

Aerobic and anerobic contamination of mobile phones of health personnels with probable transfer of bacterial microbes to their hands at a tertiary care hospital of India

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Abstract

Background and Aims: Mobile phone (MP) contamination of health personnels (HPs) in hospitals is a potential health hazard to the patients and the HP themselves. However, transfer of microbes from MPs of HP to their hands has not been demonstrated before, which would make potential threat into an actual peril. The primary objective was to determine aerobic and anerobic bacterial contamination of MP and hands of HP. The secondary objective was to determine probable transfer of bacterial microbes from MP to hands of tested HP.

Material and Methods: Three swabs each were taken from 374 HP first from their MP, second from their dominant hand and third from their dominant hand after cleaning with disinfectant followed by a mock phone call of one minute (DHM). Aerobic and anerobic bacterial microbes were identified with standard methods.

Results: Three hundred twenty-two HPs were recruited. Bacterial contamination was seen in 92% MP, 85% dominant hands, and 68% DHM of tested HP. Of these, contamination with potentially pathogenic bacterias (PPB) was 50% in MP, 25.6% in hands, and 31% in DHM. Anerobic contamination (1.6%) was present on MP but not in hands or DHM. In 54.7% HP, there was presence of similar bacterial microbes in MP and DHM of which 30% were PPB. When disinfectant was used in non-protocolized way in DHM, decrease in aerobic spore forming bacteria (ASB) was seen but not of gram-positive and gram-negative bacterial microbes.

Conclusion: There is significant aerobic bacterial contamination, including PPB, seen in MP, hands, and DHM of HP in a tertiary care hospital of India; however, anerobic bacterias are found only in MP. Similar bacterial microbes in MP and DHM point to probable transfer of aerobic bacterias from MP to hands of HP which does not decrease when hand disinfectants are used in non-protocolized way, which is a point of concern.

Keywords: Disinfectant, hand hygiene, healthcare workers, mobile phones, potential bacterial pathogen

Introduction

Healthcare-associated infections are a global burden and are on the rise causing morbidity and mortality of patients.^[1] A major contributing factor is the presence of inanimate objects in the hospital environment.^[1-5] Mobile phones (MPs) of

health personnels (HPs) have previously been found to be highly contaminated with aerobic bacterial microorganisms.^[6-8] This is considered a risk factor for patient infection because of speculation of their passage from MP to hands of HP. Determining transmission of bacterial microbes from MP of HP to their hands would make theoretical danger of patient infection from contaminated MP a step closer to actual threat,

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but to the best of our knowledge this has not been determined previously.

In our hospital, feature MP (MP with basic dialling and messaging) are provided to HP for patient care. Primary objective of the present study was to determine aerobic and anerobic bacterial contamination of MP and hands of HP at our hospital. The secondary objective was to determine transfer of bacterial microbes from MP of HP to their hands.

Material and Methods

The present prospective cross-sectional study was conducted at All India Institute of Medical Sciences, New Delhi, India, a tertiary care 2,000 bedded institute, from 2009 to 2012. This study was funded by Indian Council of Medical Research and was conducted jointly by the Department of Anesthesiology and Department of Microbiology (Bacteriology laboratory) of our hospital. At the time of the present study, 840 feature MPs (same model) were provided to HPs working at our hospital. The MPs are connected via closed user group system which is a service provided by the mobile operators of our hospital to mobile subscribers to make and receive free calls from any member associated within the group. The mobile numbers of all users are available in the hospital directory and can be enquired from the telephone exchange anytime of the day making contact easy with any HP. MPs are carried by HPs at all times including their homes.

After ethical clearance and informed consent, almost 50% of HPs with their MPs (374) were selected by random number generated by computer and were recruited for the present study. Identity of the participants was kept confidential. Following routine work in the hospital for 4–6 h, three swabs were taken from each HP. First swab was taken from MP of recruited HP by a dry/sterile cotton viscose swab with wooden stick (Cosmo scientific traders, New Delhi, ISO 9001) by rolling on all surfaces of MP and immediately inoculated in brain heart infusion broth and transported to the laboratory where swabs were streaked within half an hour onto following plates: for aerobic contamination streaking was done on blood agar supplemented with 5% defibrinated sheep blood and MacConkey agar which were incubated aerobically at 37°C for 24–48 h. For anerobic contamination, streaking of swabs was done on brain heart infusion blood agar (BHIA) which was incubated anaerobically for 48 h. Isolated microorganisms were identified using standard methods such as gram stain, colony morphology, motility and biochemical tests with automated standard API systems to determine aerobic and anerobic organisms.^[9] *Methicillin sensitive staphylococcus aureus* (MSSA) and Methicillin resistant staphylococcus aureus (MRSA) were identified

by cefoxitin disc diffusion test disk on Mueller–Hinton agar plates using a bacterial suspension with the turbidity adjusted to a 0.5 McFarland standard. Plates were incubated at 35°C for 24 h. Results were interpreted according to CLSI guidelines. The interpretive criteria for cefoxitin were: *S. aureus*, sensitive ≤ 21 mm, resistance ≥ 22 mm.^[10]

The other two swabs were taken from the hands of HP. First swab was taken from the dominant hand (hand used to hold MP) of HP. The second swab was taken from dominant hand of HP after cleaning with a disinfectant (Sterilium; Bode Chemia, Hamburg, Germany; Active ingredients in 100 g: Propan-2-ol 45.0 g, propan-1-ol 30.0 g, mecetroniumetilsulfate 0.2 g, Glycerol 85%, tetradecan-1-ol, fragrances, patent blue V 85%, purified water) and holding the phone for a 1 min. mock phone call (Disinfected Hands holding mobile phone-DHM). HPs were asked to disinfect their hands as they would in normal clinical practice. Standardizing the quantity of the disinfectant used, the time spent on cleaning and procedure of using disinfectant (whole hand, whole hands with fingers, or only fingers) was not asked for to keep the study clinically relevant. Both swabs were obtained from the dominant hand (five fingertips and palm) by a sterile cotton viscose swab with wooden stick (Cosmo scientific traders, New Delhi, ISO 9001) rubbed over the entire ventral surfaces of the thumb and fingers which were cultured and processed for identification of aerobic and anerobic organisms as described above for determination of bacterial contamination of MP.

Statistical analysis was done by Fischer's exact test to compare proportions. The proportions of MP detected to have presence of bacterial contamination were compared to the proportions of contaminated hands. Similar comparison was done between hands and DHM and to compare proportions of contamination with gram-positive, gram-negative, and aerobic spore forming bacteria. The statistical analysis was performed using software graph Pad-Prism version 8.0 (2019, San Diego). $P < 0.05$ was considered statistically significant.

Results

A total of 374 HPs with their MPs were recruited for the study. Of these, 52 individuals did not provide us with samples/their information sheet was misplaced. Finally, a total of 322 HPs were recruited for the present study [Figure. 1]. Of these, 52.1% (168/322) were HP who were in direct contact with patients.

Of the 322 tested HP, bacterial contamination was seen in 91.92% (296/322) MP, 85% (274/322) dominant hands, and 68% (219/322) DHM. 8% (26/322) MP had no

bacterial growth, however 11% (3/26) dominant hands of HP owning these sterile MP were contaminated [Figure. 1].

On analysis of the contaminated MP (296) of the tested HP, 92.5% had contaminated dominant hand and 73.9% had contaminated DHM [Table 1]. Of the bacterial contaminants, PPB was seen in 50% (148/296) MP, 25.6% (76/296) hands, and 31% (92/296) DHM [Table 1]. Of these PPB, gram-positive PPB was in 36.4% (108/296) MP, 15.8% (47/296) dominant hands, and 18.2% (54/296) DHM. *Methicillin sensitive staphylococcus aureus* (MSSA)

was most commonly isolated from MP, hands, and DHM. Gram-negative bacterias (GNB) were seen in 12.1% (36/296) MP, 9.8% (29/296) hands, and 12.8% (38/296) DHM. Many GNB remained unidentified as study protocol warranted only standard methods for identification. Anerobes (1.6%; 5/296) were found only in MP of which *Clostridium baratti* was seen in 1 MP, *Clostridium perfringens* was seen in 2 MP, and *Clostridium bifermentas* was seen in 2 MP. Non-PPB [*Micrococcus* and aerobic spore forming bacteria (ASB)] were found maximally in hands of tested HP (61.8%) compared to MP (53%) and DHM (38.5%). Total bacterial pathogens (PPB + non-PPB) isolated from MP were 313 because of presence of more than one bacteria. Total bacterial pathogens [Potentially Pathogenic Bacteria (PPB) + non PPB] isolated from hands were 166 and 209 from DHM [Table 1].

To evaluate possible transmission of microbes from MP to hands of tested HP, similar microbes were determined from MP of HP, hands of HP and DHM of HP. Similar microbes in MP and dominant hands were seen in 71.6% tested HP, of which PPB were 36.7% of which MSSA was seen maximally (14.6%). Similar microbes in MP and DHM were in 54.7% tested HP of which PPB was 30% of which MSSA was maximally seen (11.7%) [Table 2]. Similar non-PPB (*Micrococcus* and ASB) were seen in 63.2% MP and hands of tested HP and 64.8% MP and DHM [Table 2]

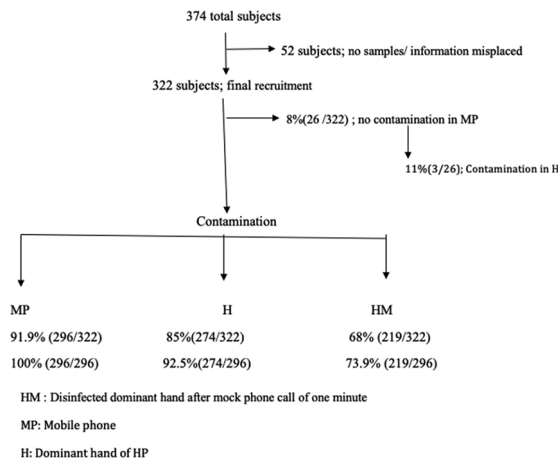


Figure 1: Contamination of MP, Hands and DHM

Table 1: Bacterial microbes in hands & DHM with contaminated MP (296)

	Microbe	MP (296) N (N/296%)	Hand (274/296; 92.5%) N (N/296%)	DHM (219/296; 73.9%) N (N/296%)	
PPB					
Total PPB		149 (50%)	76 (25.6%)	92 (31%)	
GPB	Total GPB	108 (36.4%)	47 (15.8%)	54 (18.2%)	
	MSSA	64 (21.6%)	35 (11.8%)	22 (7.4%)	
	MRSA	7 (2.3%)	6 (2.25%)	6 (2.0%)	
	<i>Enterococcus</i>	6 (2.0%)	5 (1.6%)	7 (2.3%)	
	CoNS	31 (10.4%)	1 (0.3%)	19 (6.4%)	
	GNB		36 (12.1%)	29 (9.8%)	38 (12.8%)
	<i>Acinetobacter</i>	8 (2.7%)	3 (1.0%)	4 (1.4%)	
<i>Escherichia coli</i>	4 (1.3%)	3 (1.0%)	3 (1.0%)		
<i>Klebsiella pneumoniae</i>	4 (1.3%)	2 (0.67%)	2 (0.6%)		
<i>Pseudomonas stutzeri</i>	1 (0.3%)	1 (0.3%)	0		
Other GNBs	19 (6.4%)	20 (6.7%)	29 (9.7%)		
Anerobes		5 (1.6%)	0	0	
Total		5 (1.6%)	0	0	
<i>Clostridium baratti</i>		1 (0.3%)	0	0	
<i>Clostridium perfringens</i>		2 (0.6%)	0	0	
<i>Clostridium bifermentas</i>		2 (0.6%)	0	0	
Non PPB					
GPB	<i>Micrococcus</i>	7 (2.3%)	7 (2.3%)	3 (1.01%)	
	ASB **	157 (53.0%)	83 (61.8%)	114 (38.5%)	
PPB + non PPB		313*	166	209	

*Multiple organisms' detected/MRSA Methicillin resistant/MSSA Methicillin Sensitive S.aureus/CONS coagulase negative staphylococci/ASB: aerobic spore forming bacilli. DHM: disinfected hands after holding mobile phone for one minute

of which ASB was more. Total number of isolated pathogens similar in MP and hands of tested HP were 212. Due to presence of multiple microorganisms, total similar number of pathogens in MP and DHM was 171.

All isolated bacterial aerobes and anaerobes are enumerated in Tables 1 and 2.

Proportion of contaminated MP was significantly higher than proportion of contaminated hands ($P = 0.009$). Contamination of DHM was significantly lower than proportion of contaminated hands ($P = 0.0001$). Proportion of gram-positive contamination was significantly higher in MP than contaminated hands ($P = 0.001$). Proportion of gram-positive contamination was comparable in hands and DHM ($P = 0.515$). Proportion of gram-negative contamination was comparable between MP versus hands and hands versus DHM ($P = 0.432$; $P = 0.308$). Proportion of ASB contamination was statistically higher in MP than hands ($P = 0.045$) and was significantly higher between hands and DHM ($P = 0.001$) [Table 3].

Discussion

The present study reveals that at a tertiary care hospital setting in India, bacterial contamination is seen in 92% MP of tested HP, 85% dominant hands of tested HP, and 68% DHM of tested HP. PPB contamination is seen in 50% MP, 25.6% hands, and 31% DHM. Of the PPB, GPB is maximally isolated from all three, of which MSSA is most frequent PPB present in MP, hands of HP, and DHM. Anaerobic contamination (1.6%) is present in MP but not in hands or DHM. In 55% HPs, there is presence of similar bacterial microbes in MP and DHM, which indicates probable transfer of bacterial microbes from MP to hands of tested HP, of which 30% are PPB. There is decrease in ASB but not GPB and GNB in hands when disinfectant is used by HP in non-protocolized way.

The use of MP by HP for patient care is highly prevalent in health care institutes throughout the globe. In India, there is no central surveillance data, but high contamination of MP found in the present study is in accord with other studies from India where 88–95% MP were found contaminated by aerobic bacterial microorganisms especially CoNS.^[11-14]

Bacterial microbes cause various infections. GPB are divided into PPB and non-PPB. Non-PPB include *Micrococci* and ASB and PPB include MSSA, MSA, enterococci, and CoNS. PPB are a leading cause of bacteremia, endocarditis, or osteomyelitis.^[15-19] All GNB are pathogenic and are leading cause of hospital-acquired infections in the ICU and multi-drug resistant bacterial infections.^[20-23] In the present

study, presence of both GPB and GNB were found in MP, hands, and DHM of tested HP which has potentially serious threatening clinical implications.

Contamination of MP and hand contamination of HP has previously been reported but to the best of our knowledge, transfer of bacterial microbes from MP to hands of HP has

Table 2: Similar microbes isolated from MP and hands of same HP

Microbe	MP & hands (212/296; 71.6%) n (%)	MP & DHM (162/296; 54.7%) n (%)
PPB		
Total	78 (36.7%)	66 (30%)
MSSA	31 (14.6%)	19 (11.7%)
MRSA	4 (1.8%)	4 (2.4%)
<i>Enterococcus</i>	4 (1.8%)	5 (3.0%)
CoNS	24 (11.3%)	18 (11.1%)
<i>Acinetobacter</i>	2 (0.9%)	4 (2.4%)
<i>Escherichia coli</i>	2 (0)	2 (1.2%)
<i>Klebsiellapneumoniae</i>	2 (0.9%)	2 (1.2%)
<i>Pseudomonas stutzeri</i>	1 (0.5%)	0
Other GNB's	8 (3.7%)	12 (7.4%)
Non PPB		
Total	134 (63.2)	105 (64.8%)
Micrococcus	1 (0.4)	1 (0.6%)
ASB	133 (62.7)	95 (58.6%)
Total (PPB + Non PPB)	212	171*

*Multiple organisms' found. MRSA Methicillin resistant/MSSA Methicillin Sensitive *S.aureus*/CONS coagulase negative staphylococci/ASB: aerobic spore forming bacilli, DHM: Disinfected dominant hand after mock phone call of 1 min

Table 3: Proportion of contamination in mobile phones, hands and DHM

	Total contamination present	Total contamination not present	P
Mobile phones	296	26	$P^a=0.009^*$
Hands	274	48	$P^b=0.001^*$
DHM	219	103	
GPB present GPB not present			
Mobile phones	113	209	$P^a=0.001^*$
Hands	47	275	$P^b=0.515$
DHM	54	268	
GNB present GNB not present			
Mobile phones	36	286	$P^a=0.432$
Hands	29	293	$P^b=0.308$
DHM	38	284	
ASB present ASB not present			
Mobile phones	157	165	$P^a=0.04^*$
Hands	183	139	$P^b=0.001^*$
DHM	114	208	

P^a : Proportion of contamination of mobile phones vs proportion of contamination of hands. P^b : Proportion of contamination of hands vs proportion of contamination of DHM. DHM: Disinfected dominant hand after mock phone call of one minute. * $P<0.05$, GPB: gram positive bacteria, GNB: gram negative bacteria, ASB: aerobic spore forming bacilli

not been demonstrated before.^[24] In the present study, similar PPB between MP and hands was seen in 37% HP and similar PPB between MP and DHM was seen in 31% HP, which strongly suggests transfer of bacterial microbes from contaminated MP to dominant hand. Thus, contaminated MP can act as reservoir of pathogens introducing community acquired infections to areas previously free of them.

Anerobes can cause endocarditis, abscess, intraabdominal infections, and wound infection.^[25-27] Like aerobic bacterias, they too can contaminate MP and hands of HP. However, no previous study, to the best of our knowledge, has determined this before. In the present study, anerobes were found only in MP and not in hands which may suggest non-transfer from MP to hands of tested HP. Clinical implications of this is unknown and further studies to determine potential threat of this are suggested.

In the present study, use of disinfectant did not significantly decrease gram-positive and gram-negative bacteria in dominant hands, though ASB significantly decreased. This may expose patients, HP themselves and their family members, especially vulnerable age group of children playing phone and elderly, to bacterial contaminants. However, the limitation of the present study is that the tested HPs were not asked to disinfectant their hands for recommended 1.5 min. This was deliberate to simulate the actual practice of using disinfectants by HP, however further studies are recommended with control group with standard protocol of hand disinfection for comparison, making interpretation of results better and helpful for others. Also, WHO recommendation of hand cleaning with disinfectants is recommended [Figure. 2].^[28] The other limitation of the present study was non-determination of transfer of bacterial microbes from hands of tested HP to patients, HP themselves, and/or their family members for which further studies are recommended. The present study

also addresses the urgent need to invent an effective method to decontaminate MPs of HP in hospitals. The results of the present study have been submitted to the administration of our hospital for further action.

To conclude, at a tertiary care hospital in India, there is probable transfer of aerobic bacterial microbes but not anerobes from mobile phones to hands of tested HP with no decrease seen in potentially pathogenic gram-positive and gram-negative bacterias when hand disinfectants are used in non-protocolized way.

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Conflicts of interest

There are no conflicts of interest.

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Figure 2: WHO recommendation of washing hands

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