Original Research Paper

Volume - 13 | Issue - 10 | October - 2023 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Medical Microbiology

SMARTPHONES HARBOURING SMART BACTERIA: A POTENTIAL THREAT IN HOSPITAL ENVIRONMENT

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ABSTRACT **Background:** Smartphones or mobile phones acting as potential fomites in the hospitals has raised our concern. This study wanted to evaluate the association between bacterial flora of smartphones of the health-care workers and their habits of hand-washing and cleaning of phones. **Methods**: Swab samples were taken from the surfaces of smartphones and were incubated aerobically at 37^{0}C. The colonies were counted and identified phenotypically. **Results:** Polymicrobial bacterial growth was present universally, often with count around 10^5 per sample. The predominant organisms were Coagulase negative *Staphylococcus species*, *Staphylococcus aureus, Bacillus species, Pseudomonas* and *Enterococcus species.* Less common isolates were *Escherichia coli, Klebsiella species and Proteus species.* Around 43% were multi-drug-resistant pathogens. Only 10% of the study population had the habit of daily sanitisation of smartphones with reportedly lower bacterial load on their smartphones. **Conclusion:** Mobile phone flora being easily transmissible by direct hand-to-hand contact, were responsible for increasing hospital acquired infections. Hospital-strains were easily transmitted to household contacts of health-care workers, thus aggravating chances of skin and food-borne infections. The occurrence of those unwelcome events can be reduced only by stringent hand-washing and proper sanitisation of smartphone surfaces.

KEYWORDS : mobile phones, bacterial flora, MRSA, hospital acquired infections

INTRODUCTION

Nowadays, mobile phones, especially android phones or smartphones have become part and parcel of our daily life owing to their versatile updated applications. We often use these multi-functional gadgets at our workplaces to cope up with our advanced technological demand. Even in health care set-up, 98% of health care workers own a mobile phone and 84.5% bring it to the hospital every day. [1] While using in a hospital environment, these devices are frequently being infested with microbes by coming in contact with various contaminated surfaces, by our oral flora during a telephonic conversation, or by skin flora while handling it throughout the day.

It has been a common practice during the Covid -19 pandemic period to sanitise all our belongings after returning home. Many people built up the habit of disinfecting the surfaces of their mobile phones with alcohol-based hand sanitisers or UV rays. Effective may it be against the virus, but the efficacy against common aerobic bacteria encountered in domestic, commercial and hospital environments is unpredictable. This study intended to evaluate the extent of surface contamination of mobile phones or smartphones by the common aerobic bacteria and their association with the cleaning habits of their owners.

METHODS

Swab samples were taken from the mobile phones of 60 health care workers including 20 doctors, 20 nursing staff and 20 lab technicians. Samples were also taken from 20 household contacts of those health care workers. At first the detailed procedure was explained to each participant and consent was taken from them before taking swab samples from each mobile phone. Sterile disposable cotton swabs were soaked in sterile normal saline, twirled up against the inner surface of the test tube to drain the excess fluid. The damp swab is then rolled over 360^0 on the whole surface of individual mobile phone. Swab samples were taken from both front and back surfaces of the mobile phones.

The swabs were put back into the sterile test tubes and the caps were sealed with parafilm. The samples were sent immediately to the department of Microbiology, inoculated on blood agar and MacConkey agar and incubated aerobically overnight at 37^{0}C. The growths were observed for colony count and types of bacterial colonies.

Bacterial species identification was done by conventional phenotypic method and drug sensitivity was done by Kirby Bauer disc diffusion method for determining specific resistance pattern like Methicillin resistant *Staphylococcus aureus* (MRSA), Methicillin resistant Coagulase negative *Staphylococcus species* (MRCoNS), extended spectrum beta lactamase (ESBL) producing Gram negative bacilli (GNB), and metallo-beta lactamase (MBL) producing Gram negative bacilli (GNB).

RESULTS

All 80 people included in this study possessed smartphones/ android phones. The samples from all the smartphones yielded mixed bacterial growth mostly comprising of two or three species of Gram-positive cocci, and *Bacillus species*.

The coagulase negative *Staphylococcus species* (CoNS) were universally present. *Staphylococcus aureus, Enterococcus sp., Bacillus sp.,* and *Pseudomonas species* were also quite common. Other GNB like *Escherichia coli, Klebsiella species* and *Proteus species* were present in lesser number. The drug resistant strains like MRSA, MRCoNS, ESBL and MBL producing bacteria were present in high percentage- 43% (164 isolates) collectively. Whenever present, *Pseudomonas* and *Proteus sp.* showed heavy bacterial growth. (Table-1)

Table 1: Aerobic bacteriological profile contaminating smartphone surfaces

Organism	No of cases (%)	% of Cases with heavy growth of the organism
MRSA	72 (90%)	88.9%
MSSA	6 (7.5%)	50%
MRCONS	48 (60%)	87.5%
MSCONS	32 (40%)	78%
Pseudomonas sp.	48 (60%)	100%
Enterococcus sp.	60 (75%)	33.3%
Micrococcus sp.	20 (25%)	75%
Escherichia coli	10 (12.5%)	60%
Klebsiella sp.	5 (6.25%)	60%
Proteus sp.	4 (5%)	100%
Bacillus sp.	74 (92.5%)	91.9%

All the isolates of MRSA and MRCoNS were multi drug resistant (MDR) being methicillin resistant per se. Eighty percent of *Escherichia coli* and *Klebsiella species* were MDR and ESBL producers, while 66.7% of *Pseudomonas species* were MDR as well as MBL producers.

Only eight persons had the habit of cleaning their smartphones daily, while rest of them used to do so at irregular intervals or not at all. The habit of daily cleaning has shown significant chances of reducing bacterial growth on the mobile phone surfaces than the other group. (*p*-value: 0.006)

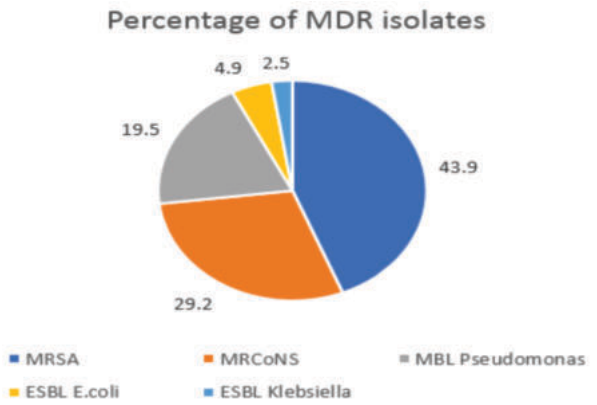

Figure 1: Proportion of MDR organisms isolated from smartphone surfaces. (N=164)

Table 2: Relationship between bacterial colonisation and cleaning habits (n=80)

Cleaning habit	No. of cases	Heavy growth	Moderate growth	Low growth
Daily	8	2	2	4
Weekly	33	14	15	4
Monthly	21	12	7	2
Rarely /never	18	7	8	3
Total	80	35	32	13

DISCUSSION

Today's smartphones have become the integral part of our lives. This unique multi-functional gadget enables us to upgrade our applications, update our knowledge and uplift our abilities. Lesser do we pay attention to that fact that a smartphone can be a real good 'breeding ground' of many common bacteria owing to the combination of constant handling and the generation of heat by it.[2] It becomes more a danger while used by health care workers in hospital set- up. It can act as a high potential fomite due to frequent contact with hands, and subsequent hand to hand transmission of nosocomial infections. [3] This study found heavy growth of bacteria with co-existence of multiple species on the surfaces of smartphones in general. It is aptly said by some author that "mobile phones are dirtier than a toilet seat or the bottom of the shoe". [4] As smartphones are not cleaned regularly, bacteria may remain for prolonged period on their surfaces and can act as a long-term source of infections to the patients as well as the health care workers themselves. [5] M Bisht et al found 99% mobile phones to be contaminated, quite similar to Selim HS et al, and Daka D et al. [2,6,7]

Like them, we also found 100% of the smartphones as contaminated. Polymicrobial growth was present universally in a much higher rate than previous Indian studies.[2,8]

The predominance of Gram-positive isolates was in concordance with that of several previous studies.[2,7,9,10] Studies from different parts of the world singled out CoNS species as the predominant mobile phone contaminant, though with varied frequency. [11-13] We also reported alike with isolation of CoNS from 100% of the samples. Although it is a normal skin commensal, it may cause opportunistic infections and several nosocomial infections including endocarditis, catheter associated blood stream infections and surgical wound infections. [14,15]

Next in the line were *S. aureus* (97.5%) - the established pathogen, and *Bacillus species* (92.5%) - the aerobic spore bearer with low pathogenic potential. Our study found that commonest potential pathogen isolated from smartphone surfaces was MRSA (90%), often (in 60%) mixed with MRCoNS and *Pseudomonas species*. Studies from aborad also found a high prevalence of *Staphylococcus aureus* (64%) by Fauci et al. [16] The bacterial spectrum of our study also included Gram-positive cocci like *Enterococcus sp.* (60%) and *Micrococcus sp*. (25%). In much lower extent, it included GNB like *Escherichia coli* (12.5%), *Klebsiella sp.* (6.25%) and *Proteus sp.* (5%). A similar picture was presented by M Bisht et al, with exception of few *Citrobacter* isolates. [2] On the contrary, Arora et al. and Das et al. found only Gram-positive organisms but no Gram-negative ones. [4, 17] *E. coli* isolation rate (12.5%) was comparable to Tambekar et al with 11% reported value. [18] Low prevalence of *Klebsiella* (5%) was similar to Bisht. [2] Fewer they might be, but 80% of all *E. coli* and *Klebsiella* isolates were ESBL producers and MDR pathogens. Similarly, *Pseudomonas species*, have 66.7% isolates as MBL producers and MDR, quite relatable to the study by Mushabati et al in Zambia. [11] All those MDR superbugs were probably originated as hospital strains, reportedly being responsible not only for various nosocomial infections, but also for community acquired infections and outbreaks.[11] Some of the MRCoNS, MRSA and MDR *Pseudomonas* were also isolated from healthy household contacts of health care workers with no exposure to hospital environments, indicating a probable transmission through the smartphones.

Only 10% people had a habit of cleaning the smartphones with alcohol-based hand-rub or other sanitisers after using the phone in hospital or outside market places, and half of this group have a lower bacterial load on their phones. Rest of the 90% used to sanitise their phone irregularly- at varied interval of weeks to months, 90% of their phones harboring moderate to heavy growth of bacteria. The association between daily cleaning of smartphones with lower bacterial load on them was statistically significant (*p*-value: 0.006), as supported by Bodena in 2019 [19], although other studies found no correlation between mobile phone contamination and disinfection practices or restriction of phones in work area. [20]

CONCLUSIONS

Smartphones can act as excellent media for growth of several bacteria and are quite capable of transmission of the bacteria by direct hand to hand or indirect contact. There could be "tens of thousands of microbes living on each square inch of the phone." [14] MDR superbugs have smartly evolved to resist killing by many antibiotics and disinfectants and can easily grow on smartphone surfaces, thus causing cross-contamination in both hospital and domestic fields. Though not proven unanimously, adherence to proper hand hygiene practices and restricted use of mobile phones in high risk areas like operation theatre and intensive care units will be helpful to reduce cross contamination. [14]At home, mobile phones should be restricted during eating or cooking. If the phone is used, hands should be washed or cleaned immediately before resuming the act. To prevent colonisation over mobile phones, effective sanitization is important. This is probably the simplest effective means to outsmart the MDR superbugs.

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