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Assessment of Ultrasound Equipment as a Possible Source of Nosocomial Infection in Lagos State Hospitals and Radio-Diagnostic Centres

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Abstract
AIM: *To assess the role of ultrasound equipment as a possible source of nosocomial infections in Lagos State Hospitals and diagnostic centres and to identify the types of Microorganisms found in the equipment.*
METHODS : *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 (Chocolate and MacConkey agar) for 48 hours at a temperature of 37^0 in order to grow microorganism, after which the culture plate was examined microscopically against a bright light in order to identify the isolated organisms based on their colonial characteristics.*
RESULTS :*Transabdominal ultrasound probes, transvaginal probe, ultrasound couch and ultrasound gel all were contaminated with microorganisms. Staphylococcus aureus was the most frequent and most common organisms found (33.8%). Other organisms such as Staphylococcus epidermidis (15.4%), Candida albicans (6.2%), aerobic spore formers (26.2%), Klebsiella pneumonia (6.2%), Pseudomonasaeruginosa (3.1%), among others were also identified.*
CONCLUSION :*Ultrasound equipment is a possible source of nosocomial infection for patient undergoing ultrasonography. The most commonly isolated bacterial were staphylococcus aureus, Staphylococusepidermidis, Aerobic spore formers, among others according to this research.*
KEYWORDS: *Ultrasound, Nosocomial infection, Contamination, ultrasound transducer and coupling gel, chemical sterilization , droplets, vermin-D, Aseptic, Culture media, MaCconkey agar and chocolate agar.*

I. Introduction

Nosocomial Infections also called hospital acquired infection are infections which a patient develops during hospitalization which was not present or incubating at the time of their admission. It is an infection that first appears between 48hours and 72 hours after a patient is admitted to a hospital or a health care facility (Encyclopedia of surgery, 2008,Damani, 1997). Those infections incubating but not clinically apparent at admission are not considered as nosocomial infection. With recent changes in health care delivery, the concept of nosocomial infections has sometimes been expanded to include healthcare-associated infections including infections acquired in institution other than health-care facilities (http://:www.wikipedia.org. 2010).Studies shows that at least 50% of patient became infected during hospitalization. (WHO 2010) With the increased use of invasive procedures, at least 80% of patient now acquires 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. The Common nosocomial infections are:

- staphylococcus aureus
- Influenza
- Hepatitis A, B and C
- Herpex simplex
- Human Immuno-deficiency virus (HIV)
- Urinary tract infections, among others.

The following are some of the causes of nosocomial infection

- Non-cleaning of health care facilities before use

- Non-disinfecting of contaminated equipment
- Non-sterilization of heat sensitive items in chemical sterilization.
- Movement of Medical staff from patient to patient unprotected, there by acting as a host for spread of pathogens.
- Many medical procedure by pass the body's immune system among other factors.

Routes of Transmission of Nosocomial Infection

Microorganisms are transmitted in hospitals by several routes and the same microorganism may be transmitted by more than one route. There are five main routes of transmission which are:

II. Contact Transmission

This is the most important and frequent mode of contact transmission and is divided into two groups:

a. DIRECT CONTACT TRANSMISSION

Involves a direct body surface to body surface contact and physical transfer of micro-organisms between a susceptible host and an infected or colonized person. This occurs when a medicalpersonnelcarrya immobile patient for clean up or performs other care activities that require direct personal contact. Direct contact transmission also can occur between two patients, with one serving as the source of the infecting micro-organisms and the other as a susceptible host.

b. INDIRECT – CONTACT TRANSMISSION

Involves contact of a susceptible host with a contaminated intermediate object; These are inanimate materials such as: contaminated instruments, needles, dressings and contaminated gloves. Additionally, the improper use of saline flush syringes, vials and bags have been implicated in disease transmission in the ultrasound procedures despite healthcare access to gloves, disposable needles, intravenous devices and flushes (Jain et al., 2002).

DROPLET TRANSMISSION

It occurs when droplets are generated from the source person mainly during coughing, sneezing, talking and during the performance of certain procedures such as bronchospy. Transmission occurs when droplets containing germ from the infected person are propelled at a short distance through the air and deposited on the host's body.

AIRBORNE TRANSMISSION

It occurs by dissemination of either air borne droplet nuclei or dust particles containing the infections agent. Microorganisms carried in this manner can be dispersed widely by air currents and may become inhaled by susceptible host within the same room or over a longer distance from source patient. The arrangement of the facility movement ventilation matters alot, special air handling and ventilation are required to prevent air borne transmission. Microorganisms transmitted by airborne transmission include: legionella, mycobacterium tuberculosis and varicella viruses.

COMMON VEHICLE TRANSMISSION

Applies to microorganisms transmitted to the host by contaminated items such as food, water, medical devices and equipment.

VECTOR BORNE TRANSMISSION

Occurs when vectors such as rats, flies, mosquitoes and other vermin transmits micro-organisms.

IMPACT OF NOSOMOMIAL INFECTIONS

Nosocomial infections add to functional disability, emotional stress and may in some cases lead to disabling conditions that reduces the quality of life. In addition, nosocomial infections have now become one of the leading causes of death (Ponce-de-leon, 1991). The impact of nosocomial infections takes on even more significance in resource-poor-countries, especially those affected mostly by HIV/AIDS because recent findings strongly suggest that unsafe medical care may be an important factor in transmitting HIV (Gisselquist et al, 2002). During the past 10-20 years little progress has been made in addressing the basic problems responsible for the increasing rates of nosocomial infections in many countries and in some countries, conditions are actually worsening (Gisselquist et al, 2002). Nosocomial infections increase the cost of healthcare in the countries with low healthcare budget through increased length of hospitalization, treatment with expensive medication (e.g. Antiretroviral drugs for HIV/AIDS and antibiotic) and use of other services (e.g. Laboratory test, ultrasound services X rays and transfusions). As a consequence, in resource poor countries, efforts to

prevent nosocomial infections must assume even greater importance if progress is to be made in improving the quality of patient care in hospitals and other health care facilities.

PREVENTING AND CONTROLLING OF NOSOCOMIAL INFECTIONS

Most of these infections can be prevented with readily available, relatively in expensive strategies (EbbinLeutenbach, 2006)by:

- Adhering to recommend infection prevention practices especially hand hygiene and wearing of gloves.
- Paying attention to well-established processes for decontamination and cleaning of soiled instruments and other items followed by either sterilization or high level of disinfection
- Improving safety in operating rooms and other high risk areas where the most serious and frequent injuries and exposures to infections agents occur.

Unfortunately, not all nosocomial infections are preventive. For example, some reflect the influence of advantage age, chronic disease such as uncontrolled diabetes, end-stage kidney disease of advanced age, chronic disease such as advanced pulmonary emphysema, severe malnutrition, treatment with certain drugs (e.g. antimicrobials, corticosteroids and other agents that disease immunity), the increasing impact of AIDS (e.g. opportunistic infections) and irradiation (infection prevention Guideline, 2002).

Since nosocomial infection have been cited(Kartaginer, et al., 1997, Bello et al., 2004, Kepple et al., 1996) as an increasing problem in hospitals and medical diagnostic centres, the role of ultrasound equipment as a possible source of nosocomial infection have not been investigated in Lagos State hospitals and hence, the need for this study.

III. Material And Method

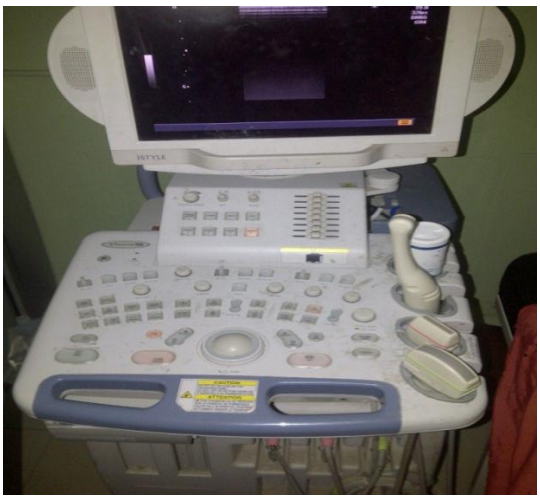
STUDY AREA

This study were carried out in three radio- diagnostic center in Lagos state namely LUTH Idi-araba, Life channel diagnostic centreFagbaIju and Esteem medical diagnostic services limited Ebute-Meta Lagos.

SAMPLE SIZE

A total of 36 swab samples were aseptically collected using a sterile swab sticks from ultrasound probes, couches and coupling gel from 3 different radio- diagnosticcentres in Lagos state selected at random.Swabs were collected aseptically from the surface of ultrasound probes and couches before and after scanning periods. Swabs were taken immediately after scanning a patient and in the middle of the scanning period. The swabs were labeled appropriate and were taken to the laboratory immediately for culture on MacConkey and chocolate agar for isolation of pathogens. Figure 1 shows the ultrasound machine from where samples were collected.

FIGURE 1: shows a Doppler Ultrasound machine consisting of all relevant probes



PREPARATION OF CULTURAL MEDIA

All culture (MacConkey and chocolate agar) were prepared according to the manufacturer's instructions (Biotec Product, 2012).

MacCONKEY AGAR PREPARATION AND INNOCULATION

MacConkey agar is differential agar: A 50 grams of MacConkey agar (powder) was added to 1 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 121^0C. The media is poured into the petri-dishes after allowing cooling to 47^0 C, the culture plate is covered and allowed to set before inoculation of samples.

CHOCOLATE AGAR PREPARATION AND INNOCULATION

Chocolate agar is both an enriched and differential agar: 20 grams of chocolate agar (powder) was added to 1 liter of deionized waterand allowed to soak for 10 minutes. The mixture is mixed by autoclaving for 15min at 121^0C. The media is poured into the petri-dishes after allowing to cool to 47^0C, the culture plate is covered and allowed to set before inoculation of samples.

INNOCULATION, INCUBATION AND CULTURE READING (BACTERIAL CULTURE)

The swab samples were cultured aseptically on a highly nutritious non- selective media (chocolate and MacConkey agar) designed to support the growth of most commonly encountered bacteria and fungi. Cultures were then incubated in this culture plate at a temperature of 37^oc for48 hours (Monica 2000) in order to grow microorganism after which the culture plate was examined macroscopically against a bright light in order to grow microorganism.The culture plate was also examinedmacroscopically against a bright light in order to identify the isolated organisms based on their colonial characteristics using a light microscope shown in figure 3 below. Figure 2 shows the incubator machine used in incubating the organisms.

FIGURE 2: shows the incubator used for this process

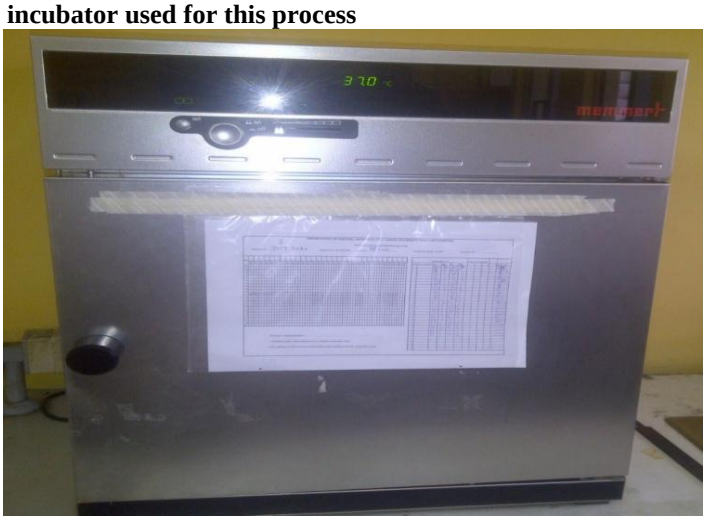
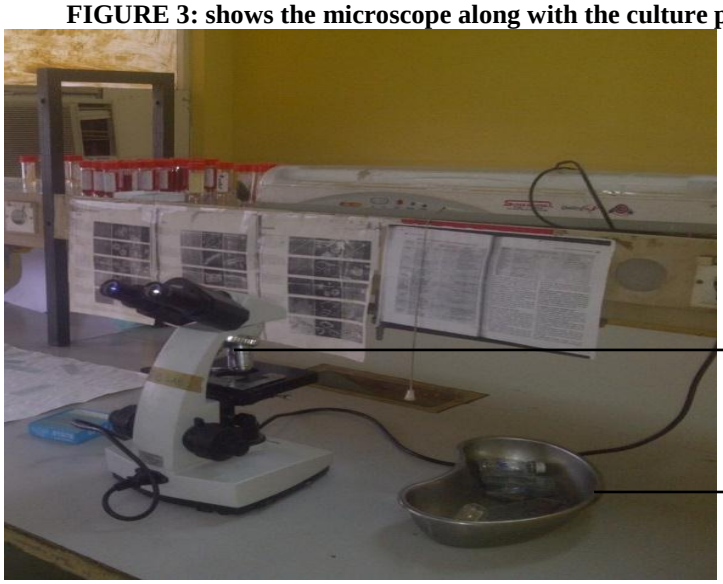


FIGURE 3: shows the microscope along with the culture plate used in examining the organism.



The data was analyzed using statistical package for social science (SPSS) version 14.0 software. Inferential statistic was applied in determining the frequency of occurrence. Chi- square test was applied to test the

significant of site of collection and the type of organism isolated as well as time of collection and growth density.

IV. Results

Table 1a: The relationship between site of collection and isolate (organisms).

Isolated Organism	**Site of collection**							
	Trans-abdominal probe		**Trans-vaginal probe**		**Ultrasound couch**		**Ultrasound Gel**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
No growth	2	7.7.*	0	0.0	1	5.3	9	0.0
Aerobic spore formers	6	23.1	3	23.1	6	31.4	2	28.6
Staph aureus	12	46.2	2	15.4	3	15.8	4	57.1
Staph epidemis	4	15.4	3	23.1	3	15.8	0	0.0
Coliform	0	0.0	1	7.6	1	5.3	0	0.0
Kleb pneumonia	0	0.0	2	15.4	2	10.5	0	0.0
Candida albicans	1	3.8	2	15.4	2	10.5	0	0.0
CladosporumSpp	0	0.0	0	0.0	1	5.3	0	0.0
Pseudomonas	1	3.8	0	0.0	0	0.0	7	14.3
Total	26	100.0	13	100.0	19	100.0	22	100.0

Table 1b: Chi square Tests

	Value	**Df**	**P-value**
Pearson	23.363	24	.498
N of valid cases	65		

Table 1a shows the relationship between the site collection and the isolated organisms. Transabdominal probe and ultrasound gel harbors the highest percentage of staphylococcus aureus 46.2% (n=12) and 57.1% (n=4) respectively, the ultrasound couch has the highest percentage of aerobic spore formers 31.4% (n=6).

Table 2a: The relationship between site of collection and growth density

Growth density	**Site of collection**							
	Trans-abdominal probe		**Trans-vaginal probe**		**Ultrasound couch**		**Ultrasound Gel**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**
No growth	2	7.6	0	0.0	1	5.6	0	0.0
Scanty growth	8	30.8	8	61.5	13	72.2	2	28.6
Moderate growth	8	30.0	5	38.5	4	22.2	4	57.1
Heavy growth	8	30.8	0	0.0	0	0.0	1	14.3
Total	26	100.0	13	100.0	18	100.0	7	100.0

Table 2b: Chi-square Tests

	Value	**Df**	**P-value**
Pearson	17.834	9	.037
N of valid cases	64		

Table 2a shows the relationship between the site of collection and growth density. Transabdominal probe had growth density of 30.8% (n=8) in all. Transvaginal probe had scanty growth of 61.5% (n=8). From the ultrasound couch, 72.2% (n=13) of the samples had scanty growth, while 22.2% (n=4) had moderate growth, there was no heavy growth seen on transvaginal probe

Table 3a: The relationship between time of collection and isolated organisms

Isolated organism	**Time of collection**			
	Before Scanning		**After scanning**	
	n	**%**	**n**	**%**
No growth	2	7.1	1	3.3
Aerobic spore formers	8	28.6	7	23.3
Staph aureus	8	28.6	10	33.3
Staph Epidermidis	7	10.7	7	23.5
Coliform	2	7.1	0	0.0
Kleb pneumonia	1	3.6	3	10.0
Candida	3	10.7	1	3.3
CladosporumSpp	1	3.6	0	0.0
Pseudomonas Aeruginosa	0	0.0	1	3.3
Total	**28**	**100.0**	**30**	**100.0**

Table 3b: Chi square Tests

	Value	**Df**	**P-value**
Pearson	8.164	8	418
N of valid cases	58		

Table 3a shows the profile of time of collection and the isolated organisms. The percentage of some of the organisms isolated after scanning period was higher than that isolated before scanning period.

Table 4a: The relationship between time of collection and growth density

Isolated organism	**Time of collection**			
	Before Scanning		**After scanning**	
	n	**%**	**n**	**%**
No growth	2	7.4	1	3.3
Scanty growth	20	74.1	9	30.0
Moderate growth	518.5		8	26.7
Heavy growth	0	0.0	12	40.0
Total	27	100.0	30	100.0

Table 4b: Chi square Tests

	Value	**Df**	**P-value**
Pearson	15.273	3	.002
N of valid cases	57		

Table 4a shows the relationship between time of collection and growth density. The percentage of heavy and moderate growth of organisms after scanning periods was quite higher than before scanning periods, while that of the scanty growth was higher before scanning than after scanning periods. 40.0% (n=12) were heavy growth, 26.7% (n=8) were moderate growth, 30.0%(n=9) were scanty growth and 3.3% (n=1) of the sample were no growth after scanning period, while before scanning periods, the percentage of scanty growth was 74.1% (n=20), moderate growth was 18.5% (n=5), there was no heavy growth seen and 7.4% (n=2) had no growth as was shown in the table. The time of collection of the sample plays a significant role (p-0.002) in determining the density of organisms found and the growth density.

Table 5: Relationship between isolated organism and the frequency of occurrence of organisms.

Organisms isolated	**Frequency of occurrence**	
	n	**%**
No growth	3	4.6
Aerobic spore formers	17	26.2
Staph aureus	22	33.8
Staph Epidermidis	10	15.4
Coliform	2	3.1
Klebsiella pneumonia	4	6.2
Candida albicans	4	6.2
Cladosporum spp.	1	1.5
Pseudomonas Aeruginosa	2	3.1
Total	65	100.0

Table 5 shows the profile of the organisms isolated and the frequency of occurrence of these microorganisms. In this table the frequency of occurrence of staphylococcus aureus was the highest 33.8% (n=22). This is because it is the most common organisms found on the human skin. Aerobic spore formers was 26.2% (n=17), staphylococcus epidermis had the percentage of 15.4 %(n=10) of the sample, while coliform had 3.1% (n=2), candida albicans had 6.2.% (n=4), while cladosporum spp. Was 1.5% (n=1), pseudomonas aeruginosa 3.1% (n=2) and 4.6% (n=3) were no growth as shown in the bale.

V. Discussion And Conclusion

The results of this study have shown that a number of organisms were found on the transabdominal probe, transvaginal probe, ultrasound couch and the ultrasound gel. These organisms isolated were aerobic spore formers, staphylococcus aureus, staphylococcus epidermidis, coliform,klebsiella pneumonia,. Candida albicans, cladosporum spp. and pseudomonas aeruginosa.From the study, staphylococcus aureus was the most commonly isolated organisms 33.8% (n=22) from the ultrasound equipment as shown in table 5. This is theline with Ohara et al., (Ohara et al., 1999) who revealed high level of contamination of ultrasound equipment (39%) with staphylococcus aureus. The most probable reason for having staphylococcusaureus 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),

osteomyelitis, endocarditis, sepsis, among others. It is still one of the five major causes of nosocomial infection (Nester et al., 2004). Staphylococcus epidermidis (23.1%) was also common isolated in the swabbed samples. This is similar to the findings of Abdullah (Abdullah, 1998) who found a 23.5% incidence of staphylococcus epidermidis in the ultrasound gel which has been recognized as a major infection associated with prosthetic joints and the urinary tract. Aerobic spore former was also commonly isolated (31.4%). This is also an environmental organisms. These isolated organisms were not highly pathogenic but could cause nosocomial infections if conditions were favorable in the susceptible patient. The most commonly contaminated ultrasound equipment was transabdominal probe which had the highest percentage of heavy growth of organisms like staphylococcus aureus (30.7%) as shown in table 2. This is in line with Mirza et al (Mirza et al., 2007) who noted a high level of bacterial count on a transabdominal probe due to patient's body contact. Ohara et al (Ohara et al.,1998) also discovered the transmission of bacterial from patient's skin to the ultrasound probe and the most significant organisms was staphylococcus aureus and pseudomonas aeruginosa. Spencer et al (Spencer et al.,1998) also reported that transabdominal probe, if cultured after routine scanning of intact skin, may become colonized with skin flora in up to 30% of cases. Transabdominalprobe is the most frequently used probe for abdominal and pelvic ultrasonography and therefore harbours microorganisms from patient's skin. There was a statistically significance between site of collection of sample and growth density (p=0.03). There was no statistical significance between time of collection and isolated organisms.

Ultrasound gel was also contaminated with organisms like staphylococcus aureus 57.1% (n=4), aerobic spore formers 28.6% (n=2) pseudomonas aeruginosa 14.3% as shown in table. Its heaviest contamination was with staphylococcus aureus. This shows that ultrasound gel might be a possible vehicle for the spread of nosocomial infection. This is in line with Fowler et al (Fowler et al., 1999) who detected staphylococcus contamination of ultrasound gel and noted that the gel was often not removed or the equipment cleaned prior to subsequent patient's examination. Hutchinson et al (Hutchinson et al.,2004) also reported that ultrasound gel is a potential source of infection. Ultrasound couch was contaminated with significant organisms as shown in table 1 and 2.

The reason for the contamination could be because the couch was not cleaned before and after scanning periods with a compatible disinfectant (e.g.70% alcohol) or that the decontamination protocols was sometimes poor. Transvaginal probes was also contaminated with some relevant microorganisms such as candida albicans, staphylococcus aureus etc. The probable reasons for this contamination was also because the probe was not decontaminated with a compatible disinfectant such as 70% alcohol before and after scanning a patient or that the decontamination protocols was sometimes poor.

The results of this study have shown that ultrasound equipment were contaminated with different microorganisms. The most frequently found organisms were staphylococcus aureus, staphylococcus epidermidis, aerobic spore formers, klebsiella pneumonia among others.

There was no relationship between site of collection and organisms found as shown by the chi-square analysis (p=.498). Site of collection played a significant role in growth density as shown by the chi-square analysis(p=0.03). There was also no relationship between time of collection and isolated organism (p=.418). Time of collection played a significant role in determining the growth density or organisms found (p=.0021).

Ultrasound equipment has been shown to be a possible source of nosocomial infection for patient undergoing ultrasonography in this report. The most commonly isolated bacteria were staphylococcus aureus, staphylococcus epidermidis, aerobic spore formers, among others. This is because this equipment comes into direct contact with the skin of the patients and sonographers during scanning procedures, enabling it to be a potential factor for the spread of nosocomial infection.

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