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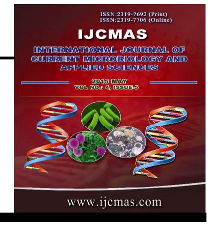


Original Research Article

Evidence of Cross Contamination of Ultrasound Equipment: A call for Infection Prevention Strategy in the Use of Diagnostic Tools

Stephen T. Odonkor[1]*, Theophilus Sackey[1] and Tahiru Mahami[2]

[1]Radiological and Medical Sciences Research Institute (RAMSRI) of the Ghana Atomic Energy Commission P. O. Box LG 80, Legon-Accra, Ghana
[2]Biotechnology and Nuclear Agriculture Research Institute (BNARI), of the Ghana Atomic Energy Commission P. O. Box LG 80, Legon-Accra, Ghana

**Corresponding author*

A B S T R A C T

These diagnostics equipment are used for diagnostic tests which provide objective information about a person's health, including risk assessment, monitoring the course of a disease or to assess a patient's response to treatments, or even to guide the selection of further tests and treatments. One of the most commonly used diagnostic equipment is the ultrasound. However Infections caused by diagnostic equipment as a result of cross contamination markedly threaten the security of patients, especially patients in intensive care units. With increasing use of ultrasound in medical diagnosis, there is also the potential for transmission of nosocomial infection via the ultrasound probe, ultrasound couch and also the coupling. The aim of this study was to evaluate the presence of pathogens on the ultrasound machines and couch/ bed. Microbiological cultures were carried out on samples obtained from ultrasound probes, gel and couch before and after scanning period. Cultures were incubated in a culture plate for 48 hours at a temperature of 37 ^{0}C in order to grow microorganism. The isolated microorganism were identified and characterized by conventional methods. The findings of the study showed that the Trans-abdominal ultrasound probes, - probe, and ultrasound couch were all contaminated with microorganisms. *Staphylococcus aureus* was the most frequent and most common organisms found (27%). This was followed by *Staphylococcus epidermidis* and *Candida albicans* both with 15.4% each. The least bacteria isolate (2) was *Enterococcus faecalis*, representing 7.7%. The following microbes: *Klebsiella pneumonia, Pseudomonas aeruginosa, Enterococcus faecalis* and *Candida albicans* were not isolated from the ultrasound couch/bed. Generally more microbes were isolated from the trans-abdominal probe (15) than the Trans-vaginal probe (8). In conclusion, Ultrasound equipment is a possible source of nosocomial infection for patient undergoing ultrasonography. There is a need to properly decontaminate the ultrasound probes and couch/bed, to avoid cross infections.

K e y w o r d s

Ultrasound, Nosocomial infection, Contamination, Ultrasound probe, Sterilization, Bacteria, Fungi

Introduction

Diagnostic equipment can be found every day in outpatient care centres, in emergency rooms and impatient rooms and intensive care units. These diagnostics equipment are used for diagnostic tests which provide objective information about a person's health, including risk assessment, monitoring the course of a disease or to assess a patient's response to treatments, or even to guide the selection of further tests and treatments. One of the most commonly used such diagnostic equipment is the ultrasound.

Ultrasound has been used to image the human body for over half a century (Edler and Lindstrom, 2004). Today, ultrasound (US) is one of the most widely used imaging technologies in medicine. It is portably free of radiation risk, and relatively inexpensive when compared with other imaging modalities, it is used to investigate organs such as the liver, heart, kidney or the abdomen. It is also useful in helping the surgeon when carrying out some types of biopsies

However Infections caused by diagnostic equipment as a result of cross contamination markedly threaten the health of patients, especially patients in intensive care units. Surveillance studies, has shown that contaminated medical devices can act as a source of hospital infections (Guinto et al., 2002). In addition to devices used in invasive interventions, such as ventilator and catheter, the equipment commonly used in the hospital, such as sphygmomanometers, thermometer and stethoscope bear a high risk of transmitting nosocomial infection from patient to patient (Zachary et al., 2001).

Nosocomial infections are one of the leading causes of death (Ponce-de-Leon, 1991) with considerable economic costs (Plowman et al., 1999). The increased length of hospitalization for infected patients is the greatest contributor to cost (Pittet et al., 1994; Kirkland et al., 1990; Wakefield et al., 1998). Coella et al. (1993) observed an overall increase in the duration of hospitalization for patients with surgical wound infections to be 8.2 days, ranging from 3 days for gynaecology to 9.9 for general surgery and 19.8 for orthopaedic surgery. Prolonged stay not only increases direct costs to patients or payers but also indirect costs due to loss of work hours. The increased use of drugs, the need for isolation, and the use of additional laboratory and other diagnostic studies also contribute to costs.

The increase use of invasive procedures predisposes more patients to a higher risk of acquiring nosocomial infections. These infections are commonly acquitted when health care workers become complacent and specific hygienic practices are neglected. Nosocomial infections have become an increasingly recognized problem and medical devices such as ultrasound equipment can be one of the vehicles for the spread of these infections. Ultrasound equipment have been the subject of several studies to determine its role in cross-infection as these devices comes into direct contact with patients and sonographers during scanning procedures. With increasing use of ultrasound in medical diagnosis, there is the potential for transmission of nosocomial infection via the ultrasound probe, ultrasound couch and also the coupling gel. Whenever any part of ultrasound equipment is contaminated, be it the transducer or the coupling gel, there is a risk of cross-contamination from the equipment to the patient. This study aimed at evaluating the presence of bacterial pathogens on the on the ultrasound machines and couch/ bed.

Materials and Methods

Study area and sample size

This study was carried out in two ultrasound centers in Accra. A total of 40 swab samples were aseptically collected using sterile swab sticks from ultrasound probes and couches from 2 different diagnostic ultrasound centers in Accra selected at random. Swabs were collected aseptically from the surface of ultrasound probes and couches before and after scanning periods. The swabs were labeled appropriately and were taken to the laboratory immediately for culture. Figure 1 shows a picture of one of the ultrasound machines from which swab samples was taken.

Media preparation and inoculation

All culture media were prepared according to the manufacturer's instructions. For example MacConkey agar was prepared by dissolving 25 grams of MacConkey agar (powder) into 1/2 litre of deionized water and allowed to soak for 10 minutes. The mixture is mixed by swirling and sterilized by autoclaving for 15 minutes at 1210C. The media was then poured into Petri-dishes after allowing cooling to 47^{0}C. The media was then tested for sterility before inoculation of samples. The same procedure was followed for all other meida. The swab samples were cultured aseptically on a broad range of media including (MacConkey agar, Blood agar, Chocolate agar and Sabourad agar) to ensure the growth and isolation of most commonly encountered bacteria and fungi. Bacterial cultures were then incubated at 37^{o}C for 48 hours while fungi cultures were incubated at 28°C for 5 days (Monica, 2000) in order to grow microorganism. A combination of conventional methods and API were then used to identify bacterial isolates whiles fungi were identified by comparing microscopic and macroscopic features with standard keys.

Table 1 shows the number of microorganisms isolated from two ultrasound facilities. Out of the 40 samples, 24 samples were collected from facility A and 16 samples from facility B. Sixteen (16) representing 61.5% isolates were obtained from the 24 samples collected from facility A, whereas 38.5% isolates were obtained from the 16 samples collected from facility B.

Figure 2 shows the percentage distribution of organisms isolated before and after scanning within the facilities. Out of the total number of isolates obtained from samples collected in facility A, 56.2% were obtained before scanning whereas 43.8% were obtained after scanning. Conversely, in facility B, 40% of the isolates were obtained before scanning whereas 60% of isolates were obtained after scanning. This shows that Contrary to Facility A, there were more isolates obtained after scanning than before scanning from samples collected in facility B.

Figure 3 shows the distribution of gram positive bacteria isolates found on the trans-abdominal probe, trans-vaginal probe and ultrasound bed/couch. Eight of the gram positive bacteria isolates were found on trans-abdominal probe, 5 were found on trans-vaginal probe and 3 were found on ultrasound bed/couch. Although there were more gram positive isolates on the trans-abdominal probe than there were on trans-vaginal probe, the error bars indicates that there is no significant difference between gram positive bacteria isolates found on the trans-abdominal probe and trans-vaginal probe. Likewise, the error bars show no significant difference between gram positive bacteria isolates found on trans-vaginal probe and ultrasound bed/couch though more gram positive bacteria isolates were found on the trans-vaginal probe. However, there was a significant difference between isolates found on trans-abdominal probe and isolates found on ultrasound bed/couch.

Figure 4 shows the distribution of gram negative bacteria isolates found on the trans-abdominal probe, trans-vaginal probe and ultrasound bed/couch. Five (5) of the gram negative bacteria isolates were found on trans-abdominal probe, 4 were found on trans vaginal probe and 1 was found on ultrasound bed/couch. Although there were more gram negative bacteria isolates found on the trans abdominal probe than there were on trans vaginal probe, the error bars indicates that there is no significant difference between gram negative bacteria isolates found on the trans abdominal probe and trans vaginal probe. The error bars however, show a significant difference between gram negative bacteria isolates found on trans-vaginal probe and ultrasound bed/couch. Similarly, the error bars show a significant difference between gram negative bacteria isolates found on trans-abdominal probe and that which was found on ultrasound bed/couch.

Table 2 shows the microorganisms isolated from the ultrasound probes and couch from the two different ultrasound centers. Seven (7) Microorganisms were isolated in all. Six of the microorganisms (*Staphylococcus aureus, Staphylococcus epidermidis, Klebsiella pneumonia, Pseudomonas aeruginosa*, *E. coli* and *Enterococcus faecalis*) isolated were bacteria. Whiles *Candida albicans* was the only fungi isolated. The highest number (7) of microbes isolated was *Staphylococcus aureus.* This was followed by *Staphylococcus epidermidis* and *Candida albicans* both with 15.4% each. The least bacteria isolated (2) was *Enterococcus faecalis,* representing 7.7%. The following microbes: *Klebseilla pneumonia, Pseudomonas aeruginosa, Enterococcus faecalis* and *Candida albicans* were not isolated from the Ultrasound couch/bed. Generally more microbes were isolated from the trans-abodomianl probe (15) than the Trans-vaginal probe (8)

Figure 5 shows the percentage distribution of coliform bacteria and non-coliform bacteria. Out of the total bacteria isolates, there were 43.5% coliform bacteria and 56.5% non-coliform bacteria. This shows that there were more non coliform bacteria than coliform bacteria.

Figure 6 shows the percentage distribution of bacteria and fungi isolated. Out of the total number of microbes, 88.5% were bacteria whereas 11.5% were fungi. These shows there were more bacteria found than fungi.

The findings of this study indicate the presence of both bacteria and fungi on the trans-abdominal probe, trans-vaginal probe, and ultrasound couch/bed. Almost all of the microorganisms isolated, were of medical importance these included: *Klebseilla pneumonia*, *Pseudomonas aeruginosa*, *E. coli* and *Enterococcus faecalis* and *Candida albican*. Although *Staphylococcus epidermidis,* is considered a normal flora of the body, it is capable of causing diseases in the immunocompromised and neonates. The highest number (7) of microbes isolated was *Staphylococcus aureus* representing 27% of the total isolates. This is in agreement with a study conducted by (Ohara et al., 1999) who revealed high level of contamination of ultrasound equipment (39%) with staphylococcus aureus, as well as Akpochafor *et al*. (2014) who also observed a 33.8% contamination of ultrasound probes with *Staphylococcus aureus*. The most probable reason for having *Staphylococcus aureus* as the most commonly isolated organisms is because *Staphylococcus aureus* form part of the skin's natural flora and is found in up to 40% of healthy people (Nester et al., 2004). *Staphylococcus aureus* have been known to cause a range of illness from minor skin infection such as pimples, impetigo, boils (furuncle), cellulitis, scalded skin syndrome, abscesses, etc to life threatening diseases such as pneumonia, meningitis, pelvic inflammatory disease (PID) among others. It is worth noting that *Staphylococcus aureus* is still among the top five major nosocomial infections (Nester et al., 2004). The second highest occurring microorganism isolated were *Staphylococcus epidermidis* and *Candida albicans* both with 15.4% occurrences. The occurrences of *Staphylococcus epidermidis* is in line with the findings of (Abdullah, 1998) in a similar study. S*taphylococcus epidermidis* has been recognized as a major infection associated with prosthetic joints and the urinary tract, particularly in the immunocompromised. The most commonly contaminated ultrasound equipment was trans-abdominal probe which had the highest number (15). This phenomenon was also observed by Mirza et al. (2007), who noted a high level of bacterial count on a trans-abdominal probe due to patient's body contact. Similarly Ohara et al. (1999), discovered the transmission of bacterial from patient's skin to the ultrasound probe and the most significant organisms been *Staphylococcus aureus* and *Peudomonas aeruginosa*. In this present study, the second highest occurring microorganism isolated were *Staphylococcus epidermidis* and *Candida albicans* both with 15.4% occurrences. This present study also observed the presence of *Pseudomonas aeruginosa*. Spencer (1988) also reported that trans-abdominal probe, if cultured after routine scanning of intact skin, may become colonized with skin flora in up to 30% of cases. Trans-abdominal probe is the most frequently used probe for abdominal and pelvic ultrasonography and therefore harbours microorganisms from patient's skin. Ultrasound couch was contaminated with significant organisms as shown in Table 2. The reason for the contamination could be because the couch was not cleaned before and after scanning periods with a compatible disinfectant or that the decontamination procedure may have been ineffective. In conclusion ultrasound equipment has been shown to be a possible source of nosocomial infection for patients undergoing ultrasonography in this study. There is therefore the need for adequate sterilization procedures to be carried on before and after every scanning session.. There is also the need for new strategies and policy directions to curb cross contaminations of diagnostic equipment.

Table.1 No. of Microorganisms isolated from two ultrasound centers

Ultrasound facility	Total number of samples taken	No of isolates obtained (%)
A	24	16 (61.5%)
B	16	10 (38.5%)
Total	40	26 (100%)

Table.2 Organisms isolated and corresponding sites

Isolated Organism	Site of Sample			Total No. (%)
	Trans-Abdominal probe	Trans-Vaginal Probe	Ultrasound Bed/Couch	
Staphylococcus aureus	4	2	1	7(27%)
Staphylococcus epidermidis	3	0	1	4(15.4%)
Klebsiella pneumonia	2	1	0	3(11.5%)
Pseudomonas aeruginosa	1	2	0	3(11.5%)
E. coli	2	1	1	4(15.4%)
Candida albicans	2	1	0	3(11.5%)
Enterococcus faecalis	1	1	0	2(7.7%)

Figure.1 An ultrasound machine from which samples were collected

Figure.2 Percentage distribution of organisms isolated before and after Scanning within facilities

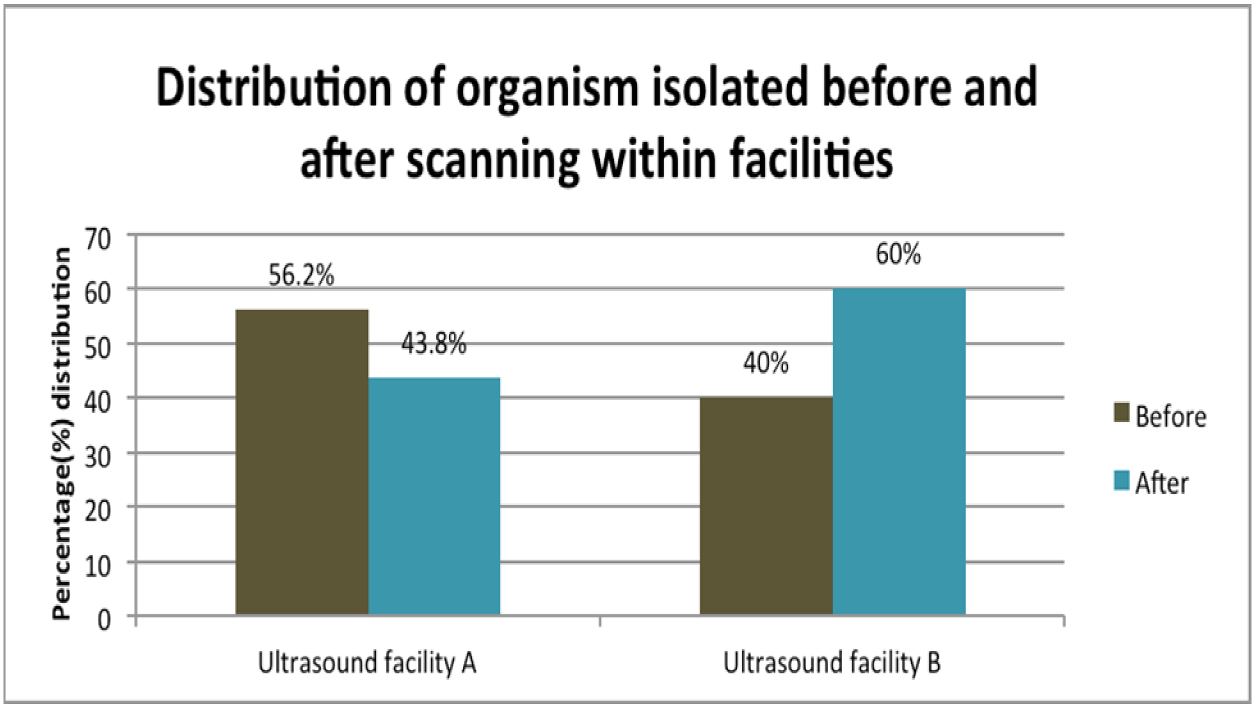


Figure.3 A graph showing the distribution of gram positive bacteria

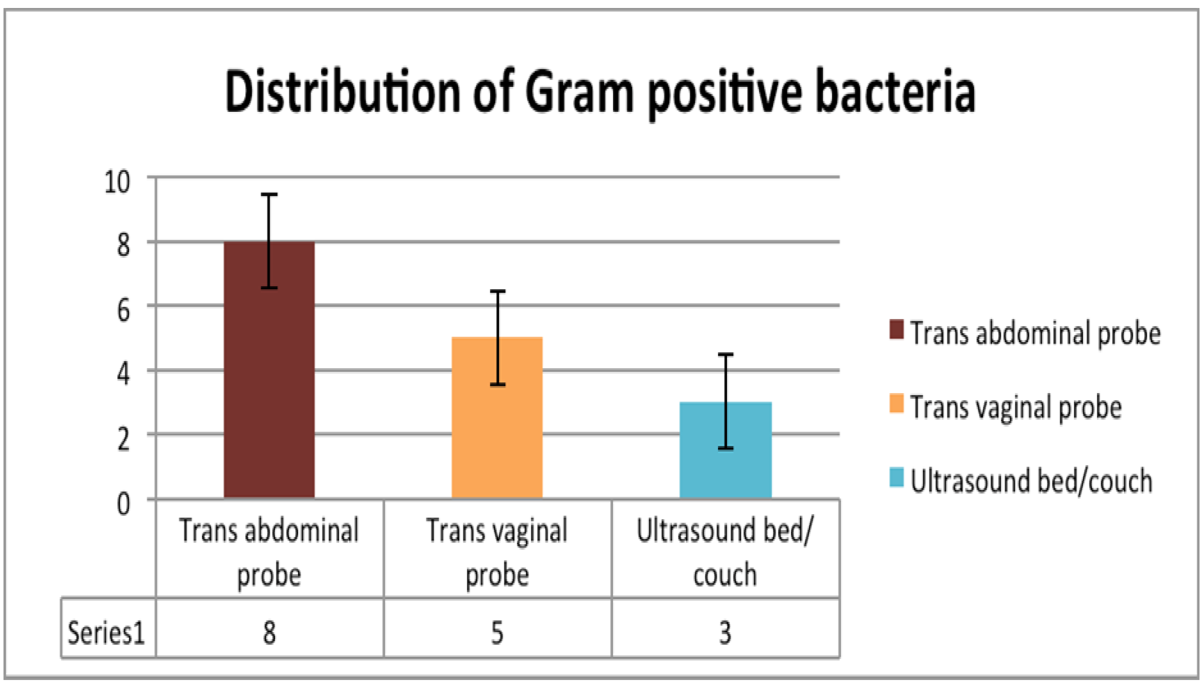


Figure.4 A graph showing the distribution of gram negative bacteria

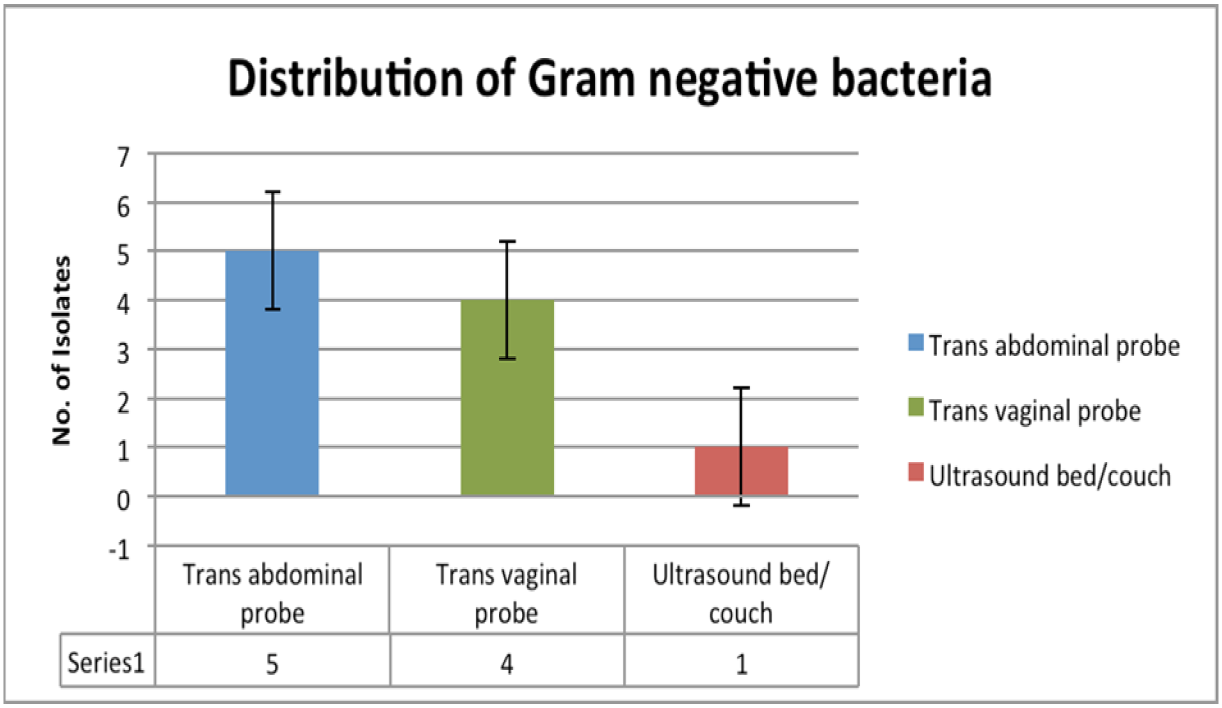


Figure.5 Percentage Distribution of Coliform bacteria and Non Coliform bacteria

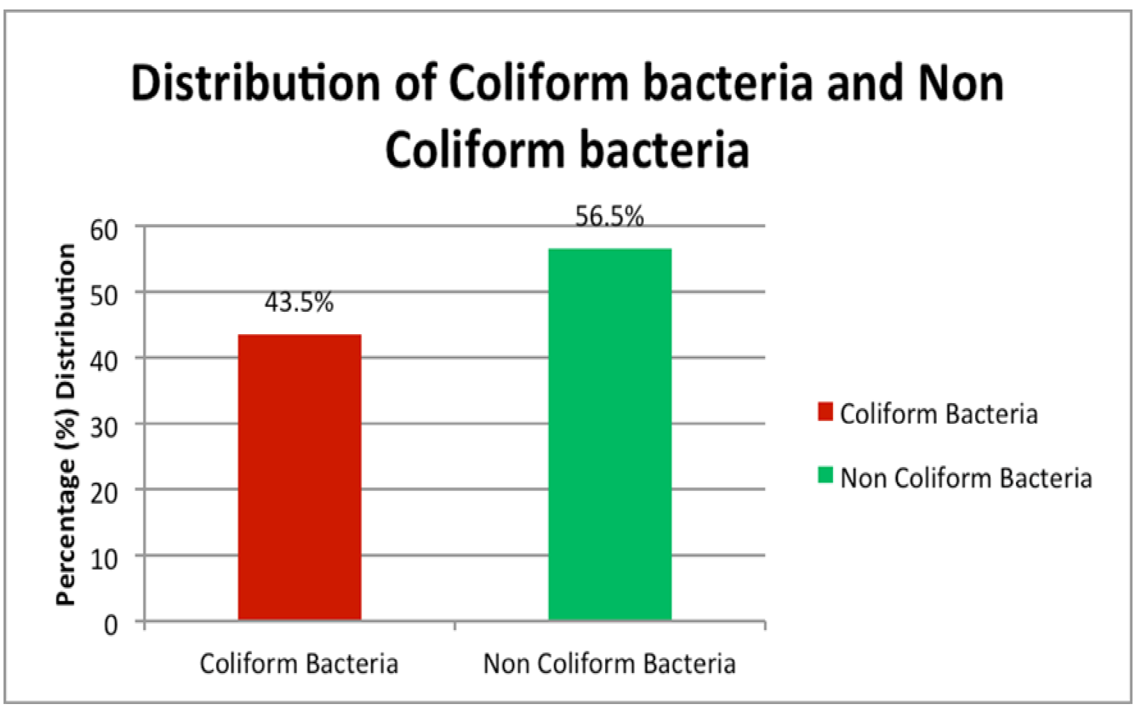
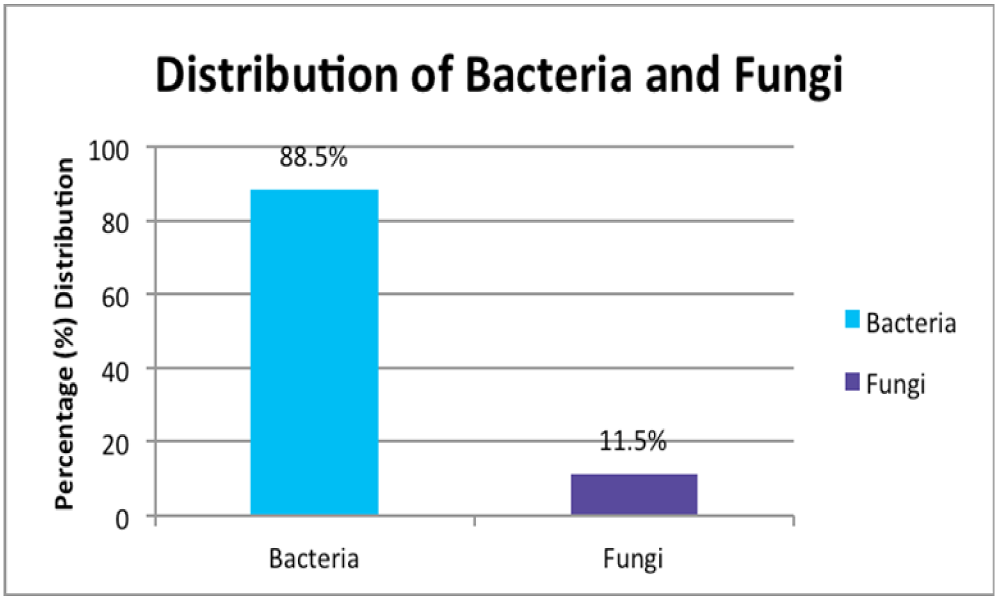


Figure.6 Percentage distribution of bacteria and fungi



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