospital, frequency of use of gadgets and the frequency of disinfection of laptops and mobile phones.

**Table 1. Distribution of microbial contamination of laptops and mobile phones according to speciality**

Department	Laptops CFU-N (%)	Mobiles CFU-N (%)	Total CFU per dept	% (Total CFU per dept/Total CFU of all departments)	Total CFU of all departments
Public health dentistry	3900 (6.19)	1600 (4.74)	5500	5.68	96900
Pedodontics	8100 (12.85)	1300 (3.85)	9400	9.71	
Prosthodontics	8800 (13.96)	2550 (7.55)	11350	11.72	
Oral surgery	9200 (14.6)	6250 (18.51)	15450	15.95	
Oral medicine	3300 (5.23)	1000 (2.96)	4300	4.44	
Oral pathology	3500 (5.55)	800 (2.37)	4300	4.44	
Endodontics	10500 (16.66)	3600 (10.66)	14100	14.55	
Periodontics	6400 (10.15)	8600 (25.48)	15000	15.5	
Orthodontics	9300 (14.76)	8200 (24.29)	17500	18.05	

**Table 2. Distribution of microbial contamination of mobiles and laptops among specialities**

	<b>Organism</b>	<b>Public health</b>	<b>Pedodontics</b>	<b>Prosthodontics</b>	<b>Oral surgery</b>	<b>Oral medicine</b>	<b>Oral pathology</b>	<b>Endodontics</b>	<b>Periodontics</b>	<b>Orthodontics</b>
<i>Staphylococcus aureus</i>	Mobile	0	4.17	10	16.6	0	2.5	16.7	29.2	20.8
	Laptop	0	1.25	12.5	18.75	10.63	10	22.5	25.0	21.87
<i>Coagulase -ve staphylococcus Micrococci</i>	Mobile	29.63	9.88	17.28	8.64	12.3	2.4	9.88	0	9.87
	Laptop	2.56	5.12	16.67	3.84	11.54	10.3	25.6	5.13	19.23
<i>Acinetobacter</i>	Mobile	12	8	8	4	0	0	12	28	28
	Laptop	0	0	31.03	13.79	3.44	0	6.9	17.2	27.58
<i>Diphtheroids</i>	Mobile	0	0	12.5	0	0	0	0	50	0
	Laptop	33.87	0	19.35	27.42	0	0	1.61	11.3	6.45
<i>B. anthracis</i>	Mobile	0	0	33.33	0	0	0	66.7	0	0
	Laptop	0	22.73	15.91	13.64	4.54	0	22.7	11.4	9.09
<i>B. subtilis</i>	Mobile	0	0	0	0	100	0	0	0	0
	Laptop	0	6.66	13.33	10	0	0	23.3	33.3	13.33
<i>Enterococci</i>	Mobile	3.85	3.85	3.84	0	0	15.4	3.85	65.4	3.84
	Laptop	16.12	41.94	1.07	8.60	0	10.8	3.23	16.1	2.15
<i>Pseudomonas</i>	Mobile	0	0	0	0	9.5	0	0	66.7	23.81
	Laptop	0	0	7.89	15.79	0	0	18.4	7.89	13.15
	Mobile	0	20	70	60	20	0	0	0	0
	Laptop	0	0	11.76	23.53	0	0	5.88	13.5	35.29

**Table 3. Distribution of microorganisms in laptops and mobiles**

Microorganism	% of microbial contamination of laptops	% of microbial contamination of mobiles
<i>Staphylococcus aureus</i>	88.89	77.78
Coagulase -ve staphylococcus	100	88.89
Micrococci	66.67	77.78
Enterococci	66.67	33.34
Diphtheroids	77.78	22.23
<i>B. anthracis</i>	66.67	11.12
<i>B. subtilis</i>	88.89	77.78
<i>Acinetobacter species</i>	62.50	22.23
<i>Pseudomonas species</i>	66.67	33.34

**Table 4. Correlation between laptops and mobile phones among various specialities**

Department (Laptop * Mobile)	r value	P value
Public health dentistry	-0.164	.630
Pedodontics	-0.108	.751
Prosthodontics	0.809*	.003*
Oral surgery	-0.96	.779
Oral medicine	0.395	.229
Oral pathology	0.894*	.000**
Endodontics	0.860*	.001*
Periodontics	0.323	.333
Orthodontics	0.533	.91

\* Statistically significant at  $P < .05$ ; \*\* Statistically significant at  $P < .001$

This study showed that 88% of laptops and 98% of the mobile phones were contaminated with more than one pathogenic organism which is similar to a study done by Brady et al. [4] which showed that 89.7% of mobile phones were contaminated. The most dominant organism isolated was *Staphylococcus aureus* which is due to the fact that most organisms get killed within hours due to drying, but bacteria like *Staphylococcus aureus* and *Acinetobacter* are resistant to drying, can survive for weeks, and multiply rapidly in a warm environment. Jesle et al. [21] found that rate of bacterial contamination of hospital care workers (HCW's) was 95% while that of mobile phones was 90% which is similar to a study by Sweta Singh et al. [20] who reported that out of 50 mobile phones cultured, 98% were positive which could be due to the constant presence of the microorganisms in the air-water aerosol produced during work with dental unit handpieces while working in a patient's mouth and mixes with the surrounding air, thus influencing its composition.

The present study is contradictory to a study by Harish Trivedi et al. [22] where 58.66% of hand samples and 46.66% of mobile phones were found to be contaminated by bacteria. In the present study 20% had single species (n=3), 45% had two species (n=15) and 35% had more than two types of species (n=7) which is contradictory to a study done by Ulger et al. [23]

which showed that 94.5% of phones showed evidence of bacterial contamination. They found that 49% of phones had one bacterial species, 34% had two different species and 11.5% had two or more different species. Two studies have provided suggestive evidence linking computer use to cross-contamination of patients [24,25].

In the present study, 88.89% of laptops and 77.78% of mobile phones were contaminated by *Staphylococcus aureus*, 62.50% of laptops and 22.23% of mobile phones by *Acinetobacter species* and 66.67% of laptops and 33.34% of mobile phones by *Pseudomonas species* which is contradictory to a study by William et al. [19] where 50% of keyboards were contaminated with *Staphylococcus aureus*, 32% by *Acinetobacter species* and 23% by *Pseudomonas species*. The higher rates of contamination of mobile phones and laptops in the present study might be due to the influence of various factors like general hygiene and hand washing practices of the HCWs, lack of knowledge about the role of gadgets in infection transmission, frequency of use, use of gadgets in clinical settings etc.

For laptops, 10.15% of laptops from Department of Periodontics were contaminated followed by 13.96% from Prosthodontics, 16.6% from Endodontics which is contrary to a study done by Brady et al. [4] where 23% of laptops were contaminated which could be due to the constant

use of laptops by the dentists near clinical settings and their usage with gloved hands immediately after a dental procedure. In case of mobile phones, 25.48% from Periodontics, 10.66% from Endodontics, 7.55% from Prosthodontics were contaminated which is contrast to a study by Sham S. Bhat et al. [26] where 4% from Prosthodontics, 5% of mobiles from Orthodontics showed pathogenic organisms. This demonstrates that mobile phones can serve as reservoirs for contaminating microorganism. This raises the concern that contact with contaminated mobile phones will serve as a mechanism for contaminating the hands of health care workers.

Hence, in a country like India, mobile phones and laptops of HCWs play an important role in transmission of infection to patients, which can increase the burden of health care. Simple measures such as increasing hand hygiene and regular decontamination of mobile phones with alcohol disinfectant wipes may reduce the risk of cross contamination caused by these devices. One study reported the use of 70% isopropyl alcohol as an effective disinfectant [15]. Another study reported that restricted use of mobile phones during working hours along with proper hand hygiene practices enabled mobile phones to remain free of contamination [16]. The findings of the present study is alarming which shows that dentists are lacking the awareness of the safety measures when a significant number of them neither clean their hands before and after seeing a patient nor disinfect their laptops and mobile phones after using in the hospital setup. Hand washing is the simplest and most economical measure that can prevent the transfer of harmful pathogens.

Currently in India, there are no rules restricting dentists to use laptops and mobile phones into a sterile clinical setup. There are also no cleaning guidelines for laptops and mobile phones of health care workers. The limitation of the study is that the design of this study being a cross-sectional one does not permit causal inference between microorganisms present in laptops and mobiles. Further studies for the assessment of microbial contamination among dental specialties and methods of decontamination of laptops and mobile phones should be done.

## 5. CONCLUSION

Laptops and mobile phones may act as a reservoir of microorganisms associated with

healthcare associated infections (HAI). This study showed that 88% of laptops and 98% of the mobile phones were contaminated. It appears that routine disinfection of mobile phones and laptops may be effective in reducing microbial contamination.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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