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Contamination of X-Ray Equipment and Accessories with Nosocomial Bacteria and the Effectiveness of Common Disinfecting Agents

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Abstract: Radiography plays a very important role in medical diagnosis but the equipment and accessories used bear a considerable risk of harbouring nosocomial bacteria which may complicate patient's original condition. The aim of the study was to identify the nosocomial bacteria commonly found on x-ray equipment and accessories in this locality and assess the effectiveness of some common chemical disinfectants used in x-ray units. Swab samples were collected from selected x-ray equipment and accessories. The swabbing procedure was carried out using sterile Evepon™ swab sticks. The selected surfaces were first swabbed before being cleaned with chemical disinfectant of appropriate dilution. The surfaces were then cleaned with chemical disinfectant and swabbed again. A short time interval was allowed before the second swabbing for the disinfectant solution to dry. The swab samples were then taken to the microbiology laboratory for culturing and identification using standard laboratory procedure. Cystine lactose electrolyte deficient (CLED) and blood agar media were used to prepare the culture samples. The prepared samples were put in petri dishes and incubated for 24 hours at a temperature of 37°C. At the end of the incubation period, the samples were viewed under microscope to identify the bacteria. Bacteria were isolated in 142 swabs representing 47.2% of all the swab samples. *Staphylococcus aureus*, *klebsiella spp*, *coliform* and coagulase-negative *staphylococcus epidermidis* were the bacteria isolated from the swab samples. *Klebsiella spp* were isolated most often (49 times; 34.5%) and and coagulase-negative *staphylococcus epidermidis* were isolated the least number of times (18 times; 12.7%). The x-ray cassettes recorded the highest number of times bacteria were isolated (54 times; 38%) with *coliform* being isolated most often (45 times; 31.7%). Sodium hypochlorite was the most effective chemical disinfectant. No bacterial isolates were seen in the swab samples collected after its use.

Key words: Nosocomial bacteria · X ray equipment · Accessories · Disinfecting agents

INTRODUCTION

The radiology department plays a very important role in medical diagnosis. It regularly receives large number of patients from the wards and out-patient clinics. As a result of large patient traffic into the department there are increased chances of spreading nosocomial pathogens amongst patients and to the radiology staff. Nosocomial pathogens include bacteria, fungi and viruses and may or may not result in infectious diseases to patients and radiology staff, depending on their immune status.

An infection is regarded as nosocomial if it is as a result of treatment in a hospital or hospital-like setting, but secondary to the patient's original condition and manifests 48 hours or more after hospital admission or within 30 days after discharge [1]. Nosocomial pathogens and infections are relatively common because hospitals receive large number of patients, some of whom may be immunocompromised. Nosocomial pathogens and by extension the resulting infectious diseases can complicate and prolong hospital admission [2]. There are opportunities for spread of nosocomial pathogens in the radiology department. The pathogens are brought into

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the department by patients and because there are intimate contacts between them and the radiographer as well as equipment and accessories, the pathogens spread among the patients and to staff. The high risk individuals are patients with varying degrees of illnesses who are in close proximity to one another, who may already be infected and use the same radiography equipment and accessories which may have been contaminated. This problem is complicated by personnel shortages which have affected practice in such a manner that one radiographer is responsible for many severely ill patients spanning across HIV/AIDS, diabetic, tuberculosis, pyomyositis patients and road traffic accident victims.

Nosocomial infections are widespread. They are important contributors to morbidity and mortality and will become even more important as a public health problem with increased economic and human impact. This is because of increasing number and crowding of people, impaired immunity due to old age, illnesses and treatments, new microorganisms and increasing bacterial resistance to antibiotics [3]. According to Weinstein [4] 25-50% of nosocomial infections are due to combined actions of the patient's own microbial flora and invasive medical devices. Nosocomial urinary tract infections are common and almost invariably occur as a result of some urinary tract manipulations such as urethral dilatation, cystoscopy, retrograde pyelography and urinary catheterization [5]. Inglis [6] listed nosocomial bacteria which include *staphylococcus aureus*, *pseudomonas aeruginosa, klebsiella spp, enterococcus spp, citrobacter spp, acinobacter spp, yersina enterolitica, treponema palladium, mycobacterium tuberculosis,* coagulase-negative *staphylococci (epidermidis and saprophyticus)* and *coliform spp*. These microorganisms are associated with hands of medical staff and paramedics, hospital equipment and accessories such as patient support systems, couch, x-ray cassettes[7] and changing gowns [8].

Chemical disinfectants are a collection of chemicals with varying antimicrobial spectra and uses. The chemical disinfectants which effectiveness was investigated in this study are chloroxylenol, dichloroxyleenol, sodium hypochlorite and methylated spirit.

The aim of this study was to identify the nosocomial bacteria commonly found on x-ray equipment and accessories in this locality and assess the effectiveness of some common chemical disinfectants used in x-ray units.

MATERIALS AND METHODS

The data were collected directly from swab cultures from selected x-ray equipment and accessories in selected standard conventional x-ray units in Enugu metropolis, Nigeria. The swab cultures were collected from x-ray couches, chest stands, x-ray cassettes, handles of x-ray tube heads, control panels, exposure buttons and patients' x-ray gowns.

The swabbing procedure was carried out using sterile Evepon™ swab sticks. Nutrient broth was used to moisten the swab sticks and the surfaces to be swabbed as the swab sticks and swabbed surfaces were dry. This was to keep the microorganisms alive from the time of collection to the time it gets to the microbiology laboratory. The selected surfaces were first swabbed before being cleaned with chemical disinfectants of appropriate dilutions: 13.5ml of chloroxylenol 4.8% in 250ml of water, 10ml of dichloroxylenol 2% in 1000ml of water, solution of 3.5% sodium hypochlorite and methylated spirit. The surfaces were then cleaned with chemical disinfectant and swabbed again. A short time interval was allowed before the second swabbing for the disinfectant solution to dry. The two swabs were labeled A and B; A for before applying disinfectant solution and B for after applying disinfectant solution. They were then taken to the microbiology laboratory for culturing and identification using standard laboratory procedure. This data collection procedure was done on different days after work for the different chemical disinfectant solutions investigated.

Cystine lactose electrolyte deficient (CLED) and blood agar media were used to prepare the culture samples. The prepared samples were put in petri dishes and incubated for 24 hours at a temperature of 37°C in an incubator manufactured by B. Bran Scientific and Instrument Company with model number DHG-9023A. At the end of the incubation period, the samples were viewed under Olympus binocular microscope at magnification of 40X to identify the bacteria.

RESULTS

Table 1 shows the overall number of times were isolated from the swabbed surfaces. Bacteria were isolated in 142 swabs representing 47.2% of all the swab samples obtained. Table 2 shows that *staphylococcus aureus*, *klebsiella spp*, *coliform* and coagulase-negative *staphylococcus epidermidis* were the bacteria isolated from the swab samples. *Klebsiella spp* were isolated most often (49 times; 34.5%) and and coagulase-negative

Table 1: Total number of cultured samples and culture isolates

Total number of cultured samples	Number of culture isolates	Percentage of isolates
301	142	47.2%

Table 2: List of isolated bacteria and their prevalence

BACTERIA	PREVALENCE
Staphylococcus aureus	30 (21.1%)
Psuedomonas aeruginosa	Nil
Klebsiella spp	49 (34.5%)
Acinobacter spp	Nil
Coliform	45 (31.7%)
Coagulase-negative S. epidermidis	18 (12.7%)
Citrobacter spp	Nil
Yersina enterocolitica	Nil
Treponema palladium	Nil
Mycobacterium tuberculosis	Nil
Total	142 (100%)

Table 3: X-ray equipment and accessories, and their bacterial load

Equipment/accessories	Klebsiella spp	S. aureus	S. epidermidis	Coliform	Total number of isolates
X-ray couch	8	5	3	7	23 (16.2%)
Chest stand	12	4	-	1	17 (12.0%)
Tube head handle	8	5	-	3	16 (11.3%)
Exposure button	-	3	1	2	6 (4.2%)
Control panel	2	8	2	5	17 (12.0%)
Patients' gown	5	2	-	2	9 (6.3%)
X-ray cassettes	14	3	12	25	54 (38.0%)
Total	49 (34.5%)	30 (21.1%)	18 (12.7%)	45 (31.7%)	142 (100%)

Table 4: Chemical disinfectants and number of bacterial isolates after their use

Disinfectant	Number of bacterial isolates
Chloroxylenol	7 (4.9%)
Dicholoroxylenol	7 (4.9%)
Sodium hypochlorite	0 (0%)
Methylated spirit	3 (2.1%)
Total	17 (11.9%)

staphylococcus epidermidis were isolated the least number of times (18 times; 12.7%). Table 3 shows the bacterial load of the x-ray equipment and accessories. The x-ray cassettes recorded the highest number of times bacteria were isolated (54 times; 38%) with *coliform* being isolated most often (45 times; 31.7%). Table 4 shows that sodium hypochlorite was the most effective chemical disinfectant. No bacterial isolates were seen in the swab samples collected after its use.

DISCUSSION

This study investigated the involvement of x-ray equipment and accessories as reservoirs of nosocomial bacteria. It also investigated the effectiveness of four commonly used chemical disinfectants. The general objective was to assess the risk of nosocomial infections associated with the use of x-ray equipment and accessories.

The result of the study shows that x-ray equipment and accessories carry a considerable risk of harbouring nosocomial bacteria with about 47% culture isolates of bacteria from different points. This is comparable with Alvarado's [7] report that there is more than 40% nosocomial infection rate in sub-Saharan Africa. This could be attributed to poor hygiene practices as there exists no strict monitoring or control of hygiene level in the x-ray units selected for this study. In most of the units cleaning the equipment and accessories with water alone was considered an adequate measure. The result could also be due to advances into new and more invasive procedures in these units. The invasive nature of the

procedures and poor sanitary management of the instruments used are thought to be major contributing factors. The report of Wilde [8] indicates that every instrument used in the hospital has a risk of being a vector of nosocomial pathogens no matter where it is found.

The following bacterial pathogens were found on x-ray equipment and accessories in this study: *klebsiella spp*, *coliform*, *staphylococcus aureus* and coagulase-negative *staphylococcus epidermidis*. In a similar study in Canada, coagulase-negative *staphylococcus epidermidis*, *bacillus spp*, *micrococcus spp* and *staphylococcus aureus* were identified on 232 scissors sampled [2]. Coagulase-negative *staphylococcus epidermidis* and *staphylococcus aureus* are the bacteria identified in the previous and present studies. These bacteria are potentially harmful due to their high prevalence and they can invade the body through any open route or wound. Thus, surgical site infection can result from them. Also, trauma patients with open wounds or minor breached skin surfaces are at risk. *Klebsiella spp* was the most prevalent nosocomial bacteria identified in the study and appears to be spread by the radiographers' hands. It was found at all the places where radiographers make contacts with their hands such as tube head handles, exposure buttons, control panels, x-ray couch and x-ray cassettes. This result suggests that most infectious agents are spread by the hands of health care staff. The consistent manner in which *klebsiella spp* was found at all sites handled by radiographers calls to question their hand washing habits. In an ideal situation radiographers have to thoroughly scrub their hands after every patient and must use sterile gloves on each patient. The result suggests that adequate hand hygiene is not being practiced as has been noted by Levin ET AL, [9].

The x-ray cassettes were found to be the most frequently contaminated accessories as indicated by the results. This is in line with the report of a similar study in England which targeted x-ray cassettes used for mobile, accident and emergency and inpatient radiography [7]. The result of that study demonstrated large levels of growth of swab samples taken from cassettes and cultured in the microbiology laboratory. Coagulase-negative *staphylococcus*, *micrococci*, *diphtheriods* and species of *bacillus* were identified. The report noted that patient's skin is often in direct contact with the cassettes making them potential sources of nosocomial infections. Both patients and radiographers make direct contacts with x-ray cassettes and they may be vectors of bacteria which can invade the body through open routes, wounds or breached skin surfaces. The x-ray couch with the same contact characteristics as the cassettes come next with bacteria being found in 23 different swabs. *Klebsiella spp* and *coliform* were identified as the leading contaminants identified.

Chloroxylenol, dichloroxylenol, sodium hypochlorite and methylated spirit were the commonly used disinfectants in the units selected for the study. These chemicals were investigated for effectiveness and sodium hypochlorite was found to be the most effective with complete clearance of bacterial load after use. One may be tempted to suggest routine use of sodium hypochlorite on all x-ray equipment and accessories but this is hindered by the fact that chlorine attacks stainless steel and will be injurious to the stainless steel components. Methylated spirit was also effective with only 2.1% failure rate. The effectiveness of spirit is diminished if the disinfected surfaces were not cleaned first before its application. Articles to be disinfected must therefore be cleaned before they are disinfected because dirt diminishes the effectiveness of disinfectants and may even inactivate them [10]. Chloroxylenol and dichloroxylenol recorded equal failure rates of close to 5% but are nonetheless useful and suitable for most purposes.

The result of this study should be seen from the "all or none" law perspective. That is to say that if there was any degree of contamination, the unit carries a risk of nosocomial infection since the bacteria are constantly replicating. Any amount of microorganism is sufficient to cause infection. The x-ray units should therefore be bacteria-free and any presence of microorganisms represents a significant threat.

Recommendations: Based on the results of this study, we recommend the following measures should always be taken to minimize the risk of nosocomial infection in the radiology department:

- Dilute solution of sodium hypochlorite should be routinely used for disinfecting x-ray equipment and accessories, especially those without stainless steel components
- X-ray equipment and accessories should be properly disinfected immediately after use and before the next patient is attended to
- Radiographers should wash their hands after attending to a patient and before attending to the next patient
- Radiographers should use a pair of sterile latex or polythene gloves for each patient
- 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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