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Prevalence and Risk Factors of Bacterial Contamination on Healthcare Professionals' Mobile Phones in a Cameroonian Tertiary Hospital: Efficacy of Common Decontamination Methods

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A B S T R A C T

Mobile phones have become essential tools in both daily life and healthcare environments. However, their widespread use in clinical settings raises concerns regarding their role in transmitting pathogenic bacteria. This study aimed to assess the prevalence of bacterial contamination on the mobile phones of healthcare professionals (HPs), identify the isolated organisms, evaluate common decontamination methods, and determine associated risk factors. A prospective cross-sectional analytical study was conducted from June to July 2024, involving 162 HPs selected through convenience sampling. Data on hygiene practices and mobile phone usage were collected using a self-administered questionnaire. Mobile phones were swabbed and analyzed in a microbiology laboratory for bacterial cultures. Bacterial contamination was found on 66.7% of the samples. The predominant isolates included *Staphylococcus saprophyticus* (29.6%), *S. epidermidis* (20.4%), and *S. aureus* (11.1%). Key risk factors identified included inadequate hand hygiene (OR = 5.876), infrequent disinfection of phones, and the absence of structured cleaning protocols. Disinfectants such as 10% bleach and 70% alcohol demonstrated efficacy, although their effectiveness varied depending on contact time. The mobile phones of HPs may serve as significant reservoirs for potentially harmful bacteria. Implementing standardized disinfection protocols is crucial for reducing the risk of cross-contamination in healthcare environments.

Introduction

The year 1970 marked a significant turning point in the realm of technology, particularly with the advent of mobile phones (Fard *et al.,* 2018). Since their introduction, mobile phones have proliferated worldwide, bringing about profound changes to our daily lives, both in professional and social contexts (Madhuri *et al.,* 2015; Bodena *et al.,* 2019). They have become an essential tool within the healthcare delivery system, enhancing the quality of care and facilitating communication (Kotris *et al.,* 2017; Ulger *et al.,* 2015). Mobile phones facilitate communication among healthcare departments, improving access to patient information and overall care (Prgomet *et al.,* 2009; Ventola, 2014). Typically, mobile phones are kept in bags or pockets for convenient access by patients, visitors, and healthcare workers in hospitals (Fard *et al.,* 2018). However, amidst these advantages, it's crucial to recognize the potential health risks associated with their use (Rana *et al.,* 2013). The frequent handling of mobile phones by healthcare professionals, combined with a lack of regular disinfection, can turn these devices into likely carriers of bacterial pathogens, including multidrug-resistant organisms (Famurewa & David, 2009; Banawas *et al.,* 2018). The surfaces of healthcare professionals' mobile phones can harbor various healthcare-associated pathogens (Selim & Abaza, 2015), particularly bacteria linked to skin colonization. This occurs mainly due to the warm and moist conditions commonly found in the human body, especially on the palms of the hands (Tagoe *et al.,* 2011). Furthermore, the heat generated by mobile phones can create an environment conducive to bacterial growth. Furthermore, these bacteria can survive for weeks on non-living surfaces (Kramer *et al.,* 2006; Weber *et al.,* 2010). As a result, mobile phones can facilitate microbial cross-contamination between HPs and patients, posing a risk for nosocomial infections (NIs) (Ulger *et al.,* 2009; Brady *et al.,* 2011). NI are a significant concern for patient safety globally, particularly in low- and middle-income countries, as they contribute to considerable morbidity, mortality, and increased healthcare costs (Burke, 2003; Allegranzi *et al.,* 2011).

Studies have shown that coagulase-negative staphylococci (CoNS) are the most frequently found contaminants on mobile phone surfaces (Tagoe *et al.,* 2011; Kumar *et al.,* 2014; Chaka *et al.,* 2016). Other studies have identified pathogenic organisms, such as methicillin-sensitive *Staphylococcus aureus* (MSSA), methicillin-resistant *Staphylococcus aureus* (MRSA), *Escherichia coli* (*E. coli*), *Corynebacterium spp*., *Enterococcus faecalis*, *Clostridium perfringens*, *Klebsiella spp*., *Enterobacter spp., Pseudomonas spp., Aeromonas spp., Acinetobacter spp.,* and *Stenotrophomonas maltophilia* (Shahaby *et al.,* 2012; Selim and Abaza, 2015; Yao *et al.,* 2022). The presence of these organisms poses a risk to infection control measures and can increase the incidence of nosocomial infections (NIs) (Misgana *et al.,* 2015).

While research from various countries has highlighted the role of mobile phones in the transmission of NIs, Cameroon lacks comparable investigations. Given the recognized geographical differences in mobile phone contamination and the distinct contexts of various communities (Oluduro *et al.,* 2011), assessing contamination rates in Cameroon is essential. Additionally, there are no restrictions on mobile phone use in hospitals, and many healthcare professionals do not routinely clean their devices (Julian *et al.,* 2012; Bhardwaj *et al.,* 2020).

Therefore, this study aimed to evaluate the prevalence of bacterial contamination on mobile phones, identify factors associated with this issue, and assess the effectiveness of disinfectants used by healthcare professionals at the Yaoundé General Hospital in the Central Region of Cameroon.

Materials and Methods

Study Design, Location and population

This study was carried out using a prospective cross-sectional analytical design, involving 162 healthcare professionals from the Yaoundé General Hospital from June to July 2024. As the largest tertiary care facility in Yaoundé, the capital of Cameroon, this hospital serves millions of residents and offers specialized medical care across the country. Participants included both men and women from various departments within the hospital, with their socio-demographic characteristics outlined previously (Tchinda *et al.,* 2025).

Data and sample collection

A self-administered questionnaire was used to collect data on sociodemographic variables (such as gender and department), hand hygiene practices (like frequency of disinfection and use of disinfectants), and mobile phone

disinfection routines (types of disinfectants employed and circumstances prompting phone cleaning). The process of collecting samples from the mobile phones of healthcare workers and transporting them to the laboratory has been detailed earlier[28].

Isolation and identification of bacteria from mobile phones

Bacteria were isolated using standard culture media and subsequently identified through morphological and biochemical tests, including the APINE® gallery as outlined in previously described protocols (Tchinda *et al.,* 2025).

Effectiveness of Disinfectants on Identified Bacterial Isolates

We evaluated the effectiveness of disinfectants by using sterilized metal tongs which were treated in an autoclave. Both 10% bleach and a 70° alcohol-based disinfectant were utilized for this study. 70° Bacterial strains were applied to the metal bar of the tongs, which were then submerged in the designated disinfectant, with the exposure time carefully recorded. Two pairs of tongs were utilized for this purpose. After 5 and 10 minutes of exposure, the tongs were removed, rinsed in sterile saline, and then inoculated on blood agar plates, which were incubated at 37°C for 24 hours under anaerobic conditions. Following incubation, we assessed bacterial growth, or the absence thereof.

Statistical Analysis

The collected data underwent a thorough review for completeness and consistency before being entered into CSPro (Census and Survey Processing System) software version 7.0, and later transferred to SPSS (Statistical Package for Social Sciences) version 25.0 for analysis. We utilized descriptive statistics to determine the distribution of each study variable and to characterize the findings (frequencies). Prevalence was expressed as proportions of each group relative to the total population, presented as frequencies. We also investigated associations between sociodemographic factors, disinfection practices, and mobile phone contamination through binary logistic regression analyses. The strength of these associations was measured using odds ratios (OR) along with 95% confidence intervals (CI 95%). Results were deemed statistically significant at $p \leq 0.05$.

Ethical considerations

Respect for the respondents was upheld throughout the study, ensuring data anonymity. This study was conducted in accordance with the Declaration of Helsinki. Prior to administering the questionnaire, all participants were verbally informed of the study's objectives and purpose. Ethical approval (No. 4370 CEI-Udo/06/2024/M) was obtained from the Institutional Ethics Committee for Human Health Research at the University of Douala (CEI-UDo), in addition to approval from the director of Yaoundé General Hospital (N/Ref 445-24/HGY/DG/DPM/APM-TR) to carry out the study. The anonymity of respondents was guaranteed, and both verbal and written consent was obtained from all study participants.

Results and Discussion

Frequency of bacteria isolated before disinfection

Of the 162 mobile phones sampled and inoculated, 33.3% exhibited a sterile culture, while 66.7% displayed bacterial growth. Among the bacteria identified 29.6% were *Staphylococcus saprophyticus* and 20.4% were *Staphylococcus epidermidis,* being the most commonly isolated (Figure 1).

Effectiveness of disinfectants on identified bacterial isolates

Efficacy of 10% bleach on bacterial isolates

The findings indicate that 10% bleach solution is highly effective in disinfecting the tested bacterial isolates. In fact, a marked reduction (over 80%) in viable microorganisms was observed as early as 5 minutes of contact, reaching zero for most strains after 10 minutes. However, the *E. coli* strain still showed a few residual colonies after 10 minutes. Consequently, bleach has proven to be an effective disinfectant, even at a concentration of 10%, successfully eliminating nearly all bacteria in less than 10 minutes of contact time (Table 1).

Effectiveness of a 70% alcohol-based solution on bacterial isolates

Table 2 demonstrates that a 70% alcohol-based disinfectant solution was also highly efficient against the various bacterial strains examined. After just 5 minutes

of contact, viable micro-organisms were nearly eradicated, with total elimination occurring after 10 minutes for most isolates. *Staphylococcus saprophyticcus* was the only strain to show a few remaining colonies after 5 minutes. These results indicate that 70% alcohol is an exceptionally effective disinfectant, capable of eliminating the majority of bacteria in just 5 minutes.

Factors associated with the presence of germs on mobile phones

Table 3 highlights the factors contributing to the presence of germs on healthcare workers' mobile phones, as identified through logistic regression analysis. Notably, the absence of phone cleaning was significantly associated with a higher presence of germs (p=0.03). Similarly, forgetting to wash one's hands was also significant (p=0.037). Additionally, lack of time emerged as a limiting factor for hand hygiene practices (p=0.001).

Mobile phones, while non-medical devices, are increasingly employed in healthcare settings for purposes like epidemiological data collection and disease tracking within communities and medical facilities (Waruingi *et al.,* 2009). In Cameroon, mobile phones are used in medical settings without any restrictions, despite their high microbiological load.

The present study found that 66.7% of healthcare workers had bacterial contamination on their phones. Higher contamination rates have been reported in Hawassa and Gondar (Ethiopia) (Gashaw *et al.,* 2014), India (Sedighi *et al.,* 2015; Pal *et al.,* 2015), and Iran. Conversely, India recorded lower contamination rates at 24% (Balapriya *et al.,* 2016). These differences could be attributed to variations in hand hygiene practices, hospital policies on phone usage, adherence to infection prevention measures, and the frequency of cleaning mobile phones during working hours, and the awareness of healthcare workers about the role mobile phones play in the spread of microbes.

The identification of bacteria cultured from the mobile phones of healthcare professionals (HPs) revealed two main groups: Gram-positive bacteria and Gram-negative bacilli. Our findings revealed that Gram-negative bacilli (3.8%) were less common compared to Gram-positive bacteria (61.7%). This contrasts with data obtained by Njall *et al.,* (2013) at Laquintinie Hospital in Cameroon, where Gram-negative bacteria were predominant, although it aligns with studies conducted by Uwingabiye *et al.,* (2015). These discrepancies might be attributed to the fact that Gram-negative bacilli do not thrive on dry surfaces like normal skin and mobile phones.

In terms of bacterial proportions, our investigation revealed that *Staphylococcus saprophyticus* (29.6%) was the most frequently isolated bacterium, closely followed by *Staphylococcus epidermidis* (20.4%).

Considering that *Staphylococcus epidermidis* is naturally found on the skin, this finding aligns with prior research by Sepehri *et al.,* (2009), which noted that 40% of the bacteria from healthcare workers' hands were commensals like *Staphylococcus epidermidis*.

The isolation rate of *Staphylococcus aureus* in the present study matched findings by Zakai *et al.,* (2016). However, other studies in Ethiopia (Misgana *et al.,* 2014; Gashaw *et al.,* 2014; Verma *et al.,* 2015), India (Sharma & Jhanwar, 2015), Italy (64.1%) (La Fauci *et al.,* 2014), and Nigeria (25.6%) (Amala & Ejikema, 2015) reported higher isolation rates.

Additionally, *Klebsiella pneumoniae* (2%) ranked as the fourth most predominant bacterial pathogen in this study, which is lower than findings from Belgium (15.25%) (Tiwari *et al.,* 2016) and India (19%) (Tankhiwale *et al.,* 2012). *Escherichia coli* (1.2%) was the fifth bacterium isolated, consistent with a study in Iran by Hosseini *et al.,* (2018). Nevertheless, this rate is lower than those reported in Ethiopia (23.5%) (Verma *et al.,* 2015), Belgium (25.42%) (Tiwari *et al.,* 2016), and India (16%) (Tankhiwale *et al.,* 2012). The presence of *E. coli* indicates poor hand hygiene and inadequate sanitation of mobile phones, as this organism is typically part of the intestinal flora and a common cause of nosocomial infections.

Our results indicate that mobile phones act as reservoirs for bacteria linked to both community-acquired and nosocomial infections. In our study, 66.7% of the phones were found to be contaminated with pathogens, a rate lower than the 80.2% reported in a study by Yao *et al.,* (2022) in China.

This could be attributed to moderate hand hygiene and phone sanitation. Most healthcare professionals (96.9%) recognized the risk of cross-contamination from their hands, and 90.7% knew the proper handwashing procedures.

Table.1 Reduction (%) in viable bacterial isolates after disinfection with 10% bleach at 5 and 10 minutes of contact time.

Bacterial isolates	Before disinfection	After disinfection	
		5 min	10 min
Staphylococcus aureus	11.1%	1.2%	0%
Staphylococcus epidermidis	20.4%	0.6%	0%
Staphylococcus saprophyticcus	29.6%	11.1%	0%
Klebsiella pneumoniae	2%	1.9%	0%
Klebsiella oxytoca	0.6%	0.6%	0%
E.Coli	1.2%	1.2%	0,6%
Bacillus	0.6%	0%	0%

Table.2 Reduction (%) in viable bacterial isolates following treatment with 70% alcohol-based disinfectant at 5 and 10 minutes of contact time.

Bacterial isolates	Before disinfection	Afterdisinfection	
		5 min	10 min
Staphylococcus aureus	11.1%	0%	0%
Staphylococcus epidermidis	20.4%	0,6%	0%
Staphylococcus saprophyticcus	29.6%	5,3%	0%
Klebsiella pneumoniae	2%	0,6%	0%
Klebsiella oxytoca	0.6%	0,6%	0%
E.Coli	1.2%	1,2%	0%
Bacillus	0.6%	0%	0%

Figure.1 Distribution (%) of bacterial species isolated from healthcare professionals' mobile phones prior to disinfection at Yaoundé General Hospital.

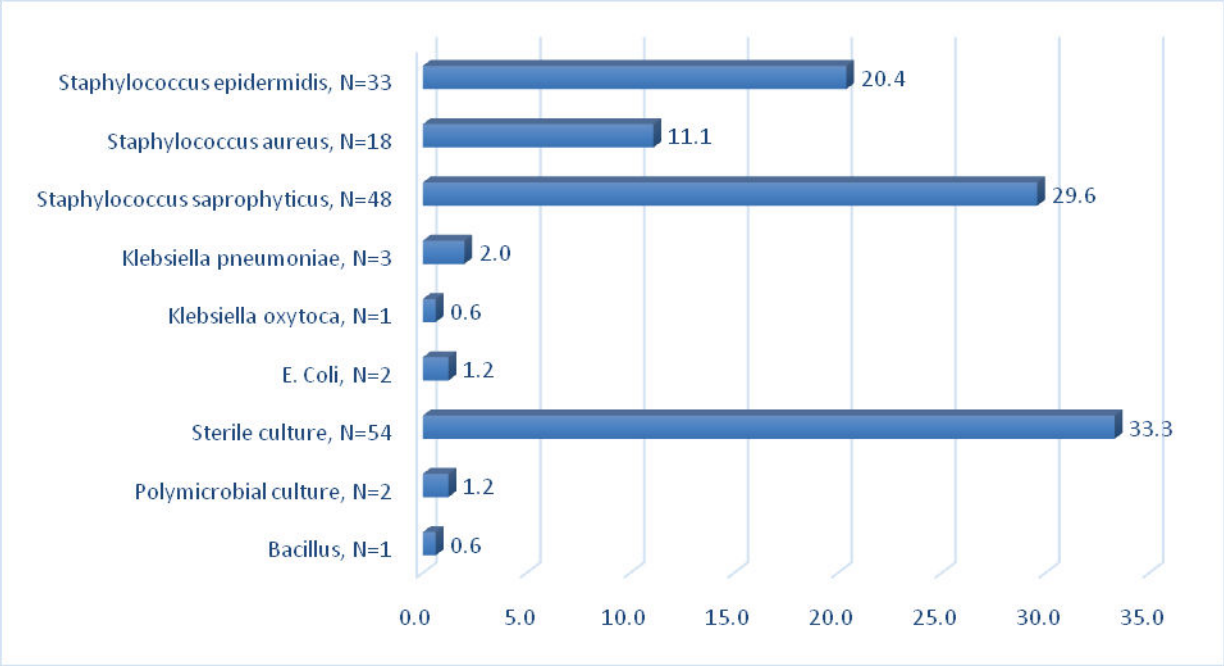

Table.3 Distribution of data after logistic regression

Variables	OR	CI (95%)	P-value
Work area			
Administration block	0.456	0.250 – 0.830	0.865
Laundry	0.824	0.250 – 1.678	0.997
Surgery	1.005	0.430 – 1.930	0.744
Out patient department	0.619	3.50 – 4.120	0.700
Technical Affairs Department	1.386	0.340 – 6.730	0.910
Approved Treatment Centre	0.790	1.250 – 4.730	0.360
Dialysis	3.962	1.560 – 8.750	0.245
Registration	2.790	2.150 – 10.840	0.358
Gastrology	3.548	0.550 – 15.650	0.456
Oncology	2.493	4.250 – 9.830	0.688
Ophthalmology	1.525	0.740 – 3.530	0.994
Pharmacy	3.122	2.450 – 7.970	0.567
Radiology	1.459	0.012 – 0.407	0.672
Emergency	2.520	0.112 – 4.407	0.331
Urology	1.650	1.015 – 7.456	0.765
Time to complete all 5 steps of hand washing			
Before and after any clean or aseptic procedure	3.659	1.782 – 7.312	0.379
After touching body fluids	1.002	0.052 – 0.312	0.199
After touching the patient	0.067	0.043 – 4.657	0.785
Before touching the patient	1.497	1.685- 3.719	0.688
At any time	2.497	1.685- 23.619	0.088
Reasons for inadequate hand hygiene			
Forget	5.876	0.971 – 25.591	**0.037****
Lack of time	1.659	0.010 – 3.733	**0.001*****
Circumstances in which the phone must be cleaned			
Hydroalcoholic hand solution	5.025	0.554 – 3.059	0.241
Water and soap	1.770	0.455 – 3.059	0.668
Bleach-based disinfectant	3.702	1.351 – 11.029	0.418
No	15.861	0.971 – 45.591	**0.043****
Type of disinfectantused			
70° alcohol-based disinfectant	3.560	1.787 – 8.837	0.784
Soap and water	0.860	0.867 – 5.837	0.268
Water and bleach	1.770	0.455 – 3.059	0.668
No	3.654	0.971 – 35.591	**0.03****

****Significant at 1%; **significant at 5%; *significant at 10%.*

Yet, only 43.2% reported washing their hands after contact with patients, although the majority used soap and water (89.5%). While our study confirms that washing hands with soap and water is not completely effective, this finding aligns with earlier studies by Kac *et al.,* (2005) in 2005 and Lucet *et al.,* (2002), which noted that transient flora often remained on hands unless treated with alcohol-based solutions.

Before disinfection, our cultures revealed a contamination rate of 66.7% on mobile phones. However, after a 5-minute application of a disinfectant, there was a significant reduction in pathogens to 48.2%, leading to a final contamination rate of 18.5%. This observation is consistent with findings by Murgier *et al.,* (2016). in France, which illustrated that even after 5 minutes, few microorganisms were eliminated, with

disinfectant efficacy increasing after 10 minutes and peaking around 15 minutes, excluding certain pathogens like tuberculosis that required longer exposure around 120 minutes. After 10 minutes of disinfection, we achieved a remarkable 99% sterile culture outcome, indicating almost complete eradication of microorganisms.

Various factors were associated with mobile phone contamination in our study. We identified a correlation between the hospital departments and the presence of bacteria (P = 0.002), with the outpatient consultation service displaying the highest levels of contamination during culture. This could be due to the large number of people frequenting this area, suggesting that installing hand sanitizer dispensers at the department's entrance would be beneficial. Furthermore, timing of disinfection and bacterial presence was also correlated (P = 0.001), emphasizing that handwashing solely after contacting an infectious surface is not an effective approach. There were notable variables significantly related to how electronic devices are disinfected and the presence of germs before cleaning, including the specific circumstances under which phones are cleaned (P = 0.00), the type of disinfectant used (P = 0.004), and frequently interrupting work to answer the phone (P = 0.000) were significantly connected to the presence of germs before cleaning. Studies by Kac *et al.,* (2005) and Lucet *et al.,* (2002). confirmed that alcohol-based hand sanitizers were effective in removing transient flora remaining on hands.

This study identified a high prevalence of bacterial contamination on mobile phones used by healthcare professionals, with *Staphylococcus saprophyticus*e merging as the most commonly isolated microorganism. Disinfectants were found to require at least ten minutes to effectively eliminate nearly all bacterial presence. Factors that were most strongly associated with bacterial contamination of mobile phones included inadequate hand hygiene, time constraints that hindered proper handwashing, the lack of a designated cleaning protocol and area for phones, and the absence of disinfectant use.

Based on these findings, it is imperative for healthcare professionals to clean their mobile phones after each use and to perform hand washing before and after patient interactions in the hospital. Additionally, implementing guidelines regarding mobile phone usage, particularly in sensitive areas, is crucial to curbing the transmission of bacteria from hands to phones and, ultimately, to patients.

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Author's Contributions

CFT: conceptualized the study, designed the experiments, and wrote the manuscript. LONT: conducted the study and designed the experiments. DI: analyzed the data and revised the manuscript. KDAN: supervised laboratory work and revised the manuscript. GEF and GNN: participated in laboratory work and revised the manuscript. FMYT, GA and SGM participated in laboratory work. ATD conceived the study and revised the final form manuscript. All authors have read, revised, and approved the final version of the manuscript.

Data Availability

All data generated or analyzed in the course of this study are included in this manuscript.

Declarations

Ethical Approval Not applicable.

Consent to Participate Not applicable.

Consent to Publish Not applicable.

Conflict of Interest The authors declare no competing interests.

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