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Environmental Reservoirs of Healthcare Associated Infections in the Neonatal Wards of a University Teaching Hospital in Lagos, Nigeria

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Abstract

Introduction: Healthcare-Associated Infections (HAIs) are major public health problems globally, with higher prevalence in developing countries. They are part of the major causes of mortality and morbidity at neonatal wards. They increase the use of medical resources, duration of hospitalization, as well as cost of treatment. This study was done to determine the environmental reservoirs of healthcare associated infections at the Neonatal wards of Lagos University Teaching Hospital.

Methodology: A total of 220 environmental surface swab samples were collected using sterile ethylene oxide swab sticks pre-moistened with sterile normal saline and were cultured on standard media and incubated aerobically at 36 ± 1°C for 18 to 24 hours. Identification of bacterial isolates was performed using the Biomerieux Vitek® 2 equipment.

Results: The overall contamination rate was 8.84%. Twenty isolates were isolated; *Klebsiella pneumoniae* was the most prevalent isolate (45%) The sinks were the most contaminated surfaces with a rate of 60%.

Conclusion: This study showed areas of environmental contamination which could serve as potential sources of healthcare associated infections. Thorough cleaning, disinfection of these surfaces and proper hand hygiene practices would be needed to reduce the risk of infections in the study site.

Keywords: Neonatal • Contamination • Healthcare associated infections • Reservoirs

Introduction

Hospital-acquired infections are infections that occur 48 hours after the admission of a patient in the hospital, infections that occur up to 72 hrs after a patient has been discharged or up to 30 days after an operation which can be due to microbial agents [1]. Neonatal infections acquired either at birth or during hospitalization, are HCAI, unless there is an evidence of trans-placental transmission [2]. The source of the pathogen could be the patient's microbial flora or the hospital environment. The infections are spread to susceptible people through various means, which could be medical equipment, bed linens, potable water, hospital environment, hospitalized individuals and healthcare staff, which serve as reservoirs for the infections [1].

Healthcare-associated infections (HAIs) are major public health problems globally, with higher prevalence in developing countries. The incidence of infections varies widely among Neonatal Intensive Care Units (NICUs); at a rate of about 7%-38.5% [3-5]. It is estimated to cause about 40% of all neonatal deaths depending on environmental factors and differences in clinical practices [6,7]. Reports from the Western world indicates that the incidence ranges from 6%-25% with a significant variation by birth weight of the babies and treatment conditions. A study by the European Study Group (ESG) for instance, found an infection rate of 7% in seven NICUs, while some workers in Poland reported a higher incidence of 38.5% [5]. In the Middle East, an incidence rate of 13.7 infections per 1000 patient days was recorded in a hospital in Saudi Arabia [8]. Elsewhere in East Asia, an incidence rate of 25.3% was observed by other investigators in Japan [9]. In Italy, a surveillance research was carried out on a neonatal intensive care unit from 2006-2010. It was reported that 153 HAIs were diagnosed out of 1699 neonates of all birth weights with a frequency of 9% [10]. In Nigeria, HAIs rate of 2.7% was reported from Ife while 3.8% from Lagos and 4.2% from Ilorin [11]. At the Lagos University Teaching hospital (LUTH) a prospective cohort study was conducted at the Intensive Care Unit (ICU) between September 2011-July 2012 of which 71 patients were recruited with a 45% healthcare-associated infection rate representing a prevalence rate of 79 per 1000 patient-days in the intensive care unit [12].

Based on available statistics of health-care associated infections in various hospitals, healthcare-associated infections are a significant risk factor for high rates of mortality and morbidity at neonatal intensive care units and intensive care units worldwide [1]. It has an impact on the health-care system as it increases the use of medical resources, duration of hospital stays as well as cost of treatment both in developed and developing countries [3]. These are major public health problems globally, particularly in developing countries where infection rates are higher due to overcrowding of hospitals, poor infection control practices and inappropriate use of limited resources [11,13].

Healthcare associated infections till date are still causes for alarm around hospitals globally [1,14]. It is therefore important to detect the reservoirs of these infections, so as to mitigate the incidence and spread of infections. To minimize the transmission of microorganisms from equipment and the environment, adequate methods for cleaning, disinfecting and sterilizing must be in place. Written policies and procedures which are updated on a regular basis must also be developed for healthcare settings and compliance should always be monitored [15,16].

A similar study was conducted at the Lagos University Teaching Hospital (LUTH) by Ogunsola et al. [17], however, this study differs from the aforementioned in these ways; the study sites are different. The sites involved in the previous research were medical, surgical, haemodialysis wards and microbiology laboratory, while this research was conducted at the neonatal wards. The previous research was conducted in the year 2000. In the last 20 years, a lot of things would have changed; hence, the need for this study.

The aim of this study was to determine the environmental reservoirs of healthcare associated infections in the neonatal wards of Lagos University

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Teaching Hospital.

Methodology

This study was conducted at the Lagos University Teaching Hospital, a tertiary healthcare center located at Lagos, Nigeria. It is a 761-bed capacity hospital with various sub specialties. The study was a cross- sectional hospital-based study of the neonatal wards (the out-born and in-born units) in LUTH. Swab samples of incubators, cots, medication trolleys, feeding tables, feeding trays, door handles, infusion stands, mattresses, refrigerators, medical equipment, sinks, A.C vents, doctors' tables and nurses' tables were collected after routine hospital cleaning for processing.

Total population survey method was employed, and a total of 220 samples were collected from both wards. Ethylene oxide sterilized swab sticks pre-moistened with normal saline were used to collect samples from the various surfaces. The samples were transported immediately after collection to the medical microbiology laboratory of LUTH for processing.

The samples collected were cultured on sheep blood agar and Mac Conkey agar plates, after which they were incubated for 18-24 hours at 37°C. Gram stain was done on the isolates, after which they were identified using the Biomerieux Vitek® 2 Compact, automated ID/AST instrument. After identification, isolates were stored in glycerol broth at -20°C in a freezer. The data were analysed using SPSS statistics 23.0.0 (SPSS Inc., Chicago, Ill.). Statistical significance was determined by using the chi-square test with p value<0.05 considered as significant. Ethical approval was obtained from the Health Research and Ethics Committee, Lagos University TeachingHospital (LUTH).

Results

One hundred and fifteen out of the 220 samples collected were from the out-born unit, 2 yielded a mixed growth while 11 yielded pure growth. The contamination rate for the Out-Born unit (OB) was 11.3%. Of the 105 samples collected from the In-Born (IB) unit, five yielded growths, giving a contamination rate of 4.76%. The overall contamination rate for the neonatal units is 8.84%. There was a total of 20 isolates, (15 from OB and 5 from IB). The isolates from OB were; *Klebsiella pneumoniae* (8), *Enterobacter cloacae* (4), *Acinetobacter baumannii* (1), *Enterobacter asburiae* (1), *Staphylococcus aureus* (1) as seen in Table 1. The isolates from IB were; *Klebsiella pneumoniae* (1), *Staphylococcus aureus* (3), *Staphylococcus cohnii ssp urealyticus* (1) as seen in Table 2. *Klebsiella pneumoniae* was the most prevalent organism, accounting for 45% of all the isolates, as seen in Figure 1.

OB with a contamination rate of 11.3% was more contaminated than IIB which had a contamination rate of 4.54%. In the OB, contamination levels were high on the environmental surfaces ranging from 6% for the mattresses to 100% for the feeding trolley, feeding tray, flask. Six (60%) of the sinks were contaminated while one (50%) of the 2 refrigerators was contaminated. In IB, contamination levels were low. The range was from 11% for the sinks to 100% for the treatment room table. One (10%) incubator was contaminated, while one (25%) table was contaminated. In both wards medical equipment, switches, sockets, and cots were not contaminated. These can be found in Tables 1 and 2.

Sites	**No of samples tested**	**No contaminated (%)**	**KP**	**AB**	**EA**	**EC**	**SA**
Incubators	15	0 (0%)	-	-	-	-	-
Sinks	10	6 (60%)	4		1	1	-
Taps	2	0	-	-	-	-	-
Door handles	6	0	-	-	-	-	-
Infusion stands	9	1 (11%)	1	-	-	-	-
Food trolley	1	1 (100%)	1	-	-	-	1
Refrigerator	2	1 (50%)	-	-	-	1	-
Doctor's desk	1	0	-	-	-	-	-
Nurses' desk	1	0	-	-	-	-	-
Mattresses	17	1 (6%)	-	-	-	1	-
Cots	3	0	-	-	-	-	-
Fans	1	0	-	-	-	-	-
Bedside table	13	0	-	-	-	-	-
Light switches	8	0	-	-	-	-	-
Medical equipment	11	0	-	-	-	-	-
Soaps	2	0	-	-	-	-	-
Feeding tray	1	1 (100%)	1	-	-	-	-
Flask	1	1 (100%)	1	-	-	-	-
Sockets	10	0	-	-	-	-	-
Feeding table	1	1 (100%)	-	1	-	1	-
AC Vent	0	0	-	-	-	-	-
TOTAL	115		8	1	1	4	1

KEY: KP: *Klebsiella pneumonia*; AB: *Acinetobacter baumannii*; EA: *Enterobacter asburiae*; EC: *Enterobacter cloacae*; SA: *Staphylococcus aureus.*

Table 1. Reservoirs of healthcare associated infections in OB.

Sites	No of samples tested	No contaminated (%)	KP	AB	EA	EC	SA	SC
Incubators	10	1 (10%)	-	-	-	-	1	-
Sinks	9	1 (11%)				-	1	-
Medication trolley	2	0	-	-	-	-	-	-
Door handles	8	0	-	-	-	-	-	-
Infusion stands	7	0	-	-	-	-	-	-
Food trolley	1	0	-	-	-	-	-	-
Refrigerator	1	0	-	-	-	-	-	-
Doctor's desk	1	0	-	-	-	-	-	-
Nurses' desk	1	0	-	-	-	-	-	-
Mattresses	12	0	-	-	-	-	-	-
Cots	8	0	-	-	-	-	-	-
Fans/switches	4	0	-	-	-	-	-	-
Bedside table	5	0	-	-	-	-	-	-
Light switches	3	0	-	-	-	-	-	-
Medical equipment	20	0	-	-	-	-	-	-
Soaps	3	0	-	-	-	-	-	-
Sockets	3	0	-	-	-	-	-	-
AC vent	2	1 (50%)	-	-	-	-	-	1
Treatment room table	1	1 (100%)	-	-	-	-	1	-
Tables	4	1 (25%)	1	-	-	-	-	-
TOTAL	105		1	0	0	0	3	1

KEY: KP: *Klebsiella pneumonia*; AB: *Acinetobacter baumannii*; EA: *Enterobacter asburiae*; EC: *Enterobacter cloacae*; SA: *Staphylococcus aureus*; SC: *Staphylococcus cohnii ssp urealyticus*.

Table 2. Reservoirs of healthcare associated infections in IB.

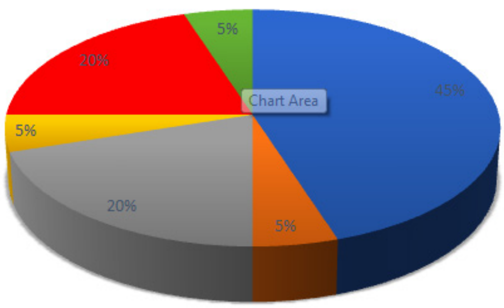

Figure 1. Distribution of isolates, (■) *Klebsiella pneumoniae*; (■) *Acinetobacter baumannii*; (■) *Enterobacter cloacae*; (■) *Enterobacter asburiae*; (■) *Staphylococcus aureus*; (■) *Staphylococcus cohnii.*

Discussion

The hospital environment is home to many microorganisms and as a result, contaminated surfaces have been reported to increase the prevalence of healthcare associated infections, especially among infants because of their lowered immunity [18].

The contamination rate in the environment was higher in the out-born ward, (11.6%), than in the inborn ward (4.76%). Studies have shown that factors such as high unit occupancy density, frequent visits by parents and visitors, traffic by medical personnel may be responsible for the high contamination rates recorded in Neonatal wards [16,19]. The effects of these factors however, can be mitigated by improved cleaning, disinfection and decontamination practices [20]. Poor hygienic practices which include; improper hand washing, improper glove use, lead to the transfer of organisms from the hands of the health workers on to environmental surfaces in the wards, especially the high touch surfaces which include bed rails, door handles, tables, and switches [15]. In addition, because the health workers are in close proximity to the babies, there could be transmission of organisms from their hands to the babies directly [15].

As a result of the feedback given to the paediatrics department on the high contamination rate in OB, the ward was closed for a proper cleaning and disinfection, and the healthcare workers were trained on environmental cleaning and disinfection on proper disease prevention practices.

Klebsiella pneumoniae was the most common organism isolated from the environment, with a prevalence rate of 45%. This is in contrast with the study carried out by Saka et al. at the paediatric wards of the University of Ilorin teaching hospital, where *Staphylococcus aureus* was the most prevalent organism with 39.4%, but similar to the study by Gracia-cruz et al. in Mexico, where *Klebsiella pneumoniae* was highly prevalent. It was isolated from the feeding flask, tray, sinks and an infusion line [18,21]. The isolation sites for this organism all have a thing in common which is that the organism flourishes in wet environments. *Klebsiella pneumoniae* is an enteric organism and is widely associated with contamination of potable water and faecal-oral transmission. The presence of this organism in feeding utensils could be an indication of contamination of water from the sinks which is used to wash the feeding tray and flask; it could also be an indication of contaminated water used in preparing the babies' food. This is not a surprise because *Klebsiella pneumoniae* has been reported widely as a common contaminant of hospital surfaces and a cause of healthcare associated infections [13,15,17,22].

Enterobacter cloacae had the second highest prevalence (20%). It was isolated from a feeding table, a mattress, a sink and one of the two refrigerators in ward OB. The contaminated refrigerator is the one in which medication are stored for patients. This is a concern because if the storage point of medication is contaminated, it is very likely that the medication stored there would also be contaminated. If and when these medications are administered to patients, it could lead to another infection which would then be hospital acquired. This contamination could also lead to an outbreak of *Enterobacter cloacae* in the ward if not curtailed in time. *E. cloacae* was absent in IB.

Staphylococcus aureus, along with *Enterobacter cloacae*, had a prevalence rate of 20%. It was more prevalent in IB with a rate of 60% than in OB with a low rate of 7%. It was isolated from the feeding trolley, an incubator, the treatment room table and a sink. The reason for the isolation of *Staphylococcus aureus* on the dry surfaces may be due to the fact that *S. aureus* can survive desiccation for a long period of time and coupled with the fact that these surfaces are usually touched by the healthcare workers. *Staphylococcus aureus* is a known coloniser of the skin of humans and this is not a surprise [15, 17,23,24]. The isolation of *Staphylococcus aureus* from the treatment room table is similar to earlier studies which had been carried out on this organism. There have been reports of environmental isolation of *Staphylococcus aureus* from items such as stethoscopes, floors, charts, computer keyboards, door handles, tourniquets, pens, telephones, furniture, bed linen, patients' gowns and bedside table and mobile phones [25-27].

Acinetobacter baumannii was isolated only at ward OB with a prevalence of 7%, it was isolated from the feeding table but was absent in IB. *Acinetobacter baumannii* is a ubiquitous opportunistic gram-negative pathogen isolated from soil, water, animals, and humans and is a predominant cause of healthcare associated infections and outbreaks in susceptible hosts, particularly in the ICUs [28-31]. Strains proliferate in moist environments such as in this study. It was isolated from the feeding table which is a moist environment because of constant washing and cleaning with water. The patients who are fed from the feeding table in which *Acinetobacter baumannii* was isolated from in this study could become carriers of this organism because up to 75% of hospitalized patients can become colonized with Acinetobacter spp [32-34].

Enterobacter asburiae had a low prevalence (5%) and was only isolated from a sink in ward OB. This is not really surprising because members of the family Enterobacteriaceae are found in moist environments, and are associated with contamination of hospital water [13,15,17].

Conclusion

This study showed areas of environmental contamination which could serve as potential sources of healthcare associated infections. Thorough cleaning, disinfection of these surfaces and proper hand hygiene practices would be needed to reduce the risk of infections in the study site. Proper standard operating procedures should also be put in place to ensure that hand and personal hygiene is properly followed and monitored. It should also include penalties to erring health workers. There should also be enough education of patients' relatives, community members and health workers on the importance of proper hygiene in the prevention of healthcare associated infections.

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