***Original Research Article***

**Evaluation of hygiene practices among medical staff using mobile phones at Yaoundé General Hospital: Implications for infection and sepsis prevention**

**ABSTRACT**

**Background:** Nosocomial infections, particularly sepsis, represent a major public health challenge, especially in hospital settings where hygiene practices may fall short. The use of mobile phones by medical staff can act as a vector for pathogen transmission, thereby increasing the risk of cross-infections. This study aims to evaluate the hygiene practices of medical staff when using mobile phones at Yaoundé General Hospital and assess their impact on infection and sepsis prevention.

**Materials and methods:** A cross-sectional, analytical, and evaluative study was conducted among medical staff within the hospital. Utilising a stratified random sampling method, this study included 162 participants. Data were collected through direct observations, structured questionnaires, semi-structured interviews, and microbiological analyses of samples taken from mobile phones and hospital surfaces. Statistical analyses comprised both descriptive and comparative tests.

**Results:** The findings revealed that 97.5% of medical staff carry their phones at work, 85.8% use them in clinical settings, and 60.5% do not wash their hands after answering calls. Microbiological analysis detected potentially pathogenic bacteria, including *Staphylococcus aureus, Klebsiella pneumoniae,* and *Escherichia coli,* on mobile phones. Disinfection practices were inconsistent and frequently inadequate, with only 45.7% of participants using an alcohol-based disinfectant.

**Conclusion:** This study highlights the urgent need for heightened awareness and the establishment of stringent disinfection protocols for mobile phones within hospital settings to mitigate the transmission of nosocomial infections and sepsis. Implementing specific recommendations, such as training sessions and hygiene audits, is essential to enhance the hygiene practices of medical staff.

**Keywords:** Hospital hygiene, mobile phones, nosocomial infections, sepsis, prevention, disinfection.

1. **INTRODUCTION**

Hand and surface hygiene are essential in preventing nosocomial infections, including sepsis, which remains a significant cause of morbidity and mortality in healthcare facilities worldwide (Pittet *et al*., 2000). Sepsis is characterised by a severe and toxic response of the body to an infection, leading to tissue damage, organ failure, and often death (Singer *et al*., 2016). Each year, more than 30 million people develop sepsis, with over 7 million resulting in death (Fleischmann *et al*., 2016).

In low- and middle-income countries (LMICs), particularly in many regions of Africa, a significant number of sepsis cases can be attributed to weak healthcare systems. These, include poor sanitation, inadequate hygiene conditions, and substandard healthcare services (World Health Organization, 2018). It is estimated that at least 2 million deaths due to sepsis occur in Africa each year (World Health Organization, 2018).

Sepsis often arises from failures within healthcare systems. These failures typically reflect lack of effective Infection Prevention and Control (IPC) measures particularly those aimed at preventing antimicrobial resistance, as well as insufficient sanitation, poor hygiene practices, substandard quality of healthcare, and inadequate training and support for healthcare practitioners. Additionally, mobile phones, which are commonly used by medical personnel, can serve as potential vectors for microbial contamination (Sani *et al*., 2019). Studies have shown that these devices can harbor various pathogens, including multidrug-resistant bacteria, thereby increasing the risk of cross-infections in hospital settings (Badran *et al*., 2015).

The use of mobile phones in hospitals has significantly increased in recent years, providing undeniable benefits in terms of communication and access to information. However, this practice raises serious concerns regarding hygiene and patient safety. Mobile phones can transmit pathogens, which increases the risk of nosocomial infections and sepsis, particularly in clinical environments where patients are often vulnerable (World Health Organization, 2016). The impact of mobile phone usage on infection and sepsis prevention is substantial, and strict control measures are essential to protect these vulnerable patients (World Health Organization, 2016). According to the World Health Organization “WHO” (2020), "the most effective way to reduce the incidence of antimicrobial-resistant infections is to protect individuals from the cross-transmission of microbes, particularly through contact with the hands of healthcare workers."

In Cameroon, although awareness of hygiene practices is on the rise, there is limited data regarding the mobile phone usage habits of healthcare professionals within hospital environments. A study conducted in Yaoundé revealed that 60% of doctors did not wash their hands after using their phones (Ngowe *et al*., 2020).

This study aims to evaluate the hygiene practices of medical staff concerning mobile phone use at Yaoundé General Hospital and to assess the impact of these practices on infection and sepsis prevention. Furthermore, this study seeks to highlight the necessity of establishing guidelines to minimise infection risks in this context.

1. **MATERIALS AND METHODS** 
   1. **Study Setting**

The study was conducted at Yaoundé General Hospital (HGY), a referral healthcare facility located in the Djoungolo Health District of the Yaoundé V Subdivision. The hospital serves as a diverse patient population across various departments, including general medicine, surgery, pediatrics, emergency care, and other specialised services.

* 1. **Study Type**

This was a cross-sectional, analytical, and evaluative study aimed at examining the hygiene practices of medical staff when using mobile phones in a hospital setting and their impact on the prevention of nosocomial infections and sepsis.

* 1. **Target Population and Inclusion Criteria**

Individuals and equipment that met the following criteria were included in the study:

* Healthcare personnel (doctors, nurses, and nursing assistants), with at least six months of experience in their current role.
* Cleaning staff responsible for maintaining hygiene standards, employed at the hospital for a minimum of three months.
* Hygiene officers and department heads with specific responsibilities for infection prevention.

Exclusion criteria: Individuals who refused to participate and areas restricted according to hospital regulations were excluded from the study.

* 1. **Sampling**

A stratified random sampling method was used to ensure fair representation across different hospital departments (emergency, surgery, pediatrics, etc.). A total of 162 participants were included in the study.

* 1. **Data Collection Techniques and Tools**

Three data collection techniques were employed:

* Direct observation of the hospital environment.
* Questionnaires administered to medical staff and cleaning personnel.
* Microbiological swabbing of surfaces and electronic devices for laboratory analysis.

The questionnaires included sections on :

* Knowledge of hygiene practices
* Mobile phone usage in the hospital setting
* Perceptions of risks related to mobile phone use

Direct observations were conducted to assess compliance with hygiene protocols in real time, particularly concerning to phone disinfection and hand hygiene practices.

* 1. **Data Collection Procedure**

Data were collected through face-to-face administration of questionnaires, ensuring accurate and direct responses. Additionally, random observations were conducted across various hospital departments to complement the analysis with empirical insights, providing a deeper understanding of actual hygiene practices and interactions.

After completing the self-administered questionnaires, the mobile phones of healthcare professionals were swabbed using sterile swabs. Before sampling, the swabber's hands were cleaned with alcohol-based hand sanitizer, and sterile, powder-free disposable gloves were worn for each sample to prevent cross-contamination. Swabs were moistened with sterile saline solution before swabbing the exposed surfaces of the mobile phones, which included the keyboard, touchscreen, earpiece, and back of the phone, as these areas frequently come into contact with the users. The samples were transported to the laboratory, inoculated on fresh Blood Agar (BA) and Eosin Methylene Blue (EMB) agar, and assigned a unique identification number. The mobile phones were then disinfected using alcohol wipes and returned to their owners.

* 1. **Isolation and identification of bacteria from mobile phones**

Samples were inoculated on BA media aerobically at 35-37°C for 24 hours as well as on EMB and Chapman media under the same conditions. The plates were examined for colony growth and morphological characteristics. Pure isolated colonies were differentiated by Gram staining into Gram-negative and Gram-positive bacteria. Gram-positive cocci underwent a catalase test, and those that were catalase-positive were further tested for coagulase to differentiate *Staphylococcus aureus* from coagulase-negative staphylococci (CoNS). Gram-negative isolates were identified using API 20E micro galleries, which helped to differentiate oxidase-positive Gram-negative bacteria (such as *Pseudomonas* spp. and *Vibrio* spp.) from oxidase-negative Enterobacteriaceae.

* 1. **Statistical analysis**

The collected data was thoroughly checked for completeness and consistency before being entered into CSPro (Census and Survey Processing System) version 7.0. The data was then transferred to SPSS (Statistical Package for Social Sciences) version 25.0 for statistical analysis. Descriptive statistics were used to illustrate the distribution of each variable in the study, allowing for a better understanding of their characteristics (frequencies). Comparison tests, including chi-square tests and t-tests, were used to assess differences between the groups. The results were considered statistically significant at p ≤ 0.05.

* 1. **Ethical considerations**

The study maintained respect for the interviewees by ensuring the anonymity of their data throughout the research process. It was conducted in alignment with the Declaration of Helsinki. Prior to the administration of the questionnaire, all participants were verbally informed about 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 of the University of Douala (CEI-UDo). Additionally, authorisation from the Director of Yaoundé General Hospital (N/Ref 445-24/HGY/DG/DPM/APM-TR), was obtained before the start of data collection. The anonymity of the respondents was assured, and each participant expressed their consent before answering the questions. Participation in the study was entirely voluntary.

1. **RESULTS**
   1. **Characteristics of the study population**

A total of 162 healthcare professionals were included in this study. Women represented 51% of the staff, while men accounted for 49%, resulting in a sex ratio of 0.95.

**Fig. 1.** **Distribution of the study population by gender**

The majority of hospital staff are over the age of 44 (33%). The age groups of 25-34 and 35-44 are also well represented, accounting for 26% and 22%, respectively. There are fewer young individuals under the age of 25 (19%) (see Fig. 2).

**Fig. 2. Age distribution of hospital staff**

The breakdown of hospital staff by category reveals that support staff (30%) and nurses (27%) make up the majority of the workforce. Paramedical professionals account for 23%, while medical staff represent 19% (see Fig. 3).

**Fig. 3. Breakdown of hospital staff by professional category**

Hospital staff are distributed across various sectors as follows: the laboratory (13.6%), oncology (11.7%), pharmacy (11.1%) and outpatient service (11.1%) are the most represented sectors. This is followed by surgery (8%) and linen services (6.8%). Emergency (5.6%) and dialysis (4.9%) come next, while sectors such as reprographics, radiology, ophthalmology and others make up smaller proportions, ranging from 0.6% to 3.7% (see Fig. 4).

**Fig. 4. Distribution of healthcare staff by department**

* 1. **Distribution of the Study Population Based on Hand Hygiene**

Table 1 presents the distribution of study participants in relation to hand hygiene practices. The findings indicate that 96.9% of the 162 healthcare workersare aware that poor hand hygiene can lead to cross-contamination. Furthermore, 90.7% report that they are capable of performing all steps of handwashing. Regarding the ideal timing for handwashing, 43.2% of personnel say they wash their hands "after touching patients," while 36.4% believe it should be done "before and after any clean or aseptic procedure." Additionally, "water and soap" (89.5%) remain the most commonly used method of handwashing among healthcare workers. The primary reason for inadequate hand hygiene is reported as "lack of time" (65.4%).

**Table 1. Distribution of the study population according to hand hygiene (N=162)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables Modality** | | **Number**  **(n)** | **Percentage (%)** |
| **Did you know that hands can cause cross-contamination and infections in your patients?** | No | 5 | 3.1 |
| Yes | 157 | 96.9 |
| **Will you be able to carry out all 5 stages of hand washing?** | No | 15 | 9.3 |
| Yes | 147 | 90.7 |
| **If so, when?** | Before and after any clean or aseptic procedure | 59 | 36.4 |
| After touching body fluids | 12 | 7.4 |
| After touching the patient | 70 | 43.2 |
| Before touching the patient | 10 | 6.2 |
| There is no time | 11 | 6.8 |
| **What do you use to wash your hands?** | Hydroalcoholic hand solution | 4 | 2.5 |
| Water and soap | 145 | 89.5 |
| Bleach-based disinfectant | 13 | 8.0 |
| **What are the reasons for inadequate hand hygiene?** | Forget | 56 | 34.6 |
| Lack of time | 106 | 65.4 |

* 1. **Distribution of the Study Population Based on Electronic Device Disinfection Practices**

According to Table 2, a vast majority of participants (97.5%) carry their mobile phones to the workplace, but only 87.7% are aware that electronic devices can cause cross-contamination. Approximately 85.8% of healthcare personnel use their phones while working, and 89.5% report cleaning their devices. The majority of participants (54.3%) state that they clean their phones after touching a potentially pathogenic object. As for disinfectants, water and bleach (63.6%) and 70% alcohol-based disinfectant (45.7%) are the most commonly used products. Moreover, 72.2% of participants admit they often stop working to answer their mobile phones, and 60.5% do not wash their hands afterward.

**Table 2. Breakdown of the study population according to mobile phone disinfection practices (N=162)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Variables Modality** | | **Number**  **(n)** | **Percentage**  **(%)** |
| **Do you carry your mobile phone to work?** | No | 4 | 2,5 |
| Yes | 158 | 97.5 |
| **Did you know that electronic devices can cause cross-contamination and infections in your patients?** | No | 20 | 12.3 |
| Yes | 142 | 87.7 |
| **Do you use your phone when you work?** | No | 23 | 14.2 |
| Yes | 139 | 85.8 |
| **Do you clean your phone?** | No | 17 | 10.5 |
| Yes | 145 | 89.5 |
| **If yes, under what circumstances?** | When touching a potentially pathogenic object | 88 | 54.3 |
| After each treatment | 7 | 4.3 |
| After the end of the service | 57 | 35.2 |
| No specific time | 10 | 6.2 |
| **What disinfectant do you use?** | 70° alcohol-based disinfectant | 74 | 45.7 |
| Soap and water | 4 | 2.5 |
| Water and bleach | 77 | 47.5 |
| What I find | 7 | 4.3 |
| **Do you often stop work to answer your mobile phone?** | No | 45 | 27.8 |
| Yes | 117 | 72.2 |
| **If so, do you wash your hands after answering?** | No | 98 | 60.5 |
| Yes | 64 | 39.5 |

* 1. **Effectiveness of Disinfectants on Isolated Bacteria**

Table 3 shows that disinfection with water and soap was highly effective in eliminating certain bacteria isolated from mobile phones. *Staphylococcus epidermidis* demonstrated a 100% reduction in several departments, including emergency and pharmacy. Similarly, *Staphylococcus aureus* was completely eliminated in departments such as oncology and surgery. However, no reduction was noted for *Klebsiella pneumoniae* and *Escherichia coli*, which maintained a 0% elimination rate. *Staphylococcus saprophyticus* showed only limited reductions, with rates of 16.6% in radiology and 5.6% in outpatient consultations. These results highlight the effectiveness of water and soap against certain bacterial strains while emphasising the need for focused attention on more resistant bacteria.

**Table 3. Percentage of bacteria isolated from mobile phones before and after disinfection with soap and water**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Department**  **(frequency)** | **Bacteria** | **Before disinfection** | **After disinfection** | **Percentage reduction** |
| Emergency  (N=9) | *Staphylococcus épidermidis* | 2 (22.2%) | 0 | 100% |
| *Staphylococcus saprophyticcus* | 3 (33.3%) | 1(11.1%) | 22.2% |
| Radiology  (N=6) | *Klebsiella pneumoniae* | 1 (16.7%) | 1(16.7%) | 0% |
| *Staphylococcus aureus* | 1 (16.7%) | 0 | 100% |
| *Staphylococcus Saprophyticcus* | 2 (33.3%) | 1(16.7%) | 16.6% |
| *Staphylococcus épidermidis* | 1 (16.7%) | 0 | 100% |
| Pharmacy  (N=18) | *Escherichia coli* | 1 (5.6%) | 1(5.6%) | 0% |
| *Staphylococcus épidermidis* | 5 (27.8%) | 0 | 100% |
| *Staphylococcus aureus* | 3 (16.7%) | 1(5.6%) | 11.1% |
| *Staphylococcus Saprophyticcus* | 6 (33.3%) | 1(5.6%) | 27.7% |
| Urology  (N=6) | *Staphylococcus saprophyticcus* | 1 (16.7%) | 0 | 100% |
| Oncology  (N=19) | *Staphylococcus aureus* | 2 (10.5%) | 0 | 100% |
| *Staphylococcus épidermidis* | 7 (36.8%) | 1(5.3%) | 31.5% |
| Bacillus | 1 (5.3%) | 0 | 100% |
| *Staphylococcus Saprophyticcus* | 3 (15.8%) | 2(10.5%) | 5,3% |
| Gastrology  (N=5) | *Staphylococcus épidermidis* | 2 (40%) | 0 | 100% |
| *Staphylococcus Saprophyticcus* | 2 (40%) | 1(2%) | 38% |
| Dialysis  (N=8) | *Staphylococcus Saprophyticcus* | 6 (75%) | 0 | 100% |
| Approved Treatment Centre (N=8) | *Staphylococcus épidermidis* | 1 (12.5%) | 0 | 100% |
| *Escherichia coli* | 1 (12.5%) | 1(12.5%) | 0% |
| *Staphylococcus Saprophyticcus* | 1 (12.5%) | 1(12.5%) | 0% |
| Laboratory  (N=22) | *Staphylococcus épidermidis* | 2 (9.1%) | 0 | 100% |
| *Staphylococcus Saprophyticcus* | 5 (22.7%) | 4(18.2%) | 4,5% |
| Administrative block (N=2) | *Staphylococcus Saprophyticcus* | 1 (50%) | 0 | 100% |
| Surgery (N=13) | *Staphylococcus aureus* | 3 (23.1%) | 0 | 100% |
| *Staphylococcus Saprophyticcus* | 3 (23.1%) | 1(7.7%) | 15.4% |
| *Staphylococcus épidermidis* | 1 (7.7%) | 0 | 100% |
| *Klebsiella pneumoniae* | 1 (7.7%) | 1(7.7%) | 0% |
| Ophthalmology  (N=4) | *Staphylococcus Saprophyticcus* | 1 (25%) | 1(25%) | 0% |
| *Staphylococcus aureus* | 2 (50%) | 0 | 100% |
| Out patient  (N=18) | Culture polymicrobienne | 2 (11.1%) | 0 | 100% |
| *Staphylococcus aureus* | 3 (16.7%) | 0 | 100% |
| *Staphylococcus épidermidis* | 7 (38.9%) | 0 | 100% |
| *Staphylococcus Saprophyticcus* | 3 (16.7%) | 2(11.1%) | 5,6% |
| *Klebsiella pneumoniae* | 1 (5.6%) | 1(5.6%) | 0% |
| Technical Affairs Department (N=1) | *Staphylococcus Saprophyticcus* | 1 (100%) | 1(100%) | 0% |
| Laundry  (N=11) | *Klebsiella oxytoca* | 1 (9.1%) | 1(9.1%) | 0% |
| *Staphylococcus épidermidis* | 1 (9.1%) | 0 | 100% |
| *Staphylococcus Saprophyticcus* | 8 (72.7%) | 1(9.1%) | 63,6% |
| Reprography (N=6) | *Staphylococcus aureus* | 4 (66.7%) | 1(16.7%) | 50% |
| *Staphylococcus saprophyticcus* | 1 (16.7%) | 0 | 100% |
| Registration (N=6) | *Staphylococcus aureus* | 1 (16.7%) | 0 | 100% |
| *Staphylococcus épidermidis* | 2 (33.3%) | 0 | 100% |
| *Staphylococcus Saprophyticcus* | 1 (16.7%) | 0 | 100% |

* 1. **Relationship Between the Presence of Germs Before Disinfection and the Service**

This subsection examines the relationship between the presence of germs before disinfection (dependent variable) and service-related variables. Table 4 demonstrates a significant association (P = 0.002) between the presence of germs before disinfection and different hospital services. This indicates that bacterial contamination of mobile phones varies significantly depending on the department.

**Table 4. Relationship between departments and the presence of germs before disinfection**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | **Presence of germs before disinfection** | | **P-value** |
| **Negative** | **Positive** |
| **Place of Department** | Administration block | 1 | 1 | **0.002** |
| Laundry | 1 | 10 |
| Surgery | 5 | 8 |
| Outpatients | 2 | 16 |
| CTA | 5 | 3 |
| DAT | 0 | 1 |
| Dialysis | 2 | 6 |
| Registration | 2 | 4 |
| Gastrology | 1 | 4 |
| Laboratory | 15 | 7 |
| Oncology | 6 | 13 |
| Ophthalmology | 0 | 4 |
| Pharmacy | 2 | 3 |
| Pharmacy downstairs | 1 | 12 |
| Radiology | 1 | 5 |
| Reprography | 1 | 5 |
| Emergency | 4 | 5 |
| Urology | 5 | 1 |
| **Total** | | **54** | **108** | **162** |

* 1. **Measurement of the presence of germs before disinfection according to hand hygiene variables**

According to Table 5 below, only two variables- ‘time to perform all five steps of hand washing’ (P= 0.001) and ‘reason for not ensuring adequate hand hygiene’ (P= 0.034)- are significantly associated with the presence of germs before disinfection.

**Table 5. Relationship between hand hygiene and the presence of germs before disinfection**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables Modality** | | **Presence of germs before disinfection** | | **P-value** |
| **Negative** | **Positive** |
| Did you know that hands can cause cross-contamination and infections in your patients? | No | 2 | 3 | 0.541 |
| Yes | 52 | 105 |
| Will you be able to carry out all 5 stages of hand washing? | No | 4 | 11 | 0.397 |
| Yes | 50 | 97 |
| If so, when? | Before and after any cleaning or aseptic procedure | 21 | 38 | **0.001** |
| After touching body fluids | 10 | 2 |
| After touching a patients | 20 | 50 |
| No | 3 | 8 |
| What do you use to wash your hands? | Hydroalcoholic solution | 2 | 2 | 0.102 |
| Water and soap | 51 | 94 |
| Bleach-based disinfectant | 1 | 12 |
| What are the reasons for inadequate hand hygiene? | Forgetten | 13 | 43 | **0.034** |
| Lack of time | 41 | 65 |
| **Total** | | **54** | **108** | **162** |

* 1. **Measurement of the presence of germs before disinfection according to variables linked to mobile phone disinfection practices**

Table 6 indicates that variables linked to electronic device disinfection practices, specifically: circumstances under which the phone is cleaned (P= 0.000), type of disinfectant used (P= 0.004), and the frequency of stopping work to answer mobile phones (P= 0.000), are significantly associated with the presence of germs before disinfection.

**Table 6. Association between variables related to disinfection practices for electronic equipment and the presence of germs before disinfection**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables Modality** | | **Presence of germs before disinfection** | | **P-value** |
| Negative | Positive |
| Do you use your phone at work? | No | 8 | 15 | 0.524 |
| Yes | 46 | 93 |
| Do you clean your phone? | No | 4 | 13 | 0.268 |
| Yes | 50 | 95 |
| If yes, under what circumstances? | When touching a potentially pathogenic object | 21 | 67 | **0.000** |
| After each treatment | 0 | 7 |
| After the end of the service | 32 | 25 |
| No | 1 | 9 |
| What disinfectant do you use? | 70° alcohol-based disinfectant | 35 | 39 | **0.004** |
| Soap and water | 1 | 3 |
| Water and bleach | 18 | 59 |
| No | 0 | 7 |
| Do you often stop work to answer your mobile phone? | No | 28 | 17 | **0.000** |
| Yes | 26 | 91 |
| If so, do you wash your hands after answering? | No | 28 | 70 | 0.078 |
| Yes | 26 | 38 |
| **Total** | | **54** | **108** | **162** |

1. **DISCUSSION**

The results of this study indicate that the use of mobile phones by medical personnel in hospital settings poses a potential risk of microbial contamination and the transmission of nosocomial infections. In this study, 77.16% of mobile phones were found to be contaminated with pathogenic agents. Furthermore, 97.5% of participants reported bringing their phones to work, and 85.8% used them during their shifts. These findings differ from those of Uwingabiye *et al.* (2015) at the Mohammed V Military Teaching Hospital in Rabat, where a 100% bacterial contamination rate was reported for all mobile phones. Similarly, Yao *et al.* (2022) found that 95.5% (106/111) of the mobile phones studied were contaminated with bacteria. In comparison, Ulger *et al.* (2009) reported that 94.5% of phones showed bacterial contamination with various species. On the other hand, Missri *et al.* (2019) reported a lower contamination rate of 39.3%. The observed differences may be attributed to several factors, including study methodology, participants’ hygiene behaviors, the study location, and the frequency of mobile phone use in high-risk environments.

The bacterial cultures obtained from microbiological swabbing of mobile phones revealed a diverse array of bacterial species, showcasing polymorphic characteristics. This supports the findings of Uwingabiye *et al.* (2015), who noted that the bacterial cultures of swabs from healthcare workers' phones were more polymorphic than those of the control group. The microbiological analysis in this study revealed the presence of pathogenic bacteria, including *Staphylococcus saprophyticus* (29.6%), *Staphylococcus epidermidis* (20.4%), *Staphylococcus aureus* (11.1%), *Klebsiella pneumoniae* (2%), and *Escherichia coli* (1.2%) on the mobile phones of medical personnel. Several previous studies on bacterial contamination of mobile phones have demonstrated that they can harbour *Staphylococcus aureus*, coagulase-negative staphylococci (CNS), *Staphylococcus sp.*, *Bacillus spp.*, *Escherichia coli*, *Klebsiella pneumoniae*, *Acinetobacter sp.*, *Enterococcus faecalis*, *Pseudomonas aeruginosa*, and *Pseudomonas fluorescens* (Badran et al., 2015; Uwingabiye et al., 2015; Nwankwo et al., 2014; Ulger et al., 2009). These microorganisms are part of the normal flora of human skin and mucous membranes but can also be found in the environment (Badran et al., 2015; Uwingabiye et al., 2015). Some of these pathogens can be multidrug-resistant, including methicillin-resistant *Staphylococcus aureus* (MRSA) and beta-lactamase-producing Enterobacteriaceae (Nwankwo et al., 2014; Gholamreza et al., 2009; Mushabati et al., 2021; Zenbaba et al., 2023). These findings corroborate the observations of Brady *et al.* (2006), which indicated that mobile phones of healthcare workers can harbour pathogenic microorganisms, thereby increasing the risk of cross-infections when proper hygiene protocols are not followed.

This contamination could be attributed to inadequate hygiene measures, particularly the low rate of handwashing after phone use, which was observed in 60.5% of participants in our study. Furthermore, while 89.5% of participants reported cleaning their phones, disinfection practices were found to be irregular and inadequate. Only 45.7% of healthcare workers used an alcohol-based disinfectant, while 47.5% preferred bleach, and 2.5% relied solely on water and soap. In a different context, a study conducted by Uwingabiye *et al.* (2015) examined handwashing practices among healthcare personnel. Their findings revealed that out of 120 participants, 50% used soap, 24% used alcohol-based hand sanitizer, 22% combined soap and hand sanitizer, 2% used only water, 1% used povidone-iodine, and 1% used a combination of soap and povidone-iodine. Similarly, Ramesh *et al.* (2008) reported that alcohol-based disinfectants are more effective at reducing bacterial contamination on electronic surfaces in hospital settings. The limited effectiveness of water and soap in eliminating certain bacteria, as observed in our study, highlights the need for stricter disinfection protocols. These findings emphasise the importance of enhancing hygiene practices to reduce the risk of cross-contamination.

Moreover, the results showed a high level of awareness regarding the importance of hand hygiene, with 96.9% of participants recognising the risk of cross-contamination. The majority (90.7%) felt capable of performing the five steps of handwashing, and key moments for hand hygiene were generally well understood, particularly before and after procedures and after touching a patient. However, the use of alcohol-based hand sanitizers remains very low (2.5%), and lack of time was identified as the main reason for inadequate hand hygiene practices (65.4%), a finding supported by other studies (Sax et al., 2009). This suggests the need to develop strategies that integrate essential hygiene practices into healthcare workers’ routines while addressing time constraints and reinforcing the importance of hand hygiene for patient safety.

A study by Pittet *et al.* (2000) revealed that 90% of healthcare workers recognise the link between hand hygiene and the prevention of nosocomial infections. However, despite this awareness, actual handwashing behaviors remain insufficient. Our study reflects this issue, with 34.6% of participants admitting to forgetting to wash their hands, while 65.4% cited a lack of time as the main reason for inadequate hygiene. This emphasises the need for targeted interventions to optimise the time allocated for these essential practices.

Regarding critical handwashing moments, our study indicates that 43.2% of respondents wash their hands after touching a patient, which aligns with the World Health Organization (WHO) recommendations stressing the importance of hand hygiene at every stage of patient care (WHO, 2009). However, the very low usage of alcohol-based hand sanitizers (2.5%) contrasts with findings from Mody *et al.* (2017), which indicate that disinfectant solutions are often more effective and practical in clinical environments.

One key factor contributing to the inefficiency of hygiene practices observed in this study istime constraints. Approximately 65.4% of participants cited lack of time as the main barrier to adhering to hand hygiene protocols. This finding is consistent with the results of Sax *et al.* (2009), which identified time pressure as a major obstacle to compliance with WHO guidelines on hand hygiene in hospital settings. Targeted interventions, such as providing easily accessible disinfectants and continuous staff training on the importance of hygiene, could improve these practices. Other studies, including those by Sax *et al.* (2009), have also highlighted time constraints as a critical issue, indicating that time pressure in clinical environments can hinder adherence to hygiene practices. A proactive approach, incorporating reminders and regular training on the importance of hygiene, could help improve compliance. Additionally, a study by Erasmus *et al.* (2010) emphasises the need for continuous education and reminders to maintain proper hand hygiene, which is particularly relevant for our study population to enhance compliance with handwashing recommendations.

The results in Table 3 illustrate the inconsistent effectiveness of disinfecting with soap and water on bacteria isolated from mobile phones across different hospital departments. Strains such as *Staphylococcus epidermidis* and *Staphylococcus aureus* showed a 100% reduction after disinfection, aligning with the findings of Pittet *et al.* (2000), which emphasise the importance of handwashing and disinfection in preventing nosocomial infections. However, bacteria like *Klebsiella pneumoniae* and *Escherichia coli* did not exhibit significant reduction, with rates of 0%. This may indicate resistance to traditional disinfection methods, a phenomenon also observed by Mody *et al.* (2017) in other clinical settings.

The persistence of *Staphylococcus saprophyticus* in multiple departments, with limited reductions of 16.6% and 5.6%, suggests that certain strains may be more difficult to eliminate, necessitating adapted disinfection protocols. This observation aligns with previous studies highlighting the need to improve disinfection practices for more resilient strains (Weber *et al*., 2013). While soap and water can effectively reduce bacterial load, continuous efforts to evaluate and improve disinfection methods are essential for ensuring a safe environment, especially in healthcare settings.

Finally, the significant association between the presence of germs on mobile phones and the lack of handwashing after their use (p = 0.000) reinforces the idea that these devices are a major source of infection transmission. Sani *et al.* (2019) demonstrated that the repeated contact of phones with the hands of medical personnel, combined with poor adherence to hygiene measures, facilitates the spread of multidrug-resistant bacteria in hospital settings.

Given these findings, it is vital to implement corrective measures to reduce the risk of contamination from mobile phones in hospitals. Strategies should include adopting strict disinfection protocols for electronic devices, promoting the use of alcohol-based hand sanitizers, and raising awareness among healthcare staff about proper hygiene practices. In addition, conducting regular audits and further studies on the effectiveness of different disinfection methods will help optimise the prevention of nosocomial infections.

1. **CONCLUSION**

This study highlights the significance of mobile phones as potential vectors for the transmission of nosocomial infections within hospital settings. The findings indicate that healthcare personnel frequently use mobile phones, often without strict adherence to hygiene protocols, which promotes cross-contamination and increases the risk of sepsis. Microbiological analysis has demonstrated the presence of pathogenic bacteria on these devices, emphasising the urgent need for increased awareness and improved preventive measures. To mitigate these risks, it is essential to implement systematic disinfection protocols for mobile phones and enhance compliance with hand hygiene standards. Hand hygiene remains a crucial element in combating healthcare-associated infections. The integration of continuous training, awareness campaigns, and regular audits emerges as key strategies for strengthening the safety of both patients and hospital staff. Ultimately, this study lays the groundwork for further research into the effectiveness of various mobile phone disinfection methods and their role in reducing nosocomial infections. A more rigorous and standardised approach to hygiene practices in healthcare settings is imperative to prevent the transmission of pathogens and enhance the quality of care.

**AVAILABILITY OF DATA AND MATERIAL**

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

**Disclaimer (Artificial intelligence)**

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

**REFERENCES**

Badran, A., Khedher, N. B., & Khelifa, A. (2015). Contamination of mobile phones in healthcare settings: A review. *Journal of Hospital Infection, 90*(3), 205-212.

Brady, R. R., Wasson, A., Stirling, I., McAllister, C., & Damani, N. N. (2006). Is your phone bugged? The incidence of bacteria known to cause nosocomial infection on healthcare workers' mobile phones. *Journal of Hospital Infection, 62*(1), 123-125.

Erasmus, V., Daha, T. J., Brug, H., Richardus, J. H., Behrendt, M. D., Vos, M. C., & van Beeck, E. F. (2010). Systematic review of studies on compliance with hand hygiene guidelines in hospital care. *Infection Control and Hospital Epidemiology, 31*(3), 283-294. doi:10.1086/650451.

Fleischmann, C., Scherag, A., Adhikari, N. K., Hartog, C. S., Tsaganos, T., Schlattmann, P., Angus, D. C., & Reinhart, K.; International Forum of Acute Care Trialists. (2016). Assessment of global incidence and mortality of hospital-treated sepsis: Current estimates and limitations. *Am. J. Respir. Crit. Care Med.*, 193(3), 259-272. doi:10.1164/rccm.201504-0781OC.

Missri, L., Smiljkovski, D., Prigent, G., et al. (2019). Bacterial colonization of healthcare workers' mobile phones in the ICU and effectiveness of sanitization. *Journal of Occupational and Environmental Hygiene, 16*(2), 97-100. doi:10.1080/15459624.2018.1546051.

Mody, L., Kauffman, C. A., & Cormican, M. (2017). The role of hand hygiene in the prevention of infections in healthcare settings. *Infection Control and Hospital Epidemiology, 38*(5), 519-523.

Mushabati, N. A., Samutela, M. T., Yamba, K., et al. (2021). Bacterial contamination of mobile phones of healthcare workers at the University Teaching Hospital, Lusaka, Zambia. *Infection Prevention in Practice, 3*(2), 100126. doi:10.1016/j.infpip.2021.100126.

Ngowe, N. M., et al. (2020). Assessing hand hygiene practices among health professionals in Yaoundé, Cameroon. *Cameroon Medical Journal, 16*(1), 35-40.

Nwankwo, E. O., Ekwunife, N., & Mofolorunsho, K. C. (2014). Nosocomial pathogens associated with the mobile phones of healthcare workers in a hospital in Anyigba, Kogi state, Nigeria. *Journal of Epidemiology and Global Health, 4*(2), 135-140. doi:10.1016/j.jegh.2013.11.002.

Pittet, D., Hugonnet, S., Harbarth, S., et al. (2000). Effectiveness of a hospital-wide program to improve compliance with hand hygiene. *The Lancet, 356*(9238), 1307-1312.

Ramesh, J., Carter, A. O., Campbell, M. H., et al. (2008). Use of mobile phones by medical staff at Queen Elizabeth Hospital, Barbados: Evidence for both benefit and harm. *Journal of Hospital Infection, 70*(2), 160-165.

Sax, H., Allegranzi, B., Chraïti, M. N., Boyce, J., Larson, E., & Pittet, D. (2009). The World Health Organization hand hygiene observation method. *American Journal of Infection Control, 37*(10), 827-834.

Sani, N., Manzoor, M., & Rahman, S. (2019). Mobile phones as a potential reservoir of pathogens in the healthcare environment: A review. *Journal of Infection and Public Health, 12*(6), 1031-1037.

Singer, M., et al. (2016). The Third International Consensus Definitions for Sepsis and Septic Shock (Sepsis-3). *JAMA, 315*(8), 801-810. doi:10.1001/jama.2016.0287.

Ulger, F., Esen, S., Dilek, A., Yanik, K., Gunaydin, M., & Leblebicioglu, H. (2009). Are we aware how contaminated our mobile phones with nosocomial pathogens? *Annals of Clinical Microbiology and Antimicrobials, 8*, 7. doi:10.1186/1476-0711-8-7.

Uwingabiye, J., Moustanfii, W., Chadli, M., & Sekhsokh, Y. (2015). Study of bacterial flora contaminating mobile phones before and after disinfection: Comparison between nursing professionals of the Military Hospital Mohammed V in Rabat and controls. *Pan Afr. Med. J.*, 22, 326. doi:10.11604/pamj.2015.22.326.7292.

Weber, T. S., & Rutala, W. A. (2013). Environmental cleaning and disinfection. *Infection Control and Hospital Epidemiology, 34*(7), 705-709.

Yao, N., Yang, X. F., Zhu, B., et al. (2022). Bacterial colonization on healthcare workers' mobile phones and hands in municipal hospitals of Chongqing, China: Cross-contamination and associated factors. *Journal of Epidemiology and Global Health, 12*(4), 390-399. doi:10.1007/s44197-022-00057-1.

Zenbaba, D., Sahiledengle, B., Beressa, G., et al. (2023). Bacterial contamination of healthcare workers' mobile phones in Africa: A systematic review and meta-analysis. *Tropical Medicine and Health, 51*(1), 55. doi:10.1186/s41182-023-00547-3

World Health Organization (WHO). (2009). *WHO Guidelines on Hand Hygiene in Health Care*. WHO.

World Health Organization (WHO). (2016). *Guidelines on core components of infection prevention and control programmes at the national and acute health care facility level*. WHO.

World Health Organization (WHO). (2018). *The global burden of sepsis: A call to action*. WHO. Available at: <https://www.who.int/news-room/fact-sheets/detail/sepsis>.

World Health Organization (WHO). (2020). *Infection prevention and control*. WHO. Available at: <https://www.who.int/infection-prevention/en/>.