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# Infection control in a resource constrained radiology department: a case study of a Zimbabwean hospital

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**Abstract**

The purpose of this study was to investigate whether radiology equipment could be a reservoir for microorganisms which aid the spread of infection to patients. Swab samples were collected from selected X-ray equipment and accessories and sent to the microbiology laboratory for culturing and identification using standard laboratory procedure.

Bacteria were isolated in 38 swabs representing 42% of all the swab samples. Staphylococcus aureus, lactose fermenting coliforms, staphylococcus saprophyticus, pseudomonas aeruginosa and coagulase-negative staphylococcus were the bacteria isolated from the swab samples.Lactose fermenting coliforms were isolated the most , namely 17 times (45%); pseudomonas aeruginosa were only isolated once. X-ray cassettes recorded the highest number of times that bacteria were isolated (55%) with coliform being isolated most often (52%).

The research concluded that the cleaning criterion that was being employed was inadequate resulting in the presence of microorganisms on imaging equipment and accessories. The study therefore recommended that the radiology staff should adhere more to infection control policies to curb the growth of microorganisms.

**Keywords**

bacteria; fomites; vectors; cassettes; nosocomial

## Introduction and background

A radiology department is a medical melting pot in which different types of patients converge. In resource constrained settings, these diverse patients wait for long hours in close proximity with other patients. The potential of contracting infection from other patients is thus exponentially increased. Staff shortages further increase the burden of overworked radiographers. In these circumstances radiographers often focus primarily on core radiography responsibilities and relegate other important functions, such as infection control, to the back burner. This inadvertently exposes both the radiology staff and patients to healthcare associated infections (HAI). HAI are defined as infections not present and without evidence of incubation at the time of admission to a healthcare setting[1].

Hospital infections (nosocomial) not only impose a burden of illness and prolonged admission on patients but also impact of the financial costs of a hospital. For example, additional investigations to determine possible causes of HAI in patients as well as and treatment and management of the affected patients. This in turn prevents the use of beds for other patients[2]. In resource constrained settings, characterized by many competing needs for too few resources, this extra burden exacerbates an already cryptic problem. In an effort to minimize the spread of infection it is standard practice to perform damp dusting of equipment and surfaces in radiology departments every morning. Inadequate cleaning of surfaces can be a source of cross infection. The purpose of the current study was twofold. Firstly, to establish the extent to which different pieces of radiology equipment could be reservoirs of microorganisms. Secondly, to identify the healthcare cadres that face the greatest risk of acquiring healthcare associated infections. The setting of the study was the Harare Central Hospital in Zimbabwe.

## Materials and methods

The selected department has one functional X-ray machine used for accident and emergency cases, ward patients, special radiographic procedures and general radiography. All the cassettes, probes, hatches, door handles, lead rubber aprons and machines that were functional were included in the study. The decision regarding selection of equipment to be sampled for bacteria and places to be swabbed were based on the following criteria:

- Where a large number of patients had direct skin contact with the equipment
- Where patients respired directly onto the equipment surface
- Where the equipment used was in contact with the radiographer.

A total of 90 cultures were taken over a period of two weeks. The potential fomites were each swabbed three times using a sterile cotton swab using Armies transporting media. Blood, chocolate and MacConkey agar were used to maximize organism collection, whilst ensuring their viability. The culture plates were examined for the number of colonies and the colony type and each was recorded. The microorganisms were isolated and categorized by the microbiology department. The microorganisms were not typed further than their basic classification due to resource limitations and the exploratory nature of the study. Protozoa were not included within the study due to the fact that few are pathogenic to man. Viruses were also not included. Observations were made by the researcher in terms of focusing on the staff's infection control practices, such as the use of disposal gloves and the frequency and thoroughness of the cleaning. The aim was to establish the adequacy of the cleaning criterion.

## Results

A total of 30 potential fomites were swabbed during the study. A total 90 cultures were taken over a space of two weeks. The findings revealed that 58% of the sample collected did not grow microorganisms. The remaining 42% grew a range and number of organisms, some growing more than one organism from each swab. Neither fungi nor viruses were isolated during the study. Tables 1 and 2 present summaries of the results.

Bacteria were isolated in 38 swabs representing 42% of all the swab samples. Coagulase-negative staphylococcus, pseudomonas aeuruginosa, staphylococcus saprophyticus, staphylococcus aureus and lactose fermenting coliforms were the bacteria isolated from the swab samples. Lactose fermenting coliforms were isolated the most, namely 17 times (45%) and pseudomonas aeuruginosa were isolated the least number of times, namely only once (3%). The colonies were grouped into three categories: light, moderate and heavy. Twenty three colonies were light (60%), nine were moderate (24%) and six were heavy (16%).

The X-ray cassettes recorded the highest number of times bacteria were isolated (n=21) which was 55% of the entire sample. Lactose fermenting coliforms were isolated most often (n=11) which was 52% of the sample.Coagulase negative staphylococcus, pseudomonas aeuriginosa, staphylococcus saprophyticus and staphylococcus aureus were also isolated from the cassettes.

Microorganisms, namely coagulase negative staphylococcus (n=1 and heavy), staphylococcus saprophyticus (n=1 and heavy) and lactose fermenting coliforms (n=1 and light) were isolated from the lead rubber aprons. Tables 3 and 4 below present summaries of the organisms that were isolated from the equipment and the contact categories.

Coagulase negative staphylococcus was the most collected microorganism (from n= 6 different fomites), followed by lactose fermenting coliforms (n=5) and lastly staphylococcus saprophyticus (n=3). Most microorganisms collected were light (n=10), followed by those which were moderate (n=3) and lastly those which were heavy (n=1). Some fomites were found to have more than one type of microorganism, for example the horizontal bucky handle.

## Discussion

Although relevant virus test were not done in this study their presence cannot be ruled out. All the microorganisms isolated are associated with various infections. Coagulase negative staphylococcus has been identified as an agent of clinically significant nosocomial bloodstream infections and also accounts for significant morbidity and mortality in patients with native valve endocarditis[3], Staphylococci epidermis, a type of coagulase negative staphylococci, is capable of adhering to plastics and metals and by so doing creep into the body through devices such as catheters and prostheses. The resistance of staphylococci to many antibiotics has been reported rendering them difficult to manage clinically[4]. The significance of this finding lies in the fact that plastics and metals, which have been identified as potential fomites, abound in radiology departments. This is particularly true of cassettes and x-ray equipment which are all made of metals.

Lactose fermenting coliform had the highest number of colonies identified (45%). Although most coliforms are not harmful it has been reported that 29% of all nosocomial infections involve coliforms or *Proteus*[5]. The presence of lactose fermenting coliforms, is indicative of fecal contamination. Fecal contamination is itself often accompanied by the presence of other pathogens of fecal origin, such as viruses, protozoa, and other multi-cellular parasites that were not tested in the current study. Inadequate cleaning of surfaces as well as poor hygiene can be sources of this type of contamination. Inadequate cleaning and poor hygiene are common in resource constrained radiology facilities for two reasons. First, imaging departments often lack funds to acquire efficacious disinfectants. Second, radiographers in resource constrained department are often overloaded with work. In an attempt to deal with large volumes of patients basic hygiene rituals, such as the cleaning of hands, are often omitted.

Staphylococcus aureus bacteria which is a pyrogenic organism known to cause infections such as boils, post-operative wound infections, septicaemia, osteomyelitis and pneumonia was isolated from the cassettes indicating that patients and radiographers that come into contact with these cassettes risk contracting these infections. This bacterium has also gained notoriety for its capability of developing resistance to antibiotic treatment.

Saprophyticus is known as the coagulase-negative species of staphylococcus and is a natural habitat on the human skin and genital system. It is often active

**Table 1:** Ranking of fomites versus contact category in descending order.

| Rank | Number of Microorganisms | Site | Contact Category |
|---|---|---|---|
| 1. | 21 | Cassette | Radiographer, Dark Room Technician (DRT) and patient |
| 2. | 3 | Lead rubber apron | Radiographer & patient |
| | 3 | Horizontal bucky Handle | Radiographer only |
| 3. | 2 | Hopper handle | Radiographer & DRT |
| 4. | 1 | Horizontal bucky (towards the edge) | Radiographer & patient |
| | 1 | Erect bucky | Patient only (upper quadrant) |
| | 1 | Probe lens | Patient only |
| | 1 | X-ray tube handles | Radiographer only |
| | 1 | Hatch handle | DRT & Radiographer |
| | 1 | Viewing box | Radiographer only |
| | 1 | X-ray control panel | Radiographer only |
| | 1 | Chin rest | Patient only |
| | 1 | Darkroom work surface | Radiographer & DRT |
| 5. | 0 | Door handle | Radiographer & patients |
| | 0 | Probe handle | Radiographer only |
| | 0 | Actinic marker | Radiographer & DRT |
| | 0 | Disinfectant bottle | Radiographer only |
| | 0 | Tap handle | Radiographer only |

**Table 2:** Microorganisms versus number of colonies.

| Microorganism | Number of colonies | | | Total |
|---|---|---|---|---|
| | Light | Moderate | Heavy | |
| Coagulase-negative Staphylococcus | 5 | 5 | 1 | 11 |
| Pseudomonas Aeuruginosa | | 1 | | 1 |
| Staphylococcus Saprophyticus | 5 | 1 | 1 | 7 |
| Staphylococcus Aureus | 1 | | 1 | 2 |
| Lactose Fermenting Coliforms | 12 | 2 | 3 | 17 |
| | | | | 38 |

**Table 3:** Equipment on which microorganisms were isolated.

| Microorganism | Fomite | Number of Microorganisms | | | Total |
|---|---|---|---|---|---|
| | | Light | Moderate | Heavy | |
| **Coagulase negative staphylococcus** | *Horizontal bucky* | 1 | | | 6 |
| | *Erect bucky* | 1 | | | |
| | *Probe lens* | | 1 | | |
| | *X-ray tube handles* | | 1 | | |
| | *Hatch handle* | 1 | | | |
| | *Viewing box* | 1 | | | |
| **Staphylococcus Saprophyticus** | *X-ray control panel* | 1 | | | 3 |
| | *Chin rest* | 1 | | | |
| | | | | | |
| | *Horizontal bucky handle* | 1 | | | |
| **Lactose Fermenting Coliforms** | *Darkroom work surface* | 1 | | | 5 |
| | *Hopper handle* | 1 | | 1 | |
| | *Door handle* | | 1 | | |
| | *Horizontal bucky handle* | 1 | | | |

in various urinary tract infections, especially cystitis in sexually active women. It is associated with pyelonephritis in women and in 15-20% of the common urinary tract infections.

Pseudomonas aeruginosa has been noted to be an important cause of infection, especially in patients with compromised host defense mechanisms. It is the most common pathogen isolated from patients who have been hospitalized longer than one week. Nosocomial infections caused by these microorganisms include pneumonia, urinary tract infections (UTIs), endocarditis, gastrointestinal infections, central nervous system infections, ear infections including external otitis, eye infections, septicemia and bacteremia and bone and joint infections. Pseudomonal infections are known to be complicated and life threatening.The high prevalence of HIV and AIDS in Africa has resulted in many patients with compromised defense mechanisms being referred to a radiology department as part of the diagnosis and management of HIV-related infections such as tuberculosis. These patients are therefore at the risk of contracting pseudomonas aeruginosa infections in a radiology departments.

Most microorganisms were isolated from cassettes which are used in almost all radiological procedures. In many of these procedures a cassette comes into contact with a patient's skin. Radiographers who carry cassettes also come into contact with microorganisms. A cassette, being a reservoir of microorganisms, can be a source of cross infection putting both a radiographer and patient at risk. Furthermore, cassettes are often transported to the wards, the operating theatre and the intensive care units, In these places cassettes often come into contact with immuno-suppressed patients who are particularly at risk of acquiring HAI (hospital associated infections). It is therefore very important that cassettes are properly disinfected and regularly monitored to make sure that they do not become vectors of microorganisms.

A radiographer has a diverse role, visiting many different areas within the radiology department and hospital environment and, as such is in danger of being both a vector for the carriage of infection and also a victim of infections contracted from those sites. From the 13 fomites found to be contaminated by microorganisms, the incumbent radiographer was seen to be in contact with 11 sites. Fomites in the radiographer only contact category was found to be contaminated were the X-ray control panel, the viewing box, the X-ray tube handles and the horizontal bucky handle. This represents 31% of the total fomites swabbed. In the radiographer and patient contact category three sites were identified: cassette, lead rubber apron and horizontal bucky. Furthermore, there were four sites in the radiographer and darkroom technician contact category.

Radiographers as well as radiologists tend to be preoccupied with matters of radiation protection and often have peripheral interest in infection control hence they consider it as the province of infection control nurses[9]. This attitude can be attributed to the fact that infection prevention and control receives peripheral consideration in the training of radiographers while radiation protection is vigorously underscored. The current study shows that in a radiology department a radiographer is the cadre most exposed to both ionizing radiation sources as well as HAI sources. In view of this radiographers should approach infection control issues with the same zeal used to tackle radiation protection.

Fomites found to be at particular risk of infection were the cassette, lead rubber apron, film hopper handle, horizontal bucky, horizontal bucky handle, erect bucky, probe lens, hatch handle, viewing box, chin rest, darkroom work surface, X-ray control panel and X-ray tube handle. The greatest numbers of bacteria were isolated on the cassette. This may be expected as this is the most commonly used radiographic item in imaging departments. Of concern in terms of infection control was that the department in the study did not have gowns for patients leading to direct patient skin to equipment contact. Wearing a clean

gown reduces the transfer of microorganisms from a patient's skin to the equipment. Clean gowns for patients play a protective role to minimize risks of cross infection. Hence it is not surprising that in this study a number of organisms that reside on human skin were isolated from the equipment especially the cassette, erect bucky and the horizontal bucky. In resource constrained settings where there are many competing needs for limited budgets it would seem that patient gowns may not be ranked highly in the list of radiology priorities. This has huge infection control implications.

The lead rubber apron in the study was the fomite that was ranked second in contamination after cassettes. The primary purpose of wearing a lead rubber apron is to protect a radiographer from being exposed to unnecessary ionizing radiation. It is ironical this necessary accessory is also a source of infection due lack of adequate infection control measures being implemented. Boyle and Strudwick[6] reported the contamination of lead rubber aprons with a range of bacteria. Furthermore, in one study 10% of radiographers reported that they did not clean lead rubber aprons at all[7]. Contamination to the aprons can stem from a number of sources including, but not limited to, radiographers and the patients they come into contact with. However, aprons can also accumulate dust when they are not in use. Staphylococci present in the human skin can collect in dust and then survive for long periods of time[7].

During the study it was established that some of the equipment was cleaned regularly using a lemon based disinfectant. Lemon based disinfectants have been shown to be effective against a broad spectrum of Gram negative and Gram positive organisms including *klebsiella, pseudomonas salmonella and E. coli*[5]. The presence of microorganisms on surfaces that were supposedly cleaned implies that the cleaning is inadequate. Although damp dusting was done every morning not all pieces of equipment were cleaned. Although cassettes were cleaned at least twice a week in the morning, they were only disinfected five times in between patients and sometimes only wiped with linen after being soiled. This practice poses a risk of cross infection as physical removal of dirt does not necessarily translate to removal of microorganisms. This observation is supported by the presence of microorganisms on the cassettes from the swab tests. International best practice recommends that devices and pieces of equipment that come into contact with patients should be cleaned after every patient[8]. This practice was not adhered to thus increasing the chances of accumulation and spread of bacteria. Windows and walls may also be a source of infection if they are not adequately and regularly cleaned as some pathogens, such as the tuberculosis (TB) bacterium, can attach to walls and infect healthy individuals who respire in the room.

Two important observations were made with respect to damp dusting. Although damp dusting was done every morning not all pieces of equipment were cleaned. For example, the door handle, lead rubber aprons, the viewing box and the hatch handle were not cleaned at all during the course of the study. When cleaning was done a lemon based disinfectant was used.

## Conclusion

Previous studies have shown that all equipment should be adequately cleaned as they are at risk of becoming vectors for microorganisms that cause nosocomial infections. In this study pieces of equipment and accessories used during an examination that were of particular risk were :

- the lead rubber apron
- the horizontal bucky and handle
- cassettes
- the X-ray tube handle
- the viewing box
- the X-ray control panel
- the chin rest
- the probe lens
- the erect bucky
- the film hopper handle
- the hatch handle
- the darkroom work surface.

As evidenced by the presence of microorganisms on equipment and observations of radiographers in practice, the cleaning criteria at this hospital's radiology department are not adequate.

To address these weighty infection control issues it is recommended that the infection control policy be strengthened to bring it in line with international best practice. This policy must be reproduced and made available to staff and should form the basis of ongoing educational and training programmes. It is especially recommended that devices and pieces of equipment that come into contact with patients should be cleaned after every patient. Purchase of disposable cassette covers to avoid transmitting infections through direct contact especially where body fluids are concerned is also recommended.

This study did not carry out elaborate typing of microorganisms from their basic classification and also did not test for the presence of viruses. It is therefore recommended that further research be done to cater for these omissions. Such research could entail swabbing the hands of the radiology staff in order to ascertain whether they are infection contaminated. Mapping of the movement of cassettes should also be considered.

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