Bacterial contamination of mobile phones of healthcare workers at a tertiary care hospital

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Abstract

Introduction: Mobile phones are used extensively by the healthcare workers who are completely unaware of the microbial load they carry. There are no guidelines on the cleanliness of these mobile phones which makes them an important source of hospital acquired infections among the patients in the hospital.

Objectives: This study was conducted to determine the extent of bacterial colonisation of mobile phones from health care workers and elucidate its antibiotic sensitivity pattern.

Settings and Design: The present study was hospital based cross-sectional study, carried out to analyse the bacterial colonization of mobile phones of healthcare personnel in the tertiary care hospital for a period of three months from 1st July 2017 to 30th September 2017.

Materials and Methods: A sterile swab moistened with sterile normal saline was rolled over the exposed areas of the mobile phones of 117 health care personnel which included 18 samples from technicians, 35 from nurses, 29 from ward boys, and 35 samples from doctors. The swabs were cultured on 5% sheep blood agar and MacConkey agar plates. Plates were incubated aerobically at 37°C for 24 hours. The growth was identified by standard microbiological techniques and their antibiotic sensitivity pattern was carried out as per CLSI guidelines.

Statistical Analysis: Statistical Analysis was done using MedCalc and Microsoft excel.

Results: Overall bacterial contamination was found to be 92% (108) and maximum contamination was noted on the mobile phones of laboratory technicians (100%). All the healthcare workers showed polymicrobial growth on their mobile phones and maximum isolates were observed on the mobile phones of ward boys. *Staphylococcus aureus*, 44 (37.6%) was the most common isolate followed by Coagulase Negative Staphylococcus, *Pseudomonas aeruginosa*, 14 each (12%) and Acinetobacter species 6(5.1%). These isolates were resistant to commonly available antibiotics like Co-Trimoxazole, Ampicillin, and Amoxyclav. MRSA was found to be 16% in our study, whereas ESBL and MBL were not noted.

Conclusions: As these organisms can become an important source of Hospital acquired infection, strict hand hygiene, decontamination of mobile phones and restriction of the use of mobile phones in high risk areas should be advocated.

Keywords: Hospital acquired infections, Health care workers, MRSA (Methicillin resistant *Staphylococcus aureus*) ESBL-Extended spectrum betalactamases, MBL- Metallo-ss betalactamases.

Introduction

Mobile phones have become an essential commodity in our daily lives. They can act as a source of hospital acquired infections because of arrays of microbial flora they carry. Most personal objects are stored in changing rooms but the mobile phones are often taken by the staff into the operation room, intensive care unit and wards where calls are made or answered while attending patients.[1]

Apart from making calls, mobile phones are also used extensively because they provide an easy access to the internet social media, MMS services etc.[2] These mobile phones harbor a wide array of microorganisms which includes Coagulase negative Staphylococci (CONS) *Staphylococcus aureus*, *Escherichia coli*, *Klebsiella pneumoniae*, Acinetobacter species, *Enterococcus faecalis*, and *Pseudomonas aeruginosa*.[3,4] Multidrug resistant strains like Methicillin resistant *Staphylococcus aureus* (MRSA) and Extended spectrum beta lactamases producing organisms (ESBL), high-level aminoglycoside-resistant *Enterococcus*, and carbapenem-resistant *Acinetobacter baumanii*[5,6] have also been isolated from mobile phones.

Majority of the staff neither clean their mobile phones regularly nor wash hands after using these mobile phones.[7] There are no restrictions on the use of mobile phones in the hospital setting and no guidelines have been formulated on cleanliness of mobile phones in the healthcare settings. Further sharing of mobile phones between the hospital staff may distinctly facilitate the spread of potentially pathogenic bacteria to the community.[4]

As such mobile phones can act as a potential source of hospital acquired infections and increase the spread of multidrug resistant organisms among the patients. Hence the present study was carried out to screen the mobile phones of healthcare workers so as to elucidate all possible contaminants which can act as a source of infection, with their antibiotic resistance pattern.

Materials and Methods

Place and Duration of Study: The study was carried out in the Department of Microbiology of a tertiary care hospital for a period of three months from 1st July 2017 to 30th September 2017.

Type of Study: It is a hospital based cross-sectional study.

Inclusion Criteria: After obtaining clearance from the ethical committee of the institute, all the healthcare personnel carrying mobile phones i.e. doctors, technicians, nurses, ward boys were included in the study.

Sample Size Calculation: Prevalence of bacterial contamination was done on the basis of various other studies on mobile phones which was found to be 40%-100%.[8,9] We considered the prevalence to be 65% (in the middle range)as per Pinchal et al.[10] If the allowance of error (E) of 15% of prevalence was considered at the rate of 5% level of significance, the sample size was calculated using the formula as shown. Contingency for the unknown circumstance was 10%.

$$n= \frac{(Z\alpha/2)^2 \times P(1-P)}{E^2} = \frac{(1.96)^2 \times 65(35)}{(9.75)^2} = \frac{8739.64}{95.1} = 92 + 10\% = 101$$

For convenience, more than 110 samples had to be taken. A total of 117 samples were considered in which 18 samples were taken from technicians, 35 from nurses, 29 from ward boys, and 35 samples were taken from doctors.

Collection of Samples: After taking an informed consent, a sterile cotton swab moistened with sterile normal saline, was rolled over the exposed outer surfaces of the mobile phones. The most frequent areas of contact of the mobile phones were included i.e. the fingers: the buttons of the keypad, earpiece, back side and lateral side of the phone.

Identification of Isolates: The swabs were inoculated on a plate of 5% sheep blood agar & Mac Conkey's agar (Hi-Media Laboratories). The plates were incubated aerobically at 37ºC for 24 hrs. The colonies were identified phenotypically by gram staining, motility and biochemical tests as per standard protocol.

As the finding of total aerobic colony count >5 colony forming units/cm^2 from a hand contact surface, indicates an increased risk of infection for the patient in that environment,[11] only those colonies whose count was more than 5 were considered.

Antibiotic Susceptibility Testing: Antimicrobial sensitivity testing was done on Muller Hinton Agar (MHA) by Kirby Bauer disc diffusion method as per CLSI Guidelines.[12] Commercially available discs (Hi-media) were used. The discs used and their concentrations were: Vancomycin (2mcg), Co-trimoxazole (25mcg), Ciprofloxacin (30mcg), Linezolid (30mcg), Ampicillin (10mcg), Piperacillin +Tazobactam (100/10mcg), Amikacin (5mcg), and Imipenam (10mcg). Penicillin (10units), Tetracycline (30mcg), Clindamycin (2mcg), Cefoxitin (30mcg), Linezolide (30mcg) Gentamycin (10mcg), Cefepime (30mcg) Amoxyclav (30mcg) Cefotaxime (30mcg) Ceftazidime+clavunic acid (30mcg+10mcg).

1. MRSA were confirmed by using Cefoxitin discs as per CLSI guidelines.[12]
2. ESBL production was confirmed by the double disk synergy test, using Ceftazidime and the Ceftazidime and clavulanic acid combination.[13]
3. MβL producers were identified by the Imipenem-EDTA disc method.[14]

Staphylococcus aureus (ATCC 25923), *E. coli* (ATCC 25922) and *Pseudomonas aeruginosa* (ATCC 27853) were used as quality control throughout the study for culture and antimicrobial susceptibility testing.

Results

Out of 117 mobile phones, 108 showed growth of bacterial pathogens in significant amount, so the overall prevalence of mobile phone contamination was found to be 92%. All the mobile phones of laboratory technicians were contaminated (100%) followed by doctors (94.2%). (Table 1)

Majority of the mobile phones of health care personnel showed the growth of single species. Polymicrobial growth i.e growth of more than one type of species was a common feature of the mobile phones of all the health care workers as seen in Table 2.

Only those species which showed the count of more than 5 colony forming units/cm^2 were considered for the study. Of these, the most common bacterial isolates among all health care workers mobile phones was found to be *Staphyloccocus aureus* (37.6%) followed by Coagulase Negative Staphylococcus, *Pseudomonas aeruginosa* (12% each) and Acinetobacter spp. (5.1%). Details of bacterial isolates obtained from mobile phones of health care personnel is shown in Table 3.

When a comparison was made between the growth of organisms from the mobile phones of doctors and that of other healthcare personnel, it was found that out of 35 doctors, 11 yielded growth whereas among 82 other healthcare personnel,70 yielded growth. The isolation of bacterial species between the doctors and other healthcare personnel was found to be significant (p value 0.03). (Table 4)

When the antibiotic resistance was observed between various isolates, it was found that *Staphylococcus aureus* showed resistance to commonly used antibiotics with MRSA being 16%. There were 7 strains of MRSA of which 4 were observed in doctors (9%) 2 in nurses (4.5%), and 1 in ward boys (2.27%). Table 5 further organism like *Pseudomonas, Klebsiella,* and *Acinetobacter* were resistant to Co-Trimoxazole, Ampicillin, and Amoxyclav with no ESBL & MBL production in either of them. (Table 6)

Table 1: Bacterial contamination of mobile phones

S. No.	Health care personnel	No of samples	Growth of contaminants	Percentage
1	Laboratory technicians	18	18	100%
2	Nurses	35	31	88%
3	Ward boys	29	26	90%
4	Doctors	35	33	94.2%
	Total	117	108	92%

Table 2: Types of colonies grown on mobile phones of health care personnel

S. No.	Health care personnel	No growth	Type of colonies				
			1 type	2 types	3 types	4 types	More than 4
1	Laboratory Technicians	-	10	6	1	1	-
2	Nurses	4	11	12	6	2	-
3	Ward boys	3	08	8	8	1	1
4	Doctors	2	16	8	8	1	-
	Total	09	45	34	23	5	1

Table 3: Distribution of bacterial isolates from mobile phones

Organisms	Laboratory Technicians	Doctors	Nurses	Ward boys	Total	%
Staphylococcus aureus	12	08	08	16	44	37.6%
CONS	05	01	02	06	14	12%
Pseudomonas aeruginosa	-	02	06	05	14	12%
Acinetobacter spp	01	-	01	05	6	5.12%
Klebsiella spp	-	-	1	1	2	1.7%
Escherichia coli	-	-	-	-	-	-
Others	1	-	1-	1	3	2.5%

Others: Aerobic spore bearing gram positive rods, moraxella species, Micrococci

Table 4: Comparison of bacterial isolates between doctors & other healthcare personnel

Organisms	Doctors (n=35)	Other healthcare personnel. (n=82)	Z value	P value
Staphylococcus aureus	08	36	2.15	0.03S
CONS	01	13	1.9	0.047S
Pseudomonas aeruginosa	02	12	1.36	0.173NS
Acinetobacter spp	00	06	1.64	0.010NS
Klebsiella spp	00	02	0.931	0.30NS
Others	00	03	0.65	0.509NS
Total	11	70		

S-Significant at the corresponding p value, NS-Not significant.
Others: Aerobic spore bearing gram positive rods, moraxella species, Micrococci

Table 5: Antibiotic resistance pattern of gram positive bacterial isolates

Antibiotics	*Staphylococcus aureus* (44)	CONS (14)	*Pseudomonas aeruginosa* (14)	Acinetobacter spp (06)	Klebsiella spp (02)
Penicillin	9(20.45%)	1(2.27%)	Not tested	0 (0%)	0 (0%)
Tetracycline	0 (0%)	1(2.27%)	0 (0%)	0 (0%)	0 (0%)
Clindamycin	6(13.63%)	0 (0%)	Not tested	Not tested	Not tested
Cefoxitin,	7(16%)	0 (0%)	Not tested	Not tested	Not tested
Linezolide	0 (0%)	0 (0%)	Not tested	Not tested	Not tested
Vancomycin	1(2.27%)	0 (0%)	Not tested	Not tested	Not tested
Ciprofloxacin	1(2.27%)	0 (0%)	Not tested	Not tested	Not tested
Gentamicin	0 (0%)	0 (0%)	Not tested	Not tested	Not tested
Co-trimoxozole	3(6.81%)	0 (0%)	2(4.54%)	1(2.27%)	1(2.27%)
Ampicillin	1(2.27%)	0 (0%)	1(2.27%)	3(6.81%)	0 (0%)
Cefepime	Not tested	Not tested	0 (0%)	0 (0%)	0 (0%)

Piperacillin+Tazobactum	Not tested	Not tested	0 (0%)	0 (0%)	0 (0%)
Imipenem	Not tested	Not tested	0 (0%)	0 (0%)	0 (0%)
Amoxyclav	1(2.27%)	0 (0%)	1(2.27%)	3(6.81%)	2(4.54%)
Amikacin	Not tested	Not tested	0 (0%)	0 (0%)	0 (0%)
Cefotaxime	Not tested	Not tested	0 (0%)	0 (0%)	0 (0%)
Ceftazidime+clavunic acid	Not tested	Not tested	0 (0%)	0 (0%)	0 (0%)

Table 6: Comparison of antibiotic resistance between doctors & health care professional

Organisms	Doctors (n=35)	Other Health care professional (n=82)
MRSA	**4 (11.4%)**	3 (3.65%)
CONS	-	2 (15.38%)
Pseudomonas aeruginosa	-	2 (16.67%)
Acinetobacter spp	-	3 (3.65%)
Klebsiella spp	-	2 (15.38%)
Others	-	-

Discussion

Mobile phones are used without any restriction in the hospitals which makes them a potential reservoir of bacterial pathogens. We had swabbed the mobile phones of 117 healthcare workers in our institute and the bacterial contamination was found to be 92%. Jayalaxmi et al[15] had reported the bacterial contamination of 91.6% which corresponded to our study. Similarly Badr et al[16] have reported the contamination as 93.7% and Ulger et al[5] have reported it as 94.5%. Other authors have reported the contamination rate even lesser i.e. 65%,[10] 72%[17] and 40.62%[8] respectively. Higher contamination rate in our study might be due to lack of personal hygiene in the hospital staff, improper hand washing technique, tendency to use mobile phones frequently, and keeping their mobile phones snugly in the pockets.

Maximum contamination was observed in the mobile phones of technicians (100%) as they were readily exposed to body fluids and the load of work they have in our laboratory prevented them from washing hands and changing gloves after dealing with each patient. Pal et al[18] had also reported maximum contamination in the mobile phones of technicians. Doctors mobiles were next in queue with 94% contamination and then followed by nurses and ward boys. Similar pattern has been observed by Trivedi et al[4] and Tambe et al[19] although the carriage rate differs in their studies depending on their hospital setup and their working conditions.

Polymicrobial growth was mostly observed in doctors followed by nurses and technicians. Bhat et al,[3] Tagoe et al[9] and Tambe et al[20] had also reported similar findings with variation in the isolation pattern in different group of healthcare workers. The mobile phone of ward boys showed maximum no of isolates in our study. They are in direct contact with the patients and are unaware of the standard precaution that are to be followed while handling these patients. Further they are constantly in contact with their phones without washing hands inevitably transmitting the flora of their hands to their mobiles and contaminating their mobiles as well. Similar findings have been observed by Trivedi et al[4] who have reported maximum contamination of persons handling, shifting and cleaning of OT/ICU/CCU.

Staphylococcus aureus was the most common isolate (37.6%) observed followed by Coagulase Negative Staphylococccus and *Pseudomonas aeruginosa* for 12% each. Ulger et al[20] had done a review article on mobile phones and nosocomial infections in which they had reported *Staphylococcus aureus* as the major contaminant followed by Coagulase Negative Staphylococcus and *Pseudomonas*. Higher isolation of *Staphylococcus aureus* could be due to mobile phones being held in the pockets (warmth) and heat created by vibrations of mobiles which favors the growth of these pathogens.[21] Further these are sturdy organisms able to survive desiccation. Datta et al[17] have also reported maximum isolation of *Staphylococcus aureus* followed by Coagulase Negative Staphylococcus. Coagulase Negative Staphylococcus is the common flora of skin, hence chances of its isolation from mobile phones is more. Misagna et al[21] have reported Staphylococcus aureus in 29.4% of isolates and Tambe et al[20] have reported Staphylococcus aureus in 54.16% of isolates. Other authors have reported Coagulase Negative Staphylococcus as the most common isolate followed by *Staphylococcus aureus.*[4,19,22,23]

Pseudomonas aeruginosa and Acinetobacter spp are intrinsically resistant to commonly used disinfectants that favor their survival on the mobile phones. Pal et al[19] have found *Pseudomonas aeruginosa* and Acinetobacter spp 6.67% and 5.93% respectively which is slightly less than our findings. They have also

reported gram negative bacilli in the range of 1-2% which corresponds to our finding.

When the isolates between mobiles of doctors and the other health care personnel were compared it was found that the doctors harbored mainly Staphylococcus spp and other health care personnel harbored all the types of bacterial pathogens. Doctors are generally aware and resort to hand washing techniques more frequently than the other staff eliminating the other pathogens from their transient flora.

When the resistance pattern of these isolates was observed, *Staphylococcus aureus* was the organism showing maximum resistance to all possible drugs. MRSA was found to the extent of 16% with 9% in doctors phones, followed by 4.5% in nurses and 2.27% in ward boys Srikanth et al[24] have reported MRSA as 2%, Saeedah et al[25] as 6% and Datta et al[17] as 18%. Also Ustan et al[26] have reported MRSA as 9.5% and Chawla et al have reported MRSA as 20%.[27] Our observations correspond to these findings. Higher rates of MRSA have been reported by Rana et al[28] and Tambe et al[20] (40% and 54.16% respectively).

Although *Pseudomonas aeruginosa*, Acinetobacter spp and Klebsiella spp have shown resistance to many antibiotics ESBL and MBL production has not been reported in our study. The antibiotics which were resistant were Amoxyclav, Ampicillin and Cotrimoxazole. Even Pal et al[14] have reported similar resistance to Amoxyclav and no ESBL producing isolates. ESBL production was observed by Ustan et al[25] to the extent of 11.2% Badr et al[16] have reported ceftazidime resistance to the extent of 31.3% in gram negative bacilli while Tekerekoğlu et al[6] have reported ESBL in 40% of isolates.

Finally when the resistant isolates of mobile phones were compared between doctors and other health care personnel, doctors harbored mainly MRSA while the other health care personnel showed multidrug resistant organisms. Mobile phone acting as a reservoir of various pathogens, should be regularly disinfected with 70% alcohol, as proved by Singh et al[29] and Arora et al.[8]

Conclusions

Almost all healthcare personnel have few or more contamination of their mobile phones. Mobile phones harbor a wide range of bacterial pathogens ranging from *Staphylococcus aureus* to Acinetobacter spp. These organisms are multidrug resistant and can become an important source of nosocomial infections. It is advocated that the other health care personnel should follow the hand hygiene and standard precautions to obviate the flora of their mobiles. Mobile phones must not be allowed in areas like operation theaters, ICU/ NICU, burn units etc, both for the patient safety and prevention of nosocomial infections. Regular cleaning of mobile phones with 70% alcohol is advised.

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