Antibiotic Susceptibility of Bacteria Isolated from Mobile Phones among Pre-Clinical Medical Students of Ambrose Alli University, Ekpoma, South-South, Nigeria

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ABSTRACT

Background: Cellular phones are used without limits, irrespective of their unknown infectious load, and thus cellular phones can serve as a container of infection among undergraduates.

Objective: This study investigated the microbial profile and antibiotic susceptibility patterns of bacteria isolated from mobile phones belonging to pre-clinical medical students at Ambrose Alli University, Ekpoma, Edo State.

Design: Two hundred mobile phone surfaces (130 from females, 70 from males) were sampled using swabs moistened with sterile peptone water inoculated unto MacConkey and nutrient agar. Positive isolates were then identified by the API Identification System (Biomèrieux): API STAPH for *Staphylococcus*spp, API 20 NE for non-Enterobacteriaceae Gram negative and API 20 E for Enterobacteriaceae. Antibiotic susceptibility tests were performed on each of the isolates by using disc diffusion method on Muller-Hinton agar

Results: All sampled devices (100%) showed bacterial contamination, with *S. aureus* being the most prevalent isolate (40.0%), followed by *E.coli* (26.0%), *Klebsiella*spp, (16.0%), *P.aeruginosa*(10.5%) and *Proteus mirabilis*(7.5%). Female student phones has more microorganisms(65.0%) compared to males (35.0%) which was statistically not significant at P>0.05. Age group 20-25 years had more bacterial carriage, both males (42.9%) and females (37.7%), next was 26-30years in males (28.6%), females (26.6%) followed by 31-35yrs in males (18.6%), females (23.9%) while the least was reported in >35years in both males (10.0%) and females (11.5%).

Antimicrobial susceptibility testing revealed ciprofloxacin and cefepime(100%) as the most effective antibiotics closely followed by Erythromycin (97.3%) while chloramphenicol (0%) and vancomycin (4.9%) showed the lowest efficacy.

Conclusion: Mobile phones serve as significant reservoirs for pathogenic bacteria within medical undergraduate communities, therefore personal hand hygiene and phone decontamination ethanol or alcohol-based sanitizers should be adopted.

Keywords: Antibiotics, Susceptibility, Bacteria, Mobile Phones.

INTRODUCTION

Mobile phones are ubiquitous and are used as primary communication devices. They account for over 5 billion mobile phone users globally (over two-thirds of the world's population) with an increase of 100 million unique mobile phone users each year [1]. According to [2] the number of mobile phone users accessing popular messaging apps to communicate was 2.77 billion. A mobile or cellular telephone is a long range portable electronic device for personal telecommunication [3].

The United States Centre for Disease Control and Prevention (CDC) outlined that up to 80% of all infectious diseases was transmitted via hands [4]. Researchers have shown that mobile phones are reservoirs of microbes while users neglect and rarely decontaminate these devices. The high rates of use and touch contact of mobile phone surfaces and individual tendencies to touch their face regularly (up to 23 times an hour) [5]or/and other surrounding surfaces [6] accounts for the microbial load on phone surfaces. In another study, [7] stated that mobile phones act as 'Trojan horse' devices which: (i) bypass gold standard hand hygiene practices; (ii) are likely linked to pathogen movement via cross-contamination transmission pathways during epidemics and pandemics and (iii) contribute to global population infections and hospitalizations due to nosocomial infections.

In addition to the standard voice function of a telephone, mobile phones can support many additional services such as SMS for text messaging, email, pocket switching for access to the Internet, and MMS for sending and receiving photos and video. With all the achievements and benefits of the mobile phone, it is easy to overlook the health hazard it might pose to its many users [8]. In addition, mobile phones might act as fomites as they are carried with their owner to places such as toilets, hospitals and kitchens, which are loaded with microorganisms [9].

Unlike fixed phones, mobile phones serve as a perfect habitat for the microbes to breed– providing higher temperature and humid condition [10]. Mobile phone usage has increased dramatically. In such environments where the percentage presence of bacteria is likely high, such as in hospitals, abattoirs, market places and toilets, this could enhance pathogen transmission and intensify the difficulty of containing disease spread [11].

In Nigeria, a recent report showed that about 205.4 million cellular mobile connections were active in early 2024, which is about 90.7% of the total population [12]. The use of mobile phones is commonplace in the country, especially among youth who are often glued to phones accessing social media platforms. Previous studies examining the bacterial flora on mobile phones reported the incidence of antibiotic-resistant bacteria among the various categories of healthcare workers in Nigeria [13]and elsewhere [14]. The use of mobile phones by healthcare workers and the absence of disinfection of their mobile phones provided room for spreading nosocomial pathogens [15,16]. In addition, the microbial examination of mobile phones among students of tertiary institutions, particularly in Nigeria [17.18] showed the incidence of certain bacteria such as *Pseudomonas*spp., *Escherichia coli*, *Salmonella*spp., *Staphylococcus*spp. However, the antibiotic-resistant profile of bacterial pathogens isolated from mobile phones, especially among undergraduate students in Nigeria has not been extensively investigated.

Aim: This study aimed to investigate the presence of pathogenic bacteria on the surfaces of cell phones of pre-clinical medical students at a Nigerian university based on gender and to investigate the antibiotic resistant profile of the isolates.

MATERIALS AND METHODS

Samples Design and Area: The study was carried out in the Faculty of Basic Clinical Sciences College of Medicine, Ambrose Alli University, Ekpoma, Edo state-Nigeria from September 2025 to February 2026. Approval for the study was given by the Research and Ethics Committees (REC) of Ambrose Alli University, Ekpoma, Edo State. Consent to participate was sought from volunteer pre-clinical students who were informed about the confidentiality of information that they provide. Socio-demographic data such as age, gender and marital status of each student were extracted by voice recording.

Sampling collection and Processing Technique: Samples from mobile phones were collected using sterile cotton swabs. Each swab was first moistened with sterile peptone water and was rotated over the surface of both sides of the tested mobile phone together with the keypad in nontouchscreen phones for 4-6 secs. The swabs were immediately transported to the laboratory using sterile carnisters.

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Isolation Method: The swab samples were streaked (surface spread) over the surface of blood and MacConkey's agar plates while the cotton ends of these swabs were cut off and soaked in 10 ml peptone water and incubated aerobically at 37°C for 24 - 48 hours. Isolated bacterial agents were identified using standard microbiological methods such as colony morphology, color, size, and shape and microscopy (e.g., Gram staining) to distinguish between gram-positive and gramnegative bacteria. Methicillin-resistant *Staphylococcus aureus* was identified by disk diffusion method described by Kirby and Bauer .

Positive samples were prepared for further culture on different growth media: Mannitol salt-agar (Oxoid) to isolate *Staphylococci*, MacConkey-agar (Biomèrieux) to isolate Gram-negative bacteria and Enterococcosel-agar (Biomèrieux) to isolate faecal enterococci. The isolated microorganisms were then identified by the API Identification System (Biomèrieux): API

STAPH for *Staphylococcus*spp, API 20 NE for non-Enterobacteriaceae Gram negative and API 20 E for Enterobacteriaceae

Antibiotic susceptibility tests

Antibiotic susceptibility tests were performed on each of the isolates by using disc diffusion method on Muller-Hinton agar as recommended by Clinical Laboratory Standards Institute (CLSI), using the following antibiotic disks: ciprofloxacin (5 µg), ampicillin (10 µg), norfloxacin

(10 µg), erythromycin (15 µg), chloramphenicol (30 µg), vancomycin(30µg), cefepime (30 µg) The microorganisms were briefly suspended in saline to a turbidity of 0.5 McFarland standards. A swab of the cell suspension was subsequently spread in three directions on the entire surface of a Mueller Hinton agar plate (MHA), and left for 15 minutes to air dry at room temperature before antibiotic disks were applied onto the agar. Plates were then incubated at 36°C for 18-24 hours. *S. aureus* (ATCC #25923) used was as a control and the results were interpreted according to CLSI guidelines.

Statistical Analyses

Descriptive statistics were used to present the socio-demographic information and bacterial count analysis. The results were presented in tabular form and analysed using percentile and SPSS version 20.0.

RESULTS

The findings from our research showed that the keypad phone is more in use (80.5%) by undergraduates than the screen touch phone (19.5%) in both males and females as shown in Table1.

Table 1: Socio-Demographic Status of Participants

		Males(%) (n=70)	Females(%) (n=130)	Total (%) n(200)
Gender:	**Males**			
	Female			
Age Range				
20-25yrs		25 (35.8)	50(38.5)	75 (37.5)
26-30yrs		29 (41.4)	40(30.7)	69(34.5)
31-35yrs		11 (15.7)	23(17.7)	34(17)
>35yrs		5(7.1)	17(13.1)	22(11)
Mobile phone:	Screen Touch:	15(21.4)	24 (18.5)	39 (19.5)
	Key Pad:	55(78.6)	106(81.5)	161(80.5)
Marital Status:	Single	66 (94.3)	115 (88.5)	181(90.5)
	Married	4 (5.7)	15 (11.5)	19 (9.5)

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Table 2 revealed that the most prevalent isolate was *S. aureus* (40%) with an occurrence of 23% in females and 17% in males which was statistically not significant at P< 0.05.

Table 2: Comparism of bacterial isolated from mobile phones of both males and females (N%)

Bacterial isolates	Male	Female	Total	X^2
Staphylococcus aureus	34(17)	46(23)	80(40)	p-value
Escherichia coli	20(10)	32(16)	52(26)	
*Klebsiella*Spp	8(4)	24(12)	32(16)	X= 0.77
Pseudomonas aeruginosa	5(2.5)	16(8)	21(10.5)	P>0.05
Proteus mirabilis	3(1.5)	12(6)	15(7.5)	
Total	70(35)		130(65)	200 (100)

The age range (20-25yrs) in females had the highest rate of bacterial occurrence (37.7%) while the least (11.5%) was reported in age group > 35yrs with *S.aureus* being the most prevalent (35.4%) followed closely by *E.coli* (24.6%) and the least was *P.mirabilis* (9.2%) in Table 3.

Table 3: Percentage occurrence of bacteria in mobile phones of females in relation to Age N(%)

Bacterial isolates	Age Range (yrs)				
	(20-25)	(26-30)	(31-35)	(>35)	Total
S. aureus	17(37.0)	13(28.3)	10(21.7)	6(13.0)	46(35.4)
E. coli	9(28.1)	7(21.9)	13(40.6)	3(9.4)	32(24.6)
KlebsiellaSpp	10(41.7)	8(33.3)	4(16.7)	2(8.3)	24(18.6)
P.aeruginosa	7(43.8)	4(25)	3(18.8)	2(12.5)	16(12.3)
P. mirabilis	6(50)	3(25)	1(8.3)	2(16.7)	12(9.2)
TOTAL	49(37.7)	35(26.9)	31(23.9)	15 (11.5)	**130**

In males, the age group bacterial occurrence is reported in Table 4, with ages 20—25yrs having the highest isolation rate (42.9%) followed by ages 26-30yrs (28.6%) and the least was >35yrs (10%). *S.aureus* was also the most prevalent(41.4%), *E.coli* (24.3%) and the least was *P.mirabilis* (5.7%).

Table 4: Percentage occurrence of bacteria in males in relation to Age

Bacterial isolates	Age Range (yrs)				
	(20-25)	(26-30)	(31-35)	(>35)	Total
S. aureus	11(37.3)	8(27.6)	6(20.7)	4(13.8)	29(41.4)
E. coli	8(47.1)	5(29.4)	3(17.6)	1(5.9)	17(24.3)
Klebsiella Spp	4(36.4)	3(27.3)	2(18.2)	2(18.2)	11(15.7)
P. aeruginosa	4(44.4)	3(33.3)	2(22.2)	0(-)	9(12.9)
P. mirabilis	3(75)	1(25)	0(-)	0(-)	4(5.7)
Total	**30(42.9)**	**20(28.6)**	**13(18.6)**	**7(10)**	**70(100)**

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The antibiotic profile of the isolated bacteria showed a variation amongst antibiotics tested. Some of the isolates showed susceptibility to one or more antibiotics while resistance was also observed to multiple antibiotics as shown in Tables 5a&b. All isolates were 100% susceptible to ciprofloxacin and cefepime (100%) apart from *E.coli* (96.1%) and *Klebsiella* (93.1%) to cefepime with two strains each showing resistance. A 100% resistance to chloramphenicol was observed in all the isolates except *E.coli* that exhibited a 4.7% susceptibility and 92.3% resistance. All Gram-negative bacteria showed poor susceptibility to vancomycin at 19.2% (*E.coli*),23.1%(*Klebsiella* sp), 42.9% (*P.aureginosa*) and *Proteus* spp (53.3%) as reported in Table 5a. Susceptibility to vancomycin was observed in the Gram-positive organism ;*S.aureus (*88.8%*)* as shown in Table 5b.

Table 5a: Antibiotic susceptibility pattern of Gram-negative bacterial isolates (%)

	Cip	E	C	Nor	Va	AMP	Fep
E. coli (n=52)	50(100)	48(92.3)	4(7.7)	51(98.1)	10 (19.2)	17(32.7)	50(96.1)
Klebsiella spp (n=32)	32(100)	28(87.2)	0(0.0%)	6(18.8)	12(23.1)	3(9.4)	30(93.8)
P. aureginosa (n=21)	21(100)	17(81.0)	0(0.0%)	13(61.9)	9(42.9)	11(52.4)	21(100)
Proteus spp (n=15)	15(100)	10(66.7)	0(0.0%)	3(20.0)	8(53.3)	6(40.0)	15(100)

Table 5b: Antibiotic susceptibility pattern of Gram-positive bacterial isolate (%)

	Cip	E	C	Nor	Va	AMP	Fep
S.aureus (n=80)	80(100)	78(97.5)	0(0.0%)	69(86.3)	71(88.8)	43(53.8)	80(100)

Note: Fep: Cefepime, Va: Vancomycin, C: Chloramphenicol, Amp: Ampicillin, Nor: Norfloxacin, E: Erythromycin, Cip :Ciprofloxacin

DISCUSSION

Cellphones, especially smartphones, are one of the most common items people carry with them both in their professional and personal lives [19].

In this work, 200 swab samples tested showed evidence of bacterial contamination, indicating a 100% bacterial contamination in the mobile phones among pre-clinical medical undergraduates. Our finding is consistent with a similar study Nigeria by [20] at Ogume and [21] at Owerri among undergraduates, a similar result was reported in Ahvaz-Iran by [22] observed bacterial growth in all samples taken from mobile phones of (77) students from faculty of dentistry, also in Baghdad-Iran, [23] mentioned in their studies that, the rate of bacterial contamination of dental students' mobile phones was 100% while a similar result from Egypt by [24] revealed a contamination rate of 96.5% of bacteria from mobile phones of medical undergraduates.

We observed that *Staphylococcus aureus* was the most prevalent (40%) bacteria followed by *E.coli* (26.0%),*Klebsiella* (16.0%), *P.aureginosa*(10.5%) while the least prevalent (7.5%) was *P.mirabilis*. These results closely aligns with the results from similar research in Nigeria by [25] who reported a 41.7% prevalence of *S.aureus* and [21] reported 42.9%. Results from this research was at variance with Clement *et al.*2021 whose results showed a higher prevalence of 67.1% but lower (8.1%) from results of [26] carried out in Turkey. Our result for *E. coli* prevalence was similar to that reported in Nigeria by [26] at 26.0%. These varying results may be attributable to differences in hand hygiene habits, device handling frequency, phone sanitization routines and specific environments.

The swabbed mobile phones of the females were more contaminated (65.0%) than those of their male colleagues (35.0%), while in relation to age, the age group 20-25yrs had the highest contamination rate in both males (42.9%) and females (37.7%). This is similar with the result of [25] who reported that cell phones of females (56.3%) were more contaminated than those of males (43.7%). The high prevalence and cocktail of bacteria in female mobile phones could be attributable to social behaviour such was carrying phones in handbags with residue makeup, styling of hair, wearing of long nails, longer daily usage (exchange of phones for picture snap shots and other social activities).

In our study, all isolates were found to be susceptible to ciprofloxacin (100%) and cefepime except for two isolates of *E. coli* and *Klebsiella*spp with 96.1% and 93.8% susceptibility to cefepime respectively. Our results are consistent with results from similar studies in Nigeria by [21, 27] and in Ethiopia by [28,29]. The highest level of resistance was seen in chloramphenicol (100%) and vancomycin (86.2%), this is due to the fact that Gram negative bacteria have impermeable outer membrane which makes it difficult for a heavy molecule antibiotic like vancomycin to pass through the outer pores of the organisms, as reported in a similar study from Nigeria by [27]. Also a high resistance to chloramphenicol in our study may suggest that isolates originated from highly resistant sources where antibiotics are generally sold over the counter in Nigeria with or without a physician's prescription leading to antibiotic misuse, overuse and abuse. while the differences in bacterial resistance may be affected by the season, location, hygiene practice and type of population involved in study.

CONCLUSION

In our study, we were able to demonstrate the prevalence of bacterial colonization among pre - clinical medical undergraduates mobile phones as well as the antimicrobial susceptibility profiles of the isolated bacterial pathogens against the tested antibiotics. The high effectiveness of ciprofloxacin and cefepime on the isolates is suggestive as potential drugs of choice for treating infections related to bacteria isolated from the mobile phones sampled. The consistent detection of bacterial pathogens in all sampled phones emphasizes the role of these devices as vectors in the transmission of infectious agents and diseases.

RECOMMENDATIONS

We recommend education/ training programs at an early stage for pre-clinical medical students on hand hygiene and infection control strategies. Additionally, an assessment of the knowledge, attitude and behavior of the students on handling of mobile phone devices should be carried out while institutional awareness campaigns on handling and disinfecting mobile phones can also mitigate the public health risk associated with mobile phone contamination. We also recommended further studies to identify the genetic diversity of the isolated bacteria and to determine the resistance genes for antibiotic resistant isolates.

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