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Original Article

Microbiology Section

Cell Phones of Health Care Professionals: A Silent Source of Bacteria

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ABSTRACT

Introduction: Cell phone has become part and parcel of modern life. To live a life without cell phone is an impossible task for maximum people. Health care providers are also integral part of this era of mobile phones. During various activities linked to health care services health care professionals used to touch their cell phones many a time. Hence, mobile phones are found to be contaminated with various microorganisms.

Aim: To find out bacteriological profile of cell phones used by different categories of health care providers in a tertiary care centre of eastern India and antibiotic resistance pattern of the isolates.

Materials and Methods: A cross sectional study was conducted in a tertiary care centre of eastern India during August-September 2013. Swabs from 100 mobile phones belonging to doctors, nurses, ward boys, laboratory technicians, according to the availability were collected. The swabs were processed to isolate and identify the bacteria. Antibiotic sensitivity tests of these isolates were done following Clinical Laboratory Standard Institute guidelines. Data were analysed by Chi square test to determine p value.

Result: Eighty seven percent of cell phones collected from the health care workers were found to be contaminated by 135 isolates comprising of 12 different bacterial species. Coagulase negative *Staphylococcus* (31.11%) was the most frequently isolated bacteria followed by *Staphylococcus aureus* (14.7%), *Micrococcus* sp (14.7%), *Bacillus subtilis* (13.33%), *Pseudomonas* sp (6.67%), *Diphtheroids* (6.67%), *Acinetobacter* sp (5.93%)etc.

Cell phones of laboratory technicians were hundred percent contaminated, followed by nurses (96%), ward-boys (88%) and doctors (70%). Conventional phones with keypads were found more contaminated than touch screen phones. Almost one fifth of *S.aureus* was found to be methicillin resistant. Amikacin and amoxicillin-clavulanic acid were the two most sensitive drugs against gram negative bacteria.

Conclusion: This study confirmed that mobile phones used by the health professionals of this hospital were contaminated with multi drug resistant pathogenic and potential pathogenic bacteria. So the need to improve health consciousness among people while handling mobile phones in the hospital is an urgent issue.

Keywords: Bacterial contamination, Health care personnel, Mobile phone

INTRODUCTION

Cell phone is an essential commodity in the modern world. In addition to the usual voice call of a traditional telephone, a cell phone can advocate many additional services such as text messaging, access to the Internet, MMS and what not [1]. The Telecom Regulatory Authority of India (TRAI 2009-2010) reported that the number of mobile phone users in India stood at 584.32 million [2]. Moreover, easy access and affordability of mobile phones leading to a dramatic increase in use of cell phones. India becomes the second largest mobile phone user in the world which accounted for over 10% of the world's online population in 2011 [3].

In spite of all the advantages gained from the cell phones, the health hazard it might pose to its users should not be over looked. Cell phones come in close contact with the body such as face, ears, lips and hands during usage and serve as a ready surface for colonization of pathogenic as well as non pathogenic microorganisms. So, in addition to the health hazards caused by electromagnetic radiation emission, cell phones could act as a fomite for microorganisms and it can eventually transmit more than just a call [4].

Studies in different parts of India show that predominant organisms isolated from contaminated cell phones are Coagulase negative *Staphylococci* (CoNS) followed by *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae*, *Acinetobacter* sp, *Enterococcus faecalis*, and *Pseudomonas* aeruginosa [4,5]. Multidrug resistant strains were isolated from mobile phones including Methicillin resistant *Staphylococcus aureus* (MRSA) and Extended spectrum beta lactamases producing organisms (ESBL), high-level aminoglycoside-resistant *Enterococcus* sp, and carbapenem-resistant *Acinetobacter baumanii* [6,7]. But most of the health - professionals are not aware of the fact.

There was lack of guidelines for maintaining cleanliness,

restriction of usage of mobile phones in hospital settings. Moreover, use of the same phones both inside and outside of hospitals, help to spill out notorious multidrug resistant bacteria of hospital environment in the community.

Paucity of such studies from hospitals in eastern part of India made us to carry out the study. This data will further be used to build awareness about the health risks not only to the patients in the hospital but also to the loved ones at home. Hospital infection control committee can formulate a sound and feasible policy with respect to cell phone usage within hospital premises.

MATERIALS AND METHODS

A hospital based cross sectional study was conducted in a tertiary care hospital of eastern part of Bengal during the months of August and September 2013. A total of 100 cell phones were randomly sampled from laboratory technicians, ward boys, nurses and doctors working in the hospital on the days of sampling. Any person who had participated in the study once was excluded from repeat enrolment so that each person submitted his or her cell phone only once. The sample size (n) was calculated by taking prevalence of bacterial contamination of mobile phones used by health care workers 72%, in a previous study in North India [4] with the allowance of error (E) of 15% of prevalence rate at 5% level of significance. Contingency for the unknown circumstance was 10%.

$$n = \frac{(Z\alpha/2)^2 \times P(1-P)}{E^2} = \frac{(1.96)^2 \times 72(28) = 67 + 10\% = 74}{(10.80)^2}$$

So for convenience 100 samples were taken.

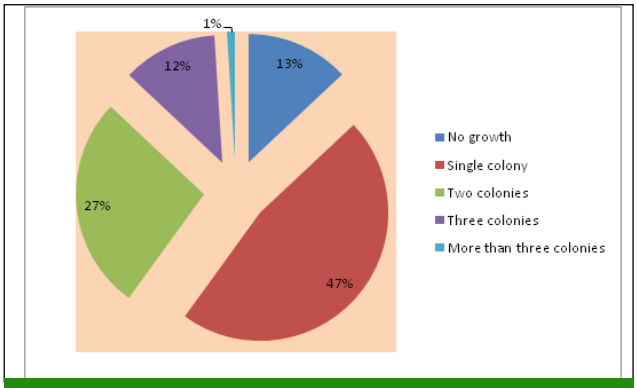
After getting informed consent of the health care workers, sterile swab moistened with sterile normal saline were used to swab various surfaces of the cell phones. The swabs were placed in properly tagged sterile containers (serial number, source) and then with a properly filled case record form were brought to the bacteriology laboratory for analysis. The swabs were inoculated on a plate of Blood agar media & Mac Conkey's agar media (Hi-Media Laboratories). The plates were incubated aerobically at 37°C for 24 hrs. The colonies were identified phenotypically by gram staining, motility and biochemical tests as per standard protocol [8]. Antibiotic sensitivity test of pathogenic bacteria was done by modified Kirby Bauer Disc Diffusion method on Muller Hinton's media with proper standardization by ATCC control strains (*Escherischia coli*- ATCC 25922; *Staphylococcus aureus* - ATCC 25923; MRSA – ATCC 43300, *Enterococcus faecalis* – ATCC 29212; *Pseudomonas* aeruginosa- ATCC 27853) [9]. Following antibiotic discs, containing measured and standard amount of antibiotics (procured from Hi Media Pvt. Ltd Mumbai and BD diagnostic) were used for drug testing: Amikacin (AK-30 mcg), Gentamicin (G-10 mcg), Amoxycillin- Clavulanic acid (AMC-20/ 10mcg), Ampicillin (AMP-10 mcg),Ceftriaxone (CTR-30 mcg), Cefotaxime (CTX-30 mcg), Cefoxitin (CX-30 mcg), Chloramphenicol (C-30 mcg), Clindamycin (Cd-2 mcg), Ciprofloxacin (CIP-5 mcg), Levofloxacin (LE-5 mcg), Vancomycin (VA-30 mcg), Cotrimoxazole (COT -25 mcg).

Percentages were used for mainly for interpretation of the data in this study. But differences between proportions were evaluated by Chi square test. p value <0.05 was considered significant. Study was conducted after taking permission from Institutional Ethical Committee.

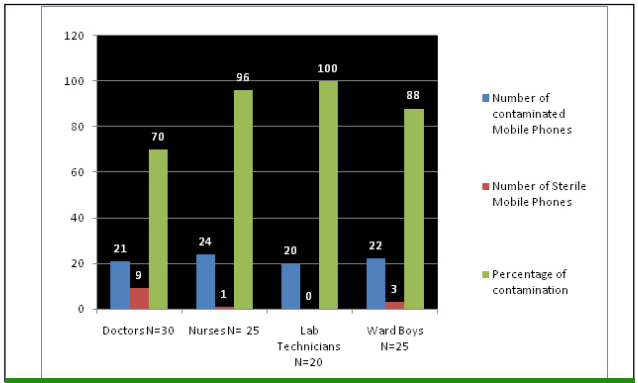
RESULT

Out of 100 cell phones sampled 87 were found contaminated with varied numbers of bacteria. Forty seven percent cell phones had single bacterial contamination while 40% cell phones were contaminated with two or more types of bacteria [Table/Fig-1].

Cell phones of laboratory technicians were hundred percent contaminated, followed by nurses (96%) [Table/Fig-2]. Differences in rate of contamination in different groups of health professionals were statistically significant.



[Table/Fig-1]: Distribution of types of colonies in cell phones



[Table/Fig-2]: Distribution of contaminated cell phones among different categories of health care professionals

Total 135 bacteria were isolated, comprising of 12 species. Of which 82.96% were gram positive organism and 17.04% were gram negative. The most commonly isolated organism was Coagulase-negative *Staphylococcus* (31.11%) followed by *Staphylococcus aureus* (14.07%), *Micrococcus* sp (14.07%), *Bacillus subtilis* (13.33%), *Pseudomonas* sp

Bacteria found in Mobile Phones	Doctors N=30	Lab Technicians N=20	Ward Boys N=25	Nurses N= 25	Total organism found	% of different organism
Staphylococcus epidermidis	9	11	14	8	42	31.11
Staphylococcus aureus	8	6	4	1	19	14.07
Micrococcus sp.	1	9	6	3	19	14.07
Bacillus subtilis	3	2	4	9	18	13.33
Diphtheroids	1	3	1	4	9	6.67
Enterococcus faecalis	1	0	3	0	4	2.96
α haemolytic *Streptococcus*	0	0	0	1	1	0.74
Pseudomonas sp.	0	0	0	9	9	6.67
Acinetobacter sp	2	2	4	0	8	5.93
E.coli	1	0	1	0	2	1.48
Klebsiella sp	1	0	1	0	2	1.48
Non fermenter gram negative *Coccobacillus*	2	0	0	0	2	1.48
Total no. of isolates	29	33	38	35	135	100

[Table/Fig-3]: Distribution of organisms in different groups of Health Professionals

(6.67%), *Diphtheroid* (6.67%), *Acinetobacter* sp. (5.93%) etc. [Table/Fig-3]. 32.59% (44/135) mobiles sampled, presented with bacteria that are established nosocomial pathogens like *Staphylococcus aureus*, *Enterococci*, *Pseudomonas*, *Acinetobacter*, *Escherichia coli* and *Klebsiella* sp whereas 31.1% were potential pathogen like *Staphylococcus epidermidis*.

[Table/Fig-4] Shows that phones operating with conventional keypads were found more contaminated than touch screen phones (p value= 0.001). Differences in rate of contamination of cell phones are not significant in male and female individuals [Table/Fig-5].

Fourteen (14%) health care personnel were totally not aware of the fact that microorganisms could be present in cell phones.

	Contaminated	Sterile	Percentage of contamination (%)	Statistics
Touch phone N=28	19	9	67.86	χ^2=10.359 with df= 1, p value= 0.001
Key pad phone N=72	68	4	94.44	

[Table/Fig-4]: Relationship of Types of phone and contamination

	Contaminated	Sterile	Percentage of contamination (%)	Statistics
Female N=47	40	7	85.1	χ2=0.054 with df= 1 p value= 0.816
Male N=53	47	6	88.68	

[Table/Fig-5]: Relationship of Gender and contamination of phones

Among them 57.14% (8/14) were doctors followed by ward boys (35.7%) and nurses (7.14%). Ninety three percent health professionals never even thought of cleaning their cell phones.

Most of the individuals (78%) keep their mobile phones into their clothing (pockets). These were more contaminated than those kept in bags [Table/Fig-6].

Out of 19 *Staphylococcus aureus*, 4 (21.05%) were methicillin resistant (MRSA), but among coagulase negative *Staphylococcus* only one was resistant to cefoxitin [Table/Fig-7]. Resistant pattern of gram negative organisms was shown in [Table/Fig-8].

	Contaminated	Sterile	Percentage of contamination (%)	Statistics
Clothing n=78	66	12	84.6	χ^2=0.953 with df= 1 p value= 0.329
Bag n=22	21	1	95.45	

[Table/Fig-6]: Relationship of site of placement and contamination of phones

DISCUSSION

Out of the total 100 cell phones sampled, 87 were found contaminated with varying number of bacteria. Incidence of contamination in our study was less than that of the studies by Tagore D N et al., [10], Bhat S S et al., [4], Ulger F et al., [6], Badr et al., [11] where 100% , 99% ,94.5%, 93.7% cell phones were contaminated respectively but it was more than that were observed by Arora U et al., [12] (40.62%),Trivedi H R et al., [5] (46.66%), Panchal et al., [13] (65%), Dutta et al., [14] (72%). Wide range of variation might be due to difference

Antibiotic	*S.aureus* N=19(%)	CoNS N=42(%)	*Enterococcus* N=4(%)	αHaemolytic *Streptococcus* N=1(%)	Total resistance N=66 (%)
Ampicillin	15(78.94)	27(64.28)	4(100.00)	0(0.00)	46(69.7)
Cefoxitin	4(21.05)	1(2.38)	4(100.00)	0(0.00)	9(13.63)
Vancomycin	0(0.00)	0(0.00)	0(0.00)	0(0.00)	0(0.00)
Cefotaxime	10(52.63)	15(35.71)	4(100.00)	0(0.00)	29(43.93)
Ceftriaxone	7(36.84)	13 (30.95)	3(75.00)	0(0.00)	23(34.8)
Chloram Phenicol	8(42.1)	13(30.95)	2(50.00)	0(0.00)	23(34.8)
Ciprofloxacin	12(63.15)	14(33.33)	1(25.00)	0(0.00)	27(40.9)
Levofloxacin	8(42.1)	11(26.19)	1(25.00)	0(0.00)	20(30.30)
Cotrimoxazole	11(57.89)	20(47.6)	3(75.00)	0(0.00)	34(51.51)
Gentamicin	11(57.89)	9(21.42)	4(100.00)	0(0.00)	24(36.36)
Amikacin	4(21.05)	6(14.28)	2(50.00)	0(0.00)	12(18.18)
Amoxyclav	6(31.57)	7(16.67)	4(100.00)	0(0.00)	17(25.75)

[Table/Fig-7]: Resistance pattern of pathogenic gram positive organisms

Antibiotic	*Pseudo-monas* N=9(%)	*Acineto-bacter* N=8(%)	*E.coli* N=2(%)	*Klebsiella* N=2(%)	NF GNCB N=2(%)	Total resistance N=23(%)
Ampicillin	9(100.00)	8(100.00)	2(100.00)	2(100.00)	2(100.00)	23(100.00)
Cefotaxime	5(55.55)	7(87.5)	1(50.0)	2(100.00)	2(100.00)	17(73.91)
Ceftriaxone	3(33.33)	7(87.5)	1(50.0)	2(100.00)	0(0.00)	13(56.52)
Chloram Phenicol	3(33.33)	3(37.5)	0(0.00)	2(100.00)	0(0.00)	8(34.78)
Cipro Floxacin	4(44.44)	3(37.5)	0(0.00)	1(50.00)	0(0.00)	8(34.78)
Levo Floxacin	2(22.22)	4(50)	0(0.00)	1(50.00)	2(100.00)	9(39.13)
Cotri Moxazole	9(100.00)	6(75)	2(100.00)	2(100.00)	0(0.00)	19(82.6)
Gentamicin	3(33.33)	4(50)	2(100.00)	0(0.00)	2(100.00)	11(47.82)
Amikacin	2(22.22)	3(37.5)	1(50.00)	0(0.00)	0(0.00)	6(26.08)
Amoxyclav	1(11.11)	2(25)	0(0.00)	0(0.00)	2(100.00)	5(21.74)

[Table/Fig-8]: Resistance pattern of gram negative organisms
NFGNCB= Non-fermenter Gram negative *coccobacilli*

in awareness regarding usage of mobile phones, maintaining hand hygiene and frequency of handling cell phones in hospital during patient care.

In the present study 40% cell phones had polymicrobial growth which was in concordance with that isolated by Bhat S S et al., [4] (38.8 %) but it shows contrast to a study conducted by Tagore D N et al., [10] where 91% of cell phones showed polymicrobial growth.

Results from this study showed 100% of the cell phones belonging to Laboratory technicians were contaminated whereas only 70% of doctors possessed contaminated phones. Category wise carriage rate was found statistically significant in this study. Similar pattern was observed by Trivedi HR et al., [5], Tambe N.N et al., [15], Akinyemi K O et al., [16] and opposing views showing higher carriage rate in medical personnel than paramedical ones were also found in some studies [12,13]. Direct exposure to body fluids, tissues etc. consisting of different pathogenic organisms might be the reasons of higher carriage rate in Laboratory technicians.

In the current study, CONS was the main organism isolated. (31.11%). Similar results were observed in different studies in Egypt [17], Nigeria [16], Punjab [12], Gujrat [5] and Karnataka [4]. In contrast, studies in Chandigarh [14], Mumbai [15], Saudi Arabia [18], Uttarakhand [19] and Turkey [6] revealed that *Staphylococcus aureus* was the predominant organism and *Bacillus* sp was most common organism contaminating the cell phones in Cape coast [10].

Gram negative organisms were isolated only in 17.04% cases. Most of the studies [14,16,18, 19] done in this field reflect the same feature except a few [4,6,10].

Predominance of CoNS reflects the fact that normal commensal of the skin can easily be transferred to the object that comes

in contact with body surface. Combination of constant handling and heat generated during receiving phone call might facilitate the survival and growth of the microorganisms on the cell phone surface. Of the 135 isolates, 44(32.59%) isolates like *S.aureus*, *Enterococcus* spp, *Pseudomonas* sp, *E.coli, Klebsiella* sp, *Acinetobacter* sp were established pathogens for hospital associated infections. Though, CoNS is a component of normal skin flora but in hospital set up it could emerge as a pathogen, increasing number of microorganisms causing nosocomial infections.

The high isolation of *Bacillus*, *Micrococcus*, *Diphtheroids* in more than one third cases confirms that these bacteria are omnipresent in nature being able to colonize anything. The presence of *E. coli* (1.48%) and *Enterococcus* sp (2.96%) though less in number than the number observed in currency notes (34.48%)circulating in this hospital in a previous study [20] suggest faecal contamination of cell phones also.

Study revealed that conventional key pad had higher rates of contamination than touch screen phones (p value= 0.001). This might be due to the fact that chance of retention of bacteria in cracks and crevices present in the conventional keypad was more.

Almost equal rate of contamination was found in the cell phones used by male and female health personnel. But proportion of contamination of mobile phones of male resident doctors was more than female resident doctors in a study by Kokate et al., [21].

A high isolation of bacteria was observed in those phones which were kept in clothing like pocket, than those kept in bags. But that was not of statistical significance. The warmth of clothing conferred a good breeding ground for the microorganisms mainly *Staphylococcus* sp, *Acinetobacter* sp that resist drying. So the warm and cosy environment in the pocket surrounding mobile phones coupled with its regular handling creates a main breeding ground for microorganisms.

All the 100 HCP used same phones in and outside the hospital. 14% of health professionals including doctors were totally not aware about the fact that cell phones could act as a source of bacteria. 93% of the participants never cleaned their mobile phones.

Almost all of the health care workers do not wash their hands after receiving phone calls and before touching patients except 3 persons working in neonatal wards. Almost same picture was revealed in Karnataka [4], Turkey [6].

Antibiotic sensitivity pattern of the isolates showed that 21.05 % of *Staphylococcus aureus* were resistant to methicillin (MRSA). Incidence of MRSA isolated from cell phones was variable in different geographical areas like13.63% in Uttarakhand [19], 16.9% in Mumbai [15] 52.4% in Bhabnagar [5] and 52% in Turkey [6]. Though gram negative organisms were multidrug resistant but extended spectrum beta lactamases producing organism was not found. In this study, isolates showed good sensitivity pattern against Amoxycillin-clavulanic acid and amikacin which was similar to a study in Bhabnagar [5] whereas in a Nigerian [16] study fluoroquinolones and ceftriaxone were found most effective against the isolates. Variation in antibiotic resistance pattern in different geographic areas or different time frame in same place might depend on antibiotic policy of the hospital at that particular time.

CONCLUSION

From this study it can be concluded that more than three fourth of cell phones belonging to healthcare personnel harboured potential pathogens including some multidrug resistant strains but health care workers were quite unaware of the fact. As there is paucity of information about suitable mobile disinfection methods that are both effective and at the same time do not damage the mobile phones, restricted use of mobile phones in hospital is to be emphasized. Moreover, hand washing after or before attending a call is to be recommended strictly. Use of headset or ear set during hospital hours might be a good alternative for using hand set. Furthermore study of appropriate disinfection methods for mobile phones and establishment of transmission of bacteria from hand to phones and vice versa may be considered.

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