Infection Control in A Resource Constrained Radiology Department: A Case Study of a Zimbabwean Hospital

G R Chingarande, L Chidakwa

Citation

G R Chingarande, L Chidakwa. *Infection Control in A Resource Constrained Radiology Department: A Case Study of a Zimbabwean Hospital*. The Internet Journal of Radiology. 2013 Volume 16 Number 1.

Abstract

The purpose of this study was to investigate whether the 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 the swab samples were taken 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 most often (17 times; 45%) and pseudomonas aeruginosa were isolated the least number of times (once; 3%). X-ray cassettes recorded the highest number of times bacteria were isolated (55%) with coliform being isolated most often (52%) from the cassettes.

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.

BACKGROUND AND PURPOSE

The 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 the radiographer who is already overworked. In these circumstances the radiographer often focuses primarily on the core radiography responsibilities and relegates 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). Healthcare-associated infections are defined as infections not present and without evidence of incubation at the time of admission to a healthcare setting (Coffin S, 2008)1. Hospital infections not only impose a burden of illness and prolonged admission on the patient; it also imposes the cost of investigation and treatment on the hospital, as well as preventing the use of the bed for other patients (Bannister B, 1996)2. In resource constrained settings, characterized by too many competing needs for too few resources, this extra burden exacerbates an already cryptic problem. The purpose of the current study was to establish the extent to which different pieces of radiology equipment can be reservoirs of microorganisms and to identify the healthcare cadres that face the greatest risk of acquiring healthcare associated infections. The setting of the study was Harare Central Hospital in Harare, Zimbabwe.

MATERIALS AND METHODS

The department has 1 functional X-ray machine used for Accident and Emergency cases, ward patients, special procedures and for general radiography. All the cassettes, probes, hatches, door handles, lead aprons and all machines that were functional were included in the study. A judgmental decision was made on which items of equipment were to be swabbed. This judgment was informed by the literature review and, based on the following criteria:

1. Where a large number of patients had direct skin contact with the equipment;
2. Where patients respired directly onto the equipment surface;
3. Where the equipment used, was in contact with the radiographer.

A total of 90 cultures were taken over a period of 2 weeks. The potential fomites were each swabbed 3 times using a

sterile cotton swab using Armies transporting media. Blood, chocolate and Mac Conkey agar was 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.

RESULTS

A total of 30 potential fomites were swabbed during the study with a total 90 cultures taken over a space of two weeks, of which 58% grew no 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 below present summaries of the results.

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 apron	Radiographer & patient
	3	Horizontal Bucky Handle	Radiographer only
3.	2	Hopper handle	Radiographer and 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 and Radiographer
	1	Viewing box	Radiographer only
	1	X-ray control panel	Radiographer only
	1	Chin rest	Patient only
	1	Darkroomwork surface	Radiographer and DRT
5.	0	Door handle	Radiographer & patients
	0	Probe handle	Radiographer only
	0	Actinic marker	Radiographer and DRT
	0	Disinfectant bottle	Radiographer only
	0	Tape 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

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 most often (17 times; 45%) and pseudomonas aeuruginosa were isolated the least number of times (once; 3%). The colonies were grouped into; light, moderate and heavy. Twenty three colonies were light (60%), 9 were moderate (24%) and 6 were heavy (16%).

The X-ray cassettes recorded the highest number of times bacteria were isolated (21times; 55%) with lactose fermenting coliforms being isolated most often (11 times; 52%). Coagulase negative staphylococcus, Pseudomonas aeuriginosa, Staphylococcus saprophyticus and Staphylococcus aureus were also isolated from the cassettes. Microorganisms namely Coagulase negative staphylococcus (1and heavy), Staphylococcus Saprophyticus (1 and heavy) and Lactose Fermenting Coliforms (1 and light) were isolated from the lead aprons. Table 3 below presents a summary of the organisms that were isolated from the rest of the equipment.

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			

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

DISCUSSION

Although no viruses were isolated in this study because the relevant tests were not performed, 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, (Chu.V, 2008)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 clinically4.

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. (Douglas. F, 2000)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.

Staphylococcus aureus bacteria, 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 and is often active 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 1 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.

Most microorganisms were isolated from cassettes. The cassette is one device that is involved in almost all radiological procedures. In many of these procedures the cassette comes into contact with the patient's skin. Radiographers who carry the cassettes also come into contact with it. The cassette, being a reservoir of microorganisms can be a source of cross infection putting both the radiographer and the patient at risk. Furthermore, the cassettes are often transported to the wards, the theater and the intensive care units and, in these places, the cassette

often comes into contact with immuno-suppressed patients who are particularly at risk of acquiring 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.
The 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 the victim of infections contracted from those sites. From the 13 fomites found to be contaminated by microorganisms, the radiographer was seen to get in contact with 11 sites. Fomites in the radiographer only contact category 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 3 sites were identified (cassette, lead apron and horizontal Bucky). Furthermore, there were 4 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 viewing it as the province of infection control nurses. This attitude can be attributed to the fact that infection control receives peripheral consideration in the training of radiographers while radiation protection is vigorously underscored. The current study shows that in the radiology department the radiographer is the cadre most exposed to both sources of radiation and sources of hospital associated infections. Hence, the radiographer 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 apron, 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 piece of equipment in daily use and it is used for all patient cases from general to accident and emergency. Furthermore, it was observed in the current study that the department had no gowns for patients leading to direct patient skin to equipment contact. The absence of patient gowns which also play a protective role in infection control facilitates the transfer of microorganisms from the patient's skin to the equipment. Hence it is not surprising that a great 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, such as the setting for this study; characterized by too many competing needs for limited budgets patient gowns may not be ranked highly in the list of radiology priorities. This has huge infection control implications.
The Lead rubber apron was the fomite that was ranked second in contamination after the cassettes. It is ironical that the aprons whose purpose is to protect can actually become a source of infection. Boyle and Strudwick (2010)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 aprons at all. Contamination to the aprons can stem from a number of sources including but not limited to the 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 (Wilson, J 2006)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. coli5. 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, for example, the door handle, lead aprons, the viewing box and the hatch handle were never cleaned during the course of the study. Moreover, although cassettes were cleaned at least twice a week in the morning, they were only disinfected 5 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 patient8. 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 TB bacterium can attach to walls and infect healthy individuals who respire in the room.

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. For this study pieces of equipment used during an examination that were of particular risk were the lead apron, the horizontal Bucky and handle, the cassette, the X-ray tube handle, the viewing box, the X-ray control panel, the chin rest, the probe lens, the erect Bucky, the hopper handle, the hatch handle and 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 is 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 test for the presence of viruses. It is therefore recommended that further research be done to cater for these omissions. Such research might consider swabbing the hands of the radiology staff in order to ascertain whether they are not infection contaminated. Mapping of the movement of cassettes should also be considered.

References

1. Coffin S.E. Health-care Associated Infections Principles and Practice of Pediatric Infectious Diseases. 3rd Edition, Churchill Livingstone, 2008.
2. Bannister B. A (1996). Infectious Disease, 1st Edition, Blackwell Science Limited.
3. Chu V, (2008), Emergence of Coagulase negative staphylococci as a cause of native valve endocarditis. Clin Infect Dis; 46: 232.
4. Gould, D. Brooker C. Applied microbiology for nurses. Basingstoke: Macmillan Press Limited; 2000.
5. Guentzel, NM. In: Medical Microbiology. 4th Edition. Galvestone: Texas; 1996.
6. Boyle, H and Strudwick, R.M. (2010), Radiography, Issue 4, Volume 16, pages 297-303.
7. Wilson, J. In: Infection control in clinical practice. 3rd ed. Edinburgh: Elsevier Limited; 2006.
8. Department of Health. Epic Project. London: Department of Health; 2001.

Author Information

George R Chingarande
University of Zimbabwe College of Health Sciences
Harare, Zimbabwe
gchingarande@yahoo.com

Lavendah Chidakwa
University of Zimbabwe
Harare, Zimbabwe