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Staphylococcus aureus Surface Colonization of Medical Equipment and Environment, Implication in Hospital-Community Epidemiology

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Abstract

Staphylococcus aureus has been known to be a predominant nosocomial infection occurring majorly among immune-compromised patients in hospital environments and other health care facilities. This study was carried out to identify the prevalence of *Staphylococcus aureus* on fomites in both male and female orthopedic wards, Radiology Department and the hospital environment at the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile-Ife, Nigeria.

Standard conventional methods of microbial analysis in isolation of *S. aureus* including catalase, coagulase and DNase tests as well as the antibiograms of the isolates from fomites were determined. Out of 34 (thirty-four) samples collected, 11 samples were confirmed positive for *S. aureus* isolates with the female ward constituting of 45.5%. Pure cultures of *S. aureus* isolated were 100% susceptible to both ciprofloxacin and pefloxacin, 69% resistant to amoxicillin and ampiclox, 80% to septrin, 54% erythromycin, 31% streptomycin, 38% rocephin and 15% to gentamycin used. Periodic routine disinfection of hospital environment should be implemented in order to reduce the risk of infection among patients and staff. Protocols to reduce the transmission may need to be extended to hospital beds, trolleys, nurse desk, tables and taps. Frequent need for strict compliance to effective Infection Control Program must be maintained.

Keywords: *Staphylococcus aureus*; Fomite; Orthopedic; Radiology; Nosocomial infections

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Introduction

Staphylococcus aureus is one of the most frequently isolated human pathogen bacteria in the community and hospital infections [1]. It is therefore one of the most devastating and widespread disease causing bacteria in hospital epidemiology due to its ability to produce wide range of toxins and adhesion factors [2].

Staphylococcus aureus, a major human pathogen causing a large variety of infections worldwide and predominates in surgical wound infections with prevalence rate ranging from 4.6-54.4% [3].

Staphylococcus aureus being among the most frequently reported bacterial nosocomial pathogens [4] and could be found on common surfaces in hospitals such as floors and door handles even after disinfection, and can indirectly be transmitted through fomites, or contaminated inanimate objects, causing infections [5].

Fomites consist of either porous or nonporous surfaces or inanimate objects that when contaminated with pathogenic microorganisms can transfer them to a new host thereby serving as vehicles of transmission [6,7]. Fomites are associated particularly with hospital acquired infections that remain a major cause of patient morbidity and mortality [8,9].

It has been estimated that 20 to 40% of hospital acquired infections have been attributed to cross infection via the hands of hospital workers who have become contaminated from direct contact with the patient or indirectly by touching contaminated

environmental surfaces [3,10,11]. Stethoscopes, neckties (Merlin et al.; Williams and Davis), skin cells, hair, food, computer keyboards, pens, tables, artificial acrylic fingernails [12], beddings and clothing are common hospital sources of pathogens [7,13].

Nosocomial and Community-Acquired Infections *S. aureus* can grow in a wide range of temperatures (7° to 48.5°C; optimum 30 to 37°C), pH (4.2 to 9.3; optimum 7 to 7.5), and sodium chloride concentration up to 15% NaCl. *S. aureus* is a desiccation tolerant organism.

About 20-30% of individuals are persistent carriers of S. aureus, which means they are always colonized by this bacterium, and 30% are intermittent carriers [14]. Ability to survive in potentially dry and stressful environments, such as the human nose and on the skin and inanimate surfaces and can remain viable on hands and environmental surfaces for extended durations after initial contact [15].

This study determines if hospital fomites could be contaminated with microorganisms associated with nosocomial infections with emphasis on *Staphylococcus aureus* and to detect the possibility of cross contamination between health care workers including the antibiotic sensitivity pattern of the isolates recovered.

Materials and Methods

Collection of samples

A total of 34 samples were collected aseptically from the Orthopedic male and female ward Radiological unit and railings at Obafemi Awolowo University Teaching Hospital Complex (OAUTHC) Ile-Ife using sterile swab sticks and were transferred immediately to the Microbiological Laboratory for analysis.

Methods of isolation

A swab stick was used to swab fomites surface. Swabs collected from the hospital wards and environmental surfaces were inserted aseptically into test tubes that contain freshly prepared nutrient broth and then incubated at room temperature (37°C). After 24 hours, the broth culture was inoculated into mannitol salt agar (MSA) plates using the inoculating loop. The streaking was done and the plates were incubated at 37°C for 24 h. Golden yellow color showed the fermentation of the mannitol which is a presumptive test for *Staphylococcus aureus*. Conventional method of using catalase and coagulase tests for isolation of Gram positive coagulase positive staphylococci were adopted.

DNase test

A loopful of the 24 h agar culture was smeared on freshly prepared DNase agar plates and incubated at 37°C for 24 h. After 24 h, the plates were flooded with 1 N HCl and left for 5 minutes allowing for penetration before pouring away. A clear zone was observed around the colonies. This confirms *Staphylococcus aureus* is isolated.

Antibiotic sensitivity testin

Antibiotic sensitivity testing was performed by the disk diffusion method as described by Bauer-Kirby method modified by the National Committee for Clinical Laboratory Standard. The pattern of antibiotic sensitivity of *S. aureus* to 10 antibiotics (gentamicin (10 µg), Streptomycin (30 µg), ampiclox (30 µg), ciprofloxacin (10 µg), erythromycin (10 µg), amoxicillin (30 µg), rocephin (25 µg), septrin (30 µg), pefloxacin (10 µg), and zinnacef (20 µg)) was determined. The *S. aureus* isolates were inoculated in nutrient broth and incubated at 37°C for 24 h. The inoculum was transferred into the Mueller-Hinton agar plates. Antibiotic discs were carefully placed on the plates. Plates were incubated at 37°C for 18 to 24 h. The zones of inhibition were measured, recorded and interpreted according to the Clinical Laboratory Standard Institute provided [16].

Results

Out of the 50 isolates obtained from the Medical Facilities and Personal Equipment examined, 36 (72%) were from female wards, 22 (44%) from the male wards. Out of a total of thirty-four (34) samples isolated from hospital sources which includes the Male and Female Orthopedic Ward, Radiology Department and Hospital Environment, 25 samples were positive for Staphylococcal growth while 9 samples were positive for Micrococcus. In culture, positive cases, Staphylococci accounted for 56% (14) and Staph aureus accounted for 44% (11). The number of *Staphylococcus aureus* was higher in Female Ward (45.5%) than in Male Wards (36.4%). Among them, 18.18% were trolleys, 9.09% were tables, 18.18% Hospital beds, 9.09% bed railings, 18.18% nurse desks, 9.09% taps, and 18.18% Hospital railings **(Table 1)**.

Among 11 isolates of *Staphylococcus aureus,* all isolate showed (100%) sensitivity towards Ciprofloxacin and Pefloxacin while some showed (100%) resistance to amoxicillin and Ampiclox.

The results obtained from OAUTHC showing the occurrence of *S. aureus* contamination of hospital fomites and environment are presented in **Tables 2 and 3**. From the Male Orthopedic Ward, the percentage occurrence of *S. aureus* is 36.36% while the Female Orthopedic having the highest occurrence of 45.45%. The Radiology Department showed no indication for the presence of *S. aureus* colonization while the hospital environment had a percentage of 18.18% **(Tables 2 and 3)**.

Discussion

This study shows that (45.5%) fomites colonization in Females Orthopedic Wards have a higher chance of spreading acquired hospital infections than (36.4%) surface colonization in Male Orthopedic or in the immediate Environment. This, which supported the report of Bhatt et al. [16] where, records of predominance of *S. aureus* in (60%) Female wards are higher than (40%) obtained in Male wards at a study of Antibiotic susceptibility pattern of *Staphylococcus aureus* and methicillin-resistant *Staphylococcus aureus* in a tertiary care hospital. However, the result was contrary to the findings of Khanal et al. [17] who recorded a significantly higher rate among Males (75%) than in the Females (25%) in a study of Prevalence of Methicillin-resistant *Staphylococcus aureus* (MRSA) among skin infection cases at a hospital in Chitwan.

Table 1: Number of samples and the percentage of *S. aureus* obtained at the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC) Ile-Ife, Osun State.

Wards/Environment	Number of samples obtained	Number of Staphylococcal isolates recovered	% occurrence of isolates	No. of S. aureus recovered	% occurrence of S. aureus
Male Orthopedic	12	10	71.42	4	36.36
Female Orthopedic	12	10	71.42	5	45.45
Radiology	5	1	7.14	-	-
Environment	5	4	28.57	2	18.18
Total	34	25		11	

Table 2: Percentage Composition of Microbial Isolates colonizing Facilities/Equipment Surfaces.

Medical Facilities	Sample Taken: Male and Female wards. Orthopedic Radiology	% *Staphylococci* sp.	% *Enterobacteria* sp. and Micrococcus sp.	% *S. aureus* recovered
Personnel Equipment Examined		M%; F%	M%; F%	M%; F%
Physician Examination Table (PET)	5	3 (9.76); 5 (11.6)	1 (5.3); 2 (0)	2 (9.1); 3 (8.3)
Hospital Chairs (HC)	5	3 (9.76); 5 (11.6)	2 (10.5); 0 (0)	3 (13.6); 4 (11.1)
Patients Trolley (PT)	5	4 (12.9); 4 (9.3)	1 (5.3); 1 (14.3)	3 (13.6); 4 (11.1)
Hospital Bed Linen (HBD)	5	2 (6.2); 4 (9.3)	3 (5.3); 1 (14.3)	1 (2.27); 4 (11.1)
Bed Railings (BD)	5	3 (9.7); 4 (9.3)	2 (10.5; 1 (14.3)	2 (9.1); 3 (8.3)
Ward Water Tap (WWT)	5	2 (6.2); 4 (9.3)	3 (15.8); 1 (14.3)	2 (9.1); 3 (8.3)
Nurses Desk (ND)	5	4 (12.9); 5 (11.6)	1 (5.3); 0 (0)	3 (13.6); 5 (13.9)
Corridor Railings (CR)	5	4 (12.9; 4 (9.3)	1 (5.3); 1 (14.3)	3 (13.6); 4 (11.1)
Personnel Stethoscope (PS)	5	4 (12.9); 5 (11.6)	1 (5.3); 0 (0)	2 (9.1); 4 (11.1)
Door Handles (DH)	5	2 (6.2); 3 (7.0)	3 (15.8); 2 (28.6)	1 (2.2); 2 (5.6)
Total (n)	50	31 (62%); 43 (80%)	19 (38%); 7 (14%)	22 (44%); 36(72%)
Note: 7 (14%) and 19 (38%) isolates accounted for *Micrococcus* sp. and the *Enterobacteriaceae* sp. in both male and female wards studied. While 31 (62%) and 43 (80%) of the isolates accounted for *Staphylococci* sp. in both male and female wards in the study area respectively. KEY: F=Female; M=Male				

Table 3: Percentage susceptibility pattern of *S. aureus* recovered.

Antibiotics	% Resistant	% Sensitive
Amoxacillin	100	-
Rocephin	90.9	9.1
Ciprofloxacin	-	100
Streptomycin	63.6	36.3
Septrin	81.8	18.2
Erythromycin	90.9	9.1
Pefloxacin	-	100
Gentamycin	90.9	9.1
Ampiclox	100	-
Zinnacef	45.5	54.5

All isolates recovered were found to be sensitive to ciprofloxacin and pefloxacin (100%) while (100%) resistant to amoxicillin and ampiclox. Similar study performed by Baral et al. [18] showed that *S. aureus* was susceptible to ciprofloxacin (88.3%). This is also agreed with the report of some workers Omololu-Aso et al. [19] and Nwankwo and Nasiru [20] where susceptibility of *S. aureus* isolates on fomites at OAUTHC and a tertiary health institute in Kano revealed 88.62% and 78.9% strains sensitivity to ciprofloxacin respectively. In the findings of Baba et al. [2] and Ako-Nai et al. [21], it was also recorded that for β-lactamase producing strains of *Staphylococcus aureus*, resistance to amoxicillin was 100% and 86.8% respectively. The patterns of sensitivity among isolates were zinnacef 55%, streptomycin 36%, septrin 18%, rocephin 9%, erythromycin 9%, ciprofloxacin 100%, Pefloxacin 100%, and Gentamycin 9%. All isolates were resistant to amoxicillin and ampiclox used.

Some researchers Kramer et al. [5] concluded in their study that the common nosocomial pathogens such as *Staphylococcus aureus* may well survive or persist on surfaces for months and can thereby be a continuous source of transmission if no regular surface disinfection is performed. In this report, isolated strains were taken from various fomite sources which might have been contaminated although, duration of stays was not considered. There are a number of known factors from different lines of evidence that support the use of bed occupancy, trolleys and Hospital railings as an operational target and measure of quality which includes the risk of cross contamination between inpatients in overcrowded ward and the need for timely admission to an

appropriate ward. Staff welfare may also be adversely affected by high bed-occupancy. Most reports concerning inpatients cross-infection consider the spread of methicillin-resistant *Staphylococcus aureus* (MRSA) in hospitals, and this has been shown to correlate with bed-occupancy rates Borg Cunningham et al. [22] Based on published hospital performance data (NSW Health, [23] there is a significant negative association between bed-occupancy rates and emergency department admission performance which correlates with the findings of this work.

Irregular cleaning and effective disinfection of door knobs of the Orthopedic ward tables, nurse desks, beds, trolleys and taps may allow pathogens that contaminate them by setting on them or by hand, to survive and be transmitted to patients or health care workers. Although surface cleaners play a role in reducing the spread of infections, not all disinfectants work equally well at killing all pathogens [24,25]. Some pathogens are more susceptible to specific detergents than others. Therefore, there is a need for regular cleaning and disinfection of fomites identified to be easily contaminated with specific pathogens. The effective use of disinfectants constitutes an important factor in preventing hospital acquired infections and improving cleaning of environmental surfaces and hand hygiene have been shown to reduce the spread of hospital acquired pathogens [25,26].

Conclusion and Recommendation

The result of this study is an indication that fluoroquinolones are effective in treatment of *Staphylococcus aureus* infection. The isolation of *Staphylococcus aureus* from this study also indicates that it can be a vehicle for disease transmission in tertiary hospitals increasing health care treatment cost and increasing morbidity rate. Therefore, there is a need for thorough disinfection and conscientious contact control procedures to minimize the spread of this pathogen in hospitals where interaction between patients and health care workers is very common and frequent. It is also necessary to encourage avoiding touching fomites with gloved hands.

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