ASSESSMENT OF MEDICAL WASTE MANAGEMENT PRACTICES IN AHMADU BELLO UNIVERSITY TEACHING HOSPITAL AND AHMADU BELLO UNIVERSITY HEALTH SERVICES, ZARIA, NIGERIA

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NOVEMBER, 2015

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A THESIS SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES AHMADU BELLO UNIVERSITY, ZARIA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF A
MASTER OF SCIENCE DEGREE IN ENVIRONMENTAL MANAGEMENT

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NOVEMBER, 2015

DECLARATION

I declare that the work in this dissertation entitled **ASSESSMENT OF MEDICAL WASTE MANAGEMENT PRACTICES IN AHMADU BELLO UNIVERSITY TEACHING HOSPITAL AND AHMADU BELLO UNIVERSITY HEALTH SERVICES, ZARIA, NIGERIA** has been carried out by me in the Department of Geography. The information derived from literature have been duly acknowledged in the text and list of references provided. No part of this dissertation was previously presented for another degree or diploma at this or any other Institution.

_____ _____ _____

Farida Isyaku Signature Date

CERTIFICATION

This dissertation titled **ASSESSMENT OF MEDICAL WASTE MANAGEMENT PRACTICES IN AHMADU BELLO UNIVERSITY TEACHING HOSPITAL AND AHMADU BELLO UNIVERSITY HEALTH SERVICE, ZARIA, NIGERIA** by Farida Isyaku meets the regulations governing the award of the degree of MSc in Environmental Management of the Ahmadu Bello University Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

I dedicate this dissertation to my husband and kids for their patience, encouragement, endurance and perseverance.

ACKNOWLEDGEMENTS

First of all I would like to thank the Almighty Allah (SWT), Who sustained me and gave me the commitment and tolerance to overcome various obstacles and come up to the accomplishment of this dissertation.

I would like to express my deepest appreciation to my supervisors, Prof. E.O. Iguisi and Dr. I.I. Abbas for their excellent advice and also for spending their precious time in improving the quality of this research. I am also deeply grateful to the Head of Department (Dr Jaro Musa), the Postgraduate Coordinator (Dr. R.O. Yusuf), and all the other staff academic and non-academic staff of the Department of Geography as well as my colleagues for their support throughout the actualisation of this dissertation. The assistance of the Managements and staff of waste management units of both ABUTH and ABUHS in facilitating data collection are also duly acknowledged.

ABSTRACT

Healthcare services are aimed at improving wellbeing and preventing potential human health risks and environmental hazards. In the process, however, wastes that are potentially harmful are generated. Poor management of these healthcare wastes (HCW) exposes the health workers, patients, waste handlers and the general public to health risks. Thus, this study focussed on the assessment of HCW management practices at Ahmadu Bello University Teaching Hospital (ABUTH) Zaria and Ahmadu Bello University Health Service (ABUHS) A.B.U. Zaria. The study utilised two sets of questionnaire to capture HCW management practices including collection, segregation, storage, disposal and treatment. One of the set of questionnaire was administered to all the waste handlers while the second set of questionnaire was administered to all the heads of waste management units in each of the hospitals. While the former was used for identifying the HCW management practices in the two hospitals, the latter was used for assessing the effectiveness of HCW management practices in the hospitals in accordance with Townend and Cheeseman (2005) guidelines. The study established the total quantities of HCW generated at ABUTH and ABUHS as 845kg and 77kg per day respectively; which translates to 1.18kg and 1.54kg per day per bed at ABUTH and ABUHS respectively. The study revealed availability of operational staff specifically responsible for medical waste management and personal protective equipment for use by medical waste handlers in both ABUTH and ABUHS. The study further revealed availability of receptacles, storage containers, dumpsites and separation of collection of sharps or infectious materials at both ABUTH and ABUHS. The study, however, also established absence of colour coding, central purpose-built storage facility, recycling on healthcare waste management in both ABUTH and ABUHS. It was concluded that both the ABUTH and ABUHS are classified as Level 2 hospitals based on their operational performance in accordance with the Townend and Cheeseman (2005) guidelines, which implies that some aspects are considered sustainable while some other aspects considered unsustainable. The study recommended more sustainable practices in the management of HCW. Given the importance of effective healthcare waste management practices and the current unsustainable level of performance, the study recommended further study on the effects of the healthcare wastes from the two hospitals on the environment (soil, water and air).
Williams

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LIST OF ACRONYMS

ABUHS	Ahmadu Bello University Health Services
ABUTH	Ahmadu Bello University Teaching Hospital
AZT	Azidothymidime
BATS	Best available technologies
GPS	Global Positioning System
GIS	Geographic Information System
HCW	Health Care Waste
HCWM	Health Care Waste Management
ISWA	International Solid Waste Association
LAWMA	Lagos State Waste Management Agency
MSW	Municipal Solid Waste
POPS	Persistent organic pollutants
PVC	Polyvinyl chloride
TDG	Transport of dangerous good
UNDP	United Nation Development Programme
UNEP	United Nation Environment Programme
VSM	Viable System Model
WSSD	World Summit for Sustainable Development
WHO	World Health Organisation

CHAPTER ONE

INTRODUCTION

1.1: BACKGROUND TO THE STUDY

Encarta (2007) defines waste as unwanted or unusable items, remains, by-products or household garbage. Sinnot (1999) argues that waste arises mainly as by-products or unused reactants from the process, or as off-specification product produced through mis-operation. There is a wide variation in volume and diversity of wastes from domestic, commercial, industrial and institutional land use types. In particular, institutional land uses such as hospitals lead to the production of potentially toxic, infectious and hazardous wastes as a result of the demand for health-care activities. Despite problems arising from these unwanted wastes, a civilized society cannot do without a healthcare system because it is a basic requirement for human kind (Nemathaga, Maringa and Chinuka,2008).

Undoubtedly, medical establishments play important roles in different activities by the use of modern technology to restore and maintain community health. Medical establishments include hospitals, clinics, medical centres, home health care, blood banks, veterinary offices, clinical facilities, research laboratories, clinical laboratories, and all unlicensed and licensed medical facilities(Labib, Hussein, El-Shall, Zakaria and Mohamed, 2005).

The World Health Organization (WHO) (2002) defines hospital solid waste as “any solid waste that is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or testing of biological, including but not limited to soiled or blood-soaked bandages, culture dishes and other glassware”. Hospital solid wastes also include discarded surgical gloves and instruments, needles, lacents, cultures, stocks and swabs used to inoculate cultures and remove body organs(Abdel-Salam, 2010).United States Environmental Protection Agency (USEPA, 1989) refers to hospital wastes as all biological or non-biological wastes that are discarded and not intended for further use and these include pathological, infectious, hazardous chemicals, radioactive wastes, stock cultures, blood and blood products, animal carcasses, pharmaceutical wastes, pressurized containers, batteries, plastics, low-level radioactive wastes, disposable needles, syringes, scalpels and other sharp items. Others include food service, cleaning and miscellaneous wastes (Oyeleke and Istifanus, 2009), toxic chemicals, cyto-toxic drugs, flammable and radioactive wastes that can often be considered infectious (Caltivelli, 1990).

Globally, wastes generated from hospitals are now recognized as serious problems that have detrimental effects on the environment and/or human beings through direct or indirect contact. Exposure to hazardous healthcare waste can result in disease or injury (WHO, 1999). Diseases like typhoid, cholera, acquired immunodeficiency syndrome (AIDS), and viral hepatitis B can be transmitted through the

mismanagement of hazardous hospital waste (Mato and Kassenga, 1997). It has been estimated that each year, there are about 8 to 16 million new cases of Hepatitis B virus (HBV), 2.3 to 4.7 million cases of Hepatitis C virus (HCV) and 80,000 to 160,000 cases of Human Immune-deficiency Virus (HIV) due to unsafe injections and mostly due to very poor waste management systems (WHO, 1999; Townend and Cheeseman, 2005). Environmental nuisance may also arise due to foul odour, flies, cockroaches, rodents, and vermin as well as contamination of underground water by untreated medical waste in landfills (Nemathaga *et al.*, 2008).

In most countries of the world, sound management of healthcare waste has become one of the most crucial issue confronting hospitals and the society at large. Public concern and awareness on this issue are increasing via the media, conferences, strategic meetings, debates and it is a subject of several studies such as Nemathaga *et al.* (2008), Ajimotokan and Aremu (2009) and Abah and Ohimain (2011). Advocates of environmental protection have drawn the attention of the national policymakers to the health hazards and potential danger to natural resources caused by inadequate management of wastes (Federal Environmental Protection Agency, 1991).HCW must be properly managed in a way that minimizes risk to human health and reduced negative impact on the environment. Just as a Botanist regards a weed as a plant in a wrong place so also waste is a resource in a wrong place (Ogedengbe, 2002). Ogedengbe (2002) further argued that HCW is a resource which ifadequately managed can serve as manure for farming via composting the “biodegradable” aswell

as raw materials for some factories and industries through material recovery and recycling(reuse) of the “non-biodegradable”.

As primitive as open dump method of solid wastes disposal is, Johanessen and Boyer (1999) observed that it remains the predominant means in developing countries. Rushbrook and Pugh (1999) considered the open dump method of solid waste disposal as both“naïve and dangerous” because of the leaching effects of chemicals and biological contaminantsin the wastes, which constitutes a direct route for transmission of communicable diseases.Although, incineration is not an unclean process of disposing wastes, it is still the mosteffective method of treating HCW because it involves the application of combustion processunder controlled condition at high temperature, converting wastes containing stocks ofinfectious agents and pathological materials to inert mineral residues and gases (Omotoso, Faluyi and Iyanda, 2007).However, incineration is regarded as the most expensive waste management option because itrequires capital intensive plant, highly skilled personnel and careful maintenance (Onipede and Bolaji, 2004) and it maylead to the production of dioxins, furans or other toxic pollutants as emissions and residues. Improper HCW disposal method like open air burning, land filling, dumping into water bodies is common in developing countries, constitutes environmental threats, increased vulnerability for potential transmission of communicable diseases and natural disasters.

In developing countries like Nigeria, where many health concerns are competing for limited resources, it is not surprising that the management of healthcare wastes has received less attention and the priority it deserves. Although reliable records of the quantity and nature of healthcare wastes and the management techniques to adequately dispose of these wastes has remained a challenge in many developing countries of the world, it is believed that several hundreds of tons of healthcare waste are deposited openly in waste dumps and surrounding environments, often alongside with non-hazardous solid wastes (Abah and Ohimain, 2010). Unfortunately, practical information on this important aspect of healthcare management is inadequate and research on the public health implications of inadequate management of healthcare wastes are few and limited in scope. In addition, a near total absence of institutional arrangements for HCW in Nigeria has been reported by others (Coker, Sangodoyin and Ogunlowo, 1998).

1.2: STATEMENT OF THE RESEARCH PROBLEM

The sustainable management of Healthcare Waste (HCW) has continued to generate increasing public interest due to the health problems associated with exposure of human beings to potentially hazardous wastes arising from healthcare (Ferreira, 2003; Da Silva, Hoppe, Ravanello and Mello, 2005; Tudor, Noonan and Jenkin, 2005). Whilst hospitals and healthcare units are supposed to safeguard the health of the community, the mismanagement of HCW poses health risks to people and the environment by contaminating the air, soil and water resources. Presently, considerable gap exist with regards to the assessment of healthcare waste

management practices particularly in Nigeria and in several other countries in sub-Saharan Africa.

HCW are a special category of waste because they often contain materials that may be harmful and can cause ill health to those exposed to it. A number of studies have indicated that the inappropriate handling and disposal of healthcare wastes pose health risks to health workers who may be directly exposed and to people near health facilities, particularly children and scavengers who may become exposed to infectious wastes and a higher risk of diseases like hepatitis and HIV/AIDS (WHO, 1999; 2002; Oke, 2008; Coker, 2009; PATH, 2009; Adegbite, Nwafor, Afon, Abegunde and Bamise, 2010).

The nature and quantity of healthcare waste generated as well as institutional practices with regards tosustainable methods of healthcare waste management, including waste segregation and waste recycling are often poorly examined and documented in several countries of the world despite the health risks posed bythe improper handling of HCW (Oke, 2008; Farzadika, Moradi and Mohammadi, 2009). It is also of serious concern that the level of awareness, particularly of health workers, regarding healthcare waste has not been adequately documented.

Studies on Hospital solid waste have been carried out by different researchers. (Longe and Williams, 2006) surveyed medical waste management practices and their implications to health and environment in metropolitan Lagos. The study assessed

management practices in four hospitals ranging in capacity from 40 to 600 beds. The study established average generation rate of medical waste of 0.562kg/bed/day to 0.670kg/bed/day; with infectious waste accounting for between 26 to 37% of the total volume. Only two of the hospitals investigated carried out treatment of their infectious and sharp waste types by incineration before final disposal.

Nemathaga *et al.* (2008) studiedhospital solid waste management practice in Limpopo provinceof South Africa. The author looked at the issues and current short comings faced by many hospitals in the province. According to the study, a major policy implementation gap was identified between the national government and the hospitals. Although modern practices such as landfills and incinerators were reported to be used, daily operations were not carried out in accordance with these minimum standards. The authors also noted that there was no proper separation of waste according to the classification demanded by the national government.

Ajimotokan and Aremu (2009), in a study titled "case study evaluation of health-care waste challenges in Hospitals within Ilorin metropolis", found out that about 177.67Kg of waste was generated daily and the average waste generated perbed/per day was 1.56Kg. They further reported that the management of the waste was often poor, with a mixture of potentially infectious and non-infectious waste being a common sight in the hospital waste bins and hospital environment.

Abah and Ohimain(2011), in the study entitled “health care waste management in Nigeria”, focused on the estimation of the quantity,evaluation of the waste segregation practice and determination of the knowledge of health care workers regarding healthcare waste management. The findings revealed that the average amount of health care waste was 0.62Kg/person/day at the out patients ward and that the proportions of respondents who had received specific training in the management of healthcare waste was 11.5% (6/52). The number who understood the importance of HCW management in the provision of safety to the public was 46% (24/52).

Toyobo, Baba and Oyeniyi (2012) appraised the medical waste characteristics and management practices in University College Hospital (UCH), Ibadan and Obafemi Awolowo Teaching Hospital Ile-Ife in Nigeria. The authors examined characteristic of waste generation, identified waste disposal methods, assessed waste management practices, and highlighted possible suggestions towards a healthy environment for patients for the case studies. The study revealed improper waste management handling and open dump disposal methods in the two hospitals. The study subsequently recommended proper trainings and workshops should be conducted to make the resident doctors and waste management teams in the hospitals aware of the issues and practices of hospital waste management. Beside this, the study recommended that the regulation of audit process in this life sensitive issue should be maintained.

Studies on healthcare wastes have not been adequately undertaken and reported in the present study area. It is not clear at this point in time what the nature of HCW is, how much is being generated and how they are managed in the study area. Besides, existing literature (Nemathaga *et al.*, 2008; Uwa, 2008; Toyobo *et al.*, 2012) indicates that there appears to be much difference in the way and manner wastes generated in various healthcare institutions are managed in Nigeria and hence, the necessity for this researchdesigned to compare Ahmadu Bello University Teaching Hospital (ABUTH) and Ahmadu Bello University Health Service (ABUHS) because of the potential high risk to the health of the vast number of people who are mainly students, staff, visitors and the communities at large.

The research questions that were addressed by this study have been summarized below:

i. What is the nature of the health care waste generated in Ahmadu Bello University Teaching hospital (ABUTH) and Ahmadu Bello University Health Service (ABUHS)?
ii. What is the quantity of HCW generated in the two hospitals?
iii. What are the methods of waste collection and disposal in the two hospitals?
iv. How effective are the HCW management practices in the two hospitals?
v. Where are the dumpsites of the two hospitals located?

1.3: AIM AND OBJECTIVES OF THE STUDY

The aim of the study is to assess the medical waste management practices in Ahmadu Bello University Teaching Hospital (ABUTH) Zaria and Ahmadu Bello University Health Service (ABUHS) A.B.U. Zaria. The specific objectives of the study are to:

i. characterize the nature of the Healthcare Waste (HCW) generated in the two hospitals;
ii. determine the quantity of HCW generated in the hospitals;
iii. examine methods of HCW collection and disposal in the hospitals;
iv. identify and map out the waste dumpsites of the two hospitals; and
v. assess the effectiveness of HCW management practices in the hospitals.

1.4: SCOPE OF THE STUDY

This study covered two hospitals, namely: Ahmadu Bello University Teaching Hospital (ABUTH) in Shika (Giwa Local Government Area of Kaduna State)and Ahmadu Bello University Health Services (ABUHS) in Samaru campus, Zaria (Sabon-Gari Local Government Area of Kaduna State. The ABUTH was primarily established for training medical students at undergraduate and postgraduate levels but it also provide healthcare services to the people within its catchment area at primary, secondary and tertiary levels. The ABUHS was primarily established for providing healthcare service to students, staff and the immediate community. The ABUHS offers both primary and secondary healthcare services and enjoys referral collaboration relationship with the ABUTH. Both hospitals are accredited by the

National Health Insurance Scheme and serve the healthcare needs of their catchment areas.

Each of the hospitals is made up of departments/units and wards with both skilled and unskilled medical personnel. Wastes are generated from every segment of the hospitals which needs proper management. The study focused on the waste management practices in the two hospitals with reference to general management strategy, waste collection and segregation, waste recycling, waste storage, waste treatment and offsite disposal. On the temporal dimension, the study focused on current practices in both hospitals to enable the provision of solution to contemporary problem.

1.5: SIGNIFICANCE OF THE STUDY

The concern regarding medical waste is mainly due to the presence of pathogenic organisms and organic substances in hospital solid wastes in significantly high concentrations. The substantial number of organisms of human origin in solid waste suggests the presence of virulent strains of viruses and pathogenic bacteria in undetected numbers. Improper handling of solid waste in the hospital may increase the airborne pathogenic bacteria, which could adversely affect the hospital environment and community at large. Improper medical management has serious impact on human environment. Apart from risk of water, air and soil pollution, it has considerable impact on human health due to aesthetic effects (Slack, Gronow and Voulvoulis, 2004). The safe disposal and subsequent destruction of medical waste

therefore, is a key step to the reduction of illnesses or injuries through contact with this potentially hazardous material, and in the prevention of environmental contamination.

It is hoped that this study will provide a practicable hospital waste management approach that will be beneficial to the government and will reduce the negative impacts on the environment and communities within the neighbourhood of the waste dump sites of the selected hospitals.

CHAPTER TWO

LITERATURE REVIEW

2.1: INTRODUCTION

This chapter presents the review of relevant literatures that are of importance to the study. Several concepts and techniques were also defined in order to provide the direction of the study.

2.2: WASTES

Waste has been defined as any "unwanted material arising in the course of production and consumption" (Encarta, 2007). The UKGovernment's Environmental Protection Act 1990 goes furtherto define waste as"any substance which constitutes a scrap material, aneffluent or unwanted surplus substance arising from theapplication of any process.Any substance or articles which demand to be disposedof as being contaminated, broken, worn out or otherwisespoiled (explosives are not included)".The European Economic Community (EEC) defined waste as: "any substance or object the holder disposes of or isdemanded to dispose of pursuant to the provisions of thenational law in force (Commission of the EuropeanCommunities, 1992)". According to Uwa (2008), a waste is any substance forwhich the owner or generator has no further use and whichhe discards. Waste may be solid, semi-solid, liquid orgaseous; and in each case may be toxic or non-toxic, combustible or non-combustible.

Everywhere in the world, waste is oftendiscussed according to some criteria which are outlined by Uwa(2008):-

a. The source of the waste e.g.: domestic, commercial, industrial, agricultural and hospital.
b. The method of disposal e.g.: landfill, incineration,tipping, composting, pulverisation.
c. The degree of risk for human health and environment e.g.: toxic waste, infectious waste.
d. Economic value, for example, in relation to the productionof a solid refuse-derived fuel (RDF).

Waste is generated daily by households,hospitals, commercial establishments, industries, governmental operations, and virtually every element ofsociety. Waste is generally taken to include allgaseous, liquid waste generated from a large rangeof community activities, i.e. simply trash, rubbish orgarbage. A significant quantity of solid ishazardous. Municipal waste composition changes withtime and by region. For instance in 1939 it was mostlygarbage mixed with paper products, cans, dust, bottles, andcinders. From about 1955, waste grew less dense asless ash was produced. Since 1977, greater quantities ofpaper, glass and plastics have been produced imparting ahigher calorific value to waste.

In the USA,waste includes refuse, garbage, slurries and all materials that arenormally discarded after use and also by-products ofmanufacturing or mining activities that are normallydiscarded (Longe and Williams, 2006). In the UK waste includes municipal solid waste whose average composition is: metals(mainly ferrous) 9%, glass 9%,

paper 32%, plastics 8%,vegetable 20%, dust and others 18%, textiles and others 4%(Abdel-Salam, 2010).

2.3CLASSIFICATION OF WASTES

There is a difficulty in defining waste as toxic orhazardous because this terminology includes any substance that could be harmful both to humans and to the environment. In Nigeria, there are no legal categories for waste definitions. TheEEC definitions which exist for the terms 'toxic' and ‘hazardous' may have a wider meaning in Nigeria and include difficult, special, clinical, toxic or controlled waste which is shown below (UK Government's Environmental Protection Act, 1990):

i. Controlled wastes: These are the wastes subject to the Control of Pollution Act (COPA) 1974. Controlled wastes are divided into three categories: household, commercial, and industrial. These wastes do not include explosives, waste from mines and quarries, or agricultural wastes.

ii. Special waste:This is a category of waste which 'is or may be so dangerous or difficult to dispose of that specialprovision is required for its disposal'. These wastes are given very specific definitions: either medicinal products available only on prescription, or specified materials which are dangerous to human health, or those substances with a flashpoint of 21°C or less.

iii. Toxic waste: This is a rather loose definition, which is often used to refer to those wastes which have toxic properties but are not exactly equivalent to special wastes.

iv. Hazardous wastes: These are wastes which fall under the UK Trans-frontierShipment of Hazardous Waste Regulations (1988). As with toxic wastes, this definition is

somewhat hazy under UK law, being analogous to special wastes. The new definition of hazardous wastes under EC Directive COM(88) 399 is more specific, including those wastes which are hazardous by means of their physical or chemical characteristics, the process by which they were produced, or their effect on human health or the environment.

v. Difficult wastes: These wastes as defined by the Department of Environment (DoE) cover all special waste plus some other substances such as ferrous metal scrap which are not special wastes. However, this term is ‘generally used to include wastes which could in certain circumstances be harmful in either the shortorlong term to the environment. It also includes wastes whose physical properties present handling problems’ (Department of the Environment, Waste Management Paper No. 4, 1988, para 3.4 (b).

vi. Clinical wastes: Clinical wastes include human tissue, body fluids, or excretions; drugs and medicinal products; swabs and dressing; urine containers, incontinence pads and stomapads; syringes; and also needles, scalpel blades, and other’ sharps’.

Akhtar (1999) further argued that hazardous wastes should be defined as those wastes which, due to their nature and quantity are potentially hazardous to human health and the environment and which require special disposal techniques to eliminate or reduce the hazards. Uwa (2008) cited a report on waste establishments drawn up in 1968 by the Incinerator Institute of America (IIA), which classified wastes tobe incinerated into seven categories, as shown below.As a guide, the

components of waste most usually encountered have been classified into various types alongwith their Kilo-Joule values and their moisturecontent:

2.3.1 Type 0- Trash

This type of waste includes 10% dampness, 5%non-combustible solids and has a heating value of 9010 kilo joule per kilo when burnt. This waste comprises compounds of highcombustion value that burn easily. They include material such as cardboard, paper, cartons, wood boxes and combustible floor sweepings that are from trade and industrial activities. These components contain up to 10 % (by weight) of laminated paper, coated paper, treated corrugated cardboard, plastic bags, oily rubbish rags and plastic or rubber scraps.

2.3.2 Type 1- Rubbish

This waste includes up to 25% dampness, 10%incombustible solids and has a heating value of 6890 kilo jouleper kilo as fired. This compound burns easily and consists of waste such as cardboard cartons, paper, wood scrap, foliage and refuse from industrial activities. The dampness is up to 20% by weight from restaurant or cafeteria waste but contains little or no treated, paper, plastic or rubber wastes.

2.3.3 Type 2-Refuse

This type of waste is typical residential refuse andcomprises up to 50% dampness, 7% non-combustible solids andhas a heating value of 4558 kilo joule per kilo upon combustion.This material has approximately equal amounts of garbageand, rubbish.

2.3.4 Type 3-Garbage

This contains up to 70% moisture, up to 5%incombustible solids and has a heating value of 2650 kilo joule per kilo. Garbage consists of vegetable and animal wastesfrom markets, cafeterias, hotels, restaurants, hospitalsand other such institutions.

2.3.5 Type 4- Human and animal remains

Animal and other organic waste consists of up 85%dampness, 5% non-combustible solids with a heating valueof 1060 kilo joule per kilo as fired. Human and animal wasteconsists of organs, carcasses and solid organic wastes fromhospitals, laboratories, abattoirs, animal compounds andsimilar sources.

2.3.6 Type 5- Liquid by-product waste

This kind of waste is gaseous, liquid or semi-liquid,e.g. tar or solvents, sludge, paints, fumes, etc. From industrial processes, kilo joule values are very variable andmust be determined in relation to the nature of theindividual waste material.

2.3.7 Type 6- Solid by-product waste

This type of material is made up of items such asplastic, rubber, and wood from industrial processes. The kilo joule values must again be determined for individual compounds(IIA, 1968).

2.4HEALTHCARE WASTES

Healthcare waste (HCW) and healthcare facilities (HCFs) are characterized by their hierarchical structure and complexity. The categories of healthcare waste range from

infectious, pathogenic and sharp to genotoxic, chemical and radioactive waste, each with a compliment of diverse health risks. Treatment and disposal also vary according to category (Pruss *et al.,* 1990). On the side of HCFs, the institutions range from teaching, specialist, general and maternity hospitals; others are clinics, psychiatric and orthopaedic hospitals with different sizes, ownership, specialty and competence. They are complimented by internal actors in the medical and para-medical fields; and their external counterparts in government and other non-medical specialists and professionals. In addition, the healthcare sector has metamorphosed to services-based business sector recently with the number of small-scale HCFs growing rapidly with little attention paid to HCW management especially in developing countries.

The management challenges of such a multi-faceted and complex entity as HCFs and the wastes they generate need, of necessity, to be underpinned by sustainable development concept incorporating the economic, environmental and social dimensions. This is in addition to the infusion of associated key environmental management principles as they relate to HCW management: Polluter Pays Principle (PPP), Precautionary Principle (PP) (Carter, 2001) and Duty of Care Principle (WHO, 1999).

2.5: NATURE AND SOURCES OF HCW

The nature and sources of HCW are important components of HCW management. The complexities of HCW and its configuration as a system made up of several sub-

systems (Rampersuad, 2008; Chaerul *et al*., 2008; Tudor *et al.*, 2008) is forcefully underscored by the liberal application of a wide but related interchangeable nomenclature. Current mainstream HCW management literature tend to employ terms for waste generated in healthcare and related facilities and activities interchangeably to refer to healthcare waste. Evidence in support of this assertion has been accumulating over the years. For example the term medical waste has been adopted by a number of researchers (Monee, 2005; Oweis *et al*., 2005; Jang *et al*., 2006; Dehghani *et al.*, 2008; Marinkovic *et al.*, 2008). Idowu and Alo (2010) on the one hand and Arab *et al*. (2008), Askarian *et al.* (2004) andCooker *et al.* (2004) on the other hand had shown preference for clinical waste and hospital waste respectively. Other researchers such as Gupta *et al*. (2009) have opted for the adoption of biomedical waste. The nuances in the terminology used by various researchers to designate waste generated on daily basis from healthcare facilities and activities is a testimony to their bewildering diversity in terms of sources, types, nature and treatment options; as well as the type of waste stream of interest to a researcher (WHO, 1999).

In the WHO (1999) healthcare waste definition and classification, HCW is defined as including all the waste generated by healthcare establishment, research facilities and laboratories including waste generated from minor or scattered sources such as those produces in the course of healthcare undertaken in the home such as dialysis, insulin and injection (WHO, 1999). This definition is of interest to this research topic and its adoption is in line with the general contemporary practice adopted by the

UNEP/World Bank (2005). This trend in the use of HCW is validated by a plethora of researchers in the field of HCW management including Patil and Prakel (2005); Shinee *et al.* (2008); Coker and Sridhar (2010); Sridhar *et al*. (2009) and Coker and Sridhar (2010). Others comprise Coad and Christen (1999), Johannsennen *et al*. (2000), Rot (2005); Brent *et al.* (2006) and Ngwuluka *et al.* (2009).

The need for the orderly grouping of the highly varied elements of HCW into different sub-sets that are each characterized by narrower identical attribute to simplify understanding (Igwe, 2002) informed the WHO (1999) classification. The categories and sub-sets of healthcare waste yielded by the exercise comprise: pathological waste, bio-medical waste, clinical waste, infectious waste (of which infected sharps are a sub-category), pharmaceutical waste and genotoxic waste. Another dimension of equal significance in the classification of HCW is the dual grouping into two major groups namely non-risk or general healthcare waste comparable to domestic waste; and healthcare waste regarded as hazardous (also known as "health-care risk waste; and may create a variety of human health risk and environmental damage. Each one of the two groups follows different management and treatment pathways in HCW management but must nevertheless be viewed holistically. For example, the non-hazardous waste steam from HCW constitute the same category of urban solid waste which from a sustainability prospective is treated as a source of wealth and points to avenues which need to be further explored in HCW management. Abah and Ohimain (2011) suggest that the materials which include paper, glasses and plastics can be safely and easily recycled for which market

is readily available and the proceeds go to improve funding for HCW management. The works of Lee *et al*. (2002) and Narayan (2001) on the analysis of the recycling potential of medical plastics wastes validates the potential economic benefit as well as points to feature directions in sustainable HCW management.

Pharmaceutical waste and waste water constitute critical component of HCW. Abundant evidence of their potential human health risk and environmental degradation is premised on the grounds that they are neither removed completely nor degraded in treatment plants (Ternes, 1998; Burser *et al*., 1999; Stempt*et al*., 1999; Latch *et al*., 2003 andSherer, 2006). Specifically, Castensson (2008) and Kummerer (2009) identified the burying of pharmaceutical waste as being improper for environmental reasons because it is implicated in the leaching of waste into groundwater and surface water.

Indeed, HCW management literature in support of the occurrence of pharmaceutical waste in waste water as well as in surface ground and drinking waters abound in studies carried out in developed countries. They include the studies by Herberer (2002); Jones *et al*. (2002); Zuccato *et al.* (2006); Castensson (2008); Kiel *et al.* (2008); and Kummerer (2009). Ngwuluka *et al.* (2011) noted, on the contrary, that while developed countries have been monitoring and determining pharmaceutical wastes, there exists no apparent indication that Nigeria is monitoring it. They went on to assert as evidence the little awareness in Nigeria about the hazards of

pharmaceutical waste as an emerging contaminant as a result of limited number of actors who are aware of the requirements of regulatory authorities.

2.6: CLASSIFICATION OF HEALTH CARE WASTES

Health care wastes are generated by hospitals, animal research facilities and laboratories all of which can be represented in hospitals. The most accepted and recognized is that by the UNEP/WHO. Table 2.1 shows the United Nations Environmental Programme/World Health Organization classification of Health Care Waste (HCW) (UNEP/WHO, 2005).

Table 2.1: UNEP/WHO Classification of Health Care Waste (HCW)

Main Group	Sub-group I	Sub-group II
A: Non-risk HCW	A1: Recyclable waste A2: Biodegradable waste A3: Other non-risk waste	
B: HCW requiring special attention	B1: Human anatomical waste	
	B2: Sharps	
	B3: Pharmaceutical waste	B31: Non-hazardous Pharmaceutical waste B32: Potentially hazardous Pharmaceutical waste B33: Hazardous Pharmaceutical waste
	B4: Cyto-toxic pharmaceutical waste	
	B5: Blood and body fluids	
C: Infectious and highly infectious waste	C1: Infectious waste	
	C2: Highly infectious waste	
D: Other hazardous waste		
E: Radioactive waste		

Source: UNEP/WHO (2005)

2.7: LEGISLATIVE FRAMEWORK FOR HEALTHCARE WASTE MANAGEMENT

According to Rampersuad (2008), the legislative framework is supported by a set of laws, regulations and standards established by governments to address environmental issues by reducing or preventing pollution. Law is therefore an important tool that underpins appropriate and sustainable HCW management systems. Akhtar (1999) went further to emphasize the overall importance of law and regulations in HCW management by attributing a well-administered and proper HCW management system as the outcome of a well synthesized law. In tune with this thinking, Thumbnail *et al.* (2008) confirms that the management practice does not seem to improve unless a well synthesized law concerning HCW management is in place.

In Nigeria for example, the Constitution of the Federal Republic of Nigeria 1991 falls short of providing the necessary legal teeth in favour of sustainable HCW management. As noted by Townend and Vallini (2008), this supreme legal order is robust in the clear definition of duties and responsibilities among the three constituent units of the federal entity in healthcare at central, state and local government levels. However, the Environmental Law Research Institute (2011) considers the provision for HCW management issues in Nigeria in the constitution as marginal at best. In line with this contention, Akhtar (1999) called attention to Sections 33 and 34 of the Nigerian Constitution 1999 which guarantee fundamental

human rights to life and human dignity respectively as seen as being argued to address HCW management via the need for healthy and safe environment to give these rights effect as being relevant to public health and safety.

The inadequacies of laws in Nigeria for a proper and sustainable HCW management procedure was also noted by Abah and Ohimain (2011) with regard to the public health act 1958 and various state edicts on environmental sanitation which also provides regulations on the management of solid waste, particularly non-hazardous general (municipal) waste. They faulted these laws for not adequately addressing the important aspects of healthcare waste. With specific attention to the Draft Nigerian National HCW (2007) which is a national legislative policy, Abah and Ohimain (2011) went further to draw attention to its non-implementation at any level despite the fact that Nigeria is a signatory to several multilateral environmental agreement (MEAs) including the Basel Convention as well as Hazardous Chemicals and Waste Convention (UNEP,2002).

With specific reference to international laws, Ngwuluka *et al.* (2009) advocatedthat healthcare establishment owes it as a duty to the environment and public health abides by the agreement of member state of the (Basel Convention, 1999). The Environmental Law Research Institute (2011) in considering the issues of nonor poor implementation and enforcement of existing environmental laws, underscored the extension of this weakness of the implementation of international environmental agreement in Nigeria. In this regard, the institute found that while section 12 of the

Nigerian constitution 1999 established, though impliedly, that international treaties (including environmental treaties) ratified by the national assembly should be implemented as law in Nigeria, this has not been effected as regards HCW management. Specifically with reference to one of the relevant international-level laws governing HCW management, the Stockholm convention, the main treaty addressing the disposal of persistent organic pollutants (POPS), it has been highlighted that the requirements to use best available technologies (BATS) for the medical waste incinerators is not feasible for medical institutions in sub-Saharan African due to high cost (UNDP undated).

Law is the driver for any quest for sustainable HCW management. This section on the review of the statues of environmental law in Nigeria, and the paucity of implementation and enforcement is germane to this study. A critical issue raised with regards to the use of BATS for medical waste incineration and cost, for example, point to the need to keep the level of development and social, economic and environmental conditions prevailing in the countries of the developing world.

2.8: APPLICATION OF MODELS AND METHODOLOGIES IN HCW MANAGEMENT

The application of models in healthcare waste management (HCWM) has been on the upswing in recent years of which a number focus on healthcare management and related issues in the developing world. Ekwueme *et al.* (2002) focused on model-based estimates of risks of diseases transmission and economic costs of seven

injection devices in sub-Saharan Africa; while the work by Kane *et al*. (1999) explored model-based regional estimates of the transmission of hepatitis B, Hepatitis C and human immunodeficiency viruses through unsafe injection in the developing world.

A good example, but encompassing the generic waste, is the work of Morrissey and Brown (2004) on waste management models and their application to sustainable waste management, Specifically, with regard to the use of system model, noted for its applicability in complex systems (systems within systems) like healthcare waste and its management. Rampersaud (2008) has applied it to represent healthcare waste management system that minimize infection risk in developing countries. In the study, Rampersaud (2008) applied system approach to represent healthcare waste system in Guyana as a "system" to waste management using the viable system model (VSM) which is qualitative in nature with its roots in cybernetics (Schwaninger, 2006) with the aim of applying systems thinking. As highlighted by the OECD (2007) viability is related to sustainability.

Furthermore, Brent *et al.* (2006) applied the Analytical Hierarchy Process (AHP) in the content of sustainable development to optimize HCWM systems in rural areas of developing countries. The AHP is a well-known multi-attribute weighting method for decision support (Madu, 1994). As such, it has been used for solving complex decision-making problem in various disciplines such as variability determination (Alidi, 1996), forecasting (Carmone *et al.*, 1997) and project management. Unlike the

VSM which is qualitative in nature, the AHP is a multi-criteria decision analysis (MCDA) technique (Morrissey and Brown, 2004) in which a mixture of quantitative and qualitative information can be incorporated.

Other contributors to the use of system in HCWM research include Tudor *et al.* (2008) who used the systems approach in search of improvement in the management of waste from healthcare facilities for best practice using England and Wales as a case study (Hokkanen and Salmien (1997) whose work focused on choosing a solid waste management system using multi-criteria decision analysis. Related to the use of models in HCWM is also the application of goal programming approach by Chaerul *et al*. (2008) aimed at resolving complexities in healthcare and waste management. Not to be left out are the studies by Kaiser *et al.* (2001); and Rogers *et al.* (2002) on life-cycle thinking in the search for solution to HCW.

Overtime, various methodologies (qualitative and well as quantitative) have been used by researchers all over the world to assess and quantify HCWM. They include physical observation, questionnaire administration, and quantification (Adegbite*et al*., 2010;Olubukola, 2009; Phengxay *et al.*, 2005). Other methodologies include checklists (Townend and Cheeseman, 2005) as well as the use of private and public records. In addition, Abah *et al.* (2011) carried out a cross-sectional descriptive study at tertiary healthcare facility (Teaching hospital) in Nigeria based on methods of Townend and Cheeseman (2005) and UNEP/WHO (2005).

2.9: HEALTHCARE WASTE MANAGEMENT AND TREATMENT

The literature on HCW management is rich in studies which explore and expound various management approaches and methodologies for the achievement of an affective, responsive and sustainable process. The crux of the matter, however, is the existence of discernible dichotomy in the profile of the highly complex HCW which consist of a waste treatment component and a management dimension both of which must of necessity be treated holistically. According to WHO (1998), Townend and Cheeseman (2005) and WHO (1999) the management dimension of HCW comprises such issues as legal framework and policy planning, organizing human resources including training and capacity building, finance, institutional arrangement (UNEP, 2005).

On the other hand, the treatment of HCW is dominated by technology concerns comprising incineration, safe landfill; sterilization; autoclaves and microwaves, chemical disinfection; and design of HCW transportation (WHO, 2008; UNEP, 2005).According to Townend and Cheeseman (2005) and WHO et al., (1999), these technology aspects focus on safe, efficient and sustainable methods of handling, treatment and disposal of waste from healthcare activities. The elements comprise segregation, packaging and treatment for reduction in volume, transporting processing of hazardous and non-hazardous waste and disposal.

A number of studies demonstrate, however, that both treatment and management dimensions of HCW need to be examined holistically (WHO, 2008) espousal of the

holistic approach to management of HCW as an essential component for preventing health system. In support of this view, Patil and Skedhar (2001) posit that management of HCW is not strictly about data compilation and technology of waste treatment and disposal but also involves training, commitment, management, leadership and effective legislative. As Sheth et al. (2006) rightly pointed out, treatment and management of HCW for sustainability need to incorporate all the elements of both management and technical. These elements were listed byRutala and Weber (1991) as planning and procurement, staff training and behaviour, proper use of tools, machines and pharmaceuticals, proper methods applied to segregation, reduction in volume, treatment and disposal.

2.10: MAJOR ISSUES IN HCW TREATMENT AND MANAGEMENT

2.10.1 HCW Treatment

The treatment dimension of HCW has equally generated a great number of studies. The reason is that the nature of the components of HCWs, their toxicity and potential hazard are different, necessitating different methods and options for treatment and disposal (Sah, 2007). Different methods have been developed for rendering biochemical waste environmentally innocuous and aesthetically acceptable (Sah, 2007). However, different studies have shown that there is no single method of medical waste treatment or disposal that completely eliminates all risks to humans or the environment (Sheth *et al.*, 2006; Kralj and Stamenkovic, 2006; Sah, 2007; Stamenkovic and Kralj, 2007).

2.10.2 Incineration of Waste

Of the technologies to be considered in the management of HCW, incineration of which there are many types is a prominent medium (Hagenmaier *et al.,* 1987; Barb and Condon, 1999). Consequently, all aspects of incineration of HCW are an approach that has received a great deal of attention in HCW literature. They include the question of identification of environmentally sound technologies (Jeremy and Honor, 2005; Ramabitsa-Siimame, 2006), construction and documentation (Picken, 2004), types of incinerators which include autoclave (Sah, 2007) and a new innovation known as hydroclave treatment; and microwave and chemical disinfection (Sah, 2007). Kela *et al*. (1999) made a strong case in favour of management dimensions of HCW management. According to the authors, technology can help but has to be part of a larger solution. Instead, emphasis should be on training for segregation, local housekeeping and disinfection, safety practices for nurses, ward boys and rag pickers from occupational hazard view point, and waste minimization which can help ultimately to solve the problem of medical waste.

With due attention to alternative for the treatment and disposal of healthcare waste, Emmanuel *et al.* (2004) examined the question of non-incineration of medical waste treatment technologies in Europe which is of interest to developing countries; while Rogers *et al.* (2002) focused on small-scale medical waste incineration. With regards to the use of technology in HCW management, Brent *et al.* (2007) righty argued that the approach can be seen as a major limitation to introducing safe HCW management systems. They expounded further that developing countries often do not have support

system to install, maintain and operate developed world environmental technologies. The sustainable approach, it was stressed, is to accommodate the use of more environmentally sound technologies (ESTs) in the design of HCW management systems. Pruss *et al.* (1999) argued in favour of incineration of general infectious waste as long as pharmaceutical waste is not more than 1% of the total to limit toxic emissions into the air.

2.10.3 Sharps

The management of sharps (i.e. syringes) in HCW has a high profile because of the enormous adverse health impact and risk worldwide. For example, the WHO (1999) estimates that unsafe injections cause approximately 30,000 new HIV infection, 8 million HBV infections, and 12 million HCV infections worldwide every year. The WHO/USAID (1998) also examined two alternative approaches. One is a cost effective and waste management perspective in which syringe can be re-used (after proper cleaning and sterilization in a steam sterilizer) in preference to disposable syringe; the other is a public health perspective involving one time use of auto-destruct needles. An appropriate summary proposed by Nema and Gupta (1999) is to base the choice of disposal facilities on the type of treatment and the choice of treatment to determine the choice of disposal facilities

2.10.4 HCW Segregation

Waste segregation is a critical first step for the achievement of waste minimization, cost reduction and sustainable waste management (Going, 2001) and offers the health facility the means to make more accurate assessment of their waste composition and

also positions the facility for practical HCW management strategies. The emphasis in HCW is segregation of source. The WHO (1995) recommends the segregation of HCW preferably at the source of production and provides guidelines for the safe and sound management of medical waste in developing countries. The use of instructive posters and colour code bins are very important to achieve effective segregation of waste. Hagen *et al.* (2001) in their study of infectious waste in Saudi Arabia hospital has also reported the importance of providing instructive posters as a tool to promote effective segregation of healthcare waste. The WHO (1996) in their study, noted that the lack of HCW management manual and hospital policy on HCW management are likely to be responsible for a low awareness of health workers on HCW management. This is consistent with the outcome of other studies such as Askarian *et al.* (2004). The guiding principle recommended is the minimization of non-hazardous HCW impacts in terms of quantity or ill-effects by reducing quantity of waste, reusing the waste products with simple treatments and recycling the waste by using it as a resource to produce some or modified products – an approach referred to as 3Rs (Shimuzu, 2006) which stands for reduce, reuse recycle. The 3Rs was given a high priority at the 2002 World Summit for Sustainable Development (WSSD).

2.10.5 Management

The management component of HCW depends on good governance as one of the main strategic factors that need consideration for the success of raising the standards of HCW management (UNEP,2005) in HCFs. The others are institutional arrangements which include framing of appropriate HCWM policies, laws,

regulations, guidelines, standards and enabling instruments. Other factors suggested by UNEP (2005) including clear cut roles and responsibilities capacity building through knowledge sharing, enabling policy framework addressing economic and market-based instruments, facilitating or providing accurate and timely information to all stakeholders (UNEP, 2005) and financing which is considered a fundamental issue (WHO, 2008).

2.11: GUIDELINES FOR ASSESSING HEALTHCARE WASTE MANAGEMENT

The current widely accepted and used guidelines for the evaluation and assessment of wastes and resources management at healthcare facilities is the one prepared by Townend and Cheeseman (2005). According to Townend and Cheeseman (2005), the, guidelines should be simple, elegant and effective, without compromising the underlying complexity associated with these issues. They further argued that the guidelines need to clearly identify key aspects that need to be considered in order to bring about improved performance.

The method used to formulate the guidelines was based on the approach used in the 'Guidelines for Landfill Evaluation developed by the Working Group on Sanitary Landfill of the International Solid Waste Association (ISWA).This used a relatively simple table format, linking performance level to a range of key characteristics. The performance level for landfill evaluation ranged from 'no protection' through to 'extensive protection' and the characteristics assessed were:(a) aesthetics/regard for

health, safety and quality of life of neighbours and passers-by; (b) groundwater protection; (c)surface water protection; (d) landfill gas; and (e) on-site health and safety. Each of these was given a series of characteristic descriptors for each performance level.

Assessing the level of sustainable development associated with healthcare facilities is more complex. However, it was decided that five different operational performance levels given in Table 2.2 would be considered, ranging from ‘operating in a totally unsustainable manner with reluctance to change’ (level 0) to ‘operating in a way that displays all the characteristics normally associated with sustainable development’(level 4).

Table 2.2: Operational performance levels used in the assessment guidelines

Level	Operational performance
Level 0	Operating in a totally unsustainable manner with reluctance to change.
Level 1	Generally operating in an unsustainable manner, although there is some evidence of awareness and willingness to change.
Level 2	Operating in a manner with some aspects that are considered sustainable and others that are considered unsustainable.
Level 3	Generally operating in accordance with sustainable development, but some aspects not ideal.
Level 4	Operating in a way that displays all the characteristics normally associated with sustainable development.

Source: Townend and Cheeseman (2005)

Two different sets of characteristics to be considered andassessed were identified. The first includes general characteristicsassociated with healthcare facility management andresources utilization. The second set is more directly relatedto waste

management and materials handling issues.Presenting the assessment guidelines in this relatively simpleway has three main advantages.

i. Identifying the current ranking of the facility by matching the characteristic descriptorsto the working practices observed indicates how a healthcarefacility is currently performing against the requirementof sustainable development.

ii. This also clearly indicates thechanges that need to be introduced to operate at a higher level.

iii. The simplicity of the guidelines means that they are applicableto all countries and healthcare facilities, irrespective of thelocal level of social, economic and environmental development.

Townend and Cheeseman (2005) stressed the importanceof giving early consideration to sustainabledevelopment issues when assessing practices in lowandmiddle-income countries. This enables new and differentmethods to be developed that take account of cultural andeconomic factors in the community, and not just import thepractices from other cultures.

The guidelines for the evaluation of wastes and resourcesmanagement at a healthcare facility are given in Tables 2.3 and 2.4. Table 2.3 includes consideration of general management;Social issues;Health and safety;Energy and water use; andPurchasing and supply.

Appropriate characteristic descriptors for each of these aredefined.

Table 2.3: Guidelines for the evaluation & assessment of resources & wastes management at

Level	General management	Social issues	Health and safety	Energy and water use	Purchasing and supply
0	• Management unaware of sustainable development (SD) • No commitment to SD • No mass balance under-taken • Evidence of corruption • Lack of awareness of best value • No continuous improvements taking place • No ISO 14001	• No staff consultative committee • No patient consultative committee • No health and safety committee • No health and safety representatives • No equal opportunities policy • No Investor in People schemes or similar	• Health and safety (H&S) awareness. • No H&S policy. • No H&S advisor. • No H&S posters. • Basic protective clothing	• No energy policy • No checks on energy use • No renewable energy sources • Buildings not insulated • No check on water consumption • No inspection to detect waste of water • No staff car sharing scheme • Low percentage of use of public transport	• Uncoordinated purchasing and supply. • No detailed specifications for goods. • No waste prevention. • Regard for rate of use due to economic circumstances. • No regard for clean production practised by suppliers.
1	• Some awareness of top management in sustainable development (SD) • Minimal commitment to SD • No mass balance under-taken • Evidence of corruption • Minimal awareness of best value • Minimal continuous improvements taking place • No ISO 14001	• No staff consultative committee • No patient consultative committee • No health and safety committee • No health and safety representatives • Some equal opportunities policy • No Investor in People schemes or similar	• Health and safety (H&S) policy. • No implementation of policy. • No H&S advisor. • No H&S posters. • Basic protective clothing.	• No energy policy • Checks on energy use • No renewable energy sources • Some buildings insulated • No check on Water consumption • No inspection to detect waste of water • No staff car sharing scheme • Medium percentage of use of public transport	• Some controls on suppliers. • No detailed specification of goods • No waste prevention practices. • No regard for clean production practised by suppliers

Level	General management	Social issues	Health and safety	Energy and water use	Purchasing and supply
2	• All top management aware of sustainable development (SD) • Some commitment to SD • No mass balance under-taken • No evidence of corruption • Minimal awareness of best value • Some continuous improvements taking place • No ISO 14001	• No staff consultative committee • No patient consultative committee • No health and safety committee • Health and safety representatives • Equal opportunities policy • No Investor in People schemes or similar	• Health and safety (H&S) policy. • Basic risk assessment. • Person responsible for H&S. • H&S posters. • Basic protective clothing.	• No energy policy • Checks on energy use • Some renewable energy sources • Some buildings insulated • Check on water consumption • No inspection to detect waste of water • No staff car sharing scheme • Medium percentage of use of public transport	• Some controls on suppliers through tendering process. • Some detailed specification of goods • No waste prevention practices. • No regard for clean production practised by suppliers.
3	• Some top management trained in sustainable development (SD) • Some commitment to SD • No mass balance under-taken • No evidence of corruption • Awareness of best value • Some continuous improvements taking place • No ISO 14001	• Staff consultative committee • No patient consultative committee • Health and safety committee • Health and safety representatives • Equal opportunities policy • No Investor in People schemes or similar	• Health and safety (H&S) policy. • Risk assessment and control. • Part-time professional safety advi-sor. • H&S posters. • Some protective clothing.	• Energy policy • Checks on energy use • Some renewable energy sources • Some buildings insulated • Check on water consumption • No inspection to detect waste of water • no staff car sharing scheme • Medium percentage of use of public transport	• Co-ordinated purchasing and supply. • Working with suppliers and service providers to: - • Reduce materials used. • Reduce packaging. • Reduce use of hazardous chemicals e.g. CFCs. • Stock management

4	• Top management trained in sustainable development (SD) • High-level commitment to SD through committee framework • Mass balance under-taken • No evidence of corruption • Best value and continuous improvements under-taken • ISO 14001 awarded	• Staff consultative committee • Patient consultative committee • Health and safety committee • Health and safety representatives • Full equal opportunities (EO) policy • EO framework for enforcement • Investor in People schemes or similar	• Health and safety (H&S) policy. • Full risk assessment. • Full risk control. • Full time professional safety advisor. • Wide use of H&S posters. • Full protective clothing.	• Full energy policy • Regular checks on energy use • Some renewable energy sources • Buildings insulated • Water consumption regularly checked • Annual inspection to detect waste of water • Staff car sharing scheme in operation • High percentage of use of public transport • Heat and power recovery from waste disposal	• Co-ordinated purchasing and supply. • Working with suppliers and service providers to: • Reduce materials used. • Reduce packaging. • Identify materials for recycling. • Reuse when so designed. • Reduce use of hazardous chemicals. • Stock management • Use of recycled products. • Life-cycle assessments. • Eliminate other heavy metals. • Always consider whole life costs of materials.

Source: Townend and Cheeseman (2005)

Table 2.4 includes assessment criteria for aspects directly related to waste management. These include waste management responsibility; segregation; storage and packaging; waste transport; waste recycling and reuse; waste treatment; and off-site disposal.

Table 2.4: Guidelines for the evaluation and assessment of resources and wastes management at

Level	Waste management – responsibility, segregation, storage and packaging	Waste transport	Waste recycling and reuse	Waste treatment	Off-site disposal
0	• No waste management strategy • Waste organized by operative staff • Limited segregation of some of the most hazardous wastes (sharps radioactive). • Segregation not regulated or controlled. • Storage containers not specific. • No colour coding. • Waste dumped outside building	• Municipal solid waste (MSW) collec-tion and transport with open topped vehicles used for all wastes. • No compaction.	• Some re-use of materials. • Syringes re-used. • No recycling at the HC facility	• Autoclaving of lab wastes. • Crude incineration on site of hazardous wastes. • Encapsulation of hazardous materials e.g. sharps using cement mortar. • Some burying on HC facility in remote areas. • Return of outdated pharmaceuticals to supplier. • Chemical disinfection of body fluids and faeces for very infectious diseases. • Environmental pollution and dangers to public health from crude incinerators.	• Level 1 landfill sites. • Scavenging and recycling on dumps by dump residents. • Syringes being recycled for re-use • Scavenging by animals and insects. • Environmental pollution taking place. • Dangers to public health. • No site security
1	• No waste management strategy • Part time person responsible • Some segregation of hazardous HCW e.g. Infectious and sharps, radioactive. • Specified storage containers for sharps. • No colour coding. • Waste dumped outside building	• Municipal solid waste collection and transport by enclosed compac-tion vehicles for most waste • Separate collection of segregated wastes in enclosed vehicles	• Some re-use of materials. • Syringes re-used • Minimal recy-cling at the HC facility.	• Autoclave treatment of lab wastes. • Some burying on HC facility in remote areas. • Return of outdated pharmaceuticals to supplier. • Single cell incineration plant. • Environmental pollution from incinerator.	• Level 1 landfill sites. • Some scavenging and recycling. • Syringes being recycled for re-use • Scavenging by animals and insects. • Environmental pollution taking place. • Dangers to public health. • No site security

Level	Waste management – responsibility, segregation, storage and packaging	Waste transport	Waste recycling and reuse	Waste treatment	Off-site disposal
2	• Custom and practice policy • Person responsible for WM. Part-time • Segregation of hazardous HCW. • Some colour coding. • Specified storage containers and packaging for sharps and hazardous HCW. • Others not specified. • Open waste compound	• MSW collection and transport with enclosed compaction vehicles for non-hazardous wastes. • Dedicated vehicles for hazardous. HCW. • Transport of dangerous goods (TDG) documentation	• Some re-use of materials. • Some recycling practised at the HC facility. e.g. paper, card-board, metals.	• Autoclave treatment of lab wastes. • Multi-chamber incineration plants. • Alternative treatment technology systems (e.g. microwave) • Some environmental pollution from incinerators (Not to EU Standards).	• Level 2 landfill sites. • HCW in specially prepared areas. • Some environmental pollution taking place. • Some dangers to public health. • Security during working hours • No fencing
3	• Local waste management policy and strategy • Part-time waste manager • Segregation of some materials: returnable, hazardous, infectious, radioactive, paper. • Full colour coding. • Dangerous goods storage in UN approved containers and packaging. sharps containers to approved standard • All waste in containers or sacks to approved standards. • Containers cleansed. • Compaction where appropriate. • Purpose built waste compound.	• MSW collection and transport with enclosed compaction vehicles for non-hazardous wastes. • Basle Convention requirements applied. • Dedicated vehicles for hazardous. HCW. • TDG documentation. • Carriers registered. • Appointment of TDG advisers.	• Some re-use of materials. • Recycling of some materials e.g. paper, printer cartridges, waste oil.	• On-site autoclave treatment of lab wastes. • Alternative technology systems of infectious waste treatment. • Incineration of hazardous materials to EU Incineration Directive •Emission Standards • Municipal incineration plants to EU Incineration Directive Emission Standards	• Level 3 engineered landfill sites. • Only treated HHCW waste to landfill. • Waste treated by alternative technologies shredded • Incinerator residuals to • Hazardous waste engineered sanitary landfill. • Site fenced

4	• Waste management policy • Full-time waste manager • Full segregation of materials : - • Recyclable, returnable, hazardous infectious, radioactive, construction, compost, electrical electronics, and food • Contracts with secondary raw material Industry. • Full colour coding • Storage in UN approved con-tainers and packaging. • All waste in containers or sacks to approved standards. • Containers cleansed. • Compaction where appropriate. • Balers for packaging waste. • Stored in dedicated and secure waste compound.	• MSW collection and transport with enclosed compac tion vehicles for non- hazardous wastes • Proximity principle applied • Maximum payloads to reduce vehicle emissions • Basle Convention requirements applied. • Dedicated vehicles for hazardous. HCW • Carriers registered • TDG documentation • Appointment of TDG advisers	• Re-use of materials where possible • Recycling of: - paper, glass, plastic, metals, construction waste, green compost, electri cal and electronic goods, textiles, food waste, printer car-tridges, waste oil, • Seeking to improve local economy and employment by developing use of recyclables.	• On-site autoclave treatment of lab wastes. • Alternative technology systems of Infectious waste treatment. • Incineration of hazardous materials to EU Incineration Directive Emission Standards • Municipal incineration plants to EU Incineration Directive Emis-sion Standards • Hazardous waste to strictly con-trolled landfill sites. • Incinerator residuals recycled where possible. • Disinfected waste used as renewable fuel after shredding.	• Level 4 engineered sanitary landfill. • Waste treated by alternative technologies shredded • Hazardous waste to strictly control-led landfill sites. • Site fenced

Source: Townend and Cheeseman (2005)

2.12: HCWMSTUDIES OF TERTIARY HEALTH FACILITIES

The work done by WHO (1999) in Geneva on medical waste discovered that the potential environmental and health hazards could be deleterious, if not properly handled, the worst scenario being in developing countries. Da Silva*et al*. (2005) surveyed 91 healthcare facilities on Medical Waste Management (MWM) in the southern Brazil, and found out that little or no attention was given to other lethal medical waste other than sharps.

However, such residues can potentially transmit diseases and present an additional risk to the staff of the healthcare facility, patients and the community when the wastes are not managed properly. The illegal dumping of medical wastes in disadvantaged residential areas has resulted in situations where children have been found playing with medical waste materials such as syringes. For example, a hospital in South Africa treated 48 children with Azidothymidine (AZT) after some where pricked with needles and others where potentially lethal pills they found in the field in Elsie's River (Hardy, 1992). Most hazardous and toxic wastes are placed on land sites with few safeguard to protect those living nearby and water sources from contamination (Hardy, 1992). A number of empirical studies have therefore attempted to examine the medical waste management practices in a number of hospitals (Mastorakis *et al.,* 2011).In Africa, the situation appears to be more critical as reports from all round the continent indicate poor MWM practices (Mayele et al., 2003).

Healthcare waste management (HCWM) issues in Nigeria have generated a lot of studies since the 1990s. An exploration to the literature depicts the approaches, themes, areas of concentration, arguments, and methodologies. A striking characteristic is the interest in the downstream aspect of HCWM founded on broad based topics. For example, the work by Akinwale and Sridhar (2010) examined non segregation of HCW in rapidly increasing HCFs and environmental problems caused by poor management of general waste, and the resurgence of sanitation-related diseases in Nigeria's urban centres. An identical urban environment quality stance, still from the downstream approach was adopted by Coker (2009) dealing with hospital waste in Ibadan with emphasis on the obstacle to and proposals for sustainable HCWM. The same goes for Sridhar and Ayeni (2003) on infection potential of waste from selected HCFs in Ibadan and Coker (2009) on the characterization and management of solid wastes in Ibadan. Longe and Williams (2006) examined medical waste management in Ibadan and in Lagos metropolis. Ngwuluka *et al.* (2009) followed the same path in their study of waste management in healthcare establishment in Jos metropolis. Bassey *et al.* (2006) also studied the characterization of solid medical wastes in the Federal Capital Territory, Abuja, Nigeria.

The attempt to examine HCWM upstream is the subject of Adegbite*et al.* (2010) on assessment of dental waste management in a Nigerian tertiary hospital, and that of Mokuolu (2009) on the management of solid hospital waste in a tertiary hospital. The technological dimension was covered by Coker *et al.* (2004) in their work on

management of pollution from hospital incineration in Nigeria. On the other hand, Coker *et al.* (2010) examined engineering applications in problems of HCWs from General and specialist Hospital in Ibadan. Oke (2008) looked at the management of immunization of solid waste in Kano; while the work of Sridhar and Ayeni (2003) focused on treatment and disposal of HCWs. To complete the picture is the work of Ngwuluka *et al.* (2009) and Abah *et al.* (2011) on pharmaceutical waste management in some Nigerian pharmaceutical companies. There are also Abah and Ohimain (2010) and Sridhar and Coker (2009) on healthcare waste management including treatment and disposal.

Abah and Ohimain (2011) discovered from their study of healthcare waste management in Nigeria that the level of healthcare waste management is zero and therefore unsustainable. They also revealed that there were no focal persons or waste managers responsible for healthcare waste management, rather the orderlies in the various hospitals undertook to the sanitation of the hospital. According to their report, the members of personnel who understood the management in the provision of awareness programs were not in place.

The work of Sridhar and Coker (2009) recommended that while selecting the management method, the technical, human and financial resources of each facility should be kept in mind. However, the study of Coker (2009) concluded that the poor management of HCW is a major cause of some diseases, some of which are life threatening. Health workers such as Nurses Doctors, Pharmacists and waste handlers

including sweepers and other auxiliary staff as well as relations of patients are more prone to non-communicable diseases. The study of Coker *et al.*(2009) suggested proper disposal at dump sites. The study revealed that there are no sorting and segregation of those wastes at source to be disposed at Aba-Ekuin Ibadan, which is indeed a bad practice. A holistic approach should be adopted by integrating waste management with the development of any HCF from the onset to help the situation (Sridhar and Coker, 2009), part of which should be political will.

Work by Ajadike (2003) discovered inadequacies in equipment, skills, personnel, funding and general institutional failure in supervision and enforcement of compliance and lack of proper legislation and institutional framework for this sort of hazardous waste management. The study by Ogbonna (2011) was undertaken at five different hospitals as representative of healthcare institutions in Port-Harcourt city, Nigeria, to investigate the medical waste category and its management practices like incinerator was non-existent in hospitals, no segregation of waste nor colour coding at the various hospitals, for the different waste streams neither do they keep records of waste generated and disposed. In addition, it was discovered that both hospitals waste and domestic waste are treated alike. Lack of relevant training and protective equipment for waste handlers was a common feature in the survey. Human and financial resources as well as institutional capacity necessary to effectively manage medical waste as part of the effort to enhance protection of human life and the environment from health hazards were lacking. From the findings of Ogbonna et al., (2012), it was further shown that all the hospitals surveyed fell below the

recommended waste management practices as preserved by the World Health Organization and other regulatory authorities. The study revealed that wastes were not segregated into marked or colour coded containers/bins for the different waste stream. No record of waste generation and disposal was kept, no training of personnel on waste handling and provision of safety gadget and proper education on waste reduction strategies.

Ngwuluka *et al.* (2009)in the survey conducted in Jos discovered that although the hospital authorities claimed to have being training the waste handlers, the outcome of the survey indicated otherwise. If indeed the handlers were being trained, then the training was inappropriate and had not been impacted on their skills and knowledge of the personnel. The study recommended that all workers should be trained and retrained without any exception in the hospitals, in order to create awareness of waste, its effects, importance of guidelines and implementation of the waste management options for the different categories of waste.

Mokuola (2009) conducted a cross sectional study in Abuja, and revealed that there were no segregation of healthcare waste at source, no colour coding but hospital use locally built brick incineration and others. The Lagos state waste management agency (LAWMA) has been able to establish health facility monitoring and accreditation agency (HEFAMAA) as one of the outcome and recommendations of Longe and Williams (2006).

Lessons from the above review of HCWM literature in Nigeria are of great relevance to the topic of this study. All the studies adjudged HCWM in Nigeria to be poorly managed. The studies highlight the precarious position of HCWM in Nigeria in a number of critical areas. Ngwuluka *et al*. (2009), Idowu (2010) and Coker and Sridhar (2010) underscored the existence of little knowledge of hospital waste management in Nigeria especially in the areas of record keeping of the actual quantities of medical waste generated, and lack of any HCWM plan. They also held the inexistence of HCWM policy, plans and the inadequacies of government regulatory body as the reason for the absence or guidelines. Other deficiencies include inadequate training of HCW handlers (Ngwuluka *et al*., 2009), staff training and awareness and education to influence the management of hazardous waste (Ngwuluka *et al.*, 2011) the situation in Nigeria has been found to exist in other developing countries characterised by the absence of national regulations for HCW management, low awareness about HCW management by personnel and waste workers (Arab *et al*., 2008; Mesdaghininia *et al*., 2009). Knowing the great importance of the health hazards posed by improper management of healthcare waste, it reassures that this study is very important.

Uwa (2008) assessed the healthcare waste management practices in four tertiary healthcare facilities in Enugu metropolis. The study also explored the level of effectiveness of clinical governance efforts and identified the structure and pattern of best practice indicators using WHO's best practice standards. The result showed significant level of awareness of HCWM as well as significant difference between

HCWM practice and sustainability factors. The result further showed that good clinical governance is not significant in the quality of HCWM in the tertiary healthcare facilities in Enugu metropolis. The study concluded that HCWM in Enugu metropolis is unsustainable.

2.13: INCORRECT DISPOSAL OF HEALTH CARE WASTES

The unsafe disposal of health-care waste (for example, contaminated syringes and needles) poses public health risks. Contaminated needles and syringes represent a particular threat as the failure to dispose of them safely may lead to dangerous recycling and repackaging which lead to unsafe reuse. Contaminated injection equipment may be scavenged from waste areas and dumpsites and either be reused or sold to be used again. UNEP/WHO (2005)estimated that, in 2000, contaminated injections with contaminated syringes caused:

- 21 million hepatitis B virus (HBV) infections (32% of all new infections);
- two million hepatitis C virus (HCV) infections (40% of all new infections); and
- at least 260 000 HIV infections (5% of all new infections).

In 2002, the results of a WHO assessment conducted in 22 developing countries showed that the proportion of health-care facilities that do not use proper waste disposal methods ranges from 18% to 64%.

In addition to the public health risks, if not managed, direct reuse of contaminated injection equipment results in occupational hazards to health workers, waste handlers

and scavengers. Where waste is dumped into areas without restricted access, children may come into contact with contaminated waste and play with used needles and syringes. Epidemiological studies indicate that a person who experiences one needle stick injury from a needle used on an infected source patient has risks of 30%, 1.8%, and 0.3% respectively of becoming infected with HBV, HCV and HIV.

CHAPTER THREE

STUDY AREA AND RESEARCH METHODOLOGY

3.1: INTRODUCTION

This chapter presents the study area and the methodology adopted in carrying out the research.

3.2: THE STUDY AREA

Although Ahmadu Bello University Teaching Hospital (ABUTH) is located in Shika (Giwa Local Government Area of Kaduna State) and Ahmadu Bello University Health Services (ABUHS) is located in Samaru (Sabon-Gari Local Government Area of Kaduna State) Campus.The hospitals are both affiliated to Ahmadu Bello University; Zaria.The locations of the two hospitals are shown in Figure 3.1. Zaria is located between latitude $11^0$03`N and $11^0$15`N of the equator and longitude $07^0$33`E and $07^0$45`E of the Greenwich meridian. Zaria is located in the central plains of the northern Nigeria highland standing at an average height of 670m above sea level and is about 83km North of Kaduna town along Kaduna-Kano Highway. It is the second largest city in Kaduna State. It is drained by three major rivers namely; Kubanni River, Saye River and Galma River. The climatic characteristics are that of the tropical savannah (Hore, 1970).

Zaria itself is a very large and heterogeneous city whose 1,490,000 population comes from different parts of the world (Dogara, 2013). It is second in size only to the state

capital, Kaduna. Zaria experiences a tropical continental climate, which is characterised by distinct wet and dry seasons. Analysis of the long term records of rain fall from the Institute of Agricultural Research and the meteorological station at the Nigerian College of Aviation Technology shows that the area enjoys mean annual rainfall of about 1060mm. The seasonality in climate is largely determined by the movement of inter-tropical convergent zone (ITCZ) across the country. This ITCZ is the zone where the two dominant air masses the tropical continental (cT) from the North-East and the tropical maritime (mT) from the South-West meets (Ayoade, 1987). Also the high mean daily maximum temperature rises gradually from a low temperature of about 26.6^0C in January to a major peak of 39^0C in April or October the dry season starts from November to February. The relative humidity falls from 69% to 36% whilst the harmattan wind becomes steady and contains particles with associated poor visibility. Natural vegetation of the study area is of the northern Guinea Savannah. Its characteristic vegetation cover is preserved due to poor management practices like fuel wood harvesting, annual bush burning, cultivation and intensive grazing.

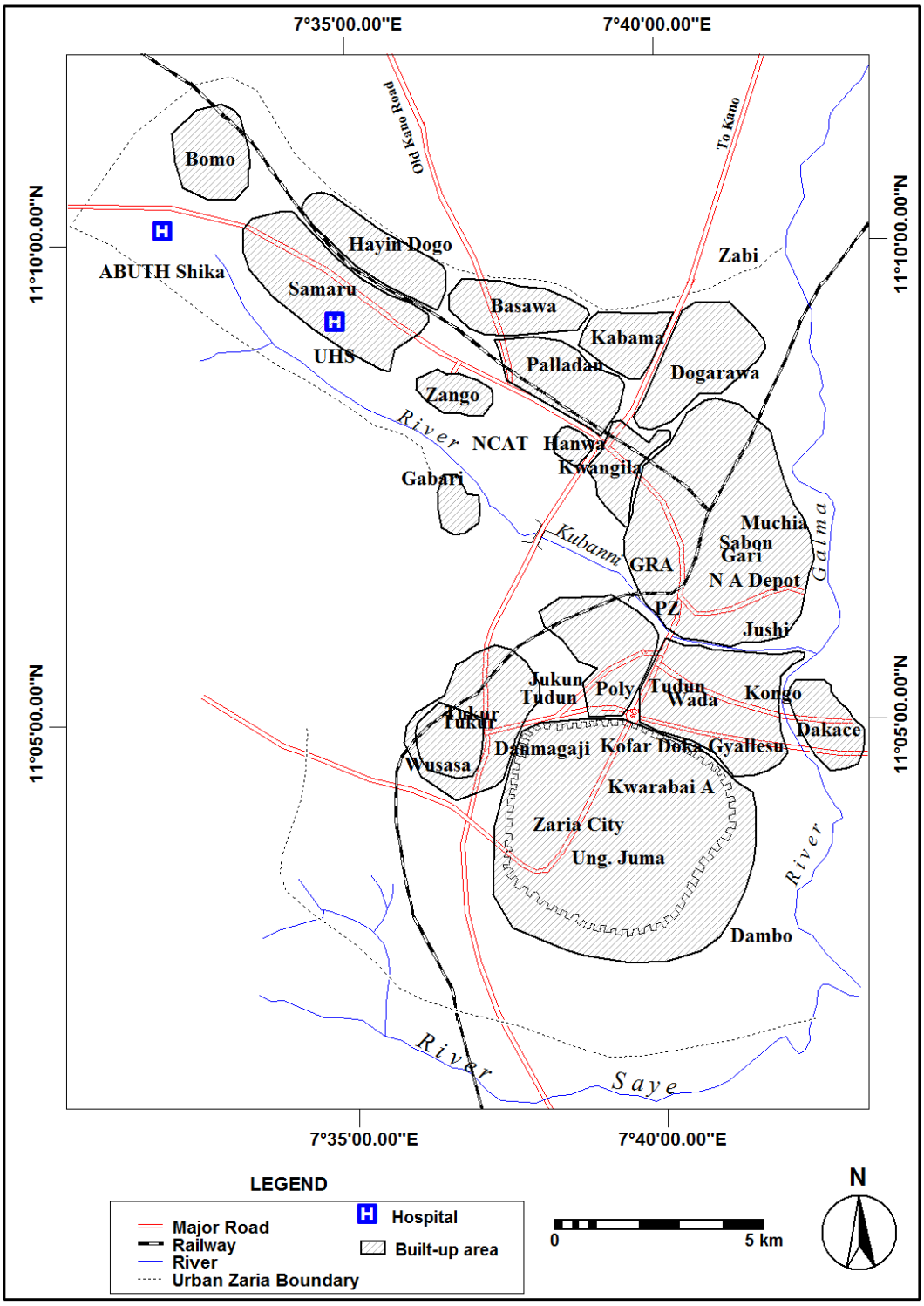


Figure 3.1: Zaria and its environs showing ABUTH and ABUHS
Source: Modified from urban Zaria map

3.3: RESEARCH METHODOLOGY

3.3.1: Reconnaissance Survey

Reconnaissance survey of the two hospitals was carried out with the purpose of familiarization with the hospital systems and the waste dump sites. The specific type and sources of data required to achieve each of the study objectives are outlined below:

3.3.2: Types of data utilised

The types of data required for this research include:

i. Co-ordinates of the waste dumpsite

ii. Amount of waste generated per bed per day in each of the hospitals using a weight measuring scale; and

iii. The nature of HCW, methods of HCW collection and disposal; the effectiveness of HCW management practices in the two hospitals.

3.3.3: Sources of data

The data used for the study are from primary and secondary sources and include:

Primary sources

i. Co-ordinates of the waste dumpsite: This was sourced from the study area using Global Positioning System (GPS).

ii. Pictures of the waste dumpsite: The pictures were taking using camera in the field.

iii. Amount of waste generated per bed per day in each of the hospitals: The amount was calculated using a weight measuring scale.

iv. The nature of HCW, methods of HCW collection and disposal; the effectiveness of HCW management practices in the two hospitals will be collected using two sets of structured questionnaires. One set administered on the waste handlers and another set administered to each of the waste management head in the hospitals.

v. Topographic map of the study area: The topographic map sheet of the study area was sourced from the map library of the Department of Geography, Ahmadu Bello University, Zaria.

Secondary sources

vi. Literature such as journals, textbooks, conference proceedings, dissertations and online publications.

3.4 SAMPLE SIZE AND SAMPLING TECHNIQUE

From the reconnaissance survey carried out, it was discovered that two(2) staff were involved in waste handling at ABUHS while one hundred and ninety (190) staff were involved in waste handling at the ABUTH; and thus completed the first set of questionnaire. The head of the waste management unit and the former Medical Director of ABUHS completed the second set of questionnaire while the four heads of waste management units at ABUTH completed the second set of questionnaire.Purposive sampling technique was thus used for the two surveys. Frantic efforts were made to ensure that all the copies were returned.

3.5 METHODS OF DATA ANALYSIS

For clarity, the methods that were employed to analyse the data collected to meet the study objectives are outlined below on objective-by-objective basis:

Objective 1: To characterise the nature of the Healthcare Waste (HCW) generated in the two hospitals.Using the UNEP/WHO (2005) form (Table2.1), an inventory of the nature of wastes generated in the two hospitals were collated. The form contents were used as section A on the questionnaire.

Objective 2: To determine the quantity of HCW generated in the hospitals: From the different types of waste generated and collected in the out-patient and in-patient wards over a period of one week, the weighing balance was used to determine the quantity of each type of waste generated per day in each hospital. The entire quantity of waste generated were weighed together each day prior to disposal at the dumpsites and recorded. Calculations of average quantity of waste per bed per day were carried out by dividing the total quantity of waste by the number of beds in each hospital.

Objective 3: To examine methods of HCW collection and disposal in the hospitals: The data required to achieve the above objective were equally obtained using the questionnaire administered to waste handlers in each of the two hospitals. The collected data from the questionnaires were analysed using descriptive statistical techniques, including frequency counts, percentages and tables.

Objective 4: To assess the effectiveness of HCW management practices in the hospitals.

In order to assess the HCW management practices of the two hospitals, an overall performance rating was assigned using the approach outlined in the guidelines

suggested by Townend and Cheeseman (2005). The guideline is as presented in Tables 2.3 and 2.4. The guidelines was prepared as a questionnaire which was administered to the Heads of Waste Management Units of the two hospitals

Objective 5: To identify and map out the waste dumpsites of the two hospitals.

After the dumpsites have been identified in the study area, the GPS was used to pick the coordinates of the dumpsites and these coordinates were transferred to the GIS environment where the base map (topographic map of the study area) was used to generate the dumpsites map using Arc GIS 9.2. Photographs of the dumpsites were also taken for visual purpose.

CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSIONS

4.1: INTRODUCTION

This chapter shows the presentation of results obtained from the field. The results are presented in tables, charts and maps. The discussion of the results is also presented in this chapter.

4.2: THE NATURE OF WASTE IN THE HOSPITALS

The characterization and the nature of the HCW generated in the hospitals using the UNEP/WHO (2005)format is as presented in Table 4.1.

Table 4.1: The character and nature of the HCW in the hospitals

Waste Category	ABUHS				ABUTH			
	Yes	%	No	%	Yes	%	No	%
Recyclable wastes	2	100	0	0	190	100	0	0
Biodegradable wastes	2	100	0	0	190	100	0	0
Other non-risk wastes	2	100	0	0	190	100	0	0
Human anatomical wastes	0	0	2	100	160	84.21	30	15.79
Sharps	2	100	0	0	190	100	0	0
Non-hazardous Pharmaceutical wastes	2	100	0	0	190	100	0	0
Potentially hazardous Pharmaceutical wastes	2	100	0	0	177	93.12	13	6.8
Hazardous Pharmaceutical wastes	2	100	0	0	174	91.58	16	8.42
Cyto-toxic pharmaceutical wastes	2	100	0	0	162	85.26	28	14.74
Blood and body fluids	2	100	0	0	190	100	0	0
Infectious wastes	2	100	0	0	190	100	0	0
Highly infectious wastes	2	100	0	0	165	86.84	25	13.16
Other hazardous wastes	0	0	2	100	180	94.74	10	5.26
Radioactive wastes	0	0	2	100	80	42.11	110	57.89

Source: Author's fieldwork (2014)

From Table 4.1, it can be observed that at the ABUHS, the respondents said all the waste categories according to UNEP/WHO classification were present except radioactive wastes, other hazardous wastes and human anatomical wastes are not present. However, it was recorded that all the waste categories according to UNEP/WHO classification were present at the ABUTH.

4.3: QUANTITY OF HCW GENERATED AT THE HOSPITALS

The quantity of wastes generated in the two hospitals under study could not be done using the standard UNEP/WHO (2005) form because the wastes in both hospitals were not sorted. Hence, the quantity of the daily wastes generated was done according to the Department/Unit where the wastes were generated. These are shown in Table 4.2 for ABUTH and Table 4.3 for ABUHS.

Table 4.2: Quantity of Healthcare Waste at ABUTH

S/No	Department/Unit	Weight (Kg)
1	Male and Female Medical Wards	237
2	Microbiology, Haematology & Paediatric Wards	81
3	Obstetrics and Gynaecology Ward	76
4	Accident and Emergency & Labour Wards	160.5
5	Chemical Pathology	12
6	Clinical Pharmacology Ward	5
7	Mortuary	22
8	Male and Female Surgical Wards	168.5
9	General Out Patient Department (GOPD) laboratory	74
10	Sharp boxes	9
	Total	845

Source: Author's fieldwork (2014)

From Table 4.2, the total quantity of HCW generated at ABUTHis shown as 845kg per day. With 717 beds in the ABUTH, the quantity of HCW per bed per day is 1.18kg. The Table further shows that male and female medical wards generates the

highest quantity of wastes (237kg), followed by the male and female surgical wards (168.5kg) and Accident and Emergency &labour wards (160.5kg). The Table also shows that Clinical Pharmacology Ward generates the least quantity of waste (5kg). Figure 4.1 shows the distribution of the HCW in percentages.

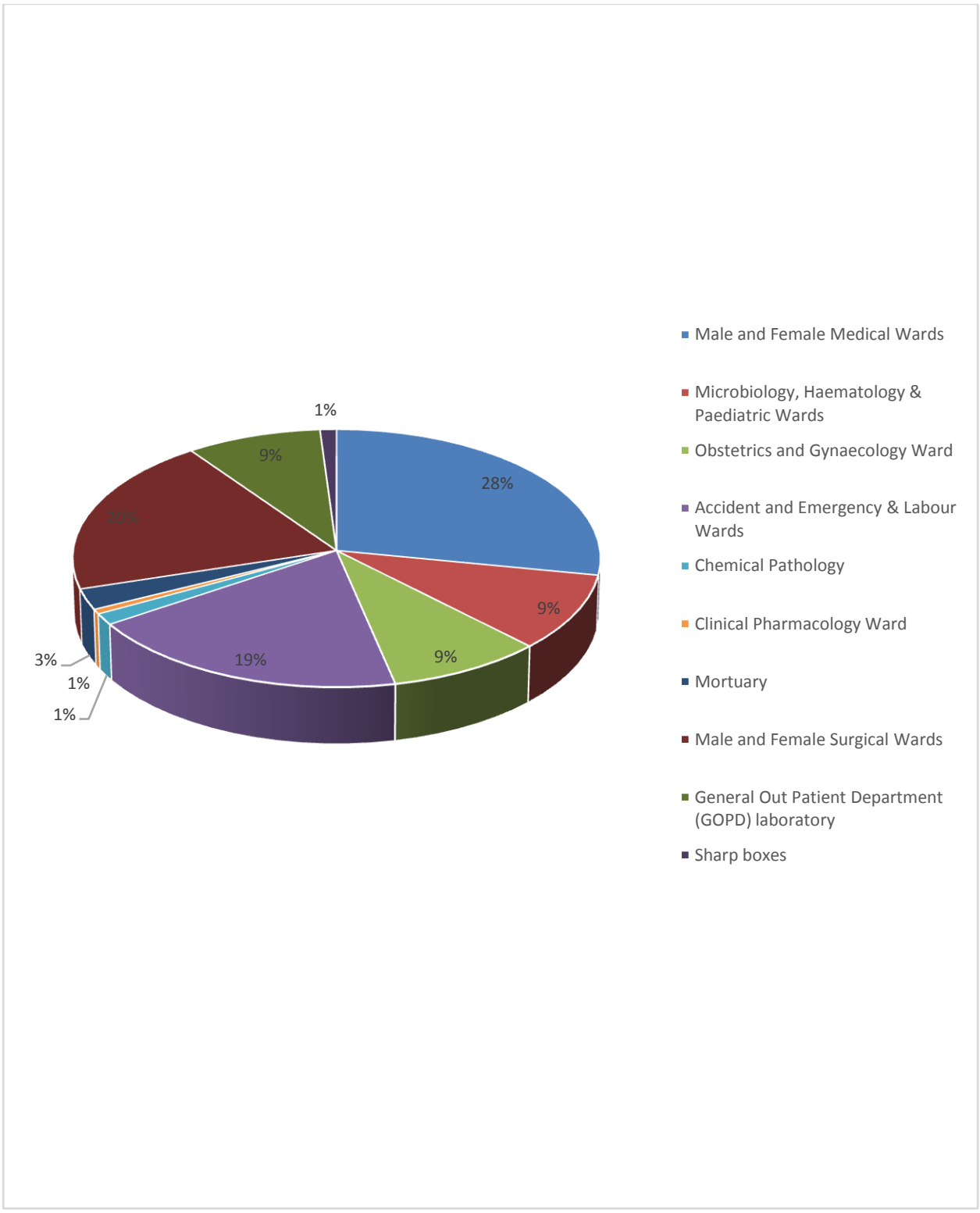


Figure 4.1: Proportion of Weight of HCW in different locations at ABUTH
Source: Author's fieldwork (2014)

As shown in Figure 4.1, the units with leading proportions are Male and Female Medical Wards (28%), Male and Female Surgical wards (20%) and Accident and Emergency & Labour wards (19%).

Table 4.3: Quantity of Healthcare Waste at ABUHS

S/No	Department/Unit	Weight (Kg)
1	Emergency	5
2	Dressing room	4.5
3	Laboratory	45
4	Safety box	3.5
5	Pharmacy	1
6	Injection room	1
7	General Out Patient Department (GOPD) laboratory	17
	Total	77

Source: Author's fieldwork (2014)

The total quantity of HCW generated at ABUHS was 77kg per day. With the 50 beds capacity, the quantity of HCW at ABUHS per bed per day is 1.54kg. It is of equal importance to point out that several medical activities (such as delivery, surgery, etc) were not being carried out at ABUHS. When the need arises for these activities, the cases are referred to the ABUTH. The proportion of HCW generated in the different units of ABUHS is shown in Figure 4.2. The locations with leading proportions are laboratory (58%) followed GOPD laboratory (22%).

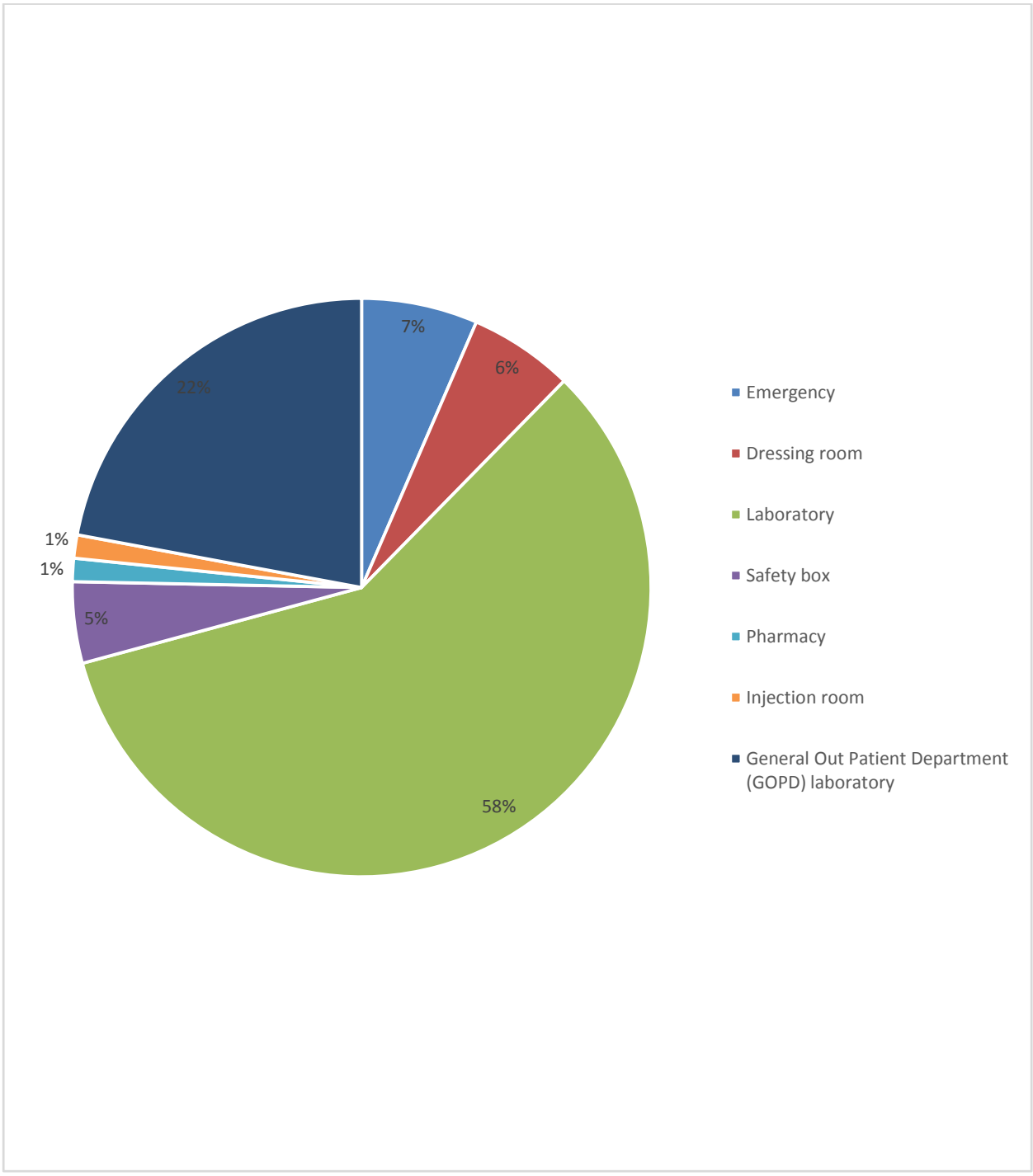


Figure 4.2: Proportion of quantity of HCW in different units at ABUHS

Source: Author's fieldwork (2014)

4.4: METHODS OF HCW COLLECTION AND DISPOSAL

The questionnaires administered to the health workers were used for the examination of HCW collection and disposal methods. The result is as presented in Tables 4.4 to 4.18.

Table 4.4: Presence of Receptacles/Storage Containers

Hospital	Yes		No	
	Frequency	Percentage	Frequency	Percentage
ABUTH	117	61.58	73	38.42
ABUHS	2	100.00	0	0.00

Source: Author's fieldwork (2014)

Table 4.4 shows that 61.58% and 100% of respondents from ABUTH and ABUHS respectively indicated that there were receptacles and storage containers available in their hospitals for medical waste management.

Table 4.5: Availability of Colour Coding for the Receptacles

Hospital	Yes		No	
	Frequency	Percentage	Frequency	Percentage
ABUTH	27	14.21	163	85.79
ABUHS	0	0.00	2	100.00

Source: Author's fieldwork (2014)

Table 4.5 shows that 85.79% and 100% of respondents from ABUTH and ABUHS respectively indicated that there were no colour coding practices for receptacles in their hospitals for medical waste management.

Table 4.6: Separation of Collection for Sharps or Infectious Materials

Hospital	Yes		No	
	Frequency	Percentage	Frequency	Percentage
ABUTH	156	82.11	34	17.89
ABUHS	2	100.00	0	0.00

Source: Author's fieldwork (2014)

Table 4.6 reveals that 82.11% and 100% of respondents from ABUTH and ABUHS respectively indicated that there were separations of collection for sharps or infectious materials in their hospitals.

Table 4.7: Availability of a central purpose-built facility for waste storage

Hospital	Yes		No	
	Frequency	Percentage	Frequency	Percentage
ABUTH	41	21.58	149	78.42
ABUHS	2	100.00	0	0.00

Source: Author's fieldwork (2014)

Table 4.7 shows that 21.58% and 100% of respondents from ABUTH and ABUHS respectively indicated that there were central purpose-built facility for waste storage in their hospitals.

Table 4.8: Availability of Temporary Waste Storage Facility

Hospital	Yes		No	
	Frequency	Percentage	Frequency	Percentage
ABUTH	32	16.84	158	83.16
ABUHS	0	0.00	2	100.00

Source: Author's fieldwork (2014)

Table 4.8 shows that only 16.84% and none of the respondents from ABUTH and ABUHS respectively indicated that there were temporary waste storage facility available in their hospitals.

Table 4.9: Average Storage Hours of waste at the facility

Hospital	Less than 24hrs	24 - 48 hrs	More than 48 hrs
ABUTH	32	0	0
ABUHS	0	0	0

Source: Author's fieldwork (2014)

Table 4.9 shows that all the 16.84% of respondents from ABUTH that indicated availability of temporary waste storage facility provided that the wastes were stored there for an average of less than 24 hours.

Table 4.10: Presence of dumpsite within the hospital complex

Hospital	Yes		No	
	Frequency	Percentage	Frequency	Percentage
ABUTH	190	100	0	0.00
ABUHS	2	100.00	0	0.00

Source: Author's fieldwork (2014)

Table 4.10 shows that 100% of respondents from ABUTH and ABUHS respectively indicated that there were dumpsites within their respective hospitals for medical waste management.

Table 4.11: Dumping of waste in open waste disposal site

Hospital	Yes		No	
	Frequency	Percentage	Frequency	Percentage
ABUTH	164	86.32	26	13.68
ABUHS	2	100.00	0	0.00

Source: Author's fieldwork (2014)

Table 4.11 shows that 86.32% and 100% of respondents from ABUTH and ABUHS respectively indicated that wastes from their respective hospitals were dumped in open disposal sites.

Table 4.12: Availability of Waste Recycling at ABUTH and ABUHS

Hospital	Yes		No	
	Frequency	Percentage	Frequency	Percentage
ABUTH	23	12.11	167	87.89
ABUHS	1	50.00	1	50.00

Source: Author's fieldwork (2014)

Table 4.12 shows that only 12.11% and 50% of respondents from ABUTH and ABUHS respectively indicated availability of recycling of medical waste management in their respective hospitals.

Table 4.13 Current Practice of Waste treatment at ABUTH and ABUHS

Current practice	ABUTH Yes Frequency	%	No Frequency	%	ABUHS Yes Frequency	%	No Frequency	%
Autoclaving of laboratory wastes	59	31.05	131	68.95	0	0.00	2	100.00
Crude incineration of hazardous wastes	77	40.53	113	59.47	2	100.00	0	0.00
Burying of wastes	141	74.21	49	25.79	0	0.00	2	100.00
Use of chemicals to disinfect body fluids	88	46.32	102	53.68	2	100.00	0	0.00
Practice of waste pre-treatment	48	25.26	142	74.74	2	100.00	0	0.00
Use of other advanced waste treatment technologies	26	13.68	134	86.32	0	0.00	2	100.00

Source: Author's fieldwork (2014)

Table 4.13 shows the waste treatment practices at both ABUTH and ABUHS. According to the respondents, the dominant practices include burying of wastes at the ABUTH while crude incineration, burying, use of chemicals to disinfect body fluids and waste pre-treatment were the dominant practices at the ABUHS.

Table 4.14: Method of waste transportation

Transportation Method	ABUTH Frequency	Percentage	ABUHS Frequency	Percentage
Open vehicles	48	25.26	0	0.00
Enclosed compaction vehicle	14	7.37	0	0.00
Trolley	11	5.79	2	100.00
Wheeled Vehicles	10	5.26	0	0.00
Trucks	107	56.32	0	0.00

Source: Author's fieldwork (2014)

Table 4.14 shows that open vehicles and trucks were the dominant methods for transporting wastes at ABUTH while the use of trolleys was the dominant method at the ABUHS.

Table 4.15 Final Destination of Wastes

	ABUTH		ABUHS	
Final Destination of wastes	Frequency	Percentage	Frequency	Percentage
Open dumpsite	106	84.21	1	50.00
Landfills	37	19.47	0	0.00
Shredding	10	5.26	0	0.00
Buried	37	19.47	1	50.00

Source: Author's fieldwork (2014)

Table 4.15 shows that open dump sites was (84.21%), landfills was 19.47%, shredding was 5.26% and burial was 19.47% as final destinations of wastes from ABUTH while open dump sites (50%) and burial (50%) as the final destination of wastes from ABUHS.

Table 4.16 Frequency of outside transportation of waste

	Daily		Twice daily		Thrice daily		Once a week	
Hospital	Frequency	%	Frequency	%	Frequency	%	Frequency	%
ABUTH	129	67.89	61	32.11	0	0.00	0	0.00
ABUHS	1	50.00	1	50.00	0	0.00	0	0.00

Source: Author's fieldwork (2014)

Table 4.16 shows that the frequency of outside transportation of wastes as daily was 67.89% and twice daily was 32.11% at ABUTH while the frequencies were daily of 50% and twice daily was 50% at ABUHS.

Table 4.17 Wastes Disposal Techniques used at ABUTH

Waste Category	Burial		Incineration		Open dumping		Landfills		Not applicable	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Recyclable waste	4	2.11	42	22.11	144	75.79	0	0.00	0	0.00
Biodegradable waste	92	48.42	53	27.89	45	23.68	0	0.00	0	0.00
Other non-risk waste	50	26.32	21	11.05	119	62.63	0	0.00	0	0.00
Human anatomical waste	120	63.16	55	28.95	0	0.00	15	7.89	0	0.00
Sharps	15	7.89	175	92.11	0	0.00	0	0.00	0	0.00
Non-hazardous Pharmaceutical waste	97	51.05	19	10.00	74	38.95	0	0.00	0	0.00
Potentially hazardous Pharmaceutical waste	105	55.26	69	36.32	15	7.89	0	0.00	0	0.00
Hazardous Pharmaceutical waste	150	78.95	17	8.95	23	12.11	0	0.00	0	0.00
Cyto-toxic pharmaceutical waste	141	74.21	31	16.32	18	9.47	0	0.00	0	0.00
Blood and body fluids	150	78.95	25	13.16	15	7.89	0	0.00	0	0.00
Infectious waste	141	74.21	26	13.68	23	12.11	0	0.00	0	0.00
Highly infectious waste	141	74.21	27	14.21	12	6.32	0	0.00	0	0.00
Other hazardous waste	164	86.32	20	10.53	6	3.16	0	0.00	0	0.00
Radioactive waste	173	91.05	11	5.79	6	3.16	0	0.00	0	0.00

Source: Author's fieldwork (2014)

Table 4.17 shows the disposal methods for different waste categories at the ABUTH. The Table reveals that burial method was popular for disposing biodegradable wastes (48.42%), human anatomical wastes (63.16%), non-hazardous pharmaceutical wastes (51.05%), potentially hazardous pharmaceutical wastes (55.26%), hazardous pharmaceutical wastes (78.95%), cyto-toxic pharmaceutical wastes (74.21%), blood and body fluids (78.95%), infectious wastes (74.21), highly infectious wastes (74.21%), other hazardous wastes (86.32%), and radioactive wastes (91.05%). The Table further shows that incineration was popular for disposing sharps (92.11%) and potentially hazardous wastes (36.32%) while open dumping was popular for disposing recyclable wastes (75.79%), other non-risk wastes (62.63%) and non-hazardous pharmaceutical wastes (38.95%).

Table 4.18: Wastes Disposal Techniques used at ABUHS

Waste Category	Burial		Incineration		Open dumping		Landfills		Not applicable	
	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent	Freq.	Percent
Recyclable waste	0	0.00	0	0.00	2	100.00	0	00.00	0	0.00
Biodegradable waste	0	0.00	0	100.00	2	100.00	0	0.00	0	0.00
Other non-risk waste	0	0.00	0	00.00	2	100.00	0	0.00	0	0.00
Human anatomical waste	0	00.00	0	00.00	0	0.00	0	0.00	2	100.00
Sharps	0	00.00	2	100.00	0	0.00	0	0.00	0	0.00
Non-hazardous Pharmaceutical waste	0	00.00	0	00.00	2	100.00	0	0.00	0	0.00
Potentially hazardous Pharmaceutical waste	0	00.00	2	100.00	0	0.00	0	0.00	0	0.00
Hazardous Pharmaceutical waste	0	00.00	2	100.00	0	0.00	0	0.00	0	0.00
Cyto-toxic pharmaceutical waste	0	00.00	2	100.00	0	0.00	0	0.00	0	0.00
Blood and body fluids	0	00.00	2	100.00	0	0.00	0	0.00	0	0.00
Infectious waste	0	00.00	2	100.00	0	0.00	0	0.00	0	0.00
Highly infectious waste	0	0.00	2	100.00	0	0.00	0	0.00	0	0.00
Other hazardous waste	0	0.00	0	0.00	0	0.00	0	0.00	2	100.00
Radioactive waste	0	0.00	0	0.00	0	0.00	0	0.00	2	100.00

Source: Author's fieldwork (2014)

Table 4.18 shows the disposal methods for different waste categories at the ABUHS. The Table reveals that burial method was popular for disposing other non-risk wastes (50%), human

anatomical wastes (100%), sharps (100%), non-hazardous pharmaceutical wastes (50%), potentially hazardous pharmaceutical wastes (50%), hazardous pharmaceutical wastes (50%), cyto-toxic pharmaceutical wastes (50%), blood and body fluids (50%), infectious wastes (50%), highly infectious wastes (50%), other hazardous wastes (50%), and radioactive wastes (100%). The Table further shows that incineration was popular for disposing biodegradable wastes (100%), non-hazardous pharmaceutical wastes (50%), potentially hazardous pharmaceutical wastes (50%), hazardous pharmaceutical wastes (50%), cyto-toxic pharmaceutical wastes (50%), blood and body fluids (50%), infectious wastes (50%), highly infectious wastes (50%) and other hazardous wastes (50%). The Table equally reveals that open dumping was popular for disposing recyclable wastes (50%) and other non-risk wastes (50%).

4.5: MAPPING THE WASTE DUMPSITES OF THE TWO HOSPITALS

The location of the dump sites within the premises of the two hospitals is as presented in figure 4.3. Plate 4.1 shows the picture of the dump site at the ABUHS while plate 4.2 shows the picture of the dumpsite at the ABUTH. The GPS readings for the locations of the two dumpsites are given in Table 4.19:

Table 4.19: GPS Locations of the Dumpsites for ABUTH and ABUHS

Name of Hospital	Longitude	Latitude
ABUTH	$7^0$35’50”E	$11^0$10’32”N
ABUHS	$7^0$39’38”E	$11^0$8’25”N

Source: Author’s fieldwork (2014)

M,

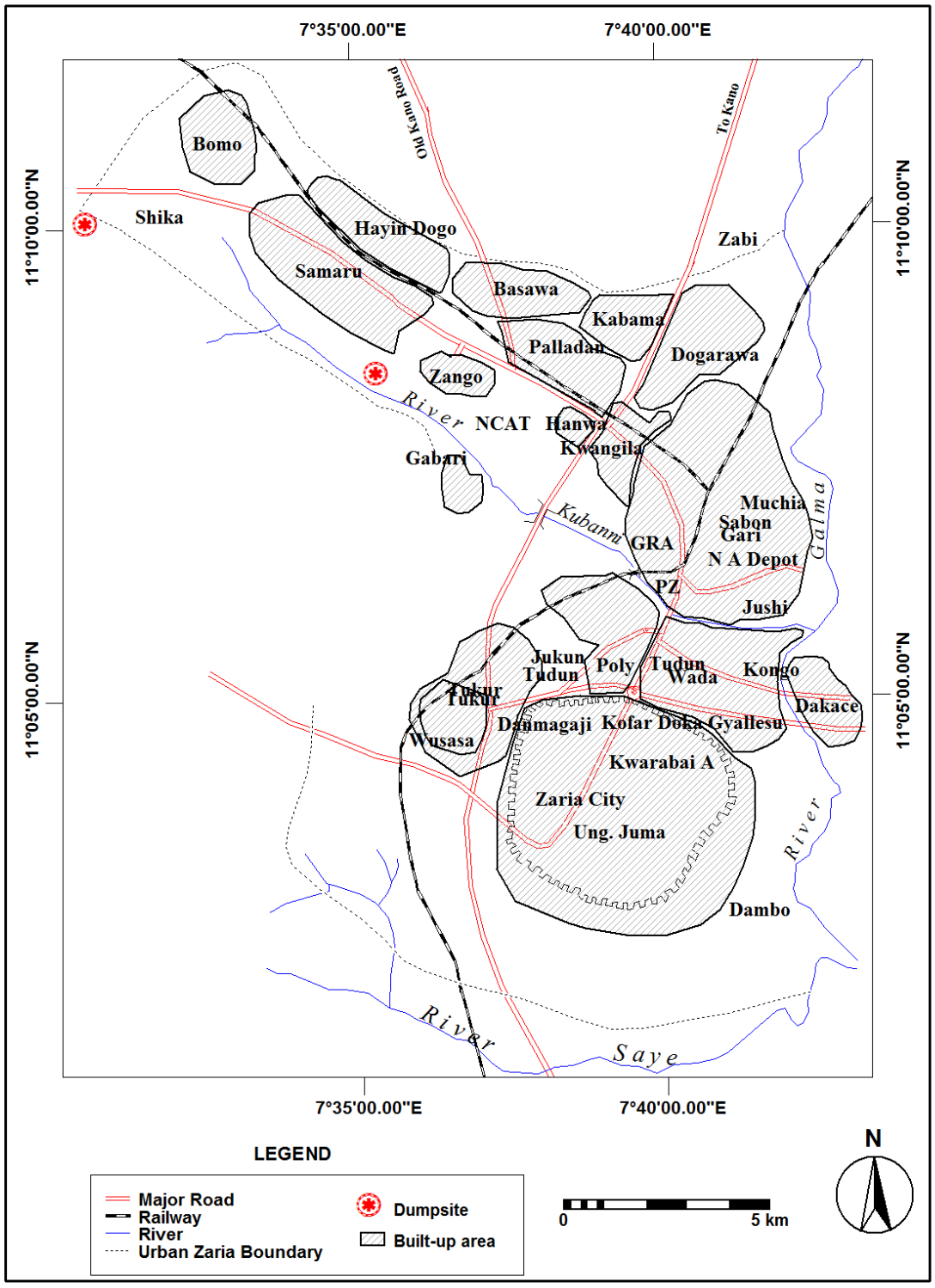

7°35'00.00"E
7°40'00.00"E
11°10'00.00"N
11°05'00.00"N
Old Kano Road
To Kano
Bomo
Shika
Hayin Dogo
Samaru
Basawa
Kabama
Palladan
Dogarawa
Zabi
Zango
River
NCAT
Hanwa
Kwangila
Gabari
Kubanni
Muchia
Sabon
Gari
GRA
N A Depot
Galma
PZ
Jushi
Jukun
Tudun
Poly
Tudun
Wada
Kongo
Tukur
Tukur
Dakace
Danmagaji
Kofar Doka
Gyallesu
Wusasa
Kwarabai A
Zaria City
Ung. Juma
River
Dambo
River
Saye
LEGEND
Major Road
Railway
River
Urban Zaria Boundary
Dumpsite
Built-up area
0
5 km
N

Figure 4.3: Location of Dumpsites for ABUTH and ABUHS
Source: Modified from urban Zaria map 2014



Plate 4.1: Open Dumpsite for ABUHS located between ABU Area A quarters and Koreye village, Zaria

Source: Author's fieldwork (2014)



Plate 4.2: Open Dumpsite at ABUTH located with the hospital, Zaria

Source: Author's fieldwork (2014)

From the manner of disposal of healthcare waste in the two locations, it is clearly observed that there are some environmental consequences. For instance, non-structured interview with some residents of Koreye revealed that during rainy season their farmlands on the downstream section of the open dumpsite of ABUHS usually affected as the supposed dangerous chemicals from the waste pollutes the soil; thus leading to reduced crop yield.

Although this study did not authenticate or validate this claim by collecting and analysing sample of soils from these farmlands, it no doubt calls for concern. After all it is a clearly established fact that waste can lead to soil pollution (Abdel-Salam, 2010).

4.6: THE EFFECTIVENESS OF HCW MANAGEMENT PRACTICES

The effectiveness of HCW management practices in the two hospitals was investigated using the questionnaire administered to the waste handlers and also by another set of questionnaire administered to the heads of the waste management units at the hospitals. The results are therefore presented in Table 4.20.

Table 4.20: Assessment of effectiveness of healthcare waste management at ABUTH and ABUHS

Measure	ABUTH	ABUHS
Level of awareness of top management on sustainable development (SD):		
All top management trained in sustainable development	X	X
Some top management trained in sustainable development	X	X
All top management aware of sustainable development		
Some top management aware of sustainable development	√ (50%)	X
Management unaware of sustainable development	√ (25%)	√ (100%)
	√ (25%)	X
Level of commitment of top management to sustainable development (SD):		
High level		
Some level	√ (50%)	√ (50%)
Minimal level	√ (25%)	√ (50%)
No commitment	X	X
	X	X
Conduct of Mass balance	√ (100%)	X
Availability of cases of corruption	√ (25%)	X

Level of awareness of best value		
Best value undertaken in the hospital	√ (25%)	X
There is awareness of best value	X	√ (50%)
There is minimum awareness of best value	√ (75%)	√ (50%)
There is a lack of awareness of best value	X	X
Level of awareness of continuous improvement		
Continuous improvements undertaken in the hospital	X	X
Some continuous improvements take place	√ (50%)	√ (50%)
Minimum continuous improvements take place	√ (50%)	√ (50%)
No continuous improvements take place	X	X
Availability of ISO 14001 certification	X	X
Availability of a staff consultative committee	√ (100%)	√ (100%)
Availability of a patient consultative committee	√ (50%)	X
Availability of a health and safety committee	√ (75%)	X
Availability of a health and safety representative	X	X
Availability of equal opportunities policy and framework	X	X
Availability of Investor in People (or similar) scheme	X	X
Current state of health and safety		
There is health and safety awareness	√ (100%)	√ (50%)
There is a health and safety policy	√ (25%)	√ (50%)
There is a health and safety advisor	X	X
There are health and safety posters in use	√ (75%)	√ (50%)
There are basic protective clothing	√ (75%)	√ (100%)
There are full protective clothing	X	X
Energy and Water usage practice		
Availability of energy policy	X	X
Conduct of regular checks on energy use	√ (50%)	√ (100%)
Use of renewable energy sources	√ (25%)	X
Conduct of regular checks on level of water consumption	√ (25%)	X
Availability of insulation in buildings		
Conduct of regular checks to detect water wastage	√ (25%)	√ (50%)

Availability of car sharing scheme	√ (25%)	X
Recovery of heat and power from wastes	√ (75%)	X
Level of usage of public transport	X	X
	Medium (100%)	Low (100%)
Current state of purchasing and supply (procurement) of goods		
Uncoordinated purchasing and supply	X	X
Purchasing and supply is coordinated	√ (100%)	√ (100%)
There is some control on suppliers through tendering	X	√ (100%)
There is usually detailed specifications for goods	X	√ (100%)
There are usually no detailed specifications for goods	X	X
There are no waste prevention practices		
There are waste prevention practices	X	X
We work with suppliers and service providers to reduce materials used, reduce packaging and use of hazardous chemicals	X	√ (100%)
We work with suppliers and service providers to reduce materials used, reduce packaging, eliminate heavy metals, reduce use of hazardous chemicals, identify materials for recycling and to reuse recycled products	X	X
There are no regards for clean production practices by suppliers		
We conduct stock management	X	X
There are no regards for rate of use of facilities depending in economic circumstances	X	√ (50%)
We always conduct life cycle assessments and consider whole life costs of materials	X	X
	X	X
Availability of budget for waste management	X	X
Availability of operational staff responsible for waste management	√ (100%)	√ (100%)
Availability of strategy or policy for waste management	√ (25%)	√ (100%)

Availability of training on waste management	√ (100%)	√ (100%)
Venue of waste management trainings	Within the hospital (100%)	Within the hospital (100%)
Availability of Personal Protective Equipment	√ (100%)	√ (100%)
Presence of receptacles/storage containers	√ (75%)	√ (100%)
Availability of colour coding	X	X
Separation of collection for sharps or infectious wastes	√ (25%)	X
Availability of central purpose-built facility for waste storage	√ (25%)	√ (100%)
Availability of temporary waste storage facility	√ (100%)	√ (100%)
Average storage duration at temporary facility	Less than 24hrs (100%)	Less than 24hrs (100%)
Presence of dumpsite within hospital complex	√ (100%)	√ (100%)
Dumping of waste in open waste disposal site	√ (100%)	√ (100%)
	√ (100%)	X
Current waste transportation practice		
Transportation of all non-hazardous municipal solid wastes collected in open topped vehicles	X	√ (100%)
Compaction of wastes	√ (100%)	√ (50%)
Transportation of all non-hazardous municipal solid wastes collected in enclosed compaction vehicles	X	X
Conduct documentation for Transport of Dangerous Goods (TDG)	X	X
Appointment of TDG advisers	X	X
Separation of segregated wastes in enclosed vehicles	X	X
Availability of dedicated vehicles for hazardous wastes	X	X
Application of Basle Convention Requirements	X	X
Availability of recycling	X	X
Seeking to improve local economy and employment by developing use of recyclables	X	X
Current waste treatment practice		
Availability of autoclaving of laboratory wastes	X	X
Practice of crude incineration of hazardous wastes	√ (75%)	√ (100%)
Use of single cell incineration plant	X	X
Use of multiple-chamber incineration plants	X	X
Recycling of residuals from incineration	X	X
Conduct of incineration according to international	X	X

standards		
Use of disinfected wastes as renewable fuel after shredding	X	X
Burying of wastes		
Use of chemicals to disinfect body fluids	√ (100%)	√ (100%)
Practice of waste pre-treatment	√ (100%)	√ (100%)
Use of other advanced waste treatment technologies	√ (100%)	√ (100%)
	X	X
External contracting of waste treatment	√ (75%)	X
Method of waste transportation	√ (100%)	X
Open vehicles	X	X
Enclosed compaction vehicle		
Trolley	X	√ (100%)
Wheeled Vehicles	X	X
Trucks	X	X
Final destination of wastes		
Open dumpsite	√ (100%)	√ (100%)
Landfills	X	X
Shredding	X	X
Buried	X	X
Frequency of outside transportation of waste	Daily (100%	Daily (100%)
Waste disposal practice		
Presence of scavenging and recycling by residents on dumpsites	√ (100%)	X
Presence of scavenging by animals and insects on dumpsites	√ (100%)	X
Availability of reports of recycling of syringes for re-use from the dumpsites	X	X
Availability of fencing and security for the dumpsite	X	X
Presence of environmental pollution at the dumpsite	√ (100%)	√ (100%)
The dumpsite posing as danger to public health	√ (100%)	√ (100%)
Availability of any engineered sanitary landfill for hazardous wastes	√ (100%)	X

Source: Adapted from Townend and Cheeseman (2005)

From Table 4.20, 50% of the respondents from ABUTH indicated that all top management are aware of sustainable development, 25% indicated that some top

management are aware of sustainable development while 25% indicated that management are unaware of sustainable development. The Table also shows that all the respondents indicated that some top management are aware of sustainable development.

The Table shows that 50% of the respondents indicated high level of commitment of top management to sustainable development at both ABUTH and ABUHS; and that the remaining 50% of the respondents indicated some level of commitment of top management to sustainable development at both ABUTH and ABUHS. The Table shows that all of the respondents from ABUTH indicated that mass balance is conducted while all the respondents from ABUHS indicated that mass balance is not conducted.

The Tablefurther shows that 75% and 100% of respondents indicated that cases of corruption are not available with respect to waste management at ABUTH and ABUHS respectively. The Table shows that 75% and 50% of the respondents indicated that there is minimum awareness of best value at ABUTH and ABUHS respectively. The Table also shows that 50% of the respondents indicated that there is awareness of best value at ABUHS.

The Tablereveals that 50% each of the respondents from ABUTH and ABUHS indicated that some continuous improvements take place while the remaining 50% each of the respondents indicated that minimum continuous improvements take place

at the two hospitals. The Tableshows that both ABUTH and ABUHS do not have ISO 14001 certification. The Tablealso shows that 100%, 50% and 75% of the respondents from ABUTH respectively indicated availability of staff consultative committee, availability of patient consultative committee and availability of health and safety committee. The Tablefurther shows that 100% of the respondents from ABUHS indicated availability of staff consultative committee.

The Table shows that there is health and safety awareness (100%), policy (25%), posters in use (75%) and basic protective clothing (75%) at the ABUTH. The Table also shows that there is health and safety awareness (50%), policy (50%), advisor (100%), posters in use (50%) and basic protective clothing (100%) at the ABUHS.
The Table shows that the following energy and water usage practices take place at ABUTH: conduct of regular checks on level of energy use (50%), use of renewable energy sources (25%), conduct of regular checks on level of water consumption (25%), availability of insulation in buildings (25%), conduct of regular checks to detect water wastage (25%) and availability of car sharing scheme amongst staff(75%). The Table also shows that the following energy and water usage practices take place at ABUHS: conduct of regular checks on level of energy use (100%) and availability of insulation in buildings (50%).

The Table shows that all the respondents indicated medium and low levels of usage of public transport by staff at ABUTH and ABUHS respectively. The Tablealso shows that of all the identified purchasing and supply practices, all the respondents

indicated only that purchasing and supply is coordinated at ABUTH. In addition, the Table shows availability of the following purchasing and supply practices at ABUHS: that purchasing and supply is coordinated (100%), there is some control on suppliers through tendering (100%), there are usually detailed specifications for goods (100%), there are waste prevention practices (100%) and conduct of stock management (50%).

The Table shows that all the respondents from ABUTH and ABUHS respectively indicated that there is no specific budget for waste management. This implies overwhelming evidence of non-existence of specific budget for waste management in the case study hospitals.From the Table, it is shown that all the respondents from ABUTH and ABUHS respectively indicated that there are operational staff specifically responsible for medical waste management in their hospitals.

The Table reveals that 25% and 100% of respondents from ABUTH and ABUHS respectively indicated that their hospitals have specific policy or strategy for medical waste management. The Tablealso shows that all the respondents from ABUTH and ABUHS respectively indicated that their hospitals have specific training on medical waste management. The Tablefurther shows that all the trainings workshops conducted on medical waste management by both ABUTH and ABUHS are held in-house within the respective hospitals.

The Table reveals that all the respondents from ABUTH and ABUHS indicated that there are available personal protective equipment for use by medical waste handlers. The Tablealso shows that 75% and 100% of respondents from ABUTH and ABUHS respectively indicated that there are receptacles and storage containers available in their hospitals for medical waste management.

The Tablefurther shows that all the respondents from ABUTH and ABUHS indicated that there are no colour coding practices for receptacles in their hospitals for medical waste management. The Table also reveals that 75% and 100% of respondents from ABUTH and ABUHS respectively indicated that there are no separations of collection for sharps or infectious materials in their hospitals. The Tablealso shows that 25% and 100% of respondents from ABUTH and ABUHS respectively indicated that there are central purpose-built facility as well as temporary waste storage facility available in their hospitals. The Tablefurther shows that all respondents from both ABUTH and ABUHS indicated that the wastes are stored in the temporary waste storage facility for an average of less than 24 hours.

The Table shows that all the respondents from ABUTH and ABUHS indicated that there are dumpsites within their respective hospitals for medical waste management and that wastes from their hospitals are dumped in open disposal sites. The Tablealso shows that from the identified current waste transportation practices, all the respondents at ABUTH practice transportation of all non-hazardous municipal solid wastes collected in open topped vehicles (100%) and transportation of all non-

hazardous municipal solid wastes collected in enclosed compaction vehicles (100%). The Tablefurther shows that from the identified current waste transportation practices, the respondents at ABUHS practice compaction of wastes (100%) and transportation of all non-hazardous municipal solid wastes collected in open topped vehicles (50%). The Tablealso shows that all the respondents from ABUTH and ABUHS indicated non-availability of recycling of medical waste management in both hospitals and that no improvement to local economy and employment by developing use of recyclables are sought at both hospitals.

The Table shows the current waste treatment practices at ABUTH to include of crude incineration of hazardous wastes (75%), burying of wastes (100%), use of chemicals to disinfect body fluids (100%) and practice of waste pre-treatment (100%). The Tablealso shows the current waste treatment practices at ABUHS to include of crude incineration of hazardous wastes (100%), burying of wastes (100%), use of chemicals to disinfect body fluids (100%) and practice of waste pre-treatment (100%). The Table 4.59 further shows that 75% and none of the respondents from ABUTH and ABUHS respectively indicated that there is external contracting of waste treatment in their respective hospitals and that open vehicles is the dominant methods for transporting wastes at ABUTH while the use of trolleys is the dominant method at the ABUHS. The Tablealso shows that all the respondents indicated open dump sites as final destinations of wastes from both ABUTH and ABUHS and that the frequency of outside transportation of wastes as daily at both ABUTH and ABUHS.

The Table shows the waste disposal practices at ABUTH to include presence of scavenging and recycling by residents on dumpsites (100%), presence of scavenging by animals and insects on dumpsites (100%), presence of environmental pollution at the dumpsites (100%) and the dumpsite posing as danger to public health (100%). The Tablealso shows the waste disposal practices at ABUHS to include presence of environmental pollution at the dumpsite (100%) and the dumpsite posing as danger to public health (100%).

The Table shows the disposal methods for different waste categories at the ABUTH and reveals that burial method is popular for disposing human anatomical wastes (75%), potentially hazardous pharmaceutical waste (100%), hazardous pharmaceutical waste (75%), cyto-toxic pharmaceutical waste (100%), blood and body fluids (75%) and radioactive waste (50%). The Tablealso shows that incineration is popular for disposing other non-risk wastes (25%), sharps (100%), non-hazardous pharmaceutical wastes (25%), hazardous pharmaceutical waste (25%), blood and body fluids (25%), infectious waste (100%), highly infectious waste (100%), other hazardous waste (100%) and radioactive waste (75%). The Table further shows the open dumping to popular for disposing recyclable waste (100%), biodegradable waste (100%), other non-risk waste (75%) and non-hazardous pharmaceutical waste (75%).

The Table shows the disposal methods for different waste categories at the ABUHS and that burial method is popular for disposing human anatomical wastes (50%), sharps (100%), potentially hazardous pharmaceutical wastes (100%), hazardous pharmaceutical wastes (50%) and blood and body fluids (100%). The Table further shows that incineration is popular for disposing recyclable waste (50%), biodegradable waste (50%), other non-risk waste (100%), non-hazardous pharmaceutical waste (100%) and highly infectious waste (100%). The Table also shows that open dumping is popular for disposing biodegradable waste (50%) and other non-risk waste (50%).

Going by the scores obtained from the two hospitals assessed as shown in Table 4:20, it is clear that both hospitals are operating in a manner with some aspects that are considered sustainable and others that are considered unsustainable. Hence, in accordance with the Townend and Cheeseman (2005) guidelines, both the ABUTH an ABUHS can be classified as Level 2 hospitals based on their operational performance.

4.7: DISCUSSION OF RESULTS

The need for the orderly grouping of the highly varied elements of HCW into different sub-sets that are each characterized by narrower identical attribute to simplify understanding (Igwe, 2002) informed the WHO/UNEP classification. The categories and sub-sets of healthcare waste yielded by the exercise comprise: Recyclable wastes, Biodegradable wastes, Other non-risk wastes, human anatomical

waste, sharps, non-hazardous pharmaceutical wastes, potentially hazardous pharmaceutical wastes, hazardous pharmaceutical wastes, cyto-toxic pharmaceutical wastes, blood and body fluids, Infectious wastes, highly infectious wastes, other hazardous wastes and radioactive wastes.From this study,the respondents at the ABUHS revealed that all the waste categories according to UNEP/WHO classification were present except radioactive wastes, other hazardous wastes and human anatomical wastes are not present. However, it was recorded that all the waste categories according to UNEP/WHO classification were present at the ABUTH.

The study showed that the total measured quantity of HCW generated as 845kg per day(1.18Kg per bed per day)and 77kg per day (1.54kg per bed per day) at ABUTH and ABUHS respectively. The study further showed that at ABUTH, Male and Female Medical Wards generates the highest quantity of wastes (28%), followed by the Male and Female Surgical Wards (20%) and Accident and Emergency & Labour Wards (19%). The study also showed that Clinical Pharmacology Ward generates the least quantity of waste (1%). These figures are quite high compared to the results of Longe and Williams (2006) who had surveyed medical waste management practices and their implications to health and environment in metropolitan Lagos. The study assessed management practices in four hospitals ranging in capacity from 40 to 600 beds and established average generation rate of medical waste of 0.562kg/bed/day to 0.670kg/bed/day; with infectious waste accounting for between 26% to 37% of the total volume.In a study titled “case study evaluation of health-care waste challenges

in Hospitals within Ilorin metropolis", Ajimotokan and Aremu (2009) found out that about 177.67Kg of waste was generated daily and the average waste generated per bed/per day was 1.56Kg. Abah and Ohimain (2011), in the study entitled "health care waste management in Nigeria", focused on the estimation of the quantity, evaluation of the waste segregation practice and determination of the knowledge of health care workers regarding healthcare waste management. The findings revealed that the average amount of health care waste was 0.62Kg/person/day at the out patients. It can thus be concluded that the quantity of wastes generated are within the range of other previous studies. Besides, it seems that the practices in the two hospitals studied are such that disposals are done when the waste containers are filled up and not necessarily on daily basis.

From the results, lack of awareness about the health hazards related to health-care waste, inadequate training in proper waste management, absence of waste management and disposal systems, insufficient financial and human resources and the low priority given to waste management issues are the most common problems connected with health-care waste. The hospitals either do not have appropriate regulations, or do not enforce them since the essential issue is the clear attribution of responsibility for the handling and disposal of waste. To achieve the safe and sustainable management of health-care waste, financial analyses should include all the costs of disposal. Although treatment and disposal of health-care waste has been done fairly well in the hospitals to reduce risks, indirect health risks may occur through the release of toxic pollutants into the environment through treatment or

disposal. For example, landfills contaminate drinking-water if they are not properly constructed.

Occupational risks exist at disposal facilities that are not well designed, run, or maintained. It is also worth noting that incineration of waste has been widely practised at the hospitals but inadequate incineration or the incineration of unsuitable materials results in the release of pollutants into the air and of ash residue. Incinerated materials containing chlorine can generate dioxins and furans, which are human carcinogens and have been associated with a range of adverse health effects. Incineration of heavy metals or materials with high metal content (in particular lead, mercury and cadmium) can lead to the spread of toxic metals in the environment. Dioxins, furans and metals are persistent and bio-accumulate in the environment. Alternatives to incineration are now available, such as autoclaving, microwaving, steam treatment integrated with internal mixing, and chemical treatment.

At the hospitals, however, autoclaving was still at the infant stage. In the last few years, there has been growing controversy over the incineration of health care waste. Under some circumstances, including when wastes are incinerated at low temperatures or when plastics that contain polyvinyl chloride (PVC) are incinerated, dioxins and furans and other toxic air pollutants may be produced as emissions and/or in bottom or fly ash (ash that is carried by air and exhaust gases up the incinerator stack). Exposure to dioxins, furans and co-planar PCBs may lead to adverse health effects.As primitive as open dump method of solid wastes disposal is,

Johanessen and Boyer (1999) observed that it remains the predominant means in developing countries.

Rushbrook and Pugh (1999) considered the open dump method of solid waste disposal as both“naïve and dangerous” because of the leaching effects of chemicals and biological contaminants in the wastes, which constitutes a direct risk to transmission of communicable diseases. Although, incineration is not an unclean process of disposing wastes, it is still the most effective method of treating HCW because it involves the application of combustion process under controlled condition at high temperature, converting wastes containing stocks of infectious agents and pathological materials to inert mineral residues and gases (Omotoso, Faluyi and Iyanda, 2007). However, incineration is regarded as the most expensive waste management option because it requires capital intensive plant, highly skilled personnel and careful maintenance (Onipede and Bolaji, 2004) and it may lead to the production of dioxins, furans or other toxic pollutants as emissions and residues. Improper HCW disposal method like open air burning, land filling, dumping into water bodies is common in developing countries, constitutes environmental threats, increased vulnerability for potential transmission of communicable diseases and natural disasters.

Going by the effectiveness assessment scores obtained from the two hospitals, they were both classified as operating in a manner with some aspects that are considered sustainable and others that are considered unsustainable. In accordance with the

Townend and Cheeseman (2005) guidelines, both the ABUTH an ABUHS were classified as Level 2 hospitals based on their operational performance. This finding is in tune with the outcome of all the studies, which adjudged HCW in Nigeria to be poorly managed. The studies highlight the ineffective pattern of HCWM in Nigeria in a number of critical areas. For example, Ngwuluka *et al*. (2009), Idowu (2010) and Coker and Sridhar (2010) underscored the existence of little knowledge of hospital waste management in Nigeria especially in the areas of record keeping of the actual quantities of medical waste generated, and lack of any HCWM plan. They also held the inexistence of HCWM policy, plans and the inadequacies of government regulatory body as the reason for the absence or guidelines. Other deficiencies identified include inadequate training of HCW handlers (Ngwuluka *et al*., 2009), staff training and awareness and education to influence the management of hazardous waste (Ngwuluka *et al.*, 2011) the situation in Nigeria has been found to exist in other developing countries characterized by the absence of national regulations for HCW management, low awareness about HCW management by personnel and waste workers (Arab *et al*., 2008; Mesdaghinia *et al*., 2009).

CHAPTER FIVE

SUMMARY,CONCLUSION AND RECOMMENDATIONS

5.1: SUMMARY

This study assessed medical waste management practices in Ahmadu Bello University Teaching Hospital (ABUTH) Zaria and Ahmadu Bello University Health Service (ABUHS) A.B.U. Zaria. The study specifically embarked on the characterization of healthcare wastes (HCW) in the two hospitals and the quantity of wastes generated per day per bed in the hospitals.The study also examined methods of HCW collection and disposal in the hospitals as well as the effectiveness of HCW management practices in the hospitals. Finally, the study identified and mapped out the waste dumpsites in the two hospitals.

The study used co-ordinate data of the waste dumpsites in the hospital sourced from the study area using Global Positioning System (GPS) to establish and map the locations of the dumpsites in the hospitals on the topographic map. The study equally used the amount of waste generated per bed per day in each of the hospitals collected through a weight measuring scale. Two sets of structured questionnaires were used to extract information about nature of HCW, methods of HCW collection and disposal and the effectiveness of HCW management practices from the staff involved in waste management in the hospitals. Pictures of the waste dumpsites from the hospitals were equally taken using camera in the field. Geographic Information Systems and descriptive statistics were used as the analytical methods.

5.2: MAJOR FINDINGS

i. The study revealed that at the ABUTH, all the HCW according to UNEP/WHO (2005) were generated. They are Recyclable wastes, Biodegradable wastes, Other non-risk wastes, human anatomical waste, sharps, non-hazardous pharmaceutical wastes, potentially hazardous pharmaceutical wastes, hazardous pharmaceutical wastes, cyto-toxic pharmaceutical wastes, blood and body fluids, Infectious wastes, highly infectious wastes, other hazardous wastes and radioactive wastes. At the ABUHS, all the wastes found in ABUTH except human anatomical wastes, other hazardous wastes and radioactive wastes were equally found.

ii. It was found out that the total quantities of HCW generated at ABUTH and ABUHS are 845kg and 77kg per day respectively. This translates to 1.18kg and 1.54kg per day per bed at ABUTH and ABUHS respectively.

iii. Waste collections at the two hospitals were in receptacles/storage containers displayed at the patients' bedsides and at strategic locations within and outside of the various units/wards before been sorted and onward transfer to storage before been disposed.

iv. Disposal at ABUHS were incineration and open dumping methods. The wastes often incinerated are Sharps, Potentially hazardous Pharmaceutical wastes, Hazardous Pharmaceutical wastes, Cyto-toxic pharmaceutical wastes, Blood and body fluids, Infectious wastes and Highly infectious wastes while Recyclable wastes, Biodegradable wastes, Other non-risk wastes and Non-hazardous Pharmaceutical wastes were dumped in an open dumpsites within the hospital premise before been conveyed away. At the ABUTH, the three mainly used disposal methods were burial,

incineration and open dumping depending on the nature of the waste. However, landfill method was been used for biodegradable wastes.

v. From the study, both the ABUTH and ABUHS can be classified as Level 2 hospitals based on their operational performance in waste management in accordance with the Townend and Cheeseman (2005) guidelines.

5.3: CONCLUSION

Healthcare services are aimed at preventing potential human health risks and environmental hazards as well as improving wellbeing. In the process, however, wastes that are potentially harmful are generated. Poor management of these healthcare wastes (HCW) exposes the health workers, patients, waste handlers and the general public to health risks. The following conclusions can be deduced from the findings of this study involving Ahmadu Bello University Teaching Hospital (ABUTH) Zaria and Ahmadu Bello University Health Service (ABUHS) A.B.U. Zaria:

i. All the waste categories according to UNEP/WHO classification were present at ABUTH while all but radioactive wastes, other hazardous wastes and human anatomical wastes are present at ABUHS.

ii. The rate of waste generation at ABUTH (1.18kg/bed/day) and at ABUHS (1.54kg/bed/day) falls within reported range of 0.562kg/bed/day to 1.56kg/bed/day.

iii. Waste collections at the two hospitals were in receptacles/storage containers displayed at the patients' bedsides and at strategic locations within and outside of the

various units/wards before been sorted and onward transfer to storage before been disposed.

iv. Disposal at ABUHS werelargely incineration and open dumping methods.Although treatment and disposal of health-care waste has been done fairly well in the hospitals to reduce risks, indirect health risks may occur through the release of toxic pollutants into the environment through treatment or disposal.

v. There is low awareness about the health hazards related to health-care waste, inadequate training in proper waste management, absence of waste management and disposal systems, insufficient financial and human resources and the low priority given to the topic are the most common problems connected with health-care waste. The hospitals either do not have appropriate regulations, or do not enforce them since the essential issue is the clear attribution of responsibility for the handling and disposal of waste.

vi. The management practices at ABUTH and ABUHS give room for so much concern considering the fact that both hospitals are classified as Level 2 hospitals based on their operational performance in accordance with the Townend and Cheeseman (2005) guidelines. This implies that some aspects of sustainable waste management are yet to be implemented. The hospitals have enormous population influx based on patronage and the availability of high number of students on training should be seen to be high above board in waste management to avoid outbreak of infection.

5.3: RECOMMENDATIONS

The following recommendations are proffered to the management of the hospitals and such others of the same performance level:

i. Improvements in health-care waste management that will rely on the following key elements:

- building a comprehensive system, addressing responsibilities, resource allocation, handling and disposal. This is a long-term process, sustained by gradual improvements;
- raising awareness of the risks related to health-care waste, and of safe and sound practices;
- selecting safe and environmentally-friendly management options, to protect people from hazards when collecting, handling, storing, transporting, treating or disposing of waste

ii. The management of the two hospitals should increase attention and diligence to avoid the substantial disease burden associated with poor practice, including exposure to infectious agents and toxic substances and enhanced the use of incinerators that provide an interim solution especially since the options for waste disposal such as autoclave, shredder or microwave are limited.

iii. Whatever the technology used, best practice must be promoted to ensure optimal operation of the system. To reduce exposure to toxic pollutants associated with the combustion process such as dioxins, furans, co-planar PCBs, nitrogen and sulphur

oxides as well as particulate matter and to minimize occupational and public health risks, "best practices" for incineration must be promoted, and must include the following elements:

- Effective waste reduction and waste segregation, ensuring that only appropriate wastes are incinerated;
- Citing incinerators away from populated areas or areas where food is grown, thus minimizing exposures and thereby risks;
- A properly engineered design, ensuring that combustion conditions are appropriate, e.g., sufficient residence time and temperatures to minimize products of incomplete combustion;
- Construction following detailed dimensional plans, thus avoiding flaws that can lead to incomplete destruction of waste, higher emissions, and premature failure of the incinerator;
- Proper operation, critical to achieving the desired combustion conditions and emissions. In summary, operation must: utilize appropriate start-up and cool-down procedures; achieve (and maintain) a minimum temperature before waste is burned; use appropriate loading/charging rates (both fuel and waste) to maintain appropriate temperatures; ensure proper disposal of ash; and ensure use of protective equipment to safeguard workers;
- Periodic maintenance to replace or repair defective components, including inspection, spare parts inventory, record keeping, and so forth;

- Enhanced training and management, possibly promoted by certification and inspection programmes for operators, the availability of an operating and maintenance manual, management oversight, and maintenance programmes.

iv. Management and operational problems with incinerators, including inadequate training of operators, waste segregation problems, and poor maintenance, are recognized as critical issues that should be addressed in assessment and waste management plans.

v. Given the importance of effective healthcare waste management practices and the current unsustainable level of performance, it is important to investigate the effects of the healthcare wastes from the two hospitals on the total environment (soil, water and air).

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APPENDIX A: QUESTIONNAIRE FOR WASTE HANDLERS

Department of Geography
Faculty of Science
Ahmadu Bello University, Zaria
MSC Environmental Management

Assessment Of Medical Waste Management Practices in Ahmadu Bello University Teaching Hospital (ABUTH) and Ahmadu Bello University Health Services (ABUHS), Zaria, Nigeria.

Dear Sir/Ma
The purpose of this questionnaire is to collect relevant information for the research study on medical waste management practices at ABUTH and ABUHS. The information collected will be used for academic purpose only. Your cooperation is kindly requested for the provision of adequate and accurate information to the questions, as all information provided will be treated as confidential.

Thank you.

PART I
Name of your Hospital……..

PART II
SECTIONA: WASTE CLASSIFICATION
Please tick whichever is applicable.
1 Non- Risk Health Care Wastes generated in your hospital
(a) Recyclable waste ■
(b) Biodegradable waste
(c. Other non-risk waste
2. Health Care Wastes requiring special attention in your hospital
(a) Human anatomical waste
(b) Sharps
(c. Non-hazardous Pharmaceutical waste
(d) Potentially hazardous Pharmaceutical waste
(e) Hazardous Pharmaceutical waste
(f) Cyto-toxic pharmaceutical waste
(g) Blood and body fluids
3 Infectious and highly infectious waste in your hospital
(a). Infectious waste
(b) Highly Infectious waste
4 Other Hazardous waste in your hospital (Specify if any)……..
5 Radioactive waste in your hospital (Specify if any)……..

SECTIONB: MEDICAL WASTE MANAGEMENT PRACTICE

Please indicate the appropriate answer to the questions below as it applies to your hospital.

	General management strategy	Yes	No
6	Is there any budget for waste management?		
7	Are there operational staff responsible for management of medical wastes?		
8	Is there any waste management policy or strategy?		
9	Is there any training on waste management for staff?		
10	Is there any personal protective equipment worn by operative staff?		

SECTION C: WASTE COLLECTION AND SEGREGATION

	Waste collection and segregation	Yes	No
11	Is there presence of receptacle/storage containers in your hospital?		
12	Is there any color coding for the receptacles?		
13	Are sharp or infectious materials collected separately?		

SECTION D: WASTE RECYCLING

	Waste recycling	Yes	No
14	Is there any form of recycling?		

SECTION E: WASTE STORAGE

	Waste storage	Yes	No
15	Is there waste storage facility in the hospital? If Yes, please specify type, location and approximate number ***** What is the average storage period at the temporary facility (less than 24hours, 24 to 48 hours, more than 48 hours, etc)		
16	Are wastes dumped outside the hospital buildings (but within the		

	premises)?		
17	Are the wastes dumped in an open waste disposal site?		

SECTION F: WASTE TREATMENT

	Waste treatment	Yes	No
18	Is there Autoclaving of laboratory waste?		
19	Is crude incineration practiced?		
20	Are wastes buried?		
21	Are chemicals used to disinfect body fluids?		
22	Is waste pre-treatment practiced?		
23	Are other advanced technologies used?		

SECTION G: WASTE DISPOSAL

	Waste disposal	Yes	No
24	How is waste transported? (open vehicles, enclosed compaction vehicle, Trolley, wheeled vehicles, Trucks) *****		
25	What is the final destination of the waste? (open dump, landfills, shredding, buried, some other technology) *****		
26	What is the frequency of outside Transportation (Once daily, Twice daily, Trice daily, once a week, others) *****		

SECTION H: DISPOSAL TECHNIQUE

27. Indicate the disposal technique used for the following types of waste

Waste Category	Waste Disposal technique				
	Burial	Incineration	Open dumpi	landfills	Not applicable

			ng		
Recyclable waste					
Biodegradable waste					
Other non-risk waste					
Human anatomical waste					
Sharps					
Non-hazardous Pharmaceutical waste					
Potentially hazardous Pharmaceutical waste					
Hazardous Pharmaceutical waste					
Cyto-toxic pharmace					

utical waste					
Blood and body fluids					
Infectious waste					
Highly infectious waste					
Other hazardous waste					
Radioactive waste					

APPENDIX B: QUESTIONNAIRE FOR HEADS OF WASTE MANAGEMENT UNITS

Department of Geography
Faculty of Science
Ahmadu Bello University, Zaria
MSC Environmental Management

Assessment Of Medical Waste Management Practices in Ahmadu Bello University Teaching Hospital (ABUTH) and Ahmadu Bello University Health Service (ABUHS), Zaria, Nigeria.

QUESTIONNAIRE FOR HEAD OF WASTE MANAGEMENT UNIT

Dear Sir/Ma

The purpose of this questionnaire is to collect relevant information for the research study on medical waste management practices at ABUTH and ABUHS. The information collected will be used for academic purpose only. Your cooperation is kindly requested for the provision of adequate and accurate information to the questions, as all information provided will be treated as confidential.

Thank you.

Farida Isyaku
MSc/SCIE/01411/2010-2011

SECTION1: BACKGROUND INFORMATION

Jobtitle:

_____

_____

Rank:

_____

Name of Hospital: ABUTH [ ]
ABUHS [ ]

SECTION2: MEDICAL WASTE MANAGEMENT PRACTICE

General Management

1. Indicate which best reflect level of awareness of your hospital's top management on sustainable development (SD)

a. All top management trained in sustainable development
b. Some top management trained in sustainable development
c. All top management aware of sustainable development
d. Some top management aware of sustainable development
e. Management unaware of sustainable development

2. Indicate the level of commitment of your hospital's top management to sustainable development (SD)

a. High level of commitment
b. Some level of commitment
c. Minimal level of commitment
d. No commitment

3. Is mass balance undertaken in your hospital?

a. Yes b. No

4. Are there cases of corruption with respect to waste management in your hospital

a. There is evidence of corruption b. There is no evidence of corruption

5. Indicate which best reflect level of awareness of best value in your hospital

a. Best value undertaken in the hospital
b. There is awareness of best value
c. There is minimum awareness of best value
d. There is a lack of awareness of best value

6. Indicate which best reflect level of awareness of continuous improvement in your hospital

a. Continuous improvements undertaken in the hospital
b. Some continuous improvements take place

c. Minimum continuous improvements take place
d. No continuous improvements take place
7. Is your hospital ISO 14001 certified?
a. Yes b. No

Social Issues

8. Do you have a staff consultative committee in your hospital?
a. Yes b. No
9. Do you have a patient consultative committee in your hospital?
a. Yes b. No

10. Do you have a health and safety committee in your hospital?
a. Yes b. No
11. Do you have health and safety representatives in your hospital?
a. Yes b. No
12. Do you have equal opportunities policy and framework for enforcement in your hospital?
a. Yes b. No
13. Do you have Investor in People schemes (or similar) in your hospital?
a. Yes b. No

Health and Safety

14. Indicate which reflect the current state of health and safety in your hospital (tick all that is applicable)
a. There is health and safety awareness
b. There is a health and safety policy
c. There is a health and safety advisor
d. There are health and safety posters in use
e. There are basic protective clothing
f. There are full protective clothing

Energy and Water Use

15. Do you have an energy policy in your hospital?
a. Yes b. No
16. Do you conduct regular checks on level of energy use in your hospital?
a. Yes b. No
17. Do you use renewable energy sources in your hospital?
a. Yes b. No
18. Do you conduct regular checks on level of water consumption in your hospital?
a. Yes b. No
19. Are the buildings in your hospital insulated?
a. Yes b. No
20. Do you conduct regular checks to detect waste of water in your hospital?
a. Yes (State interval) b. No
21. Is there car sharing scheme amongst the staff of your hospital?
a. Yes b. No

22. What is the level of usage of public transport by the staff of your hospital?
a. High b. Medium c. Low
23. Do you recover heat and power from wastes in your hospital?
a. Yes b. No

Purchasing and Supply (Procurement)

24. Indicate which reflect the current state of purchasing and supply (procurement) of goods in your hospital (tick all that is applicable)
a. Uncoordinated purchasing and supply
b. Purchasing and supply is coordinated
c. There is some control on suppliers through tendering
d. There is usually detailed specifications for goods
e. There are usually no detailed specifications for goods
f. There are no waste prevention practices
g. There are waste prevention practices
h. We work with suppliers and service providers to reduce materials used, reduce packaging and use of hazardous chemicals
i. We work with suppliers and service providers to reduce materials used, reduce packaging, eliminate heavy metals, reduce use of hazardous chemicals, identify materials for recycling and to reuse recycled products
j. There are no regards for clean production practices by suppliers
k. We conduct stock management
l. There are no regards for rate of use of facilities depending in economic circumstances
m. We always conduct life cycle assessments and consider whole life costs of materials

Waste management practice – responsibility, segregation, storage and packaging

Please indicate the appropriate answer to the questions below as it applies to your hospital. Note that the questions with ***** require answers other than Yes or No.

	General waste management strategy	Yes	No
1	Is there any budget for waste management?		
2	If the answer to Q1 is Yes, what is the approximate annual budget? ****		
3	Are there full time operational staff responsible for management of medical wastes?		
4	If the answer to Q3 is Yes, what is the approximate number of staff in the medical waste management unit? *****		
5	Is there any waste management policy or strategy?		
6	Is there any training on waste management for staff?		
7	If the answer to Q6 is Yes, within what time interval does a staff typically receive training? *****		
8	If the answer to Q6 is Yes, is the training conducted within the hospital or at an external organisation? *****		
9	Is there any personal protective equipment worn by operative staff?		
10	If the answer to Q9 is Yes, what is your assessment of adequacy of the protective facilities? *****		

Please indicate the appropriate answer to the questions below as it applies to your hospital. Note that the questions with ***** require answers other than Yes or No.

	Waste collection and segregation	**Yes**	**No**
11	Is there presence of receptacle/storage containers in your hospital?		
12	Is there any colour coding for the receptacles?		
13	Are sharp or infectious materials collected separately?		
14	Is segregation regulated or controlled? ********* If segregation is practiced, what is being segregated, and where does the segregation take place?		
15	Who are the persons responsible for waste collection? (Health workers, Hospital maids, Others)********* What is the frequency of waste collection from the sources of the waste per day (Twice daily, Once daily, Every two hours, etc)		

Please indicate the appropriate answer to the questions below as it applies to your hospital.

	Waste storage	**Yes**	**No**
16	Is there any central purpose-built facility for waste storage? If Yes, please specify type and number ***** Provide an assessment of the central waste facility in terms of connection to a central sewer and water, ventilation, safety, cleanliness, storage facility and capacity?		
17	Is there a temporary waste storage facility in the hospital? If Yes, please specify type, location and approximate number ***** What is the average storage period at the temporary facility (less than 24hours, 24 to 48 hours, more than 48 hours, etc)		
18	Are wastes dumped outside the hospital buildings (but within the premises)?		
19	Are the wastes dumped in an open waste disposal site?		

Please indicate the appropriate answer to the questions below as it applies to your hospital. Note that the questions with ***** require answers other than Yes or No.

	Waste transportation	**Yes**	**No**
20	Are all non-hazardous municipal solid wastes collected and transported in open topped vehicles? Do you compact the wastes?		
21	Are the non-hazardous municipal solid wastes collected and transported by enclosed compaction vehicles?		
22	Do you conduct documentation for the Transport of Dangerous Goods (TDG)		
23	Do you appoint TDG advisers		
24	Do you separate collection of segregated wastes in enclosed vehicles?		
25	Do you have dedicated vehicles for hazardous wastes?		
26	Do you apply the Basle Convention requirements?		

Please indicate the appropriate answer to the questions below as it applies to your hospital. Note that the questions with ***** require answers other than Yes or No.

	Waste recycling	**Yes**	**No**
27	Is there any form of recycling?		
28	If the answer to Q27 is Yes, what items of waste is/are recycled? ***** What item(s) of waste is/are re-used?		
29	Do you seek to improve local economy and employment by developing use of recyclables?		

Please indicate the appropriate answer to the questions below as it applies to your hospital. Note that the questions with ***** require answers other than Yes or No.

	Waste treatment	**Yes**	**No**
30	Is there Autoclaving of laboratory waste?		
31	Is crude incineration of hazardous wastes practiced?		
32	Do you use: Single cell incineration plant? Multi-chamber incineration plants?		
33	Are residuals from incineration recycled?		
34	Are the incinerations done to any international standards such as EU directive?		
35	Are the disinfected wastes used as renewable fuel after shredding?		
	Are wastes buried?		
36	Are chemicals used to disinfect body fluids?		
37	If the answer to Q36 is Yes, what chemicals are being used? *****		
37	Is waste pre-treatment practiced?		
38	Are other advanced technologies used?		
39	If the answer to Q38 is Yes, what advanced technologies are being used? *****		

Please indicate the appropriate answer to the questions below as it applies to your hospital. Note that the questions with ***** require answers other than Yes or No.

	Waste disposal	**Yes**	**No**
40	Is waste disposal contracted out?		
41	How is waste transported? (open vehicles, enclosed compaction vehicle, Trolley, wheeled vehicles, Trucks) *****		
42	What is the final destination of the waste? (open dump, landfills, shredding, buried, some other technology) *****		
43	What is the frequency of outside Transportation (Once daily, Twice daily, Trice daily, once a week, others) *****		
44	Are there scavenging and recycling on dump sites by dump residents?		
45	Are there scavenging on dump sites by animals and insects?		
46	Do you have reports of syringes being recycled for re-use from the dump sites?		
47	Is the dump site secured (with security) and fenced?		
48	Does any form of environmental pollution take place at the dump site?		
49	Does the dump site pose any danger to public health?		
50	Is there any engineered sanitary landfill for hazardous wastes?		

51. Indicate the disposal technique used for the following types of waste

Waste Category	Waste Disposal technique				
	Burial	**Incineration**	**Open dumping**	**landfills**	**Not applicable**
Recyclable wastes					
Biodegradable wastes					
Other non-risk wastes					
Human anatomical wastes					
Sharps					
Non-hazardous Pharmaceutical wastes					
Potentially hazardous Pharmaceutical wastes					
Hazardous Pharmaceutical wastes					
Cyto-toxic pharmaceutical wastes					
Blood and body fluids					
Infectious wastes					
Highly infectious wastes					
Other hazardous wastes					
Radioactive wastes					