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Study of Antibiotic Resistant Bacterial Flora, Methicillin Resistant Staphylococcus Aureus (MRSA) and Extended Spectrum β -Lactamase (ESBL) Profile Associated with Mobile Phones of Healthcare Workers and Non-Healthcare Workers

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Abstract

Despite advancements in diagnostics and treatment, hospital-acquired infections remain a significant global healthcare issue, with potential pathogens found in healthcare workers' cell phones. Cell phones are often not thoroughly cleaned and treated with improper hand hygiene, despite the higher risk of contamination when examining patients or handling specimens. This study aimed to identify bacterial flora from mobile phones of healthcare workers and non-healthcare workers in Subharti Hospital and Subharti University, examining 150 samples. From 75 samples of HCWs mobile phones, bacterial growth was found on 74 and 102 bacteria were isolated, out of which 33(32.6%) bacterial colonies from HCWs mobile phones, A single, multiple or mixed colonies are observed and 102

bacteria were isolated. Age between 16-25 years have got a high chance of contamination, users of touch-screen mobile phones and users in toilets are highly contaminated with *S. aureus* along with users of same mobile phones for more than 5 years. The number of MRSA were 100% higher in the mobile phones carried in pockets than those carried in mobile-bags and those who do not regular disinfect their mobile phones.6%) bacterial isolates from Nurses, Technicians and Attendants respectively, 2(5.12%) Nurses, 1(5%) Technician and 2(12.5%) Attendant samples isolated were detected as 5(4.90%) MR SA. Also, 1(2.56%) nurse and 1(5%) technician bacterial isolates were positive for ESBL- producers 1(0.98%) *Escherichia coli* & 1(0.98%) *Klebsiella spp.*

Keywords: E. Coli, Mobile Phones, ESBL-Producers, Health Care Workers, MRSA

Introduction

Advancement in modern technology has major impacts and contributed significantly in medicinal field. Modern technology is growing at a rapid phase, in which 'Mobile Phone' is one of the fastest growing sectors in the developing technology for individual use^[1]. Mobile phones are widely used by Health Care Workers (HCWs) and non-Health Care Workers (non-HCWs) equally in every aspect. It became an essential commodity in our daily lives, worldwide they can act as one of the source of Hospital Acquired Infections (HAIs) or Health care Associated Infections (HCAIs) also known as Nosocomial Infections because of arrays of microbial flora they carry. According to the Global Antibiotic Resistance Partnership (GARP), hospitals in India have a high burden of HAIs, many of which are resistant to antibiotic treatment^[2]. the most common sites of infection of HAIs and their common causative pathogens are as- the blood stream (coagulase-negative *staphylococci*), lungs (*Staphylococcus aureus* and *Pseudomonas aeruginosa*), urinary tract (*E. coli* and *Klebsiella*) and surgical wounds (*S. aureus*)^[3]. It is the main cause of septicemia, endocarditis, osteomyelitis, pneumonia, toxic shock syndrome, food poisoning, etc., and the complications are more prevalent among weakened immune system. In addition, on dry surfaces, most of the gram positive bacteria including MRSA have been shown to survive for months^[4]. Hospitals in India have a high burden of infection in their ICUs and general ward, many of which are resistant to antibiotic treatment, according to a report of Global Antibiotic Resistant Partnership (GARP)^[5]. In recent years, MRSA strains has emerged, becoming rapidly dominant pathogens, Vancomycin is used to be the antibiotic treatment of MRSA but several reports shown resistant patterns against vancomycin and treatment was

problematic and indicate immediate medical attention if MRSA present in mobile phones [6]. *Staphylococci spp.* was first sensitive to penicillin before 1940, and was used for treatment in 1941. In short time, strains containing β -lactamase enzymes were generated in *S. aureus* and resistance was spread in the environment. The lack of binding of β -lactams to penicillin-binding proteins (PBPs) is the main cause of *Staphylococcus aureus* resistance to the antibiotics. These proteins are responsible for building the bacterial cell wall; they are targeted by beta-lactam antibiotics. PBP2a is one of sub-groups of mutant PBPs; it is 78 kDa. It increases the resistance of *Staphylococcus aureus* to beta-lactams due to the high expression and low binding to beta lactamase [7, 8, 9]. MRSA which are separated from hospitals are called Health care-associated MRSA (HA-MRSA) and those which are separated from community are called Community- Acquired MRSA (CA-MRSA) [10, 11]. In 2000s, the epidemiology of ESBL-producing organisms changed as *Escherichia coli*, which produces the CTX-M ESBL type, was increasingly described as an important cause of community-acquired urinary tract infections worldwide [12, 13]. As per several reports from various countries, it seems that existing flora on the mobile phones of HCWs are different from non-HCWs concerning the frequency and type of bacteria [14, 15, 16]. Hand washing and cleaning of mobile phones may not usually be performed often enough as per several surveys during working days. Studies have investigated that 88% respondents stated they had never cleaned their phones [15]. Thus, using and sharing of mobile phones between the hospital staffs facilitate the spread of micro-organisms, therefore, the potential act of mobile phones as a source of microbial transmission is considerable [17, 18]. Bacteria isolates from mobile phones of HCWs may vary in number and antibiotic sensitivity compared to non-HCWs personnel [19]. Due to many benefits of mobile phones in HCWs and non-HCWs daily life, their hazard to human health is often overlooked. The pathogens passed from the contaminated hands and skin of the users to other users, and through that, there was an exchange of flora between the users [20].

Collection of sample and bacterial isolates

After taking an informed consent, a sterile swabs moistened with sterile normal saline were rolled over the exposed surfaces of the mobile phones. Maximum care was taken to ensure that all the buttons of the keypad, screen, mouthpiece, earpiece, sides, and back of the mobiles would be properly swabbed since these areas are the most frequent spots in contact with the fingers. Verbal questionnaires are also collected. After collection, the samples were immediately transported to the laboratory and inoculated on Nutrient agar and Mac-Conkey's agar and plates were incubated aerobically at 37 degree Celsius for 24 hours.

Observation and Results

In this study a total of 150 mobile phone swabs were examined, out of which 75 were from Health Care workers mobile phones and the other 75 were from non-Health Care workers mobile phones. From 75 samples of HCWs mobile phones, bacterial growth was found on 74 (98.6%) and 102 bacteria were isolated, out of which 33(32.3%) were *Staphylococci spp.* from which 5(4.90%) were positive for MRSA. Also, 3(2.94%) *E. coli*, 3(2.94%) *Klebsiella spp.* and 5(4.90) *Proteus spp.* were also isolated, from which

1(0.98%) *E. coli* and 1(0.98%) *Klebsiella spp.* was tested positive for ESBL-producers. From 75 samples of non-HCWs mobile phones, bacterial growth was found on 73(97.3%) and 96 bacteria were isolated. On 39(40.62%) *Staphylococci spp.* isolated, no MRSA was found. Also, 4(3.39%) *E. coli*, 1(0.98%) *Klebsiella spp.* and 1(0.98%) *Proteus spp.* was isolated and no ESBL-producers detected. From 74(98.6%) bacterial colonies from HCWs mobile phones, A single, multiple or mixed colonies are observed and 102 bacteria were isolated. Out of 10 types of bacteria isolated, Gram positive bacilli 50(49.01%) is the predominant bacteria, followed by 33(32.3%) *Staphylococcus spp.* [i.e. MSSA 14(13.72%), MRSA 5(4.90%) and CoNS 14(13.7%)], *Proteus spp.* 5(4.90%), *Pseudomonas spp.* 4(3.92%), *Micrococci* 3(2.94%), *Escherichia coli* 3(2.94%), *Klebsiella spp.* 3(2.94%) and *Enterobacter spp.* 1(0.98%). Different types of bacteria grown from HCWs mobile phones are shown in [Table 1].

Table 1: Number and types of organisms isolated from HCW's mobile phones

Isolated organisms (n=10)	Number of isolated organisms (n=102)	Percentage (%)
Coagulase negative <i>Staphylococci</i>	14	13.72%
Methicillin Resistant <i>Staphylococcus aureus</i>	05	4.90%
Methicillin Susceptible <i>Staphylococcus aureus</i>	14	13.72%
<i>Micrococcus</i>	03	2.94%
Gram positive bacilli	50	49.01%
<i>Escherichia coli</i>	03	2.94%
<i>Klebsiella spp.</i>	03	2.94%
<i>Proteus spp.</i>	05	4.90%
<i>Pseudomonas</i>	04	3.92%
<i>Enterobacter spp.</i>	01	0.98%
Total	102	100

In HCWs, out of 102 isolated organisms, Antibiotic Susceptibility Testing (AST) was performed for 19(18.62%) isolates of *Staphylococcus aureus*. Of the 8 antibiotic used, Linezolid (LZ), Clindamycin (CD), Cotrimoxazole (COT), Cefepime (CPM) and Gentamicin(GEN) were found to be the most effective antibiotics having 100% sensitivity. In contrast, Cefoxitin (CX) showing 73.6% sensitivity was the least active antibiotic followed by Tetracycline (TE) 78.9% sensitivity and Ampicillin (AMP) 84.2% sensitivity. Five (26.3%) bacterial isolates were detected as Methicillin resistant *Staphylococcus aureus* (MRSA). Antibiotic sensitivity patterns for *Staphylococcus aureus* from HCWs mobile phones shown in [Table 2].

Table 2: Antibiotic susceptibility patterns of *Staphylococcus aureus* isolated from HCW's

S. No	Antibiotics	<i>Staphylococcus aureus</i> (n=19)			
		Sensitive	%	Resistant	%
1	LZ	19	100	-	00
2	CD	19	100	-	00
3	COT	19	100	-	00
4	TE	15	78.9	4	21.0
5	CX	14	73.6	5	26.3
6	AMP	16	84.2	3	15.7
7	CPM	19	100	-	00
8	GEN	19	100	-	00

[LZ: Linezolid; CD: Clindamycin; COT: Cotrimoxazole; TE: Tetracycline; CX: Cefoxitin; AMP: Ampicillin; CPM: Cefepime; GEN: Gentamicin]

Escherichia coli, *Klebsiella spp.* and *Proteus spp.* for the detection of ESBL-producers. Of the 9 antibiotic used, Piperacillin + Tazobactam (PIT), Cefepime (CPM), Imipenem (IPM), Amikacin (AK) were found to be the most effective antibiotics showing 100% sensitivity. In contrast, Cotrimoxazole (COT), Ceftazidime (CAZ) Ceftazidime / Clavulanic acid (CAC), Ampicillin (AMP) and Tetracycline (TE) were the least active antibiotics showing 66.6% sensitivity to both *E. coli* 1(0.98%) and *Klebsiella spp.* 1(0.98%) respectively. Hence, two (1.96) bacterial isolates were detected as ESBL-producers. Antibiotic sensitivity patterns for Gram negative bacilli from HCWs mobile phones shown in [Table 3].

Table 3: Antibiotic susceptibility pattern of Gram-negative organisms isolated from HCW's

S. No	Antibiotics	<i>Escherichia coli</i> (n=3)				<i>Klebsiella spp.</i> (n=3)				<i>Proteus spp.</i> (n=5)			
		S	%	R	%	S	%	R	%	S	%	R	%
1	PIT	3	100	-	-	3	100	-	-	3	100	-	-
2	CPM	3	100	-	-	3	100	-	-	3	100	-	-
3	IPM	3	100	-	-	3	100	-	-	3	100	-	-
4	COT	2	66.6	1	33.3	2	66.6	1	33.3	3	100	-	-
5	AK	3	100	-	-	3	100	-	-	3	100	-	-
6	AMP	2	66.6	1	33.3	2	66.6	1	33.3	3	100	-	-
7	CAC	2	66.6	1	33.3	2	66.6	1	33.3	3	100	-	-
8	CAZ	2	66.6	1	33.3	2	66.6	1	33.3	3	100	-	-
9	TE	2	66.6	1	33.3	2	66.6	1	33.3	3	100	-	-

[PIT: Piperacillin+Tazobactam; CPM: Cefepime; IMP: Imipenem; COT: Cotrimoxazole; AK: Amikacin; AMP: Ampicillin; CAC: Ceftazidime/Clavulanic acid; CAZ: Ceftazidime; TE: Tetracycline]

A total of 96 bacteria were isolated from 73(97.3%) positive bacteria growth from non-HCWs mobile phones. A single and multiple colonies were observed. Gram positive Bacilli 47(46.07%) is the predominant followed by *Staphylococcus spp.* 39(38.2%) [i.e CoNS 20(20.8%) and MSSA 19(19.7%)], *Micrococci* 5(4.90%), *E.coli* 4(3.93%), *Pseudomonas* 3(2.94%), *Enterobacter spp.* 2(1.96%), *Klebsiella spp.* 1(0.96%) and *Proteus spp.* 1(0.96%) respectively. Different types of bacteria grown from non-HCWs mobile phones are shown in [Table 4].

Table 4: Number and types of organisms isolated from non-HCW's mobile phones

Isolated organisms (n=9)	Number of isolated organisms (n=96)	Percentage (%)
Coagulase negative <i>Staphylococci</i>	20	20.83%
Methicillin Susceptible <i>Staphylococcus aureus</i>	19	19.79%
<i>Micrococci</i>	05	5.20%
Gram positive bacilli	41	42.70%
<i>Escherichia coli</i>	04	4.16%
<i>Klebsiella spp.</i>	01	1.04%
<i>Proteus spp.</i>	01	1.04%
<i>Pseudomonas</i>	03	3.12%
<i>Enterobacter spp.</i>	02	2.08%
Total	96	100%

In non-HCWs, out of 96 bacterial isolates, Antibiotic susceptibility testing (AST) were performed from 19(19.79%) *Staphylococcus aureus* isolated. All the 8 antibiotics used shows 100% sensitivity. No MRSA was detected. Antibiotic susceptibility patterns of *S. aureus* from non- HCWs shown in [Table 5].

Table 5: Antibiotic susceptibility patterns of *Staphylococcus aureus* isolated from Non-HCW's

S. No	Antibiotics	<i>Staphylococcus aureus</i> (n=19)			
		Sensitive	%	Resistant	%
1	LZ	19	100	-	00
2	CD	19	100	-	00
3	COT	19	100	-	00
4	TE	19	100	-	00
5	CX	19	100	-	00
6	AMP	19	100	-	00
7	CPM	19	100	-	00
8	GEN	19	100	-	00

LZ; Linezolid CD: Clindamycin COT: Cotrimoxazole; TE: Tetracycline; CX: Cefixime; AMP: Ampicillin; CPM: Cefepime; GEN: Gentamycin

All the non-HCWs bacterial isolates showing 4(3.93%) *E. coli*, 1(0.98%) *Klebsiella spp.* and 1(0.98%) *Proteus spp.* was also performed antibiotic susceptibility test for detecting ESBL- producers. Nine antibiotics used all showing 100% sensitivity towards them. No ESBL producer was detected. Antibiotic susceptibility pattern of Gram-negative organisms isolated from non- HCW's shown in [Table 6].

Table 6: Antibiotic susceptibility pattern of Gram-negative organisms isolated from Non-HCW's

S. No	Antibiotics	<i>Escherichia coli</i> (n=4)				<i>Klebsiella spp.</i> (n=1)				<i>Proteus spp.</i> (n=1)			
		S	%	R	%	S	%	R	%	S	%	R	%
1	PIT	4	100	-	-	1	100	-	-	1	100	-	-
2	CPM	4	100	-	-	1	100	-	-	1	100	-	-
3	IPM	4	100	-	-	1	100	-	-	1	100	-	-
4	COT	4	100	-	-	1	100	-	-	1	100	-	-
5	AK	4	100	-	-	1	100	-	-	1	100	-	-
6	AMP	4	100	-	-	1	100	-	-	1	100	-	-
7	CAC	4	100	-	-	1	100	-	-	1	100	-	-
8	CAZ	4	100	-	-	1	100	-	-	1	100	-	-
9	TE	4	100	-	-	1	100	-	-	1	100	-	-

[PIT: Piperacillin+Tazobactam; CPM: Cefepime; IMP: Imipenem; COT: Cotrimoxazole; AK: Amikacin; AMP: Ampicillin; CAC: Ceftazidime/Clavulanic acid; CAZ: Ceftazidime; TE: Tetracycline]

Association between both HCWs and non-HCWs isolates of 38(19.9%) *Staphylococcus aureus* was noted with various attributes. It shows that females are more prone to *S. aureus* contamination more than male. Age between 16-25years have got a high chance of contamination, users of touch-screen mobile phones and users in toilets are highly contaminated with *S. aureus* along with users of same mobile phones for more than 5 years. Whereas, disinfectant users reduced the growth of isolation shown in [Table 7].

Table 7: Association between the rate of *Staphylococcus aureus* isolates from HCWs and Non-HCWs with several characteristics of users and mobile phones

S. No	Attributes	Growth(n=38)	%
1	Gender	Male	44.7
		Female	55.2
2	Age	16-25	36.8
		26-30	26.3
		31-36	21.0
		37-51	15.7
3	Status	HCW	50.0
		NHCW	50.0
4	Mobile phone types	Touch-screen	86.8
		Keypad	13.1
5	Used in toilet	Yes	55.2
		No	44.7
6	Disinfectant used	Yes	34.2
		No	65.7
7	Storage of mobile phones	Clothes	84.2
		Bag	15.7
8	Age of mobile phones	1-5 years	31.5
		5-10 years	42.1
		More than 10 years	26.3

Association between the rate of MRSA and ESBL-producers isolates with various attributes is noted. The number of MRSA were 100% higher in the mobile phones carried in pockets than those carried in mobile-bags and those who do not regular disinfect their mobile phones. Females (80%) were quite higher in number of contamination with MRSA

than males (20%). Also, users of touch-screen mobile phones (80%) showed higher chance to MRSA contamination. The ESBL-producing bacteria were detected 100% in females from HCWs, users of keypad phones, users of mobile phones in toilet who does not regular disinfect and carried in clothes pockets shown in [Table 8].

Table 8: Association between the rate of isolation of MRSA (n=5) and ESBL- producer (n=2) with several characteristics of users and mobile phones

S. No	Attributes	Growth		%	
		MRSA	ESBL	MRSA	ESBL
1	Gender	Male	1	20	-
		Female	4	80	100
2	Age	24-27	2	40	50
		30-35	3	60	-
		36-40	-	50	-
3	Status	HCW	5	100	100
		NHCW	-	-	-
4	Mobile phone types	Touch-screen	4	80	-
		Keypad	1	20	100
5	Used in toilets	Yes	3	60	100
		No	2	40	-
6	Disinfectant used	Yes	0	0	-
		No	5	100	100
7	Storage of mobile phones	Clothes	5	100	100
		Bags	0	0	-
8	Age of mobile phones	1-5 years	3	60	-
		5-10 years	2	40	-

Among Health care workers (HCWs), maximum number of samples processed were from Nurses 28(37.3%), Technicians 13(17.3%) and Attendants 13(17.3%), followed by Doctors 11(14.6%), Medical students 6(8%) and Safai Karamcharis (5.33%). Out of 75 HCWs samples, samples processed were majority in Microbiology 7(9.33%) followed

by Blood bank 6(8.00%), MSW 6(8.00%), FMW 6(8.00%), MMW 6(8.00%), GW 5(6.66%), EW 5(6.66%), OPD 5(6.66%), PW5(6.66%), Pathology 4(5.33%), NICU 4(5.33%), FSW 4(5.33%), ENT 4(5.33%), FOW 4(5.33%) and MOW 4(5.33%).r. Area-wise and profession-wise distribution of samples is shown in [Table 9].

Table 9: Distribution of HCWs mobile phones samples according to profession and area

Area	Doctors	Nurses	Technicians	Students	Attendants	Safai karamcharis	Area wise distribution of samples
Microbiology	00	00	06	01	00	00	07
Blood bank	00	01	05	00	00	00	06
Pathology	01	00	02	00	01	00	04
NICU	01	02	00	00	01	00	04
FSW	01	02	00	00	01	00	04
MSW	01	02	00	00	02	01	06
FMW	01	04	00	00	00	01	06
MMW	01	01	00	00	02	02	06
GW	00	02	00	02	01	00	05
EW	00	02	00	01	02	00	05
ENT	01	02	00	00	01	00	04
OPD	01	03	00	01	00	00	05
FOW	01	02	00	00	01	00	04
MOW	01	02	00	01	00	00	04
PW	01	03	00	00	01	00	05
Profession wise distribution of samples	11	28	13	06	13	04	75

Among 39(38.2%), 20(19.6%) and 16(15.6%) bacterial isolates from Nurses, Technicians and Attendants respectively, 2(5.12%) Nurses, 1(5%) Technician and 2(12.5%) Attendant samples isolated were detected as 5(4.90%) MRSA. Also, 1(2.56%) nurse and 1(5%)

technician bacterial isolates were positive for ESBL-producers 1(0.98%) *Escherichia coli* & 1(0.98%) *Klebsiella spp.* Respectively. Distribution of bacteria from different types of HCW's is shown in [Table 10 (A)].

Table 10: (A) Distribution of bacteria isolated from HCW's mobile phones according to the profession

Isolated microorganisms (n=102)	Doctors (n=11)	Nurses (n=28)	Technicians (n=13)	Students (n=6)	Attendants (n=13)	Safai karamchar is (n=4)
CONS (14)	00	04	03	03	03	01
MSSA (14)	01	04	04	01	03	01
MRSA (05)	00	02	01	00	02	00
Micrococci (03)	00	00	01	01	00	01
Gram positive bacilli (50)	09	22	08	02	06	03
<i>Escherichia coli</i> (03)	00	02	01	00	00	00
<i>Klebsiella spp</i> (03)	00	01	00	01	00	00
<i>Pseudomonas</i> (04)	01	01	02	00	00	00
<i>Proteus spp</i> (05)	00	02	00	01	02	00
<i>Enterobacter spp</i> (01)	00	01	00	00	00	00
Total (%)	11(10.7%)	39(38.2%)	20(19.6%)	09(8.82%)	16(15.6%)	06(5.88%)

Among the mobile phones bacteria isolated from HCW's, 5(4.90%) MRSA were detected in Female Surgical Ward 1(16.6%), Gynecology ward 1(10%), Emergency ward 1(16.6%), NICU 1(20%) and Pathology 1(25%). Also, in

Blood bank 1(11.1%) and NICU 1(20%), ESBL- producing *Escherichia coli* 1(33.3%) & *Klebsiella spp.* 1(33.3%) were detected. The distribution of bacteria isolated from HCW's working in different areas is shown in [Table 10 (B)].

Table 10: (B) Distribution of bacteria isolated from HCW's mobile phones based on the location

	CONS	MSSA	MRSA	Micrococci	Gram positive bacilli	<i>Escherichia coli</i>	<i>Klebsiella spp.</i>	<i>Pseudomonas spp.</i>	<i>Proteus spp.</i>	<i>Enterobacter spp.</i>	Number of total isolated organisms (n=102)
Microbiology	04	01	00	01	05	00	00	02	00	00	13
Blood Bank	00	03	00	00	04	01	00	00	01	00	09
Pathology	00	01	01	00	03	00	00	00	00	00	04
NICU	01	01	01	00	01	00	01	00	01	00	05
Female surgical ward	01	00	01	00	03	00	00	00	01	00	06
Female medical ward	01	03	00	00	03	00	00	01	00	00	08
Male surgical ward	02	00	00	01	05	00	00	00	00	01	09
Male medical ward	00	01	00	00	04	01	01	00	00	00	07
Paediatric Ward	00	02	00	00	03	00	00	00	00	00	05

Male ortho ward	02	00	00	01	02	00	00	00	00	00	05
Female ortho ward	01	00	00	00	03	00	00	00	00	00	04
ENT ward	00	01	00	00	03	00	00	01	01	00	06
Gynaecology ward	02	01	01	00	04	01	01	00	00	00	10
Emergency Ward	00	01	01	00	03	00	00	01	00	00	06
OPD	00	01	00	00	04	00	00	00	00	00	05
Total	14	16	05	03	50	03	03	05	04	01	102

In Non-Health Care Workers (NHCWs), out of 75 non-HCWs mobile phone samples collected, 49 samples are from who are not in contact with patients or not visited hospitals during last 15 days, whereas the remaining 26 samples are from who were in contact with patients or visited hospitals in the last 15 days. Samples were obtained from Shopkeepers 6(8.0%), Security 9(12.0%), non-medical students 18(24.0%), Non-medical Attendant 6(8.0%),

Faculties 5(6.6%), Safai Karamcharis 5(6.6%), Patients 16(21.3%) and Patient attendant 10(13.3%) respectively. From 75 non-HCWs, samples processed were majority in Outside Hospital 49(65.3%) followed by MMW 7(9.3%), MSW 7(9.3%), GW 6(8.0%), FSW 6(8.0%), FMW 5(6.66%), and PW 5(6.66%) respectively, Area-wise and occupation-wise distribution of samples is shown in [Table 11].

Table 11: Distribution of non-HCW’s mobile phones sample according to occupation and area

Area of collection	Shopkeeper	Security	Faculty	Patients	Student	Attendant	Patient attendant	Safai karamcharis	Area wise distribution of samples
Outside Hospital	06	09	05	00	18	06	00	05	49
FSW	00	00	00	02	00	00	02	00	04
FMW	00	00	00	01	00	00	00	00	01
GW	00	00	00	02	00	00	04	00	06
MMW	00	00	00	05	00	00	02	00	07
MSW	00	00	00	05	00	00	02	00	07
PW	00	00	00	01	00	00	00	00	01
Occupation wise distribution of samples	06	09	05	16	18	06	10	05	75

From Non-HCWs bacterial isolates, a difference in number of bacteria can be observed between non-HCWs visiting hospital in the past 15 days versus non-HCWs who does not have any visit in the past 15 days. Patients 19(19.7%) and Patient attendants 18(18.7%) shows a great positive growth as comparing to Shopkeepers 6(6.25%), Faculties 8(8.3%),

Security 6(6.25%) and Safai karamcharis 6(6.25%) except for Students 22(22.9%) which has the predominant isolated bacteria and does not visited hospital in the last 15 days. Distribution of bacteria from different types of Non-HCW’s mobile phones is shown in [Table 12].

Table 12: Distribution of bacteria isolated from non-HCW’s mobile phones according to the occupation

Isolated microorganisms (n=96)	Shopkeeper s (n=6)	Security (n=9)	Faculties (n=5)	Patients (n=16)	Attendants (n=6)	Safai karamcharis (n=5)	Students (n=18)	Patient Attendant (n=10)
CONS (20)	04	01	00	03	01	03	04	04
MSSA (19)	00	01	03	05	01	00	07	01
MRSA (00)	00	00	00	00	00	00	00	00
<i>Micrococcus</i> (05)	00	00	00	02	00	00	01	02
GPB (41)	03	03	05	07	05	03	07	08
<i>Escherichia coli</i> (04)	00	00	00	01	01	00	01	01
<i>Klebsiella</i> spp. (01)	00	00	00	00	00	00	00	01
<i>Proteus</i> spp. (01)	00	00	00	00	00	00	00	01
<i>Pseudomonas</i> spp. (03)	01	00	00	01	00	00	01	00
<i>Enterobacter</i> spp. (02)	00	01	00	00	00	00	01	00
Total	08	06	08	19	08	06	22	18

Discussion

In present study, sample size of HCWs and non-HCWs are equal. Out of 75 samples of HCWs mobile phone examined, 74 (98.6%) yielded growth and 102 bacteria were isolated. Also, 75 samples of non-HCWs mobile phones yielded 73(97.3%) growth and 96 bacterial isolated. This study shows that the number of organisms isolated from mobile

phones of HCWs is significantly higher than that of the non-HCWs. Gram positive spore bearers (GPSB) were the predominant organisms found for both HCWs (49.1%) and non-HCWs (42.7%). GPSB are non-pathogenic commensals to human beings and may be present on mobile phones as contaminants. By excluding growth of Gram positive bacilli, this present studies showed growth of *Staphylococci* 38.3%

which was predominant gram positive nosocomial infection in our hospital, *Staphylococcus aureus* comprised (18.6%) in HCW sand (19.7%) in non-HCWs whereas isolation of CoNS were 13.7%.(HCWs) and 20.8% (non-HCWs). CoNS are a normal skin flora but are also responsible for a large number of hospital-acquired infections. The common commensals found are *Micrococcus*, in both HCWs (2.94%) and non-HCWs (5.20%), which are present along with some of the pathogens and also individually. In both HCWs and non-HCWs, *Staphylococcus aureus* contamination of mobile phone was quite higher in females 55.2% as compared to males 44.7%. This may be because female usually have longer nails as comparing to males, which can direct transmit pathogens to mobile phones while using. Also, age group 16- 25(36%) is heavily contaminated. In this study, all the isolates of *Staphylococcus aureus* from HCWs were 100% susceptible to Linezolid (LZ), Clindamycin (CD), Cotrimoxazole (COT), Cefepime (CPM) and Gentamycin (GEN). While resistant to Tetracycline (TE) 21%, Ampicillin (AMP) 15.7% and Cefoxitin (CX) 26.3%. In contrast, all the 8 antibiotics are 100% susceptible to non-HCWs mobile phones. The occurrence of MRSA 5(4.90%) in Subharti Hospital amongst the HCWs is shown by the results in present study. While, no MRSA strain is found from NHCWs mobile phones in this study. In present study, amongst various categories of HCWs screened, 5(4.90%) MRSA strains were isolated from mobile phones of 4(80%) Females and 1(20%) Male, Age group of 24-27 [2(40%)] and 30-35 [3(60%)], Nurses 2 (5.12%), Attendants 2 (12.5%) and Laboratory Technician 1(5%) staffs respectively. The MRSA strains were detected from Female surgical ward (FSW)16.6%, Emergency ward (EW)16.6%, NICU 20%, Pathology laboratory 25%, and Gynecology ward (GW) 10% in Subharti Hospital. Mobile phones are very frequently used in hospital wards by HCWs as they are effective means of communication. However, less attention is paid to standard infection control practices while using. In HCWs, the occurrence of ESBL [2(1.96%)] seen in our Subharti hospital is quite low, but isolation of ESBL producing organisms in mobile phones is not common. The ESBL producers was found among *Escherichia coli* 1(33.3%) and *Klebsiella spp.* 1(33.3%). Other gram negative bacteria isolated from HCWs mobile phones includes non-ESBL producer *E. coli* (2), *Klebsiella spp* (2) and *Proteus spp.* (5), non-fermenter *Pseudomonas* (4) and *Enterobacter spp.*(1). In contrast, in NHCWs, no occurrence of ESBL producing organisms was found. Other gram negative isolated were *Escherichia coli* (4), *Klebsiella spp.* (1), *Proteus spp.* (1), *Pseudomonas* (3) and *Enterobacter spp.* (2). The incidence of ESBL producers was found among HCWs mobile phone samples from Nurse 1 (2.56%) and Laboratory technician 1 (5%) in NICU 1(20%) and Blood bank 1(11.1%) respectively. The ESBL producers were isolated 100% from female mobile phone samples, age group 24-27(50%) and 36-40(50%) is the highest incidence rate. The findings from the response to questionnaire shows that ESBL producers was detected from users of keypad mobile phone (100%), users of mobile phones in toilet (100%), non-disinfectant users (100%) and one storing mobile phones in clothes pockets (100%).

Conclusion

From this study, it concludes that there is definitely colonization of bacteria on mobile phones. The warm and

heat environment given by the mobile phones coupled with its constant handling enhances bacterial growth. It highlights that mobile phones of healthcare workers (HCWs) can be contaminated by a wide range of bacteria including MRSA and ESBL producers. This study reports that the mobile phones of HCWs harbors more bacteria than non-HCW sand are in a higher chance of transmitting pathogens to the owner, patients and to the community. According to our data, there is a lack of awareness amongst HCWs about using mobile phones in toilets, importance of washing hands and regular disinfection of mobile phones because it may contribute to a significant risk of transmission of multi-drug resistant like MRSA and ESBL producer. Hand washing protocol must be practice regularly before and after patient care. Disinfecting a mobile phone at a regular basis should be practice more regularly. HCWs mobile phones represent a hospital community, so, sharing of mobile phones among colleagues should be avoided or regular disinfect of mobile phones should be practices more often. Also, non-HCWs mobile phones represent an environment of community, so, to avoid endemic in the community.

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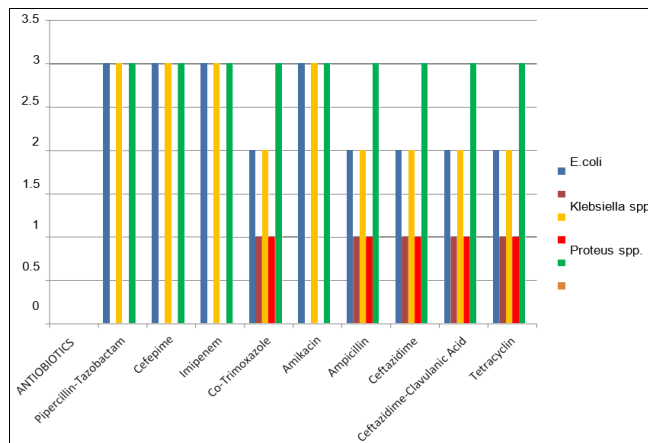


Fig 2: Spectrum of Antimicrobial Susceptibility Pattern of *E.coli*, *Klebsiella spp* and *Proteus spp.* from mobile phones of HCWs

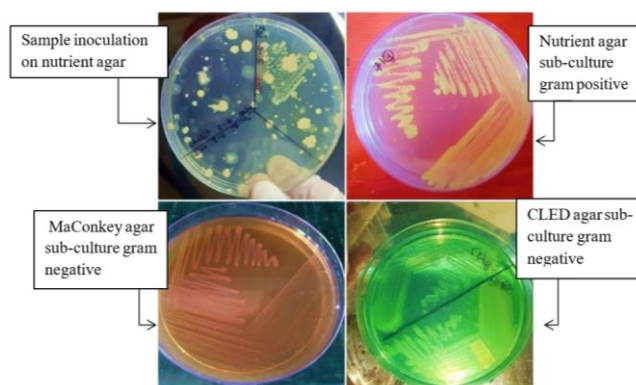


Fig 3: Picture showing sample inoculated and sub-cultured plates

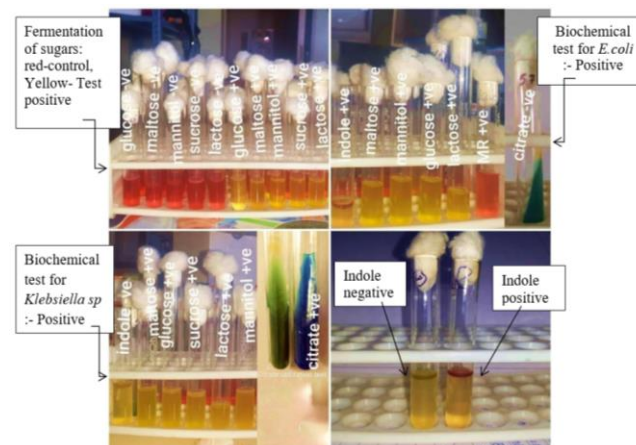


Fig 4: Picture showing biochemical test and identification of bacteria

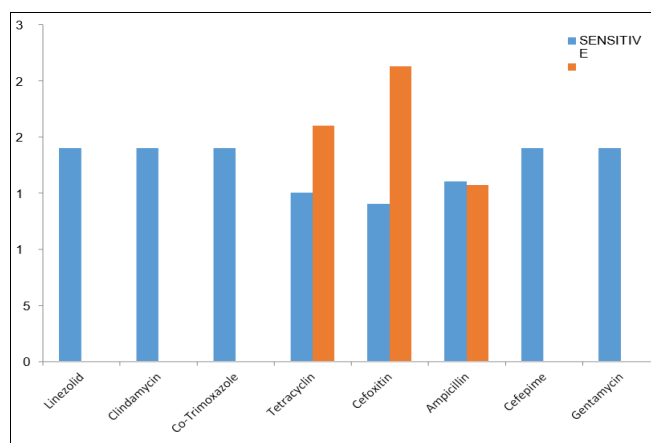


Fig 1: Spectrum of Antimicrobial Susceptibility Pattern of *Staphylococcus aureus* from mobile phones of HCWs

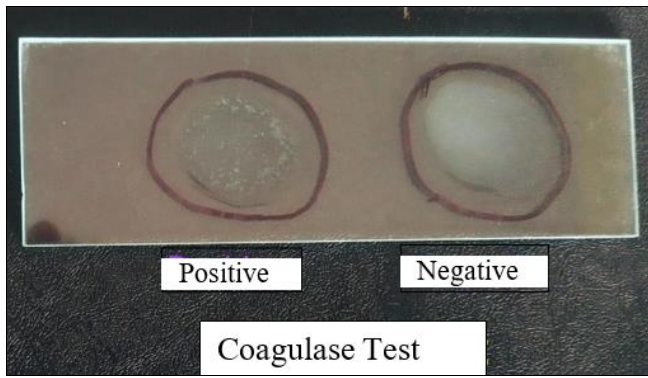


Fig 5: Picture showing Slide Coagulase Test

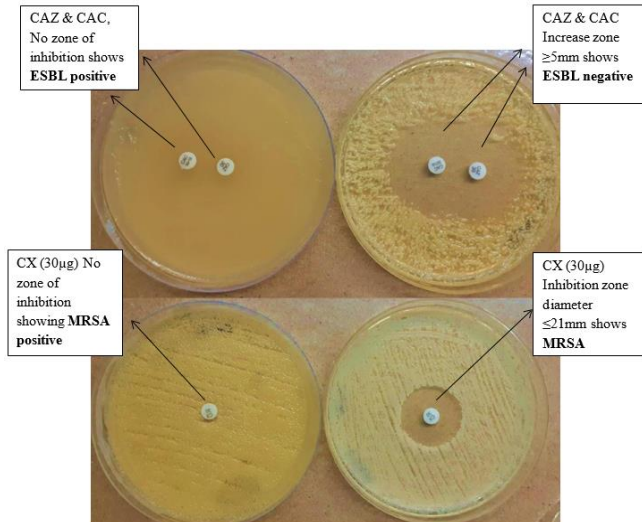


Fig 6: Picture showing Antibiotic Sensitivity Testing by Disk diffusion method