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Assessment of Bacterial Contamination on Fomites and Healthcare Workers and Antibiotic Susceptibility Patterns of Bacterial Isolates in the Gynecology Ward of Abia State Tertiary Healthcare Facilities in Abia State

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ABSTRACT

Background: Bacterial contamination of the Gynecology ward is a public health concern because it is the primary cause of nosocomial infections in postpartum moms and one of the primary risk factors for sepsis in newborns. This study evaluated the bacterial contamination of fomites, nostrils, and palms of healthcare workers in the Gynecology ward.

Methods: A total of 244 samples were collected and cultured on Blood, Mannitol salt, and MacConkey agar. Standard biochemical tests were carried out to characterize the organisms. Antibiotic susceptibility patterns of the isolates were carried out using the Kirby-Bauer disc diffusion method.

Results: Out of the 244 samples, 95(38.93%) yielded bacterial growth. Of these, 75 isolates (40.76%) were isolated from fomites, while 20 (33.33%) were isolated from the palms of hands and nostrils of healthcare workers. The most common bacterial isolate was *Staphylococcus aureus* (46 isolates 48.42%), whereas the least common was *Streptococcus spp.* (1isolates 1.05%). The Gram-negative bacterial isolates were resistant to Ceftriaxone, Cefuroxime, Cotrimoxazole, and Ceftazidine. The Gram-positive bacterial isolates were resistant to Ampicillin, Ciprofloxacin, Augmentin, Ceftazidine, and Cephalexin.

Conclusion: This study revealed the presence of bacterial pathogens on fomites and within the nostrils of healthcare workers in the Gynecology ward, underscoring the necessity for regular monitoring of bacterial contamination in these environments.

1. Introduction

The rise in prenatal deliveries and the impact of the hospital environments on women's delivery experiences are pressing concerns (Omo-Aghoja et al., 2010). The transfer of labor from home to hospital and the classification of delivery as a pathological event result in hospital settings that prioritize medical safety (Omo-Aghoja et al., 2010). Healthcare-associated infections continue to be one of the key reasons for patient morbidity and mortality, with approximately 99,000 individuals in the United States succumbing to nosocomial infections annually, out of an estimated 1.7 million affected (Zaragoza et al., 2014; Klevens et al., 2007). Medical staff may become contaminated by contacting infectious surfaces in patient environments or close to patients. According to Daneman et al. (2013), Zaragoza et al. (2014), and Kramer et al. (2006), patients may also contract nosocomial diseases through contact with contaminated surfaces in healthcare facilities. All surfaces in healthcare facilities should be visibly clean, and devoid of residues such as body fluids (Wolde et al., 2023). However, microbiological contamination does not always correlate

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with apparent cleanliness; even surfaces that appear clean can harbor infectious agents (Wolde et al., 2023). Hospital wards' quantifiable levels of inanimate surface contamination vary based on the kind of surfaces, ward type, or hygiene practices used in a particular unit. (Claro et al., 2015). The nasal carriage of Staphylococcus aureus by healthcare workers is a major hospital reservoir for this pathogen, with approximately 25% of hospital-based healthcare workers being stable nasal carriers (Wolde et al., 2023). This bacterium can asymptomatically colonize human skin and anterior nares, posing a risk for invasive infections (Tiago et al., 2020). Healthcare workers (HCWs) who carry pathogens are a major reservoir of pathogens that cause hospital-acquired infections (HAI) because they are the intermediary between healthcare facilities and the population. Despite adherence to sanitation protocols, inanimate hospital environments can still be contaminated with a variety of microbes, particularly potentially pathogenic bacteria due to the hands of healthcare staff being a main transmission route (Beggs et al., 2015). The primary objective of this study was to assess the bacterial contamination of fomites, palms, and nostrils of healthcare workers in the Gynecology ward of tertiary healthcare facilities at Abia State.

2. Materials and Methods

2.1 Study Location

This study was carried out in the Gynecology wards of the Federal Medical Centre, Umuahia, and Abia State University Teaching Hospital, Aba. FMC is located in Umuahia (the capital city) while ABSUTH is located in Aba (the commercial city). Ethical approval was obtained from the healthcare facilities before sampling and analysis. Informed consent was sought from the participating healthcare workers, and the samples collected from them were handled with the utmost confidentiality and were not used against them in any form. In addition, data analysis and presentation were aggregated to maintain the anonymity of the participants.

2.2 Sample Collection and Processing

A total of 244 samples were collected from fomites, palms, and nostrils of healthcare workers, and analyzed in the laboratory between May and July 2024. Specifically, 184 samples were collected from inanimate surfaces (fomites), while 60 samples were collected from the palms and nostrils of healthcare workers. Sterile swab sticks moistened with sterile water were used to swab the surfaces of the mattress, tables, footwear, clinical coats, bed sheets, and pillows. These inanimate surfaces/fomites were selected based on their frequent use and direct contact with patients, healthcare workers, and visitors. Sterile swab sticks moistened with sterile water were used to swab the palms of the hands of healthcare workers and only sterile swab sticks were used to swab the nostrils of healthcare workers. To guarantee maximal coverage of a surface area, the swab sticks were rolled back and forth. The swabs were tightly sealed and carefully labeled with the names of the fomite it was collected from. Samples from the nostrils and palms of healthcare workers were carefully labeled to avoid mix-ups. All swab samples were transported in sealable, leak-proof plastic bags within 1 h of collection for laboratory analysis. Gram-stained isolates were identified using standard biochemical tests after the swab sticks were inoculated onto appropriate media (Blood agar, MacConkey agar, Mannitol salt agar) and incubated for 24 to 48 h at 37°C (Cheesbrough, 2006). The biochemical tests used to identify the bacterial isolates included pigment production, tube coagulase test (TCT), catalase test, motility test, indole test, Triple sugar Iron agar, and acid production (Cheesbrough, 2006; Acharya, 2024; Aygan & Arikan, 2007).

2.3 Antibiotic Susceptibility Test

The disk diffusion method was used to test for antibiotic susceptibility, and the results were interpreted using Mueller Hinton agar (Hardy Diagnostics USA) in accordance with the Clinical Laboratory Standards Institute (CLSI, 2011) guidelines. A sterile cotton wool swab was dipped into a suspension of the organism's overnight growth, and adjusted to a McFarland No 0.5 opacity standard, to inoculate Mueller-Hinton culture plates. Any extra liquid from the swab was then expressed using the spread plate procedure before inoculation. Antibiotic discs (Biomark, India) with the following concentrations were used: Tetracycline (30 µg), Ampicillin (10µg), Meropenem (10 µg), Gentamicin (10 µg), Erythromycin (5 µg), Ciprofloxacin (5 µg), Cotrimoxazole (25µg), Cefuroxime (10 µg), Augmentin (30 µg), Cefalexin (10 µg), Vancomycin (30µg), Ceftazidime (10µg), Chloramphenicol (10 µg), Ceftriaxone (30 µg), Cefotaxime (30µg), and Amikacin (30µg). After overnight incubation, the control and test plates were carried out to ensure confluent or near-confluent growth. Using a ruler on the underside of the plate the diameter of each zone of inhibition was measured in mm. The endpoint of inhibition was defined as the point at which growth commenced (Jorgensen & Turnidge, 2007).

2.4 Methicillin-resistant Staphylococcus aureus using Cefoxitin disc diffusion

The Clinical and Laboratory Standards Institute's (CLSI, 2011) criteria were followed when conducting the test. Each isolate was suspended to a turbidity of 0.5 McFarland Standard before being plated onto a Mueller-Hinton agar plate (Hardy Diagnostics USA). On each plate, a 30 µg Cefoxitin disc (Oxoid) was placed. After a 24-hour incubation period at 35°C, the sizes of the zones were assessed. Resistance was defined as isolates with an inhibitory zone size of less than or equal to 19 mm, with reference strains including ATCC 3359 (MRSA).

2.5 Method of Data Analysis

The statistical package for Social Sciences (SPSS Inc, Chicago IL. USA) version 20.0 statistical software was used

for data analysis. Categorical variables, such as the frequency of the bacterial isolates, were summarized using proportions expressed in percentages.

3. Results and Discussion

A total of 244 samples were collected and analyzed in the laboratory. The bacterial isolates recorded in this study were 38.93%. Four different bacterial isolates were identified, with *Staphylococcus aureus* being the most prevalent at 48.42%. The other isolates included coagulase-negative *Staphylococci* (27.37%), *Escherichia coli* (23.16%), and *Streptococcus* spp. (11.05%). As shown in Table 1, *Staphylococcus aureus* was the highest bacterial isolate, comprising 46 isolates (48.42%), followed by coagulase-negative *Staphylococci* with 26 isolates (27.37%), *Escherichia coli* with 22 isolates (23.16%), and *Streptococcus spp.* as the least prevalent with 1 isolate (1.05%). Table 2 illustrates that from fomites/inanimate surfaces, *Staphylococcus aureus* accounted for 37 isolates (49.3%), coagulase-negative *Staphylococci* for 21 isolates (28.0%), *Escherichia coli* for 16 isolates (21.3%) and *Streptococcus spp.* for 1 isolates (1.3%). The highest bacterial pathogen was identified in footwear (n = 28) and Mattress (n = 21). In Table 3, *Staphylococcus aureus* constituted 9 isolates (45.0%), coagulase-negative *Staphylococci* 5 isolates (25.0%), and *Escherichia coli* 6 isolates (30.0%) from the palm of hands and nostrils of healthcare workers. Table 4 indicates that *Staphylococcus aureus*, Coagulase Negative *Staphylococci* (CoNS), and *Streptococcus spp.* were sensitive to Cotrimoxazole, Tetracycline, Erythromycin, Cefuroxime, Vancomycin, and Gentamicin, while *Escherichia coli* was sensitive to Chloramphenicol, Amikacin, Gentamicin, Ciprofloxacin. Specifically, *Staphylococcus aureus* isolates were susceptible to Erythromycin (56.52%), Tetracycline (56.52%), Cotrimoxazole (78.26%), Cefuroxime (56.52%), Gentamicin (56.52%), Vancomycin (56.52%). Coagulase-negative *staphylococci* isolate demonstrated susceptibility to Erythromycin, 65.38%, Tetracycline, 61.54%, Ciprofloxacin, 76.92%, Cotrimoxazole (69.23%), Gentamicin (76.92%), Vancomycin (80.77%). In addition, *Escherichia coli* isolates were susceptible to Chloramphenicol (81.81%), Gentamicin (81.81%), Ciprofloxacin (81.81%), and Amikacin (100%). Finally, as shown in Table 5, 15 isolates of *Staphylococcus aureus* were identified as methicillin-resistant using the cefoxitin disc diffusion method.

Table 1. Diversity and Percentage of Bacterial Isolates

ISOLATES	NO	PERCENTAGE(%)
Staphylococcoccus aureus	46	48.42
CoNS	26	27.37
Escherichia coli	22	23.16
Streptococcus spp	1	1.05
	95	

KEY: CoNS- COAGULASE NEGATIVE STAPHYLOCOCCI

Hospital-acquired infections (HAIs) can result from bacterial contamination in hospital wards. Visitors, healthcare personnel, and patients can all contract these infections. Despite improvements in hygiene protocols, the hospital environment remains a significant concern due to persistent contamination. In this study, the overall bacterial contamination rate from fomites/inanimate surfaces, palms of hands, and nostrils of healthcare workers in the gynecology wards was 38.93%. These findings were higher than those reported by Uneke et al. (2014) in Nigeria but lower than the rates of Konjit et al. (2021) in Indonesia (74.7%) and Saadi et al. (2022) which showed a high prevalence (65.25%) of bacteria in various hospital surfaces. These findings may be due to the type of inanimate surfaces/fomites and the potency of disinfectants used in cleaning the surfaces.

Table 2. Distribution of Bacterial Isolates from Fomites in the Gynaecology wards at FMC, Umuahia, and ABSUTH, Aba

ITEMS		NO EXAMINED	NO BACTERIAL ISOLATES				
			Staph aureus	CoNS	*E.Coli*	*Strept* spp	Total
Mattress	FMC	30	1	0	10	0	21
	ABSUTH	24	8	2	0	0	
Bedsheet	FMC	18	3	0	0	0	5
	ABSUTH	12	2	0	0	0	
CC (Clinical coat)	FMC	7	0	2	1	0	6
	ABSUTH	6	0	0	3	0	
Footwear	FMC	38	18	7	2	1	28
	ABSUTH	0	0	0	0	0	
Pillow	FMC	3	1	0	0	0	9
	ABSUTH	28	2	6	0	0	
Table	FMC	5	0	1	0	0	6
	ABSUTH	13	2	3	0	0	
Total		184	37	21	16	1	75
	Percentage (%)		49.3	28.0	21.3	1.3	

Of the 244 samples collected and analyzed, 95 (38.93%) yielded bacterial growth. *Staphylococcus aureus* with 46 isolates (48.42%) was the predominant bacterial isolate. This is similar to the findings of Kalu et al. (2023) on bacterial contamination in labor wards and delivery rooms in selected primary healthcare facilities in Abia state. This also agrees with Bhatta et al. (2018) on the bacterial contamination of frequently touched objects in a tertiary care hospital in Pochara. However, this contrasts with the findings of Essien et al. (2017), whose predominant bacterial isolate was

Proteus spp. Out of the 184 samples collected from fomites (inanimate surfaces), 75 (40.76%) yielded bacterial growth. *Staphylococcus aureus* with 37 isolates (49.30%) and coagulase-negative *staphylococci* (22 isolates, 28.0%) as the predominant bacterial isolates. This is in contrast with the findings of Essien et al. (2017) on bacterial contamination on hospital surfaces in Bingham University Teaching Hospital, Jos, while being consistent with the findings of Kalu et al. (2023) and Bhatta et al. (2018). These findings indicate that bacteria can persist on inanimate surfaces/fomites if cleanliness is not adequately maintained. Among the 60 samples collected and analyzed from the palms and nostrils of healthcare workers, 20 (33.33%) yielded bacterial growth, with *Staphylococcus aureus* (9 isolates45.0%) as the predominant bacterial isolate. This is similar to the findings of Junu et al. (2022), Wolde et al. (2023), Walana et al. (2020), and Tiago et al. (2020). However, the bacterial contamination of the palms and nostrils of healthcare workers was very low. This might be the result of rigorous adherence to conventional clinical procedures, frequent hand-palm disinfection, and rigorous face mask use. This supports the notion that *Staphylococcus aureus* most frequently colonizes the nostrils. Compared to nasal carriers, there are fewer reports of hand carriers. Compared to the findings of Pant & Sharma (2016), the prevalence of hand carriers in this study was lower, which may suggest improved hand hygiene practices among participating healthcare workers. In this investigation, *Staphylococcus aureus* accounted for 48.42% of the germs isolated from inanimate surfaces and fomites. A Brazilian multicenter study found that *Staphylococcus aureus* was the most commonly recovered organism from hospital surfaces and equipment in 53.3% of cases (Rodrigues et al., 2019). These findings are similar to one another. These results are also in line with those of Munveshyaka et al. (2021) on inanimate surfaces and equipment. In this study, we observed a resistance pattern with the commonly used antibiotics including Ampicillin, Gentamicin, Ciprofloxacin, and Ceftriaxone. A similar pattern was reported in other studies (Adamu et al., 2014; Montero et al., 2015), potentially attributed to the availability, cost, and abuse of these medications. This aligns with the findings of Sanusi et al. (2023). In contrast, Adam et al. (2020) found that the highest resistance rates of *Staphylococcus aureus* were found in trimethoprim-sulfamethoxazole. On the other hand, Munveshyaka et al. (2021) investigation revealed that *Escherichia coli* and *Staphylococcus aureus* were susceptible to a number of widely used antibiotics. There was no trend of multidrug resistance in any of the bacterial isolates.

Table 3. Distribution of Bacterial Isolates from Healthcare Workers in the Gynecology Wards at FMC, Umuahia and ABSUTH, Aba

SITE of C		NO EXAMINED	NO BACTERIAL ISOLATES				
			Staph aureus	CoNS	*E.Coli*	*Strept* spp	Total
Palm	FMC	15	2	0	3	0	10
	ABSUTH	15	2	0	3	0	
Nostril	FMC	15	0	5	0	0	10
	ABSUTH	15	5	0	0	0	
Total		60	9	5	6	0	20
	Percentage (%)		45.0	25.0	30.0	0	

Key: Site of C= Site of Collection

Table 4. Antibiotic Susceptibility Test for the Bacterial Isolates

GPB/GNB	N.O Isolates	AMP	MEM	ERY	TET	COT	CRX	CHL	CTR
Staphylococcus aureus	46	11(23.91)	10(21.74)	26(56.52)	26(56.52)	36(78.26)	26(56.52)	-	-
CoNS	26	10(38.46)	13(50)	17(65.38)	16(61.54)	18(69.23)	12(46.15)	-	-
Streptococcus spp	1	0	1(100)	1(100)	1(100)	1(100)	1(100)	-	-
Escherichia coli	22	-	11(50)	-	13(59.09)	10(45.45)	10(45.45)	18(81.81)	10(45.45)
GPB/GNB	**N.O Isolates**	**GEN**	**CIP**	**AUG**	**VAN**	**CPZ**	**CP**	**CTX**	**AMK**
Staphylococcus aureus	46	26(56.52)	14(30.43)	14(30.43)	26(56.52)	12(26.09)	10(21.74)	-	-
CoNS	26	20(76.92)	20(76.92)	13(50)	21(80.77)	13(50)	0	-	-
Streptococcus spp	1	0	0	1(100)	0	1(100)	0	-	-
Escherichia coli	22	18(81.81)	18(81.81)	-	13(59.09)	10(45.45)	-	11(50)	22(100)

Key: GPB = Gram positive bacteria, GNB = Gram negative bacteria, N.O = Number of, AMP = Ampicillin, MEM = Meropenem, ERY = Erythromycin, TET = Tetracycline, COT = Cotrimoxazole, CRX = Cefuroxime, GEN = Gentamicin, CIP = Ciprofloxacin, AUG = Augmentin, VAN = Vancomycin, CPZ = Ceftazidime, CP = Cephalexin, CHL = Chloramphenicol, CTR = Ceftriaxone, AMK = Amikacin

With the advent of MRSA, which is resistant to all beta-lactam antibiotics, including monobactams and cephalosporins, a class of antibiotics frequently used to treat *Staphylococcus* infections, the issue of the prevalence of *Staphylococcus aureus* infections keeps getting worse (Bush & Bradford, 2016). Accurately identifying MRSA requires quick and early detection because it leads to treatment issues and promotes its spread (Mehta et al., 2020). Fifteen out of the 46 *Staphylococcus aureus isolates* were MRSA representing 32.61% and indicating that one out of

approximately three *Staphylococcus aureus* carriers harbors MRSA. Although burn centers in the United States, Iran, and the United Kingdom have reported MRSA rates of 2.5%, 7%, and 9%, respectively (Patel et al., 2013; Khosravi et al., 2012), the current rate of MRSA observed is comparatively higher than 16.5% reported in another region of Nigeria (Shittu et al., 2011). This was in contrast with the findings of Saadi et al. (2022) which showed a high prevalence (65.25%) of bacteria in various hospital surfaces. According to Miragaia (2018), mecA genotyping by PCR remains the primary recommendation forMRSA detection, despite its limited regular application. The phenotypic detection of MRSA via disk diffusion has not yielded consistently reliable results; however, disk diffusion remains a commonly utilized method due to its speed and cost-effectiveness (Bennett & Sharp, 2008).

Table 5. MRSA using Cefoxitin Disc Diffusion Method

ISOLATES	TOTAL NO TESTED	MRSA	PERCENTAGE (%)
Staphylococcus aureus	46	15	32.61

MRSA = Methicillin-resistant Staphylococcus aureus

4. Conclusion

The findings of this study have significant implications for hospital infection control and prevention. The recovery of pathogens from fomites and other critical areas raises serious concerns regarding therapeutic strategies. The documented resistance patterns of bacterial isolates provide a basis for developing intervention strategies. The current study emphasizes the importance of regular cleaning and disinfection of fomites and inanimate surfaces, as well as promoting strict adherence to face masks and proper hand hygiene among healthcare workers. The cefoxitin disk diffusion method can serve as a practical alternative for laboratories unable to perform molecular testing for MRSA, although genotypic detection using PCR to identify the mecA gene remains the most accurate method. Public health may be at risk from the spread of MRSA, a strain of *Staphylococcus aureus*. Therefore, in order to stop the spread of *Staphylococcus aureus* infections on fomites and inanimate surfaces as well as healthcare personnel at tertiary hospitals in Abia state, prevention and control measures are required. Cefoxitin medications are second-generation antibiotics that are rarely prescribed in medical settings, which may explain their increased susceptibility to the *Staphylococcus aureus* isolates in our study. Extensive infection control procedures are required to prevent or contain some bacterial strains, such as *Staphylococcus aureus* and *Escherichia coli*, because they have a higher tendency to cause contamination, particularly in gynecology wards. Regular evaluations of antibiotic sensitivity patterns and microbial flora in gynecology wards are critical. Enhanced tools should be made available to promote appropriate antibiotic use and hospital hygiene, with all healthcare professionals actively participating in infection control initiatives within their institutions.

Authors' Contributions

Ebubechi Uloma Okey-kalu: Conceptualization; Methodology; Data curation; Formal analysis; Funding acquisition; Investigation; Resources; Visualization; Writing-original draft; Writing-Review and editing. **Ikechukwu Okoli:** Supervision; Methodology; Investigation.

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Conflicts of Interest

The Authors declare that there is no conflict of interest.

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Ethical considerations

This study was approved by the Ethics committee of the Federal Medical Centre, Umuahia (code: FMC/QEH/G.596/Vol.10/746) and Abia State University Teaching Hospital (code: ABSUTH/MAC/117/VOL1/60).

Using artificial intelligence

This research did not utilize any artificial intelligence techniques.

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