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A Study of the Potentially Harmful Pathogens on Environmental Surfaces in Healthcare Facilities in Edo State, Nigeria.

Adam V.Y, Okojie O.H

Department of Community Health, University of Benin Teaching Hospital, Benin City, Nigeria

KEYWORDS

ABSTRACT

Introduction
Inadvertent exposure to environmental and airborne pathogens can result in adverse patient outcomes and transmission of hospital acquired infections (HAIs) in healthcare workers (HCWs). Without effective infection control, diseases may be readily transmitted from patient to patient and to a lesser extent, from patient to HCWs.

Objective
To determine potential pathogens present on environmental surfaces in secondary and tertiary healthcare facilities (HCFs) in Edo State, Nigeria.

Method
Environmental sampling and analysis was done to determine presence of potential pathogens in nine (9) health facilities. Sterile swabs were used to collect surface samples from non-absorbent surfaces in the health facilities. A total of 324 samples were analyzed. All the isolates were tested for their susceptibility to the various common antimicrobial agents using the standard agar disk diffusion technique. The antimicrobial agents used in this study were gentamycin, nalidixic acid, nitrofurantoin, ampicilin, co-trimoxazole, cefuroxine, ceftazidine, augmentin, ciprofloxacin, ofloxacin and ceftriaxone.

Results
Potentially harmful pathogens namely *Staphylococcus aureus, Streptococcus spp, Proteus spp, Escherichia coli and Klebsiella spp* were identified in the samples from the health facilities and these were resistant to antibiotics which are commonly prescribed and in the national essential drug list.

Conclusion
The study revealed presence of potentially pathogenic microorganisms on the physical surfaces of secondary and tertiary healthcare facilities in Edo State, Nigeria. Health facilities need to develop and implement infection prevention and control programmes for the protection of patients, patient care givers and healthcare

Correspondence to:
Adam V.Y
Department of Community Health,
University of Benin Teaching Hospital,
PMB 1111 Benin City, Nigeria.
+2348023327951
E-mail: advinco@yahoo.com; vincent.adam@uniben.edu

INTRODUCTION

The hospital environment is one of the risk factors for HAIs because many infectious agents are present.[1,2] The environment may be conducive to growth and survival of infectious agents and sharing of equipment may increase the chance of exposure to the microbial flora of other patients.[3] Studies have revealed that a wide range of environmental HAI pathogens are present on hospital surfaces.[1-5]

Infectious agents present new challenges in the health care setting.[2] The emergence of life-threatening infections such as severe acute respiratory syndrome (SARS) and re-emerging infectious diseases like plague and tuberculosis (TB) have highlighted the need for efficient infection control programmes in all HCFs and capacity building for health-care workers (HCWs) so that they can implement them. A breach in infection control practices facilitates transmission of infection from patients to HCWs, other patients and attendants.6 In the United Kingdom (UK), there have been documented cases of infections acquired from hospital, e.g E. coli 0157, and the causative agents of bacterial meningitis, diphtheria and tuberculosis.[1,7] HAIs are today by far the most common complications affecting inpatients. Indeed, the Harvard Medical Practice Study II found that a single type of HAI i.e. surgical–wound infection constituted the second largest category of adverse events.[8] The HCF environment is rarely implicated in disease transmission except among patients who are immuno-compromised. Nonetheless, inadvertent exposure to environmental pathogens (e.g. Aspergillus spp and Legionella spp) or airborne pathogen (e.g. Mycobacterium tuberculosis) can result in adverse patient outcomes and cause illness among HCWs.[9]

Environmental infection control strategies and engineering controls can effectively prevent these infections. The incidence of HAIs and pseudo-outbreaks can be minimized by9: appropriate use of cleaners and disinfectants; appropriate maintenance of medical equipment; adherence to water quality standards for haemodialysis and to ventilation standards for specialized care environments (e.g. airborne infection isolation rooms, protective environments or operating rooms); and prompt management of water intrusion into the facility.

It is estimated that the rate of nosocomial infections could be reduced by between 15-30% if the standard precautions guideline were strictly adhered to. [7,10,11] Control of infection is an important consideration throughout the hospital environment such as wards, operating theatres, service departments like sterile departments, portering, laundry, pharmacy etc where there is exposure to a range of potential human pathogens, with consequent risk of harm or disease.[7]

In HCFs, the risk of acquiring infection by both patients and HCWs from each other is fairly high. HAIs remain problem in both developed and developing countries and an important cause of morbidity and mortality.[12-14] Correct wearing and removal of personal protective equipment (PPEs) prevent potentially contaminated surfaces from touching the wearer's bare hands, face or uncontaminated materials or equipment because they provide a physical barrier between microorganism and the wearer thus reducing but not completely eliminating the risk of acquiring an infection. [6,8,15-19]

Inadequate decontamination has frequently been associated with outbreaks of infection in hospitals[5,16,20,21,] it is vital that re-usable equipment is scrupulously decontaminated between each patient. To ensure that control of infection is maintained at a high level, all HCWs must be aware of the implication of safe decontamination and their responsibilities to their patients/clients, themselves and their colleagues.[16] A variety of airborne infections in susceptible hosts can result from exposures to clinically significant microorganisms released into the air when environmental reservoirs (i.e. soil, water, dust and decaying organic matter) found on surfaces are disturbed. Once these materials are brought indoors into a health-care facility by any of a number of vehicles (e.g. people, air currents, water, construction materials and equipment), the attendant microorganisms can proliferate in various ecological niches within the HCF environment and, if subsequently disturbed into the air, serve as a source of airborne health-care associated infections.[22]

The purpose of this study was therefore to identify the presence of pathogenic infective agents present on common surfaces in health facilities, so as to highlight the potential for acquiring infections by patients and HCWs alike. It is hoped that findings from this study would provide a basis for activating the effective infection control strategies in HCFs.

METHODOLOGY

A cross sectional study was carried out over a period of six (6) months from August 2008- January 2009. The study was carried out in Edo State, located in the heart of the tropical rain forest and lying between longitude 5°E and 6°42"E and latitude 5°45"N and 7°35"N of the equator, in the south-south geo-political zone of Nigeria, with the State capital in Benin City.[23] There are three federal tertiary HCFs in the State namely: University of Benin Teaching Hospital, Benin City, Psychiatric Hospital, Uselu, Benin City and Irrua Specialist Teaching Hospital, Irrua.[23,24] There are thirty three (33) State owned secondary health facilities in the state stratified on the basis of the three senatorial districts in the state as follows: Edo North twelve (12) ; Edo Central eight (8) and Edo South thirteen (13).[23,24]

From each of the three senatorial districts, two (2) HCFs were selected by simple random sampling method. The selected HCFs in each of the three senatorial districts were: Edo North Senatorial Region (General Hospital, Fugar and Central Hospital, Auchi); Edo Central Senatorial Region (Central Hospital, Uromi and General Hospital, Iruekpen) and Edo South Senatorial Region (General Hospital, Abudu and Central Hospital, Benin City). All the three (3) federal tertiary health facilities in the state were used for the study.

Approval was obtained from the Edo State Hospital Management Board to carry out the study in the state owned secondary healthcare facilities. Also, establishment consent was sought from the management of the respective health facilities that were used for the study while ethical approval was obtained from the University of Benin Teaching Hospital Ethics and Research Committee.

Environmental surface sampling though not routinely done in healthcare settings[22] was carried out for this research. Sterile swabs were used to collect surface samples from non-absorbent surfaces like trolleys for instruments and devices, handles of wash hand basin and other items like cups used for hand washing, nursing tables in the ward and working benches in the laboratory and pharmacy department and benches in the waiting area. In all, six (6) samples were collected each from the following areas in the hospital: accident and emergency (A/E), out-patient department (OPD), laboratory (Lab), pharmacy, theatre, medical ward, surgical ward, obstetrics and gynaecology (O/G) ward, paediatric ward and the waiting area making a total of sixty samples per hospital. Forty eight (48) to sixty (60) samples were collected depending on the units available in the health facility.

Laboratory analysis was done in the Microbiology laboratory of the University of Benin Teaching Hospital. The microbiological tests were carried out in line with the procedures outlined in the District Laboratory Practice in Tropical Countries (Part 2).[25] A total of 468 samples were collected, however only 324 viable ones were analyzed because the laboratory procedure required samples to get to the laboratory within 2-3 hours (maximum) of samples collection. Samples were cultured using chocolate and blood agar, MacConkey agar, Nutrient agar and broths. Culture technique used involved streaking aseptically the various agar plates with sterile wire loop which were well spaced out to form discrete colonies. Inoculated plates were incubated overnight at 37°C in blood agar, chocolate and MacConkey agar.

Biochemical tests were carried out after conventional morphological examination to identify the growth of suspected pathogens on the second day. Here the organisms were grouped into gram negative and gram positive bacteria using the gram stain technique.[25]

Antimicrobial susceptibility testing[25] was done on nutrients agar plates. All the isolates were tested for their susceptibility to the various common antimicrobial agents using the standard agar disk diffusion technique.[25] The various antimicrobial agents used in this study include gentamycin, nalidixic acid, nitrofurantoin, ampicilin, co-trimoxazole, cefuroxine, ceftazidine, augmentin, ciprofloxacin, ofloxacin and ceftriaxone. The plates were inoculated with the isolates after which the antibiotics in a multidisc form were laid on the agar and incubated at 37°C. The diameter of zone of inhibition was measured by standard technique. A standard sensitive strain Escherichia coli cw 3310 was included as control organism. The susceptibility of the bacteria to the above antimicrobial agents was obtained and converted to continuous data from discrete data using a scoring system. The different sensitivity codes were scored as follows: R = resistant, was scored 0; + = less resistant, was scored 1; ++ = intermediate sensitivity, was scored 2 and +++ = sensitive, was scored.[3] The sensitivity of the bacteria to the indicated antibiotic was obtained by scoring the bacteria isolates according to their antibiotics susceptibility represented in percentages thus converting them from discrete to continuous data. For example, Staphylococcus aureus was isolated from twenty (20) different areas in the health facilities, which were then subjected to the above antimicrobial agents with different sensitivity codes. Thus, the maximum score for a sensitivity test for Staphylococcus = 20 x 3 = 60. The average for all the Staphylococcus isolates and their different sensitivity to antimicrobial agents was calculated in percentage. Using the same process for the other bacterial organisms and the different antimicrobial drugs/agents, the scores for each antibiotic were summed up for the different bacterial organisms isolated and converted to percentages. Efficacy of the antimicrobial agent was obtained by calculating the average sensitivity of each antibiotic to the five (5) different bacterial organisms isolated in the study.

Laboratory quality control ensured that aseptic techniques were maintained during all the procedures and preparations including collection, transportation and analysis of samples and unused sterile swabs (10) and culture media plates were randomly selected and inoculated at 37°C for 18-24hours. The presence of any growth meant the discarding of the batch. In addition the colour of the culture media was carefully and thoroughly checked before use and the incubator temperature was maintained at 370°C throughout the incubation period. This was monitored with a thermometer. The results obtained were compared with known standards.

RESULTS

A total of 324 samples were analyzed. Ninety four (29.0%) of the samples analyzed yielded positive growth of aerobic bacterial organism. Thirty two (34.0%) of the ninety four samples that yielded growth were environmental contaminants as shown by the presence of Bacillus spp.[25] The different bacterial growth which the study yielded included Staphylococcus aureus, Proteus spp, Klebsiella spp, Escherichia coli and Streptococcus spp as shown in Table I. S. aureus constituted majority (62.9%) of the bacterial organism isolated from the health facilities followed by Proteus spp with 19.3% and Klebsiella spp made up 4.8% of the bacterial growth. There was no statistical significant difference in bacteria isolates obtained from secondary and tertiary health facilities (p=0.986).

Table I: Bacterial organism isolated by health facility type.

Bacteria	**Secondary Freq. (%)**	**Tertiary**	**Total**
Staphylococcus aureus	20(64.5)	19(61.3)	39(62.9)
Streptococcus spp	2(6.5)	2(6.5)	4(6.5)
Proteus spp	6(19.3)	6(19.3)	12(19.3)
Klebsiella spp	1(3.2)	2(6.5)	3(4.8)
Escherichia coli	2(6.5)	2(6.5)	4(6.5)
Total	**31(10 0.0)**	**31(10 0.0)**	**62(100.0)**

Fishers = 0.36, df = 4, p = 0.986.

Table II shows that majority of the bacterial growth were from the accident and emergency area of the health facilities (21.0%), followed by the outpatient department (17.7%), thirdly by those collected from the laboratory (16.1%).Those from the waiting area and children ward were 9.7%, respectively.

Table II: Bacterial growth in the health facilities

Location in the Hospital	No of swab samples	Bacterial Growth Frequency	(%)
Laboratory	36	10	16.1
Obstetrics and gynaecology ward	18	1	1.6
Theatre	36	4	6.5
Surgery ward	18	1	1.6
Accident and emergency	24	13	21.0
Male medical ward	36	3	4.8
Female medical ward	36	4	6.5
Outpatient department	36	11	17.7

S. aureus was isolated from swabs taken from every part of the health facilities except the female medical ward and gynaecological wards. Proteus was also isolated in many parts of the health facilities except the laboratory, theatre, surgery ward and medical ward, while E. coli was isolated from swabs from the laboratory and female medical ward. The laboratory accounted for 20.5% of the Staphylococcus growth, second only to the 28.2% growth from the accident and emergency department and lastly 2.5% growth from the pharmacy and surgery ward. Proteus spp was more in the outpatient department with 30.0% of Proteus growth obtained from there. Streptococcus was mainly found in the waiting area since 50.0% of its growth was from there. From the study, the obstetrics and gynaecology and surgery wards yielded the least growth of bacteria with 10.0% and 2.5% growth of Proteus spp and S. aureus, respectively.(Table III)

Table III: Distribution of bacteria in the health facilities.

Location in the hospital	*Staph. aureus*	*Strep spp*	*Proteus*	*Klebsiella*	*E. coli*	Total
Lab	8(20.5)	-	-	-	2(50.0)	10(16.1)
O/G	-	-	1(10.0)	-	-	1(1.6)
Theatre	3(7.7)	-	-	1(33.3)	-	4(6.5)
Surgery ward	1(2.5)	-	-	-	-	1(1.6)
A/E	11(28.2)	1(25.0)	1(0.0)	-	-	13(21.0)
Male medical ward	2(5.1)	-	-	1(33.3)	-	3(4.8)
Female medical ward	-	-	2(20.0)	-	2(50.0)	4(6.5)
OPD	7(17.9)	1(25.0)	3(30.0)	-	-	11(17.7)
Pharmacy	1(2.5)	-	2(20.0)	-	-	3(4.8)
Waiting area	3(7.7)	2(50.0)	1(0.0)	-	-	6(9.7)
Paediatric/children ward	3(7.7)	-	2(20.0)	1(33.3)	-	6(9.7)
Total	39(100.0)	4(100.0)	10(100.0)	3(100.0)	4(100.0)	62(100.0)

Table IV shows that ciprofloxacin had the highest efficacy of 77.3%, followed by ofloxacin, 66.3% and gentamycin, 64.5%, nitrofurantoin had the least efficacy of 7.7%.

Table IV: Antibiogram of different bacterial species from various areas of health facilities in Edo State

ISOLATES	Freq	GEN	NAL	NIT	AMP	COT	CXM	CAZ	AUG	CIP	OFX	CFT
		Average sensitivity to various antibiotics (%)										
Staphylococcus aureus	20	70.1	28.4	11.7	21.7	18.4	20.0	30.1	65.1	83.5	65.1	68.5
Proteus spp	7	85.7	19.0	4.8	14.3	4.8	52.4	23.8	47.6	80.9	66.6	61.9
Streptococcus spp	3	33.3	11.1	22.2	44.4	44.4	44.4	22.2	66.6	66.6	66.6	55.5
Klebsiella spp	3	66.6	33.3	0.0	44.4	22.2	11.1	33.3	66.6	77.7	66.6	22.2
Escherichia coli	3	66.6	0.0	0.0	44.4	22.2	11.1	33.3	66.6	77.7	66.6	22.2
Average sensitivity to antibiotic (%)		64.5	18.4	7.7	29.4	24.6	25.8	30.8	60.3	77.3	66.3	50.5

GEN = Gentamycin
AMP = Ampicillin
CIP = Ciprofloxacin
CXM = Cefuroxine
COT = Co-trimoxazole
OFX = Ofloxacin
NAL = Nalidixic acid
CAZ = Ceftazidine
CFT=Ceftriaxone
NIT = Nitrofurantoin
AUG = Augmentin

DISCUSSION

The bacterial growth of *S. aureus, Streptococcus spp, Proteus spp, Klebsiella spp and E. coli* in secondary and tertiary HCFs in the study area underscores the need to improve infection prevention and control concepts in the HCFs since isolated micro-organisms are potential sources of infection, especially to immuno-compromised, malnourished and even generally to patients, caregivers, HCWs and visitors to the HCFs.[1,22]

The presence of such microorganisms could be as a result of poor cleaning, disinfection and decontamination practice of patients care equipment in the HCFs.[1,2,5,8,20,22] Furthermore the materials used for cleaning and disinfection are obviously not adequate and effective with possible spread of HAI pathogens to other surfaces in the HCFs.[26] Such microorganisms pose a threat to those who seek care in the health facilities, their relatives and even the HCWs and have a potential of aggravating the financial burden of those involved.

The study also revealed that the bacterial organisms yielded from the HCFs surfaces were resistant to the common antibiotics such as ampicillin, cotrimoxazole etc but sensitive to second line and expensive prescriptive antibiotics such as cephalosporin. This could be due to the long term abuse of the former by individuals who indulge in self medication and non compliance with complete dosage of drugs in addition to the irrational prescription of antibiotics by health workers including doctors which will further worsen the financial burden on the patients, families and the community. It also increases the fear of emergence of some pathogens resistance to antibiotics like antibiotic-resistant gram positive *cocci* [vancomycin-resistant enterococci (VRE), methicillin-resistant *Staphylococcus aureus* (MRSA) and *Staphylococcus aureus*]. They have also been shown to have intermediate levels of resistance to glycopeptides antibiotics [vancomycin intermediate resistant *S. aureus* (VISA) or glycopeptides intermediate resistant *S. aureus* (GISA)] which represent a crucial and growing concerns in infection control.[1,4,6,22]

The secondary and tertiary health facilities had similar prevalence for the different organisms isolated. This might be an indication that there are no differences in the infection control practices and strategies in the two levels of health facilities. Efficient infection control progamme and capacity building for HCWs when put together will ensure appropriate restriction to the spread of infections.[6] The accident and emergency units, outpatient departments and the laboratories had higher growth of organisms as shown in the result, this could be as a result of increased movement of HCWs and patients including patient relatives, increased workload on hospital staff and faulty organizational factors which are characteristic of such departments and are all risk factors for HAIs.[1,3,6,9,12,22]

CONCLUSION

Potentially harmful infectious microorganisms such as *S. aureus, Streptococcus spp, Proteus spp, Klebsiella* spp and *E. coli* were isolated in health facilities especially in the accident and emergency areas and the out-patient departments of the health facilities. The Federal Ministry of Health should develop a national programme/policy to support health facilities in reducing the risk of healthcare associated infections. Healthcare facilities need to develop and implement infection prevention and control programmes for the protection of patients, patient caregivers and healthcare workers.

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