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## **An Investigation of X-Ray Equipment and Accessories as Possible Vectors of Nosocomial Infection in Government and Private Hospitals in Anambra State, Nigeria**

**J. C. Eze<sup>1</sup>, H. U. Chiegwu<sup>1</sup> and M. C. Okeji<sup>2</sup>**

<sup>1</sup>*Department of Radiography/Radiological Sciences, Faculty of Health Science and Technology, Nnamdi Azikiwe University, Nnewi Campus, Nigeria.*

<sup>2</sup>*Department of Medical Radiography/Radiological Sciences, Faculty of Health Science and Technology University of Nigeria, Enugu Campus, Nigeria.*

### **Authors' contributions**

*This work was carried out in collaboration between all authors. Author JCE designed the study, wrote the protocol and the first draft of the manuscript. Author HUC analysed the data while author MCO managed the literature. All authors read and approved the final manuscript.*

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### **ABSTRACT**

**Background:** Nosocomial infections have become a major challenge in health care delivery institutions, as they affect the quality of health care delivered. The medical imaging department is central within the hospital to the diagnosis of illness and disease; hence the need to investigate the role of the imaging department in the spread of nosocomial infection within the health care institutions.

**Aim:** This study was carried out to investigate whether x – ray equipment and accessories harbour nosocomial pathogens, and their potential role in causing nosocomial infections within healthcare delivery institutions in government and private hospitals within the study area.

**Study Design:** A non-experimental, prospective study design was used.

**Place and Duration of Study:** This study was carried out in some selected medical imaging departments in Anambra state from March to July 2012.

**Method:** Wet Sterile swab sticks were used to swab the surfaces of selected x-ray equipment and accessories, at the close of work. The swab samples were then taken to the microbiology laboratory for culturing and identification. MacConkey and Blood agar media (inhibitor) were used to prepare the culture media. The prepared media were put in petri dishes and swab samples were inoculated onto the culture plates. Culture plates were then incubated for 24 hours, at a temperature of 37°C. At the end of the incubation period, the culture plates were viewed macroscopically under a bright light, to identify the bacteria; according to their colonial characteristics. Data were analysed using frequency and percentage.

**Results:** Bacteria were isolated in 182 samples (86%), out of the 200 samples collected. Bacteria isolated were; *Staphylococcus aureus* (140), *Pseudomonas aeruginosa* (88), *Proteus spp* (28), *Streptococcus* (52), and *Coliform spp* (80) *Staphylococcus aureus* was the bacterium isolated most often (140 times), while *Proteus spp.* was isolated the least number of times (28 times). But the largest number of sample was recorded on cassettes (60 times), for both government and private institutions. Bacterial isolates had a higher prevalence in government institutions (96), except *Coliform spp.* which had a higher prevalence in private institutions.

**Conclusion:** This study has established the bacteria contamination of X – ray equipment and accessories used in the medical imaging departments of health care delivery institutions. Hence, these equipment and accessories have a potential to cause nosocomial infections in patients and health care workers.

**Keywords:** Investigation; nosocomial bacteria; x-ray equipment; accessories; government; private.

## 1. INTRODUCTION

The medical imaging department (MID) plays a vital role in medical diagnosis, hence, an appreciable number of patients that come into health care delivery institutions, visit the MID for one investigation or the other [1,2,3]. The department is central within the hospital to the diagnosis of illness and disease. Patients with hospital acquired infection/ nosocomial infection stay more in admissions in the hospital than their counterparts without such condition. Nosocomial infections cause a significant drain on the patient's resources because the patient has to spend more money and time staying in the hospital. It also affects the government resources because government has to provide means of controlling such infections. Infection control is fundamentally about preventing the transmission of infection throughout the hospital [4], and it is regarded as an essential part of clinical practice. It usually involves massive investments. In this study area infection control is by the conventional disinfection methods of spraying and wiping which do not fully protect the patients, healthcare professionals or communities against major pathogens. These control measures exist more in surgical wards and operating theatres than any other part of the hospital including the MID. Because of this patients that come for investigations in the department are more prone to being infected by pathogens.

Patients that come to the department include patients from the wards and from out-patient clinics. Such patients could be post – traumatic, post – operative, or immunocompromised. These conditions make them possible vectors of, or highly susceptible to nosocomial pathogens which in turn cause infections [1,2].

As a result of the large influx of patients into the MID, the chances of spread of nosocomial infections among patients, and to the staff are increased; as a result of increased contact between patients and health care delivery equipment [1,2,5,6].

Nosocomial infections (NI) or hospital acquired infections (HAI) are infections whose developments are favoured by hospital environments, such as one acquired by a patient during hospital visits, or one developing among hospital staff [7]. Emmerson et al. [8] defined nosocomial infections as those infections which were not present or incubating at time of their admission. These infections usually manifest 48 hours or more after hospital admission, or within 30 days after discharge [7]. Nosocomial pathogens are microorganisms, including bacteria, algae, protozoa and fungi which are capable of causing nosocomial infections.

The hospital environment is a potential reservoir of infectious agents since it houses both patients with direct pathogenic micro-organisms and a large number of susceptible/immunocompromised individuals [9,10]. The nosocomial pathogens that cause infections can come from endogenous and exogenous sources. Endogenous are those from the patient's own microbial flora while the latter are from surrounding hospital environment. The environment frequently becomes contaminated with pathogenic microorganisms [11,12]; the medical imaging department as part of the hospital environment should therefore not be an exception. In developing countries such as Nigeria, the incidence of nosocomial infection can be devastating resulting in major disease outbreaks in hospitals and other health care facilities. This may be attributed to poor infrastructure, overcrowding, inadequate personnel and management in most hospitals. The infrastructures in most government hospitals lack maintenance and the wards are usually overcrowded. More patients visit public hospitals because they are more affordable than the private hospitals and this leads to congestion in such hospitals. Nosocomial infections lead to increased cost of health care delivery and prolonged admission of patients in the hospitals and hence congestion of the wards [13,14], as well as high mortality rates [15,16].

Nosocomial infections usually require a vector by which to be transmitted. Direct contact between the patient and caregivers' hands, has been established as one of the ways of transmitting nosocomial bacteria [11,17]. In the conventional x – ray unit of the MID, there is usually an appreciable level of contact between patients and accessories used in this unit [1,2]. Investigations which have been conducted by various researchers on the presence of nosocomial bacteria on x- ray equipment and accessories turned out positive, with bacteria such as *Staphylococcus aureus*, *Klasiella spp*, *coliform* and *Escherichia coli*, being the most commonly predominant [1,2,18].

Balla et al. [17] conducted a study to assess the frequency of pathogens on caregivers' hands after direct contact with patients, and confirmed the presence of nosocomial pathogens. Furthermore, investigations carried out to examine the life span of nosocomial pathogens on x – ray cassettes confirmed not only the survival but also the growth of these pathogens on x-ray cassettes [19]. X-ray equipment and accessories are subject to a high turnover of handling and use which may affect how potential bacteria would develop. Cleaning is done mainly by wiping and damp clothes and this may not be effective or sufficient. If the correct cleaning materials are not employed the equipment and accessories would harbour pathogens which could be transmitted to patients. The aim of this study was to establish whether x-ray equipment and accessories in public and private health hospitals in Anambra state harbor nosocomial infections.

## 2. MATERIALS AND METHODS

This was a non – experimental prospective study conducted in the medical imaging department of health care delivery institutions within Anambra State Nigeria. A total of 200 swab samples was collected; 100 from government hospitals and 100 from private hospitals. The swabs were collected for each of institutions on the days they had an appreciable number of patient inflow in the departments. Sterile swab sticks were used to aseptically swab the x-ray tube couches, chest stands, x-ray tube head handles, exposure buttons, control consoles, x-ray cassettes and anatomical markers. Precaution was taken to ensure that no cleaning method was carried out on these surfaces before the collection of samples, which was done at the end of work for the day. Swab samples were labeled appropriately and taken to microbiology laboratory for culturing. The equipment and accessories were however cleaned in the morning with disinfectants before work started.

The culture media (MacConkey and Blood agar) were prepared according to the manufacturer's instructions. The samples were prepared and put into the autoclave and heated for 15 minutes at a temperature of 121°C to achieve sterilization of the culture medium. The medium was afterwards poured into petri dishes, after allowing the medium to cool to 47 °C and culture plates were covered and allowed to set before inoculation of samples. After inoculation, culture plates were placed in an incubator and incubated for 24 hrs at a temperature of 37 °C in order to grow microorganisms. After incubation the culture plates were examined macroscopically under a bright light in order to identify the isolated microorganisms based on their colonial characteristics.

All data were analysed descriptively using frequency and percentage.

## 3. RESULTS

Table 1 shows the total number of samples collected from both government and private institutions and the number of growth recorded. A total of 182 (86%) out of the 200 samples had bacterial growth while 28 samples (14%) yielded no growth. 96 samples out of 100 samples had bacterial growth in government institutions. In private institutions 56 samples out of 100 samples recorded bacterial growth.

Table 2 Shows the total number of samples collected from each surface and the number of growth recorded in government institutions. It showed that x – ray cassettes recorded the highest number of growth of (32) ie 16%.

Table 3 Shows the number of samples collected from each surface and the number of growth recorded in private institutions. X – ray cassettes recorded the highest number of (28) ie 14%.

Table 4 Shows that *staphylococcus aureus* was the most commonly isolated bacteria in both institutions accounting for 140 (70%) of isolates.

Table 5 shows X-ray equipment and accessories and their respective bacterial loads for each of the bacterial isolates. X-ray cassettes had the highest bacterial load for *Staphylococcus aureus* (44), *Pseudomonas aeruginosa* (40) *Streptococcus* (24) and *Coliform spp* (36).

**Table 1. Overall number of samples collected and the number of growth recorded**

	Government institutions	Private institutions	Total (%)
Total number of samples	100	100	100%
Number of samples with growth	96(48%)	76 (38%)	182 (86%)

**Table 2. Number of samples collected from each surface and the number of growth recorded in government institutions**

Surface	Number samples	Number with growth
X ray couch	16	16
Chest stand	8	8
Tube head handle	16	8
Exposure button	8	16
Control console	8	16
X ray cassettes	36	32
Anatomical markers	8	8
<b>Total</b>	<b>100</b>	<b>96</b>

**Table 3. Number of samples collected from each surface and the number of growth recorded in private institutions**

Surface	Number of samples	Number with growth
X ray couch	16	12
Chest stand	8	8
Tube head handle	16	16
Exposure button	8	4
Control console	8	4
X ray cassettes	36	28
Anatomical markers	8	4
<b>Total</b>	<b>100</b>	<b>76</b>

**Table 4. Bacteria isolates and their frequency of occurrence**

	<i>Staphylococcus aureus</i>	<i>Pseudomonas aeruginosa</i>	Proteins Spp	Streptococcus	Coliform Spp
Government institution	72	60	16	28	36
Private institution	68	28	12	24	44
<b>Total</b>	<b>140(70%)</b>	<b>88(44%)</b>	<b>28(14%)</b>	<b>52(26%)</b>	<b>80(40%)</b>

**Table 5. X – ray equipment and Accessories and their respective bacteria loads for each of the bacteria isolates**

	X – ray couch	Chest stand	Tube head handle	Exposure button	Control console	X – ray cassette	Anatomical marker	Total
<i>S. aureus</i>	28	16	16	12	12	44	12	150
<i>Pseudomonas</i>	8	8	20	4	-	40	8	88
<i>Proteus spp</i>	8	-	4	8	-	4	4	28
<i>Streptococcus</i>	12	4	-	4	8	24	-	52
<i>Coliform spp</i>	8	4	16	4	8	36	4	80

#### 4. DISCUSSION

This study investigated x–ray equipment and accessories as possible vectors of nosocomial bacteria in government and private health institutions. The study has shown that x-ray equipment and accessories used in the medical imaging departments harbour nosocomial pathogens, especially bacteria. Bacteria most commonly isolated were; *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Proteus spp*, *Streptococcus* and *Coliform spp*.

From the study, *Staphylococcus aureus* was the most occurring bacteria, with a frequency of 140 (70%). This is in line with Fox and Harvey [2] who found *Staphylococcus aureus* to be the most common bacteria to be isolated from x–ray cassettes. *Staphylococcus aureus* are cutaneous bacteria that colonize the skin and nose of both hospital staff and patients. They cause a wide variety of lung, bone, heart and blood stream infections, and are frequently resistant to antibiotics [20].

*Pseudomonas aeruginosa* was the second most prevalent bacteria, with a frequency of 88 (40%). This microorganism is often isolated in water and damp areas. They may colonize the digestive tract of hospitalized patient [20]. The effect of infection with *Pseudomonas aeruginosa* may be mild, as in folliculitis and external otitis, but wound infection may be more severe. Furthermore, greater morbidity is associated with infection in individuals who have a compromised immune system, or who have another health condition, such as diabetes.

*Coliform spp.* with a frequency of 80 (40%) was also isolated. This is in line with Ochie and Ohagwu [1], who found 45% prevalence of *Coliform spp.*, on x–ray equipment and accessories.

*Streptococcus* (26%) and *proteus spp.* (14%) were also isolated. In a similar study by Le Frock et al. [21]. *Streptococcus* was also identified as one of the microorganisms colonizing x-ray cassettes, x-ray tables, chest boards, Franklin head units and wheel chairs in the imaging department. *Proteus spp.* may colonize sites when the host defenses are compromised, and can cause serious infections like; surgical site infections, bacteraemia and lung infections [20].

X-ray cassettes had the highest frequency of bacterial growth, for both government and private institutions, as shown in Tables 2 and 3. This result agrees with Ochie and Ohagwu [1] who also found x-ray cassettes to be the most frequently contaminated accessories. The surface of the equipment which the radiographer touches, like the tube head handle,

exposure button and control console all recorded bacterial growth, as seen in Tables 2, 3, 5. This result also suggests that microorganisms are spread by the radiographer's hands.

The x-ray couches and chest stands also recorded appreciable bacterial growth, for both government and private institutions; as can be seen in Tables 2 and 3. These surfaces are also considered as patient contact surfaces.

The anatomical markers also recorded bacterial growth, as seen in Tables 2 and 3. This result agrees with Hodges [22] who also identified bacterial growth on radiographic marker tapes cultured. Bacteria identified include; *S. epidermis*, *Streptococcus*, *Micrococcus*, *S. aureus*, *Acinetobacteria*. It suggests that radiographic/anatomical markers could be a source of nosocomial infection to the society – if they are carried out of the hospital environment, and to the radiographers – who carry them about – as occupational infection.

All bacteria isolated had a higher prevalence in government institutions than in private institutions except Coliform spp. which had a higher prevalence in private institutions. This may be attributed to the state of the infrastructures, overcrowding and management of personnel and equipment. There is more influx of patients to the public hospitals than the private hospitals. The attitude of personnel / staff in handling government property within the area of study could also be the reason for the higher prevalence in government hospitals.

## 5. CONCLUSION

Nosocomial bacteria were found on the surfaces of x – ray equipment and accessories; hence they are potential sources of nosocomial infections within health care delivery institutions. Growths were recorded more in government than private institutions. Infection control measures are not adequately adopted.

## RECOMMENDATIONS

Based on the results of this study, the following recommended measures should always be taken, to minimize the risk of nosocomial infection in the imaging department.

X- ray equipment and accessories should be properly disinfected immediately after use and before the next patient is attended to. X-ray couch, cassettes, chest stands and anatomical markers should be disinfected in between patients while the control panel and exposure buttons should be disinfected each day.

- Radiographers should wash their hands by scrubbing with soap and water, alcohol or antiseptics after attending to a patient and before attending to the next patient. Radiographers should also imbibe the culture of proper hand washing with these agents at the end of procedures for the day.
- There should be constant monitoring of the bacterial load of the equipment and accessories to reduce the risk of nosocomial bacteria growing on them.

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## **COMPETING INTERESTS**

Authors have declared that no competing interests exist.

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