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STAPHYLOCOCCUS AUREUS CONTAMINATION OF FREQUENTLY TOUCHED OBJECTS IN A TERTIARY CARE HOSPITAL IN GHANA

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ABSTRACT

Staphylococcus aureus can cause infections that range from mild to serious and sometimes fatal. Surfaces in the hospital environment are vital to the spread of S. aureus. The study aimed to investigate the presence and antimicrobial resistance pattern of S. aureus on doors, benches, and mobile phones at the Kumasi South Government Hospital (KSGH). A total of 199 samples were collected. Standard microbiological techniques were employed for bacterial culture and antibiotic susceptibility tests. The overall contamination rate of S. aureus was 19.6%, of which 23.5%, 21.2%, and 14.3% were from benches, phones, and doorknobs, respectively. The highest level of resistance was recorded against ampicillin and penicillin, while gentamicin was recorded as the lowest. Occurrence of multi-drug resistance (MDR) was noted among isolates derived from clinical departments (93.1%; 27/29) and non-clinical departments (90.0%; 9/10); however, the difference was not statistically significant (p = 0.752; OR = 1.5; 95% CI: 0.12–18.57). Surfaces with high hand-touch rate assessed in this study harbour S. aureus, serving as potential niches for continuous transmission, highlighting the need for regular disinfection or decontamination.

Keywords: *Staphylococcus aureus*, antimicrobial resistance, nosocomial infection, tertiary hospital, Ghana.

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INTRODUCTION

Staphylococcus aureus is commonly found inhabiting the skin and nasal cavities of both humans and animals (Adzitey *et al.*, 2019). It is a frequently encountered bacterial pathogen in both hospital and community-acquired infections (Naimi *et al.*, 2003). *S. aureus* significantly contributes to foodborne illnesses, and conditions such as endocarditis, boils, impetigo, cellulitis, and scalded skin (Adzitey *et al.*, 2019; Taylor *et al.*, 2017). The virulence of *S. aureus* is attributed to its ability to produce a wide range of toxins and adhesive elements, making it one of the most harmful and widespread bacteria responsible for causing diseases in hospital settings (Baba-Moussa *et al.*, 2008). *Staphylococcus aureus* is a widespread human pathogen, with a prevalence ranging from 4.6% to 54.4%, and responsible for various illnesses, particularly common in surgical wound infections (Omololu 2017) Even after routine disinfection, it can persist on hospital surfaces such as floors and door handles and can be transmitted indirectly through fomites, potentially leading to infections (Kramer *et al.*, 2006).

Healthcare personnel, objects, and the hospital environment are prone to microbial colonization. Direct interaction with contaminated objects or infected/colonized individuals can lead to transmission, potentially resulting in illness and death (Bhatta *et al.*, 2018)2018. In low-resource nations, accurate data on such hospital-acquired infections (HAIs) are hard to come by, and the amount of data currently available understates the total burden (Allegranzi *et al.*, 2011). According to available statistics, the prevalence of HAI in underdeveloped nations is 15.5 cases per 100 patients (Allegranzi *et al.*, 2011). These diseases are thought to be widespread across sub-Saharan Africa (Rothe *et al.*, 2013). Lack of national infection prevention and control (IPC) strategies, shortage of IPC staff, and lax adherence to current HAI recommendations are the main causes of the high prevalence of HAIs that continue to exist (Rothe *et al.*, 2013).

Staphylococcus aureus has historically been acknowledged as a significant contributor to disease worldwide and was reported as the third most common bacterial pathogen in Ghana based on nationwide antimicrobial resistance surveillance data (Opintan *et al.*, 2015). Most of the currently available data concerning the prevalence of *S. aureus* in Africa are derived from patient-based sources. However, for effective control of this organism, it is essential to consider the "one health" approach, which encompasses factors such as environmental persistence. The study therefore sought to ascertain the prevalence and antibiotic susceptibility of *S. aureus* in the Kumasi South Government Hospital (KSGH). The specific goals of this investigation were to ascertain the antibiotic susceptibility levels of isolated *Staphylococcus aureus,* as well as the prevalence of these bacteria on phones, door handles, and working benches of the hospital.

MATERIALS AND METHODS

Study design, period and study area

This laboratory-based cross-sectional study gathered swab samples from mobile phones, doors, and work surfaces within the hospital. The study was conducted between May and July 2023. A total of 199 swab samples were obtained, comprising 70 samples from interior and exterior door handles, 68 samples from the workbenches, and 61 samples from the mobile phones. The study was performed at the Kumasi South Government Hospital (KSGH) at Atonsu-Agogo of Kumasi, Ashanti region, Ghana. The hospital is among the leading providers of healthcare in Kumasi. The hospital catchment area is the southern part of kumassi with a population of about 36,797. All laboratory procedures were done at the Department of Clinical Microbiology of the Kwame Nkrumah University of Science and Technology (KNUST).

Sampling

Sterile cotton swabs were dampened with sterile normal saline and utilized to collect samples from the outer and inner surfaces of door handles, mobile phones, and workbenches. Each sample swabbed was pre-enriched in sterile brain heart infusion (BHI) broth and transported within one hour of collection to the laboratory in a cold box (2-8°C).

Laboratory analysis

Bacterial culture and identification

Swabs were cultured on mannitol salt agar plate and incubated aerobically for 24 hours at 37^{o}C. Colonies that were mannitol fermenters were subcultured on blood agar. Presumptive *S. aureus* isolates were further identified as

gram-positive cocci that tested positive for catalase and coagulase tests.

Antimicrobial susceptibility testing:

The isolates were subjected to antibiotic susceptibility testing using the Kirby-Bauer disc diffusion method on Mueller-Hinton agar (HI media, Mumbai, India) according to CLSI (2022). Bacterial strains resistant to at least one antimicrobial agent in three or more categories were classified as multidrug-resistant (MDR), based on the criteria established by Magiorakos *et al.* (2012)

Quality Control

All biochemical identification tests and media were quality controlled using *S. aureus* ATCC 25923 strain.

Data collection, management and analysis

Pearson's chi-square test and Fisher's exact test was used to measure the association between the exposure variables and an outcome. For all statistical analyses, statistical significance was assessed at p-values ≤ 0.05. All analyses were performed using the IBM SPSS Statistics 25 to analyze associations among variables.

Ethical considerations

Approval to carry out the study was sought from the administrations of Kumasi South Government Hospital and the Department of Clinical Microbiology at Kwame Nkrumah University of Science and Technology (KNUST).

RESULTS

Prevalence of *S. aureus*

To evaluate the environmental burden of *Staphylococcus aureus* within the hospital setting, surface swabs were collected from both clinical and non-clinical departments. Table 1 shows the prevalence of *Staphylococcus aureus* at the various departments or wards of the hospital. From the table, the majority of sampling was done at the maternity ward, main laboratory, critical care unit, nursing room, and Outpatient Department. The highest report of *S. aureus* was observed at the Critical Care Unit.

Table 1: *Staphylococcus Aureus* Prevalence at the Various Departments/Wards of the Hospital

Departments	S. *aureus* positive (%)	S. *aureus* negative (%)	No. of samples (%)
Clinical departments			
Outpatient Department	3 (15.8)	16 (84.2)	19 (9.5)
Maternity Ward	3 (14.3)	18 (85.7)	21 (10.6)
General Ward	4 (22.2)	14 (77.8)	18 (9.0)
Public Health	0 (0.0)	10 (100.0)	10 (5.0)
Main Laboratory	0 (0.0)	23 (100.0)	23 (11.6)
Critical Care Unit	8 (29.6)	19 (70.4)	27 (13.6)
Pharmacy	1 (10.0)	9 (90.0)	10 (5.0)
Public health lab	1 (10.0)	9 (90.0)	10 (5.0)
Nursing room	4 (16.0)	21 (84.0)	25 (12.6)
Dressing room	0 (0.0)	1 (100.0)	1 (0.5)
Emergency room	0 (0.0)	1 (100.0)	1 (0.5)
Injection room	1 (100)	0 (0.0)	1 (0.5)
Consulting room	1 (50.0)	1 (50.0)	2 (1.0)
ENT Unit	1 (100.)	0 (0.0)	1 (0.5)
VIP ward	2 (50.0)	2 (50.0)	4 (2.0)
Non-clinical departments			
General office	2 (50.0)	2 (50)	4 (2.0)

Administration	2 (25.0)	6 (75)	8 (4.0)
Accounts	0 (0.0)	2 (100)	2 (1.0)
Clerk	4 (66.7)	2 (33.3)	6 (3.0)
Human resources	2 (66.7)	1 (33.3)	3 (1.5)
Orderlies	0 (0.0)	2 (100)	2 (1.0)
Records	0 (0.0)	1 (100)	1 (0.5)

Data is presented as frequency with the corresponding percentage in parentheses.

A total of 199 swabs were collected from the various units of the hospital. The overall contamination of *S. aureus* was 19.6%. Table 2 illustrates the prevalence of *S. aureus* across different sampling locations.

Table 2: Prevalence of Staphylococcus Aureus by Sampling Location.

Location	No. of samples	*S. aureus positive n (%)*
Bench	68	16 (23.5)
Phone	61	13 (21.3)
Door knob	70	10 (14.3)
Total	199	39 (19.6)

Out of the 39 positive *S. aureus* isolates, 16.6% were from the clinical departments of the hospital, and 93.1% of the isolates were multidrug-resistant. Although there was no significant difference, a higher prevalence of MDR was observed in isolates obtained from clinical departments (93.1%; 27/29) compared to isolates recovered from non-clinical departments (90.0%; 9/10) (p-value = 0.752; OR = 1.5; 95% CI: 0.12–18.57) (Table 3).

Table 3: Prevalence of Staphylococcus aureus and Multidrug Resistance by Department

	Department			
Characteristics	**Clinical (%)**	**Non-clinical (%)**	**Odds ratio (C.I.)**	**p-value**
S. aureus (n=199)				
Yes	29 (16.6)	10 (41.7)	0.28 (0.11-0.69)	0.006
No	146 (83.4)	14 (58.3)		
MDR (n=39)				
Yes	27 (93.1)	9 (90.0)	1.5 (0.12-18.57)	0.752
No	2 (6.9)	1 (10.0)		

Antibiotic susceptibility profile

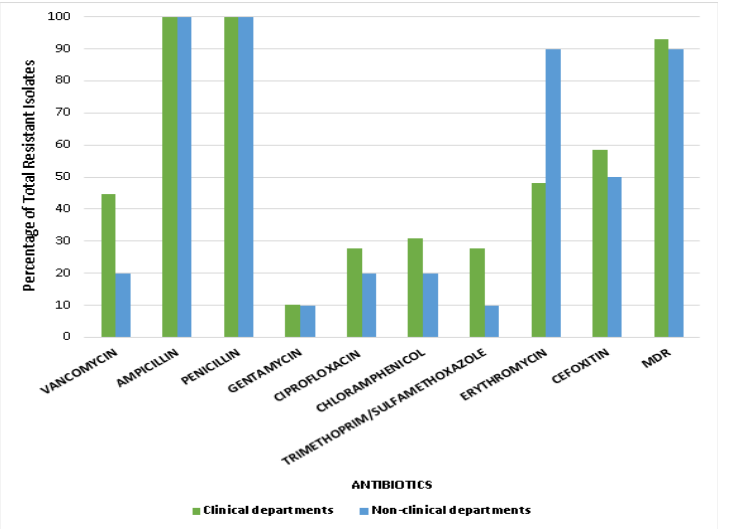


Fig. 1. Antibiotic-resistant profile of isolates from clinical and non-clinical departments

Isolates from clinical and non-clinical departments exhibited total resistance to β -lactams penicillins (ampicillin and penicillin). There was also resistance to erythromycin and cefoxitin with proportions of 48.28% and 88.6% for isolates from clinical departments and 90% and 50% for non-clinical departments, respectively. For gentamicin, 10% of non-clincal isolates showed resistance whereas in clinical, 10.3% of the isolates were resistant. Resistance to ciprofloxacin was recorded in 27.6% of the isolates from clinical department, and 20% in non-clinical department. Isolate from non-clinical departments showed slightly higher resistances to chloramphenicol at 31% compared to the clinical at 20%. Regarding sulfonamide resistance, 27.6% of the clinical isolates were resistant with 10% resistance reported in non-clinical isolates.

Multidrug resistance (resistance to at least one antimicrobial agent in three or more classes of antibiotics) was recorded among 92.3% of the isolates (clinical department; 93.1%, non-clinical department; 90.0%).

DISCUSSION

Hospital and community environments are always inhabited by microbial populations. The high incidence of infections occuring in hospitals can be attributed to contaminations resulting from inadequate hygiene and noncompliance with hospital infection control protocols (Wojgani *et al.*, 2012). Practices like using contaminated gloves while opening doors, failure to perform hand hygiene following restroom use, and non-adherence to proper disinfection protocols all contribute to the high risk of contamination (Moshi *et al.*, 2022).

The well-known nosocomial pathogen *Staphylococcus aureus* can endure for several days in a hospital setting (Chaibenjawong *et al.*, 2011). It is significant to note that, in the absence of routine preventive cleaning procedures, *S. aureus* can survive for up to seven months on arid, inert surfaces and serve as a medium of transmission (Kramer *et al.*, 2006). Overall, there was evidence of *S. aureus* contamination on 23.5% of benches, 21.3% of phones and 14.3% of benches, amounting to 19.6%. Because hands are known to be the major means of transmitting many diseases, high hand-touch environmental objects, like door knobs, phones and benches, that are not routinely cleaned may therefore harbour and easily distribute harmful germs to other individuals (White *et al.*, 2003). Mobile phones are significant reservoirs of microorganisms, as their frequent use and close contact with sensitive body areas - such as the hands, face, ears, and lips - facilitate the accumulation and transmission of infectious agents (Chawla *et al.*, 2009).

The study investigated the prevalence of *S. aureus* and MDR from 199 environmental swabs collected from the hospital

environment. We found a varying prevalence of *S. aureus* (16.6% vs 41.7%) between samples collected from clinical and non-clinical departments. However, we did not observe any significant differences in the presence of MDR isolates between the two departments (93.1% vs 90.0%). The prevalence of *S. aureus* contamination on environmental surfaces in the hospital setting reported by this study is lower than a previous study (Thapaliya *et al.*, 2017) but higher than a similar survey (Umoh, 2022).. The differences in results could be attributed to the sample size, study area, the method of sampling and processing techniques.

S. aureus isolates showed variable susceptibility to the antibiotics tested. The isolates in this study were generally resistant to most of the antibiotics, therefore, there is a need for the implementation of antibiotic stewardship programs and enhanced infection prevention protocols at the study site. In light of these findings, it is recommended that healthcare institutions adopt routine antibiotic susceptibility testing and enforce strict infection control measures to prevent the emergence and spread of *Staphylococcus aureus* and other pathogenic organisms within hospital environments. The resistance proportions in this study were high against most of the antibiotics tested. In a similar study conducted in Nigeria, by Hammuel *et al.* (2014) also reported multidrug resistance of *S. aureus* (31.3%) in hospital settings; however, the proportions of multidrug resistance observed in our study (92.3%) was higher.

This study has various limitations. The fact that sampling was done at only one tertiary hospital restricts the generalization of our findings. Furthermore, we were unable to establish a link between common nosocomial diseases and the *S. aureus* isolated from objects. Disinfectants used at the hospital was not tested for their efficacy.

CONCLUSION

All sampled door handles, benches, and mobile phones exhibited significant contamination with *S. aureus*. This indicates the potential of these items to act as fomites, contributing to hospital-acquired infections with potential public health implications. Regular disinfection of surfaces and mobile phones, along with proper hand hygiene, is essential to reduce disease transmission. The high resistance of isolates highlights the need for routine cleaning, disinfection, surveillance, and further research on the role of surface contamination in nosocomial infections, both in Ghana and across Africa.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article.

DATA AVAILABILITY STATEMENT

The data presented in this study are available on request from the corresponding author.

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AUTHOR CONTRIBUTIONS

Conceptualisation, K.G.B.; methodology, G.O.B., A.K and D.T.E.; validation, K.G.B.; formal analysis, K.A.A., K.A.A., and A.A.; investigation, G.N., J.S.K., D.A., C.H., I.A.O., and B.N.; resources, K,.G.B., and A.A.; data curation, K.G.B., G.O.B., A.K, D.T.E., K.A.A. and A.A.,; writing—original draft preparation, K.G.B., and A.A.; writing—review and editing, K.G.B., F.O.A, E.D., and A.A.; visualisation, K,.G.B., and A.A.; supervision, K.G.B.; project administration, K.G.B.

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