

Bacterial Contamination of Healthcare worker's Mobile Phones; a Case Study at Two Referral Hospitals in Uganda

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Research

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Abstract

Background

Hospital and Community-acquired infections are escalating and pose significant public health unhealthiness worldwide. The advancements of telemedicine and automation of healthcare records are supported by cellphones, laptops and wearable devices. This study focused on the incidence of healthcare workers' mobile phones becoming contaminated with pathogenic bacteria and their possible roles as vehicles of transmission of antimicrobial-resistant bacteria.

Method: A case study at two referral hospitals in Uganda between May and October 2020. Self-administered questionnaires were administered to participants after informed consent. Mobile phones of the participants in different departments of the hospitals were swabbed and samples were collected and transported to the microbiology laboratory for bacterial culture and antimicrobial susceptibility tests.

Results: The point prevalence of Healthcare workers' mobile phone bacterial contamination with one or more species was 93%. Organisms isolated were *E. coli* 5.6% (1), *Micrococcus spp* 11.1% (2), Coagulase-negative *staphylococci*, CoNS, 61.1% (11) and *Bacillus spp* 22.2% (4). About 45% of the organisms were multidrug-resistant. Resistance was major to penicillin, cotrimoxazole, ciprofloxacin and Gentamycin respectively. The isolated *E. coli* was resistant to all antibiotics used in the study. Only 15% (2) of the participants disinfected their phones at least once a week and 8% cleaned their hands after using a mobile phone.

Conclusion:

Healthcare Workers' mobile phones can act as fomites for the transmission of multidrug-resistant microorganisms. This study provides strong evidence for developing and strengthening disinfection protocols for mobile phones and does not underscore the importance of hand hygiene in the middle of a patient encounter especially when the HCW grabs a phone but doesn't re-clean their hands before patient contact.

Introduction

High incidence of hospital-acquired infections tremendously increases the mortality and morbidity of patients especially in immunosuppressed populations including paediatrics, pregnant women, surgical patients and people with chronic illnesses like HIV/AIDS.(1)

Micro-organisms especially bacteria are often found almost everywhere like; within the air, water, soil, food, and plants and animals, including humans. It's greatly observed that inanimate objects also can carry microorganisms originating from the encircling environment. To be specific; Gram-positive cocci (*Staphylococcus spp.*, *Micrococcus spp.*), but also spore-forming rods (*Bacillus spp.*) or Gram-negative bacteria, is transmitted through devices like mobile phones or computer keyboards (2).

Mobile phones became indispensable accessories for professionals and social life. Nevertheless, several kinds of research have shown the potential bacteria colonization of mobile surfaces and their ability to transmit diseases(3).

With the emerging of telemedicine, the utilization of cell phones often occurs in hospitals by health care workers, and this can be one environment where hospital-associated (nosocomial) infections are most predominant (4).

Unlike our hands which are easily disinfected using alcohol-based hand rubs (ABHR) that are made available readily across all hospitals and medical facilities, our mobile phones are quite tricky to scrub or disinfect and this is often evident as few healthcare workers perform decontamination of those devices (5).

The role of fomites within the transmission of infectious diseases in healthcare institutions was extensively investigated and mobile phones were more problematic compared to other fomites especially when handling Phones during patient care procedures, HCWs could easily transmit microorganisms from patients to their mobile phones and vice versa (6).

In Uganda, bacterial infections alone were accountable for 26% of all admissions, 23% of all mortalities and 20% of all deaths in children under the age of 5 in 2018 (7).

The spread of nosocomial infections is worsened by the emergence of anti-microbial resistant strains of bacterial organisms which significantly increase the mortality and morbidity of bacterial infections furthermore because of the cost of healthcare (8).

A reasonable gap between the knowledge about fomites acting as vectors within the spread of nosocomial infections and practices done to reduce this spread is critical. Having adequate knowledge is ineffectual until and unless it's translated into the correct application of infection control practices(9). Preventing the spread of nosocomial infections across patients and medical examiners are therefore of paramount importance towards reducing morbidity and mortality in Resource-limited countries. Little research has been done to analyze the role of mobile phones in the spread of multi-drug resistant (MDR) organisms and nosocomial infections, especially in Uganda. The aim of this study, therefore, was to spot bacteria on mobile phones, associated factors and susceptibility patterns to grasp the role of mobile phones as drivers of MDR and hospital-acquired infections in health facilities in Uganda.

Methods

Study area: This study was conducted at two hospitals in Uganda, Kabarole Regional Referral Hospital found in western Uganda which is a referral Hospital for Kamwenge, Kabarole, Kyegegwa, Ntoroko, Bundibugyo, Kitagwenda and Kyegegwa districts, with a 333-bed capacity. Mulago National Referral Hospital is a component of Mulago Hospital Complex, the teaching facility of Makerere University College of Health Sciences found in Kampala the capital of Uganda and it has a 1000 bed capacity.

Study Design and Period: A case study was conducted at two regional referral hospitals between May and October 2020.

Study Population: Healthcare workers who had used mobile phones for three months or more and consented to participate in the study.

Sampling: A total of 13 Mobile phones were conveniently sampled from healthcare workers who verbally consented to participate in the study.

A questionnaire was completed by a participant that had parameters like; the situation (Hospital department), usage time of mobile phones, smartphone or non-smartphone,

Smart Phones methods of disinfection and material used if any, the quantity from the last cleaning of the mobile phones, awareness that cell phones can function as a source or drivers of infection, washing hands before and after using the phones and using the phone when during a toilet.

Upon completion of the questionnaire, mobile phones were aseptically swabbed on the screen, keypads employing a moistened sterile swab and coded as the individuals' questionnaire.

Sample Processing: Samples collected from Kabarole Hospital were transported and analyzed at the JMEDICC Laboratory within the hospital. Those collected from Mulago Hospital were analyzed at the school of Health Sciences Clinical Microbiology Laboratory of Makerere University. All samples were transported to the laboratories within 12 hours after collection and plated immediately.

Sample Inoculation: The cotton end of the swab with the sample was soaked in 10ml peptone water and incubated aerobically at 37°C for twenty-four hours.

Isolation of Organisms: We performed pure plating where pure isolated colonies were sub-cultured onto agar plates to grow fastidious organisms and to differentiate bacteria that supported their hemolytic properties. MacConkey agar plates were also used to isolate lactose fermenters.

Identification of Organisms: From the pure colonies, gram staining was performed to differentiate gram reactions. The biochemical tests to include; catalase, Indole, Citrate, Oxidase, Urease and urease and coagulase were performed.

Antibiotic Susceptibility Tests (AST): Antibiotic susceptibility tests were performed on the Mueller-Hinton agar using the Kirby-Bauer disc diffusion technique. Four antibiotic discs contain the drugs most typically utilized in Uganda for treatment of bacterial infections; Penicillin (P) 10µg, Gentamycin (CN) 10µg, Ciprofloxacin (CIP) 5 µg and Cotrimoxazole (Cxt) 25 µg. We measured zone diameters on plain Mueller Hinton agar with a ruler for sensitivity as in Table 1(10).

Table 1 shows an interpretation of zone diameters on Mueller Hinton agar

Drug	Resistant	Intermediate.	Sensitive
CN	< 12	13-14	> 15
SXT	Less than 10	11-15	Greater than 16
P	Less than 28	-	Greater than 29.
Cip	Less than 15	15-20	Greater than 20

Quality assurance and Quality control: To avoid cross-contamination, the researcher wore a replacement pair of sterile new gloves when sampling each mobile phone after hand rubbing with locally produced alcohol-based hand sanitizer (ABHS) since it's been proven to have a high antimicrobial effect (11,12). Standard operating procedures were followed at each step including the use of American Type Culture Colonies (ATCC) that were compared with the pure colonies isolated.

Results:

Healthcare worker demographics

We screened 13 mobile phones owned by 13 healthcare workers, (4 Laboratory Technicians, 2 clinicians, 5 Nurses and 2 midwives) as presented in the supplementary material. Of the 13 phones, 2 were non-smartphone whereas 11 were smartphones as indicated in Figures 1a and b.

In principle; all the 13 healthcare workers were interviewed and 54% (n=7) of these had knowledge on mobile phones acting as reservoirs for micro-organisms, and from our analysis, only 15%(n=2) of the participants disinfected their phones at least once a week, 8% (n=1) cleaned their hands after using a mobile phone. Captivatingly, 31% (n=4) of the participants used the phones with gloved hands and 31% (n=4) used the phones while in a toilet as shown in table 2.

Results suggest that the majority of the healthcare workers do not routinely disinfect their phones and also miss the opportunity of hand hygiene after using their phones in the middle of a patient encounter.

Table 2. Associated Factors to bacterial contamination of Healthcare worker's mobile phones, n represents the total number of participants

Associated Factors	Number	Percentage
	(n=13)	
Have knowledge of Mobile phones as microorganism reservoirs	7	54
Disinfect phones	2	15
Use phone while in a toilet	4	31
Handle phone with gloved hands	4	31
Perform hand hygiene after phone contact	1	8

Bacterial isolates and susceptibility testing

In total, 13 swabs from 13 mobile phones of healthcare workers were collected and analyzed. In this way, 100% (n=2) of the None smartphones and 90.9% (n=11) of the smartphones were contaminated with one or more species of bacteria, Fig 1b. A total of 18 isolates were obtained with overall bacterial contamination registered at 92.3% (n=12). Figure 2 unveils organisms isolated as; *E. coli* 5.6% (1), *Micrococcus spp* 11.1% (2), Coagulase-negative *staphylococci*, CoNS, 61.1% (11) and *Bacillus spp* 22.2% (4). About 90% (n=10) of the CoNS isolates were resistant to Penicillin, 80% (n=9) resistant to cotrimoxazole, 60% (n=6) resistant to ciprofloxacin and all susceptible to gentamicin.

In the present case study, about 46% of the isolated organisms were multidrug-resistant, highest resistance registered with penicillin, cotrimoxazole, ciprofloxacin and Gentamicin respectively. *E. coli* was resistant to all the antibiotics used in the study as indicated in figure 2 and supplementary material.

Discussion

From this current study, the overall point prevalence of bacterial contamination of Healthcare workers' mobile phones with one or more species was at 93%. Organisms isolated were majorly, Coagulase Negative *Staphylococcus Aureus* (CoNS) in both hospitals, despite this being a skin normal flora it could be exogenously from surgical staff and can cause neonatal sepsis and also be able to transfer resistant genes to coagulase-positive *staphylococcus aureus* using horizontal gene transfer mechanism (13,14). Other organisms were *Bacillus spp*, *Micrococcus spp*, which are predominantly associated with dusty environments habitual with Sub-Saharan Africa mainly rural and semi-urban settings (15) and *E. coli* which is suggestive of faecal contamination. Our study is of great public health importance with a perspective of faecal contamination and HAI transmission respectively. *E. coli* has been found to complicate wound sepsis resulting in poor patient prognosis (16), agreeing with a study by Jana Koscova *et al* who majorly isolated skin coagulase-negative *staphylococci aureus*, species of the genus *Bacillus* and *E.coli*.

From this study, no conclusive factor was found to be associated with bacterial contamination of the Healthcare workers phones we however took into consideration the following hypotheses as factors associated with bacterial contamination, a smaller number of the HCW knew about mobile phones acting as reservoirs for micro-organisms, only 2 of the participants disinfected their phones at least once a week, some HCW used the phones with gloved hands and some used the phones while in a toilet similar findings by Ulger *et al*/indicate differences in personal hygiene and behaviours and failure of disinfecting the phones after contact as contributing factors to contamination (17).

This study further revealed that about 46% of the isolated organisms were multidrug-resistant, highest resistance registered with penicillin, cotrimoxazole, ciprofloxacin and Gentamicin respectively. *E. coli* was resistant to all the antibiotics used in the study and this can be explained by the intrinsic resistance of *E. coli* by way of possessing cascades that guard cell membrane permeability as well as producing Amp C B-lactamases (18). Coagulase Negative *Staphylococcus Aureus* (CoNS) is considered a normal flora however its drug resistance in this study is suggestive of being acquired exogenously from the hospital environment (15).

Even when the study registers a lot of strengths, we still had limitations as the study sample size was small due to lack of funding and this could also have been the reason for the lack of statistical significance of conclusive factors associated with bacterial contamination of HCW mobile phones. Bacteria quantification was not performed since the laboratories never had bacteria quantification capacity at the time of the study and in this way the study did not quantify the isolates from each mobile phone.

Conclusion

Healthcare Workers' mobile phones can act as fomites for the transmission of multidrug-resistant micro-organisms. This paper is particularly relevant because both the data-gathering and sample analysis took place during the COVID-19 pandemic, where the protocols were meant to be rigorous. Advancements in telemedicine and automated healthcare have not been matched by advancements in sanitizing and decontaminating protocols for phones and other mobile devices, this is a time bomb of microbial transmission. This study provides strong evidence for developing and strengthening disinfection protocols for mobile phones and not underscore the importance of hand hygiene in the middle of a patient encounter especially when the HCW grabs a phone but doesn't re-clean his/her hands before patient contact.

Declarations

Definition of Terms:

Disinfection; the process of cleaning an inanimate object especially with a chemical/detergent, to destroy microorganisms.

Smart Phone: is a portable device that combines telephone and **computing** functions into one unit with an extensive mobile operating system like a mini-computer which facilitate wider software, internet and multimedia function capabilities alongside core phone functions such as **voice calls** and **text messaging**.

Non-smart Phone: is a phone that does not have an operating system, computing capabilities, GPRS, syncing capabilities, video conferencing or a basic or a feature phone. A basic phone is any phone that allows the user basic features such as sending/receive calls and texts.

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Abbreviations

MDR; Multidrug-resistant, WHO; World Health Organization, IPC; infection prevention and control, HHC, hand hygiene compliance, JMEDICC; Joint Mobile Emerging Disease Intervention Clinical Capability

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Figures

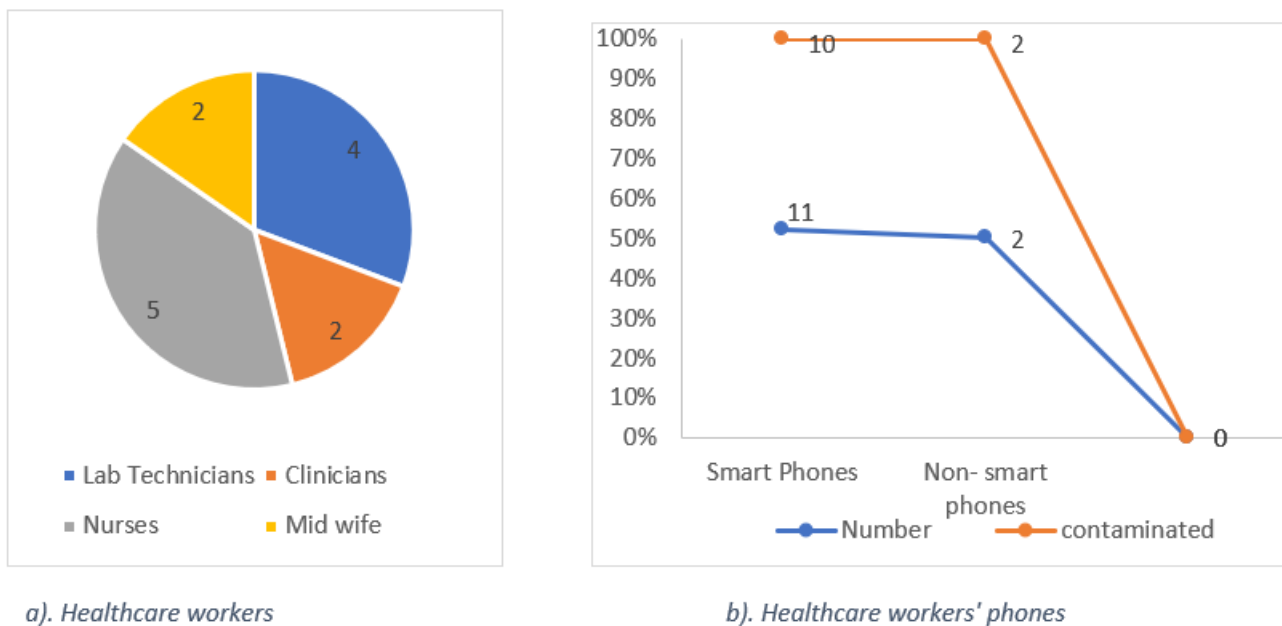


Figure 1

Healthcare workers categorized by cadre, (a) and contamination of mobile phones classified as smartphones and non-smartphone

Supplementary Files

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- [MobilephoneBacterialcontaminationsupp.docx](#)