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Pathogenic Aerobic Bacterial Contaminants on Non-Critical Hospital Surfaces within Paediatric Ward of a Nigerian Hospital

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Abstract

The study was a cross-sectional study of indoor hospital surfaces within paediatric wards to determine the pattern of pathogenic aerobic bacterial contaminants on non-critical surfaces within paediatric wards of UITH, Ilorin.

A total of 201 surface swab samples were collected, using sterile ethylene oxide sterilized swab sticks pre-moistened with sterile normal saline, from selected non-critical surfaces and were aseptically cultured on media and incubated aerobically at 35°C to 37°C for 18 to 24 hours. Identification of bacterial isolates was carried out using standard microbiological procedure.

Non-critical surfaces within paediatric wards: emergency paediatrics-unit 1 (EPU 1), emergency paediatric-unit 2 (EPU 2), paediatric medical-ward (PMW), paediatric surgical-ward (PSU) and neonatal intensive care unit (NICU).

A prevalence of 67.7% was recorded for surface contamination; *Staphylococcus aureus* was the predominant isolate 39.4% and *Pseudomonas aeruginosa* 1.3% was the least contaminant isolated from this study. Wash sinks were the most commonly contaminated site amongst surfaces studied with a proportion of 123.5%, medical tables were the least contaminated with 33.33%. Among the wards sampled, EPU2 has the highest contamination level with 87.5% while NICU has the least contamination with 67.6%.

This study showed that most of the sites sampled had bacterial contaminants indicating potential sources of cross contamination from surfaces to hands of healthcare workers, patients and vice-versa. It is pertinent to understand that non-critical hospital surfaces are important in the passive transmission of healthcare associated infectious pathogens. Thorough cleaning, disinfection of these surfaces and proper hand washing practices will break the chain of transmission.

Keywords: Bacterial; Paediatric; Pathogenic; Microbiological

Introduction

A hospital is a health institution that provides patients treatment by specialised staff and equipment. Due to high influx of patients, patient's relations and staff who may harbour different microorganisms, the hospital environment serves as a reservoir for myriad of microorganisms (bacteria, fungi and viruses). Although contamination of inanimate environment by microorganisms has long been recognized, its significance remains unclear [1].

Boyce [2] stated that the main mechanism of transmission of infections within hospital is by direct contact, in particular from the hand s of health professionals. Indoor hospital surfaces are prone to contamination by frequent contact with patients and health care providers.

Surfaces can be divided into two categories; those where hand contact is frequent which include: beds, bed rails, bedside lockers, blood pressure cuffs, infusion drug stand, television remote devices, door handles, trolleys, medical tables and wash sinks [3-6]; and those where hand contact occurs less frequently such as floors, walls and light switches [7].

Despite the various hospital infection control measures, scientific evidence suggests that environmental contamination plays an important role in the spread of Gram positive bacteria such as methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant *Enterococcus* sp (VRE) and *Streptococcus pyogenes* which survive for a varying degrees of time on dry surfaces, and many Gram negative bacilli [8-10]. Gram negative species, such as *Acinetobacter* sp, *Escherichia coli*, *Klebsiella* sp, *Pseudomonas aeruginosa*, *Serratia marcescens* and *Shigella* sp are able to survive for months on hospital surfaces [9].

Environmental contamination may play a role in the acquisition and transmission of health care associated infectious pathogens [11], when health care workers contaminate their hands or gloves by touching contaminated surfaces, or when patients come into direct contact with contaminated surfaces [4,12,13].

The role of fomites and inanimate hospital environment in transmission of infection has been debated for many years. However, there is an increasing evidence that contaminated inanimate surfaces, especially those frequently touched by hand, can contribute to the spread of healthcare associated pathogens [14-16].

Aerobic bacteria are the predominant bacteria contaminants of hospital surfaces. However, spores of anaerobic bacteria are occasionally found on surfaces when there are cases of diarrhoea. [11], suggested that it is likely that *Clostridium difficile* transmission is more dependent on contaminated environmental surfaces than other pathogens due to its ability to form resilient endospores that are shed in high numbers during episodes of diarrhoea.

Route of transmission for healthcare associated infections are complex. These include, but not limited to the hands of healthcare personnel, contaminated surfaces, inanimate objects, in some circumstances air and other routes [11].

The potentials for contaminated environmental surfaces to contribute to transmission of healthcare associated pathogens depends on a number of factors: the ability of pathogens to remain viable on a variety of dry environmental surfaces, the frequency they contaminate surfaces commonly touched by patients and healthcare workers and whether the level of contamination is sufficiently high to result in transmission of pathogens to patients [4].

Environmental surfaces were once thought to play a negligible role in the endemic transmission of healthcare associated pathogens. However, recent data indicate that contaminated surfaces play an important role in the endemicity and epidemic transmission of certain pathogens that cause healthcare associated infections [17].

The frequency of contamination of hospital surfaces with aerobic Gram negative bacilli has been less studied compared to contamination due to MRSA, VRE and *Clostridium difficile*. Prevention of infection that could threaten the wellbeing of patients, health workers and patient's relations within the hospital is the responsibility of all health workers. Previous studies across the globe have shown that a significant number of aerobic bacterial pathogen persist on hospital surfaces [9,10], and this portends health risk for healthcare workers, patients and patient's relatives. Contamination and cross contamination of hospital surfaces [17], by persistent pathogens increases the risk of acquisition of healthcare associated infection which in-turn leads to increased cost of treatment, substantial morbidity, prolonged hospital stay, treatment failure and sometimes mortality.

The study aim was to determine the pattern of bacterial contaminants on selected hospital surfaces and among the paediatric wards of university of Ilorin teaching hospital.

Methodology

This study was conducted at the university of Ilorin teaching hospital, a tertiary health centre. It is located in the north central region of Nigeria, the hospital has over 450 beds capacity with various subspecialties. The paediatric ward has over 115 bed capacity.

The study was a cross-sectional study of indoor hospital surfaces within the five paediatric wards (neonatal intensive care units, paediatric medical ward, paediatric surgical ward, emergency paediatric unit I and II.). Surface swab samples were obtained from bed rails, bed lockers, radiant warmers, incubators, trolleys, medical table, door handle and wash sinks after normal hospital cleaning and disinfection.

Total population survey was employed, and a total of 201 samples were collected from the various surfaces within the five wards. Ethical clearance was obtained from the ethics and research committee of UITH before the commencement of the study.

Samples were collected from the selected surfaces as using ethylene oxide sterilized swab sticks pre-moistened with sterile normal saline and inserted in bijou bottle containing 5 ml of sterile Stuart's transport medium and transported to microbiology lab of university of Ilorin teaching hospital within 30 minutes of sample collection.

Laboratory analyses of samples were carried out within 2 hours of sample collection. The samples were cultured on sheep blood and MacConkey agar and incubated aerobically at 35°C to 37°C for 18 to 24 hours. After aerobic incubation, visible colonies on plates were examined visually for macroscopic characteristics of aerobic bacteria: colony size, shape, colour, consistency, odour, elevation and haemolysis. Gram staining (microscopy) was carried out to determine the morphology of the bacteria, followed by a battery of biochemical reactions (such as catalase test, citrate utilization, indole test and urease test) specific for the suspected bacteria [9,6]. The data were analysed with Epi Info™ 7.

Results

From the 140 swab samples positive for bacterial growth, *Staphylococcus aureus* had the highest frequency with 39.4% and *Pseudomonas aeruginosa* has the lowest frequency of 1.3%. Some surfaces were contaminated with more than one bacterium, thus increasing the frequency of the isolates to 160 as shown in Table 1.

Name of Surface		Isolated Organism								
	N	*A. baumannii* **(N)**	*E. faecalis* **(N)**	*K. pneumoniae* **(N)**	*E. coli* **(N)**	*P. aeruginosa* **(N)**	*Staphylococcus aureus* **(N)**	*S. saprophyticus* **(N)**	*S. epidermidis* **(N)**	**Total (%)**
Bed lockers	69	22	1	15	1	0	19	2	3	91.3
Bed rails	86	10	2	8	3	0	30	2	7	71.1
Door handles	3	0	0	0	0	0	2	0	0	66.7
Incubators	7	0	0	1	0	0	2	0	0	42.9
Medical tables	6	0	0	0	0	0	2	0	0	33.3
R. warmers	6	0	1	0	0	0	2	0	0	50
Trolleys	7	0	0	1	0	0	2	0	0	42.9

Wash sinks	17	6	0	7	1	2	4	0	1	123.5

Table 1: Distribution of aerobic bacterial contaminants on selected indoor surfaces.

The selected hospital surfaces growth pattern shows that wash sinks has the highest level of bacterial contamination amongst the sample sites with a prevalence of 123.5% and medical tables had the least contamination with prevalence of 33.3% as shown in Table 2. *Staphylococcus aureus* was the most predominant isolate across the surfaces, except for wash sinks and bed lockers which were majorly contaminated with *Klebsiella pneumoniae* and *Acinetobacter baumannii* respectively.

The aerobic bacterial contaminants distribution among the paediatric wards show that Emergency paediatric unit 2 had the highest level of bacterial contamination with 87.5% while NICU had the least bacterial contamination with 67.6% as shown in Table 2.

Ward	**N**	*A. baumannii* **(N)**	*E. faecalis* **(N)**	*E. coli* **(N)**	*K. pneumoniae* **(N)**	*P. aeruginosa* **(N)**	*S. aureus* **(N)**	*S. saprophyticus* **(N)**	*S. epidermidis* **(N)**	**Total**
NICU	34	2	0	0	5	0	15	1	1	70.5
EPU 2	24	3	0	0	10	0	5	2	1	87.5
EPU 1	25	1	1	0	1	1	9	4	1	72
PMW	58	20	1	2	7	0	17	0	3	86.2
PSW	60	12	2	3	9	1	17	1	2	78.4
NICU: neonatal intensive care unit; EPU2: emergency paediatric unit 2; EPU 1; emergency paediatric unit; PMW: peadiatric medical ward; PSW: paediatric surgical ward										

Table 2: Distribution pattern of bacteria according to paediatric wards.

Discussion

Because numerous microorganisms abound in hospital environment, contaminated surfaces have been reported to increase the prevalence of healthcare associated infections, especially at both extremes of life (infancy and old age) due to lowered immunity in these age groups.

A total of 201 swab samples were collected from various hospital surfaces, in the 5 different paediatric ward of UITH. Of the 201 swab samples collected from various surfaces 140 (69.7%) were positive for bacterial growth. This is similar to the results obtained in Maiduguri by Okon et al., who sampled 267 hospital surfaces: 70.0% were positive for bacterial growth. In this study, from the 140 swab samples positive for bacterial growth there were varying number of bacterial isolates per sampled surfaces which increases the number of bacteria isolated to 160 isolates (Table 3).

The predominant aerobic bacterial (facultative anaerobe) contaminant in this study was *Staphylococcus aureus* accounting for 39.4% of the organism isolated (Table 3). This was similar to the findings of a study carried out in Sokoto, where *Staphylococcus aureus* was equally the most prevalent isolate (Muhammmad et al. 2013). The higher prevalence of *Staphylococcus aureus* may be due to ubiquitous distribution in human body as part of the normal flora (normal microbiota) of the anterior nares, nasopharynx and the skin [18]. *Staphylococcus aureus* has predilection for inanimate surfaces and are relatively resistant to drying, heat and sodium chloride these properties allow its survival on inanimate surfaces. The predominance of *Staphylococcus aureus* as found in this study is contrary to the findings of Okon et al. whose predominant isolates was found to be coagulase negative *Staphylococcus* sp and also at variance to the work of Gracia-cruz et al. [6] in Mexico, who reported a high prevalence of *Klebsiella* sp.

Isolate	**Frequency**	**Percentage (%)**
Acinetobacter baumannii	38	23.8
Enterococcus faecalis	4	2.5
Escherichia coli	5	3.1
Klebsiella pneumoniae	32	20
Pseudomonas aeruginosa	2	1.3
Staphylococcus aureus	63	39.4
Staphylococcus epidermidis	11	6.9
Staphylococcus saprophyticus	5	3.1
TOTAL	160	100

Table 3: Pattern of aerobic bacterial isolates.

Acinetobacter baumannii was the second most common isolate in this study, accounting for 23.8% of isolates (Table 3). It is now becoming a major cause of hospital acquired infection, because of its

remarkable ability to survive and spread in hospital environment, the carriage rate of *Acinetobacter baumannii* on the skin of hospitalised patients could account for the high prevalence [18]. *Acinetobacter baumannii* does not require a fastidious growth requirement; this explains its ability to persist on either moist or dry conditions in the hospital environment (Abbo et al. 2005). The source of coagulase negative *Staphylococci* from this study could include the normal skin flora (microbiota) of medical personnel, patients and fabrics [19]. However, clinical implication of coagulase negative *Staphylococci* is more pronounced in immunocompromised patients, as entry into systemic environment could initiate infections.

The distribution of aerobic bacterial contamination of the selected indoor hospital surfaces shows that the wash sinks were majorly contaminated among the sample sites of this study with a prevalence of 123.5% as shown in Table 1, this may be due to the deposition of bacterial contaminants on the surface in the process of hand washing by healthcare workers, patient's relatives and patients. The least contaminated surface from this study was the medical table with a prevalence of 33.3%, this may be due to the fact that there is reduced patient contact with the surface.

The distribution pattern of bacteria according to paediatric wards shows that emergency paediatric unit 2 (EPU 2) had the highest number of contaminated surfaces with a prevalence of 87.5% as shown in Table 2; this may be due to the fact that this is the first place children above neonatal age group are admitted to before being transferred to the general paediatric wards. The least contaminated ward among those sampled was the NICU with a prevalence of 70.5% as shown in Table 2.

The findings of this study revealed that there are bacteria contaminants on non-critical hospital surfaces within the paediatric wards in UITH; with a proportion of 69.7% i.e. 7 out of every 10 surfaces within the sampled ward carrying pathogenic aerobic bacterial contaminants. This has the potential of increasing the frequency of healthcare associated infections among the paediatric population. These organisms survive for varying degrees of time on various hospital surfaces after cleaning/disinfection and have the potentials of transiently colonising the hands and gloves of healthcare workers.

The pattern of aerobic bacteria isolates from this study is of great importance because of the immaturity of the immune system of paediatric population. Infection with this likely multidrug resistant bacteria may result in prolong hospital stay, increased cost of treatment and treatment failure.

Recommendation

Influx of patient's relation within the hospital wards especially the paediatric wards should be reduced, surveillance of healthcare associated infection should be encouraged and healthcare workers should adhere strictly to the five moment of hand hygiene recommended by World Health Organisation. Further studies should be conducted to determine the link between non-critical hospital surfaces and healthcare associated infections, presence of anaerobic bacterial and fungal contaminants on hospital surfaces and the level at which a contaminated surfaces becomes a health problem i.e. the minimum infective dose for a non-critical surface.

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