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ANTIMICROBIAL RESISTANCE PATTERN OF PATHOGENS ISOLATED FROM MOBILE PHONE AT TERTIARY CARE HOSPITAL IN SAUDI ARABIA

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ABSTRACT

Introduction: Antibiotic resistance is a problem of deep scientific concern both in hospital and community Settings. The patient environment in healthcare settings has continually proven to harbor a reservoir of potentially harmful, and even lethal multidrug-resistant organisms (MDRO). Methodology: A cross sectional study was carried out to investigate the prevalence of multidrug resistant producing pathogens contaminated mobile phones (MPs) used by patient, companions, visitors and Heath. Results: Out of 426 mobile phones enrolled, a total of 163 isolates linked to hospital acquired infection were recovered. This study revealed high prevalence of multidrug-resistant isolates reaching (71.8%), whereas Extended-spectrum beta-lactamases (ESBLs) producing K. pneumoniae, E. coli and MRSA accounted (27.6%) of the isolates. E. cloacae (88.9%) and S. aureus (85.7%) were found to be the principle MDRO. Likewise 76% of A. baumannii, K. pneumonia and E. coli were MDRO. High prevalence rate of resistant patterns were observed among Enterobacteriaceae strains with exception of P. agglomerans to ampicillin, cephlosporins and fluoroquinolones. Better activity was limited to amikacin and tigecycline, which elicited the highest susceptibility levels. Resistance rates toward carbapenems among A. baumaii and P. aerogenosa were 42.8% and 33.4%

respectively. Fifty four percent of S. aureus were resistant to oxacillin, cefoxitin, while 9.9% were resistant toward vancomycin. MRSA isolates exhibited a high range of cross-resistance to ≥9 tested antibiotics. Conclusion: The results clearly indicated the emergence of mobile phones as carrier of multiple drug-resistant bacterial pathogens. Regular decontamination of mobile phones and hand hygiene compliance can help reduce the burden of MDRO.

KEYWORDS: Multidrug-resistance, ESBL, MRSA, Hospital Acquired infection, Mobile phone, Saudi Arabia

INTRODUCTION

Hospital-acquired infections (HAI) have been recognized for over a century as a critical problem affecting the quality of healthcare, and they constitute a major source of adverse healthcare outcomes.[1] Infections with multidrug-resistant pathogens are a significant cause of morbidity and mortality worldwide, primarily among immunocompromised and elderly people, especially if the causative organism has developed resistance to a number of antimicrobial agents. Patients infected with multidrug-resistant organisms usually have a significantly longer hospital stay, are more likely to be in need of intensive care, costly therapies and treatments, and have a worse prognosis.[2,3] According to the analysis of European Centre for Disease Prevention and Control (ECDC) and European Medicines Agency (EMEA) in 2007, an estimated number of deaths attributable to infections due to selected multidrug-resistant bacteria, Staphylococcus aureus, Enterococcus spp, Escherichia coli, Klebsiella spp., Enterobacter spp., or Pseudomonas aeruginosa and Acinetobacter baumannii, in the EU, Iceland and Norway was about 25,000.[4] The problem is particularly severe in developing countries, where the burden of infectious diseases is relatively greater and where patients with a resistant infection are less likely to have access to or be able to afford expensive second-line treatments, which typically have more complex regimens than first-line drugs. The presence of exacerbating factors, such as poor hygiene, unreliable water supplies, civil conflicts, and increased numbers of immunocompromised patients increase the rate of HAIs.[5] Currently growing evidence has shown that contaminated fomite or surfaces play a key role in the spread of bacterial infections with antimicrobial resistance.[6] Mobile phones have become one of the most crucial accessories of professional and social life. Despite the potential benefits of mobile in facilitating communications, this device has been considered as one of the most important factors that threatens human health, e.g. transmitting microbial germs from one person to another.[7,10] According to the report of Brady et al.

(2006 and 2009), antibiotic-resistant strains of bacteria have been isolated from mobile phones leading to concern regarding cross-contamination and infection, especially in hospital environments.[11,12] In fact, the use of mobile phone by clinical staff, patients and their companions and visitors can enhance pathogen transmission and might intensify the hardship of interrupting infection spread. Furthermore, colonization of potentially pathogenic organisms on phones may lead to the rise of antibiotic resistance.

In Saudi Arabia, there has been a considerable increase in the use of mobile phones among the general population, and the use of this communication tool, especially in unnecessary times, is common in certain areas where the rate of bacterial presence is likely high, i.e. hospitals. Therefore a high contamination with HAIs through the frequent use of mobile phones in our country is expectable. Due to the noticeable increase in antimicrobial resistance, determination of antibiotic susceptibility profile is judicious for decolonization and treatment of bacterial infections. The present study was conducted to determine the prevalence and the patterns of antibacterial resistance producing pathogens linked to hospital acquired infections isolated from the mobile phones of patients, their companion, visitors Health care workers (HCWs) at tertiary care hospital in Riyadh, Saudi Arabia.

MATERIALS AND METHODS

Between January and May 2015, a total 426 samples of whom 274 samples were collected from mobile phone of patients, patient companions and visitors; and 152 from mobile phone of HCWs at Prince Sultan Military Medical City, Riyadh. After agreement, written consent was obtained, and participants provided details on socio-demographic characteristics (age, sex, and profession) also asked to give their mobile phones to the investigators.

Sample Collection and Bacteriological Analysis

The samples were collected aseptically using damp cotton swaps by rotating the swabs on the keys, mouthpiece, and ear-piece of the mobile phone. All swabs were immediately inoculated in Tryptic Soy Broth as transport medium and transferred to the laboratory within 1-2 hours. The samples were incubated aerobically at 37°C for 24 hours. Further subcultures were carried out on 5% sheep blood agar, MacConkey agar and CHROMagar orientation plates and were incubated aerobically at 37°C for 24 hours. Plates were observed for growth and colonial morphology of the isolates.

Gram-positive cocci were provisionally identified by conventional methods including catalase, coagulase tests and selective media Mannitol Salt Agar (Oxoid Ltd, Basingstoke, UK), and were additionally characterized to species level using the API ID 32 STAPH system (BioMerieux Ltd., Marcy l'Etoil, France) according manufacturer's instructions. The Staphaurex™ Plus Latex Agglutination Test was used to distinguish Staphylococcus aureus and methicillin-resistant S. aureus (MRSA) from other species of staphylococci (Thermo Fisher Scientific Inc. NYSE: TMO, US). Enterococcus spp. were presumptively identified based on Gram staining, the catalase test, the hydrolysis of esculin in the presence of bile, and growth in brain-heart infusion broth containing 6.5% NaCl. Conventional laboratory techniques for phenotyping were carried out on all isolates according to MicroScan Walkway 96 plus automated system (Siemens Healthcare Diagnostics Inc., West Sacramento, CA), using the Gram Negative Break-Point Combo Panel-42 and Positive Break-Point Combo Panel-28. Minimum inhibitory concentrations (MIC) were determined using the automated MicroScan Walkway 96 plus. Percentages of resistant isolates in antibiogram were calculated by dividing the number of resistant isolates (neither intermediately susceptible nor susceptible) by the total number of isolate. Multidrug resistance was defined as resistance to three or more unrelated antibacterial agents.

QUALITY CONTROL

All materials, equipment and procedures were adequately controlled. Culture media were tested for sterility and performance. Pre-analytical, analytical and post-analytical stages of quality assurance that are incorporated in standard operating procedures of the microbiology laboratory were strictly followed. Staphylococcus aureus ATCC 29213 and ATCC 43300, Enterococcus feacalis ATCC 29212, Escherichia coli ATCC 25922, Klebsiella pneumonia ATCC 700603, Pseudomonas aeruginosa ATCC 27853 were used as controls.

ETHICAL CONSIDERATION

This study was approved by the institutional research and ethics committee. Informed written consent was also obtained from volunteer participants after explaining the objectives of the study.

DATA ANALYSIS AND INTERPRETATION

Data were collected, summarized and analyzed using SPSS version 20 software and results were presented through tables, and graphs. Associations were measured using chi-square test, binary logistic regression. P-values < 0.05 were considered as statistically significant.

RESULTS

Socio-demographic characteristics

A total of 426 participants (59.6% male and 40.4% females) including, 274(64.3%) patients, patients' companions and visitors, and 152(35.7%) HCWs were enrolled in this study to screen the frequency and antibacterial resistance patterns producing bacteria are linked to HAIs from mobile phones. Age of participants ranged from 18 years to 70 years, majority 34.7% being in the age range of 26-35 years. The mean age of participants was 30.05 ± 10.5 years, 6.5% of them were older than 55 year. Only 9.5% of patients had educational level of elementary school and bellow.

Potentially Pathogenic isolates.

Out of 426 mobile phones a total of 163(38.3%) isolates are linked to HAIs were identified. The most frequently isolates was Staphylococcus aureus 63(38.7%) followed by pantoea agglomerans 22(13.5%), Klebsiella pneumonia 17(10.4%), Acinetobacter baumannii 14(8.6%), Enterococcus feacles 11(6.7%), and Escherichia coli and Enterobacter cloacae 9 each (5.5%). On the other hand the other six species Chysomonase lufeola (n=3), Erwingella americana (n=3), Acinetobacter lwoffii (n=2), Leminorella ssp (n=1), Enterobacter amingenus (n=1), Sphingomonas paucimobilis (n=1) were isolated from mobile phones of the patients, companions and visitors groups. Significantly higher rates of pathogens colonized in the mobile phones of patients, companions and visitors groups than as compared to mobile phone of HCWs (n=120; 43.8% vs n= 43; 28.2% respectively, P≤ 0.001) Figure 1.

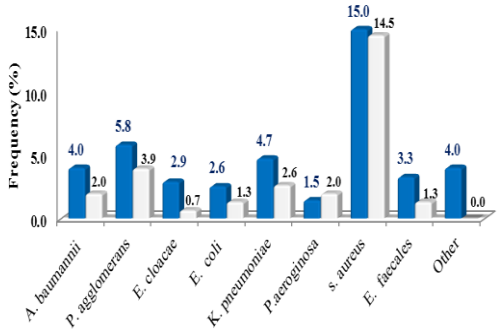

Figure 1 Type and frequency in percent (%) of potential pathogenic agents isolated from mobile phone of patients, their companions and visitors (n=274) vs. HCWs (n=152). Others: E. americana, A. lwoffii, Leminorella ssp, E. amingenus, S. paucimobilis, C. lufeola. **Blue columns**: Patients, their companions and visitors. **White columns**: HCWs

ANTIMICROBIAL RESISTANCE PATTERNS

All potentially pathogenic isolates (n=163) were tested for antimicrobial susceptibility, 137(84.0%) of them showed resistance to two or more classes of antibiotics. Among MDR strains, only 20 (12.2%) isolates were resistant to 2 classes of antibiotics, the rest 117(71.8%) were resistant to three or more classes of antibiotics. Results of drug resistance patterns compared within species showed that 88.9% of E. cloacae, 78.6% of A. baumanni, 76.5% of K. pneumonia, 77.7% of E. coli, 57.1% of P. aeroginosa, and 27.3% of P. agglomerans were MDR. Among Gram-positive bacteria 54(85.7%) of S. aureus and 7(63.6%) E. faecales were MDR (Table 1).

Table 1 Multidrug resistance patterns of potential pathogens isolated from mobile phones of patients, their companions, visitors and health care workers

Isolates	Degree of resistance										Total MDR isolates ≥ R3	
	R0	R1	R2	R3	R4	R5	R6	R7	R8	≥ R9		
Gram negative isolates											MDR	ESBL
A. baumannii (n= 14)	---	2(14.3)	1(7.1)	4(28.6)		2(14.3)	---	1(7.1)	---	4(28.6)	11(78.6)	
A. lwoffii (n= 2)	---	---	2 (100)	---	---	---	---	---	---	---	0(0.0)	---
C. lufeola (n=3)	---	---	---	1(33.3)	2(66.7)	---	---	---	---	---	3(100.0)	---
P. agglomerans (n= 22)	6(4.5)	3(36.4)	7(31.8)	5(22.7)	1(4.5)	---	---	---	---	---	6(27.3)	---
E. cloacae (n=9)	---	1(11.1)	---	---	6(66.6)	1(11.1)	---	---	---	1(11)	8(88.9)	---
E. amnigenus (n=1)	---	---	---		---	---	---	---	---	1(100)	1(100.0)	---
E. sakazaki (n= 2)	---	1(50.0)	---	1(50.0)	---	---	---	---	---		1(50.0)	---
E. americana (n= 3)	---	---	1(33.3)	---	---	---	---	---	---	2(66.7)	2 (66.7)	---
E. coli (n= 9)	---	1(11.1)	1(11.1)	---	2(22.2)	---	---	2(22.2)	---	3(33.3)	7 (77.7)	4(44.4)
K. pneumonia (n=17)	---	2(11.8)	2(11.8)	1(5.9)	---	1(5.9)	2(11.8)	3(17.6)	2(11.8)	4(23.5)	13(76.5)	9(52.9)
P. aeroginosa (n=7)	1(14.3)	2(28.6)	---	1(14.3)	1(14.3)	2(28.6)	---	---	---	---	4(57.1)	
Gram positive isolates											MDR	MRSA
S. aureus (n= 63)	2(3.2)	4(6.3)	3(4.8)	5(7.9)	8(12.7)	6(9.5)	1(1.6)	9(14.3)	4(6.3)	21(33)	54(85.7)	32(50.8)
E. faecales (n=11)		1(9.0)	3(27.3)	2(18.2	---	2(18.2)	1(9.0)	2(18.2)	---		7(63.6)	---
Total (n =163)	9(5.5)	17(10.4)	20(12.2)	20(12.2)	20(12.2)	14(8.6)	4(2.5)	17(10.4)	6(3.7)	36(22)	117(71.8)	---

Note: Data are in number (%) unless otherwise indicated.R0: susceptible to all antibiotics, R1-8: resistance to 1, 2, 3, 4, 5, 6, 7, and 8 antibiotics, ≥R9: resistance to 9 or more antibiotics, ≥R3: resistance to 3 or more antibiotics.

MDR = Multidrug-resistant; ESBL= Extended spectrum beta lactamase; MRSA= Methicillin-resistant Staphylococcus aureus.

Resistance profile for different antibiotics

The overall resistance profile of MDR gram-negative isolates are shown in Table 1. High resistance rate were observed to ampicillin 83.8% followed by ceftazidime 47.4%, ciprofloxacin 46.2% Levofloxacin 35.9%, imipenem 29.5%, and trimethoprim-sulfamethoxazole 25.6% whereas, amikacin, tigecycline and ertapenem had an overall resistance rates of 8.9%, 11.5% and 17.9% respectively. Species specific antibiotic resistance rate revealed that 88.9% of the E. coli isolates were resistant to ampicillin, 55.6% to ciprofloxacin/levofloxacin, ceftazidime, and to cefepime. 44.4% were resistant to cefotaxime, cefoxitin and moxifloxacin. The prevalence of ESBL-producing E. coli was 44.4%.

Resistance rates of K. pneumoniae were 94.1% to ampicillin, 52.9% ceftazidime, 58.8% fluoroquinolones (ciprofloxacin), 47.1% to tertracyclin, 35.3% to cefepime, moxifloxacin, and trimethoprim-sulfamethoxazole each, 52.9% to cefoxitin, 5.9% to amikacin and piperacillin-tazobactam each, whereas the prevalence of ESBL-producing K. pneumoniae was 52.9%. Resistance rates of E. cloacae and P. agglomerans were 100% and 22.7% each toward ceftazidime respectively. Thirty three (33.3%) vs. (9.1%) were resistant to cefepime and (33.3%) vs. (13.6%) to imipenem. Sixty seven (66.7%) vs. (18.2%) were resistant to fluoroquinolones (ciprofloxacin/levofloxacin), respectively.

Non-fermentative Gram-negative bacilli (NF-GNB) 21.2% and 35.7% of A. baumannii isolates were resistant to aminoglycosides (amikacin and gentamycin) respectively. High resistant to carbapenem antibiotics include imipenem 57.1%, and 35.7% to meropenem and ertapenem each. Among the P. aeroginosa a high level of resistance was recorded for ceftazidime (42.9%), Imipenem (42.9%), and cefazolin (57.1%) while all the isolates were susceptible to amikacin and gentamycin.

Table 2 Antibiotic resistance patterns of Potential pathogenic gram-negative isolates from mobile phone of participants.

Antibiotics	A. baumannii N= 14	P. agglomerans N= 22	E. cloacae N=9	E. coli N=9	K. pneumonia N= 17	P. aeroginosa N= 7	Total N= 78
amikacin	3(21.2)	0(0.0)	1(11.1)	1(11.1)	1(5.9)	1(14.3)	7(8.9)
Ampicillin	9(64.3)	18(81.8)	9(100)	8(88.9)	16(94.1)	5(71.4)	65(83.3)
Cefazolin	10(71.4)	2(9.1)	9(100)	4(44.4)	6(35.3)	4(57.1)	35(44.9)
Cefepime	3(21.4)	2(9.1)	3(33.3)	5(55.6)	6(35.3)	1(14.3)	20(25.6)
Cefotaxime	3(21.4)	2(9.1)	3(33.3)	4(44.4)	5(29.4)	1(14.3)	18(23.1)
Ceftazidime	6(42.9)	5(22.7)	9(100)	5(55.6)	9(52.9)	3(42.9)	37(47.4)
Cefoxitin	5(35.7)	1(4.5)	5(55.6)	4(44.4)	9(52.9))	1(14.3)	25(32.0)
Cefuroxime	2(14.3)	2(9.1)	1(11.1)	5(55.6)	8(47.1)	3(42.9)	21(26.9)
Ciprofloxacin	9(64.8)	4(18.2)	7(66.7)	5(55.6)	10(58.8)	1(14.3)	36(46.2)
Ertapenem	5(35.7)	0(0.0)	2(22.2)	2(22.2)	4(23.5)	1(14.3)	14(17.9)
Gentamicin	5(35.7)	1(4.5)	1(11.1)	4(44.4)	5(29.4)	1(14.3)	17(21.8)
Imipenem	8(57.1)	3(13.6)	3(33.3)	2(22.2)	4(23.5)	3(42.9)	23(29.5)
Levofloxacin	5(35.7)	4(18.2)	7(66.7)	5(55.6)	6(35.3)	1(14.3)	28(35.9)
Meropenem	5(35.7)	0(0.0)	3(33.3)	3(33.3)	4(23.5)	3(42.9)	18(23.1)
Moxifloxacin	2(14.3)	0(0.0)	2(22.2)	4(44.4)	6(35.3)	2(28.6)	16(20.5)
Pip/Tazo	5(35.7)	2(9.1)	4(44.4)	4(44.4)	6(35.3)	2(28.6)	23(29.4)
Tetracycline	6(42.9)	0(0.0)	2(22.2)	1(11.1)	8(47.1)	1(14.3)	18(23.1)
Tigecycline	2(14.3)	0(0.0)	3(33.3)	1(11.1)	3(17.6)	0(0.0)	9(11.5)
Trimeth/Sulfa	10 (71.4)	1(4.5)	3(33.3)	2(22.2)	6(35.3)	1(14.3)	21(26.9)

Note: Data are in number unless otherwise indicated.

The resistance of the S. aureus isolates to individual antibiotics is presented in Fig. 2. Among the isolates, 98.4% were resistant to ampicillin, 53.9% to oxacillin, 38.1% to ciprofloxacin and 53.9% to cefoxitin. More than 42% of S.aureus was resistant to carbapenems antibiotics. Twenty eight percent of S. aureus were resistant to clindamycin, whereas less than 10% were resistant to rifampin, vancomycin and mupirocin. The rate of MRSA among patient MPs versus HCW mobile phones was 30(73.3%) vs. 13 (59.1%). No statistical significant difference was observed in the occurrence of S. aureus and Methicillin-resistant S. aureus most frequently isolated from mobile phones of patient and HCW groups ($P \leq 0.6$).

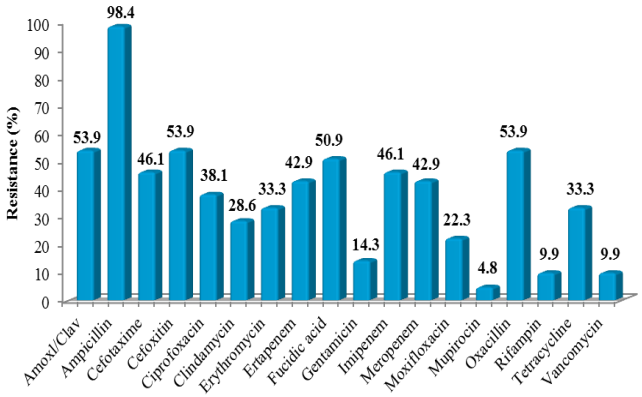

Figure 2 Resistance of S. aureus isolates against individual antibiotics. Amoxl/Clav: The combination of amoxicillin and clavulanic acid.

Only 11.1% of E. faecalis isolates were resistance to vancomycin, while 89.9% and 66.7 % were resistant to erythromycin and clindamycin respectively (Figure 3).

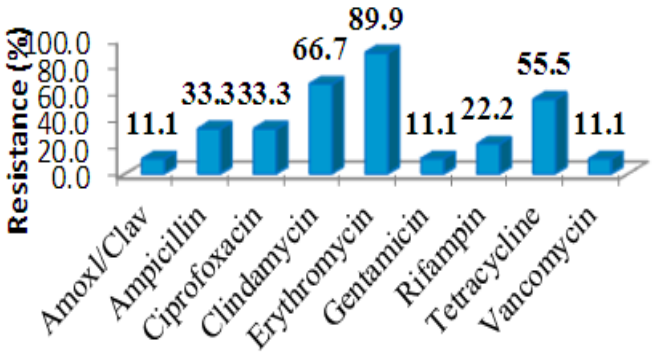

Figure 2: Resistance of *E. feacales* isolates against individual antibiotics.

DISCUSION

The role of the environment in harboring and transmitting multidrug-resistant organisms has become clearer due to a series of publications linking environmental contamination with increased risk of hospital-associated infections.[13,14] The transmission of antimicrobial-

resistant strains between individuals is further exacerbated by the high urbanization rate not only in developing countries, but also worldwide.[15] Even in developed countries, the spread of resistant microbial strains has been shown to occur not only through hospital settings but also via community-acquired infections.[16] The present study sought to characterize the antibiotic resistance pattern of pathogens responsible for infectious diseases isolated from surfaces of mobile phones used by patients' and HCWs.

A total of 163 pathogenics isolates linked to HAIs were isolated. Staphylococcus aureus was one of the most frequently encountered pathogen on mobile phones of patients' and HCWs' groups. Pantoea agglomerans was the most prevalent bacterial isolate among gram-negative bacilli followed by K. pneumonia, A. baumannii, E. coli, E. cloacae and the least P. aeruginosa. However higher contamination rate with HAIs pathogen on MPs of patients' group was found. This identified pathogens strains from MPs of participants are the most common agents that caused hospital and community acquired infection, Besides these bacteria are difficult to treat because of both their intrinsic and acquired resistance to multiple groups of antimicrobial agents.[4,17]

Eighty four percent (137/163) of potentially pathogens isolates from mobile phones were resistant to two or more antibiotics and 71.8% to three or more antibiotics, which is higher compared with previous study in Ethiopia reported (81%) of isolates were resistant to one or more antimicrobial. In study in another region in Ethiopia such as Gondar reported 16.9% of isolates were resistant to two drugs and 1.7% up to six drugs tested.[18,19] Concerning MPs contamination Sepehri et al. [20] reported also a marked resistances in bacteria isolates from mobile phones to commonly used antibiotics. Accordingly, 50% of the microbes isolated from mobile phones had shown susceptibility for only 41.67% of the tested antibiotics.

The present study showed that, E. cloacae (88.9%) and S. aureus (85.7%) were found to be the principle MDR isolates. Nevertheless more than 76% of A. baumannii, K. pneumonia and E. coli isolates were MDR while P. aeruginosa (57.1%) had the least resistance rate. The variation in prevalence of MDR isolates worldwide could be due to increase trend of MDR strain with time, difference in study period, sample size, source of samples and study population.[21]

In study conducted by Tagoe et al.[22] on antimicrobial sensitivity testing revealed that over 75% of the isolates from mobile phones were susceptible to the fluoroquinolone and

ceftriaxone antibiotics that were evaluated. In contrast, our study revealed acceptably high prevalence of resistant patterns among E. coli, K. pneumonia and E. cloacae toward ampicillin, fluoroquinolones, cephlosporins. Among third- and fourth-generation cephalosporins drugs resistance are notable and were ranged between 33.3 to 100% although resistance to ampicillin was more prevalent with more than 88.9%. The wide spread resistance to ampicillin and the third generation cephalosporin can be explained by indiscriminate use of these antibiotics in human and animals due to availability of oral formulation and over the counter unrestricted access.[17]

ESBLs continue to be a major problem in clinical setups worldwide, conferring resistance to broad-spectrum cephalosporins. In our study, the percentage of ESBL-producing E coli and K. pneumonia was noticeably high reaching at least (44.4%) and (52.9%) respectively with the possibility of an actual higher rate because of potential false negatives. The rate of ESBL producing E. coli in our study is quite similar to a report from Tanzania (45.2%) and lower than the reports from Egypt (52.94%) and Syria (52.88%).[23,24,25] Likewise, the prevalence of ESBL producing isolates of K. pneumoniae has been shown to vary from country to another.[26] Countries with a high rate of prevalence of ESBL producing K. pneumoniae include Turkey (60%), Latin America (45.4%), Western Pacific (24.6%), and European countries (22.6%) [27], whereas the rate was (52.9%) in our study. Though contamination of MP devices with ESBL-producing strains is not surprisingly and reported previously,[28] but the high rate revealed in this study is alarming. Moreover, Zowawi et al. [29] demonstrated that countries in the Arabian Peninsula, specifically, the Gulf Cooperation Council (GCC) states share a high prevalence of extended-spectrum-ß-lactamase (ESBL) and carbapenemase-producing GNB, most of which are associated with HAIs. Well-known and widespread ß lactamases genes (such as those for CTX-M-15, OXA-48, and NDM-1) have found their way into isolates from the GCC states.

NF-GNB mainly A. baumannii and P. aeruginosa, have emerged as major agents of HAIs and the resistance of these organisms to antibiotics, particularly to carbapenems, has posed important therapeutic challenges.[30,31] Results in this study revealed that 35.7% of A. baumaii isolates were resistant to ertapenem and meropenem each and 57% to imipenem. Resistance levels to imipenem varied widely around the world and among neighboring countries. Previous studies an Acinetobacter isolates in the Middle East have reported nearly similar to higher proportions of imipenem-sensitive isolates than that found in this study. Specifically,

the proportion of imipenem-sensitive isolates was 51% in Iran,[32] 35.4% in Syria,[33] forty three to 56.7% in Turkey,[34] and 10% to 55% in Saudi Arabia.[35]

Resistance rate among P. aerogenosa isolates to Cephalosporin's (ceftazidime) and carbapenems (imipenem, meropenem) were 42.9%. Generally, resistance rates among p. aeroginosa were alarmingly lower than these reported in different countries worldwide.[21,36] In a study conducted by Memish et al. [37] the resistance rates among non-fermenters were high in Saudi Arabia. As such the resistance rates vary significant change among regions. This resistance has been attributed to the extent of production of carbapenem-hydrolysing-ß-lactamase enzymes of Ambler molecular class D (oxacillinases) and B (metallo-ß-lactamases).[38] Our results corroborates with the report of Trived et al. [9] who also showed that Pseudomonas and Acinetobacter species isolated from MP showed multi drug-resistance to commonly used antibiotics.

The highest level of resistance 98.4% were observed among S. aureus isolates to ampicillin Figure 2. High resistance rate against penicillin has been reported by several research groups.[39,40] Penicillins exert their antimicrobial activity by inhibition of the synthesis of a heteropolymer, peptidoglycan. S. aureus produce ß-lactamase enzyme that destroy the ß -lactam ring of penicillin [41] that could explain penicillin resistance in this study. Fifty five (53.9%) of S. aureus were resistant to oxacillin. The high resistance rate to oxacillin is alarming and has been widely reported internationally [42,43] and even in our communities. The cause of resistance to methicillin and all other β-lactam antibiotics is the mecA gene, which is situated on a mobile genetic element, the Staphylococcal Cassette Chromosome mec (SCCmec).[44] However, the isolation of methicillin-resistant S. aureus strains from the mobile phones had been previously documented.[19,23,45]

Vancomycin is considered as an antibiotic of choice for the treatment of S. aureus infections.[46] This study revealed low resistance of the S. aureus isolates against vancomycin. This finding is in agreement with the findings of other groups from different countries.[41,47,48]. Shobha et al.[49] also reported a vancomycin-resistant S. aureus from the mobile phones. The observed high rate of multidrug-resistance bacteria in this study could be attributed to both the misuse and abuse of antibiotics. Although the geographic distribution of these bacteria is worldwide, the epidemiology and dissemination patterns appear to differ within and across regions. Further molecular epidemiologic studies are urgently required to

gain insight into resistance mechanisms that are at work here, and this will be the focus of our future studies.

CONCLUSION

The present research elucidates the high level of resistance the potentially pathogens isolated from Mobile Phone Devices surfaces (MPDs) used by various groups. Higher rates of pathogens colonized in the mobile phones of patients, their companions and visitors than as compared to mobile phone of HCWs. The results suggest that MPDs may act as a vehicle for the transmission of antibiotic resistant bacteria to human population. Our findings emphasize the need for maintaining good hygienic practices by the members of the above-mentioned groups to prevent the spread of antibiotic-resistant bacteria in hospital settings and community.

CONFLICT OF INTEREST

No conflict of interests regarding the publication of this paper.

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