MANAGEMENT OF SOLID HEALTHCARE WASTE IN THE FEDERAL CAPITAL TERRITORY: A CASE STUDY OF UNIVERSITY OF ABUJA TEACHING HOSPITAL

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M.TECH/ SSSE/2005/1399

DEPARTMENT OF GEOGRAPHY

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

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A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF TECHNOLOGY (M.TECH) IN GEOGRAPHY WITH ENVIRONMENTAL MANAGEMENT (POLLUTION AND WASTE MANAGEMENT)

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DECLARATION

I, Sanni, Olukayode Daud declare that this dissertation entitled "Management of Solid Healthcare Waste in the Federal Capital Territory: A Case Study of University of Abuja Teaching Hospital" is a record of my own research. It has not been presented any where for higher degree or any other purpose. All sources of information used have been dully acknowledged.

Sanni, Olukayode Daud
(M. Tech/SSSE/2005/1399)

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Signature & Date

CERTIFICATION

This thesis titled: "MANAGEMENT OF SOLID HEALTHCARE WASTE IN THE FEDERAL CAPITAL TERRITORY: A CASE STUDY OF UNIVERSITY OF ABUJA TEACHING HOSPITAL" by: Sanni, Olukayode Daud (M.Tech/SSSE/2005/1399) meets the regulations governing the award of the degree of M.Tech of Federal University of Technology, Minna and is approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

This project is dedicated to my wife Naseerah and my children Abdu-s-Samad, Aliyyah and Ahmad.

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ABSTRACT

The increase in number of hospitals and variety of medical services have led to rapid increase in the generation rate of potentially infectious solid healthcare waste. A study was conducted on solid healthcare waste management practices in University of Abuja Teaching Hospital. Soil samples were collected from the soil of healthcare waste dumpsite and soil adjacent to the dumpsite and taken to the laboratory for microbiological and physico-chemical analyses. Data were obtained on solid healthcare waste generation during a twelve (12) week field observation. Data were also obtained on solid healthcare waste management practices using two (2) questionnaires designed following the recommendations of SBC/UNEP (2005). The data were analyzed using percentages, proportions and tables of frequency distribution. T-test and chi-square test were carried out through SPSS 10.0 statistical package. A total of 65,873kg of solid healthcare waste was generated at the rate of 2.24kg/bed/day. Results of microbiological tests revealed the presence of some pathogenic micro-organisms in the soil of the healthcare waste dumpsite. The waste was improperly segregated, mixed together at temporary storage and dumped without any pretreatment in an open dumpsite in the hospital premises. Proper and environmentally sound management practices of solid healthcare waste should be instituted in the hospital.

TABLE OF CONTENTS PAGE

LIST OF TABLES

LIST OF FIGURES

Figure **Page**

LIST OF PLATES

CHAPTER ONE

INTRODUCTION

The importance of hospitals to the well being of the human society cannot be over emphasized. In fact they are in the core of the drive to deliver adequate modern healthcare services in the world today. Hospitals are welfare centers, where the sick, ill and injured seek succor to their ailments. There cannot be meaningful and sustainable development without a healthy population. Healthy people have a greater opportunity to fulfill their potentials and contribute to the economy of a country than those in poor health (Rushbrook and Zghondi 2005). This accounts for the importance attached to the establishment of new hospitals and maintenance of the existing ones under the National Economic Empowerment and Development Strategy (NEEDS). "The last century witnessed the rapid mushrooming of hospitals in the public and private sectors, dictated by the needs of expanding population" (Chandra 1999).

In recent years, the number of hospitals in Nigeria has grown astronomically, yet, they are insufficient to meet the demand of the ever-increasing population. The various governments at the local, state and national levels have responded by establishing more hospitals ranging in size and complexity, from tertiary health institutions like the teaching and specialist hospitals, to primary health care centers, like town clinics and dispensaries. These efforts are hardly enough to cope with the enormous demands of the large population, and are therefore being complimented by private hospitals that are seeking to cash in on the gap between government efforts and the unrelenting demand for modern healthcare services.

The increase in the number and size of hospitals, increase in the variety of medical services and increasing use of disposable medical products have contributed to rapid increase in the rate of generation of healthcare waste. The need to manage the waste from the hospitals in a proper and environmentally sound manner cannot be overemphasized, considering its potential as a source of infections to man and his environment.

1.1 THE STUDY AREA

The study was conducted in the University of Abuja Teaching Hospital (UATH). The hospital is a 350 bed facility that was commissioned in 1992 and was formerly known as Gwagwalada Specialist Hospital. It started as a general hospital run by the Federal Capital Development Authority (FCDA). It was taken over by the Federal Ministry of Health (FMH) and run as a Federal Medical Centre and tertiary health institution in 1993.

Apart from the Federal Capital Territory (FCT) Schools of Nursing and Midwifery that are attached to it, it was the only hospital of the status of Federal Medical Centre that is offering a postgraduate training of specialists in Surgery, Urology, Obstetrics, Gynecology and Paediatrics. In August 2006, the status of the hospital was upgraded to that of a teaching hospital due to the fledging Faculty of Medicine of the University of Abuja. Hence, the new appellation: "University of Abuja Teaching Hospital".

The hospital has 28 vital wards/units through which various health care services are delivered to its clients. However, in order to fully capture the solid healthcare waste emanating from the Laboratory department, its two units that generate healthcare waste the most - namely Immunology Laboratory and Sampling room were administered separate questionnaires. The hospital comprises of thirteen inpatient wards that attend to an average of 925 patients monthly and 15 outpatient units that attend to an average of 8623 patients monthly. There is also a Pharmacy department. For the purpose of this study, questionnaires were administered in the following wards/units of the hospital.

1. Special Care Baby Unit (SCBU)
2. Paediatric/Maternity Outpatient Department (PMOPD)
3. Emergency Paediatric Unit (EPU)

4. Paediatric Medical and Surgical Ward

5. Male Surgical Ward

6. Female Surgical Ward

7. Male Medical Ward

8. Female Medical Ward

9. Ante Natal Clinic

10. Labour Ward

11. Post Natal Ward

12. Gynaecology Ward

13. Accidents and Emergency (A&E) Unit

14. Casualty

15. Operating Theatre

16. Intensive Care Unit (ICU)

17. Haemodialysis

18. Dental Clinic

19. Eye Clinic

20. Eye Ward

21. Eye Theatre

22. Ear, Nose and Throat Clinic (ENT)

23. Immunology Laboratory

24. Sampling Room

25. National Programme on Immunization (NPI)

26.Family Planning Unit

27.Special Treatment Clinic (STC)

28.General Out-patient Department (GOPD)

29.Surgical Out-patient Department (SOPD)

30.Radiology Unit

31.Physiotherapy

32.Pharmacy Department

1.2 STATEMENT OF THE PROBLEM

Management of solid healthcare waste in Nigeria, like all other wastes, continues to pose serious challenge to successive administrations in the country. Manyele and Anicetus (2006) identified healthcare waste as being second only to radioactive waste in terms of potential hazards to man and his environment, yet it is not handled in a proper and environmentally sound manner in Nigeria. The management of healthcare waste from the point of generation to final disposal in Nigeria falls short of internationally acceptable minimum standard. The Federal Ministry of Health (FMH) in its "National Policy on Injection Safety and Healthcare Waste Management" (2007) observed that "the practices of indiscriminate dumping, burning and burying (of healthcare waste) are prevalent in a significant number of health facilities". This state of affairs does not augur well for the well being of Nigerians and the environment.

It also runs contrary to the "precautionary" and "duty of care" principles of the Stockholm and Basel Conventions to which Nigeria is a signatory. Similar situations have been reported in many developing countries and it was attributed to paucity of financial and technical resources; and trained manpower to deal with the problem of healthcare waste management. Also most of these countries lack the requisite legislations and policies to regulate healthcare waste management. Although, there is a national policy on environment and solid waste management in Nigeria, which touches on medical waste management, but the national policy on healthcare waste management is yet to be given a legislative backing. Therefore healthcare waste management is not given the level of attention it deserves in the country.

1.3 AIM AND OBJECTIVES

The aim of the thesis is to assess the solid waste management practices in UATH as a case study of the solid healthcare waste management practice in Nigeria. The objectives to be employed include:

i. To evaluate the quantity of solid healthcare waste generated and the rate of generation in UATH.

ii. To evaluate the microorganisms of medical interest present in the soil of UATH healthcare waste dumpsite.

iii. To examine the physicochemical characteristics of the soil of UATH healthcare waste dumpsite.

iv. To examine the present method of management of solid healthcare waste in UATH.

v. To examine whether proper segregation of solid healthcare waste is practiced in UATH.

vi. To examine whether proper and uniform colour coding of containers for waste segregation is practiced in UATH.

vii. To examine the attitude of UATH staff (central to healthcare waste management) towards proper and environmentally sound handling of healthcare waste, occupational protection and training received on healthcare waste management.

1.4 JUSTIFICATION

The United Nations Conference on Environment and Development (UNCED 1992) in chapter 21 of its Agenda 21 observed that environmentally sound management of wastes was among the environmental issues of major concern in maintaining the quality of Earth's environment and especially in achieving environmentally sustainable development in countries. It went further to say that effective control of the generation, storage, treatment, recycling and reuse, transport, recovery and disposal of hazardous waste is of paramount importance for proper health, environmental protection and natural resource management and sustainable development. It therefore becomes imperative for the University of Abuja Teaching Hospital to handle its healthcare waste in a proper and environmentally sound manner for it to deliver sustainable healthcare services to the Nigerian public. There is no gain in curing people of their primary illnesses only for them and their environment to be exposed to threats of re-infection by poorly managed healthcare waste.

As a step towards instituting a proper and environmentally sound management of healthcare waste in the hospital, this research will carry out a scientific survey of the present healthcare waste management practice in the hospital. The survey will provide useful information such as the quantity of solid healthcare waste generated in the hospital, the rate of generation and infection potential of the waste. It will also provide information on the level of understanding of the problems associated with healthcare waste management, occupational protection and training on healthcare waste management amongst healthcare workers in the hospital.

This information will be useful to the government and hospital management in formulating appropriate policies and plans to effectively deal with the problem of solid healthcare waste management in the hospital. This research would also contribute to addressing the problem of paucity of reliable data on generation rate of hospital waste in Nigeria (Coker *et al* 1999), thereby contributing to knowledge.

CHAPTER TWO

LITERATURE REVIEW

United States Environmental Protection Agency (US EPA) defined medical waste as "all waste materials generated at healthcare facilities such as hospitals, clinics, physician's offices, dental practices, blood banks and veterinary hospitals/clinics as well as medical research facilities and laboratories (http://www.epa.gov/eposwer/other/ medical 2007). But the US Medical Waste Tracking Act (MWTA) of 1988 defined medical waste as "any solid waste that is generated in the diagnosis, treatment or immunization of human beings or animals, in research pertaining thereto or in the production or testing of biologicals (http://www.epa.gov/epaoswer/other/ medical 2007).

A critical look will reveal the disparity in the approaches of these two definitions of the same origin. The MWTA approach is a legislative one and attempts to be explicit on the kind of activities that could lead to the generation of healthcare waste. EPA, the US environmental regulatory body, approaches its own definition from the point of view of an environmental watchdog, by focusing on the locations where such wastes are generated.

Pruss *et al* (1999) defined healthcare waste as including "all wastes generated by healthcare establishments, research facilities and laboratories. In addition it includes the waste originating from minor or scattered sources – such as that produced in the course of healthcare undertaken in the home (dialysis, insulin injections etc). The definition by Pruss *et al* (1999) is the one adopted and widely used by the World Health Organization (WHO) in its publications on healthcare waste; probably because it is more encompassing and takes into cognizance wastes generated outside the formal medical setting. It is therefore considered suitable to the Nigerian environment where a lot of healthcare procedures take place outside the orthodox medical practice.

Two major fundamental concepts have been observed concerning the classification of healthcare waste. The WHO prefers a wide classification from the point of view of public health and in line with the "precautionary principle". This classification in principle covers all wastes contaminated with blood and other body fluid, but excluded all theoretical pathways for infectious disease. Pruss *et al* (1999) classification shown in Table 2.1 is widely used in WHO's publications.

Table 2.1 Classification of Healthcare waste

WASTE CATEGORY	DESCRIPTION AND EXAMPLES
Infectious Waste	Waste suspected to contain pathogens e.g. laboratory cultures; waste from isolation wards; tissues (swabs), materials or equipment that have been in contact with infected patients; excreta
Pathological Waste	Human tissues or fluids e.g. body parts, blood and other body fluids, fetuses.
Sharps	Sharp wastes e.g. needles, infusion sets; scalpels; knives; blades broken glass.
Pharmaceutical Waste	Waste containing pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals (bottles, boxes).
Genotoxic Waste	Waste containing substance with genotoxic properties e.g. waste containing cytostatic drugs (often used in cancer therapy), genotoxic chemicals.
Chemical Waste	Waste containing chemical substances e.g. laboratory reagents; film developer; disinfectants that are expired or no longer needed, solvents.
Waste with high content of heavy metals	Batteries, broken thermometers, blood pressure gauges, etc.
Pressurized containers	Gas cylinders, gas cartridges; aerosol cans.
Radioactive Wastes	Waste containing radioactive substances e.g. unused liquid from radiotherapy or laboratory research; contaminated glassware, packages, or absorbent paper; urine and excreta from patients treated or tested with unsealed radio nuclides; sealed sources.

Source: Pruss *et al* (1999)

Although Pruss *et al* (1999) recognized the fact that between 75%-90% of the waste produced by healthcare providers is non-risk or general waste.

But their classification is from public health perspective; little consideration is given to general waste which is just like domestic waste, and is considered harmless. The focus is therefore the remaining 10-25% of healthcare waste, which is regarded as hazardous and requires special attention.

The United Nations Environmental Programme (UNEP) on the other hand focuses on a more pragmatic and cost effective management of healthcare waste. Its approach in classification is therefore narrower. The implication is that the desired high safety cannot be ensured for the whole disposal process, especially since it encourages the disposal of general waste from hospitals along with municipal solid waste. Figure 1.1 depicts the classification of healthcare waste by the Secretariat of the Basel Convention (SBC/UNEP 2002) in their Technical Guidelines on Environmentally Sound Management of Bio-medical and Healthcare waste.

- A: Non-risk Healthcare Waste
  - A1: Recyclable Waste
  - A2: Biodegradable Waste
  - A3: Other non-risk Waste
- B: Healthcare waste requiring special attention
  - B1: Human Anatomical Waste
  - B2: Sharps
  - B3: Pharmaceutical
    - B 3.1: Non-Hazardous pharmaceutical
    - B 3.2: Potentially Hazardous Pharmaceutical wastes
    - B 3.3: Hazardous Pharmaceutical
  - B4: Cytotoxic Pharmaceutical Waste
  - B5: Blood and Body Fluids
- C: Infectious and Highly Infectious
  - C1: Infectious Waste
  - C2: Highly Infectious Waste
- D: Other Hazardous Waste
- E: Radioactive Waste

Figure 2.1: *Classification of Healthcare Waste (Source: Technical Guideline of Environmentally Sound Management of Bio-medical and healthcare waste of the Basel Convention*

The SBC/UNEP guideline explains the different categories and classes of healthcare wastes thus:

A2. Biodegradable Healthcare Waste

This category of waste comprises of left over food, garden waste etc that can be composted.

A3 Other Non-risk Waste

This category includes all the non-risk waste that do not belong to categories A1 and A2.

B. Biomedical and Healthcare Waste requiring special attention.

B1. Human Anatomical Waste

This category comprises of non-infectious human body parts, organs and tissues and blood bags. Examples are tissue waste, removed organs, amputated parts, placentas etc.

B2. Waste Sharps

Sharps are all objects and materials that are closely linked with healthcare activities and pose a potential risk of injury and infection due to their puncture ability. Typical examples are needles, broken glassware, ampoules, scalpel, blades, lancets, vials without content etc.

B3 Pharmaceutical Waste

This includes a multitude of active ingredients and types of preparations, ranging from teas through heavy metal containing disinfectants to highly specific medicines. This category consists of expired pharmaceuticals, and pharmaceuticals that are unusable for other reasons (e.g. call back campaign). Pharmaceuticals are divided into three classes and their management follows differentiated and class-specific approach. Daughton and Ternes (1999) are of the view that pharmaceuticals and active ingredients in personal care products have received comparatively little attention as potential environmental pollutants than toxic/carcinogenic pesticides and industrial intermediate chemicals.

B3.1. Non-hazardous Pharmaceutical Waste

This class includes pharmaceuticals such as chamomile tea or cough syrup that pose no hazard during collection, intermediate storage and management. They are not considered hazardous waste and should be managed jointly with municipal waste.

B3.2. Potentially Hazardous Pharmaceutical Waste

This class embraces pharmaceuticals that pose a potential hazard when used improperly by unauthorized person. They are considered as hazardous waste and their management must take place in an appropriate waste disposal facility.

B3.3. Hazardous Pharmaceutical Waste

This class comprises heavy metal containing and unidentifiable pharmaceuticals as well as heavy metal containing disinfectants. They are regarded as hazardous wastes and their management must take place in appropriate waste disposal facility.

B4. Cytotoxic Pharmaceutical Waste

These are pharmaceutical wastes arising from the use, manufacture and preparation of pharmaceuticals with cytotoxic (antineeoplastic) effect. The potential health risk to persons who handle cytotoxic pharmaceuticals results above all, from the mutagenic, carcinogenic and tetratogenic properties of these substances (SBC/UNEP and WHO 2002). Examples of such wastes are discernible liquid pharmaceutical and materials proven to be visibly contaminated by cytotoxic pharmaceuticals. Examples of cytotoxic drugs are *azathioprine, clorambucil, chlornaphazine, melphlan* etc. Urine, faeces and vomit from patients, which may contain potentially hazardous amounts of the administered cytotoxic drug or of their metabolites and which should be considered genotoxic for at least 48hours and sometimes up to 1 week after drug administration (Pruss *et al* 1999). These wastes pose a hazard and the measure to be taken must also include those required by occupational health and safety provisions.

B5. Blood and Body fluid Waste

This category includes wastes that are not categorized as infectious waste but are contaminated with human or animal blood, secretions and excretions. It is safe to assume that these wastes might be contaminated with pathogens. Examples are dressing material, swabs, syringes without needle, infusion equipment without spike, bandages etc.

C. Infectious and Highly Infectious Waste

Infectious waste is suspected to contain pathogens (bacteria, viruses, parasites or fungi) in sufficient concentration and quantity to cause disease in susceptible hosts (Pruss *et al* 1999). Special requirements regarding the management of infectious wastes must be imposed whenever waste is known or expected to be contaminated by causative agents of diseases. Especially when this contamination gives cause for concern that the disease might spread. Wastes in this category are grouped into two depending on the degree of expected infectiousness.

C1 Infectious Waste

This class comprises all biomedical and healthcare waste known or clinically assessed by a medical practitioner or veterinary surgeon to have the potential of transmitting infectious agents to humans and animals. Examples of waste in this class include blood from patient contaminated with HIV, Viral hepatitis, brucellosis, Q fever. Faeces from patients infected with typhoid fever, enteritis, *Cholera*, respiratory tract secretions from patients infected with TB, anthrax, rabies, poliomyelitis.

C2. Highly Infectious Waste

This class includes all microbiological cultures in which a multiplication of pathogens of any kind has occurred. They are generated in institutes working in the fields of hygiene, microbiology and virology as well as in medical laboratories, medical practices and similar establishments. It also includes laboratory waste cultures and stocks with any viable biological agents artificially cultivated to significantly elevated numbers, including dishes and devices used to transfer, inoculate and mix cultures of infectious agents and infected animals from laboratories. Typical examples are sputum cultures of TB laboratories, contaminated blood clots and glass-ware material generated in the laboratories and other highly concentrated microbiological cultures carried out in medical analysis laboratories.

D. Other Hazardous Waste

This category includes gaseous, liquid and solid chemicals, waste with high content of heavy metals such as batteries, pressurized containers etc. They are not exclusive to the healthcare sector. Examples are thermometers, blood pressure gauges, photographic fixing and developing solutions in X-ray department, halogenated or non-halogenated solvents, organic and inorganic chemicals.

E. Radioactive Healthcare Waste

Radioactive waste includes liquids, gases, and solids contaminated with radio-nuclides whose ionizing radiations have genotoxic effects. X-ray, gamma ray, Alpha ray and Beta ray are the ionizing radiation of medical interest. Examples are solid, liquid and gaseous waste contaminated with radio-nuclides generated from in-vitro analysis of body tissue and fluid, in-vivo body organ imaging and tumor localization; and investigative and therapeutic procedures.

In the above classification attempt has been made to bring the environmental and pragmatic approach of UNEP together with the public health safety and the precautionary approach of the WHO. Many authors that have written on healthcare waste have used different approach in defining and classifying it. Definitions and criteria for the determination of infectious substance represent an area where international harmonization is of relevance (SBC/UNEP 2002). This is of paramount importance in the quest for standardized quantification, characterization and hence uniform and consistent codes of environmentally sound management of healthcare waste on a global basis. The need for consensus is underscored by the collaboration of major multilateral bodies, such as WHO and UNEP, to strike a balance between public health safety (precautionary principle) and the environmental protectionist approach. This has led to the issuance of joint guidance manuals like "Preparation of National Healthcare waste management in Sub-Saharan countries" by SBC/UNEP and WHO.

2.1 SOURCES OF HEALTHCARE WASTE

Pruss *et al* (1999) identified two different sources form which healthcare wastes are generated as:

i. **Major sources** – (a) Hospitals e.g. university hospitals, general hospitals, district hospital (b) Other healthcare establishments e.g. emergency medical care services, healthcare centers and dispensaries, obstetric and maternity clinics, outpatient clinics, dialysis centers etc. (c) related laboratories and research e.g. medical and biomedical laboratories, biotechnology laboratories and institutions, medical research centers (d) mortuary and autopsy centers (e) animal research and testing facilities (f) blood banks and blood collection services and (g) nursing homes for the elderly.

ii. **Minor sources** – are (a) small healthcare establishments e.g. physician offices, dental clinics and acupuncturist (b) specialized healthcare establishments and institutions with low waste generation e.g. convalescent nursing homes, psychiatric hospital, institutions for disabled persons etc.

Although minor sources may produces some healthcare waste in categories similar to hospital waste, their composition will be different (Pruss *et al* 1999). They rarely produce radioactive or cytotoxic waste, human body parts are generally not included and sharps consist mainly of hypodermic needles. (Pruss *et al* 1999)

2.2 COMPOSITION OF HEALTHCARE WASTE

Most of the waste produced in healthcare facilities is non-risk or general waste, which are comparable to domestic waste in nature. Only a small fraction between 10-25%, of the waste is considered hazardous (Pruss *et al* 1999; Chandra 1999; Coker *et al* 1999; Suwannee 2002). According to WHO (http://www.who.int 2007) sharps waste, highly infectious waste, genotoxic/cytotoxic waste and radioactive waste are considered hazardous and require special attention. In the study by Bassey *et al* (2006) in FCT, Nigeria, the proportion of the infectious waste as a percentage of total generation rate (in kg/bed/day) ranged from 0.7% in National Institute of Pharmaceutical Research and Development (NIPRD) to 25% in International Diagnostic Center (IDC), the only privately owned facility in their study. General Waste had a mean percentage of 73.5%, infectious waste 19.5%, sharps 4.5% and paper/cellulose 2.5%. The studies by Chandra (1999) and Suwannee (2002) follow this trend too. Chandra (1999) observed that hazardous waste was 15% while non-hazardous waste was 85%. He further subdivided hazardous waste into (a) hazardous but non-infective (5%) hazardous and infective (10%). It was also observed that the composition by weight was made up of plastic 14%, combustible dry cellulostic solid 45%, combustible wet cellulostic solid 18% and non-combustible waste 20%. To estimate the composition of the wastes Suwannee (2002) sorted the wastes from each hospital in his study into three main groups namely general, medical and hazardous. Medical waste was further sorted into needles, gloves, drain tube, cotton gauze, napkin, plastic syringe, and swab and body parts. It was observed in the study that average of general waste in hospitals was 85% of the total waste. A high proportion of it was generated from organic material from food preparation and remnant. The others were paper, plastic, bottle etc. The average of medical waste in hospital and clinics was 10.6% of the total waste, with the maximum being generated from emergency department and a small portion by wards, laboratories etc. In terms of weight (kg/bed/day), gloves (19.33%) and needles (18.19%) were the most prevalent medical waste. The least was swab (0.15%). The average of hazardous waste in hospitals was 0.4% of the total, the highest being from the X-ray laboratory. Longe and Williams (2006), however observed the percentage composition of healthcare waste in four Lagos hospitals – including a teaching and specialist hospital to range between 50% and 66% of the total waste stream for general waste, between 19%

and 37% of the total waste stream for infectious waste; sharps constituted between 7% and 10% while chemical waste constituted only 3% of the total waste stream.

The amount of infectious waste generated by the medical facilities as a percentage of their total waste stream varies widely depending on the type of healthcare facility, the definition of infectious waste used, and the standard operating procedure specified by it for designating and separating waste types (http://www.epa.gov/epaoswer/other/medical/ 2007).

2.3 RATE OF WASTE GENERATION

Hospital waste generation differs within and between countries (Pruss *et al* 1999). Pruss *et al* (1999) also observed that waste generation depends on numerous factors such as established waste management methods, type of health care establishment, hospital specialization, proportion of reusable items employed in healthcare and proportion of patients treated on a day-care basis. Hamoda *et al* (2005) reported that the generation rates were related to important factors such as number of patients, number of beds and the type of activities conducted in the hospital. Healthcare waste generation is usually lower in middle- and low- income countries than in high-income countries (Pruss *et al* 1999). A comparison of healthcare waste generation by Halbwachs (1994) revealed that high-income countries generate more healthcare waste and hazardous waste more than middle- and low-income countries. Low-income countries generate the least amount of healthcare waste. On a regional basis, generation rate ranges from 7-10 kg/bed/day in North America to 1.3-3kg/bed/day in Eastern Mediterranean (Johannessen 1997). Although Africa was not included in this report, it is however, apparent that, the trend follows that reported by Halbwachs (1994) for high-, middle-, and low-income countries. This is attributable to the level of affluence which enables people in high-income countries (represented by North America) to afford more medical goods and services, especially disposables than people in low-income countries (represented by Eastern Mediterranean). Chandra (1999) gave the hospital waste generated (in kg/bed/day) in the United States, Spain, United Kingdom, France and India as 4.5, 3.0, 2.5, 2.5 and 1.5 respectively. Data compiled by Economopoulos (1993) in high-income countries reveal that daily waste generation according to source size are 4.1-8.7 kg/bed, 2.1-4.2 kg/bed, 0.5-1.8kg/bed and 0.05-0.2 kg/bed for university hospital, general hospital, district hospital and primary healthcare centre respectively.

The waste generation rate also depends on the activities in hospital or ward/unit. Coker *et al* (1999) observed a significant disparity in the average waste generation per head per day of the three hospitals studied.

In one hospital, it ranged from 3.84 g/h/day at the injection room and 632.5g/h/day at the Labour ward. In another hospital the average waste generation per head per day ranged from 3.84g/head/day at the child health clinic to 229g/head/day at the neonatal ward. At the third hospital, it ranged from 2.4 g/head/day at the eye clinic to 567.9 g/head/day at the maternity unit. Coker *et al* (1999) in rationalizing the observed disparity in the waste generation rate per head per day in the hospitals in Ibadan, Nigeria suggested that, "the considerably minute quantity of solid hospital waste generated at the eye clinic is not surprising given the fact that the kind of therapy usually prescribed there do not lead to generation of much wastes. Also, the majority of the patients attending the injection room were out-patients, generating typically light-weight wastes such as needles. This is unlike relatively heavy and moisturized wastes (e.g. soaked swabs, gauze, pads and disposable napkins) that were generated by the largely in-patients at the labour and neonatal wards. This is similar to the result obtained in the FCT by Bassey *et al* (2006). The waste generation rate per bed per day ranged from 0.08kg/bed/day in the Ear, Nose and Throat (ENT) unit to 3.11kg/bed/day in the post natal unit in one hospital. In the second hospital it ranged from 0.10kg/bed/day in the antenatal unit to 4.08kg/bed/day in the labour ward. In the third, it ranged from 0.23kg/bed/day in the out-patient unit to 5.67kg/bed/day in the labour unit. The story in not different in the fourth hospital where, a range of 0.13kg/head/day in the out-patient unit to 3.03kg/bed/day in the labour ward was reported. Coker *et al* (1999) observed that the average generation rate per head per day was higher in the private hospital (186.9g/head/day) than the two public hospitals (97.5 and 167 g/head/day) in their study. They attributed this disparity to the fact that the private hospitals are generally patronized by the middle- and high-class citizens who can afford the more exorbitant charges. As opposed to the patrons of the public hospitals who are less affluent and are more prone to reusing materials from their previous treatments. This is similar to observations made by Halbwachs (1994) and Pruss *et al* (1999) for low- , middle- and high-income countries.

From the result of the study in FCT by Bassey *et al* (2006), it is apparent that the government hospitals – National hospital, Garki General Hospital and Wuse General Hospital recorded generation rates per bed per day of 3.59kg, 2.86kg and 2.50kg respectively. These figures are much higher than the 1.98kg recorded by International Diagnostic Centre, the only private hospital in the study. This is not unconnected to the fact that, as observed by Bassey *et al* (2006), the FCT is predominantly made up of civil servants, who may have preference for the public hospitals that charge lower than the private hospitals. A similar trend was reported by Suwannee (2002) that the daily hospital waste generation (kg/bed) from general hospital was higher than private hospital in Thailand. Thailand, like Nigeria is a developing country and for economic reasons, the government hospitals may enjoy more patronage than the private hospitals. Suwannee (2002) observed that daily waste generation (kg/bed) in hospitals was 4-6 times higher than clinics in all categories of waste and concluded that, the higher the number of patients the greater the waste generation. The higher average generation rate per day for hazardous waste was, however, recorded in the private hospital in the FCT by Bassey *et al* (2002). This underscores the importance of affluence as a determining factor in the generation rate of hazardous waste. This appears to agree with Halbwachs (1994) observation that high-income countries generate more healthcare and hazardous waste than middle- and low-income countries.

Suwannee (2002) also observed that the source size affects the daily hospital waste generation. It was observed that the daily waste generation (kg/bed) was higher in the small hospitals than the larger ones. Although, no reason was proffered for this trend, but it may be that the smaller hospitals enjoy more patronage than the larger ones in Thailand. Coker *et al* (1999) reported an average waste generation rate of about 150g/head/day for Ibadan, Nigeria based on the measurement of the three hospitals in their study. Whereas Bassey *et al* (2006) reported an average waste generation rate of 2.782kg/bed/day for FCT based on the measurement of the five medical facilities in their study. Suwannee (2002) observed an average daily waste generation rate of 2.048kg/bed/day for hospital and 0.366kg/bed/day for clinics in a district of Thailand. The average generation rate (kg/bed/day) reported by Bassey *et al* (2006) is somewhat similar to that reported for hospitals in Thailand by Suwannee (2002). But it is difficult to compare the result of Coker *et al* (1999) because they used a different unit, g/head/day, to quantify the average generation rate. It should be noted, however, that kg/bed/day is the unit recommended in the joint guidance manual on the "Preparation of National Healthcare Waste Management Plans in Sub-Saharan countries" by UNEP/Secretariat of the Basel Convention and WHO. In Lagos, Longe and Williams observed that, though most hospitals had no record of waste being generated, it is easily expressed in volume as most storage facilities are in liters aside those at depot centers. They evaluated and presented all data on a weight basis. They observed an average generation rate of 0.573kg/bed/day of medical waste stream in the four hospitals in their study. Hamoda *et al* (2005) observed that minimal quantities of waste were collected in the weekends in Kuwait.

2.4 HANDLING OF HEALTHCARE WASTE

The United Nations Conference on the Environment and Development (UNCED) in its Agenda 21 recommends measures for the environmentally sound management of waste, which may be summarized as follows;

- Prevention and minimization of waste production.
- Reusing and recycling the waste as much as possible.
- Treat waste by safe and environmentally sound methods.
- Dispose of final residues by landfill in confined and carefully designed sites.

The institution of a waste management plan is the best way of improving environmental performance in waste management.

The Conference of the Parties to the Basel Convention on the Control of Trans-boundary Movements of Hazardous Wastes and their Disposal at its sixth meeting in Geneva in December 2002, recommended that, such management plan be based on a system that will ensure the following.

- Availability of auditable and verifiable documentation to demonstrate that operations are taking place as required.
- Assist with the provision of quality data and information on which a state-of-the environment report can be prepared.

"A prerequisite for developing or updating such a plan is adequate characterization and analysis of the existing wastes stream and a detailed assessment of the existing waste management practices" (SBC/UNEP

2002). This initial process is commonly referred to as a waste audit (SBC/UNEP 2002, Chitnis *et al* 2005). Surveys on the generation of waste will be the basis for identifying opportunities and settings targets for waste minimization, reuse and recycling, and cost reduction (Pruss *et al* 1999). SBC/UNEP and WHO in the Guidance Manual suggested that, the healthcare wastes that are generated within a healthcare facility should always follow an appropriate and well identified stream from their point of generation until their final disposal. This stream is the minimum observance

for healthcare waste management and is composed of several steps that include waste minimization and recycling, segregation, recommended colour coding of containers, waste storage, on-site transportation of waste, off-site transportation of waste and disposal.

a. **Minimization and Recycling of Healthcare Waste**

One of the basic principles of the Basel Convention requires that each party shall take the appropriate measures to ensure that the generation of hazardous wastes within it is reduced to a minimum and adequate disposal facilities for the environmentally sound management of hazardous wastes and other wastes are available. Effective management of medical wastes incorporates waste reduction and recycling where appropriate (http://www.epa.gov/epaoswer/other/medical/ 2007). Efforts aimed at reducing waste should be focused on the two fundamental characteristics of waste which are toxicity (eliminating or finding benign substitutes for substances that pose risks when they are discarded) and quantity (changing the design or use of products to minimize the amount of waste generated when they are discarded) (http://www.epa.gov/epaoswer/other/medical/ 2007). Waste could be minimized or reduced, if conscious efforts and deliberate plans are put in place to reduce the quantity and toxicity of discarded products.

The use of disposables in healthcare has increased significantly in the last two decades (http://www.epa.gov/epaoswer/other/medical/ 2007). Although, this is very important from the point of view of infection control. But there is a need to reassess those reasons based primarily on economy and convenience. This is with a view of replacing disposable materials with reusable ones, hence, reducing waste arising from healthcare. Items which are not directly used for healthcare like paper, cardboard, glass, metal containers, plastic wrappings etc could be recycled and reused. Waste minimization has the advantages of reducing purchasing cost and cost related to waste management (Nessa *et al* 2001).

b. **Waste Segregation**

Segregation is the essence of waste management and should be done at the source of generation of biomedical waste (Chandra 1999).

Segregation is the key to effective biomedical and healthcare waste management (SBC/UNEP 2002). It is one of the most important steps to successfully manage healthcare waste (SBC/UNEP and WHO 2005). Considering the fact that only 10-25% of the healthcare waste is hazardous, a proper segregation will greatly reduce treatment and disposal costs. Segregation should always be the responsibility of the waste producer, should take place as close as possible to where the waste is generated (Pruss *et al* 1999). According to Chandra (1999) only about 15% of hospital waste is hazardous, but when hazardous waste is not segregated at source of generation and mixed with non-hazardous, then 100% waste becomes hazardous. When waste is properly segregated at source, each waste component can be adequately treated by the method best suited for its characteristics thereby preventing environmental pollution. Waste segregation also presents the opportunity of separating reusable and recyclable materials from the whole stream. Thereby reducing the quantity of waste destined for treatment and final disposition. The cost of waste management is then reduced. Recycling of healthcare waste could be flourishing business providing jobs for hundreds of people through small and medium-scale enterprises (Ahmed 1997). Segregating hazardous from non-hazardous waste greatly reduced the risk of infecting workers handling healthcare waste (SBC/UNEP and WHO 2005).

c. **Recommended Colour Coding of Containers**

The application of a colour system aims at ensuring an immediate and non equivocal identification of the hazards associated with the type of healthcare waste that is handled or treated (SBC/UNEP and WHO 2005). The most appropriate way of identifying the categories of healthcare waste is by sorting the waste into colour coded plastic bags or containers (Pruss *et al* 1999). Therefore a simple and uniform colour coding should be applied throughout a country (SBC/UNEP and WHO 2005). Table 2.2 depicts the colours recommended by SBC/UNEP and WHO (2005).

Table 2.2 Recommended Colour Coding System of Healthcare Waste

BLACK	YELLOW	BROWN
Non-risk waste of category A	Special Waste of Categories B1, B2, B4, B5	Pharmaceutical Waste of Categories B3, classes B32 and B33
Exceptionally small quality of waste category B1	Infectious waste and highly infectious waste of categories C1 and C C2, radio active waste of Categories E	Category D such as chemicals, heavy metal wastes.
Pharmaceutical waste of category B3 class B1 only	Radioactive waste of Category E	

"Waste bags and containers should be labeled in order to identify their origin in case of mishandling. Information on the content and the date of collection should be written on the bags; bags and containers should be marked with the international infectious symbol" (Pruss *et al* 1999).

d. **Waste Storage**

A storage location for healthcare waste should be designated inside the healthcare establishment (Pruss *et al* 1999). Storage area must be identified as containing infectious waste, with the biohazard symbol clearly displayed (SBC/UNEP 2002). No other material other than waste should be placed in the waste storage area. The storage area should not be close to store for fresh or cooked food. WHO recommends that the maximum storage time for healthcare waste is 72 hours in winter and 48 hours in summer for temperate climate. While the recommended time for tropical climate is 48 hours during the cool season and 24 hours during the hot season.

e. **Collection and On-site Transportation of Waste**

In order to avoid accumulation of the waste, it must be collected on a regular basis and transported to a central storage area within the healthcare facility before being treated or removed. In order to prevent injury and infection during their handling within and outside the hospital, sharps should be collected and managed separately from the other categories of hospital waste. Puncture and leak-proof containers or safety boxes must be used. The box is treated with other infectious waste (SBC/UNEP and WHO 2005). All disposable syringes and needles must be discarded of immediately following use. Syringes even without needles must be considered as unsafe (SBC/UNEP and WHO 2005).

Within hospital waste routes must be designated to avoid the passage of waste through patient care areas and separate times should be earmarked for transportation of biochemical waste to reduce chances of it's mixing with general waste (Chandra 1999). According to SBC/UNEP (2002) dedicated wheeled trolleys, containers or carts should be used to transport waste within the hospital and must meet the following specifications;

- Easy to load.
- No sharp edges that could damage waste bags or containers during loading and unloading.
- Easy to clean.

f. **Off-site Transportation of Waste**

The healthcare waste producer is responsible for safe packaging and adequate labeling of waste to be transported off-site and for authorization of its destination (Pruss *et al* 1999). Chandra *et al* (1999) recommended that the transport is done through dedicated vehicles having fully enclosed body, lined internally with stainless steel or aluminum to provide smooth and impervious surface that can be cleaned.

2.5 TREATMENT/DISPOSAL OF HEALTHCARE WASTE

According to Chandra (1999) treatment of healthcare waste is required for the following reasons;

- To disinfect the waste so that it is no longer the source of infection.
- To reduce the volume of the waste.
- Make waste unrecognizable for aesthetic reasons
- Make recycled items unusable.

Depending on the local conditions, the final choice of treatment system should be made on the basis of various factors which Pruss *et al* (1999) identified as follows:

- Disinfection efficiency.
- Health and environmental considerations.
- Volume and mass reduction.
- Occupational health and safety considerations.
- Quantity of waste for treatment and disposal/capacity of the system.
- Types of waste for treatment and disposal.
- Infrastructure requirements.
- Locally available treatment options and technologies.
- Options available for final disposal.

- Training requirements for operation of method.
- Operation and maintenance considerations.
- Available space.
- Location and surrounding of the treatment site and disposal facility.
- Investment and operating costs.
- Public acceptability.
- Regulatory requirements.

The choice of technology for healthcare waste treatment should always be driven with the objective of minimizing negative impacts on health and environment (SBC/UNEP and WHO 2005).

Some of the available treatment/disposal options available include incineration, autoclaving, microwave irradiation, chemical disinfection and land disposal. Incineration used to be the method of choice for most hazardous healthcare waste and is still widely used (Pruss *et al* 1999). According to SBC/UNEP (2002) depending on the type of incinerator the following objectives can be achieved;

- Destruction of pathogens.
- Reduction of the hazard and pollution potentials as far as possible.

- Reduction of volume and quantity.
- Conversion of remaining residue into a form which is utilizable or suitable for landfill.

Weir (2002), however, observed that 3 types of materials are difficult to incinerate. Materials with low heating values, such as full urine bags and dense body parts which may burn more slowly than the surrounding materials and not completely be destroyed during incineration. Toxic metals, such as lead, chromium and cadmium found in red plastic bags and vacutainer caps, vapourize during incineration and form fine fumes that enter the atmosphere with flue gas. Plastics composed of polyvinyl chloride contain hydrochloric acid which is released to the atmosphere during incineration. US EPA has identified medical waste incineration as the third largest source of dioxin, a known carcinogen (http://www.epa.gov/epaoswer/othermedical/mwpdfc/rx/ ch4.pdf/ 2007). The emission of toxins like dioxins, furans, mercury etc., from incinerators has led to the enactment of strict regulations and standards which are not favourable to old incinerators (Sibbald 2001). This has compelled hospital to seek the services of modern commercial incinerators. The cost implication of this has made hospitals to segregate their waste more carefully, thereby, reducing the cost of treating their infectious waste. Kumar *et al* (2004) in a survey of trace metals determination in hospital waste incinerators in Lucknow, India found that, the concentration of Zinc and Lead were very high in incinerator in comparison to other metals due to burning of plastic products. If the bottom ash is finally disposed in a poorly constructed landfill as is usually done in developing countries, the possibility of contamination of ground water and the environment by these heavy metals is very high. SBC/UNEP and WHO (2005) recommends that if the incineration option is chosen to treat used syringes and needles, temperature greater than $1400^{0}C$ must be used to completely oxidize the needle. To burn the syringes and disinfect the needles, temperature of $800\text{-}900^{0}C$ must be used. However, the incinerators like pyrolytic incinerators or rotary kilns that are capable of attaining these temperatures are expensive to install and operate. Alternatively, open air burning of cardboard safety boxes in pits can be used. Land disposal of untreated healthcare waste is not recommended and should only be used as a last resort and should be done only in a sanitary land fill (SBC/UNEP and WHO 2005). Highly infectious waste of category C2 generated in medical laboratories should be immediately pre-treated, by autoclaving or chemically using concentrated Sodium hypochlorite solution, before joining the other medical wastes (SBC/UNEP and WHO 2005).

SBC/UNEP (2002) recommended that steam sterilization or autoclaving should be used for the treatment of infectious waste because thermal methods are easy to validate and monitor and are less damaging to the environment. In fact, other methods should be considered only, if steam sterilization or autoclaving is impracticable or inappropriate.

2.6 MANPOWER AND TRAINING

Human beings are the soul of healthcare waste management. These include the hospital personnel, patients and the general public. Training of healthcare personnel in implementing the waste management policy is critical if a waste management programme is to be successful (Pruss *et al* 1999). The overall aim of training is to develop awareness of the health, safety and environmental issue relating to healthcare waste and how these can affect employees in their daily work. Special training should be targeted at the following group of personnel.

⇒ Hospital manager and administrative staff responsible for the implementation of regulation on health–care waste management.

⇒ Medical doctors.

⇒ Nurses.

⇒ Cleaners, porters, auxiliary staff and waste handlers.

The hospital management should appoint a waste management officer who should be the fulcrum of a waste management team to be made up by all vital officers in the hospital (Pruss *et al* 1999). "Proper training of workers; provision of equipment and clothing for personal protection; and establishment of effective occupational health programme that includes immunization, post-exposure prophylactic treatment and medical surveillance are essential occupational health and safety measures. "It is very important to safeguard the occupational health of healthcare workers" (http://www.epa.gov/epaoswer/other/medical 2007). Public education on hazards linked with healthcare waste and promotion of the appropriate handling and disposal of medical waste is important for community health (Pruss *et al* 1999).

2.7 PATHOGENS IN WASTES

Pathogenic organisms present in healthcare waste include a wide range of bacteria, viruses, fungi, yeast and other organisms such as mycobacteria and rickettsia, which are virulent enough to infect the human body if the opportunity arises (http://www.epa.gov/epaoswer/other/medical 2007).

The level of pathogenicity of organisms found in healthcare institutions and their increased resistance to antibiotics may make them greater threat for those who handle the material and may also introduce the possibility of public health concerns (http://www.epa.gov/epaoswer/other/medical 2007). Of particular interest are those pathogens present in the hospital environment that get transported along with wastes to the landfill where they have some degree of survival. These organisms constitute threat to the wellbeing of patients, hospital workers and the public. Uwaezuoke and Aririatu (2002) isolated 48 *Staphylococcus aureus* strains from clinical sources in Owerri, Nigeria. The strains were resistant to penicillin (95.8%), ampicilin (89.6%), tetracycline (87.5%) and chloramphenicol (75.0%). Guardabassi *et al* (1998) isolated 385 *Acinetobacter* strains from sewers receiving waste effluent from a hospital and a pharmaceutical plant. The *Acinetobacter* from the hospital sewage were found to be resistant to oxy-tetracycline. Grabow and Prozesky (1973) isolated drug resistant coliform bacteria like *E. coli* and *Salmonella typhi* from hospital and city sewages and observed that such drug resistant pathogens in the water environment could be of particular concern.

Hospital infection or nosocomial infection is any infection acquired by a patient in the hospital. The causative organism is commonly resident in the hospital or in a particular ward and can be found in the floor, walls, beddings, wastes etc. *Staphylococcus aureus* is widely distributed among patients and hospital staff and extensive contamination of the hospital environment is usual (Thomas 1973). Oyeleke *et al* (2008) reported that unsecured hospital waste dumpsite may have adverse effects on its immediate environment as a result of the different pathogenic microorganisms isolated from the waste.

2.8 HEALTHCARE WASTE MANAGEMENT IN DEVELOPING COUNTRIES

Although many developing countries, Nigeria inclusive, are signatories to international agreements such as "Basel Convention and Stockholm Convention whose underlying principles are:

a. The "polluter pays" principle implies that all producers of waste are legally and financially responsible for the safe and environmentally sound disposal of the waste they produce.
b. The "precautionary" principle is a key principle governing health and safety protection. When the magnitude of a particular risk is uncertain, it should be assumed that this risk is significant, and measures to protect health and safety should be designed accordingly.
c. The "duty of care" principle stipulates that any person handling or managing hazardous substances or related equipment is ethically responsible for using the utmost care in that risk.
d. The "proximity" principle recommends that treatment and disposal of hazardous waste take place at the closet possible location to its source in order to minimize the risks involved in its transport.

In spite of the above fact, healthcare waste management in developing countries still leaves a lot to be desired. Waste production in healthcare facilities in developing countries has brought a variety of concerns due to the use of inappropriate methods of managing the waste (Diaz *et al* 2005). Facts obtained from the Basel Convention Regional Centre for English Speaking countries website (http://www.baselpretoria.org 2007) is to the effect that most developing countries do not have any law or regulation specifically targeted at healthcare waste management. Apart from the fact that there presently exists no legislation targeted specifically at healthcare waste, there are currently insufficient resources being made available to ensure the required enforcement of the existing legislation, largely as a result of insufficient financing of waste management systems, facilities and human resources (http://www.balseprotoria.org.za.htm 2007) "National Legislation is the basis for improving healthcare waste practices in any country. It establishes legal controls and permits the national agency responsible for the disposal of healthcare waste to apply pressure for their implementation" (Pruss *et al* 1999).

Although in the National Policy on Injection Safety and Healthcare Waste Management the Federal Ministry of Health (FMH) in Nigeria has set a target of the year 2008 for itself, to ensure the enactment of relevant legislations required for effective healthcare waste management policy implementation. The FMH observed in the National Policy document that there are inadequate healthcare waste management systems for healthcare facilities in communities and that indiscriminate dumping; burning and burying are prevalent in a significant number of health facilities. To address the problem posed by the improper management of healthcare waste, the FMH has a set a number of targets to be achieved between the year 2008 and 2010. One of the targets is to ensure that teaching hospitals, specialist hospitals, Federal Medical Centers with more than 200 beds shall provide within their premises a modern incinerator which complies with WHO standard on air pollution emission, capable of on-site destruction of all hazardous waste generated in such facility. It is therefore apparent that the first line treatment recommended by the FMH is incineration. This is contrary to the recommendation of SBC/UNEP (2002), and indeed modern trend in healthcare waste management, which requires that it is only when stream sterilization is not practicable or in-appropriate that any other treatment option should be considered. This tends to discourage incineration of healthcare waste due to the problem of environmental pollution associated with it.

The disparity in the FMH and SBC/UNEP approach is a pointer to the gap between the public health and environmental protection concerns on healthcare waste management. Healthcare waste management is both a public health and environmental protection issue. But a critical look at the Nigerian policy document betrays a lack of input from the Federal Ministry of Housing and Environment (FMHE), hence the gap in approach.

Where specific laws on healthcare waste management exist (e.g. India, Thailand and Brazil), they are observed more in the breach than in adherence. There is a paucity of finance, technical and trained manpower available to economically developing countries to adequately manage their healthcare waste (Diaz and Savage 2003). Nessa *et al* (2001) reported that waste management systems are limited in Africa and South-East Asia where segregation is seldom practiced and urban hospitals burn their waste in the open within the hospital premises. This is in contrast with Europe and North America where wastes are properly segregated at the point of generation and subjected to appropriate treatment methods (Nessa *et al* 2001). Coker *et al* (1999) observed that no proper waste management practice exists in all the surveyed hospitals, which are major hospitals in the city of Ibadan, Nigeria. "Lack of training and equipment for the waste handlers was a common feature in all the surveyed hospitals, particularly in the public hospitals. "This portrays the lip service approach to the menace of hospital waste problem in Nigeria" (Coker *et al* 1999). The hospitals dumped their waste indiscriminately in open and unfenced dump sites where rain, wind, animals, and scavengers have unlimited access. These reports were corroborated by Bassey *et al* (2006) who observed that "medical waste management has received very little attention in waste management process in Nigeria". They observed that unwholesome waste disposal by many hospitals, clinics and health centers in Abuja, Nigeria poses serious health hazard to the city dwellers in general and people living within the vicinity of the healthcare institutions in particular. Almost all the healthcare institutions surveyed disposed every kind of waste generated into municipal dumpsites without pre-treatment. 18% of the health institutions surveyed incinerate their waste in locally built incinerators without safety devices. 36% of the wastes generated are disposed into municipal dumpsites. 9.1% bury their waste in the hospital premises while another 36.3% burnt waste produced in open pits. None of the health institutions segregated their wastes.

The legislation provided by the Indian Biomedical Waste (Management and Handling) Rules of 1998 notwithstanding, Pandit *et al* (2005) in a study to assess the level of awareness and practice of healthcare waste management in a district of India, where doctors and auxiliary staff from 30 hospitals were randomly selected, discovered that, there was no effective waste segregation, collection, transportation and disposal system in any hospital in the district. The doctors were aware of the existence of the laws related to waste management but did not know the details. They were also aware of the potential risk of HIV and Hepatitis B and C inherent in poorly managed healthcare waste. The auxiliary staff (ward boys, sweepers etc.) were not aware of any law or the potential dangers.

Although, laws regulating the management of healthcare waste are in existence, but Suwannee (2002) observed in a district of Thailand, that all wastes such as potentially infectious waste, waste from office, general waste, food, construction debris and hazardous chemical materials were all mixed together while they are being generated, collected, transported and finally disposed of. The hospitals in the study burned wastes or dumped wastes in municipal bins, which were transported to unsecured dumps. Some of the wastes contained mercury and other heavy metals, chemical solvents and preservatives (e.g. formaldehyde), which are known carcinogens, and plastics (e.g. PVC).

Literature is replete with reports of less than satisfactory practice in the management of healthcare waste in developing countries as evidenced in Brazil (Da Silva *et al* 2005), India (Patil and Shekdar 2001, Singh *et al* 2004), Iran (Askarian *et al* 2004; Koushiar *et al* 2006); Jordan (Bdour *et al* 2006), Pakistan (Janjua 2003; Rasheed *et al* 2005), Tanzania (Manyele and Anicetus 2006), Nigeria (Coker *et al* 1999; Bassey *et al* 2006).

In Tanzania, Manyele and Anicetus (2006) observed that the main disposal methods for medical wastes in hospitals comprised of open pit burning, burying and incineration. Ordinary incinerators, made of red bricks were used. Only 4% of the hospitals were reported to use autoclave for waste treatment. Suwannee (2002) reported improper disposal of hospital waste, open dumping and uncontrolled burning.

Although the prevailing state of affairs in developing countries was attributed to lack of enabling legislation, financial and human resources (Diaz and Savage 2003, http://www.baselpretoria.org.za 2007), Blenkharn and Basu (1995) added an attitudinal dimension to the problem, when they observed that, despite publication of clear definitive working guidelines, the introduction of increasingly stringent legislative control and availability of resources, in some cases, a large implementation gap for waste management still exists. This is in contrast to the observations of Rutala *et al* (1989); Cannata *et al* (1997); and Naudin-Rouselle and Valejo (1997) in US, Australia and France respectively, of a very high compliance rate with recommendations of regulatory bodies.

Generally in developing countries few individuals in the staff of healthcare facilities are familiar with the procedure required for a proper waste management. Furthermore, the management of wastes is usually delegated to poorly educated labourers who perform most activities without proper guidance and sufficient protection (Diaz *et al* 2005). Coker *et al* (1999) observed lack of relevant training and equipment of the waste handlers in hospitals in Ibadan. Also Bassey *et al* (2006) observed a lack of trained waste managers in the health institution in their study. In a study on safety considerations in the management of hospital generated waste in University of Calabar Teaching Hospital Asuquo *et al* (2003) discovered that 30.6% of the workers studied did not wear any form of protective clothing during work.

Though teaching hospitals are centers of excellence in medical training and care, but they appear not to be insulated from the problems of healthcare waste management being experienced in the developing world. In a study of four hospitals (including a teaching and specialist hospital) in Lagos, Longe and Williams (2006), using a questionnaire based on the guidelines of the safe management of waste from health care facilities by WHO, observed non-compliance of any of the health care facilities investigated with existing regulatory requirements. Although, 75% of the hospital segregated infectious and sharp wastes from source by the use of colour coding system, the commendable level of segregation of medical waste currently being achieved in the hospitals, surveys revealed that segregated medical wastes are sometimes mixed together by collectors either at the point of collection or at the dumpsites. The total waste stream therefore becomes infectious (Chandra 1999, WHO 2005). It was also observed that the hospitals did not use uniform colour coding for their healthcare waste. Rasheed *et al* (2005) in a cross-sectional survey conducted in eight teaching hospitals of Karachi, Pakistan – using a self administered questionnaire, with four sections, relating to the general information of the institutions, administrative information, information regarding healthcare waste management personnel and check-list of hospital waste management activities discovered that only 25% of the hospitals were segregating health care waste at source. Longe and Williams (2006) and Rasheed *et al* (2005) reported open dumping and non-treatment of infectious waste before final disposal in all the hospitals in their studies. In University of Calabar Teaching Hospital, neither generators nor managers segregated waste into infectious and non-infectious components while sterilization of waste material was not done before final disposal (Asuquo *et al* 2003).

2.9 CONDUCTING HEALTHCARE WASTE MANAGEMENT SURVEY.

According to SBC/UNEP and WHO (2005), a survey should be conducted on the current healthcare waste management situation within the hospital in close co-operation with head nurses from the medical departments. This is with a view of identifying necessary improvements. The following are some of the pertinent tasks recommended by SBC/UNEP and WHO in the guidance manual for healthcare waste management:

- ☞ Compile general information: type of waste generated in the healthcare establishment, number of beds, occupancy rates, and number of medical departments.
- ☞ Conduct a waste generation survey: Waste composition, waste quantity, sources of generation and number of beds in use. The survey should be presented in the form of average daily quantities of waste generated in (kg) in each healthcare category from each department.
- ☞ Conduct a critical review of existing waste management practices (i.e. segregation, storage, collection, transport, treatment and disposal).
- ☞ Assess existing safety e.g. protective clothing and security measures.
- ☞ Raise awareness amongst health workers.

In order to develop a waste management plan, the waste management team needs to make an assessment of all waste generated in the hospital. The survey should determine the average daily quantity of waste in each category generated by each hospital department (Pruss *et al* 1999). The development of a waste management plan for the hospital should then be based on the data obtained from the waste generation survey.

Two basic methods of calculating the daily production of hazardous healthcare waste were enunciated by SBC/UNEP and WHO (2005).

i. Weighing all bags/bins before they are emptied or disposed of. "this is the most precise option and should be used if there is an adequate scale within the healthcare facility" (SBC/UNEP and WHO 2005)

ii. Otherwise a good estimation can be obtained by estimating the volume of containers (bags, rubbish bins) used for medical waste collection in each medical unit for a defined period of time. Discussion can be held with nurses and paramedical staff in order to estimate the total volume of waste collected by using a filling rate for each category of container. A volumetric mass ratio is then applied to estimate the total weight of hazardous waste generated, depending on the type of waste thrown in the container and their humidity rate.

"Since in many sub-Saharan countries, hazardous and non-hazardous healthcare waste are not segregated at source but are mixed together, it is only possible to estimate the total quantities of healthcare waste (hazardous and non-hazardous) produced and then apply an estimated rate/ratio (that generally varies between 0.1 and 0.3) to calculate the proportion of hazardous healthcare waste generated per hospital category. The weight in kilogram of hazardous healthcare waste generated can then be estimated by using a ratio between 0.24 and 0.31.

Syringes and needles have a high potential to cause injury and transmit infection because they are often contaminated by blood and body fluids of the patients. Although it is important to estimate specifically the amount of sharps generated in the hospital but utmost care must be displayed in handling them, once syringes and needles are disposed in safety boxes, the boxes must not be re-opened again. SBC/UNEP and WHO (2005) recommended that the amount of syringes and needles and other sharps (needles, intravenous catheter, lancets, scalpels, blades and sutures) received by the hospitals or central pharmacy should be obtained from the records.

Coker *et al* (1999) and Bassey *et al* (2006) employed questionnaires, in-depth interviews, meetings, discussions and participant observed strategy in cross-sectional studies to characterize types and evaluate waste disposal techniques in Ibadan and Abuja respectively. They also employed collection, sorting (segregation, identification and characterization and weighing of waste types from ward and units of the selected hospitals.

Whereas Longe and Williams (2006) in another cross-sectional survey of healthcare waste management in Lagos metropolis, used a simple and objective questionnaire based on WHO guidelines for the safe management of waste from healthcare facilities. Waste generation was estimated in hospitals surveyed based on the number of 50 liters waste bins used for collection and storage of wastes, that were filled daily. And all data were evaluated and presented on a weight basis. A similar approach was used in Tanzania (SBC/UNEP and WHO 2005). The amount of hazardous healthcare waste generated in each healthcare facility was calculated by estimating the number of containers (bags, rubbish bins) used for healthcare waste collection during a defined period of time. Discussions were held with the medical and paramedical staff to enable adjustment to be made for the total volume of waste collected by using a filling rate for each category of container. To estimate the total weight of clinical waste generated a volumetric mass ratio of 0.30 kg/l was applied.

CHAPTER THREE

MATERIALS AND METHODS

3.1 DATA COLLECTION

Participant observation, field observations, and survey were designed and conducted to evaluate the solid healthcare waste management practice and also the generation rate of solid healthcare waste in the hospital. In-depth interviews were held with key officials such as the matrons/heads of the various wards/units, doctors, nurses, auxiliary staff supervisors and staff of the private company to whom the job of cleaning the hospital is contracted to evaluate the management practices in terms of waste segregation, collection, storage, transportation and disposal.

Two questionnaires were designed following the recommendations and guidelines of SBC/UNEP and WHO (2005) on the proper and environmentally sound management of healthcare waste. The first questionnaire was administered on the matrons/heads of each wards/units of the hospital, to evaluate the current solid healthcare waste management practices in terms of segregation and colour coding.

The second questionnaire was administered on hospital personnel central to the generation and management of healthcare waste like doctors, nurses, auxiliary staff, ward cleaners and waste handlers. It was established from the official records of the hospital that there are 150 doctors, 350 nurses, 60 auxiliary staff and 114 ward cleaners/waste handlers in the hospital. 10% of each of these categories of personnel was randomly sampled to evaluate their awareness and practice of the recommended minimum standard of environmentally sound management of healthcare waste. The questionnaire was also used to evaluate their level of training on healthcare waste management and measures put in place to protect them from the occupational hazards associated with healthcare waste.

Parallel to interviews and questionnaire administration, the quantity of solid healthcare waste generated in the hospital was evaluated by counting the number of 120 litre rubbish bins that were disposed at the dumpsite daily for twelve (12) weeks. The filling rate of each rubbish bin was observed and a volumetric mass ratio of 0.3kg/litre was applied to evaluate the total weight of healthcare waste generated daily. And then the proportion of potentially infectious healthcare waste was calculated by using a ratio of 0.3kg/litre of total solid healthcare waste generated. The solid waste generation rate in kg/bed/day was obtained by dividing by 84, the number of days for which the survey was conducted to get the waste generation rate per day. And then 350, the number of beds in the hospital, to get the waste generation rate per bed per day.

Soil samples were collected in sterile plastic universal containers from the healthcare waste dumpsite and soil adjacent to the dumpsite at a distance of 10m as control. The samples were collected consecutively for twelve weeks and taken for microbiological analysis in the microbiology laboratory of the hospital within three (3) hours of collection. The soil samples for physico-chemical analysis were collected in clean polythene bags from twenty-four (24) different spots on both the healthcare dumpsite and the adjacent control area and taken to the laboratory for the evaluation of their pH value and moisture content.

3.2 METHODS OF DATA ANALYSIS

3.2.1 MICROBIAL ISOLATION

Ten grams (10g) of soil was suspended in 90ml of sterile distilled water and serially diluted from 10^{-1} to 10^{-10} dilutions. Chocolate Agar and CLED Bovis Medium were used for the isolation and identification of bacteria. All the plates were incubated at 37°C for 48 hours under aerobic and anaerobic conditions. Sabouraud Dextrose Agar (SDA) was used for fungi culture. The SDA plates were incubated at room temperatute (28±2°C) for five (5) to seven (7) days after which colonies which developed on the plates were further investigated and results recorded.

3.3 CHARACTERIZATION AND IDENTIFICATION OF BACTERIA

Bacteria colonies of different sizes, shapes and pigmentations were selected randomly from the plates. They were further sub-cultured on nutrient agar by the streak plate technique and re-incubated at 37^0C for twenty-four (24) hours. After further purification using the streak plate technique, they were maintained on agar slants for further characterization and identification. The bacteria isolates were characterized according to their colonial morphology, cultural characteristics and biochemical reactions.

3.3.1 GRAM STAINING

Bacterial colonies which were twenty-four (24) hours old were picked by means of a sterile wire loop. They were then emulsified in a drop of distilled water that was placed on a clean slide to make a smear. The smear was air dried and heat fixed. It was then flooded with 0.5% crystal violet for one (1) minute. Thereafter, it was washed with acetone/alcohol briefly and then rinsed with water. The smear was counter stained with 1% safranin for thirty (30) seconds. It was thereafter observed under the microscope by immersion oil objective. The retaining of the dark purple colour of crystal violet indicates the presence of Gram positive bacteria. While the retention of the red colour of the counter stain indicates the presence of a Gram negative bacteria (Cheesbrough 2000; Oyeleke and Manga 2008).

3.3.2 CATALASE TEST

Two to three mililitre (2-3ml) of 3% hydrogen peroxide (H_2O_2) solution was poured into a test-tube. Colonies of the culture was taken using a sterile glass rod and immersed in the hydrogen peroxide solution. Immediate and active bubbling indicates positive catalase test. While no bubbling indicates a negative catalase test (Cheesbrough 2000).

3.3.3 COAGULASE TEST

Slide Test Method: A drop of distilled water each was placed on two (2) separate slides. A colony of the culture was emulsified in each of the drops to make two (2) thick suspensions. A loop full of plasma was added to the second suspension to differentiate any granular appearance of the organism from true coagulase clumping. The first slide was observed for clumping within ten (10) seconds. Clumping within ten (10) seconds indicate a positive coagulase test. While no clumping within 10 seconds indicate a negative coagulase test (Cheesbrough 2000).

Tube Test Method:

Zero point two mililitre (0.2ml) of human plasma was pipetted into a test-tube. 0.8ml of 18-24hours broth of culture was added to it and mixed gently. The test-tube was then incubated at 37^0C. It was examined for clotting after 1 hour. If no clotting has taken place after 1 hour, it was examined after 3 hours. Still if no clotting took place, it was left overnight and examined again. Clotting of the tube content indicates a positive coagulase test. No clotting indicates a negative coagulase test. (Cheesbrough 2000).

3.3.4 OXIDASE TEST

A piece of filter paper was placed in a clean Petri-dish. 2 to 3 drops of freshly prepared oxidase reagent (Tetra-methyl-p-phenylene diamine dichloride). A colony of the culture was picked with a sterile glass rod and smeared on the filter paper. The development of a blue-purple colour within 10 seconds is indicative of a positive oxidase test. And no blue-purple colour within 10 seconds is indicative of a negative oxidase test (Cheesbrough 2000).

3.3.5 MOTILITY TEST

Motility medium (peptone water) was fine stabbed with wire loop carrying the isolate to a depth of 1-2cm and incubated at 37^0C for 24 to

48hours. Then a hanging drop for bacteria motility examination was done.

3.3.6 INDOLE

The bacteria were inoculated in a bijou bottle containing 3ml of sterile tryptone water. It was incubated at 37^0C for up to 48 hours. 0.5ml of Kovac's reagent was added and shaken gently. Appearance of red layer is indicative of a positive indole test. While no red surface layer is indicative of a negative indole test.

3.3.7 CITRATE TEST

Slopes of the medium were prepared in bijou bottles. Using a sterile straight wire, the slope was streaked with a saline suspension of the culture and then the butt was stabbed. It was then incubated at 37^0C for 48hours. Development of bright blue colour in the medium indicates a positive citrate test. No change in colour of the medium indicates a negative citrate test (Cheesbrough, 2000).

3.3.8 UREASE TEST

A sterile urea agar slant in a bijou bottle was inoculated with the isolate and incubated at 37^0C for 24 to 72 hours. The appearance of bright pink or red colour is indicative of a positive urease test.

3.3.9 TRIPLE SUGAR IRON AGAR (TSI)

A stretch wire was used to obtain culture from a solid medium and it was used to streak the surface of the TSI slant and to stab the butt 2 or 3 times. The tube was capped tightly and incubated at 37^0C for 24 hours. Gas formation was indicated by the appearance of one or more bubbles in the butt, cracks in the butt or the butt may be pushed from the bottom. Black precipitate indicates the production of Hydrogen Sulphide. The butt will turn yellow, if only glucose is fermented, but if the fermentation of glucose is accompanied by gas production, the butt will turn yellow. If there is fermentation of either lactose or sucrose or both, in addition to glucose, the butt and the slant will turn yellow.

3.4 IDENTIFICATION OF FUNGI ISOLATES

3.4.1 IDENTIFICATION OF MOULD ISOLATES

The mould isolates were identified and classified based on factors such as growth rate, colonial morphology, microscopic morphology, the colour of aerial hyphae.

3.4.2 MOULD STAINING PROCEDURE

The adhesive side of scotch or cello tape was used to touch the surface of the mould colony (Ellen and Sydney 1990). The length of the tape was then adhered to the surface of microscopic slide to which a drop of lacto phenol cotton blue had been added. It was then viewed under x10 and x40 objective of the microscope for the shape and arrangement of the spores (macroconidia).

3.4.3 IDENTIFICATION OF YEAST ISOLATES

The yeast isolates were identified and classified by their morphological characteristics, microscopic examination and their ability to undergo sugar fermentation (Oyeleke and Manga 2008).

3.4.4 YEAST STAINING PROCEDURE

A colony of the test organism from SDA plates was picked carefully using an inoculating needle. It was then placed on a drop of lacto phenol cotton blue on a slide. It was covered with a cover slip and viewed under x10 and x40 objective (Ellen and Sydney, 1990).

3.4.5 GERM TUBE-TEST FOR CANDIDA

A colony of suspected yeast was placed in five (5) ml plasma, mixed and incubated for 30minutes – 1 hour at 37^0C. A drop is then placed on a clean slide, covered with cover slip and viewed under x10 and x40 objective.

3.5 PHYSICO-CHEMICAL ANALYSIS OF SOIL

3.5.1 DETERMINATION OF pH OF THE SOIL

The pH of the soil samples was determined using pH meter (Labtech). Ten grams (10g) of soil sample was suspended in 25ml distilled water and the suspension was stirred (Wild 1989). The pH meter was first calibrated in buffer solution of known pH (4.0 and 7.0), after which the electrode was inserted in the stirred suspension and the reading taken.

3.5.2 DETERMINATION OF MOISTURE CONTENT OF THE SOILS

This was carried out using the dry weight method. A metallic dish was dried in an oven at 80C for few minutes, cooled in a desiccator and weighed (W_1). Ten grams (10g) of the soil sample was weighed into the dish (W_2). The dish with the sample was then dried in an oven at 80C until a constant weight was reached and quickly transferred to a desiccator to cool and weighed quickly with minimum exposure to the atmosphere (W_3). The loss in weight of the sample during drying is the moisture content. It was calculated using the formula below:

$$\% \text{ moisture content} = \frac{W_3 - W_1}{W_2 - W_1} \times \frac{100}{}$$

W_1 = Weight of the dried dish without soil sample.

W_2 = Weight of the dish + weight of soil sample before drying.

W_3 = Weight of the dish + weight of soil sample after drying.

3.6 STATISTICAL ANALYSIS

Data were analyzed using percentages, proportions, and tables of frequency distribution. T-test and chi-square test were carried out through the statistical package SPSS 10.0.

CHAPTER FOUR

4.0 RESULTS

4.1 QUANTITY OF HEALTHCARE WASTE GENERATED AND RATE OF GENERATION IN UATH.

Table 4.1 shows the estimated quantity of solid healthcare waste generated in UATH during the twelve (12) weeks of field study.

DAYS	WEEKS												Total kg	Mean Kg	Std deviation	Std error
	1 Kg	2 kg	3 Kg	4 Kg	5 kg	6 kg	7 kg	8 Kg	9 Kg	10 kg	11 Kg	12 Kg				
Sunday	540	468	504	468	540	468	486	1152	468	432	1008	756	7290	607.50	237.8237	68.6538
Monday	810	676	828	936	828	792	936	1116	972	792	828	828	10342	861.83	112.5295	32.4845
Tuesday	828	856	936	828	828	720	1116	1044	990	990	828	828	10810	900.83	116.2676	33.5636
Wednesday	802.8	936	936	792	864	828	900	1008	1026	1026	738	720	10612.8	884.40	112.6909	32.5310
Thursday	723	828	972	878	828	756	1242	1008	1188	1188	684	864	10943	911.92	173.4948	50.0836
Friday	540	468	576	612	612	540	900	684	864	864	828	900	8352	696.00	158.2909	45.6946
Saturday	540	468	468	468	540	468	540	612	1152	1152	684	720	7524	627.00	206.2100	59.5277
Total	4783.8	4700	5220	4982	5040	4572	6120	6624	6174	6444	5598	5616	65873.8	784.2119	203.6020	22.2148
Mean	683.40	671.43	745.71	711.71	720.00	653.14	874.29	946.29	882.00	920.57	799.71	802.29	784.21			
Std deviation	138.1134	205.2436	221.6406	194.3620	148.431	156.1318	277.2735	211.6709	199.6297	258.0199	112.82	71.1377	203.6020			
Std error	52.2020	77.5748	83.7723	73.4619	56.1019	59.0123	104.7995	80.0041	75.4529	97.5224	42.6423	26.8875	22.2148			

Table 4.1: *Estimated Total Quantity of solid Healthcare waste (kg) generated in UATH in 12 weeks*

Table 4.2 Weekly Relationship in the Quantity of Waste Generated in Twelve Weeks

Week	Quantity Generated (kg)	Significance P = 0.05		
		< Week(s)	*> Week(s)*	*Not different from weeks*
1	683.40	8, 9		2, 3, 4, 5, 6, 7, 10, 11, 12
2	671.43	8, 9, 10		1, 3, 4, 5, 6, 7, 11, 12
3	745.71			1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12
4	711.71	8, 10		1, 2, 3, 4, 5, 6, 7, 9, 11, 12
5	720.00	8		1, 2, 3, 4, 5, 6, 7, 9, 10, 11, 12
6	653.14	7, 8, 9, 10		1, 2, 3, 4, 5, 11, 12
7	874.29		6	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12
8	946.29		1, 2, 3, 4, 5, 6	7, 9, 10, 11, 12
9	882.00		2, 6	1, 3, 4, 5, 7, 8, 9, 10, 11, 12
10	920.57		1, 2, 4, 6	3, 5, 7, 8, 9, 10, 11, 12
11	799.71			1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12
12	802.29			1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11

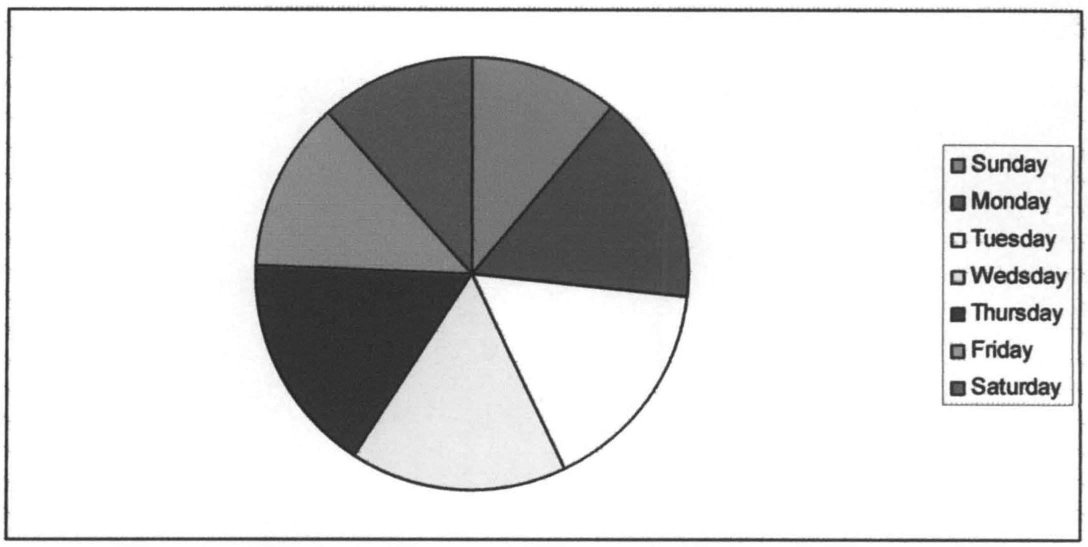

Figure 4.1: Daily Rate of Solid Healthcare Waste Generation in UATH

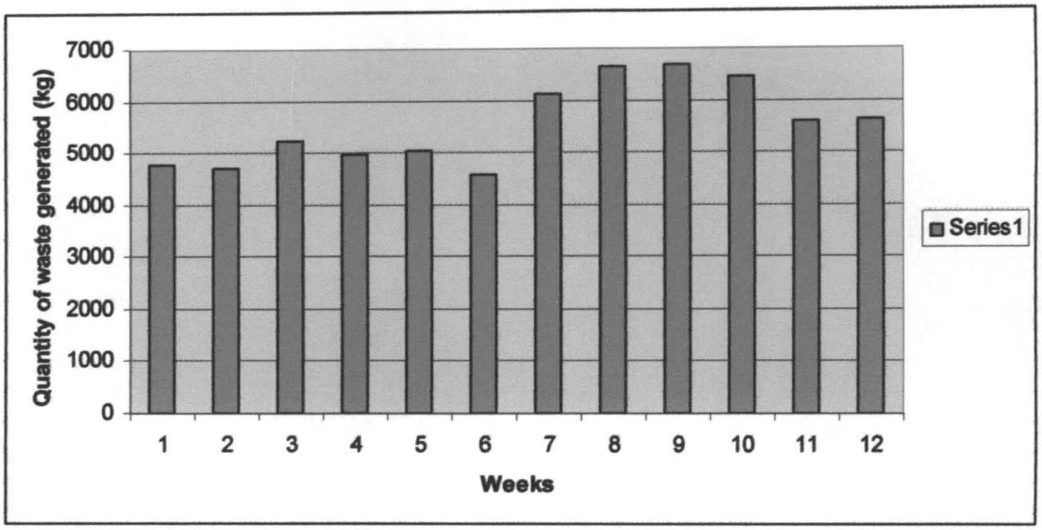

Figure 4.2: Weekly Rate of Solid Healthcare Waste Generation in UATH

4.2 IDENTIFICATION OF MICRO-ORGANISMS OF MEDICAL INTEREST IN THE SOIL OF HEALTHCARE WASTE DUMPSITE.

The frequency of isolation of bacteria and fungi from the soils of the healthcare waste dumpsite and soil adjacent to the dumpsite are presented on tables 4.3 and 4.4 respectively. Figures 4.3 and 4.4 also depict the frequency of isolation of bacteria and fungi from both soils.

Table 4.3: The Frequency of Isolation of Bacteria from Soil of Healthcare waste dumpsite and soil adjacent to the dumpsite.

No. of Samples	Isolates	Soil of Healthcare Waste Dumpsite			Soil Adjacent to the Dumpsite		
		Total No. of Isolates	% Appearance	Std Error	Total No. of Isolates	% Appearance	Std Error
12	*Citrobacter* spp	1	8.33	5.8548	2	16.67	5.6645
12	*Escherichia coli*	1	8.33		3	25.00	
12	*Salmonella typhi*	1	8.33		2	16.67	
12	*Pseudomonas aeroginosa*	2	16.67		3	25.00	
12	*Staphylococcus aureus*	8	56.67		6	50.00	
12	*Micrococcus* spp	2	16.67		3	25.00	
12	*Proteus vulgaris*	3	25.00		-	-	
12	*Aeromonas* spp	1	8.33		-	-	

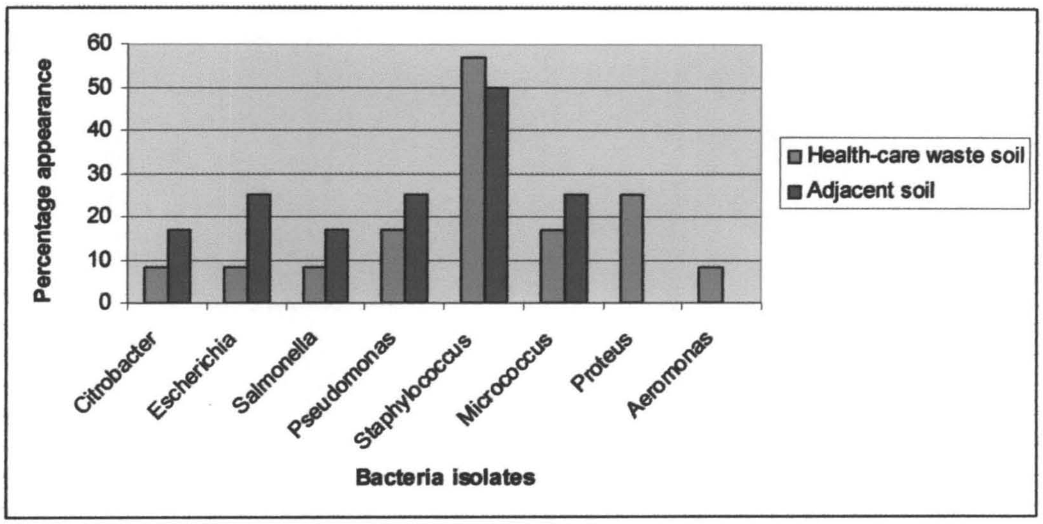

Table 4.4: The Frequency of Isolation of Fungi from the soil of Healthcare Waste Dumpsite and Soil Adjacent to the Dumpsite

No. of Samples	Isolates	Soil of Healthcare Waste Dumpsite			Soil Adjacent to the Dumpsite		
		Total No. of Isolates	% Appearance	Std Error	Total No. of Isolates	% Appearance	Std Error
12	*Aspergillus niger*	4	33.73	3.1632	3	25.00	3.1632
12	*Rhizopus nigrican*	1	8.33		1	8.33	
12	*Candida albican*	3	25.00		1	8.33	
12	*Fusarium gypsum*	2	16.67				
12	*Penicillium viricadium*	3	25.00		1	8.33	
12	*Microsporum canis*	1	8.33		1	8.33	
12	*Geotricum* spp	2	16.67		1	8.33	
12	*Sporothrix* spp	1	8.33		1	8.33	
12	*Trichophyton rubrum*	3	25.00		1	8.33	
12	*Cladiosporium* spp	1	8.33		1	8.33	
12	*Pityrosporium*spp	1	8.33		1	8.33	

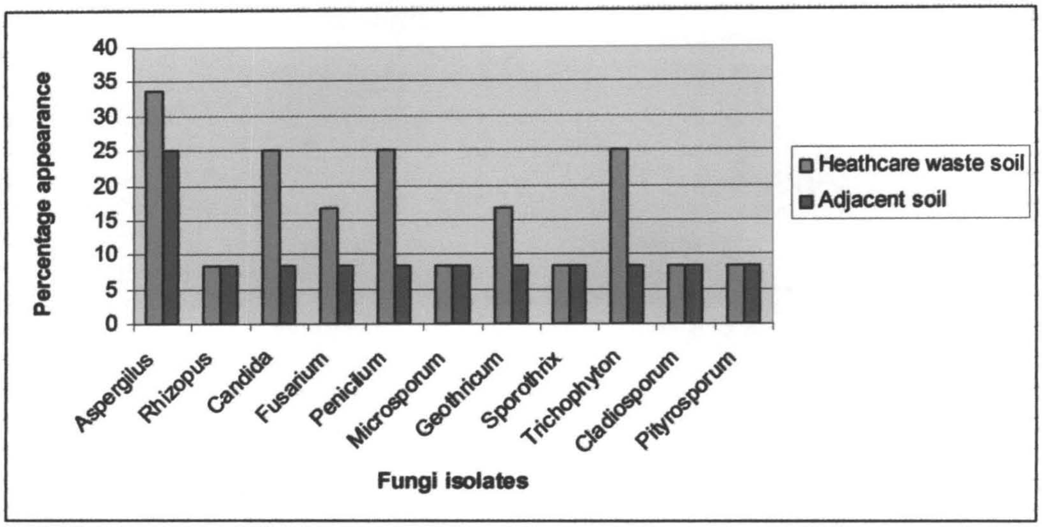

Figure 4.4: Percentage Appearancce of Fungi Isolates in both Soils

4.3 THE pH AND MOISTURE CONTENT OF THE SOIL OF HEALTHCARE WASTE DUMPSITE AND THAT OF THE ADJACENT SOIL

The pH and moisture content of the soil of healthcare waste dumpsite and that of the adjacent soil are presented on Table 4.5

Table 4.5 The Moisture Content and pH of Soil of Hospital Dumpsite and that of Soil Adjacent to the Dumpsite

Sample Code	**Soil of Hospital Dumpsite**		**Sample Code**	**Soil Adjacent to Dumpsite**	
	Moisture Content (%)	*pH*	*Sample Code*	*Moisture Content (%)*	*pH*
AHC_1	7.6	6.8	AAD_2	4.6	6.7
BHC_1	3.6	7.9	BAD_2	3.6	7.3
CHC_1	4.6	8.1	CAD_2	4.5	7.7
DHC_1	4.2	7.2	DAD_2	4.5	7.9
EHC_1	6.9	7.9	EAD_2	6.2	7.5
FHC_1	6.4	8.9	FAD_2	6.6	7.4
GHC_1	6.8	7.6	GAD_2	6.9	7.0
HHC_1	4.1	9.2	HAD_2	4.6	7.8
IHC_1	4.2	7.2	IAD_2	4.2	7.6
JHC_1	4.4	9.2	JAD_2	7.5	7.3
MHC_1	5.8	9.0	MAD_2	5.6	7.2
NHC_1	4.4	8.8	NAD_2	4.2	7.3
OHC_1	4.6	7.6	OAD_2	4.6	7.2
PHC_1	4.8	7.7	PAD_2	4.7	7.0
QHC_1	3.8	7.8	QAD_2	3.8	6.8
RHC_1	3.8	8.5	RAD_2	3.8	7.2
SHC_1	6.0	7.6	SAD_2	6.6	7.0
THC_1	3.7	8.2	TAD_2	3.7	7.8
UHC_1	4.2	8.8	UAD_2	4.4	7.6
VHC_1	4.6	8.0	VAD_2	4.2	7.2
WHC_1	4.4	7.8	WAD_2	4.1	7.4
XHC_1	4.0	8.9	XAD_2	4.0	7.6
YHC_1	3.8	9.1	YAD_2	5.6	7.6
ZHC_1	6.6	7.6	ZAD_2	6.8	7.1

4.4 PRESENT METHOD OF MANAGEMENT OF SOLID HEALTHCARE WASTE IN UATH

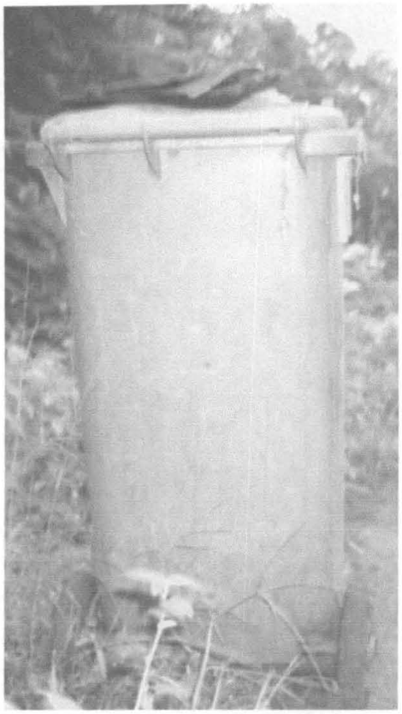

Plate I: 120 litre temporary waste storage bin used in UATH

Plates II and III: All categories of wastes mixed together in the temporary storage bin.

Plate IV: Open dumping of healthcare waste in UATH

Plate V: Open dumping of infectious waste in UATH

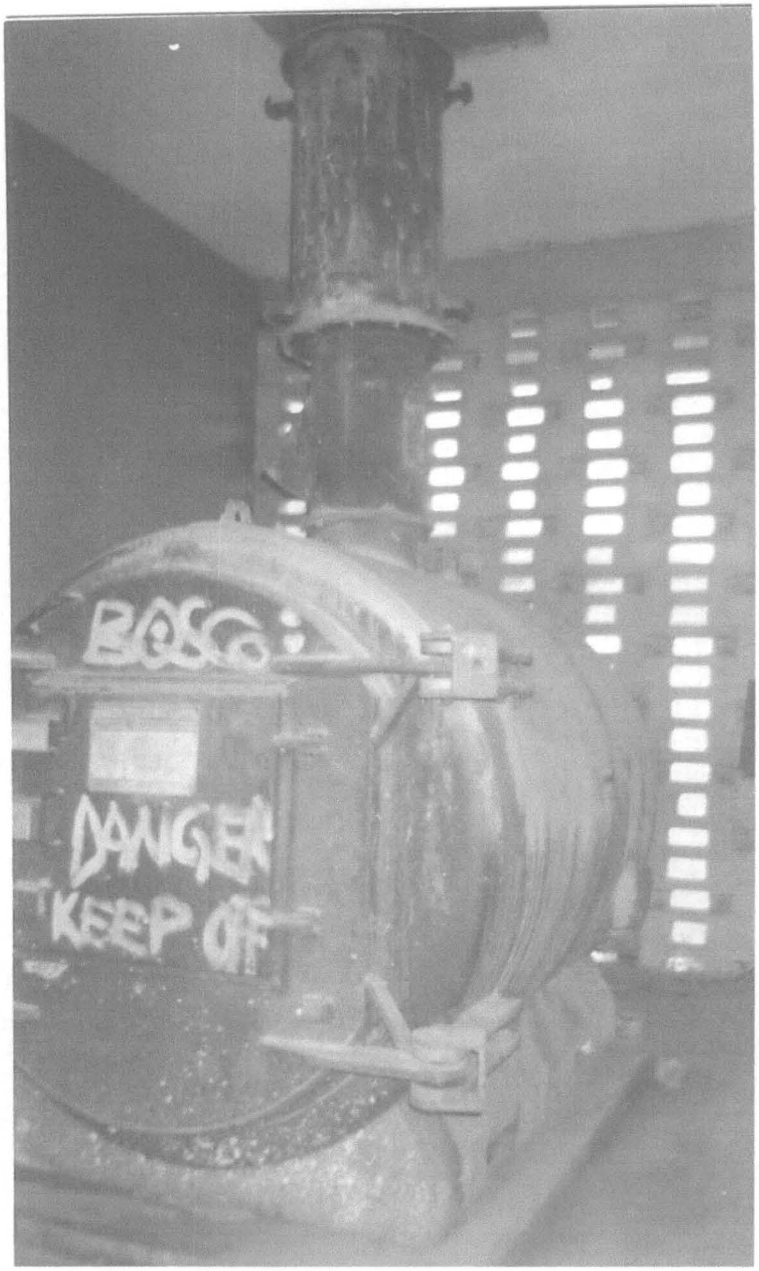

Plate VI: Unused Pyrolitic Incinerator in UATH.

4.5 SEGREGATION OF WASTE

Table 4.6: Types of Waste Segregated from the general waste stream in UATH.

Types of Waste Segregated from General Stream	No. of Wards/Units that Segregate	Percentage	Std Error
Sharp	9	28.1%	3.07
General Waste and Sharp	2	6.3%	8.00
Infectious Waste and Sharp	10	31.3	3.45
All Wastes	7	21.9%	3.15
None	3	9.4%	2.19
General	1	3.1%	
Total	**32**	**100%**	

Table 4.7 presents the types of containers/bags that are used to segregate healthcare waste in UATH.

Table 4.7 Types of Containers/Bags used to Segregate Healthcare Waste in UATH

Types of Containers/Bags	No. of Wards/Units Using each Types	Percentage	Std Error
Cardboard Boxes	3	9.4	4.18
Plastic buckets	8	25.0	3.48
Polythene bags and cardboard boxes	1	3.1	-
Cardboard boxes and Plastic buckets	15	46.9	2.21
Cardboard boxes/plastic buckets and polythene bags	2	6.3	7.50
Anything available	3	9.4	3.79
Total	**32**	**100**	

Table 4.8 shows the response of the matrons and unit heads of the wards and units to the question regarding the personnel that segregate healthcare waste.

Table 4.8: Personnel that segregate healthcare waste in UATH.

Personnel	No. of Wards/Units	Percentage	Std Error
Doctors	2	6.3%	1.00
Nurses	7	21.9%	2.81
Wards cleaners	6	18.8%	4.22
Doctors and Nurses	5	15.6%	5.15
Nurses and Ward cleaners	1	3.1%	-
Doctor, Nurses and Ward cleaners	7	21.9%	2.88
Nobody	4	12.5%	6.03
Total	**32**	**100%**	

Table 4.9 shows when segregation of wastes takes place in UATH.

Table 4.9: Timing of segregation of wastes in UATH

Timing of Segregation	No. of Wards/units	Percentage	Std Error
Periodically	2	6.3	4.00
At the end of each shift	4	12.5	3.84
Immediately waste is generated	19	59.4	2.05
At the end of each working day	3	9.4	5.03
No segregation at all	4	12.5	4.00
Total	**32**	**100.0**	**1.71**

4.6 COLOUR CODING OF CONTAINERS

Table 4.10 shows the response of the matrons/heads of wards/units to the question on whether the containers for waste segregation are colour coded or not.

Table 4.10: Colour coding of containers used for waste segregation.

Practice	Number of wards/unit involved	Percentage	Std Error
Containers are colour coded	18	56.3%	2.35
Containers are not colour coded	10	31.3%	2.41
No segregation	4	12.5%	
Total	**32**	**100%**	**1.71**

4.7 ATTITUDE OF STAFF TOWARDS HEALTHCARE WASTE, OCCUPATIONAL PROTECTION AND TRAINING ON HEALTH CARE WASTE MANGEMENT

Table 4.11: Generation of Healthcare Waste in the Course of Duty

Designation	Generation of HCW during the course of duty		Total
	Yes	No	
Doctor	14	1	15
Nurse	35	0	35
Aux Staff	0	6	6
Ward Cleaner	0	7	7
Waste Handler	0	7	7
Total	**49**	**21**	**70**

Table 4.12: Attitude of workers to environmentally sound handling of health care waste in UATH.

		Attitude to Env. sound handling of waste			Total
		Respondents' responsibility	**Ward cleaners responsibility**	**Hospital management responsibility**	
Designation	Doctor	5	3	7	15
	Nurse	8	10	17	35
	Aux Staff	0	5	1	6
	Ward Cleaner	5	0	2	7
	Waste Handler	7	0	0	7
Total		25	18	27	70

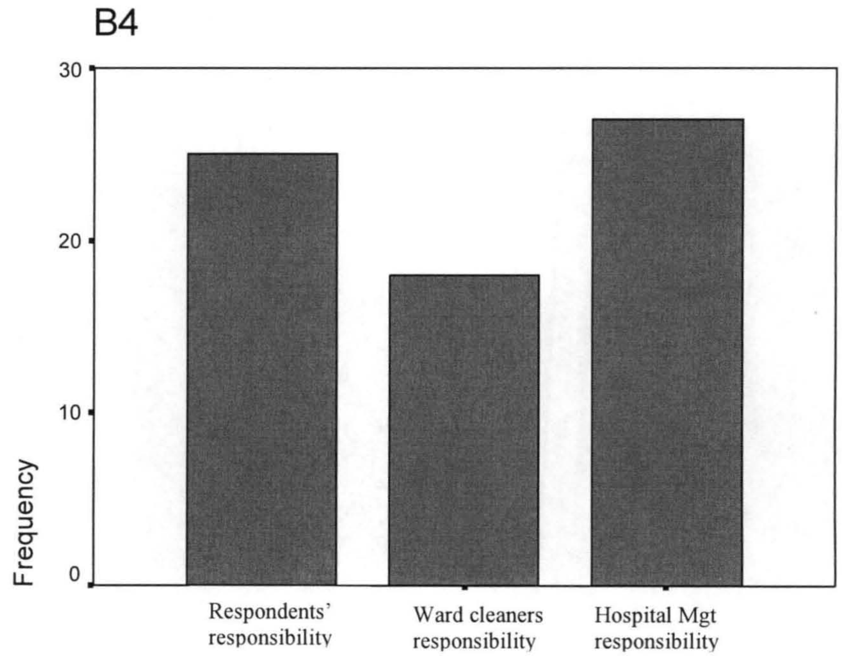

Figure 4.5: *Attitude to environmentally sound handling of health-care waste*

Table 4.13: Number of healthcare workers working in wards/units where waste segregation is practiced.

		Segregation of waste in worker's ward/unit		**Total**
		Yes	**No**	
Designation	Doctor	11	4	15
	Nurse	28	7	35
	aux Staff	1	5	6
	Ward Cleaner	4	3	7
	Waste Handler	0	7	7
Total		44	26	70

Table 4.14 shows the number of healthcare workers that use protective clothing in UATH. While table 4.15 shows the number of healthcare workers that are immunized against hepatitis and tetanus.

Table 4.14: Number of healthcare workers that use protective clothing in UATH

		Use of protective clothing		**Total**
		Yes	**No**	
Designation	Doctor	13	2	15
	Nurse	24	11	35
	aux Staff	3	3	6
	Ward Cleaner	7	0	7
	Waste Handler	5	2	7
Total		52	18	70

Table 4.15: Number of healthcare workers immunized against hepatitis and tetanus in UATH

Designation		**Immunization against hepatitis & tetanus**		**Total**
		Yes	**No**	
	Doctor	9	6	15
	Nurse	22	13	35
	aux Staff	1	5	6
	Ward Cleaner	1	6	7
	Waste Handler	0	7	7
Total		33	37	70

Table 4.16 depicts the incidence of needle prick injury amongst healthcare workers in UATH. Table 4.17 shows the number of the cases that were documented and table 4.18 shows the number that were treated with post exposure prophylaxis.

Table 4.16: Incidence of needle prick injury amongst healthcare workers in UATH

		Needle prick injury in last 6 months		**Total**
		Yes	**No**	
Designation	Doctor	4	11	15
	Nurse	2	33	35
	aux Staff	0	6	6
	Ward Cleaner	1	6	7
	Waste Handler	1	6	7
Total		8	62	70

Table 4.17: Documented cases of needle prick injury amongst healthcare worker in UATH

		Documentation of needle prick injury		Total
		Yes	No	
Designation	Doctor	1	3	4
	Nurse	0	2	2
	Ward Cleaner	0	1	1
	Waste Handler	0	1	1
Total		1	7	8

Table 4.18: Needle prick injuries treated with post-exposure prophylaxis in UATH

		Post exposure prophylaxis		Total
		Yes	No	
Designation	Doctor	1	3	4
	Nurse	0	2	2
	Ward Cleaner	0	1	1
	Waste Handler	0	1	1
Total		1	7	8

Tables 4.19 and 4.20 that received training on healthcare waste management in school and on the job respectively.

Table 4.19: Healthcare workers that received training on healthcare waste management in school.

		Training in school		Total
		Yes	No	
Designation	Doctor	9	6	15
	Nurse	19	16	35
	aux Staff	0	6	6
	Ward Cleaner	0	7	7
	Waste Handler	0	7	7
Total		28	42	70

Table 4.20: Healthcare workers that received training on healthcare waste management on the job.

		Training on the job		Total
		Yes	**No**	
Designation	Doctor	4	11	15
	Nurse	24	11	35
	aux Staff	1	5	6
	Ward Cleaner	1	6	7
	Waste Handler	0	7	7
Total		30	40	70

CHAPTER FIVE

DISCUSSION, SUMMARY, CONCLUSION AND RECOMMENDATION S

5.1 DISCUSSION

A total of 65,873.8kg of solid healthcare waste was generated during the period of the study. On a daily basis an average of 784.21kg of solid healthcare waste was generated. The highest quantity of waste of 911.92kg was generated on Thursday, while the lowest quantity of 607.50kg was generated on Sunday. There was no significant difference ($p < 0.05$) in the amount of waste generated on Monday, Tuesday Wednesday and Thursday, but the amount of waste generated on Sunday, Friday and Saturday was significantly lower ($p>0.05$) than the other four (4) days, although there is no significant difference ($p<0.05$) amongst these three days.

On a weekly basis, the highest quantity of 6,624kg was generated on the eighth week. The lowest quantity of 4,572kg was generated on the sixth week. The quantity of waste generated during the first week was significantly lower ($p<0.05$) than those of eighth and tenth weeks. But the quantity of waste generated in the third week was neither significantly lower nor significantly higher ($p<0.05$) than the quantity generated during any other week. The quantity of solid waste generated in the fourth week was significantly lower ($p>0.05$) than those of the eighth and tenth week, but was not significantly different from the other weeks. The quantity of solid waste generated in the fifth week was not significantly different from the other weeks, but it was significantly lower than that of the eighth week. The quantity of solid healthcare waste generated in the sixth week was significantly lower than those of the seventh, eighth and tenth weeks, but was not significantly different from the other weeks. In the seventh week, the quantity generated was not significantly different from the other weeks but significantly higher than that of the sixth week.

Although the quantity of solid healthcare waste generated was highest in the eighth week. But it was not significantly higher than those of the third, seventh, ninth, tenth, eleventh and twelfth weeks. In the ninth week, the quantity of waste generated was not significantly different from the other weeks, but it was significantly higher than those of second and sixth weeks. The quantity of waste generated in the tenth week was significantly higher than those of weeks one, two, four and six, while it is not significantly different from those of the other weeks. The quantity of waste generated in the eleventh and twelfth weeks followed the trend of the third week by not being significantly different from the waste generated in all the other weeks. Table 4.2 presents the weekly relationships in the quantity of waste generated in the twelve weeks of field study.

If the average daily waste generation of 784.21 kg is divided by 350, the number of beds in the hospital, we will arrive at a waste generation rate of 2.24kg/bed/day. Figures 4.1 and 4.2 depict the daily and weekly rates of generation of solid healthcare waste in UATH respectively.

Out of the 784.21kg of solid healthcare waste generated in the hospital, only 235.26kg is estimated to be infectious. If these wastes were properly segregated from the point of generation to final disposal, it is only this proportion of infectious waste that would require special treatment. The bulk of 448.95kg is harmless general waste and could join the municipal waste stream. The knowledge of the generation rate which is estimated to be 2.24kgkg/bed/day will enable the hospital management to forecast the future trend of solid healthcare waste generation and thus effectively plan and budget for waste management.

The factors responsible for daily and weekly variations in the quantity of solid waste generation were observed to be; the number of surgical operations performed, the number of child deliveries in the labour ward and the number of accidents and emergency cases. All of these mostly led to the generation of heavily blood soaked cotton gauze, bandages, sanitary pads and hand gloves. The quantity of waste generated reduced significantly ($p>0.05$) towards the weekend from Friday to Sunday as compared with the weekdays of Monday, Tuesday, Wednesday and Thursday. It was observed during the field study that patronage of the hospital reduced over the weekend. Units like General Outpatient Department, Paediatric/Maternity Outpatient Department, Dental clinic, Laboratory, Operating theatre, Radiology, Physiotherapy, Ante-natal clinic, Eye clinic, Ear, Nose and Throat clinic, Special Treatment Clinic, Family Planning Unit, National Programme on Immunization etc do not open to the public during weekends. Hence, lesser crowd of people was observed in the hospital on weekends than weekdays. This tends to be in agreement with the observation of Suwannee (2006) that the higher the number of patients the greater the waste generation. It is also in agreement with the observation of Hamoda (2005) of minimal collection of waste on weekends in Kuwait.

The solid waste generation of 2.24kg/bed/day is comparable and consistent with the rates obtained by Sumannee (2006) in Thailand and

Bassey *et al* (2005) in Abuja, Nigeria. It is also within the range observed by Johannessen (1997) for the low income Mediterranean area.

The result of the identification test carried out on the isolates from the soil of the healthcare waste dumpsite and the adjacent soil as presented on table 4.3 revealed the presence of the following bacteria species; *Citrobacter, Escherichia coli, Salmonella typhi, Pseudomonas aeroginosa, Staphylococcus aureus, Micrococcus* spp*, Proteus vulgaris* and *Aeromonas* spp. The most frequently isolated bacteria specie from the two soil samples was *Staphylococcus aureus.* It had 56.67% appearance from the soil of healthcare waste dumpsite and 50.00% appearance from the soil adjacent to the dumpsite. The bacteria specie was more frequently isolated from the soil of healthcare waste dumpsite than the soil adjacent to the dumpsite, and the difference is significant ($p>0.05$). The least frequently isolated bacteria from the soil of the healthcare waste dumpsite were *Citrobacter* spp*, Escherichia coli, Salmonella typhi and Aeromonas* spp. Also the least frequently isolated bacteria species from the soil adjacent to the dumpsite were *Citrobacter* spp and *Salmonella typhi*. Figure 4.3 presents the frequency of isolation of bacteria from the soils.

The result of the identification tests carried out on the soil of the healthcare waste dumpsite and adjacent soil revealed the presence of the following fungi species; *Aspergillus niger; Rhizopus nigrican; Candida albican; Fusarium gypsum; Penicillium viracadium; Microsporum canis; Geothricum* spp; *Sporothrix* spp; *Trichhophyton rubrum; Cladiosporum* spp and *Pityrosporum* spp. The frequency of isolation of fungi isolates identified is presented on table 4.4. The most frequently isolated fungi species from the soil of the healthcare waste dumpsite was *Aspergillus niger* followed by *Candida albican, Penicillium viricadium* and *Tricophyton rubrum*. Next were *Fusarium gypsum* and *Geothricum* spp. While the least were *Rhizopus nigrican, Microsporum canis, Sporothrix* spp. *Cladiosporium* spp *and Pityrosporium* spp. *Aspergillus niger* was also the most frequently isolated fungi species in the soil adjacent to the dumpsite. Figure 4.4 shows the percentage appearance of fungi species from the soil samples.

More bacteria species were isolated from the soil of the healthcare waste than the soil adjacent to the dumpsite, but not significantly more ($p<0.05$). But the bacteria species appeared to thrive more in the soil adjacent to the dumpsite except for *Staphylococcus aureus* that thrived more in the soil of the healthcare waste dumpsite. This may be due to the frequent burning that the healthcare waste is subjected to in the dumpsite, thereby making it less conducive to the growth of bacteria. Also the presence of chemicals in the healthcare waste dumpsite may act as anti-septic to bacteria. This agrees with Oyeleke *et al* (2008) that reported that the reason for the low level of microbial load could be due to antiseptic and other chemicals contained in the hospital wastes. Most of the bacteria were gram negative rods or bacilli (*Citrobacter* spp, *Escherichia coli, Salmonella typhi, Pseudomonas aeroginosa, Proteus vulgaris and Aeromonas* spp). The others were gram positive cocci (*Staphylococcus aureus and Micrococcus* spp). Gram negative bacilli (coliforms) like *Escherichia coli*, *Pseudomonas* spp and *Proteus* spp are implicated in cases of sepsis occurring in surgical wounds. Coliforms along with *Staphylococcus* spp are responsible for a large proportion of urinary tract infections in hospitals (Thomas 1973). These bacteria are therefore important causes of hospital acquired or nosocomial infections.

Also more fungi species ($p<0.05$) were isolated from and thrived more in the soil of the healthcare waste dumpsite than the soil adjacent to the dumpsite. This is also in agreement with Oyeleke *et al* (2008) who isolated most of these organisms. *Aspergillus niger* is an animal and human pathogen that causes diseases collectively known as aspergillosis as reported by Oyeleke *et al* (2008). Similar to the observation of Oyeleke *et al* (2008), *Microsporum canis* was one of the least frequently isolated fungi species. This organism was reported by Ernest *et al* (1984) to be the cause of dermatitis in cats and dogs which can be transmitted to humans. *Candida albicans* is reported by Cheesbrough (2000) to be the cause of candidiasis.

The pH of hospital dumpsite soil ranged from 6.8 to 9.2, while that of the adjacent soil ranged from 6.74 to 7.89 as shown on table 4.5. The result show that the pH value of the soil of the healthcare waste dumpsite is not significantly higher ($p<0.05$) than that of the adjacent soil. The moisture content of the soil of the healthcare waste dumpsite ranged from 3.6% to 7.6%. While that of the adjacent soil ranged from 3.6% to 6.9% but there is a significant difference between them ($p>0.05$). The higher pH of the soil of the healthcare waste dumpsite is similar to the observation of Oyeleke *et al* (2008). According to Oyeleke *et al* (2008) this may be as a result of the ash being generated from open burning of waste.

The task of cleaning the hospital is contracted to a private company that approaches the task strictly from the point of view of housekeeping, without any special regard for infectious healthcare waste. To discharge its contractual obligations the company employs a barely literate workforce, mostly women, as ward cleaners and waste handlers. The workforce that is lacking of any training whatsoever in healthcare waste management go about sweeping, mopping and disposing of various kinds of waste emanating from the wards/units, under the watchful eyes of their supervisors who equally had no training in healthcare waste management. The cleaning personnel indiscriminately empty waste containers from the wards/units into the twenty (20) number 120 litre temporary storage bins, placed haphazardly outside the wards/units (Plate I). An examination of the temporary storage bins revealed odd mixture of different types of healthcare waste like blood soaked bandages, cotton gauze and sanitary pads; used intravenous infusion sets; bottles and glass; filled safety boxes; unused drugs; aerosol cans; packaging for drugs, equipment, food and sachet water; food remnants; paper; grass and lawn trimmings etc (Plates II and III). Field observations reveal that healthcare wastes are dumped in an unfenced and unsecured open dumpsite in the hospital (Plate IV). Highly infectious and infectious wastes from the laboratory and wards/units are dumped openly without any pre-treatment whatsoever (Plate V). The wastes were conveyed to the open dumpsite, which is about 25m from the last unit of the hospital, in the temporary storage bins early in the morning and in the afternoon by wastes handlers working in two shifts. The dumpsite is openly patronized by flies, rodents, birds, domestic animals (like dog, goats, chicken, cattle) and human scavengers. Bon fire is made of the dumpsite periodically, during which sounds of exploding bottles and aerosol cans rent the air. The immediate vicinity of the dumpsite was covered in thick smoke during this period. However the waste was left unburnt for several weeks during the rainy season because of wetness. The immediate vicinity of the dumpsite was overwhelmed by putrefying odour while flies were having a field day on the accumulated wastes. Although there is a pyrolitic incinerator (Plate VI) installed in the hospital premises, field investigations revealed that it was never commissioned for use and open dumping and burning has been the method of choice since the inception of the hospital.

The environmental department which was, hitherto, in charge of waste management was scrapped and its entire staff was laid off earlier in the year hence the cleaning service was contracted to the private company. Apparently, this is in line with the downsizing policy of the Federal government, which encourages out-sourcing of non-core services in order to engender a more focused and efficient service delivery to the public. Field investigations revealed that the hospital neither has a waste management committee nor an infection control committee and the task of cleaning the hospital is purely housekeeping and administrative one.

The University of Abuja Teaching Hospital is a major source of healthcare waste. However, it was observed that the hospital management does not consider healthcare waste management in such a hospital as a major task, which requires careful planning and implementation by well trained personnel. The present waste management practice in the hospital falls short of the requirements for the environmentally sound handling of healthcare waste recommended by SBC/UNEP and WHO (2005). It is also in violation of the "duty of care" and the "precautionary" principles of Stockholm and Basel Conventions.

Appendix III presents the wards/units where segregation of waste is practiced in UATH. Twenty-seven (27) matrons/unit heads claimed that segregation of waste is practiced in their wards/units. While five (5) matrons/unit heads admitted that waste segregation is not practiced in their wards/units. Therefore segregation of solid healthcare waste takes place in 84% of the thirty-two (32) wards/units while it does not take place in 15.65%. There is a significant difference ($p>0.05$) between the wards/units that segregate waste and those who do not. The five (5) units where segregation of waste does not take place are, Paediatric/Maternity Outpatient Department, Dental clinic, Family Planning, Surgical Outpatient Department and Physiotherapy (Appendix III). Field observation revealed that these units are light generators of infectious healthcare waste. They hardly generated blood soaked cotton, bandages and sharps. Although, the disposition of the few syringes and needles used in these units along with the general waste stream may be overlooked because of the extremely small quantity involved, but the need to institute a uniform code of healthcare waste management practice in the hospital will not permit this. Especially considering the fact that doctors and nurses who may have become accustomed to this practice in the above mentioned units may find it difficult to adjust when they find themselves working in other wards/units where large quantities of infectious solid healthcare waste are generated.

Table 4.6 depicts the types of waste that is segregated from the general waste stream in the wards and units of UATH. Nine (9) wards/units representing 28.1% of the wards/units segregate only sharp, most especially needles and syringes, from the general waste stream. Two (2) wards/units (6.3%) segregate general waste and sharp only. Ten (10) wards/units (31.3%) segregate infectious waste and sharp. Seven (7) wards/units (21.9%) segregate all the waste categories, while four (4) wards/units segregate none of the waste categories. There is a significant difference ($p>0.05$) in the response of the wards/units.

The focus of waste segregation efforts differ from ward to ward in the hospital. A critical analysis of the responses of matrons/heads of wards/units reveal that proper segregation of solid healthcare waste into the three (3) categories recommended by SBC/UNEP and WHO (2005) takes place only in 21.9% of the wards/units ($p>0.05$). Improper segregation of solid healthcare waste takes place in the majority (65.7%) of the wards/units because they have only two receptacles for solid healthcare waste. Sharp wastes go into sharp boxes while the general waste and the infectious waste are mixed together in the same receptacle. Another 12.5% of the wards/units do not segregate waste at all. This fact is borne out during field observation. It was observed that most of the wards/units mix their general wastes and infectious wastes together, although, most of them segregate sharps properly in sharp boxes. Field investigations reveal that a non-governmental organization, Making Medical Injection Safe (MMIS), which is funded by United States Agency for International Development (USAID) donates sharp boxes to the hospital. The Federal Ministry of Health also donated yellow coloured buckets for infectious waste. The provision of materials for the segregation of waste in the hospital is externally driven and sustained, but not through the direct efforts of the hospital management.

The responses of the matrons and heads of wards and units reveal that the choice of containers or bags used to segregate solid healthcare waste vary among wards and units. As shown on table 4.7 it was observed that only 46.9% ($p>0.05$) use cardboard safety boxes for sharp waste and plastic buckets for infectious waste as recommended by SBC/UNEP and WHO (2005). 25% use only plastic buckets. 9.4% use only cardboard boxes. Another 9.4% use anything they can lay their hands on. 6.3% use cardboard boxes, plastic buckets and polythene bags. 3.1% use polythene bags and cardboards boxes. SBC/UNEP and WHO (2005) recommended the use of cardboard safety box and plastic bucket, amongst others, for segregation sharps and other waste categories respectively. This is because safety box prevents injury from sharps while plastic bucket prevents seepage of body fluids (e.g. blood and vomit).

As shown on Table 4.8, in 6.3% of the wards and units of UATH it is the medical doctors that segregate the waste. In 21.9%, it is the nurses and in 18.8%, it is the ward cleaners. Doctors and Nurses segregate the waste in

15.6% of the wards and units. In 3.1%, it is Nurses and Ward cleaners that segregate the wastes. Doctors, Nurses and Ward cleaners segregate the waste in another 21.9%, while nobody segregates the waste in 12.5%. There is a significant difference ($p>0.05$) in the responses. According to SBC/UNEP and WHO (2005), segregation of waste should be done by the person generating the waste. In a typical hospital setting, most of the infectious wastes and sharps wastes are generated in the course of medical treatment of patients by doctors and nurses. Therefore segregation of these wastes should be done by them. If wastes were segregated by the person generating them the possibility of contamination of harmless general waste and infection during sorting will be drastically reduced. Ward cleaners should only be involved in waste segregation in case of ward sweeping and accidental waste spillage. The recommendation of SBC/UNEP and WHO (2005) and Pruss *et al* (1999) and WHO (2002) is that segregation of wastes should be done immediately it is generated by the person generating it. Table 4.9 shows that, 59.4% of the wards and units in UATH segregation of waste take place immediately it is generated. But segregation of waste takes place at various times such as periodically (6.3%), at the end of each working day (9.4%), no segregation at all (12.5%) in the rest of the wards. Again there is a significant difference ($p>0.05$) in the timing of segregation of waste amongst the wards/units. It is observed that almost 60% of the wards in the hospital comply with the recommendation for timing of segregation of waste. The number of wards/units that segregate waste on time is significantly higher ($p>0.05$) than those who do not segregate waste on time. The wards/units who do not segregate solid healthcare waste on time pose grave danger to the wellbeing of health workers, especially waste handlers, who are saddled with the duty of sorting the mixed up waste.

As depicted on Table 4.10, more than half of the wards and units use colour coded containers to segregate solid healthcare waste and they are significantly more ($p>0.05$) in number than the wards and units that do not use colour coded containers. But only 66.7% of those that responded "yes" could say precisely the colour codes that were used for general wastes and infectious wastes in their units. Appendix IV depicts the colour codes that are used in different wards/units of the hospital for the segregation of general waste and infectious waste. It was observed that the SBC/UNEP and WHO (2005) recommended colour codes of black for general non-risk wastes and yellow for infectious wastes was employed in Male Surgical ward, Gynaecology ward and Ear Nose and Throat clinic. Others adopted various colour codes to segregate their wastes. Some of the other colour combinations used were yellow for general wastes and red for infectious wastes in Special Care Baby Unit; orange for general wastes and white for infectious wastes in Intensive Care Unit etc. The most amazing colour combination was in Female Medical ward, where yellow was used for general waste and black for infectious wastes. This colour code is the direct opposite of the recommendation of SBC/UNEP and WHO (2005) on colour coding of containers for segregation of healthcare wastes. Going by field observations the situation in UATH as far as colour coding of containers for segregation of wastes is concerned, could be described as a "colour riot" as each ward/unit segregated its wastes with any combination that caught its fancy. The hospital does not have any policy regarding colour coding of containers for waste segregation. This negates the recommendation of SBC/UNEP and WHO (2005) that a simple and uniform colour coding should be applied throughout a country. The practice of using multiple colour codes in one hospital is fraught with danger as medical personnel and wastes handlers have to memorize the colour codes in use in all the wards and units. This is cumbersome and staff members who find themselves posted to new wards/units may find it difficult to adjust to colour codes in use in their new duty posts, hence the danger of mixing together of different kinds of wastes. This is similar to the observations of Longe and Williams (2006) in some hospitals in Lagos.

However, field observation revealed that there is no attempt whatsoever to segregate waste in the temporary storage rubbish bins in the hospital. The practice of mixing all kinds of waste together in the temporary storage bins in UATH has the effect of nullifying the little attempt made at segregating waste at the wards/units. It also tends to discourage personnel central to waste management because, there is no point in taking the pains to segregate waste in the wards/units, only for them to be mixed together in the temporary storage bins. Consequently, healthcare waste in the hospital becomes 100% infectious (Chandra 1999; SBC/UNEP and WHO 2005). This is similar to observations made by Rasheed *et al* (2005) in Karachi and Longe and Williams (2006) in Lagos. The implication is that, instead of between 10% - 25% of the total waste stream that should be regarded as potentially infectious requiring special treatment (Pruss *et al* 1999; Chandra 1999; Coker *et al* 1999 and Suwannee 2002), the whole waste stream has become potentially infectious. The potential threat to human beings, animals and the environment is multiplied. The cost of waste management is increased. Also the opportunity for recycling materials like paper, cardboard, nylon, plastic, bottles etc. is seriously hampered because all wastes have become potentially infectious, hence the potential of generating employment and income from the recycling of healthcare wastes is drastically reduced in UATH. Oyeleke *et al* (2008) reported the following as some of the hazards associated with open and unsecured solid healthcare waste dumpsite: pathogens present in wastes can leach out and contaminate ground water and surface water; harmful chemicals present in biomedical waste such as heavy metals can also cause water pollution and excess nutrient leachate such as nitrates and phosphates can cause a phenomenon called eutrophication. The method of open burning of potentially infectious solid healthcare waste is filled with public health and environmental hazards. Some of the hazards include the release of dioxins and furans which are known carcinogens, from the combustion of the plastic products which were abound in the open dumpsite. Incomplete combustion of wastes that takes place during the open burning of solid healthcare wastes exposes human beings, animals and the environment to the risk of infection from the pathogenic microorganisms contained in the waste. The release of green house gases like methane, carbon dioxide, carbon monoxide, nitrogen oxides etc will contribute to global warming and climate change. In fact open dumping and burning of infectious solid healthcare waste is a violation of "duty of care" principle. It also contravenes SBC/UNEP and WHO (2005) recommendations that highly infectious wastes from medical laboratories should be pre-treated immediately with sodium hypochlorite solution, before joining other medical wastes. Land disposal of untreated healthcare wastes is not recommended and should only be used as a last resort and should be done only in a sanitary land fill. This unwholesome treatment of healthcare wastes is similar to the observations of Oyeleke *et al* (2008), Bassey *et al* (2006), Longe and Williams (2006), Manyele and Anicetus (2006), Rasheed *et al* (2005), Asuquo *et al* (2003) Suwannee (2002), Nessa *et al* (2001) and Coker *et al* (1999).

Table 4.11 shows the response of the staff central to healthcare waste management to the question whether healthcare waste was being produced during the course of discharging their duties. Fourteen (14) of the doctors ($p<0.05$) said that healthcare waste was being generated in the course of discharging their duties. While only one doctor ($p<0.05$) said healthcare waste not generated during the course of discharging his duty. All the nurses ($p<0.05$) admitted that healthcare waste was being generated in the course of discharging their duties. Also all the workers in the categories of auxiliary staff, ward cleaners and waste handlers

(AUX/WC/WH) said no healthcare waste was generated in the course of discharging their duties.

Attitudes towards the environmentally sound handling of healthcare waste vary among the different categories of workers in the hospital as depicted on Table 4.12 and Figure 4.5. Only five (5) of the doctors ($p<0.05$) felt that the environmentally sound management of the healthcare waste generated in the course of their duty was their responsibility. Three (3) of the doctors ($p<0.05$) felt that it is the responsibility of ward cleaners and seven (7) felt it is the responsibility of the hospital management. Eight (8) nurses ($p<0.05$) felt that the environmentally sound handling of the healthcare waste generated in the course of discharging their duties is their responsibility. 10 ($p<0.05$) of the nurses felt that it is the responsibility of wards cleaners and 17 felt it is the responsibility of the hospital management. Although workers in the category of auxiliary, ward cleaners and waste handlers, do not generate healthcare waste in the course of discharging their duties but twelve (12) of them ($p<0.05$) felt that the environmentally sound handling of the waste is their responsibility. Five (5) of them, who are auxiliary staff ($p< 0.05$) felt it is the responsibility of the ward cleaners and three (3) ($p< 0.05$) felt it is the responsibility of the hospital management. The attitudes of 66.7% of the doctors and 76.1% of the nurses go against the international convention which says that the environmentally sound handling of healthcare waste is the responsibility of the person generating it. The other categories (auxiliary staff, ward cleaners and waste handlers), although traditionally poorly educated, have a more altruistic attitude towards environmentally sound handling of healthcare waste. This is probably due to their designation as waste cleaners and waste handlers. The doctors and nurses appear to be snobbish of the waste generated by them, probably due to the elitist natures of their jobs.

Eleven (11), twenty-eight (28) and five (5) of the doctors, nurses and auxiliary staff, ward cleaners and waste handlers respectively are working in wards/units where waste segregation is practiced as depicted on table 4.13. 26.7%, 20% and 75% of the doctors, nurses and auxiliary staff, ward cleaners and waste handlers respectively are not working in an environment where they are made to handle waste in an environmentally sound manner. Although the proportion of personnel not working in wards/units where waste is handled in an environmentally sound manner is not significant ($p<0.05$) for doctors and nurses, but the activities of this minority group may thwart the effort of the majority, especially when they find themselves working alongside each other. This minority group may find it difficult to adjust to doing the correct thing. Their attitude towards waste segregation may also discourage those who are used to segregating their waste. Especially if the errant personnel happen to be senior and respected staff members who can influence their subordinates. In the wards/units where waste segregation is practiced, all categories of workers appear to be involved in the exercise.

As shown on table 4.14 fifty-two (52) workers use protective clothing while eighteen (18) workers do not. The number of healthcare workers who use protective clothing in UATH is not significantly higher ($p<0.05$) than that of those who do not. 74.3% of the workers use protective clothing while 25.7% do not. This is somewhat similar to the observation of Asuquo *et al* (2003) in University of Calabar Teaching Hospital.

Table 4.15 depicts the number of personnel that were immunized against hepatitis and tetanus. Nine (9) doctors were immunized against hepatitis and tetanus while six (6) doctors were not. Twenty-two (22) nurses were immunized against hepatitis and tetanus and thirteen (13) were not so immunized. But only two (2) of the personnel in the category of auxiliary staff, ward cleaners and waste handlers were immunized. The level of immunization against hepatitis and tetanus amongst doctors and nurses is above average but not significantly ($p<0.05$). One would have expected a higher level of immunization amongst professionals who are the elites of the medical profession. Little wonder then that the level of immunization is very low amongst personnel of lower cadre. The occupational health of healthcare worker is not accorded the level of importance it deserves especially amongst personnel of lower cadre who by the nature of their jobs are prone to injury and infection from sharps.

As shown on Table 4.16, the incidence of needle prick injury is highest amongst medical doctors in UATH, representing 50% ($p>0.05$) of the cases in the last six months. Four (4) doctors have experienced needle prick injury in the last six months as compared to two (2) nurses and two (2) workers in the category of auxiliary staff, ward cleaners and waste handlers. The incidence of needle prick injury is significant ($p>0.05$) amongst healthcare workers in the hospital. Only one (1) of the eight (8) cases of needle prick injury in the hospital in the last six (6) months was documented and only one victim, a medical doctor took post exposure prophylaxis as shown on tables 4.17and 4.18 respectively. 87.5% of the needle prick injuries in the hospital in the last six months were undocumented and untreated. This is indicative of the low level of importance attached to the risk of infection from deadly diseases such as hepatitis, tetanus and HIV amongst healthcare workers in the hospital. This lackadaisical attitude is surprising in view of the fact that almost all the respondents claimed to be aware of the hazards inherent in healthcare waste.

As shown on table 4.19 and 4.20 respectively nine (9) doctors received training on healthcare waste management while in school and only four (4) received training on healthcare waste management on the job. Nineteen (19) nurses received training on healthcare waste management while in school and twenty-four (24) received training on the job. While none of the lower cadre workers received training on healthcare waste management in school and only two were trained on the job. Significantly more ($p>0.05$) doctors received training on healthcare waste management in school than nurses. While significantly more ($p>0.05$) nurses have received training on healthcare waste management on the job than medical doctors. More nurses took advantage of a week seminar organized in the hospital by the Federal Ministry of Health during the field study of this research. Only 10% of the workers in the category of auxiliary staff/ward cleaners/waste handlers received on the job training in healthcare waste management. Considering their lack of prior training in healthcare waste management, and their vital role in the management of healthcare waste, more of these low cadre workers should have been encouraged to take advantage of the one week seminar organized by the Federal Ministry of Health. Also the syllabus of the Schools of Nursing and Midwifery should be planned in such a way as to expose more of them to training on healthcare waste management while in school. While more doctors should be encouraged to avail themselves of on the job opportunities to update their knowledge of healthcare waste management.

Most ($p>0.05$) of the hospital workers central to healthcare waste management, of all categories, are aware of the potential hazards inherent in healthcare waste. This is in contrast to the observation of Pandit *et al* (2005) in India, where most of the doctors were aware of the potential risk of infection inherent in healthcare waste, but the auxiliary staffs (ward boys, sweepers, etc.) were not aware.

5.2 SUMMARY

i. A total of 65,873kg of solid healthcare waste was generated at the rate of 2.24kg/bed/day during the 12 weeks of study.

ii. The soil of the hospital's healthcare waste contains some pathogenic bacteria and fungi.

iii. The pH of the soil of the healthcare waste dumpsite was significantly higher than that of the adjacent soil.

iii. Segregation of healthcare waste takes place in 84.45% of the wards and units but only 21.9% had provision for the segregation into the three categories recommended by SBC/UNEP (2005).

iv. There is no uniform colour coding of containers used for waste segregation in the hospital.

v. All categories of solid healthcare waste are mixed together at temporary storage, untreated and openly dumped in UATH.

5.3 CONCLUSION

The University of Abuja Teaching Hospital is a 350 bed medical facility and generates solid healthcare waste at the rate of 2.24kg/bed/day. These wastes are not properly segregated, untreated, dumped openly in the hospital premises and constitute a health hazard to the hospital workers, patients, the general public and the environment. The management of solid healthcare waste in the hospital is improper and environmentally unsound and contravenes major international conventions to which Nigeria is a signatory.

5.4 RECOMMENDATIONS

The need to institute proper and environmentally sound management of healthcare waste in UATH cannot be overemphasized. Apart from the "duty of care" imposed on it by international conventions, the hospital as a training ground for different categories of healthcare workers, owes the society the duty of instilling the etiquette of proper and environmentally sound management of healthcare waste in its students from the beginning of their training. There is no better way of doing this than the example of its own practice.

The following recommendation should be considered as part of efforts to institute proper and environmentally sound management of healthcare waste in the hospital.

1. Setting up a waste management committee and appointment of a waste management officer who will be responsible for the waste management plan in the hospital.
2. Waste reduction, reuse and recycling should be the aim of the waste management plan.

3. Formulation of a code of practice that will stipulate and enforce a uniform practice of solid healthcare waste segregation and colour coding from the generation point to final disposal.
4. Infectious healthcare waste should be adequately treated before joining the general waste stream.
5. Healthcare workers central to the management of healthcare waste should be properly trained. And also adequate protection against hazards should be given to them. Especially in the area of immunization against infectious diseases such as hepatitis and tetanus.

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APPENDIX I

SURVEY QUESTIONNAIRE FOR HEALTHCARE WASTE MANAGEMENT

QUESTIONNAIRE 1

(To be completed by matrons/heads of units/wards)

SECTION A: WARD INFORMATION

Name of Ward ....

No. of-in-patients: ..../ day

No. of out-patients: ..../ day

No. of beds (total): ..../day

Average number of beds occupied/day

SECTION B: SEGREGATION OF WASTE

1. Is segregation of waste practiced in your unit/ward? Yes [ ]
   No [ ]
2. If yes, indicate ✓ against any of the following wastes that are segregated from the general stream.
   General Waste [ ] Infection Waste [ ] Sharps [ ]
3. What type of containers/bags is used to segregate the waste?
   Polythene bags [ ] Cardboard boxes [ ] Plastic buckets [ ]
   Anything available [ ]
4. Who does the segregation? Indicate ✓ against any of the applicable options. Doctors [ ] Nurses [ ] Ward cleaners [ ]
   Others [ ] Specify ....
5. When is waste segregation done in your ward/unit?

Periodically [ ] At the end of each shift [ ]

Immediately waste is generated [ ] At the end of each working day [ ]

SECTION C: COLOUR CODING AND LABELLING

6. Are the containers used for waste segregation colour-coded/labeled? Yes [ ] No [ ]

7. If yes, what type of colour-code/label is used for:

   a. General waste ……………………………………………………

   b. Infectious waste ……………………………………………………..

SECTION D: SHARP MANAGEMENT

8. What types of containers are used to segregate sharps?

   Safety boxes [ ] Plastic buckets [ ] Metal containers [ ]

   Others [ ] specify ……………………………………………………

9. On the average estimate how many injections are administered to patients per day in your ward? ………………………………/day

10. Apart from injection what other procedures are syringes and needles used for in your ward? Taking of blood fluid specimen [ ]

    Intravenous infusion [ ] Mixing of drugs/solvents [ ]

    Others [ ] specify ……………………………………………………

11. Estimate average number of syringes and needles used per day for 10 above in your ward/unit? ………………………..

12. What type of syringes and needles are used? Disposable [ ]
Reusable [ ]

13. Is there a manual or guidelines on management of healthcare waste in your ward/unit? Yes [ ] No [ ]

14. If yes, give the title of the document. ....

APPENDIX II

SURVEY QUESTIONNAIRE FOR HEALTHCARE WASTE MANAGEMENT

QUESTIONNAIRE 2

(To be completed by doctors, nurses, auxiliary staff, ward cleaners, waste handlers)

SECTION A: PERSONAL INFORMATION

1. What is your designation? Doctor [ ] Nurse [ ] Auxiliary staff [ ]

   Ward cleaner [ ] Waste handlers [ ]

2. What is your sex? Female [ ] Male [ ]

SECTION B: WASTE INFORMATION

3. Is healthcare waste generated during the course of discharging your duty? Yes [ ] No [ ]

4. The environmentally sound handling of the waste is?

   My responsibility [ ]

   Responsibility of Ward cleaners [ ]

   Responsibilities of Hospital Management [ ]

5. Is waste segregated in your ward/unit?Yes [ ] No [ ]

   If yes, by whom?

   By the doctors [ ] By the Auxiliary staffs [ ] By the waste handlers [ ]

   By the Nurses [ ] By ward cleaners [ ]

SECTION C: OCCUPATIONAL PROTECTION

6. Do you use protective clothing? Yes [ ] No [ ]
7. Are you immunized against hepatitis B and C and tetanus?
   Yes [ ] No [ ]

SECTION D: TRAINING

8. Have your received any form of training in healthcare waste management?
   (a) In School Yes [ ] No [ ]
   (b) On the job Yes [ ] No [ ]

   If yes, what type?

   ....

   ....

9. What is the duration of the course? ....

   ....

10. Have you experienced needle prick injury in the last 6 months?
    Yes [ ] No [ ]
11. If yes, was the incident documented? Yes [ ] No [ ]
12. If yes, did you take post-exposure prophylaxis? Yes [ ] No [ ]
13. Are you aware of the potential hazard inherent in healthcare waste?
    Yes [ ] No [ ]
14. If yes name few?

    ....

    ....

    ....

    ....

Appendix III: *Practice of Waste Segregation in Wards/Units of UATH*

S/N	WARD/UNIT	RESPONSE	
		YES	NO
1.	Special Care Baby Unit		✓
2.	Paediatric/Maternity Outpatient Dept.	✓	
3.	Emergency Paediatric Unit	✓	
4.	Paediatric Medical & Surgical	✓	
5.	Male Surgical Ward	✓	
6.	Female Surgical Ward	✓	
7.	Male Medical Ward	✓	
8.	Female Medical Ward	✓	
9.	Ante Natal Clinic	✓	
10.	Labour Ward	✓	
11.	Post Natal Ward	✓	
12.	Gynaecology Ward	✓	
13.	Accidents & Emergency	✓	
14.	Casualty	✓	
15.	Operating Theatre	✓	
16.	Intensive Care Unit	✓	
17.	Haemodialysis	✓	
18.	Dental Clinic		✓
19.	Eye Clinic	✓	
20.	Eye Ward	✓	
21.	Eye Theatre	✓	
22.	Ear Nose and Throat Clinic	✓	
23.	Immunology Laboratory	✓	
24.	Sampling Room	✓	
25.	National Programme on Immunization	✓	
26.	Family Planning Unit		✓
27.	Special Treatment Clinic	✓	
28.	General Outpatient Department	✓	
29.	Surgical Outpatient Department		✓
30.	Radiology Unit	✓	
31.	Physiotherapy		✓
32.	Pharmacy Department	✓	
	Frequency	27	5
	Percentage	84.4%	15.6%

***Appendix** IV: Coloured codes used in wards/units of UATH for segregation of general and infectious wastes.*

S/N	Ward/Unit	Colour Code	
		General Wastes	Infectious Wastes
1.	Special Care Baby Unit	Yellow	Red
2.	Paediatric/Maternity Outpatient Dept	-	-
3.	Emergency Paediatric Unit	-	-
4.	Paediatric Medical & Surgical	Blue/Green	Yellow
5.	Male Surgical Ward	Black	Yellow
6.	Female Surgical Ward	Yellow	-
7.	Male Medical Ward	-	-
8.	Female Medical Ward	Yellow	Black
9.	Ante Natal Clinic	-	-
10.	Labour Ward	-	-
11.	Post Natal Ward	-	-
12.	Gynaecology Ward	Black	Yellow
13.	Accidents and Emergency Ward	Blue/Green	Yellow
14.	Casualty Ward	-	Yellow
15.	Operating Theatre	-	-
16.	Intensive Care Unit	Orange	White
17.	Haemodialysis	-	-
18.	Dental Clinic	-	-
19.	Eye Clinic	-	-
20.	Eye Ward	Black	Red
21.	Eye Theatre	-	-
22.	ENT Clinic	Black	Yellow
23.	Immunology Laboratory	-	-
24.	Sampling Room	Blue	Red
25.	National Programme on Immunization	Yellow	-
26.	Family Planning Unit	-	-
27.	Special Treatment Clinic	Red	-
28.	General Outpatient Department	White	Yellow
29.	Surgical Outpatient Department	-	-
30.	Radiology Unit	-	-
31.	Physiotherapy	-	-
32.	Pharmacy Department	Brown/Black	Red

APPENDIX V

Descriptives
TOTALHCW

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
1.00	12	607.5000	237.8237	68.6538	456.3941	758.6059	432.00	1152.00
2.00	12	861.8333	112.5295	32.4845	790.3355	933.3311	676.00	1116.00
3.00	12	900.8333	116.2676	33.5636	826.9604	974.7062	720.00	1116.00
4.00	12	884.4000	112.6909	32.5310	812.7996	956.0004	720.00	1062.00
5.00	12	911.9167	173.4948	50.0836	801.6833	1022.1500	684.00	1242.00
6.00	12	696.0000	158.2909	45.6946	595.4268	796.5732	468.00	900.00
7.00	12	627.0000	206.2100	59.5277	495.9804	758.0196	468.00	1152.00
Total	84	784.2119	203.6020	22.2148	740.0276	828.3962	432.00	1242.00

ANOVA
TOTALHCW

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1316349.898	6	219391.650	7.952	.000
Within Groups	2124312.770	77	27588.478		
Total	3440662.668	83			

Multiple Comparisons
Dependent Variable: TOTALHCW
LSD

(I) DAY	(J) DAY	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
1.00	2.00	-254.3333	67.8091	.000	-389.3586	-119.3081
	3.00	-293.3333	67.8091	.000	-428.3586	-158.3081
	4.00	-276.9000	67.8091	.000	-411.9252	-141.8748
	5.00	-304.4167	67.8091	.000	-439.4419	-169.3914
	6.00	-88.5000	67.8091	.196	-223.5252	46.5252
	7.00	-19.5000	67.8091	.774	-154.5252	115.5252
2.00	1.00	254.3333	67.8091	.000	119.3081	389.3586
	3.00	-39.0000	67.8091	.567	-174.0252	96.0252
	4.00	-22.5667	67.8091	.740	-157.5919	112.4586
	5.00	-50.0833	67.8091	.462	-185.1086	84.9419
	6.00	165.8333	67.8091	.017	30.8081	300.8586
	7.00	234.8333	67.8091	.001	99.8081	369.8586
3.00	1.00	293.3333	67.8091	.000	158.3081	428.3586
	2.00	39.0000	67.8091	.567	-96.0252	174.0252
	4.00	16.4333	67.8091	.809	-118.5919	151.4586
	5.00	-11.0833	67.8091	.871	-146.1086	123.9419
	6.00	204.8333	67.8091	.003	69.8081	339.8586
	7.00	273.8333	67.8091	.000	138.8081	408.8586
4.00	1.00	276.9000	67.8091	.000	141.8748	411.9252
	2.00	22.5667	67.8091	.740	-112.4586	157.5919
	3.00	-16.4333	67.8091	.809	-151.4586	118.5919

	5.00	-27.5167	67.8091	.686	-162.5419	107.5086
	6.00	188.4000	67.8091	.007	53.3748	323.4252
	7.00	257.4000	67.8091	.000	122.3748	392.4252
5.00	1.00	304.4167	67.8091	.000	169.3914	439.4419
	2.00	50.0833	67.8091	.462	-84.9419	185.1086
	3.00	11.0833	67.8091	.871	-123.9419	146.1086
	4.00	27.5167	67.8091	.686	-107.5086	162.5419
	6.00	215.9167	67.8091	.002	80.8914	350.9419
	7.00	284.9167	67.8091	.000	149.8914	419.9419
6.00	1.00	88.5000	67.8091	.196	-46.5252	223.5252
	2.00	-165.8333	67.8091	.017	-300.8586	-30.8081
	3.00	-204.8333	67.8091	.003	-339.8586	-69.8081
	4.00	-188.4000	67.8091	.007	-323.4252	-53.3748
	5.00	-215.9167	67.8091	.002	-350.9419	-80.8914
	7.00	69.0000	67.8091	.312	-66.0252	204.0252
7.00	1.00	19.5000	67.8091	.774	-115.5252	154.5252
	2.00	-234.8333	67.8091	.001	-369.8586	-99.8081
	3.00	-273.8333	67.8091	.000	-408.8586	-138.8081
	4.00	-257.4000	67.8091	.000	-392.4252	-122.3748
	5.00	-284.9167	67.8091	.000	-419.9419	-149.8914
	6.00	-69.0000	67.8091	.312	-204.0252	66.0252

* The mean difference is significant at the .05 level.

Descriptives
TOTALHCW

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean Lower Bound	Upper Bound	Minimum	Maximum
1.00	7	683.4000	138.1134	52.2020	555.6664	811.1336	540.00	828.00
2.00	7	671.4286	205.2436	77.5748	481.6099	861.2473	468.00	936.00
3.00	7	745.7143	221.6406	83.7723	540.7309	950.6977	468.00	972.00
4.00	7	711.7143	194.3620	73.4619	531.9595	891.4691	468.00	936.00
5.00	7	720.0000	148.4318	56.1019	582.7235	857.2765	540.00	864.00
6.00	7	653.1429	156.1318	59.0123	508.7450	797.5407	468.00	828.00
7.00	7	874.2857	277.2735	104.7995	617.8505	1130.7209	486.00	1242.00
8.00	7	946.2857	211.6709	80.0041	750.5228	1142.0486	612.00	1152.00
9.00	7	882.0000	199.6297	75.4529	697.3734	1066.6266	468.00	1062.00
10.00	7	920.5714	258.0199	97.5224	681.9428	1159.2001	432.00	1188.00
11.00	7	799.7143	112.8210	42.6423	695.3723	904.0563	684.00	1008.00
12.00	7	802.2857	71.1377	26.8875	736.4943	868.0771	720.00	900.00
Total	84	784.2119	203.6020	22.2148	740.0276	828.3962	432.00	1242.00

ANOVA
TOTALHCW

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	798195.891	11	72563.263	1.977	.043
Within Groups	2642466.777	72	36700.927		
Total	3440662.668	83			

Multiple Comparisons
Dependent Variable: TOTALHCW
LSD

(I) WEEK	(J) WEEK	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
1.00	2.00	11.9714	102.4011	.907	-192.1614	216.1042
	3.00	-62.3143	102.4011	.545	-266.4471	141.8185
	4.00	-28.3143	102.4011	.783	-232.4471	175.8185
	5.00	-36.6000	102.4011	.722	-240.7328	167.5328
	6.00	30.2571	102.4011	.768	-173.8757	234.3899
	7.00	-190.8857	102.4011	.066	-395.0185	13.2471
	8.00	-262.8857	102.4011	.012	-467.0185	-58.7529
	9.00	-198.6000	102.4011	.056	-402.7328	5.5328
	10.00	-237.1714	102.4011	.023	-441.3042	-33.0386
	11.00	-116.3143	102.4011	.260	-320.4471	87.8185
	12.00	-118.8857	102.4011	.249	-323.0185	85.2471
2.00	1.00	-11.9714	102.4011	.907	-216.1042	192.1614
	3.00	-74.2857	102.4011	.471	-278.4185	129.8471
	4.00	-40.2857	102.4011	.695	-244.4185	163.8471
	5.00	-48.5714	102.4011	.637	-252.7042	155.5614
	6.00	18.2857	102.4011	.859	-185.8471	222.4185
	7.00	-202.8571	102.4011	.051	-406.9899	1.2757
	8.00	-274.8571	102.4011	.009	-478.9899	-70.7243
	9.00	-210.5714	102.4011	.043	-414.7042	-6.4386
	10.00	-249.1429	102.4011	.017	-453.2757	-45.0101
	11.00	-128.2857	102.4011	.214	-332.4185	75.8471
	12.00	-130.8571	102.4011	.205	-334.9899	73.2757
3.00	1.00	62.3143	102.4011	.545	-141.8185	266.4471
	2.00	74.2857	102.4011	.471	-129.8471	278.4185
	4.00	34.0000	102.4011	.741	-170.1328	238.1328
	5.00	25.7143	102.4011	.802	-178.4185	229.8471
	6.00	92.5714	102.4011	.369	-111.5614	296.7042
	7.00	-128.5714	102.4011	.213	-332.7042	75.5614
	8.00	-200.5714	102.4011	.054	-404.7042	3.5614
	9.00	-136.2857	102.4011	.187	-340.4185	67.8471
	10.00	-174.8571	102.4011	.092	-378.9899	29.2757
	11.00	-54.0000	102.4011	.600	-258.1328	150.1328
	12.00	-56.5714	102.4011	.582	-260.7042	147.5614
4.00	1.00	28.3143	102.4011	.783	-175.8185	232.4471
	2.00	40.2857	102.4011	.695	-163.8471	244.4185
	3.00	-34.0000	102.4011	.741	-238.1328	170.1328
	5.00	-8.2857	102.4011	.936	-212.4185	195.8471
	6.00	58.5714	102.4011	.569	-145.5614	262.7042
	7.00	-162.5714	102.4011	.117	-366.7042	41.5614
	8.00	-234.5714	102.4011	.025	-438.7042	-30.4386
	9.00	-170.2857	102.4011	.101	-374.4185	33.8471
	10.00	-208.8571	102.4011	.045	-412.9899	-4.7243
	11.00	-88.0000	102.4011	.393	-292.1328	116.1328
	12.00	-90.5714	102.4011	.379	-294.7042	113.5614
5.00	1.00	36.6000	102.4011	.722	-167.5328	240.7328
	2.00	48.5714	102.4011	.637	-155.5614	252.7042
	3.00	-25.7143	102.4011	.802	-229.8471	178.4185
	4.00	8.2857	102.4011	.936	-195.8471	212.4185
	6.00	66.8571	102.4011	.516	-137.2757	270.9899
	7.00	-154.2857	102.4011	.136	-358.4185	49.8471
	8.00	-226.2857	102.4011	.030	-430.4185	-22.1529
	9.00	-162.0000	102.4011	.118	-366.1328	42.1328
	10.00	-200.5714	102.4011	.054	-404.7042	3.5614

	11.00	-79.7143	102.4011	.439	-283.8471	124.4185
	12.00	-82.2857	102.4011	.424	-286.4185	121.8471
6.00	1.00	-30.2571	102.4011	.768	-234.3899	173.8757
	2.00	-18.2857	102.4011	.859	-222.4185	185.8471
	3.00	-92.5714	102.4011	.369	-296.7042	111.5614
	4.00	-58.5714	102.4011	.569	-262.7042	145.5614
	5.00	-66.8571	102.4011	.516	-270.9899	137.2757
	7.00	-221.1429	102.4011	.034	-425.2757	-17.0101
	8.00	-293.1429	102.4011	.005	-497.2757	-89.0101
	9.00	-228.8571	102.4011	.029	-432.9899	-24.7243
	10.00	-267.4286	102.4011	.011	-471.5614	-63.2958
	11.00	-146.5714	102.4011	.157	-350.7042	57.5614
	12.00	-149.1429	102.4011	.150	-353.2757	54.9899
7.00	1.00	190.8857	102.4011	.066	-13.2471	395.0185
	2.00	202.8571	102.4011	.051	-1.2757	406.9899
	3.00	128.5714	102.4011	.213	-75.5614	332.7042
	4.00	162.5714	102.4011	.117	-41.5614	366.7042
	5.00	154.2857	102.4011	.136	-49.8471	358.4185
	6.00	221.1429	102.4011	.034	17.0101	425.2757
	8.00	-72.0000	102.4011	.484	-276.1328	132.1328
	9.00	-7.7143	102.4011	.940	-211.8471	196.4185
	10.00	-46.2857	102.4011	.653	-250.4185	157.8471
	11.00	74.5714	102.4011	.469	-129.5614	278.7042
	12.00	72.0000	102.4011	.484	-132.1328	276.1328
8.00	1.00	262.8857	102.4011	.012	58.7529	467.0185
	2.00	274.8571	102.4011	.009	70.7243	478.9899
	3.00	200.5714	102.4011	.054	-3.5614	404.7042
	4.00	234.5714	102.4011	.025	30.4386	438.7042
	5.00	226.2857	102.4011	.030	22.1529	430.4185
	6.00	293.1429	102.4011	.005	89.0101	497.2757
	7.00	72.0000	102.4011	.484	-132.1328	276.1328
	9.00	64.2857	102.4011	.532	-139.8471	268.4185
	10.00	25.7143	102.4011	.802	-178.4185	229.8471
	11.00	146.5714	102.4011	.157	-57.5614	350.7042
	12.00	144.0000	102.4011	.164	-60.1328	348.1328
9.00	1.00	198.6000	102.4011	.056	-5.5328	402.7328
	2.00	210.5714	102.4011	.043	6.4386	414.7042
	3.00	136.2857	102.4011	.187	-67.8471	340.4185
	4.00	170.2857	102.4011	.101	-33.8471	374.4185
	5.00	162.0000	102.4011	.118	-42.1328	366.1328
	6.00	228.8571	102.4011	.029	24.7243	432.9899
	7.00	7.7143	102.4011	.940	-196.4185	211.8471
	8.00	-64.2857	102.4011	.532	-268.4185	139.8471
	10.00	-38.5714	102.4011	.708	-242.7042	165.5614
	11.00	82.2857	102.4011	.424	-121.8471	286.4185
	12.00	79.7143	102.4011	.439	-124.4185	283.8471
10.00	1.00	237.1714	102.4011	.023	33.0386	441.3042
	2.00	249.1429	102.4011	.017	45.0101	453.2757
	3.00	174.8571	102.4011	.092	-29.2757	378.9899
	4.00	208.8571	102.4011	.045	4.7243	412.9899
	5.00	200.5714	102.4011	.054	-3.5614	404.7042
	6.00	267.4286	102.4011	.011	63.2958	471.5614
	7.00	46.2857	102.4011	.653	-157.8471	250.4185
	8.00	-25.7143	102.4011	.802	-229.8471	178.4185
	9.00	38.5714	102.4011	.708	-165.5614	242.7042
	11.00	120.8571	102.4011	.242	-83.2757	324.9899
	12.00	118.2857	102.4011	.252	-85.8471	322.4185
11.00	1.00	116.3143	102.4011	.260	-87.8185	320.4471

	2.00	128.2857	102.4011	.214	-75.8471	332.4185
	3.00	54.0000	102.4011	.600	-150.1328	258.1328
	4.00	88.0000	102.4011	.393	-116.1328	292.1328
	5.00	79.7143	102.4011	.439	-124.4185	283.8471
	6.00	146.5714	102.4011	.157	-57.5614	350.7042
	7.00	-74.5714	102.4011	.469	-278.7042	129.5614
	8.00	-146.5714	102.4011	.157	-350.7042	57.5614
	9.00	-82.2857	102.4011	.424	-286.4185	121.8471
	10.00	-120.8571	102.4011	.242	-324.9899	83.2757
	12.00	-2.5714	102.4011	.980	-206.7042	201.5614
12.00	1.00	118.8857	102.4011	.249	-85.2471	323.0185
	2.00	130.8571	102.4011	.205	-73.2757	334.9899
	3.00	56.5714	102.4011	.582	-147.5614	260.7042
	4.00	90.5714	102.4011	.379	-113.5614	294.7042
	5.00	82.2857	102.4011	.424	-121.8471	286.4185
	6.00	149.1429	102.4011	.150	-54.9899	353.2757
	7.00	-72.0000	102.4011	.484	-276.1328	132.1328
	8.00	-144.0000	102.4011	.164	-348.1328	60.1328
	9.00	-79.7143	102.4011	.439	-283.8471	124.4185
	10.00	-118.2857	102.4011	.252	-322.4185	85.8471
	11.00	2.5714	102.4011	.980	-201.5614	206.7042

* The mean difference is significant at the .05 level.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Fungi Healthcare waste soil	16.7018	11	9.2031	2.7748
	Fungi Adjacent soil	9.8455	11	5.0262	1.5155
Pair 2	Bacteria Healthcare waste soil	18.5413	8	16.5598	5.8548
	Bacteria Adjacent soil	19.7925	8	16.0216	5.6645

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Fungi Healthcare waste soil & Fungi Adjacent soil	11	.614	.045
Pair 2	Bacteria Healthcare waste soil	8	.655	.078

& Bacteria Adjacent soil

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Fungi Healthcare waste soil - Fungi Adjacent soil	6.8564	7.2930	2.1989	1.9568	11.7559	3.118	10	.011
Pair 2	Bacteria Healthcare waste soil - Bacteria Adjacent soil	-1.2512	13.5337	4.7849	-12.5657	10.0632	-.262	7	.801

Descriptives
IDNO

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Yes	27	16.44	8.81	1.69	12.96	19.93	1	32
No	5	16.80	13.33	5.96	.25	33.35	2	29
Total	32	16.50	9.38	1.66	13.12	19.88	1	32

ANOVA
IDNO

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.533	1	.533	.006	.939
Within Groups	2727.467	30	90.916		
Total	2728.000	31			

Descriptives
IDNO

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Gen	1	23.00	.	.	.	.	23	23
Sharp	9	16.56	9.21	3.07	9.48	23.63	3	30
All	7	14.71	8.32	3.15	7.02	22.41	4	27
Gen-Sharp	2	16.00	11.31	8.00	-85.65	117.65	8	24

Inf-Sharp	10	14.20	10.90	3.45	6.40	22.00	1	32
None	3	26.33	3.79	2.19	16.93	35.74	22	29
Total	32	16.50	9.38	1.66	13.12	19.88	1	32

ANOVA
IDNO

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	408.083	5	81.617	.915	.487
Within Groups	2319.917	26	89.228		
Total	2728.000	31			

Descriptives
IDNO

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
CB	3	11.33	7.23	4.18	-6.64	29.30	3	16
PLB	8	19.13	9.83	3.48	10.90	27.35	5	31
All	2	24.50	10.61	7.50	-70.80	119.80	17	32
POB-CB	1	21.00	.	.	.	.	21	21
CB-PLB	15	12.80	8.56	2.21	8.06	17.54	1	27
Anything	3	26.33	3.79	2.19	16.93	35.74	22	29
Total	32	16.50	9.38	1.66	13.12	19.88	1	32

ANOVA
IDNO

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	778.892	5	155.778	2.078	.101
Within Groups	1949.108	26	74.966		
Total	2728.000	31			

Descriptives
IDNO

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Doctors	2	24.00	1.41	1.00	11.29	36.71	23	25
Nurses	7	18.14	7.43	2.81	11.28	25.01	5	27
Ward cleaners	6	19.33	10.33	4.22	8.49	30.17	9	32
Doc-Nur	5	10.00	11.51	5.15	-4.29	24.29	1	30
Nur-Ward cleaners	1	12.00	.	.	.	.	12	12
All	7	13.29	7.61	2.88	6.25	20.32	2	24
None	4	20.50	12.07	6.03	1.30	39.70	3	29
Total	32	16.50	9.38	1.66	13.12	19.88	1	32

ANOVA
IDNO

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	547.381	6	91.230	1.046	.420
Within Groups	2180.619	25	87.225		
Total	2728.000	31			

Descriptives
IDNO

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Periodically	2	6.00	5.66	4.00	-44.82	56.82	2	10
At the end of each shift	4	22.75	7.68	3.84	10.54	34.96	13	31
Immediately waste is generated	19	15.05	8.92	2.05	10.76	19.35	1	32
At the end of each working day	3	19.00	8.72	5.03	-2.66	40.66	9	25
Total	28	15.93	9.06	1.71	12.41	19.44	1	32

ANOVA
IDNO

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	426.160	3	142.053	1.903	.156
Within Groups	1791.697	24	74.654		
Total	2217.857	27			

Multiple Comparisons
Dependent Variable: *IDNO*
LSD

(I) Timing of segregation of waste	(J) Timing of segregation of waste	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
Periodically	At the end of each shift	-16.75	7.48	.035	-32.19	-1.31
	Immediatel	-9.05	6.42	.172	-22.31	4.20

	y waste is generated					
	At the end of each working day	-13.00	7.89	.112	-29.28	3.28
At the end of each shift	Periodically	16.75	7.48	.035	1.31	32.19
	Immediately waste is generated	7.70	4.75	.118	-2.11	17.51
	At the end of each working day	3.75	6.60	.575	-9.87	17.37
Immediately waste is generated	Periodically	9.05	6.42	.172	-4.20	22.31
	At the end of each shift	-7.70	4.75	.118	-17.51	2.11
	At the end of each working day	-3.95	5.37	.469	-15.03	7.13
At the end of each working day	Periodically	13.00	7.89	.112	-3.28	29.28
	At the end of each shift	-3.75	6.60	.575	-17.37	9.87
	Immediately waste is generated	3.95	5.37	.469	-7.13	15.03

* The mean difference is significant at the .05 level.

Descriptives
IDNO

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Yes	18	16.28	9.96	2.35	11.32	21.23	1	32
No	10	15.30	7.63	2.41	9.84	20.76	5	30
Total	28	15.93	9.06	1.71	12.41	19.44	1	32

ANOVA
IDNO

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.146	1	6.146	.072	.790
Within	2211.711	26	85.066		

Groups		
Total	2217.857	27

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Designation * Generation of HCW during the course of duty	70	100.0%	0	.0%	70	100.0%

Designation * Generation of HCW during the course of duty Crosstabulation

			Generation of HCW during the course of duty		Total
			yes	no	
Designation	Doctor	Count	14	1	15
		Expected Count	10.5	4.5	15.0
	Nurse	Count	35	0	35
		Expected Count	24.5	10.5	35.0
	aux Staff	Count	0	6	6
		Expected Count	4.2	1.8	6.0
	Ward Cleaner	Count	0	7	7
		Expected Count	4.9	2.1	7.0
	Waste Handler	Count	0	7	7
		Expected Count	4.9	2.1	7.0
Total		Count	49	21	70
		Expected Count	49.0	21.0	70.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	65.556	4	.000
Likelihood Ratio	78.173	4	.000
Linear-by-Linear Association	47.554	1	.000
N of Valid	70		

Cases
a 7 cells (70.0%) have expected count less than 5. The minimum expected count is 1.80.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Designation * Attitude to Env. sound handling of waste	70	100.0%	0	.0%	70	100.0%

Designation * Attitude to Env. sound handling of waste Crosstabulation

			Attitude to Env. sound handling of waste			Total
			my resp	res ward	res hmgt	
Designation	Doctor	Count	5	3	7	15
		Expected Count	5.4	3.9	5.8	15.0
	Nurse	Count	8	10	17	35
		Expected Count	12.5	9.0	13.5	35.0
	aux Staff	Count	0	5	1	6
		Expected Count	2.1	1.5	2.3	6.0
	Ward Cleaner	Count	5	0	2	7
		Expected Count	2.5	1.8	2.7	7.0
	Waste Handler	Count	7	0	0	7
		Expected Count	2.5	1.8	2.7	7.0
Total		Count	25	18	27	70
		Expected Count	25.0	18.0	27.0	70.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	30.825	8	.000
Likelihood Ratio	33.499	8	.000
Linear-by-Linear Association	10.723	1	.001
N of Valid Cases	70		

a 10 cells (66.7%) have expected count less than 5. The minimum expected count is 1.54.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Designation * Segregation of waste in worker's ward/unit	70	100.0%	0	.0%	70	100.0%

Designation * Segregation of waste in worker's ward/unit Crosstabulation

			Segregation of waste in worker's ward/unit		Total
			yes	no	
Designation	Doctor	Count	11	4	15
		Expected Count	9.4	5.6	15.0
	Nurse	Count	28	7	35
		Expected Count	22.0	13.0	35.0
	aux Staff	Count	1	5	6
		Expected Count	3.8	2.2	6.0
	Ward Cleaner	Count	4	3	7
		Expected Count	4.4	2.6	7.0
	Waste Handler	Count	0	7	7
		Expected Count	4.4	2.6	7.0
Total		Count	44	26	70
		Expected Count	44.0	26.0	70.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.538	4	.000
Likelihood Ratio	24.967	4	.000
Linear-by-Linear Association	13.880	1	.000
N of Valid Cases	70		

a 6 cells (60.0%) have expected count less than 5. The minimum expected count is 2.23.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Designation * Who segregates waste in your ward/unit	70	100.0%	0	.0%	70	100.0%

Designation * Who segregates waste in your ward/unit Crosstabulation

			Who segregates waste in your ward/unit											Total
			doctors	aux	wh	nurses	wc	d-n	d-n-wc	n-wc	all	d-a-n-wc	none	
Designation	Doctor	Count	1	0	0	0	4	2	1	0	2	0	5	15
		Expected Count	.2	.2	1.1	1.7	4.5	.6	.6	.2	.4	.4	4.9	15.0
	Nurse	Count	0	1	4	8	8	1	2	1	0	2	8	35
		Expected Count	.5	.5	2.5	4.0	10.5	1.5	1.5	.5	1.0	1.0	11.5	35.0
	aux Staff	Count	0	0	0	0	2	0	0	0	0	0	4	6
		Expected Count	.1	.1	.4	.7	1.8	.3	.3	.1	.2	.2	2.0	6.0
	Ward Cleaner	Count	0	0	0	0	3	0	0	0	0	0	4	7
		Expected Count	.1	.1	.5	.8	2.1	.3	.3	.1	.2	.2	2.3	7.0
	Waste Handler	Count	0	0	1	0	4	0	0	0	0	0	2	7
		Expected Count	.1	.1	.5	.8	2.1	.3	.3	.1	.2	.2	2.3	7.0
Total		Count	1	1	5	8	21	3	3	1	2	2	23	70
		Expected Count	1.0	1.0	5.0	8.0	21.0	3.0	3.0	1.0	2.0	2.0	23.0	70.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	38.738	40	.527
Likelihood Ratio	43.077	40	.341
Linear-by-Linear Association	.115	1	.735
N of Valid Cases	70		

a 53 cells (96.4%) have expected count less than 5. The minimum expected count is .09.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Designation * Use of protective clothing	70	100.0%	0	.0%	70	100.0%

Designation * Use of protective clothing Crosstabulation

			Use of protective clothing		Total
			yes	no	
Designation	Doctor	Count	13	2	15
		Expected Count	11.1	3.9	15.0
	Nurse	Count	24	11	35
		Expected Count	26.0	9.0	35.0
	aux Staff	Count	3	3	6
		Expected Count	4.5	1.5	6.0
	Ward Cleaner	Count	7	0	7
		Expected Count	5.2	1.8	7.0
	Waste Handler	Count	5	2	7
		Expected Count	5.2	1.8	7.0
Total		Count	52	18	70
		Expected Count	52.0	18.0	70.0

Chi-Square Tests

	Value	df	Asymp.

			Sig. (2-sided)
Pearson Chi-Square	6.108	4	.191
Likelihood Ratio	7.759	4	.101
Linear-by-Linear Association	.005	1	.944
N of Valid Cases	70		

a 5 cells (50.0%) have expected count less than 5. The minimum expected count is 1.54.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Designation * Immunization against hepatitis & tetanus	70	100.0%	0	.0%	70	100.0%

Designation * Immunization against hepatitis & tetanus Crosstabulation

			Immunization against hepatitis & tetanus		Total
			yes	no	
Designation	Doctor	Count	9	6	15
		Expected Count	7.1	7.9	15.0
	Nurse	Count	22	13	35
		Expected Count	16.5	18.5	35.0
	aux Staff	Count	1	5	6
		Expected Count	2.8	3.2	6.0
	Ward Cleaner	Count	1	6	7
		Expected Count	3.3	3.7	7.0
	Waste Handler	Count	0	7	7
		Expected Count	3.3	3.7	7.0
Total		Count	33	37	70
		Expected Count	33.0	37.0	70.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)

Pearson Chi-Square	15.976	4	.003
Likelihood Ratio	19.293	4	.001
Linear-by-Linear Association	12.884	1	.000
N of Valid Cases	70		

a 6 cells (60.0%) have expected count less than 5. The minimum expected count is 2.83.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Designation * Training in school	70	100.0%	0	.0%	70	100.0%

Designation * Training in school Crosstabulation

			Training in school		Total
			yes	no	
Designation	Doctor	Count	9	6	15
		Expected Count	6.0	9.0	15.0
	Nurse	Count	19	16	35
		Expected Count	14.0	21.0	35.0
	aux Staff	Count	0	6	6
		Expected Count	2.4	3.6	6.0
	Ward Cleaner	Count	0	7	7
		Expected Count	2.8	4.2	7.0
	Waste Handler	Count	0	7	7
		Expected Count	2.8	4.2	7.0
Total		Count	28	42	70
		Expected Count	28.0	42.0	70.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)

Pearson Chi-Square	18.810	4	.001
Likelihood Ratio	25.768	4	.000
Linear-by-Linear Association	15.104	1	.000
N of Valid Cases	70		

a 6 cells (60.0%) have expected count less than 5. The minimum expected count is 2.40.

Descriptives
IDNO

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Yes	13	14.69	9.99	2.77	8.66	20.73	4	32
No	19	17.74	9.01	2.07	13.40	22.08	1	31
Total	32	16.50	9.38	1.66	13.12	19.88	1	32

Test of Homogeneity of Variances
IDNO

Levene Statistic	df1	df2	Sig.
.240	1	30	.628

ANOVA
IDNO

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	71.547	1	71.547	.808	.376
Within Groups	2656.453	30	88.548		
Total	2728.000	31			

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Designation * Training on the job	70	100.0%	0	.0%	70	100.0%

Designation * Training on the job Crosstabulation

			Training on the job		Total
			yes	no	
Designation	Doctor	Count	4	11	15
		Expected Count	6.4	8.6	15.0

	Nurse	Count	24	11	35
		Expected Count	15.0	20.0	35.0
	aux Staff	Count	1	5	6
		Expected Count	2.6	3.4	6.0
	Ward Cleaner	Count	1	6	7
		Expected Count	3.0	4.0	7.0
	Waste Handler	Count	0	7	7
		Expected Count	3.0	4.0	7.0
Total		Count	30	40	70
		Expected Count	30.0	40.0	70.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.319	4	.000
Likelihood Ratio	23.487	4	.000
Linear-by-Linear Association	5.799	1	.016
N of Valid Cases	70		

a 6 cells (60.0%) have expected count less than 5. The minimum expected count is 2.57.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Designation * Needle prick injury in last 6 months	70	100.0%	0	.0%	70	100.0%

Designation * Needle prick injury in last 6 months Crosstabulation

			Needle prick injury in last 6 months		Total
			yes	no	
Designation	Doctor	Count	4	11	15
		Expected Count	1.7	13.3	15.0

	Nurse	Count	2	33	35
		Expected Count	4.0	31.0	35.0
	aux Staff	Count	0	6	6
		Expected Count	.7	5.3	6.0
	Ward Cleaner	Count	1	6	7
		Expected Count	.8	6.2	7.0
	Waste Handler	Count	1	6	7
		Expected Count	.8	6.2	7.0
Total		Count	8	62	70
		Expected Count	8.0	62.0	70.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.457	4	.244
Likelihood Ratio	5.541	4	.236
Linear-by-Linear Association	.370	1	.543
N of Valid Cases	70		

a 5 cells (50.0%) have expected count less than 5. The minimum expected count is .69.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Designation * Documentation of needle prick injury	8	11.4%	62	88.6%	70	100.0%

Designation * Documentation of needle prick injury Crosstabulation

			Documentation of needle prick injury		Total
			yes	no	
Designation	Doctor	Count	1	3	4
		Expected Count	.5	3.5	4.0
	Nurse	Count	0	2	2

		Expected Count	.3	1.8	2.0
	Ward Cleaner	Count	0	1	1
		Expected Count	.1	.9	1.0
	Waste Handler	Count	0	1	1
		Expected Count	.1	.9	1.0
Total		Count	1	7	8
		Expected Count	1.0	7.0	8.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.143	3	.767
Likelihood Ratio	1.530	3	.675
Linear-by-Linear Association	.600	1	.439
N of Valid Cases	8		

a 8 cells (100.0%) have expected count less than 5. The minimum expected count is .13.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Designation * Post exposure prophylaxis	8	11.4%	62	88.6%	70	100.0%

Designation * Post exposure prophylaxis Crosstabulation

			Post exposure prophylaxis		Total
			yes	no	
Designation	Doctor	Count	1	3	4
		Expected Count	.5	3.5	4.0
	Nurse	Count	0	2	2
		Expected Count	.3	1.8	2.0

	Ward Cleaner	Count	0	1	1
		Expected Count	.1	.9	1.0
	Waste Handler	Count	0	1	1
		Expected Count	.1	.9	1.0
Total		Count	1	7	8
		Expected Count	1.0	7.0	8.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.143	3	.767
Likelihood Ratio	1.530	3	.675
Linear-by-Linear Association	.600	1	.439
N of Valid Cases	8		

a 8 cells (100.0%) have expected count less than 5. The minimum expected count is .13.

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
Designation * Awareness of hazards	70	100.0%	0	.0%	70	100.0%

Designation * Awareness of hazards Crosstabulation

			Awareness of hazards		Total
			yes	no	
Designation	Doctor	Count	15	0	15
		Expected Count	13.5	1.5	15.0
	Nurse	Count	29	6	35
		Expected Count	31.5	3.5	35.0
	aux Staff	Count	6	0	6
		Expected Count	5.4	.6	6.0

	Ward Cleaner	Count	7	0	7
		Expected Count	6.3	.7	7.0
	Waste Handler	Count	6	1	7
		Expected Count	6.3	.7	7.0
Total		Count	63	7	70
		Expected Count	63.0	7.0	70.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.238	4	.264
Likelihood Ratio	7.700	4	.103
Linear-by-Linear Association	.017	1	.896
N of Valid Cases	70		

a 5 cells (50.0%) have expected count less than 5. The minimum expected count is .60.

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	pH of Healthcare waste soil	8.1417	24	.7027	.1434
	pH of adjacent soil	7.3417	24	.3202	6.536E-02

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	pH of Healthcare waste soil & pH of adjacent soil	24	.365	.080

Paired Samples Test

	Paired Differences				t	df	Sig. (2-tailed)
	Mean	Std.	Std. Error	95% Confidence			

			Deviation	Mean	Interval of the Difference				
					Lower	Upper			
Pair 1	pH of Healthcare waste soil - pH of adjacent soil	.8000	.6574	.1342	.5224	1.0776	5.962	23	.000

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Moisture content of healthcare waste soil	4.8875	24	1.1936	.2436
	Moisture content of adjacent soil	4.9708	24	1.1804	.2410

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Moisture content of healthcare waste soil & Moisture content of adjacent soil	24	.640	.001

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Moisture content of healthcare waste soil - Moisture content of adjacent soil	-8.3333E-02	1.0077	.2057	-.5088	.3422	-.405	23	.689

APPENDIX VI

CONTAINERS		SUNDAY			MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY			
Number	Vol (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Grand Total (litres)
1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
2	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
3	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
4	120	1	1	120	2	1	240	2	1	240	2	1	240	2	1	240	1	1	120	1	1	120	
5	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
6	120	1	1	120	1	1	120	1	1	120	1	1	120	1	0.6	72	1	1	120	1	1	120	
7	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
8	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
9	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
10	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
11	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
12	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
13	120	1	1	120	2	1	240	2	1	240	2	1	240	2	1	120	1	1	120	1	1	120	
14	120	1	1	120	1	1	120	1	1	120	1	0.5	60	1	0.8	96	1	1	120	1	1	120	
15	120	1	1	120	1	1	120	1	1	120	1	1	120	1	0.8	96	1	1	120	1	1	120	
16	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
17	120	Nil			2	1	240	2	1	240	2	1	240	2	1	120	Nil			Nil			
18	120	Nil			1	0.5	60	1	1	120	1	1	120	1	0.9	108	Nil			Nil			
19	120	Nil			1	1	120	1	1	120	1	0.8	96	1	1	120	Nil			Nil			
20	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
Total				1800			2700			2760			2676			2412			1800			1800	15948
Estimated weight (kg) [multiply by 0.30]				540			810			828			802.8			723.6			540			540	4784.4
Estimated weight (kg) of infectious waste [multiply by 0.30]				162			243			248.4			240.84			217.08			162			162	1435.32

QUANTITY OF HEALTHCARE WASTE DISPOSED IN UNIVERSITY OF ABUJA TEACHING HOSPITAL (UATH) FROM SUNDAY 26-08-2007 TO SATURDAY 01-09-2007 (WEEK 1)

CONTAINERS		SUNDAY			MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY			
Number	Vol (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Grand To (litres)
1	120	1	1	120	1	1	120	1	0.5	60	1	1	120	1	1	120	1	1	120	1	1	120	
2	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
3	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
4	120	1	1	120	2	1	120	6	1	720	4	1	480	2	1	240	1	1	120	1	1	120	
5	120	1	1	120	1	0.5	60	1	0.5	60	1	1	120	1	1	120	1	1	120	1	1	120	
6	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
7	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
8	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
9	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
10	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
11	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
12	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
13	120	1	1	120	2	1	120	2	1	120	2	1	240	1	1	120	Nil			Nil			
14	120	Nil			1	0.8	96	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
15	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
16	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
17	120	Nil			2	1	120	3	1	120	3	1	360	3	1	360	Nil			Nil			
18	120	Nil			1	0.5	60	1	0.8	96	1	1	120	1	1	120	Nil			Nil			
19	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
20	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
Total				1560			2256			2856			3120			2760			1560			1560	15672
Estimated weight (kg) [multiply by 0.30]				468			676.8			856.8			936			828			468			468	4701.6
Estimated weight (kg) of infectious waste[multiply by 0.30]				140.4			203.04			257.04			280.8			248.4			140.4			140.4	1410.48

QUANTITY OF HEALTHCARE WASTE DISPOSED IN UNIVERSITY OF ABUJA TEACHING HOSPITAL (UATH) FROM SUNDAY 02-09-2007 TO SATURDAY 08-09-2007 (WEEK 2)

CONTAINERS		SUNDAY			MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY			
Number	**Vol (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Grand Total (litres)**
1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
2	120	1	1	120	1	1	120	1	1	120	1	1	120	2	1	240	1	1	120	1	1	120	
3	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
4	120	1	1	120	2	1	240	4	1	480	4	1	480	2	1	240	2	1	240	1	1	120	
5	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
6	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
7	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
8	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
9	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
10	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
11	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
12	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
13	120	1	1	120	2	1	240	2	1	240	2	1	240	3	1	360	1	1	120	1	1	120	
14	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	Nil			
15	120				1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	Nil			
16	120				1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
17	120				2	1	240	3	1	360	3	1	360	4	1	480	Nil			Nil			
18	120				1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
19	120				1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
20	120				1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
Total				1680			2760			3120			3120			3240			1920			1560	17400
Estimated weight (kg) [multiply by 0.30]				504			828			936			936			972			576			468	5220
Estimated weight (kg) of infectious waste [multiply by 0.30]				151.2			248.4			280.8			280.8			291.6			172.8			140.4	1566

QUANTITY OF HEALTHCARE WASTE DISPOSED IN UNIVERSITY OF ABUJA TEACHING HOSPITAL (UATH) FROM SUNDAY 02-09-2007 TO SATURDAY 08-09-2007 (WEEK 3)

CONTAINERS		SUNDAY			MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY			
Number	Vol (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	
1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
2	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
3	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
4	120	1	1	120	3	1	360	1	1	120	1	1	120	1	1	120	3	1	360	1	1	120	
5	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
6	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
7	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
8	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
9	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
10	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
11	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
12	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
13	120	1	1	120	2	1	240	3	1	360	3	1	360	2	1	240	2	1	240	1	1	120	
14	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	Nil			
15	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
16	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
17	120	Nil			4	1	480	2	1	240	1	1	120	3	1	360	Nil			Nil			
18	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
19	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
20	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			Grand Total (litres)
Total				1560			3120			2760			2640			2760			2040			1560	16440
Estimated weight (kg) [multiply by 0.30]				468			936			828			792			828			612			468	4932
Estimated weight (kg) of infectious waste [multiply by 0.30]				140.4			280.8			248.4			237.6			248.4			183.6			140.4	1479.6

QUANTITY OF HEALTHCARE WASTE DISPOSED IN UNIVERSITY OF ABUJA TEACHING HOSPITAL (UATH) FROM SUNDAY 16-09-2007 TO SATURDAY 22-09-2007 (WEEK 4)

CONTAINERS		SUNDAY			MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY			
Number	Vol (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	
1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
2	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
3	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
4	120	1	1	120	2	1	240	1	1	120	2	1	240	1	1	120	2	1	240	1	1	120	
5	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
6	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
7	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
8	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
9	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
10	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
11	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
12	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
13	120	1	1	120	3	1	360	3	1	360	3	1	360	2	1	240	2	1	240	1	1	120	
14	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
15	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
16	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
17	120	Nil			3	1	360	2	1	240	2	1	240	3	1	360	1	1	120	Nil			
18	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
19	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			Grand Total
20	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			(litres)
Total				1800			2760			2760			2880			2760			2040			1800	16800
Estimated weight (kg) [multiply by 0.30]				540			828			828			864			828			612			540	5040
Estimated weight (kg) of infectious waste [multiply by 0.30]				162			248.4			248.4			259.2			248.4			183.6			162	1512

QUANTITY OF HEALTHCARE WASTE DISPOSED IN UNIVERSITY OF ABUJA TEACHING HOSPITAL (UATH) FROM SUNDAY 23-09-2007 TO SATURDAY 29-09-2007 (WEEK 5)

CONTAINERS		SUNDAY			MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY			
Number	Vol (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Grand Total (litres)
1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
2	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
3	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
4	120	1	1	120	2	1	240	1	1	120	3	1	360	2	1	240	1	1	120	1	1	120	
5	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
6	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
7	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
8	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
9	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
10	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
11	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
12	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
13	120	1	1	120	2	1	240	1	1	120	2	1	240	1	1	120	1	1	120	1	1	120	
14	120	Nil			1	1	120	1	1	120	1	0.5	60	1	1	120	1	1	120	Nil			
15	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	Nil			
16	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	Nil			Nil			
17	120	Nil			2	1	240	1	1	120	2	1	240	1	1	120	Nil			Nil			
18	120	Nil			1	0.5	60	Nil	1	120	1	1	120	1	1	120	Nil			Nil			
19	120	Nil			1	0.5	60	Nil	1	120	1	0.5	60	1	1	120	Nil			Nil			
20	120	Nil			1	1	120	Nil	1	120	1	1	120	1	1	120	Nil			Nil			
Total				1560			2640			2400			2760			2520			1800			1560	15240
Estimated weight (kg) [multiply by 0.30]				468			792			720			828			756			540			468	4572
Estimated weight (kg) of infectious waste [multiply by 0.30]				140.4			237.6			216			248.4			226.8			162			140.4	1371.6

QUANTITY OF HEALTHCARE WASTE DISPOSED IN UNIVERSITY OF ABUJA TEACHING HOSPITAL (UATH) FROM SUNDAY 30-09-2007 TO SATURDAY 05-10-2007 (WEEK 6)

CONTAINERS		SUNDAY			MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY			
Number	**Vol (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Nb emptied**	**Filling rate**	**Total (litres)**	**Grand Total (litres)**
1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
2	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
3	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
4	120	1	1	120	3	1	360	3	1	360	3	1	360	5	1	600	2	1	240	1	1	120	
5	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
6	120	1	1	120	1	1	120	2	1	240	1	1	120	2	1	240	1	1	120	1	1	120	
7	120	1	1	120	2	1	240	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
8	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
9	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
10	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
11	120	1	1	120	1	1	120	2	1	240	1	1	120	3	1	360	1	1	120	1	1	120	
12	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
13	120	1	1	120	2	1	240	4	1	480	3	1	360	4	1	480	3	1	360	1	1	120	
14	120	1	0.5	60	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
15	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
16	120	Nil			1	1	120	2	1	240	1	1	120	3	1	360	1	1	120	Nil			
17	120	Nil			3	1	360	4	1	480	1	1	120	1	1	120	3	1	360	Nil			
18	120	Nil			1	1	120	1	1	120	2	1	240	4	1	480	1	1	120	Nil			
19	120	Nil			1	1	120	1	1	120	1	1	120	1	0.5	60	1	1	120	Nil			
20	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	Nil			
Total				1620			3120			3720			3000			4140			3000			1800	20400
Estimated weight (kg) [multiply by 0.30]				486			936			1116			900			1242			900			540	6120
Estimated weight (kg) of infectious waste [multiply by 0.30]				145.8			280.8			334.8			270			372.6			270			162	1836

QUANTITY OF HEALTHCARE WASTE DISPOSED IN UNIVERSITY OF ABUJA TEACHING HOSPITAL (UATH) FROM SUNDAY 06-01-2008 TO SATURDAY 12-01-2008 (WEEK 7)

CONTAINERS		SUNDAY			MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY			
Number	Vol (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Grand Total (litres)
1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
2	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
3	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
4	120	4	1	480	4	1	480	3	1	360	4	1	480	3	1	360	1	1	120	1	1	120	
5	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
6	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
7	120	2	1	240	2	1	240	2	1	240	1	1	120	2	1	240	1	1	120	1	1	120	
8	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
9	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
10	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
11	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
12	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
13	120	5	1	600	4	1	480	4	1	480	3	1	360	3	1	360	1	1	120	1	1	120	
14	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	Nil			1	1	120	
15	120	2	1	240	2	1	240	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
16	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	Nil			1	1	120	
17	120	4	1	480	4	1	480	4	1	480	4	1	480	4	1	480	1	1	120	1	1	120	
18	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	Nil			
19	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	Nil			
20	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	Nil			
Total				3840			3720			3480			3360			3360			2160			2040	21960
Estimated weight (kg) [multiply by 0.30]				1152			1116			1044			1008			1008			648			612	6588
Estimated weight (kg) of infectious waste [multiply by 0.30]				345.6			334.8			313.2			302.4			302.4			194.4			183.6	1976.4

QUANTITY OF HEALTHCARE WASTE DISPOSED IN UNIVERSITY OF ABUJA TEACHING HOSPITAL (UATH) FROM SUNDAY 13-01-2008 TO SATURDAY 19-01-2008 (WEEK 8)

CONTAINERS		SUNDAY			MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY			
Number	Vol (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Grand Total (litres)
1	120	1	1	120	1	1	120	1	1	120	1	0.5	60	1	1	120	1	1	120	1	1	120	
2	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
3	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
4	120	1	1	120	3	1	360	4	1	480	4	1	480	3	1	360	2	1	240	2	1	240	
5	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
6	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
7	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
8	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
9	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
10	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
11	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
12	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
13	120	1	1	120	4	1	480	3	1	360	4	1	480	3	1	360	3	1	360	2	1	240	
14	120	Nil	1	120	2	1	240	1	1	120	3	1	360	1	1	120	1	1	120	2	1	240	
15	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
16	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
17	120	Nil			2	1	240	4	1	480	3	1	360	4	1	480	1	1	120	2	1	240	
18	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
19	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
20	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
Total				1560			3240			3360			3540			3240			2760			2880	20580
Estimated weight (kg) [multiply by 0.30]				468			972			1008			1062			972			828			864	6174
Estimated weight (kg) of infectious waste [multiply by 0.30]				140.4			291.6			302.4			318.6			291.6			248.4			259.2	1852.2

QUANTITY OF HEALTHCARE WASTE DISPOSED IN UNIVERSITY OF ABUJA TEACHING HOSPITAL (UATH) FROM SUNDAY 20-01-2008 TO SATURDAY 26-01-2008 (WEEK 9)

CONTAINERS		SUNDAY			MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY			
Number	Vol (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Grand Total (litres)
1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
2	120	1	1	120	1	1	120	1	1	120	1	1	120	2	1	240	1	1	120	2	1	240	
3	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	2	1	240	
4	120	1	1	120	1	1	120	4	1	480	4	1	480	4	1	480	2	1	240	3	1	360	
5	120	1	1	120	1	1	120	1	1	120	1	1	120	2	1	240	1	1	120	2	1	240	
6	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	2	1	240	
7	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	2	1	240	
8	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	2	1	240	3	1	360	
9	120	1	1	120	1	1	120	1	1	120	1	1	120	2	1	240	1	1	120	1	1	120	
10	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
11	120	1	1	120	1	1	120	1	0.5	60	1	0.5	60	1	1	120	1	1	120	1	1	120	
12	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
13	120	Nil			2	1	240	4	1	480	4	1	480	5	1	600	2	1	240	2	1	240	
14	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
15	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
16	120	Nil			1	1	120	3	1	360	4	1	480	4	1	480	2	1	240	3	1	360	
17	120	Nil			2	1	240	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
18	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
19	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
20	120	Nil			1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
Total				1440			2640			3300			3420			3960			2880			3840	21480
Estimated weight (kg) [multiply by 0.30]				432			792			990			1026			1188			864			1152	6444
Estimated weight (kg) of infectious waste [multiply by 0.30]				129.6			237.6			297			307.8			356.4			259.2			345.6	1933.2

QUANTITY OF HEALTHCARE WASTE DISPOSED IN UNIVERSITY OF ABUJA TEACHING HOSPITAL (UATH) FROM SUNDAY 27-01-2008 TO SATURDAY 02-02-2008 (WEEK 10)

CONTAINERS		SUNDAY			MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY			
Number	Vol (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Grand Total (litres)
1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	Nil			
2	120	1	1	120	1	1	120	1	1	120	1	1	120	1	0.5	60	1	1	120	1	1	120	
3	120	2	1	240	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
4	120	2	1	240	2	1	240	2	1	240	2	1	240	1	1	120	2	1	240	1	1	120	
5	120	2	1	240	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
6	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
7	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
8	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
9	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
10	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
11	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
12	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
13	120	2	1	240	3	1	360	3	1	360	2	1	240	1	1	120	1	1	120	1	1	120	
14	120	2	1	240	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
15	120	2	1	240	1	1	120	1	1	120	1	1	120	1	0.5	60	1	1	120	1	1	120	
16	120	2	1	240	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
17	120	2	1	240	1	1	120	1	1	120	1	1	120	1	1	120	3	1	360	1	1	120	
18	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
19	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
20	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
Total				3360			2760			2760			2640			2280			2760			2280	18840
Estimated weight (kg) [multiply by 0.30]				1008			828			828			738			684			828			684	5598
Estimated weight (kg) of infectious waste [multiply by 0.30]				302-4			248.4			248.4			221.4			205.2			248.4			205.2	1377

QUANTITY OF HEALTHCARE WASTE DISPOSED IN UNIVERSITY OF ABUJA TEACHING HOSPITAL (UATH) FROM SUNDAY 03-02-2008 TO SATURDAY 09-02-2008 (WEEK 11)

CONTAINERS		SUNDAY			MONDAY			TUESDAY			WEDNESDAY			THURSDAY			FRIDAY			SATURDAY			
Number	Vol (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Nb emptied	Filling rate	Total (litres)	Grand Total (litres)
1	120	1	0.5	60	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
2	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
3	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
4	120	2	1	240	2	1	240	2	1	240	1	1	120	3	1	360	3	1	360	1	1	120	
5	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
6	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
7	120	1	0.5	60	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
8	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
9	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
10	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
11	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
12	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
13	120	2	1	240	2	1	240	2	1	240	1	1	120	2	1	240	2	1	240	1	1	120	
14	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
15	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
16	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
17	120	1	1	120	2	1	240	2	1	240	1	1	120	2	1	240	3	1	360	1	1	120	
18	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
19	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
20	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	1	1	120	
Total				2520			2760			2760			2400			2880			3000			2400	18720
Estimated weight (kg) [multiply by 0.30]				756			828			828			720			864			900			720	5616
Estimated weight (kg) of infectious waste [multiply by 0.30]				226.8			248.4			248.4			216			259.2			270			216	1684.8

QUANTITY OF HEALTHCARE WASTE DISPOSED IN UNIVERSITY OF ABUJA TEACHING HOSPITAL (UATH) FROM SUNDAY 10-02-2008 TO SATURDAY 16-02-2008 (WEEK 12)

APPENDIX VII

Preparation of:

1. Chocolate Agar
2. CLED Bovis Medium
3. Sabouraud Dextrose Agar

<u>10% Chocolate Agar</u>

- According to manufacturers instruction 28grams of Nutrient Agar was dissolved in 1,000ml of distilled water.
- It was heated to boil to dissolve the medium completely.
- It was sterilized at 15lbs pressure (121^0C) for 15 minutes.
- It was allowed to cool for 45minutes;
- 100ml of the melted sterilized agar was removed and 100ml of sterile blood was added aseptically to give 10% blood agar.
- The 10% blood agar was heated to 80^0C to give 10% chocolate agar.
- Calculation –

$$\underline{\text{Formula}} \qquad \frac{RXV}{0}$$

R = Required Concentration

V = Total Volume of Solution

O = Original Concentration

$$= 10\% \times 1000 = \frac{10 \times 1000}{100} = 100\text{mls}$$

- It was allowed to cool to 45^0C.

- It was mixed and was poured into sterile Petri dish aseptically.
- It was allowed to solidify, and was ready for used.

CLED Bovis Medium

- CLED = Cystine Lactose Electrolyte Deficiency
- 36 grams of the CLED Bovis Medium was dissolved in 1,000mls of de-ionized water.
- It was heated to boil.
- It was sterilized at 15 lbs pressure (121^0C) for 15 minutes.
- It was allowed to cool to 47^0C and was thoroughly mixed and was poured aseptically into sterile Petri dish.
- It was allowed to solidify and was ready for use.

Sabouraud Dextrose Agar

- 62 grams of Sabouraud dextrose agar was dissolved in 1,000mls of de-ionized water.
- It was allowed to soak for 10 minutes
- It was swirled to mix and was sterilized at 15lbs pressure (121^0C) for 15 minutes.
- It was allowed to cool to 47^0C.
- It was mixed well and poured aseptically into Petri dish.

Inoculation

- The samples were inoculated into the above medium aseptically.

- They were incubated at different temperature i.e. chocolate and CLED medium plates were incubated at 37^0C, while the Sabouraud medium Plate was incubated at room temperature.

Note: The chocolate plate was incubated in CO_2 enriched environment (anaerobic) and the CLED plate was incubated aerobically (oxygen environment), while the fungi needs more air and a reduced temperature.

APPENDIX VIII

Summary of Cultural and Biochemical Characteristics of Bacterial Isolates

Isolate Code	Cultural Characteristics	Grams Reaction	Shape	Catalase	Coagulase	Oxidase	Motility	Indole	Urease	Citrate	Slope	Butt	H2S	Gas	Isolate
HCW1	Large round greyish flat colonies	-	Rod	O	O	O	+	-	+	-	R	Y	+	-	*Citrobacter* spp
ADS1	Large round greyish flat colonies CLED-large round pinkish colonies	-	Rod	O	O	O	+	+	-	-	Y	Y	-	+	*Escherichia Coli*
HCW2a	Large and greyish flat colonies	-	Rod	O	O	O	+	-	-	+	R	Y	+	+	*Salmonella typhi*
HCW2b	Large round greyish flat colonies	-	Rod	O	O	O	+	+	-	-	Y	Y	-	+	*Escherichia Coli*
ADS2a	Large round greyish flat fishy smell colonies with haemolytic background	-	Rod	-	-	+	+	-	-	-	R	R	-	-	*Pseudomonas aeroginosa*
ADS2b	Large round greyish flat colonies	-	Rod	O	O	O	+	+	-	-	Y	Y	-	+	*Escherichia Coli*
HCW3	Small round whitish colonies	+	Cocci	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus aureus*
ADS3a	Small round whitish colonies	+	Cocci	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus aureus*
ADS3b	Large round greyish flat fishy smell colonies with haemolytic background.	-	Rod	-	-	+	+	-	-	-	R	R	-	-	*Pseudomonas aeroginosa*
HCW4a	Small round whitish colonies	+	Cocci	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus aureus*
HCW4b	Large round creamy colonies	+	Cocci	+	-	-	-	O	O	O	O	O	O	O	*Micrococcus* spp
ADS4a	Small round whitish colonies	+	Cocci	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus aureus*
ADS4b	Large round creamy colonies	+	Cocci	+	-	-	-	O	O	O	O	O	O	O	*Micrococcus* spp
HCW5a	Large round greyish flat colonies	-	Rod	O	O	O	+	-	+	+	R	Y	+	-	*Proteus vulgaris*
HCW5b	Creamy round colonies	-	Rod	-	-	-	+	-	-	-	R	R	-	-	*Aeromonas* spp
ADS5a	Large round greyish flat colonies	-	Rod	O	O	O	+	-	-	+	R	Y	+	+	*Salmonella typhi*

ADS5b	Large round creamy colonies	+	Cocci	+	-	-	-	O	O	O	O	O	O	O	*Micrococcus* spp
HCW6a	Large round greyish flat colonies	-	Rod	O	O	O	+	-	+	+	R	Y	+	-	*Proteus vulgaris*
HCW6b	Small round whitish colonies	+	Cocci	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus aureus*
ADS6	Small round greyish flat colonies	-	Rod	O	O	O	+	-	-	+	R	Y	+	+	*Salmonella typhi*
HCW7a	Small round whitish colonies	+	Cocci	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus aureus*
HCW7b	Large round greyish flat fishy smell colonies with haemolytic background	-	Rod	-	-	+	+	-	-	-	R	R	-	-	*Pseudomonas aeroginosa*
ADS7a	Large round flat dark greyish colonies	-	Rod	O	O	O	+	-	+	+	R	Y	-	+	*Citrobacter* spp
ADS7b	Small round whitish colonies	+	Cocci	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus aureus*
HCW8	Small round whitish colonies	-	Cocci in clusters	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus aureus*
ADS8	Large round whitish colonies	+	Cocci	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus typhi*
HCW9a	Large round whitish colonies	+	Cocci	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus aureus*
HCW9b	Large round creamy colonies	+	Cocci	+	-	-	-	O	O	O	O	O	O	O	*Micrococcus* spp
ADS9a	Large round greyish flat fishy smell colonies with haemolytic background.	-	Rod	-	-	+	+	-	-	-	R	R	-	-	*Pseudomonas aeroginosa*
ADS9b	Large round whitish colonies	+	Cocci	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus aureus*
HCW10	Large round greyish flat colonies	-	Rod	O	O	O	+	-	+	+	R	Y	+	-	*Proteus vulgaris*
ADS10	Large round greyish flat colonies	-	Rod	O	O	O	+	+	-	-	Y	Y	-	+	*Escherichia coli*
HCW11a	Large round greyish flat fishy smell colonies with haemolytic background	-	Rod	-	-	+	+	-	-	-	R	R	-	-	*Pseudomonas aeroginosa*
HCW11b	Small round whitish colonies	+	Cocci	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus aureus*
ADS11	Large round flat dark greyish colonies	-	Rod	O	O	O	+	-	+	+	R	Y	-	+	*Citrobacter* spp
HCW12	Small round whitish colonies	+	Cocci	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus aureus*
ADS12a	Small round whitish colonies	+	Cocci	+	+	O	O	O	O	O	O	O	O	O	*Staphylococcus aureus*
ADS12b	Large round creamy colonies	+	Cocci	+	-	-	-	O	O	O	O	O	O	O	*Micrococcus* spp

Isolate Code	Colour of Aerial hyphae	Nature of Hyphae	Shape of Asexual spore	Appearance of Sporangiophore	Characteristics of spore head	Probable Organism
MYC 1	Black	Septate	Oval	Long, erect and unbranched	Large and round	Aspergilus Niger
MYC 2	Grey	Non-septate	Oval and black	Long, erect and non-septate	Round and black	Rhizopus
MYC 3	Cream	Budding yeast		Hyphae forming pseudomycellium		Candida
MYC 4	White brown	Non-septate	Canoe shape			Fusarium
MYC 5	Yellow Green	Septate	Elliptical	3 stages branching	Free shape	Pencillium
MYC 6	Yellow	Septate	Fusiform	Canoe shaped macroconidia	Spindle shape	Microsporum
MYC 7						
MYC 8	White to creamy colour	Septate	Rectangular or rounded or irregular	Arthroconidia	Rounded or irregular form of conidia	Geothricum
MYC 9	Cream color to black	Non-septate	blastospores	Blastoconidia	None	Sporothrix
MYC 10	Pinkish buff	Septate	Spherical or pear shaped	Pencil shaped macroconidia	Chains of arthroconidia	Trichophyon
MYC 11	Velvety green to brown	Septate		Elongated	Phialides	Cladiosporum
MYC 12	Grey	Budding yeast		Oval	Round	Pityrosporium

Appendix IX: *Summary of Fungi Characteristics*