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Nosocomial pathogens associated with the mobile phones of healthcare workers in a hospital in Anyigba, Kogi state, Nigeria

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Abstract *Background:* Mobile phones of healthcare workers (HCWs) could be colonized by potential bacteria pathogens. The aim of this research is to evaluate the bacterial contamination and antibiotic sensitivity pattern of isolates from mobile phones of HCWs in Grimad hospital.

Method: A total of 112 swab samples were collected from the mobile phones of HCWs and students in June 2012 in Anyigba. While 56 samples were from HCWs in Grimad hospital, 56 samples were obtained from non-healthcare workers (NHCWs) who served as the control. The samples were all screened for bacterial pathogens by standard bacteriological procedures. Antibiotic susceptibility testing was done by the disc diffusion technique.

Results: The rate of bacterial contamination of mobile phones of HCWs was 94.6%. Bacteria isolated from mobile phones of HCWs were more resistant to antibiotics than NHCWs phones. *Staphylococcus Epidermidis* (42.9%) was the most frequently isolated bacteria followed by *Bacillus* spp. (32.1%), *Staphylococcus Aureus* (25%), *Pseudomonas Aeruginosa* (19.6%), *Escherichia Coli* (14.3%), *Streptococcus* spp. (14.3%), *Proteus* spp. (12.5%), *Klebsiella* spp. (7.1%), and *Acinetobacter* spp. (5.3%). Cotrimoxazole, ampicillin and tetracycline showed high levels of resistance while gentamicin, ciprofloxacin and ceftriaxone exhibited encouraging results.

Conclusion: The presence of bacteria pathogens associated with nosocomial infection was identified. Transmission of pathogens can be reduced by hand hygiene and regular cleaning of mobile phones.

1. Introduction

Mobile phones of healthcare workers (HCWs) could be colonized by potential bacteria pathogens and

☆ This work was carried out at the Microbiology Laboratory, Grimad Hospitals, Anyigba, Kogi State.

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could become vectors of nosocomial pathogens in healthcare facilities. Research has shown that the mobile phone could constitute a major health hazard. Microbiologists are of the opinion that the combination of constant handling and the heat generated by the phones creates a prime breeding ground for all sorts of microorganisms that are normally found on the human skin [1].

Hospital-acquired infection caused by multidrug-resistant gram-positive organisms such as *Staphylococcus aureus* and Enterococcal species is a growing problem in many healthcare institutions [2].

Hand washing may not usually be performed often enough and many people may use a personal mobile phone in the course of their work throughout the day, the potential role of mobile phones as a source of microbial transmission is considerable [3].

The regular use of the mobile phone by HCWs exposes it to an array of bacteria and makes it a good carrier for microbes, especially those associated with the skin, resulting in the spread of different microorganism from the user [4].

Many epidemiological studies have confirmed that a considerable number of contaminated surfaces play a major role in the spread of infectious diseases [5,6]. Mobile phones are more problematic compared with other stationary fomites in that they facilitate inter-ward (and possibly inter-facility) transmission [7], and pathogens on them are very difficult to eliminate.

Since there are no data on the risk of bacterial contamination of personal mobile phones among HCWs in this locality, this study was undertaken to establish a baseline of data on types of bacterial isolates and antibiotic sensitivity patterns.

2. Materials and methods

A total of 112 swab samples were collected from the mobile phones of HCWs in Grimad hospital, Anyigba, and Kogi State University students in June 2012. While 56 samples were from HCWs in Grimad hospital, 56 samples were obtained from students who were regarded as non-healthcare workers (NHCWs) and who served as the control in the study. These samples were processed in the Microbiology Laboratories of Grimad hospital, Anyigba, by standard bacteriological procedures [8]. No prior warning was given to the owners of the mobile phones which must have been in regular use for about 3 months.

Sterile swab sticks (Sterilin, UK) were made wet slightly with physiological saline and rubbed over the entire surface of the mobile phone and inoculated on MacConkey and blood agar plates. These were incubated at 37 °C for 18—24 h. Gram staining technique, carbohydrate fermentation tests in triple sugar iron agar and biochemical tests such as catalase and coagulase were used for gram-positive cocci, while oxidase, urease, citrate utilization, nitrate reduction, indole and others were used for identification of gram-negative bacilli.

Samples collected from the mobile phones of HCWs in the hospital departments were inoculated onto appropriate media without delay in the microbiology laboratory. However, Stuart's transport medium was used for the initial inoculation of the samples collected from the students' mobile phones and were sent to the hospital laboratory for further processing.

The antibiotic sensitivity pattern was determined by the disc diffusion method [9]. A suspension of each bacterium was prepared in peptone water to give a concentration equivalent to McFarland 0.5 and 1.0 standards for gram-negative bacilli and gram-positive cocci, respectively. This was inoculated on the surface of plain Mueller—Hinton agar by spreading with a swab to give a semi-confluent growth.

Antibiotic discs were placed on it and incubated at 37 °C overnight. The antibiotics tested are as follows: ceftazidime (CAZ) 30 μg, ofloxacin (OFL) 5 μg, ampicillin (AMP) 10 μg, tetracycline (TE) 30 μg, gentamicin 10 μg, amoxicillin/clavulanate (AMC) 30 μg, cotrimoxazole (COT) 30 μg, erythromycin (E) 10 μg, ceftriaxone (CRO) 30 μg, and ciprofloxacin (CPL) 5 μg.

The sensitivity pattern was determined by measuring the zones of inhibition with a calibrated ruler and interpreted according to standard guidelines for Clinical Laboratory standards (CLSI) criteria [10].

2.1. Statistical analysis

Epi Info Version 6 was used for chi-squared analysis and Fisher exact test while simple percentages were used to compare rates. The level of significance for *P* values was accepted at $P < 0.05$.

3. Results

The rate of bacterial contamination of HCW mobile phones in this study was 94.6%. When compared with the control group comprising the NHCWs, 82% bacterial contamination rate was observed. The difference was statistically significant ($P = 0.03$). The distribution and frequency of the

various types of bacterial isolates from the mobile phones of staff in different departments (as reflected in Table 1) revealed variations in contamination rates in relation to the departments. The observed differences were statistically significant ($P < 0.001$). Also among the various cadres of all the healthcare professionals (as shown in the same table) whose mobile phones were sampled, 6 doctors (13.3%) had a total number of 18 (21.4%) isolates, 30 nurses (66.7%) had 51 (60.1%) isolates, 4 pharmacists (8.9%) had 5 (5.9%) isolates, 3 laboratory scientists (6.6%) had 8 (9.6%) isolates, while 2 radiographers (4.4%) had 2 (2.4%) isolates. The differences were statistically significant ($P < 0.001$).

Bacterial isolates contaminating mobile phones of both HCWs and NHCWs were observed as reflected in Table 2. *Staphylococcus epidermidis* (42.9%) was the most frequently isolated organism among healthcare professionals. A comparison of bacteria type and frequency among both groups showed a significant difference with *S. epidermidis* ($P < 0.01$) and *Staphylococcus aureus* ($P < 0.03$). The number of mobile phones that showed no growth, single or mixed bacterial growth is presented in Table 3. When comparing between HCWs and NHCWs, there was a statistically significant difference observed.

The antibiotic sensitivity patterns of the isolates obtained from the HCW mobile phones are shown in Table 4. They exhibited a high level of resistance against cotrimoxazole, tetracycline and ampicillin, while gentamicin, ceftriaxone and ciprofloxacin showed good results. Increased numbers of bacterial isolates from the mobile phones of NHCWs were sensitive to most of the antibiotics used when compared with isolates from HCWs. This is presented in Table 5.

4. Discussion

The hospital environment plays a critical role in the transmission of organisms associated with nosocomial infections. Micro-organisms can be transferred from person to person or from inanimate objects (such as stethoscopes, bronchoscopes, pagers, ballpoint pens, patient hospital charts, computer keyboards, mobile phones and fixed telephones) to hands and vice versa [11—14]. Recent innovations in mobile communication which have been found to be useful in healthcare facilities have led to better patient control of diseases. However, the increased use of mobile phones is seen against a background rise in nosocomial infection rates as they could bring sorrow to the patient by acting as vectors in the spread of nosocomial pathogens [13,14].

In this study, mobile phones used by HCWs in various departments in the hospital, including the operating rooms and intensive care units (ICU), showed high contamination with bacteria pathogens.

The HCWs' phones showed 94.6% contamination with bacterial pathogens which compared favorably with the reports of some researchers who observed 94.5% [15] and 96.5% [16] bacterial contamination in their studies, but at variance with the findings from some other centres [17,18]. This may be mainly due to lack of awareness and low hygiene standards.

The preponderance of *S. epidermidis* (a normal skin flora) in this study is in agreement with the findings of other researchers [17,18]. The bacte-

Table 1 Distribution of isolates among mobile phones of members of staff in various departments and different professionals in a healthcare facility, Grimad hospital.

	No. of staff (%) $N = 56$	No. of isolates (%)	Mean No. of isolates per phone	Chi-square
Departments				
Laboratory	10 (17.9)	22 (22.7)	2.20	
Wards	24 (42.9)	40 (41.2)	1.67	
Theatre	7 (12.5)	12 (12.4)	1.71	$\chi^2 = 85.66$
Intensive care unit	4 (7.1)	9 (9.3)	2.25	df = 6
Outpatient department	4 (7.1)	6 (6.2)	1.50	$P < 0.001$
Pharmacy	5 (8.9)	6 (6.2)	1.20	
Radiology	2 (3.6)	2 (2.1)	1.00	
Professionals				
Doctors	6 (13.3)	18 (21.4)	3.00	$\chi^2 = 119.55$
Nurses	30 (66.7)	51 (60.1)	1.70	df = 4
Pharmacists	4 (8.9)	5 (5.9)	1.25	$P < 0.001$
Laboratory scientists	3 (6.6)	8 (9.5)	2.67	
Radiographers	2 (4.4)	2 (2.4)	1.00	

Table 2 Comparison of bacteria isolated from mobile phones of healthcare workers (HCWs) and non-healthcare workers (NHCWs) in Anyigba.

Type of bacteria	Healthcare workers (%) *N* = 56	Non-healthcare workers (%) *N* = 56	*P*-value
S. epidermidis	24 (42.9)	13 (24.0)	0.011
Staphylococcus aureus	14 (25.0)	8 (14.8)	0.027
E. coli	8 (14.3)	3 (5.5)	0.11
Klebsiella pneumoniae	4 (7.1)	1 (1.8)	0.18
P. aeruginosa	11 (19.6)	8 (14.8)	0.35
Acinetobacter spp.	3 (5.3)	0 (0)	0.12 (Fisher exact)
Bacillus spp.	18 (32.1)	16 (29.6)	0.68
Proteus spp.	7 (12.5)	2 (3.7)	0.08
Streptococcus	8 (14.3)	6 (11.1)	0.56
	97	57	

Table 3 Number of mobile phones that showed single or mixed bacteria in Anyigba.

No. of single or mixed cultures	Healthcare workers (%) *N* = 56	Non-healthcare workers(%) *N* = 56	*P*-values
No growth	3 (5.4)	10 (17.6)	0.039
One type of organism	16 (28.6)	37 (66.0)	0.000071
Two types of organisms	30 (53.6)	8 (14.2)	0.000011
Three types of organisms	7 (12.56)	1 (1.7)	0.03 (Fisher exact)
	97	56	

Table 4 Antibiotic sensitivity pattern of isolates from healthcare workers' mobile phones in Grimad hospital, Anyigba.

Pathogens	Total No. of isolates	No.(%) of isolates sensitive to									
		CN	AMC	COT	AMP	CPL	TE	CRO	CAZ	OFL	E
Gram positive											
S. aureus	14	10 (71.4)	6 (42.8)	0	0	9 (64.2)	0	8 (57.1)	4 (28.5)	10 (71.4)	8 (57.1)
S. epidermidis	24	13 (54.1)	4 (16.6)	0	0	8 (33.3)	0	8 (33.3)	5 (20.8)	8 (33.3)	10 (41.6)
Streptococcus spp.	8	4 (50.0)	2 (25.0)	0	0	2 (25.0)	0	2 (25.0)	1 (12.5)	3 (37.5)	5 (62.5)
Gram negative											
Escherichia coli	8	5 (62.5)	3 (37.5)	0	0	5 (37.5)	0	6 (75.0)	2 (25.0)	4 (50.0)	NT
K. Pneumoniae	4	2 (50.0)	1 (25.0)	0	0	2 (50.0)	0	3 (75.0)	0	2 (50.0)	NT
Acinetobacter spp.	3	1 (33.3)	0	0	0	1 (33.3)	0	1 (33.3)	0	2 (66.6)	NT
Proteus spp.	7	4 (57.1)	3 (42.8)	0	0	3 (42.8)	0	1 (14.2)	0	1 (14.2)	NT
P. aeruginosa	11	6 (54.5)	1 (7.0)	0	0	4 (36.3)	0	3 (27.2)	0	5 (45.4)	NT

CN, Gentamicin; AMC, amoxicillin/clavulanate; COT, Cotrimoxazole; CPL, Ciprofloxacin; , Ceftazidime; OFL, Ofloxacin; AMP, Ampicillin; TE, Tetracycline; CRO, Ceftriaxone; E, Erythromycin.
NT — Not Tested.

rium is responsible for a large number of hospital-acquired infections and is often difficult to treat because of its genetic characteristics and growing resistance to high-powered antibiotics [19]. It resists drying and can multiply rapidly in warm environments such as mobile phones [18]. HCWs' mobile phones in the wards harboured a higher number of isolates than in other departments just as doctors' mobile phones were more contaminated than other HCWs. Some researchers [17] from Iran made the same observation. This may be due to the fact that they have contact with many patients from various hygienic backgrounds and probably do not wash their hands thoroughly after examining each person. The mobile phones will therefore be contaminated by the hands and vice versa.

Apart from *S. epidermidis*, which was the most frequently isolated bacterium as stated earlier,

Table 5 Antibiotic sensitivity pattern of isolates from non-healthcare workers' mobile phones in Anyigba.

Isolates	Total No. of isolates	No.(%) of isolates sensitive to									
		CN	AMP	AMC	CPL	TE	CRO	CAZ	E	COT	OFL
Gram positive											
S. aureus	8	7 (87.5)	0	3 (37.5)	5 (62.5)	0	5 (62.5)	1 (12.5)	6 (75.0)	0	6 (75.0)
S. epidermidis	13	10 (76.9)	3 (23.0)	4 (30.7)	8 (61.5)	0	8 (61.5)	6 (46.1)	8 (61.5)	0	10 (76.9)
Streptococcus spp.	6	3 (50.0)	2 (33.3)	2 (33.3)	3 (50.0)	0	2 (33.3)	1 (16.6)	4 (66.6)	1(16.6)	1 (16.6)
Gram negative											
Escherichia coli	3	2 (66.6)	0	1 (33.3)	3 (66.6)	0	3 (66.6)	1 (33.3)	NT	0	3 (66.6)
K. Pneumoniae	1	1 (100)	0	0	1 (100)	0	1 (100)	0	NT	0	1 (100)
Proteus spp.	2	1 (50.0)	0	0	2 (100)	0	2 (100)	1 (50.0)	NT	0	2 (100)
P. aeruginosa	6	4 (66.6)	0	0	3 (50.0)	0	3 (50.0)	0	NT	0	4 (66.6)

Pseudomonas aeruginosa, *Acinetobacter* spp, *Proteus* spp., *S. aureus*, *Escherichia coli* and *Klebsiella pneumoniae*, which are commonly found in hospital-acquired infections, were observed in this study and were also reported by other researchers [17,18,20].

Mobile phones are always kept in handbags, pockets of the users or even placed on contaminated surfaces. It was therefore not surprising that some mobile phones presented with two or three bacteria genera during this study. This agreed with the reports of some researchers from Turkey [15]. Isolates from the mobile phones of HCWs in this study showed a high level of resistance to ampicillin, tetracycline and cotrimoxazole, whereas gentamicin, ciprofloxacin and ceftriaxone exhibited good results. The controls represented by NHCWs showed less resistant bacteria than isolates from HCWs and also had lower numbers of isolates and rate of contamination.

Since the restriction of mobile phone use by HCWs is not practically an effective method for prevention of nosocomial infections spread, the development of effective preventive strategies for well-practiced infection control plan is an essential need to encompass environmental decontamination, hand hygiene, surveillance, and contact isolation for prevention of such nosocomial infections [21].

The use of mobile phones is extremely important in the healthcare delivery system and it may not be practicable to stop its use. However, since it possesses the hazard of being a potential vector of nosocomial pathogens, a well-coordinated cleaning guideline incorporated in a strict and effective infection control policy may reduce the risk of its usage. Some researchers [22] have suggested that the best way to handle this problem is ultrasonic cleaning by an ultrasonic cleaner which cleans the mobile phones thoroughly and safely. However, one study reported the use of 70% isopropyl alcohol as an effective disinfectant [23] or antimicrobial additive materials which may be effective in reducing the risk of cross contamination [1]. Another study reported that the restricted use of mobile phones during working hours along with proper hand hygiene practices enabled mobile phones to remain free of contamination [11].

In conclusion, since contamination of the mobile phones of HCWs has been associated with nosocomial pathogens, concerted and deliberate efforts should be made to avoid the risk of transmission to patients. It is recommended that regular training programs be organized by the appropriate authorities for different cadres of HCWs to emphasize the need for the implementation of infection control policies. This should include strict hand washing after every contact with a patient, regular surface disinfection of fomites, including cell phones, pens, stethoscopes, etc., by simple methods already suggested by other researchers above. This will increase awareness and reduce the risk of infection by nosocomial pathogens that could have tragic consequences for immunocompromised patients.

Conflict of interest

None declared.

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