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ORIGINAL ARTICLE

Hand Microbiome And Resistant Strains From Cell Phones Of Health Personnel

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Abstract

Purpose: To investigate the hand microbiome of Health Personnel and the flora transferred to their hands from cell phones.

Methods: The study was conducted in a tertiary care hospital over 3 months in 50 health personnel. Their dominant hand was placed on agar plates to establish the hand microbiome. After sanitizing and drying their hands, and using their phones for a few minutes, another handprint was taken to identify the bacteria on the phone. The bacteria were identified by standard microbiologic techniques.

Results: Organisms identified in the normal microbiome included coagulase negative *Staphylococci* (CoNS, 90%), *Klebsiella and pneumoniae* (16%), *E. coli* (8%), *Staphylococcus aureus* (4%), *Pseudomona and saeruginosa* (2%) and *Acinetobacter spp.* (2%). CoNS isolated were found to be resistant to co-amoxiclav (41.67%), cotrimoxazole (20.83%), erythromycin (20.83%) and clindamycin (20.83%). Maximum resistance was observed towards co-amoxiclav. The repeat handprint showed the colony count as decreased by four times. Bacteria found were CoNS (92%), *E. coli* (4%), *Enterococcus* (4%), *Klebsiella* (2%) and *Acinetobacter* (2%). Antibiotic sensitivity was similar here with additional resistance to cefepime and cefoxitin by CoNS.

Conclusion: Hand microbiome of health personnel comprises bacteria that are dangerous to immunocompromised individuals and our phones are effectively transmitting multidrug resistant bacteria to our hands within a few moments of contact. There was also a notable lack of *S. aureus* in our samples, while many other studies have shown it to be a common nosocomial pathogen, found on hands of health personnel.

Keywords: Hand microbiome, Health Personnel, Antibiotic resistance, cell phone

1 | INTRODUCTION

Annually, about hundreds of millions of patients suffer from healthcare-associated infections worldwide [1]. The constant and unchecked antibiotic use in the latter half of the twentieth century has led to the emergence of antibiotic resistant strains. These strains may pose no threat to healthy individuals but in immune-deficient patients, it can cause life threatening infections. Doctors, nurses and hospital staff constantly worry about exposure to antibiotic resistant strains and with due cause. Hospitals are known to harbor several antibiotic resistant strains including *Staphylococcus aureus* and *Klebsiella.* The high rate of use of antibiotics in the hospital, equips hospital strains with multi drug resistance. These organisms which can get picked up by Health Personnel (HP) can easily get transferred from one patient to the next, spreading infection. Many nosocomial pathogens can survive up to several months on inanimate surfaces and can thereby be a continuous source of transmission if a regular disinfection is not done [2]. Bacterial transfer occurs within seconds of contact with contaminated surfaces [3]. Higher contamination levels of HP hands were found to be after direct patient contact, respiratory care, handling body fluids and when the appropriate sequence of patient care was not followed. Bacterial contamination increased linearly with time on ungloved hands during patient care and also, simple hand washing without specific measures of hand antisepsis was associated with higher colony counts [4]. Thus, the first part of this project is designed to study the normal microbiome of a HP at a random time of a normal working day and assess their antimicrobial susceptibility. It was done by hand printing HP hands on Blood and MacConkey agar.

Cell phones have become a necessary feature of clinical practice in a country like India where patient records are still handwritten and there is not much use of technology to store and retrieve patient information. Cell phones provide doctors and staff with laboratory and imaging results, and patient data, and is therefore being used by doctors during rounds, in order to teach students. Health personnel access pharmaceutical knowledge and literature through their cell phones, which helps with easier learning [5]. The warm environment of the cell phone serves as a good habitat for bacteria. Thus, these cell phones act as vehicles for the transmission of nosocomial infection. The human skin which comes in contact with the phone may become readily colonized by certain microbial species. Therefore, to study the contamination of HP hands by phones, the subjects were asked to use sanitizer on their hands and then handle their cell phones. A second hand print was then taken on Blood and MacConkey Agar.

Many studies have been conducted to assess the contamination of HP phones by these organisms and it has been found that cell phones may harbour *Staphylococcus aureus*, *Klebsiella pneumoniae* and *Enterococcus* [6]. This prompted us to investigate the possibility of contamination of HP hands by these organisms upon handling their cell phones and study the microbiome of HP hands for different types of bacteria.

Here, direct handprints were collected on agar plates. This method had the advantage of picking up bacteria from all over the hand rather than just from one area and was able to compare different areas of the hand to see where contamination was maximum.

EXPERIMENTAL WORK: ***Study Design:*** This study was conducted from August 2019 - October 2019 in the Department of Microbiology, in a tertiary care hospital. It was an investigative study. Hospital staff who spend considerably more time in the hospital and more time in direct contact with patients were chosen as subjects. A total of fifty samples were collected from doctors, interns, and nurses at the hospital. Informed written consent was signed by the volunteers before sample collection. The study was approved by the Institutional Ethics Committee of the concerned hospital.

Supplementary information The online version of this article (https://doi.org/10.15520/ijmhs.v10i12.3156) contains supplementary material, which is available to authorized users.

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2 | METHODOLOGY

The study group consisted of 15 Doctors, 18 Interns and 17 Nurses. They belonged to various departments including the OPD, General Medicine, Surgery, Orthopaedics, Pulmonary Medicine, Laboratory, and Obstetrics and Gynaecology. The Health Personnel were instructed to place their dominant hand, with no visible soiling, on agar plates for 5 seconds [7]. If the whole hand did not fit on the plate, they were asked to preferentially place the fingers, thumb and ball of the palm. The subjects were then asked to use sanitizer on their palm and after it had dried, they were asked to rub their hands up and down their phones for a few minutes. Repeat handprints were then collected on different agar plates by the same procedure and incubated immediately. The plates were incubated aerobically for 24 - 48 hours. After incubation, the plates were observed for colony morphology and colony count. Isolates were identified by standard microbiologic techniques: Gram staining and biochemical characteristics (including TSI, Indole Test, Mannitol Motility Test). Antibiotic susceptibility of isolates was determined by the Kirby Bauer disk diffusion method on Mueller Hinton Agar. Plate 1 is the normal hand microbiome of the HP. Plate 2 is the handprint collected after they used sanitizer and subsequently handled their phones.

3 | RESULTS

Of the 50 samples collected, growth was found on 48 of them, with one or two different types of isolates which were subsequently identified by colony morphology and biochemical tests. They were tested for antibiotic susceptibility as well.

- COLONY COUNT: Post sanitizer use and handling of phones, it was observed that the colony load deceased by around FOUR times.
- OCCUPATION WISE DISTRIBUTION: From the data collected, it was observed that doctors' hands had the least variety of organisms, harbouring mainly CoNS and E. coli. This was

TABLE 1: PLATE 1- Normal hand microbiome of a HP

Isolates	Number	Percentage (%)
CoNS	45	90
Klebsiella pneumoniae	8	16
E. Coli	4	8
Staphylococcus aureus	*2*	4
Pseudomonas aeruginosa	1	2
Acinetobacter spp.	1	2

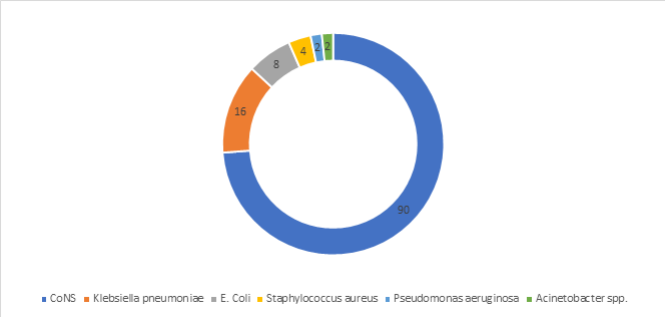

FIGURE 1: Graphical representation of distribution of isolates in plate 1

TABLE 2: PLATE 2- After handling the cell phone

Isolates	Number	Percentage (%)
CoNS	46	92
Klebsiella pneumoniae	1	2
E. coli	2	4
Enterococcus	2	4
Acinetobacter spp.	1	2

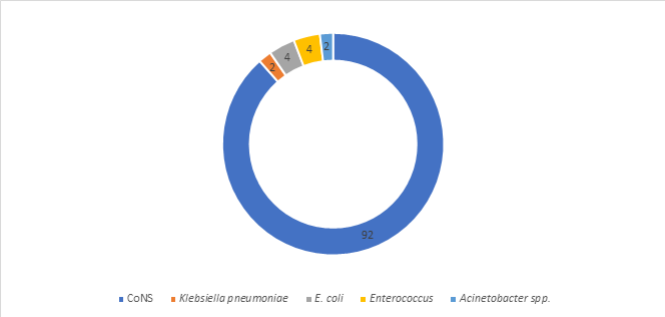

FIGURE 2: Graphical representation of distribution of isolates in plate 2

TABLE 3: Resistance pattern in plate 1- Gram positive organisms

Antibiotic	Number	Percentage (%)
Ampicillin	1	2.08
Amoxicillin-clavulanic acid	20	41.67
Erythromycin	10	20.83
Ciprofloxacin	1	2.08
Clindamycin	10	20.83
Cotrimoxazole	10	20.83
Tetracycline	1	2.08

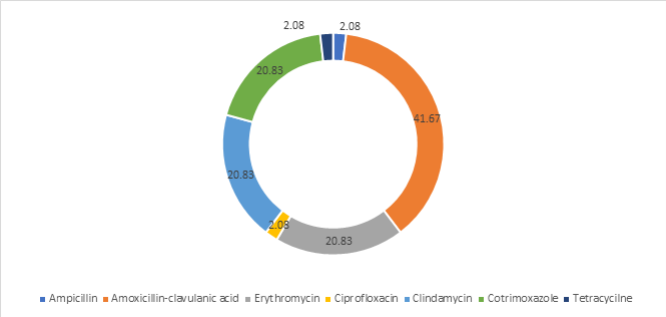

FIGURE 3: Graphical representation of pattern of antibiotic resistance in gram positive organisms isolated in plate 1

TABLE 4: Resistance pattern in plate 1- Gram negative organisms

Antibiotic	Number	Percentage (%)
Ampicillin	8	61.54
Amoxicillin-clavulanic acid	8	61.54
Ciprofloxacin	2	15.38
Cefuroxime	2	15.38
Cefepime	1	7.69
Cefoperazone	1	7.69
Cotrimoxazole	1	7.69

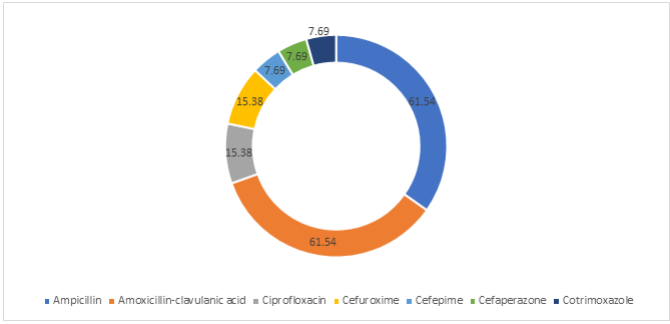

FIGURE 4: Graphical representation of pattern of antibiotic resistance in gram negative organisms isolated in plate 1

TABLE 5: Resistance pattern in plate 2: Gram positive organisms

Antibiotic	Number	Percentage (%)
Cefoxitin	1	2.17
Amoxicillin-clavulanic acid	24	52.17
Erythromycin	7	15.21
Ciprofloxacin	1	2.17
Clindamycin	8	17.40
Cotrimoxazole	13	28.26
Cefepime	1	2.17

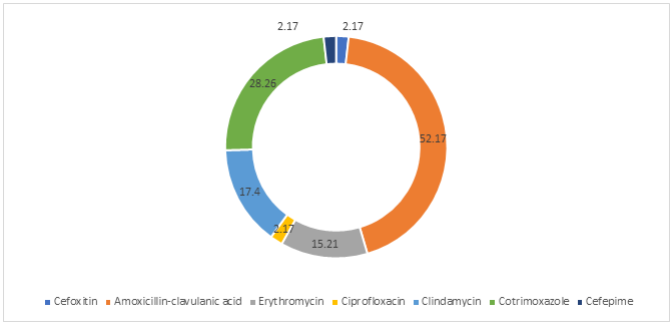

FIGURE 5: Graphical representation of pattern of antibiotic resistance in gram positive organisms isolated in plate 2

TABLE 6: Resistance pattern in plate 2: Gram negative organisms

Antibiotic	Number	Percentage (%)
Ampicillin	2	50
Amoxicillin-clavulanic acid	2	50
Cefuroxime	1	25

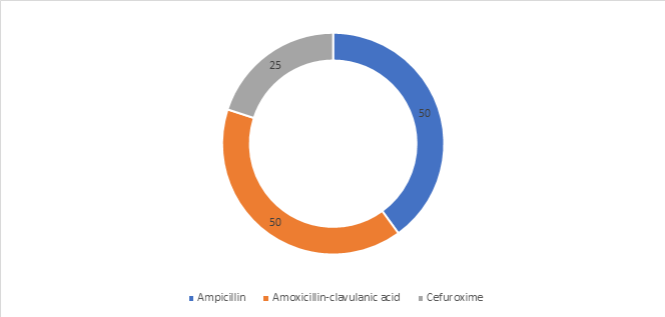

FIGURE 6: Graphical representation of pattern of antibiotic resistance in gram negative organisms isolated in plate 2

followed by nurses who harboured CoNS, *Klebsiella pneumoniae*, *Staphylococcus aureus and Acinetobacter*. Interns were found to have a wider distribution, with CoNS, *Klebsiella pneumoniae, Enterococcus and Pseudomonas aeruginosa* being the predominantly isolated organisms.

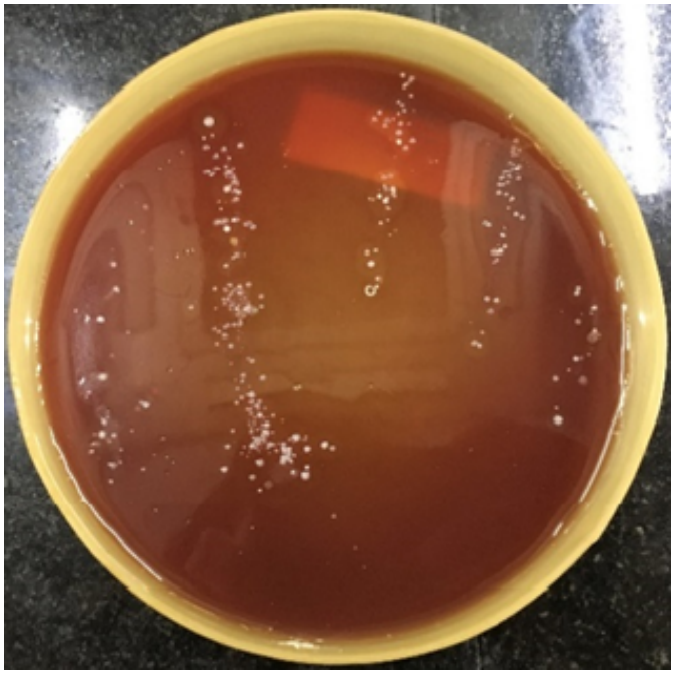

FIGURE 7: Growth on MacConkey Agar - Plate 1: Normal hand microbiome

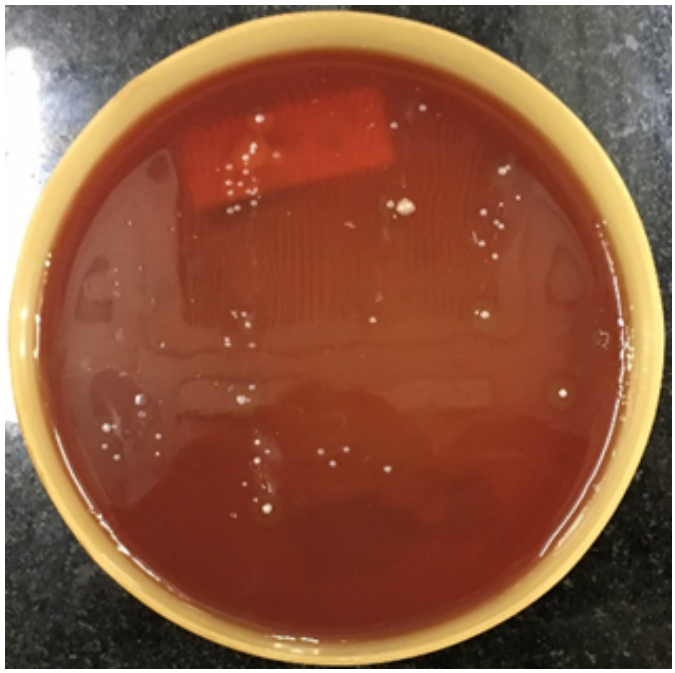

FIGURE 8: Growth on MacConkey agar - Plate 2: After sanitizing and then handling the phone

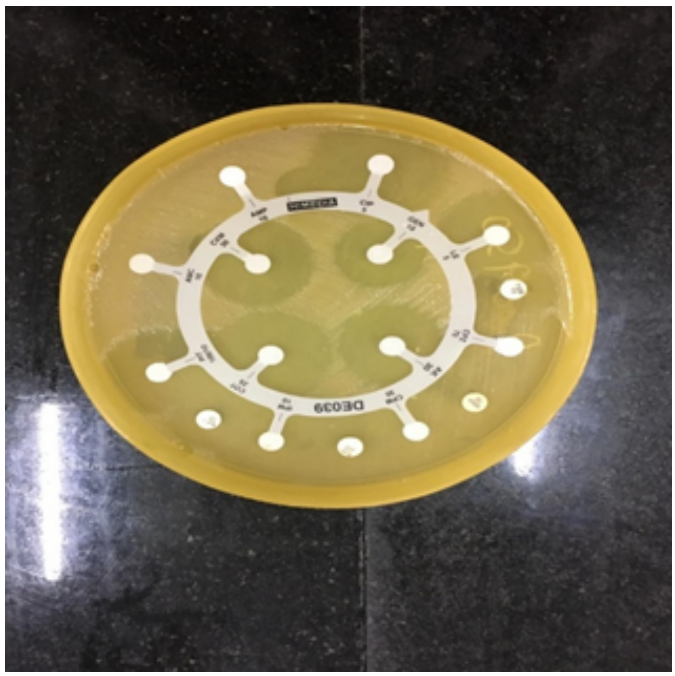

FIGURE 9: Antibiotic Susceptibility testing on Mueller Hinton Agar

4 | DISCUSSION

In the first part of this study that analyzed the normal hand microbiome of HP, it was found that CoNS

(coagulase negative *Staphylococcus*) was the predominantly isolated species, (90%). Earlier, it was historically known that these species are harmless commensals. However, due to patient and procedure-related changes, CoNS have now become one of the major nosocomial pathogens, with *S. epidermidis* and *S. haemolyticus* being the most significant species. They account substantially for foreign body-related infections (such as with catheters and IV lines) and infections in preterm newborns. However, CoNS have significantly lesser virulence factors as compared to *Staphylococcus aureus* and therefore, in this regard, it is host susceptibility that influences its pathogenicity [8]. In a hospital environment, where patients already have a weakened immunity, even these usually harmless species can prove dangerous. These organisms are also known to produce biofilms and as this project has found, they have developed resistance to many commonly used antibiotics such as amoxicillin- clavulanic acid, ampicillin, erythromycin, clindamycin and cotrimoxazole. Clindamycin and Amoxicillin - Clavulanic Acid (AMC) are second line antibiotics and co-amoxiclav is a frequently prescribed combination. Other species isolated were pathogenic forms such as *Klebsiella pneumoniae* (16%), *E. coli* (8%), *Staphylococcus aureus* (4%), *Pseudomonas aeruginosa* (2%), *Acinetobacter spp.* (2%). These species were also found to be resistant to many commonly prescribed medications such as AMC, ampicillin, and cephalosporins. *Klebsiella*, *Pseudomonas*, *Acinetobacter* and *Staphylococcus* are all known nosocomial pathogens. Contamination of surfaces in a hospital from a study was reported to be mainly due to *S. aureus*, *A. baumannii*, *Pseudomonas aeruginosa*, *E. faecalis* and *E. coli* [9]. Our study has found that the most common bacteria being picked up from HP hands was mainly CoNS, *Klebsiella* and *Pseudomonas*, and to a lesser extent *Staphylococcus aureus* (although *S. aureus* has been demonstrated as the predominant isolate on inanimate surfaces according to the aforementioned study).

For the second part of this project, we observed on Plate 2, that the colony count had significantly decreased as compared to Plate 1, which was post handling of cell phone. The colony load decreased by around 4 times. The repeat handprint revealed CoNS (92%) to again be the predominant isolate followed by *E. coli* (4%) and *Enterococcus* (4%), *Klebsiella* (2%) and *Acinetobacter* (2%). which were also found to have similar antibiotic resistance pattern. In addition, the CoNS was found to be resistant to cefepime and cefoxitin. Cefepime is considered a highly potent, fourth generation cephalosporin and is often used to treat moderate to severe nosocomial infections. Therefore, resistance to such a potent drug is alarming [10].

One study has shown that among the cell phones of HP from ICUs, *Acinetobacterbaumannii* (36.84%) was the predominant organism isolated followed by methicillin resistant *Staphylococcusaureus* (MRSA) (21.05%) [5]. Another study found the most predominant isolates were CoNS, *Staphylococcusaureus*, *Acinetobacterspecies*, *Escherichiacoli*, *Klebsiellapneumoniae*, *Pseudomonasspecies* and *Enterococcusspecies* [6]. Our study has demonstrated these organisms to be present of the hand of HP after they handled their phones, showing an effective transmission, although the bacterial load was low. However, there would be time for the bacterial colonies to grow on the hand and make the hands more infectious if the hands are not sanitized post handling the phone. Our study however, did not find as many *Staphylococcus aureus* as isolates as compared to these other studies that have taken swabs directly from cell phones of HP. From this study, it is clear that even the normal hand microbiome of HP comprises bacteria that are potentially fatal to immunocompromised individuals, who usually make up the normal hospital population. The bacteria that are transferred to our hands from various hospital surfaces and from patients, have the capacity to thrive on our hands and spread infection. We found that our phones are effectively harbouring and transmitting multidrug resistant bacteria to our hands within a few moments of contact. If the important step of hand antisepsis is missed, then these bacteria can grow on our hands and spread to patients causing potentially fatal infections. It is recommended that all HP take personal hygiene very importantly as there is currently no established method to disinfect phones. Also, we recommend that phone use be strictly regulated in critical environments such as ICUs and

OTs.

Further studies are recommended to establish any other nosocomial pathogens and also to identify the various specific mechanisms of resistance in these specific isolates, to develop better methods to combat them.

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