



Mobile Phones of Healthcare Workers are Possible Source of Nosocomial Infections: Evidence from Asante-Mampong Municipal Government Hospital, Ghana

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: The users of mobile phones often contaminate them with several microflorae including viruses, fungi, and bacteria via unhygienic conditions and habits making phones a breeding ground and a tool for the transmission of infections. This study examined microbial contamination of mobile phones of health care workers (HCWs) and the risk of nosocomial infections at the Mampong Municipal Government Hospital (MMGH), Ghana.

Methods: We employed a cross-sectional study design to characterize bacterial microflora on mobile phones of HCWs at the MMGH. A random sample of thirty-five [1] mobile phones of HCWs was swabbed for microbiological analysis from the Dental, Children, Male, Theatre and Laboratory departments. A 0.1 ml sterile buffered peptone water was used to make a uniform suspension of each sample and streaked on blood agar and MacConkey agar and incubated at 37°C for 48 hours.

Bacteria were isolated and identified using suitable laboratory and biochemical methods. Analysis of data was done using SPSS-IBM version 16.

Results: All cell phones were contaminated with one or more species of bacteria. Cell phones from Male, Dental and Laboratory departments had 85.7%, 71.4% and 57.1% prevalence of bacterial contamination respectively while Children's and Theatre departments each recorded 28.6%. Bacterial contaminants identified were *Staphylococcus epidermidis* (G+) (37%), *Staphylococcus aureus* (G+) (26%), *E. coli* (G-) (20%), *Bacillus* spp. (G+) (11%) and *Klebsiella* spp. (G-) (6%). Apart from the Children's Ward, *E. coli* was isolated at all study sites and the most prevalent (42.9%) at the Dental Unit. *Klebsiella* spp (G-) (28.6%) was isolated only at the Children's ward.

Conclusion: Mobile phones of HCWs harboured possible pathogens that could cause nosocomial infections among patients. Therefore, strict handwashing practices should be adhered to by HCWs before and after phone use before contact with the patient to reduce the risk of nosocomial infections. This has become even more relevant in the wake of Covid-19 pandemic.

Keywords: Healthcare; Mampong; mobile phones; Ghana; nosocomial diseases; infection; bacteria.

ABBREVIATIONS

HCWs : Health Care Workers
 MMGH : Mampong Municipal Government Hospital
 SMS : Short Message Service
 MMS : Multimedia Messaging Service
 GPC : Gram-Positive Cocci
 CONS : Coagulase Negative *Staphylococcus*
 SPSS-IBM : Statistical Package for the Social Sciences

1. INTRODUCTION

The global telecommunication system was developed in Europe in 1982 to establish and advance communication networks [2]. Today, for most professionals and social life in general, mobile phones have become one of the most crucial accessories. About 1.6 billion smartphones were in use worldwide in 2013, and this figure is expected to double in the coming years [3]. According to [4] survey on cell phones usage in seven (7) sub-Saharan African nations, South Africa, Nigeria and Ghana had the leading users respectively. In addition to the telephone's basic voice feature, mobile phones can support many additional features such as short message service (SMS) for text messaging, email, access to the internet and multimedia messaging service [5] to send and receive images and videos. The cell phone has, therefore, become a critical tool amongst healthcare professionals in patients care and management and for exchange and transfer of skills and knowledge [5].

Notwithstanding, constant handling of mobile phone makes it both a breeding ground and a tool for the transmission of microorganisms and hospital-associated infections [6,7]. Globally,

hospital-acquired infection is an increasing public health concern and Ghana is no exception. At least, 1.7 million nosocomial infections occurred annually in the United States of America, with nearly 100,000 deaths [4]. It has been documented that nosocomial infection affects more than 25% of patients admitted to developing countries [4]. It noteworthy that an estimated one-third of such infections can be avoided in hospital settings by adhering to standard recommendations for infection control [8]. Although the advent of cell phone has brought with its attendant benefits to humanity; there are however possible health hazards this could pose to the many users which could be overlooked. In health care settings, 5– 21% of HCW mobile phones were found to be reservoirs for bacteria liable to cause nosocomial infection [9].

Although in-hospital settings some personal items are kept in dressing rooms, however, HCWs use mobile phones everywhere in health facilities with limited restrictions. Some HCWs also fail to clean their cell phones nor wash hands regularly after using them. Moreover, mobile phones are mostly used tools that come in close contact with surfaces with high microbial contaminations [10]. During the course of the working day, HCWs may use their cell phones several times while strict adherence to handwashing may not be adequately observed. Cell phones used by HCWs may, therefore, become carriers of microorganisms and for the transmission of infections to patients at health facilities, especially in sensitive areas such as intensive care units, theatres, etc.

Failure to wash hands and disinfect cell phones regularly coupled with the ambient condition generated by the mobile phones enhance

breeding and harbouring of microorganisms on them. Cell phones are personal accessories frequently handled with high potential of being contaminated with microbial pathogens that can spread from staff to patients in a hospital setting. Although several studies elsewhere reported microbial contaminations on cell phones used by HCWs, only limited studies are conducted in this study area. Moreover, there is a paucity of data on nosocomial infections in health facilities in this study region. Hence this study profiled bacterial contaminants on mobile phones of HCWs and the possible risk of nosocomial infection.

2. METHODS

2.1 Study Design and Settings

A cross-sectional study design was used to profile bacterial microflora on HCWs' cell phones at the Mampong Municipal Government Hospital (MMGH) from January to April 2019. The MMGH is located in Asante-Mampong Township of the Ashanti Region, Ghana. Mampong is the administrative capital of the municipal with a population of 88,051 [11]. It is bounded by the Sekyere South District to the south, Sekyere Central to the east and Ejura Sekyedumasi District to the north. The Municipality occupies 23.9km² of land area. It is located within longitudes 0° 06" W and 1° 31" W and latitudes 6° 54" N and 7° 36" N.

2.2 Study participants and Sampling

The review board at the Faculty of Science and Environmental Education, University of Education, Winneba, granted ethical approval for the research protocol. Approval was sought from the Municipal Health Administrator and Medical Superintendent of the Mampong Government Hospital. Signed informed consent was obtained from each participant before data collection. All HCWs with cell phones and working at the hospital who agreed willingly to participate in the study were included. We estimated a sample size of 35 HCWs with cell phones expecting 100% microbial contamination with a power of 80% at a 95% confidence interval. A simple random technique was used to sample five [1] departments: Dental Unit, Laboratory Unit, Children's Ward, Male Ward and Theatre of which seven (7 HCWs were sampled per department/unit. Mobile phones were swabbed for microbial examinations after completing a self-administered structured questionnaire. The structured questionnaire included demographic characteristics, hand washing practices, cell

phone disinfection and several years of cell phones usage. The questionnaire was adapted from [12] with some few modifications.

2.3 Sample Processing

Strict aseptic techniques were employed during the sampling process. All sampled mobile phones were each given a unique identifier. A sterile cotton swab moisturized with sterile peptone water was rolled all over the mobile phone outer surfaces. Swabbed samples were taken, placed on ice (4°C) and then transported to the laboratory for microbial analysis.

2.4 Laboratory Methods

2.4.1 Sample preparation and inoculation

A 0.1ml of sterile peptone water was aseptically pipetted into the swab tubes containing the sample. Each tube with the swabbed sample was vortexed to achieve a uniform suspension. Several loops of each sample suspension were streaked onto a pre-labelled MacConkey Agar (Oxoid) and Blood Agar (Oxoid) and were incubated for 12 to 48 hours at 37°C.

2.4.2 Culture and morphological characteristics

The growth of bacteria on Blood and MacConkey Agar were sub-cultured onto Nutrient Agar (Oxoid) and MacConkey Agar respectively to obtain pure isolates. The subculture plates were incubated for 12 to 24 hours at 37° C. Standard microbiological methods were used to examine each isolate previously described [13].

2.4.3 Biochemical Characterization

Pure colonies were subjected to biochemical tests as previously described [13]. For Gram-positive cocci, catalase and coagulase tests were performed to distinguish *Streptococci* from *Staphylococci* Coagulase test was carried out to differentiate Coagulase Negative *Staphylococcus* (CONS) such as *Staphylococcus epidermidis* from *Staphylococcus aureus* (positive).

On the other hand, Gram-negative bacteria cultured on MacConkey Agar were identified as previously [13].

2.5 Data Management and Analysis Method

Data collected from the thirty-five [1] participants were entered into Statistical Package for the

Social Sciences (SPSS-IBM) version 16.0 software. We used descriptive statistics to summarize the distribution of various variables into tables. Discrete variables were analysed using the chi-square test.

3. RESULTS

In Table 1, 66% of the mobile phones were more than a year old, 94% HCWs did not disinfect their phones after use, 91% never disinfect or wash their hands after phone use, and 91% acknowledged possible microbial contamination of their phones while 63% realized a need to disinfect their cell phones.

Table 2 indicates the amount of mixed bacterial isolates from mobile phones of HCWs. Proportions of three types of bacteria isolated from phones for Male ward, Dental Unit and Laboratory Department were 85.7%, 71.4%, and 57.1% respectively while for Theatre and Children’s ward it was 28.6% each. Prevalence of two types of bacteria identified at the Theatre Unit and Children’s department was 57.1% each and 14.3% each for Laboratory, Dental and Male departments. The overall proportion of mixed bacterial isolates per phone were 54.3% (19) and 31.4% (11) for three and two respectively and a

single isolate 14.3% [1] with a significance level of $p < 0.015$ and alpha level of 0.05. At least one or more bacteria were recovered in all HCWs phones examined.

In Table 3, bacteria species recovered from cell phones were: 13 (37%) *Staphylococcus epidermidis*, (G+) 9(26%) *Staphylococcus aureus*, (G+) 7(20%) *Escherichia coli* (G-), 4(11%) *Bacillus* species (G+) and 2(6%) *Klebsiella* species (G-). Laboratory department recorded 28.6% each for *S. aureus* (G+), *S. epidermidis* (G+) and *Bacillus* spp (G+). Meanwhile, *S. aureus* (G+) (42.9%), *S. epidermidis* (G+) (42.9%) and *E. coli* (G+) (14.3%) were isolated at Theatre department. At the Children ward, 28.6% each of *S. aureus* (G+), *S. epidermidis* (G+) and *Klebsiella* spp (G-), were determined and *Bacillus* spp (G+). (14.3%). *E. coli* (G-) (42.9%), *S. epidermidis* (G-) (28.6%) and 14.3% each of *S. aureus* (G+) and *Bacillus* spp. (G+) were recovered at the Dental Department. The significant levels of various microbes presented in table 3 are *S. epidermidis* (G+) ($p > 0.467$), *Bacillus* spp. (G+) ($p > 0.500$), *S. aureus* (G+) ($p > 0.250$), *E. coli* (G-) ($p > 0.282$), and *Klebsiella* spp (G-) ($p = 1.0$) at 0.05alpha level of significance.

Table 1. Survey on the background of cell phone sampled

Queries	Yes [n [1]]	No [n [1]]	Total [n [1]]
Cell phone usage less than 1 year	12 (34)	23 (66)	35 (100)
Need to sanitize your mobile phone	22 (63)	13 (37)	35 (100)
Your cell phone currently disinfected	2 (6)	33 (94)	35 (100)
You disinfect hands after phone use	3 (9)	32 (91)	35 (100)
Your mobile phone may carry pathogens	32 (91)	3 (9)	35 (100)

*cell phones background

Table 2. Number of cell phones of HCWs that had multiple microbial isolates

Microbial isolates	Lab. D.	Theatre D.	Child D.	Dental D	Male D	Total	p-value
1 microbe type	2(28.6)	1(14.3)	1(14.3)	1(14.3)	0(0.0)	5(14.3)	0.015
2 microbe types	1(14.3)	4(57.1)	4(57.1)	1(14.3)	1(14.3)	11(31.4)	
≥3 microbe types	4(57.1)	2(28.6)	2(28.6)	5(71.4)	6(85.7)	19(54.3)	
Total	7	7	7	7	7	35	

KEY:

- ❖ Laboratory D. – Laboratory department
- ❖ Theatre D. – Theatre department
- ❖ Child D. – Children’s department
- ❖ Dental D. – Dental department
- ❖ Male D. – Male department
- ❖ * Those in brackets represent percentages

Table 3. Spread of isolated bacteria as per the sample sources

Sample source	No.	<i>S. aureus</i>	<i>S. epidermidis</i>	<i>Bacillus</i> spp.	<i>E. coli</i>	<i>Klebsiella</i> spp.
Lab Dept.	7	2(28.6)	2(28.6)	2(28.6)	1(14.3)	ND
Theatre Dept.	7	3(42.9)	3(42.9)	ND	1(14.3)	ND
Children's Dept.	7	2(28.6)	2(28.6)	1(14.3)	ND	2(28.6)
Dental Dept.	7	1(14.3)	2(28.6)	1(14.3)	3(42.9)	ND
Male Dept.	7	1(14.3)	4(57.1)	ND	2(28.6)	ND
Total	35	9(26.0)	13(37.0)	4(11.0)	7(20.0)	2(6.0)
p-value		0.250	0.467	0.500	0.282	1.00

Key

- Those in brackets represent percentages*() - Percentage
- *ND – None detectable 0(0.0)

4. DISCUSSION

In this study, more than a third of mobile phones used by HCWs were less than a year old. Most of HCWs failed to disinfect their cell phones and hands after phone use although many of them indicated the need to regularly disinfect phones. These results were fairly consistent with a study in France [14] where it was reported that 42% of cell phones used by the study participants were less than a year old while most of them neither sanitised their mobile phones nor thoroughly sanitized their hands after phone use although they indicated that phones could harbour pathogens. The findings in our study could be indicative of mobile phone users' behaviours and personal hygiene and handwashing practices among HCWs.

In our study, all cell phones of HCWs were contaminated with one or more bacteria species of which most had two or more different bacteria contaminants which was significant ($p < 0.015$) at an alpha level of 0.05 (Table 2). A similar study in a major city in Ghana reported all cell phones to be contaminated with varied numbers of bacteria of which the majority had two or more different bacteria contaminants [15]. A related study showed that all cell phones had mixed bacterial contaminants from participants at a library department, 70% at triage area and 90% at dialysis unit [16] while 60% had single isolates in an intensive care unit [16]. Cell phones are prone to microbial contamination even after following strict standard disinfection procedures as long as they are being used. Cell phones used by HCWs are therefore liable to bacterial contaminations. HCWs could, therefore, infect patients with pathogenic microbes with unclean hands after phone use and may endanger the lives of their patients [17]. In developing countries, the prevalence of hospital-acquired

infections and medical negligence are emerging health hazards in hospital settings [18, 19]. Medical negligence is rarely reported in most developing countries [20] and many health care providers are indifferent towards clinical negligence and medical errors [18, 19].

A previous study reported that a third of mobile phones of HCWs had three or more bacteria types and one type among non-health staff [21]. In this current study, most cell phones of HCWs had two or more bacteria species. The differences in the numbers of bacteria species might be attributable to participants' phone usage behaviours and the department at which they work. Some departments in hospital settings are more committed to strict hand washing practice regime and infection control protocols than others. Other plausible reasons for the different numbers in the bacterial isolates may be due to cell phone disinfection patterns, participant's hygiene, hand washing habits, nose picking, etc. In this study, most HCWs failed to wash their hands after phone use neither did they disinfect their phones. The findings in this study confirmed an irregular adherence to hand hygiene practices among HCWs and this behaviour is a health risk to patients and could lead to an outbreak of nosocomial infections.

In this study, most cell phones of HCWs had at least two different bacteria species from the Male ward, Dental and Laboratory departments. These departments are less restricted and concealed areas and are open to contaminations from environment accounting for the high bacteria colonization of the cell phones of HCWs. Meanwhile, the Children's Ward and Theatre recorded the lowest bacterial contaminants since these departments are more restricted areas in hospital settings with strict enforcement of handwashing practices and infection controls

compared to the other departments. The results, therefore, is indicative of the levels of infection prevention controls at each department. The findings also characterised the working environment and personal hygiene practices of HCWs. Besides, this could be a reflection of the knowledge of HCWs on preventive control measures at each unit.

We isolated and identified five different species of bacteria contaminants from HCWs cell phones fairly consistent with previous studies. With regards to the various isolates and their significant levels, we found that, *S. epidermidis* (G+) ($p>0.467$), *Bacillus* spp. (G+) ($p>0.500$), *S. aureus* (G+) ($p>0.250$), *E. coli* (G-) ($p>0.282$), and *Klebsiella* spp (G-) ($p=1.0$) at an alpha level of 0.05. In Nigeria, *S. epidermidis* (G+), *Bacillus* spp. (G+), *S. aureus* (G+), *E. coli* (G-), and *Klebsiella* spp (G-) were isolated [22], Coagulase-negative *Staphylococcus* (CoNS) and *S. aureus* (G+) were predominant isolates in Ethiopia [23], and in India, CoNS was the dominant isolate [24]. Cell phones directly come into contact with the ears, mouth, face, hands and other surfaces host to microbial flora and are therefore easily contaminated [10]. *S. aureus* (G+) and *S. epidermidis* (G+) are major normal flora in man and hence are likely to contaminate phones accounting for their high numbers in this study. Moreover, the high numbers of *S. epidermidis* (G+) and *S. aureus* (G+) perhaps may be attributed to their high nasal carriers in the human population [25]. *Bacillus* spp. (G+) is an environmental bacteria and was isolated at all study sites with varied proportions [8]. *Klebsiella* spp. (G-) is present in the respiratory tracts of individuals [26] and recorded the low numbers on the cell phones of HCWs.

S. aureus (G+) and *E. coli* (G-) isolated from the Theatre department are potential pathogens of medical importance. These bacteria are liable to cause nosocomial infection [9] including wound infections, pneumonia, urinary tract infections, etc. Theatre departments are deemed to be devoid of possible infectious agents. Surgical patients are at high risk and more prone to nosocomial infections with these bacteria which are widely reported with the tendency to develop resistance to antibiotics [27-29]. *S. aureus* (G+) and *Klebsiella* spp. (G-) were isolated in the Children's Ward and of noteworthy is *S. aureus* (G+) which is known to cause multiple-methicillin resistance in hospitalized children [28,30]. *S. aureus* (G+) isolated from cell phones of HCWs in the Children's Ward is, therefore, a major

health risk to children since this can easily infect children but difficult to treat. At the dental department, *E. coli* (G-), and *S. aureus* (G+) were isolated and could be passed on from HCWs hands to patients during dental surgery.

E. coli (G-), *Staphylococcus aureus* (G+), and *Klebsiella* spp. (G-) were isolated from cell phones of HCWs and are microbes of medical relevance. These microbes are facilitated to multiply at optimum temperature provided by our handsets, wallets, handbags, etc. [31]. These bacteria recovered are pathogens liable to cause nosocomial infections [6]. Hence their presence on mobile phones of HCWs is a potential health threat and a source of nosocomial infections.

5. LIMITATION OF THE STUDY

In this study, there were some inherent limitations. The sample size was relatively small and limited to health care workers at the study departments. Thus, the findings may not necessarily reflect the entire study population and health facilities in the region and the country at large. Notwithstanding, the findings of this study provides a crucial public health relevance and call for the need to adhere to standard hand hygiene practices and cell phones decontamination amongst HCWs. Also, the no significance level in the table 3 might be as a results of type 2 error (small sample size)

6. CONCLUSION

Cell phones of HCWs carried potential bacterial pathogens with a high risk of causing nosocomial infections and therefore strict handwashing and cell phones disinfection should be enforced and practised before and after phone use to reduce the risk of nosocomial infections. This has become even more relevant in the wake of Covid-19 pandemic.

CONSENT TO PARTICIPATE AND ETHICS APPROVAL

The review board at the Faculty of Science and Environmental Education, University of Education, Winneba, granted ethical approval for the research protocol. Approval was sought from the Municipal Health Administrator and Medical Superintendent of the Mampong Government Hospital. Signed informed consent was obtained from each participant before data collection.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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