

## The potential role of mobile phones in the spread of bacterial infections

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### Abstract

Background: Mobile phones are indispensable accessories both professionally and socially but they are frequently used in environments of high bacteria presence. This study determined the potential role of mobile phones in the dissemination of diseases.

Methodology: Specifically, 400 swab samples from mobile phones were collected and divided into groups categorized by the owners of the phones as follows: Group A was comprised of 100 food vendors; Group B, 104 lecturers/students; Group C, 106 public servants; and Group D, 90 health workers. Samples were cultured and the resulting isolates were identified and subjected to antimicrobial susceptibility tests by standard procedures.

Results: The results revealed a high percentage (62.0%) of bacterial contamination. Mobile phones in Group A had the highest rate of contamination (92; 37%), followed by Group B (76; 30.6%), Group C (42; 16.9%), and Group D (38; 15.3%). Coagulase negative *Staphylococcus* (CNS) was the most prevalent bacterial agent from mobile phones in Group A (50.1%) and least from phones in Group D (26.3), followed by *S. aureus*. Other bacterial agents identified were *Enterococcus faecalis*, *Pseudomonas aeruginosa*, *Escherichia coli*, and *Klebsiella* spp. There was no statistical significance difference ( $P < 0.05$ ) in the occurrence of *S. aureus*, the most frequently identified pathogenic bacterial agent isolated from the mobile phones in the study groups. Fluoroquinolones and third-generation cephalosporin were found to be effective against most isolates.

Conclusion: Mobile phones may serve as vehicles of transmission of both hospital and community-acquired bacterial diseases. Strict adherence to infection control, such as hand washing, is advocated.

**Key words:** Mobile phone, bacteria, disease, transmission, nosocomial

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### Introduction

The global system for mobile telecommunication (GSM) was established in 1982 in Europe with a view of providing and improving communication network. Today, mobile phones have become one of the most indispensable accessories of professional and social life. Although they are usually stored in bags or pockets, mobile phones are handled frequently and held close to the face [1,2].

The use of cell phones often occurs in hospitals, by patients, visitors and health care workers, and this is one environment where hospital-associated infection is most prevalent. Also, travellers who go to low-income countries where potable water and good sanitation are limited are exposed to the risk of contracting infections because these individuals carry phones, and the potential of such accessories in the spread of bacteria infection is not yet clear [3,4].

Enteric pathogens are the most frequent cause of diarrhoea and account for an annual mortality rate of about five million people worldwide [5]. The first study of bacterial contamination of mobile phones was conducted in a teaching hospital in Turkey with a bed capacity of 200 and one intensive care unit [6]. One-fifth of the cellular telephones examined in a study conducted in New York were found to harbor pathogenic microorganisms [7].

In Nigeria, there has been an increase in the use of mobile phones among the general population, and the use of phones is common in certain areas of the environment where the percentage presence of bacteria is likely high, such as in hospitals, in animal slaughter areas, and in toilets. Therefore, the present study was conducted to determine whether mobile phones could play a role in the spread of bacterial pathogens and to proffer possible control or

preventive measures that could be instituted to avoid this likely vehicle of infection

## Methods and Materials

### Subjects

A total of 400 mobile phones randomly sampled from the users of these phones were examined. The phones were obtained from the following study groups for three months between July and September, 2007: Group A, 100 food vendors; Group B, 104 lecturers/students; Group C, 106 public servants; and Group D, 90 health workers. The users of these mobile phones were adult volunteers. The concept of the study was explained to all subjects and their consent sought.

### Sample collection and bacteriological analysis

The samples were collected aseptically using damp cotton swabs by rotating the swabs on the keys, mouthpiece, and ear-piece of the mobile phone. Samples were first inoculated into brain heart infusion (BHI) as transport medium and incubated aerobically at 37°C for 24 hours. Further subcultures were on 5% sheep blood agar and eosin methylene-blue agar plates and were incubated aerobically at 37°C for 24 hours. Plates were observed for growth and colonial morphology of the isolates. The isolates were gram stained, and were further tested for the presence of catalase and oxidase enzymes. Gram-positive catalase-positive cocci were tested for mannitol utilisation and coagulase development. Catalase-negative gram-positive cocci were tested using API Strep (Biometieux, marcy L'etoil, France), and Gram-negative bacilli were tested using API 32 E (Biomerieux, marcy L'etoil, France). All *Staphylococcus aureus* and *Enterococcus faecalis* strains were screened for methicillin and vancomycin resistance.

### Antimicrobial susceptibility testing

Sensitivity of isolates to antibiotics was determined on Muller-Hinton agar by the disk diffusion method [8]. Briefly, five colonies of each of the isolates were emulsified in Bijou bottles containing 3 ml normal saline. A cotton swab was dipped into the suspension and the swab turned against the side of the bottles to remove excess fluid. The inoculated swab was then streaked across the surface of the Muller-Hinton agar. The inoculated plates were allowed to dry for 4-5 minutes before each of the following antibiotic disks (Oxoid, U.K) was placed on the plates: Ceftriaxone (30 µg),

Ofloxacin (5 µg), Chloramphenicol (30 µg), Erythromycin (15 µg), Gentamycin (10 µg), Nitroforantoin (300 µg), Tetracycline (30 µg), Cotrimoxazole (5 µg), Amoxycillin (10 µg), Pefloxacin (5 µg), Ciprofloxacin (5 µg) Augmentin (12.5 µg) and Streptomycin (1 µg). The plates were incubated aerobically at 37°C for 18-24 hours. The diameters of the zones of inhibition were measured with a ruler and compared with a zone-interpretation chart [8]. *Escherichia coli* ATCC 25922 was used as the control.

## Results

Out of 400 samples evaluated, a bacterial agent was observed in 248 and none from 152 samples. The results of this study showed a high percentage (62.0%) of bacterial contamination of mobile phones. Out of the four groups (A-D) studied, Group A (marketers and food vendors) had the highest rate of contamination (92; 37%). Group B (lecturers and students) had the next highest (72; 30.6%); and Group C (Public servants) (42; 16.9%) the next highest. Group D (hospital workers) had the lowest rate of contamination (38; 15.3%) (Table 1). Specifically, coagulase negative *Staphylococcus* (CNS) strains, the most frequently encountered bacterial agent, were isolated from the mobile phones of 50.1%, 39.5%, 47.5% and 26.3% of Groups A, B, C and D respectively. These results were followed closely by *S. aureus* strains which were found in 34.7%, 23.7%, 28.8% and 36.8% of Groups A, B, and C in that order. Other bacterial pathogens isolated from the mobile phones of all four groups in this study include *Enterococcus faecalis*, *Escherichia coli*, and *Klebsiella* spp. *Pseudomonas aeruginosa* strains were isolated only from the phones of Group D (Table 1). Antimicrobial susceptibility tests for the isolates revealed that ciprofloxacin, ofloxacin, and pefloxacin were found to inhibit 80.7%, 81.5% and 82.3% of the bacterial agents isolated, respectively. Ceftriaxone inhibited 79.0% of the organisms, while amoxicillin was 100% effective against *P. aeruginosa* and moderately active against *Klebsiella* species (Table 2).

## Discussion

In this study, 62% of 400 mobile phones from all the study groups were found to be contaminated by

**Table 1.** Bacterial agents identified in the study

Categories of People	No. of samples collected	No. of Positive Samples	Bacterial agents isolated						
			<i>S. aureus</i>	Coagulase negative <i>Staphylococci</i>	<i>Enterococcus faecalis</i>	<i>E. coli</i>	<i>Klebsiella pneumoniae</i>	<i>Bacillus</i> spp.	<i>P. aeruginosa</i>
Marketers / Food vendors Group A	100	92	32 (34.7)	46 (50.1)	2 (2.2)	8 (8.6)	2 (2.2)	2 (2.2)	-
Lecturer /Students Group B	104	76	18 (23.7)	30 (39.5)	10 (13.2)	8 (0.5)	6 (7.9)	2 (2.6)	2 (2.6)
Public Servants Group C	106	42	12 (28.8)	20 (47.5)	4 (9.5)	4 (9.5)	2 (4.7)	-	-
Hospital workers group D	90	38	14 (36.8)	10 (26.3)	4 (10.5)	2 (5.2)	2 (5.2)	2 (5.2)	4 (10.5)
<b>Total</b>	<b>400</b>	<b>248</b>	<b>76 (30.6)</b>	<b>106 (42.7)</b>	<b>20 (8.0)</b>	<b>22 (8.8)</b>	<b>12 (4.8)</b>	<b>6 (2.4)</b>	<b>6 (2.4)</b>

bacterial agents. Isolation of bacterial agents from electronic devices such as handheld computers and personal digital assistants has shown these devices to be possible modes of transmission of nosocomial pathogens [9]. In a study conducted in Queen Elizabeth hospital in Barbados, West Indies, over 40% of mobile phones of 266 medical staff and students were culture positive [10]. Ulger *et al.* [11] reported that 94.5% of 200 health care workers and their mobile phones were contaminated with various microorganisms, including nosocomial pathogens, in a study conducted in New York and Israel. The present study concurs with their findings; thus contaminated, close-contact objects could serve as reservoirs of bacterial agents which could be easily transmitted from the mobile phones to the hands, and then from the hands to other areas of the body such as mouth, nose and ears.

Out of the four groups (A-D) studied, Group A had the highest rate of bacterial contamination (92;37%), followed by Group B (72; 30.6%), Group C (42; 16.9%), and Group D (38; 15.3%). The high prevalence of bacterial agents isolated from the mobile phones of Group A could be attributed to the poor hygienic and sanitary practices associated with the low level of education among marketers and food vendors, especially those involved in handling raw

meats and vegetables, compared to individuals working in a hospital environment (Group D) where there is regular disinfection. Similarly, poor handling, among other factors, may account for high levels of bacterial pathogen contamination observed in the mobile phones of individuals from groups B and C. Coagulase negative *Staphylococcus* (CNS) was the most prevalent bacterial agent isolated from 106 (42.7%) mobile phones in this study. This result corroborates the findings of Karabay *et al.* [6], in which CNS was the most frequently encountered bacterial agent isolated from 68.4% of the subjects evaluated. Brady *et al.* [3] had shown that the combination of constant handling and heat generated by the phones creates a prime breeding ground for microorganisms that are normally found in our skin. This may be because these types of bacteria increase in optimum temperature and phones are perfect for breeding these germs as they are kept warm and easy to handle in pockets, handbags and brief-cases.

In this study, other organisms isolated included *S. aureus*, *P. aeruginosa* and *K. pneumoniae*, *E. coli*, and *Enterococcus faecalis*. It is a well-established fact that these bacteria are agents of nosocomial infections. Rusin *et al.* [12] had documented both gram-positive and gram-negative bacteria in the hand-to-mouth transfer during casual activities. The present findings imply that mobile phones may serve

**Table 2.** Antimicrobial susceptibility patterns of bacterial agents identified

ORGANISM	Number isolated	AUG	CRO	GEN	NIT	COT	OFL	AMX	TET	PFX	CPX	CHL	ERY	STR
		S	S	S	S	S	S	S	S	S	S	S	S	S
<i>Escherichia coli</i>	22	2 (9.1)	22 (100)	16 (72.7)	12 (54.5)	14 (63.6)	22 (100)	- (0)	- (0)	22 (100)	20 (90.9)	2 (9.1)	6 (27.8)	4 (18.2)
<i>Klebsiella pneumoniae</i> .	12	6 (50)	12 (100)	10 (83.3)	- (0)	- (0)	12 (100)	8 (66.6)	- (0)	10 (83.3)	8 (66.6)	6 (50)	4 (33.6)	2 (16.4)
<i>Pseudomonas aeruginosa</i>	6	- (0)	6 (100)	- (0)	2 (33.3)	4 (66.6)	6 (100)	6 (100)	- (0)	6 (100)	6 (100)	2 (33.3)	4 (66.6)	2 (33.3)
<i>Staphylococcus aureus</i>	76	16 (22.6)	58 (76.3)	36 (47.3)	32 (42.1)	20 (26.3)	60 (78.9)	40 (52.6)	20 (26.3)	62 (81.5)	68 (89.4)	32 (42.1)	30 (39.4)	50 (65.7)
Coagulase negative <i>Staphylococci</i>	106	30 (28.3)	78 (73.5)	54 (50.9)	42 (38.6)	22 (20.7)	82 (77.3)	36 (33.9)	40 (37.7)	86 (81.1)	80 (75.4)	30 (28.3)	40 (37.7)	44 (41.5)
<i>Enterococcus faecalis</i>	20	6 (30)	16 (80)	12 (60)	4 (20)	4 (20)	18 (90)	- (0)	6 (30)	18 (90)	16 (80)	6 (30)	10 (50)	10 (50)
<i>Bacillus spp.</i>	6	2 (33.3)	4 (66.6)	- (0)	- (0)	6 (100)	2 (33.3)	- (0)	- (0)	- (0)	2 (33.3)	- (0)	- (0)	6 (100)
Total	248	62 (25.0)	174 (79.0)	128 (51.6)	92 (37.1)	70 (28.2)	202 (81.5)	90 (36.3)	66 (26.6)	204 (82.3)	200 (80.7)	76 (39.7)	88 (35.5)	118 (47.6)

AMX→Amoxicillin,  
STR → Streptomycin,  
CHL → Chloramphenicol  
AMX → Amoxicillin

GEN→ Gentamycin,  
ERY → Erythromycin  
CRO → Ceftriazone

PFX → Pefloxacin  
OFL→ Ofloxacin  
AUG → Augmentin

CPX → Ciprofloxacin  
COT → Cotrimozazole  
NIT → Nitrofurantoin

as vehicles of transmission of diseases such as diarrhoea, pneumonia, boils, and abscesses.

Also, *P. aeruginosa* has been reported in the United States by the Centre for Disease Control and Prevention to be the most isolated nosocomial pathogen accounting for 10.1% of all hospital-acquired infections, and has been implicated in gastrointestinal infection, primarily in immunocompromised individuals [13]. It is interesting to note that there was no statistical significant difference ( $p > 0.05$ ) in the occurrence of *S. aureus*, the pathogenic bacterial agent most frequently isolated from the mobile phones of all the study groups, occurring in 32 (34.7%), 18 (23.7%), 12 (28.8%) and 14 (36.8%) of Groups A to D respectively (Table 1). The implication of this observation is that the possibility of being infected with bacterial pathogens simply by using other people's mobile phones is high.

Antimicrobial sensitivity testing revealed that over 75% of the isolates were susceptible to the fluoroquinolone and ceftriazone antibiotics that were evaluated. Previous reports in Nigeria had shown that fluoroquinolones and third-generation cephalosporin are effective against a wide range of bacteria, and are expensive and less abused [14] than

other antibiotics. Other antibiotics evaluated in this study ranged between 25.0 to 51.6% efficacy. However, the isolation of methicillin-resistant *S. aureus* strains from the mobile phones of health care workers had been documented [11]. Neither methicillin-resistant *S. aureus* strains nor strains of vancomycin resistant *Enterococci* were observed in this study.

Today's mobile phones are important devices for both the professional and social lives of their users. However, restrictions on the use of mobile phones by the Nigerian populace in certain areas of the environment where the percentage presence of bacteria is likely high (such as in hospitals, lecture theatres, animal slaughter areas, canteens, business centres, toilets and other such places) is difficult and thus not a practical solution. Users of mobile phone are hence advised to use antibacterial wipes to make their mobile phones germ free at all times. Also, strict adherence to infection control and precautions such as hand washing and good hygienic practice among the users of mobile phones is advocated, to prevent the possibility of phones as vehicles of transmission of both hospital and community-acquired bacterial diseases.

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**Conflict of Interest:** No conflict of interest is declared