BIOMEDICAL WASTE DISPOSAL AND ENVIRONMENTAL AESTHETICS OF TERTIARY HEALTH CARE CENTERS IN FEDERAL CAPITAL TERRITORY, ABUJA-NIGERIA

BY

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DEPARTMENT OF GEOGRAPHY,

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MAY, 2015.

DECLARATION

I hereby declare that this Thesis was written by me and it is a true record of my research work. It has not been presented in any previous application for a higher degree. All the sources of information are duly acknowledged by means of references.

……..... …….....

Signature Date

CERTIFICATION

This dissertation entitled “BIOMEDICAL WASTE DISPOSAL AND ENVIRONMENTAL AESTHETICS OF TERTIARY HEALTH CARE CENTERS IN FEDERAL CAPITAL TERRITORY, ABUJA-NIGERIA” byOGOLOWA, Marcel Ogiemeets the regulations governing the award of degree of MSc Environmental Management ofAhmadu Bello University, Zaria and is approved for its contributions to scientific knowledge and literary presentation.

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DEDICATION

I dedicate this work to God Almighty, for making this research work a possibility and strengthening me all the way.

To my beloved parents Mr. and Mrs. Ogolowa without whose financial and spiritual support this achievement would not have been possible. I say thank you for your support, care and love, may God reward you abundantly.

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My sincere gratitude goes to Almighty God for his grace, mercy, protection and guidance in the course of my academic journey.

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ABSTRACT

This study was carried out to assessthe Biomedical Waste disposal methods and the environmental aesthetics of Tertiary Health Care Centers (THCCs) in the Federal Capital Territory, Abuja,which are the University of Abuja Teaching Hospital (UATH), Izom Road, Gwagwalada, and The National Hospital, (TNH), Municipal Area. The study identified and characterized the categories of BMW generated in the hospitals into degradable and Non-degradable and examined the methods of BMW disposal in each of the THCCs, and the effectiveness of the BMW disposal methods in the hospitals. The study adopted a survey design. Two health centers were purposively sampled for the survey. Data were collected through the use of a questionnaire and a checklist designed by the researcher.Equal responses of staff and patients from focused group discussion and in-depth interview were discussed extensively. Observations of the clinics and surroundings were guided by a checklist. Photographs were also taken of the dumpsites. Descriptive statistics were used to present the research results. Findings revealed that constituents of biomedical waste found in both hospitals were degradable such as papers, bandages and cotton swabswhile others were non-degradable such as needles and syringes, bottles, used blades and plastics.About 90% of the respondents in both hospitals agreed that waste bin and storage container exist and waste collection is daily. However, their transportation to disposal points are ineffective as they are either transported by open vehicles, wheeled vehicles or trucks as attested to by 65% in UATH and 60% in TNH.The predominant method employed for BMW disposal in both hospitals was open burning as attested to by 66.7% in UATH and 63.4% in TNH .However there still exist other disposal techniques such as open burning, burying, shredding and landfilling.The study also found that open burning was not a reliablemethod of BMW disposal despite its benefit of mass reduction in quantity of waste, destruction of disease causing organisms and low cost of management. The massive uncontrolled smoke emanating during open burning, generatesair pollution. There were also the risk of damage to crops of the nearby farmlands due to chemical constituents of the hospital's waste placed at the dumpsite prior to open burning. Furthermore, findings showed that the dumpsites posed health risks and altered the aesthetics of the surroundings.There was a strong correlation between the level of perception on biomedical waste management between patients and staff and effectiveness of BMW disposal. The study recommends among others careful sorting of BMW before disposal, complete open burning and restriction of farming activities away from dumpsites.

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LIST OF ABBREVIATIONS

1.	UATH	□	University of Abuja Teaching Hospital
2.	TNH	□	The National Hospital
3.	THCC	-	Tertiary Health Care Centres
4.	BMW	-	Biomedical Waste

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CHAPTER ONE

INTRODUCTION

1.1. BACKGROUND TO THE STUDY

There is a significant concern expressed by environmentalists and enlightened citizenry in Nigeria that wastes generated in hospitals and other healthcare facilities are not being managed properly. Hospitals are health institutions that provide health care services while health care establishments look after the public health directly through patients care. It is also done by ensuring a clean, healthy environment for employees and community members. In other words, health care activities facilitate protecting the environment, curing patients and saving lives. However, in the course of their activities, biomedical wastes are generated, 20 percent of which expose humans to risk of infections, trauma, chemical or radiation exposure and sometimes death (International Committee of the Red Cross, 2011; Madhu, Hina, Puttaiah and Thirumala, 2013). A wide range of hospital wastes were listed by Baveja, Muralidhar and Aggarwal (2000) to include sharps, human tissues or body parts and other disposable but infectious materials referred to as 'Hospital Solid Waste'. Problem of improving the management of biomedical wastes are receiving increasing attention throughout the world since health care institutions generate tons of biomedical waste each year.

Biomedical Waste (BMW) in this study was adopted from Srivastav, Mahajan and Mathur, (2012) who posited that BMW are wastes generated during diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or biological testing. World Health Organization (WHO, 2002) has characterized Biomedical Waste (BMW) as the total stream of wastes from health care or research facilities ranging from

potentially risk waste to non-risky waste materials. Manyele, (2004) defined medical wastes as any solid waste generated in the diagnosis, treatment, or immunization of human beings or animals, as well as in related researches, production or testing of biological from all types of health care institutions, including hospitals, clinics, doctor offices and medical laboratories.

Omojasola, Adetitun, Oshin and Omojasola(2009) have also characterized health care sectors especially hospitals as massive reservoirs often neglected or even ignored in relation to their impact on the environment despite their high costs on energy use, water and waste disposal. Integrating environmental health dimensions in managing hospitals and health care centers has been achieved through efficient infection control measures, occupational health and safety of staff, proper disposal of infectious wastes, and optimal use of water, energy and medical supplies to ensure sustainability of services (Saad, 2007).

Human blood and blood products, cultures and stocks of infectious agents; pathological wastes; contaminated sharps, contaminated laboratory wastes, contaminated waste from patient care, discarded biological, contaminated animal carcasses, body parts,and bedding, contaminated equipment and miscellaneous infectious wastes are all products of BMW (Reinhardt, 1992). Infectious wastes have been described in many terms, the common terms used include: bio-hazardous waste, biological waste, medical waste, hospital waste, medical hazardous waste, infective waste, microbiological waste, pathological waste, and red bag waste.

Pathological waste, usually of human origin includes tissues, organs, and body parts removed during surgery or autopsy (Hall, 1989). Blood and blood products are generally thought to be very hazardous through the transmission of the Human Immunodeficiency and Hepatitis B viruses in blood. Sharps are waste materials, which are injurious to persons handling them. It can

be a cut or puncture on the skin by needles, broken glass, saws, nail, blades, scalpels etc. Sharps represent a special hazard due to their ability to penetrate and contaminate the individual handling them. Hershkowitz, (1990) suggested that sharps be placed in rigid, puncture-resistant containers, recapped and stored in safety boxes considerably out of reach of unauthorized staff.

Hazardous wastes are those that are majorly generated in the laboratory and contain toxic substances. Industrial and hospital waste is considered hazardous as they may contain toxic substances. Certain types of household waste are also hazardous. Hazardous wastes could be highly toxic to humans, animals, and plants, are corrosive, highly inflammable, or explosive; and react when exposed to certain things for example gases (Babatola, 2008*)*. Hospital waste are considered hazardous and nonhazardous.It has been reported that 75-90% of the waste produced by health care institutions is non-risk being generated from administrative and housekeeping/maintenance of health care establishment , the remaining 10-25% waste is regarded as 'hazardous' and may create a variety of health risks . According to WHO 85% of hospital waste is nonhazardous, 10% infective and remaining 5% non-infective but hazardous (WHO, 1999).

Environmental quality indicators were used to assess the environment's capacity for supporting human and ecological health. They can warn of impending environmental problems and enhance policymakers' and regulators' ability to manage and resolve these problems. They also may be used to gauge progress in meeting short- and long-term environmental goals. Environmental indicators are only as useful as the information on which they are based, and the measuring devices must be selected carefully. In most cases, indicators are applied for at least three years, so that trends may be examined. Some of the indicators include soil quality, water quality, air

quality, biodiversity and lots more (US EPA, 2006). This study seeks to explore how some biomedical waste affect the aesthetics of the surrounding environments of teaching hospital in Abuja municipal area with rapid urbanization and ever increasing population growth there has been a substantial increase in the generation of waste. The arising quality of life and high rates of resource consumption patterns have had an unintended and negative impact on the urban environment – generation of wastes far beyond the handling capacities of urban governments and agencies. Biomedical wastes are specifically of great concern in this era. It is the responsibility of waste generator to treat and dispose of the biomedical waste (Chitralekha and Agrawal, 2010).

Manyele, (2004) defined medical wastes as any solid waste generated in the diagnosis, treatment, or immunization of human beings or animals, as well as in related researches, production or testing of biologicals from all types of health care institutions, including hospitals, clinics, doctor offices and medical laboratories.

Waste management has continually generated global concern. Cities spend increasing resources to improve their practice. While the industrialized nations of the world are progressively solving their solid waste management problems, little progress is being recorded in most third world cities (Afon, 2005). There has always been the need for man to dispose of the waste generated in the course of his daily activities, and medical waste is part of the total waste streams generated in the built environment.

Although, medical waste represents a relatively small portion of the total waste generated in a community, medical waste management is considered an important issue worldwide (Cheng *et al*., 2009). Medical waste is infectious and hazardous. According to Becher and Lichtnecker

(2002), medical waste presents a high risk to doctors, technicians, sweepers, hospital visitors and patients due to arbitrary management.

Management of healthcare waste is very important for keeping living environment healthy. It has been reported that in UK in period of 1996 to 2004, 2140 people got occupational exposures to blood borne viruses. It has been found that 21% of the injuries occurred during the disposal process. As per study in Mexico city out of 69 interviewed waste handlers 34% (13) reported 22 needle stick injuries between them during the first 12 months and 96% had seen needles and syringes in waste .In Pakistan on average scavenger boys who were going through medical waste, for collection and resale, experienced three to five needle stick injuries a day (Acharya *et al,* 2014).

Medical care is vital for our life, health and wellbeing. But the bio medical waste generated from these activities can be hazardous, toxic and lethal. Because of their high potential for diseases transmission. In the process of health care, waste *et al* generated usually includes sharps, human tissues or body parts and other infectious materials (Baveja 2000). As a result of developing healthcare technology, the amount of hospital wastes being generated is increasing due to the use of more disposable products (Omrani 1998).

1.2. STATEMENT OF THE RESEARCH PROBLEM

The waste produced in the course of health care activities carries a higher potential for infection and injury than any other type of waste. It is essential to have reliable method for its safe handling and disposal (Omojasola, Adetitun, Oshin and Omojasola, 2009). Poor management of Biomedical Waste (BMW) have exposed medical staff, waste-handling workers and the

surrounding communities to infectious, toxic effects and injuries, a situation that poses a serious health problem in most developing countries of the world (WHO, 1999).

Management and disposalof Biomedical Waste (BMW) was considered an integral part of hospital hygiene and infection control (Ferreira and Veiga, 2003; Da Silva, Hoppe, Ravanello and Mello, 2005; Tudor, Noonan and Jenkin, 2005; Ndidi, Ochekpe, Odumosu and John, 2009; Abah and Ohimain, 2011; Ogbonna, 2011). Ubani (2004), Oke (2008), Farzadika, Moradi and Mohammadi (2009); Adegbita, Nwafor, Afon, Abegunde and Bamise (2010) revealed that BMW generated within a health care facility tended to follow an appropriate and well identified path from the point of generation to the final disposal. These paths were shown to comprise of several steps namely generation, sorting, collection and onsite transportation, on-site storage, offsite transportation and finally on or offsite treatment and disposal. Their report extended that poor sorting, handling and disposal practices of many hospitals, clinics and health centers in Nigeria revealed uncoordinated management practices that have posed serious health hazards to people living in the vicinity of health care institutions. In some cases, the institutions dispose all categories of hospital wastes to municipal dumpsites without pre-treatment. The nature and quantity of biomedical waste generated and the institutional practices towards their management (sorting and recycling) were found to be poorly examined and documented in our health care institutions in Nigeria despite the health risks posed by improper handling of biomedical wastes. Rhodes *et al.,* (2000) worked on contamination of water supply from untreated biomedical waste and reported that infectious stools and fluids are untreated and disposed of, these have created and spread epidemics in many parts of Africa. Waste water discharged from hospitals was found to drain in streams. Study by Srivastav, Mahajan and Mathur(2012) revealed that some hospitals did not have incinerators and existing ones were not designed for disposal of large quantities of

waste. Such types of incinerators become overloaded and triggered pollution and have posed risks to health of public, patients and professionals in the study area.

BMW contain plastics that emit dioxin when ignited. Similar report in 2004 indicated that untreated disposed syringes and needles have resulted to a rise in Hepatitis B, C and HIV among humans (WHO, 2002) . This observation is consistent with several studies (Allsopp, Costner and Johnson 2001; Echegaray, Rodriguez, Udaquiola and Hektor, 2002; Ndidi*et al.*, 2009; Ogbonna, 2011; Abah and Ohimain, 2011). When untreated wastes are washed into drainages, rivers and streams by surface wash have en-dangered human and aquatic lives. The concern about hazardous wastes may differ or have similar outcomes. This is because the harmful effects of some wastes may not be obvious while being used and /or before they are discarded.

Abuja, the Federal Capital Territory of Nigeria, is one of the fast growing cities in West Africa and is known to harbor various people from different walks of life; hence the need to maintain adequate health care delivery system in the study area cannot be overemphasized. Therefore, this study intends to assess the biomedical waste disposal and their effects on the environmental aesthetics of Tertiary Healthcare Centers (THCC) in Federal Capital Territory (FCT). Similar research have been conducted on this research such as environmental and health risk associated with bio medical waste management written by Nikos E. Mastorakis and group. This study is targeted at viewing the impact of BMW disposal on the environment through the following research questions;

1. What types of biomedical waste are generated in the THCCs in Federal Capital Territory?
2. What methods of biomedical waste disposal operate in the THCCs of the FCT?

3. How effective are the biomedical waste disposal methods in the THCCs of the FCT?
4. How do the methods of disposal affect the environmental aesthetics around the THCCs?
5. What are the perceptions of staff and patients on the disposal methods and the environmental aesthetics of the THCCs?

1.3. OBJECTIVES OF THE STUDY

The aim of the study is to assess the biomedical waste disposal methods on the environmental aesthetics of Tertiary Health Care Centers in the Federal Capital Territory, Abuja. Specifically, the study will be achieved through the following objectives:

i. Identify and characterize the categories of BMW generated in the hospitals.
ii. Examine the methods of BMW disposal in each of the THCCs.
iii. Examine the effectiveness of the BMW disposal methods in the hospitals.
iv. Examine the effects of BMW on the environmental aesthetics of the THCCs.
v. Examine and compare the perception of staff and patients on the disposal methods of BMW in the study area.

1.4. HYPOTHESIS

The study tested the following null hypotheses at $p \leq 0.05$ significant levels.

HO_1: There is no significant relationship between the perception of staff and patients on BMW disposal and the environmental aesthetics of the THCCs

1.5. JUSTIFICATION OF THE STUDY

This study has been designed to examine the disposal of Biomedical Waste and its effect on environmental aesthetics in the selected tertiary healthcare centers. There has been a steady increase in number of healthcare institutions across the country in conformity with population growth, thus, the quantity of biomedical waste generated is as well on the rise. Aside quantity, the composition of such waste is also changing thereby the need to re-visit management practices of Biomedical waste cannot be overlooked. Reports indicated that several hundreds of tonnes of BMW are deposited openly in waste dumps and in surrounding environments without being segregated (Alagoz and Kocasay, 2007; Abah and Ohimain, 2010).

The patients who were admitted in the hospitals are also exposed to risk associated with biomedical waste management, especially at the point of waste collection. Since, the patients are present at the primary point of waste generation and collection, there is therefore the need to examine the methods of waste collection, sorting and temporary storage in bins before evacuation for disposal. Olubukola (2009) showed that BMW management practices in Lagos is marred by poor waste sorting practices as well as lack of instructive posters on waste sorting. This thus strengthens the need to focus more attention on sorting of BMW generated in the study area. Research in the past has clarified that BMW contains hazardous materials that may expose patients particularly children and pediatric patients to infectious diseases and especially hepatitis and HIV/AIDS (WHO, 1999; 2002; Oke, 2008; PATH, 2009; Coker, 2009 and Adegbita*et al.*, 2010)

Biomedical waste is known to contain various materials some of which are harmful and can cause ill health to those involved in its handling and management. Environmental health workers and hospital management staff are especially concerned here, because they are responsible for management of such wastes. This study attempts to bring to fore the effectiveness of biomedical waste disposal methods and highlighted safety levels for environmental health workers and management staff. In the end, attempts were made to provide suggestions of effectiveness of disposal methods being employed by the hospitals and alternative methods that should also be considered.

The researcher has ascertained that similar study has been carried on in the study area in the past, therefore, the outcome of this study will serve as a tip of the iceberg that would encourage further research in similar topic as far as the study area is concerned.

Environmental Impact Assessment (EIA) workers and urban planners also stand to benefit from the outcome of this research by means of telescoping the methods of biomedical waste disposal and its impact on environmental aesthetics in the tertiary healthcare centers.

1.6. SCOPE OF THE STUDY

This study examined two tertiary health care centers located within the Federal Capital Territory (FCT), Abuja, which are the University of Abuja Teaching Hospital (UATH), Izom Road, Gwagwalada, Abuja, and The National Hospital, (TNH), Central Area, Abuja. This study was fashioned to focus on the hospitals' waste management with respect to waste handling, collection and sorting, temporary storage, treatment and recycling of biomedical wastes, as well as offsite

disposal. Also, the influence of the BMW on the aesthetics of the environment is brought to fore in this study.

The study area comprised of several departments namely General Pediatrics Out-Patient Clinic, General Adult Out-Patient Clinic and Staff Clinic), Ophthalmology (wards; Ophthalmic Surgery and Community Ophthalmology), Internal Medicine (wards; Dermatology, Cardiology, Nephrology, Endocrinology, Gastroenterology, Respiratory Medicine, Neurology and Infectious Disease) Obstetrics and gynecology and the department of Surgery.

The National Hospital (THN) Abuja is a multi-disciplinary tertiary hospital with several departments which are further subdivided into wards and units. Departments of interest and selected for this study are department of Ear, Nose and Throat, Obstetrics and Gynecology, Ophthalmology, Pediatrics, Physiotherapy, Radiotherapy and Oncology and Surgery department (units: General, Orthopedic, Neurosurgery and Spine)

CHAPTER TWO

CONCEPTS AND LITERATURE REVIEW

2.1. INTRODUCTION

Environmental challenges of 20th and 21st century indicate that waste in whatever form or classification solid, liquid or gaseous have become a major consequence of modernization and economic development (Tsiboe and Marbell, 2004). In the quest for 'Western-styled' development, humanity did not budget for the problems related to the management of waste. This chapter therefore explores literature on biomedical waste management. It examines key concepts such as, waste, biomedical waste as well as the concept of environment. The chapter further review relevant literature related to the subject matter of this study.

2.2. CONCEPTUAL ISSUES

2.2.1. Waste

Useless, cannot be used, not wanted, these are some of the dictionary meanings of waste. It can be in a solid, liquid or in a gaseous form. A product, material or container is not considered waste until someone throws it away. Waste is more easily recognized than defined. Something can become waste when it is no longer useful to the owner or it has been used for purpose it was

meant to serve (Gourlay, 1992 cited by Freduah, 2004). There are basically three types of waste namely liquid, gaseous and solid. But for the purpose of the study, the focus is on biomedical waste.

2.2.2. Biomedical Waste (BMW)

Biomedical waste is defined as any solid, fluid or liquid waste including container and any intermediate product, which is generated during diagnosis, treatment or immunization of human beings or animals or in research activities or in the production or testing of biological products [Biomedical Waste (Management and Handling) Rules 1998]. Biomedical wastes are generated primarily from health care establishments including hospitals, nursing homes, veterinary hospitals, clinics and general practitioners, dispensaries, blood banks, animal houses and research institutes. Other sources of biomedical waste are: households, industries, education institutes and research centers and clinical laboratories (Babu*et al*., 2009).

In hospitals, health care wastes generation varies considerably depending on numerous factors, such as established waste management methods, type of health-care facility, the proportion of patients treated daily, the degree of specialization of the health facility. For a correct estimation of the waste production, the following parameters need to be considered: number of hospital beds; number of in-patients and out-patients; range of services provided; and any other activity causing health care wastes generation.

Hospital wastes include different kinds of wastes such as infectious, radioactive, chemical, heavy metals and regular municipal wastes (DoE, 1998). Wastes targeted for precautions during handling and disposal include sharps (needles or scalpel blades), pathological wastes (anatomical body parts, microbiology cultures and blood samples) and infectious wastes (items contaminated with body fluids and discharges such as dressing, catheters and intravenous lines). Other wastes generated in healthcare settings include radioactive wastes, mercury containing instruments and polyvinyl chloride (PVC) plastics. These are among the most environmentally sensitive by-products of healthcare (Remy, 2001). WHO (1999, 2001, 2004) stated that 85% of hospital wastes are actually nonhazardous, around 10% are infectious and around 5% are non-infectious but hazardous wastes. In the USA, about 15% of hospital waste is regulated as infectious waste. In India this could range from 15% to 35% depending on the total amount of waste generated (Glenn and Garwal, 1999).

Biomedical waste can be categorized based on the risk of causing injury and/or infection during handling and disposal. Table 1 presents a simplified medical waste classification adapted from WHO, (2005).

2.3. REVIEW OF LITERATURE

2.3.1. BIO-MEDICAL WASTE AND MUNICIPAL WASTE MANAGEMENT

With the steady increase in the number of health care institutions, the amount of biomedical waste, (BMW) generated is also increasing. In addition to increasing quantity, the composition of BMW is also rapidly changing, affecting its sound management. The improper management of BMWs generated in health care facilities can adversely affect the health of health care providers, patients, waste handlers and individual members of the community. It also has

adverse impacts on the environment. Hospital Waste Management is part of hospital hygiene and maintenance activities. This involves management of a range of activities, which are mainly engineering functions, such as collection, transportation, operation/treatment of processing systems, and disposal of waste. However, initial sorting and storage activities are the direct responsibility of nursing personnel in the hospital.

Since majority of the health care establishments are located within the municipal area, their waste management naturally has a close linkage with the municipal system. At the same time, the civic authority is responsible for public health in the whole of the municipal area. Therefore, the health care establishments must have a clear understanding with the municipality regarding sharing of responsibilities associated with this issue. Studies have shown that about three fourth of the total hospital waste is not hazardous/infected (provided strict sorting is practiced) and can even be taken care of by the municipal waste management system, e.g., waste generated at the hospital kitchen or garden, the office or packaging material from the store etc. Such practices of strict and careful sorting would reduce the load and the cost of management of the actually hazardous and infected bio-medical waste (collection, transportation, treatment and disposal). Since, it would not be possible for each and every health care establishment to have its own full-fledged treatment and disposal system for bio-medical waste, there would be need for common treatment and disposal facilities under the ownership/supervision/guidance of the civic authority (Baveja et al 2000). From the above mentioned issues, it is clear that the success of the biomedical waste management program depends on proper in-house management (within the health care establishment) and co-ordination and co-operation amongst the various establishments themselves as well as with the civic authority.

2.3.2. Impact of Biomedical Waste on Human Health

According to the WHO (1999), the global life expectancy is increasing year after year. However, deaths due to infectious diseases are increasing. A study conducted by the WHO in 1996, reveals that more than 50,000 people die every day from infectious diseases. One of major causes for the increase in infectious diseases is improper waste management. List of infections and diseases documented to have spread through bio-medical waste. Tuberculosis, pneumonia, diarrhoeal diseases, tetanus, whooping cough etc., are other common diseases spread due to improper waste management (Chitins *et al*, 2002; Chitins *et al*, 2003; Tudor *et al*, 2005; Marinkovic*et al*, 2005). Occupational health concerns exist for janitorial and laundry workers, nurses, emergency medical personnel, and refuse workers. Injuries from sharps and exposure to harmful chemical waste and radioactive waste also cause health hazards to employees in institutions generating bio-medical waste. Proper management of waste can solve the problem of occupational hazards to a large extent (Patil&Shekar, 2001)

A study conducted in Lagos by Olubukola (2009) shows that BMW management practices is marred by poor waste sorting practices as well as lack of instructive posters on waste sorting and disposal of general wastes. Sorting of wastes according to Ndidi, Ochekpe, Odumosu and John (2009); Abah and Ohimain (2011) would result in a clean solid waste stream which could be easily, safely and cost effectively managed through recycling, composting and land filling. The nature and quantity of BMW generated in these hospitals makes it very imperative to employ waste sorting because of the health risks posed by the improper handling of BMW (Oke, 2008; Farzadika*et al.*, 2009; Abah and Ohimain, 2011; Ogbonna, 2011). (WHO, 1999; 2002; Oke, 2008; PATH, 2009; Coker, 2009; Adegbita*et al.*, 2010). Further reports also indicate that several

hundreds of tonnes of BMW are deposited openly in waste dumps alongside non-hazardous solid wastes are surrounding the environments (Alagoz and Kocasay, 2007; Abah and Ohimain, 2010). This practice is characterized by lack of proper education on waste minimization or waste reduction strategies in health care institutions. Therefore good sorting practice will ensure a reduction in the quantity medical waste which is more expensive to manage. The absence of waste sorting according to Abah and Ohimain (2011) imply that the estimates of the various waste categories may not be precise; nonetheless it provides a useful guide for the assessment of the different waste streams generated which are hazardous in nature requiring special handling to avoid health consequences.

The health hazards due to improper waste management affect not only hospital occupants; they can also spread in the vicinity of a hospital. Occupational health concerns exist for janitorial and laundry workers, nurses, emergency medical personnel, and waste handlers. Injuries from sharps and exposure to harmful chemical waste and radioactive waste can also pose health hazards to workers. The problem of occupational health hazards arising from medical waste is not well publicized as there is a lack of information. Pathogens present in waste can enter, and remain in the air within the hospital for a long period, in the form of spores or as pathogens themselves. This can result in hospital-acquired infections (nosocomial infections) or occupational health hazards. Patients and their attendants also have a chance of contracting infections caused by airborne pathogens or spores (Manyele, 2004). The routes of health care workers' exposure to hazardous substances contained in hospital waste include ingestion (swallowed material), inhalation (airborne chemicals and pathogens), and dermal absorption or through skin openings. Due to the structure of the human lung, the body's retention capacity for airborne particulates that carry toxic chemicals and pathogens is highly dependent on particle size. Dermal absorption

can be enhanced by scratched, broken, roughened or abraded surfaces of the skin on the ankles, hands, neck or facial areas. The worker's face or hands are the most affected skin areas. Water-soluble toxic chemicals can be absorbed throughout the body since the human metabolism operates on a water-based chemistry. Drinking and eating in hospitals must be done in well-controlled areas.

There are many harmful agents in the biomedical waste. The most important are Biological agents, which pollute water and food and cause alimentary infections like cholera, typhoid, dysentery, infective hepatitis, polio, ascariasis and hook worm diseases etc. Wastes breed vermin and pests. Examples are mosquitoes that transmit insect borne diseases like malaria and filarial, common house flies which transmit infections mechanically, many other insects and worms that cause nuisance e.g. cockroaches, ants, rats thriving on refuse. Dust may harbor Tubercle Bacilli and other germs, which cause diseases if inhaled. Soil polluted by night soil may be rich in Tetanus spores. Nosocomial infections and AIDS, Hepatitis B&C etc. (Yadav, 2001)

Health care resources are potentially dangerous micro-organisms that can infect hospital patients, personnel and general public. Risks of trauma and infections are many different exposure ways through injury, cut, and prick, through contact with the skin or mucous membrane, through inhalation or through ingestion. We are discussing some of the infections that can be caused by hazardous medical waste. Gastrointestinal infection that can be due to infective agent enterobacteria and transmission agent is faeces, vomit etc. Respiratory infections occur due to infective agent like mycobacterium tuberculosis, SARS (Severe Acute Respiratory Syndrome) Virus and the transmission agent of this infection is inhaled secretions, salvia etc. Eye infections are due to herpes virus and in this case transmission agent is eye secretions. Eye infections are due to infection agent streptococcus and the transmission agent is pus. AIDS are due to Human

immune Deficiency Virus and the transmission agents are Blood, sexual secretions, and other body fluids. Hemorrhagic fever is due to presence of Marburg and Junin virus is blood and secretions. Viral hepatitis A, B and C occurs due to Hepatitis A, B and C viruses and the transmission agents in this case can be faeces, blood and other biological fluids. As regards viral infections the nursing staffs are most at risk of infection through contaminated needles. According to world health organizations in 2000 that world level accidents happened due to sharps are very large 66,000 cases of infections with the Hepatitis B virus. While 16,000 cases of infections for Hepatitis C virus (Sharma, 2013).

Survival of the Pathogenic microorganism depends on the environmental conditions (temperature, humidity, organic solvents, presence of disinfectants etc.). Bacteria are less resistant than viruses. Hepatitis B virus survival depends on the conditions such as several weeks on a surface in dry air and minimum of one week at normal temperature, while several weeks on dried blood. HIV remains 3-7 days in ambient air and 21 days in 2µl of blood at ambient temperature and this virus becomes inactivated at 56ºC. In general however the survival time of microorganism present in medical waste is short probably because the waste contains the disinfectants. The role played by carriers such as rats and insects must also be taken into account in the evaluation of survival of microorganism time. They are passive carriers of pathogens and measures must be taken to control their proliferation. Since exposure conditions are same for employees dealing the house hold refuse and those dealing with medical waste. High income countries have shown the following impacts compared to the general population, in the case of persons employed in the processing of house hold waste. The risk of infection is 6 times higher and the risk of contracting an allergic pulmonary disease is 2.5% higher as well as the risk of contracting hepatitis is 1.2 times higher. Pulmonary diseases and bronchitis diseases are caused

by the exposure to the bio-aerosols contained in the air at the sites where refuse is dumped, stored or processed. Other impact on health care activities may be arises due to many chemicals and pharmaceutical products are used in health care facilities. Most chemicals have the nature of toxic, carcinogenic, mutagenic, irritant, explosive, flammable, corrosive etc. Various exposure routes for contact with these substances: inhalation of gas, vapor or droplets contact with skin. Some substances (chlorine and acids) are incompatible and can generate toxic gases when mixed. In general cleaning products and, in particular, disinfectants are examples of dangerous chemicals which are used in large quantities in hospitals and some disinfectants (such as formaldehyde) can be sensitizing or toxic (Sharma, 2013).

As regards aesthetics, sullage water, refuse and night soil, all create intolerable nuisance of sight and smell.

2.3.3. Impact of Biomedical Waste on the Environment

By environment, the study refers to all of the external factors affecting an organism. It could also mean all the circumstances, people, things, and events around an organism, a person, a community, etc. that influence an organism's life. These factors or circumstances may be other living organisms (biotic factors) or nonliving variables (abiotic factors), such as temperature, rainfall, day length, wind, and ocean currents. The interactions of organisms, people, societies, etc. with biotic and abiotic factors form an ecosystem, a community, an environment, etc. Even minute changes in any one factor in an ecosystem, a community, etc. can influence whether a particular person, plant or animal species will be successful in its environment or not (Oyeniyi, 2011).

Hospital waste is potentially dangerous, since it may possess pathogenic agents. Some of the pathogenic organisms are dangerous, because they may be resistant to treatment and possess high

pathogenicity. Inadequate waste management will cause environmental pollution, unpleasant smell, growth and multiplication of insects, rodents and worms and may lead to the transmission of diseases like typhoid, cholera, hepatitis and AIDS through injuries from syringes and needles contaminated with human blood (Henry and Heinke 1996).

The inefficient handling of biomedical waste is more likely to cause problems such as blood borne pathogens to the groups at highest risk, namely; healthcare staff, scavengers, and municipal workers (from needle sticks for example, if the biomedical wastes are handled and disposed together with domestic wastes).There is particular concern about infection with human immunodeficiency virus (HIV) and hepatitis viruses B and C, for which there is strong evidence of transmission via healthcare waste (WHO 1999). The general public's health is adversely affected by biomedical waste. Improper practices such as dumping of biomedical waste in municipal dustbins, open spaces, water bodies' etc. lead to the spread of diseases. Emissions from incinerators and open burning also lead to exposure to harmful gases which can cause cancer and respiratory diseases (Manohar*et al*, 1998; Da silva*et al*, 2005). Plastic waste can choke animals, which scavenge on openly dumped waste. Injuries from sharps are common feature-affecting animals. Harmful chemicals such as dioxins and furans can cause serious health hazards to animals and birds. Certain heavy metals can affect the reproductive health of the animals (Code &Christic, 1999).

Collection and disposal of waste in the proper manner is of great importance as it can decrease directly and indirectly health risks to people and damage to flora, fauna, and the environment (Centers for Disease Control and Prevention 2001).

Environmental aesthetics is a relatively new sub-field of philosophical aesthetics. It arose within analytic aesthetics in the last third of the twentieth century. Prior to its emergence, aesthetics within the analytic tradition was largely concerned with philosophy of art. Environmental aesthetics originated as a reaction to this emphasis, pursuing instead the investigation of the aesthetic appreciation of natural environments. Since its early stages, the scope of environmental aesthetics has broadened to include not simply natural environments but also human and human-influenced ones. At the same time, the discipline has also come to include the examination of that which falls within such environments, giving rise to what is called the aesthetics of everyday life. This area involves the aesthetics of not only more common objects and environments, but also a range of everyday activities. Thus, early in the twenty-first century, environmental aesthetics embraces the study of the aesthetic significance of almost everything other than art (Allen, 2011).

Aesthetics is, among other things, a philosophical discipline that concerns the fine arts and problems connected with artistic understanding in general, that is art philosophy. The term ‘aesthetic’ is a Germanic form of the Greek term ‘aisthesis’. The Latin term ‘aesthetica’ can be translated as perception, sense, feeling, awareness, knowledge of the fine arts, and the standards used to understand them. In this study, the idea is used to describe the qualities of the surroundings that might influence the health and wellness of patients and of the professional health-care personnel. Analysis of the workplace and the work environment is often dominated by traditional scientific evaluations, logical rational analyses that ignore the aesthetic dimension (Strati, 1998).

Aesthetically pleasing surroundings will improve a person's affective condition and contribute to a feeling of well-being (Ulrich, 2001; Fjeld, 1998; Ulrich, 1991). Therefore, aesthetics has great importance, perhaps more than we imagine.

Leisure activities such as gardening and spending time outdoors engage us more intimately, more concretely, with a range of environments, and aesthetic experience lies at the heart of many of these experiences. Qualities such as tranquility and beauty are appreciated for themselves but also for their relaxing and emotionally uplifting effects. These are strong reasons to protect both wild and other green spaces, and some conservationists are already using these reasons to argue for new management policies (Brady, 2006).

Biomedical waste if improperly handled would bring about adverse effect to the environment of any healthcare establishment, especially on environmental aspects of color, design, food, plants and structural harmony (Caspari*et al*, 2006). Improper waste handling and disposal would directly result in destruction of environmental aesthetics in our hospitals (Wikström, 2012).

High-quality holistic health care has as its goal the maintenance of all areas that influence health. High-quality implies that the aesthetic aspect should also be taken into consideration. The abstract, theoretical, and ideal are as important as the concrete, measurable, and observable in holistic health care. Art captures, expresses and recreates humanity and life, in all its diverse forms. Art is the life's spirit, the soul seeks beauty (Ulrich, 1984). Some hospitals are attentive to the aesthetic aspects of the environment and have a concrete plan to address them. Others seem to have no understanding of its importance. The decisive factor is not necessarily economic. The prevailing philosophy and ideology of the hospital administration and its employees can be equally important. There is a great deal of knowledge of and research undertaken today

regarding different areas of aesthetics. The significance of colors and their influence on an individual exemplifies an area in which it is important that the decisions made are not arbitrary, but are based on existing research and knowledge.

There is an emerging interest in the impact of aesthetic deprivation in everyday life. The philosopher Yuriko Saito has been a leader in philosophical and practical approaches to everyday aesthetics, and suggests that seemingly insignificant everyday aesthetic preferences and decisions are more significant than experiences of high art in forming and informing one's identity and view of the world. Saito argues that more attention to the beauty of everyday objects can enhance our appreciation of them and our environment. Thus, attention to everyday aesthetics, such as food, the texture of bed sheets, crockery, and interior design, could be more important to patients than introducing the fine arts to the health-care setting. A series of studies by Caspari and colleagues in Norway highlighted that there were few concrete guidelines or directions for the aesthetic aspects of hospitals, whilst another survey suggested that many patients were dissatisfied with the provision for choosing different kinds of aesthetic input in hospitals (Caspari et al, 2006).

2.3.4. Impact of Biomedical Waste on the Air Quality

Air pollution can be caused in both indoors and outdoors atmosphere. Biomedical waste that generated by air pollution are been classified in three types namely-Biological, Chemical and radioactive.

Pathogens present in the waste can enter and remain in the air for a long period in the form of spores or as pathogens. Sorting of waste, pre-treatment at source etc., can also reduce this

problem to a great extent. Sterilizing the rooms will also help in checking the indoor air pollution due to biological (Askarian*et al* 2004; Baveja*et al* 2000). The indoor air pollution caused due to the above chemicals from poor ventilation can cause diseases like Sick Building Syndrome (SBS). Proper building design and well-maintained air conditioners can reduce the SBS.

Outdoor air pollution can be caused by pathogens. The biomedical waste without pre-treatment if transported outside the institution, or if it is dumped in open areas, pathogens can enter into the atmosphere. Chemical pollutants that cause outdoor air pollution have two major sources-open burning and incinerators. Open burning of bio-medical waste is the most harmful practice. When inhaled can cause respiratory diseases. Certain organic gases such as dioxins and furans are carcinogenic (Burd 2005). The design parameters and maintenance of such treatment and disposal technology should be as per the prescribed standards (Bdour 2004).

2.3.5. Impact of Biomedical Waste on the Water

The liquid waste generated when let into sewers can also lead to water pollution if not treated properly (Rao, 1995; Rao &Garg, 1994). Water pollution can alter parameters such as pH, BOD, dissolved oxygen (DO), COD, *etc*. There are instances where dioxins are reported from water bodies near incinerator plants. Dioxins enter the water body from the air (Chitins *et al*, 2000; Ravikant*et al*, 2002; Saini and Dadhwal 1995). Radioactive waste in liquid form can come from chemical or biological research, from body organ imaging, from decontamination of radioactive spills, from patient's urine and from scintillation liquids used in radioimmunoassay. Under normal circumstances, urine and faeces can be handled as no radioactive waste so long as the patient's room is routinely monitored for radioactive contamination (Patil and Pokhrel, 2004; Shah *et al*, 2001).

2.3.6. Impact of Biomedical Waste on the Land

Soil pollution from bio-medical waste is caused due to infectious waste, discarded medicines, chemicals used in treatment and ash and other waste generated during treatment processes. Heavy metals such as cadmium, lead, mercury etc., which are present in the waste will get absorbed by plants and can then enter the food chain. Nitrates and phosphates present in leachates from landfills are also pollutants. Excessive amounts of trace nutrient elements and other elements including heavy metals in soil are harmful to crops and are also harmful to animals and human beings (Mehta 1998). Minimizing the waste and proper treatment before disposal on land are the only ways of reducing this kind of pollution (Silva *et al* 2005).

2.3.7. Need for Biomedical Waste Management

Management of BMW is needed due to health, Environmental, legal and aesthetic reasons in addition to Ethical reasons. The ethical aspect related to the social responsibilities, which the health professions have, as a result of their status, knowledge and skills and an obligation to alert those who are at risk. This is reflected by the compulsory notification of infectious and notifiable diseases as a measure of public welfare. As regards Biomedical Waste management health professionals, bear a responsibility to act in such a way to prevent exposure to various health hazards and exposures to dioxins. As Biomedical Waste are the major source of dioxine production during open dumping/burning, which are generally cause of incurable cancers, the Medical ethics dictate that prevention must be carried out as we all are bound by Hippocratic oath (Yadav,2001).

The Common Biomedical Wastes Treatment Facility (CBMWTF) is a functional waste management model which covers the responsibilities of healthcare facilities to collect biomedical wastes, treat the wastes and also provide sites for setting up of incinerator. The owners of CBMWTFs are service providers, who are providing services to health care units for collection of BMWs for its final disposal to their site. The components of a common biomedical waste treatment and disposal facility (CBMWTFs) are autoclave, shredder, compactor, and incinerator for anatomical waste, secured landfill facility, laboratory and vehicles for transportation of wastes.

The most frequently used practice of treating and disposing of medical waste was the use of private haulers that transport medical waste to treatment facilities (61.5%). The next most frequently reported techniques were pouring into municipal sewage (46.6%), depositing in landfills (41.6%), and autoclaving (32.3%). Other methods adopted by hospitals included Electro-Thermal-Deactivation (ETD), hydropulping, microwaving, and grinding before pouring into the municipal sewer. Most hospitals in Oregon and Washington no longer operate their incinerators due to more stringent regulations regarding air pollution emissions. Some hospitals however, still operate incinerators in the absence of state regulations specific to these types of facilities.

2.3.8. Collection and Sorting of Biomedical Waste

Biomedical Waste should be segregated at source of generation and collected in prescribed color-coded bins according to Yadav (2001). The dustbin, which serves as container for collection of wastes should be light with a cover and size enough to be carried by a person. Inner

plastic bag is also used to facilitate the lifting of waste content for transferring coloured bags/dustbins should be placed in different parts of the hospital.

Sorting and collection both can be considered as being complementary to each other. If containers are transported inside the premises for treatment then it shall be labelled, but if a container is transported outside the premises, where Biomedical Waste treatment facility is not present, the containers shall, also carry information prescribed.

Biomedical waste like sharps should be contained in leak proof, rigid, puncture- and break-resistant containers that are tightly lidded and labelled before storage, transport or disposal. Biomedical waste excluding sharps should be placed in leak proof plastic bags strong enough to prevent tearing, ripping and bursting open under normal conditions. The container holding the biomedical waste should be labelled with the international biohazard symbol (Chitralekha and Agrawal, 2011).

Sorting means separation of different types of wastes by sorting or the systematic separation of Biomedical Waste into designated categories. It is the most important step in the entire process of Biomedical Waste management. Special attention is needed to be given to the relatively small quantities of infectious and hazardous waste, thereby reducing not only the risks but the cost of handling, treatment and disposal. For example if general waste gets mixed with infectious waste, the whole waste has to be incinerated which may prove to be costly (Yadav M, 2001).

2.3.9. Transporting Biomedical Waste

On-site transport is done by use of different means of conveyance inside the facility – wheelbarrows, containers on wheels, carts, to the site of storage of the waste. Inside the facility,

wastes must be transported during slacker periods, i.e. periods of less human traffic in the hospital. The itinerary must be planned so as to avoid any exposure of staff, patients or the general public. It must run through as few clean zones (sterilization rooms), sensitive areas (operating theatres, intensive care units) or public areas as possible (ICRC, 2011).

Transportation of Bio-Medical wastes can be done by Carts and containers that are not used for any other function. The trolleys have to be cleaned each day. Offsite carrying vehicle should be marked with the name and address of transporter. Biohazard sign should be dyed. Appropriate system for securing the weight during transport should be ensured. Such a means of transport should be easily cleanable with rounded corners. All disposable plastic should be subjected to shredding before disposing off to vendor. No unprocessed bio-medical waste store more than 48 hours (Singh, 2014).

2.3.10. Storage of Biomedical Waste

Waste accumulation and storage is basically done in the areas and steps between the point of waste generation and location of waste treatment and disposal. Though accumulation refers to the temporary holding of small quantities of waste near the point of generation, storage of waste is categorized by longer holding periods and large waste volume. Storage areas are generally located near where the waste is treated. Any offsite holding of waste is also considered storage (Singh *et al.*, 2014).

Different types of containers are used for collection of waste. The containers or bins should be positioned in such a way that 100 % gathering is achieved. Sharps must be kept in puncture-

proof containers to keep away injuries and infection to the employees handling them. Once collection has done, then biomedical waste is stored in an appropriate place (Singh *et al.*, 2014).

Biomedical waste storage areas must be away from general traffic flow patterns and must be clearly labeled. Biohazard warning signs must be used on storage areas to signify the presence of biological hazards and to indicate precautions to be taken. Biomedical waste storage areas must be maintained in a sanitary condition at all times. They must be capable of protecting the integrity of the waste containers and allow adequate space for inspection of the area and the containers (The University of Maine, 2009)

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2.3.11. Biomedical Waste Disposal Strategies

Handling, sorting, disinfection, storage, transportation and final disposal are vital steps for safe and scientific management of biomedical waste in any healthcare establishment (Acharya and Meeta 2000). Biomedical waste can be managed properly by ensuring proper sorting at the source, the use of accurate packaging (leak resistant, puncture resistant and not susceptible to degradation by cleaning agents in case the packaging is reused), appropriate color coding, proper in-house movement of waste (minimizing employee exposure to biomedical waste in a workplace), designating waste storage areas and ensuring safe disposal.

The working group on Hospital Waste Management constituted by WHO in 1983, was unanimously agreed upon that health care establishments should be held legally accountable for their waste management practices, based on the universal principle that the "generator is responsible". As far as possible the "cradle to grave" system of notification should be followed,

which implies that all stages of waste disposal are systematically controlled. The need for and nature of the control measures must be an integral part of overall hazardous waste management policy (Yadav, 2001). Some of the strategies for biomedical waste management are discussed below.

2.3.11.1. Shredding

Shredding is a process by which wastes are fragmented or cut into smaller pieces so as to make the wastes unrecognizable. It helps in prevention of reuse of bio-medical waste and also acts as identifier that the wastes have been disinfected and are safe to dispose of. A shredder is to be used for shredding in bio-medical waste with minimum requirements (Singh & Sharma 1996; Shah *et al*, 2001; Rasheed *et al*, 2005).

2.3.11.2. Incineration

It is a controlled combustion process where waste is completely oxidized and harmful microorganisms present in it are destroyed/denatured under high temperature. Incineration is popular in countries such as Japan where land is a scarce resource, as they do not consume as much area as a landfill. Sweden has been a leader in using the energy generated from incineration over the past 20 years. Denmark also extensively uses waste-to-energy incineration in localized combined heat and power facilities supporting district heating schemes (Gupta, 1998).

Incineration is a high temperature thermal process involving combustion of the waste under controlled condition for converting them into inert material and gases. Incinerators can be oil fired or electrically powered or a combination thereof. On a broader front, three types of

incinerators are used for hospital waste: multiple hearth type, rotary kiln and controlled air types. All the types can have primary and secondary combustion chambers to ensure optimal combustion. In the multiple hearth incinerator, solid phase combustion takes place in the primary chamber whereas the secondary chamber is for gas phase combustion. They are referred to as excess air incinerators because excess air is present in both the chambers.

2.3.11.4. Autoclaving

Autoclaving is a low-heat thermal process where steam is brought into direct contact with waste in a controlled manner and for sufficient duration to disinfect the wastes. For ease and safety in operation, the system should be horizontal type and exclusively designed for the treatment of bio-medical waste. For optimum results, pre-vacuum based system is preferred against the gravity type system. It shall have tamper-proof control panel with efficient display and recording devices for critical parameters such as time, temperature, pressure, date and batch number etc (NEERI 1995, Bacini& Brunner, 1991; Prus*set al,* 1999).

Autoclave Treatment is a process of steam sterilization under pressure. It is a low heat process in which steam is brought into direct contact with the waste material for duration sufficient to disinfect the material. There are also of three types: gravity type, pre-vacuum type and retort type. In the Gravity type, air is evacuated by help of gravity alone. The system operates at

temperature of 121 degrees C and steam pressure of 15 psi for 60-90 minutes. In the Pre-vacuum type, vacuum pumps are used to evacuate air from the pre-vacuum autoclave system so that the time cycle is reduced to 30-60 minutes. It operates at about 132 degrees C. The Retort type autoclaves are designed to handle much larger volumes and operate at much higher steam temperature and pressure. Autoclave treatment is recommended for microbiology and biotechnology waste, waste sharps, soiled and solid waste.

2.3.11.5. Solar Disinfection

Chitnis*et al* (2003) assessed solar heating as an alternative technology for Open dumping/burning. They immersed infectious medical waste with heavy load of bacteria (108 to 109/g) in water in a box-type solar cooker, which was left in the sun for 6hr and the amount of viable bacteria was reduced by 7 log. The results indicated that solar heating to be a cheap method to disinfect infectious medical waste in less economically developed countries.

Spiewak*et al* (1998) explored the use of concentrated sunlight combined with dissolved photocatalysts to improve water quality. Initial experiments with bromacil using organic-dye photosensitizers indicated that the reaction kinetics was enhanced by concentrated light. Other pesticides (EPTC, Tribufos, Atrazine and Lindane) were also tested in normal and concentrated sunlight. Organic dyes were effective in degrading some of these compounds but did not appear to be promising for complete mineralization. Reaction rates were approximately proportional to sunlight intensity. The photoefficiency of reaction was in a range high enough to indicate that visible light, as well as UV, was participating in the photoreactions.

Solarisation does not destroy only soil microorganisms, but modifies the microbial balance in favour of beneficial microorganisms. Indeed, many papers report situations where the efficacy of soil solarisation is not only due to a decrease in the pathogenic populations but also to an increase in the density and activity of populations of microorganisms antagonistic to pathogens.

2.3.11.6. Microwaving

Microwave treatment is a wet thermal disinfection technology but unlike other thermal treatment systems, which heat the waste externally, microwave heats the targeted material from inside out, providing a high level of disinfection. Powered by electricity, the unit shreds the waste in a controlled environment; the waste then enters the chamber for exposure to the microwaves. The disinfection process takes place through microwave heating and wetting and shredding the waste to facilitate heating and steam penetration of the waste. The material is discharged to a storage bin for ultimate disposal. Microwave technology has certain benefits, such as, absence of harmful air emissions, no requirement of chemicals, and reduced volume of waste.

Microbial inactivation occurs as a result of the thermal effect of electromagnetic radiation spectrum lying between the frequencies 300 and 300,000 MHz. Microwave heating is an inter-molecular heating process. The heating occurs inside the waste material in the presence of steam (Pruthvish*et al,* 1998).

2.3.11.7. Hydroclaving

Hydroclave Treatment is based on an innovative equipment named Hydroclave, for steam sterilization process (like autoclave). Hydroclave is a double walled container in which the steam is injected into the outer jacket to heat the inner chamber containing the waste. Moisture

contained in the waste evaporates as steam and builds up the requisite steam pressure (35-36 psi). Sturdy paddles slowly rotated by a strong shaft inside the chamber tumble the waste continuously against the hot wall thus mixing as well as fragmenting the same. In the absence of enough moisture, additional steam is injected. The system operates at 132 degrees C and 36 psi steam pressure for sterilization time of 20 minutes. The total time for a cycle is about 50 minutes, which includes start-up, heat-up, sterilization, venting and depressurization and dehydration. The treated material can further be shredded before disposal. The expected volume and weight reductions are up to 85% and 70% respectively. The Hydroclave can treat the same waste as the autoclave plus the waste sharps (also fragmented). This technology has certain benefits, such as, absence of harmful air emissions, absence of liquid discharges, non-requirement of chemicals, reduced volume and weight of waste etc

Thisis similar to autoclaving except that the waste is subjected to indirect heating by applying steam in the outer jacket. The waste is continuously tumbled in the chamber during the process.

Hydroclave treatment is based on an innovative equipment named Hydroclave, for steam sterilization process (like autoclave). A Hydroclave is a double walled container in which the steam is injected into the outer jacket to heat the inner chamber containing the waste. Moisture contained in the waste evaporates as steam and builds up the requisite steam pressure.

2.3.11.8. Mechanical/Chemical Disinfection

This represents a technology which has been available since ages and is referred to as “mechanical/chemical” because of mechanical maceration and chemical disinfection (a result of a reaction that occurs to volatilize waste material and expose of the pathogens to a chemical

disinfectant in a controlled environment). Chemical disinfecting process is a treatment recommended for waste sharps, solid and liquid waste as well as chemical wastes. Chemical treatment involves use of at least 1% hypochlorite solution with a minimum contact period of 30 minutes or other equivalent chemical reagents, such as, phenolic compounds, iodine, hexachlorophene, iodine-alcohol or formaldehyde-alcohol combination. A number of factors should be considered regarding the effective use of chemical disinfection, including: the types and biology of microorganisms in the wastes; degree of contamination; type of disinfectant used and its concentration and quality; the contact time (Bulucea, Popescu and Patrascu, 2008).

Other disinfectants used are as follows: lime, ozone, ammonium salts and peracetic acid. Formaldehyde, glutaraldehyde and ethylene oxide must no longer be used because of their toxicity (carcinogenic or sensitizing properties). All strong disinfectants irritate the skin, eyes and respiratory system. They must be handled with caution – in particular, personal protective equipment must be used – and they must be stored correctly. Solid medical waste can be chemically disinfected, but they must first be shredded. This practice poses a number of safety problems, and the wastes are only disinfected on the surface. Thermal disinfection must be preferred over chemical disinfection for reasons of effectiveness and for ecological reasons.

Chemical processes employ disinfectants such as dissolved chlorine dioxide, bleach (sodium hypochlorite), per acetic acid, or dry inorganic chemicals. To enhance exposure of the waste to the chemical agent, chemical processes often involve shredding, grinding, or mixing. In liquid systems, the waste may go through a dewatering section to remove and recycle the disinfectant. Besides chemical disinfectants, there are also encapsulating compounds that can solidify sharps, blood, or other body fluids within a solid matrix prior to disposal. One developing technology

uses ozone to treat medical waste, and others utilize catalytic oxidation. A novel system uses alkali to hydrolyze tissues in heated stainless steel tanks.

2.3.11.9. Sanitary and Secured Land filling

Thisis necessary under certain circumstances, including;

- ✓ deep burial of human anatomical waste, when the facility of proper open dumping/burning is not available – Secured landfill
- ✓ disposal of animal waste
- ✓ disposal of autoclaved / hydroclaved / microwaved waste – Sanitary landfill;
- ✓ disposal of open dumping/burning ash – Sanitary landfill;
- ✓ disposal of sharps – Secured landfill.
- ✓ General Waste such as the waste material generated from the office, kitchen, garden, store etc., which are nonhazardous and non-toxic (Bulucea, Popescu and Patrascu, 2008).

After regulated medical waste is treated in a non-open dumping/burning technology and rendered unrecognizable (especially if required by law), the treated waste is generally discarded in a sanitary landfill. The treated waste should not be burned in an incinerator. In many cases, facilities mix their treated (non-infectious, non-hazardous) wastes with regular trash and send them to the municipal solid waste landfill. However, some landfill operators may charge a higher tipping fee for treated waste that originated from regulated medical waste. In those cases, commingling regular trash with the treated waste could result in higher disposal costs. Others may require a certificate of treatment as documented proof that the waste has been decontaminated.

Some landfills may not accept any treated waste at all. For aesthetic reasons, many landfills will not accept treated waste that is recognizable regardless of whether "unrecognizability" is required by regulations of that particular state.

2.4. HOSPITAL LIQUID WASTE HANDLING

Fuentefria D.B (2010) evaluated the contribution of untreated hospital wastewater to the dissemination of resistant *Pseudomonas aeruginosa* strains in aquatic environments, through the analysis of their antibiotic susceptibility profile and genetic similarity. Wastewater samples were collected from two hospitals located in Brazil. Superficial water samples were collected from water bodies that received this wastewater discharge. The antibiotic susceptibility profiles of the strains were determined using the disk-diffusion technique and their genotyping was done by amplification of the Enterobacterial Repetitive Intergenic Consensus sequences (ERIC-PCR). The antibiotic resistance was higher among the hospital wastewater strains and the multiresistant phenotype was also observed only among these strains. The ERIC-PCR profiles did not reveal any genetic similarity among the *P. aeruginosa* strains from the wastewater and superficial water samples. On the contrary, they showed that genetically distinct populations were established in these different environments and probably that some other contamination source could be contributing to the presence of resistant strains in these water bodies.

2.5. WASTE IN NIGERIA

Poor management of Nigeria's environment is costing the nation roughly US$5 billion annually. Much of the damage results from oil and gas extraction in the Niger Delta region, poor agricultural practices, oil exploration, oil spills, grazing and habitat destruction (Christen,

1996). Grievances over environmental management have contributed to years of instability in the oil-rich Niger Delta region of Nigeria, Africa's biggest oil producer. Figures from the World Bank suggest that US$3 billion of the losses arose from land degradation while deforestation accounts for US$2 billion a year.

Nigeria is spearheading the New Partnership for African Development [NEPAD]; the initiatives proposed might be great for Africa if acted upon. However, for many living in Lagos- Nigeria's former capital – waste disposal remains a contentious issue, and with no end in sight. Refuse is thrown onto roadways, spread on pedestrian walkways or even dumped into gutters. The problem becomes compounded during the rainy season; water, no longer flowing freely along the gutters, remains stagnant, creating the necessary conditions for mosquitoes and vector borne diseases like malaria (Coker et al, 1998). It became so bad that a pragmatist approach was adopted requiring residents to spend the last Saturday morning – each month – cleaning their property; and the refuse to be placed on the streets for collection. This of course does not always happen and the rubbish piles up (Sangodoyin, 1995).

The World Health Organization, (WHO) has stated that of waste collected and sampled, 85 per cent is non-hazardous or general, about 10 per cent is infectious and 5 per cent is hazardous. Meanwhile, the World Health Organization has ranked Lagos, a Nigerian city as the dirtiest city in the world (WHO, 2004). At the global level, 18 to 64 per cent of healthcare institutions are reported to have unsatisfactory Bio-Medical Waste Management (BMWM) facilities; predictors include lack of awareness, insufficient resources and poor disposal mechanisms. Many countries lack documented government rules related to BMWM. India was one of the first countries to implement BMWM rules (Gupta et al, 2009).

CHAPTER THREE

THE STUDY AREA AND METHODOLOGY

3.1: INTRODUCTION

This chapter gave a description of the study area in terms of location, population, size, and physical setting. It further present the method employed in carrying out the research ranging from design of the study, sampling to data analysis.

3.2: THE STUDY AREA

3.2.1: Location

Abuja occupies a land area of 8,000 square kilometers and is bounded to the North by Kaduna State, West by Niger State, East and South-East by Nassarawa State, and South-West by Kogi State. The area lies between latitude 8º 25'N and 9º 29'N and longitude 6º 25'E and 7º 39'E. The territory is currently made up of six area councils that comprise of Municipal, Abaji, Bwari, Gwagwalada, Kwali and Kuje (FCDA, 1988).

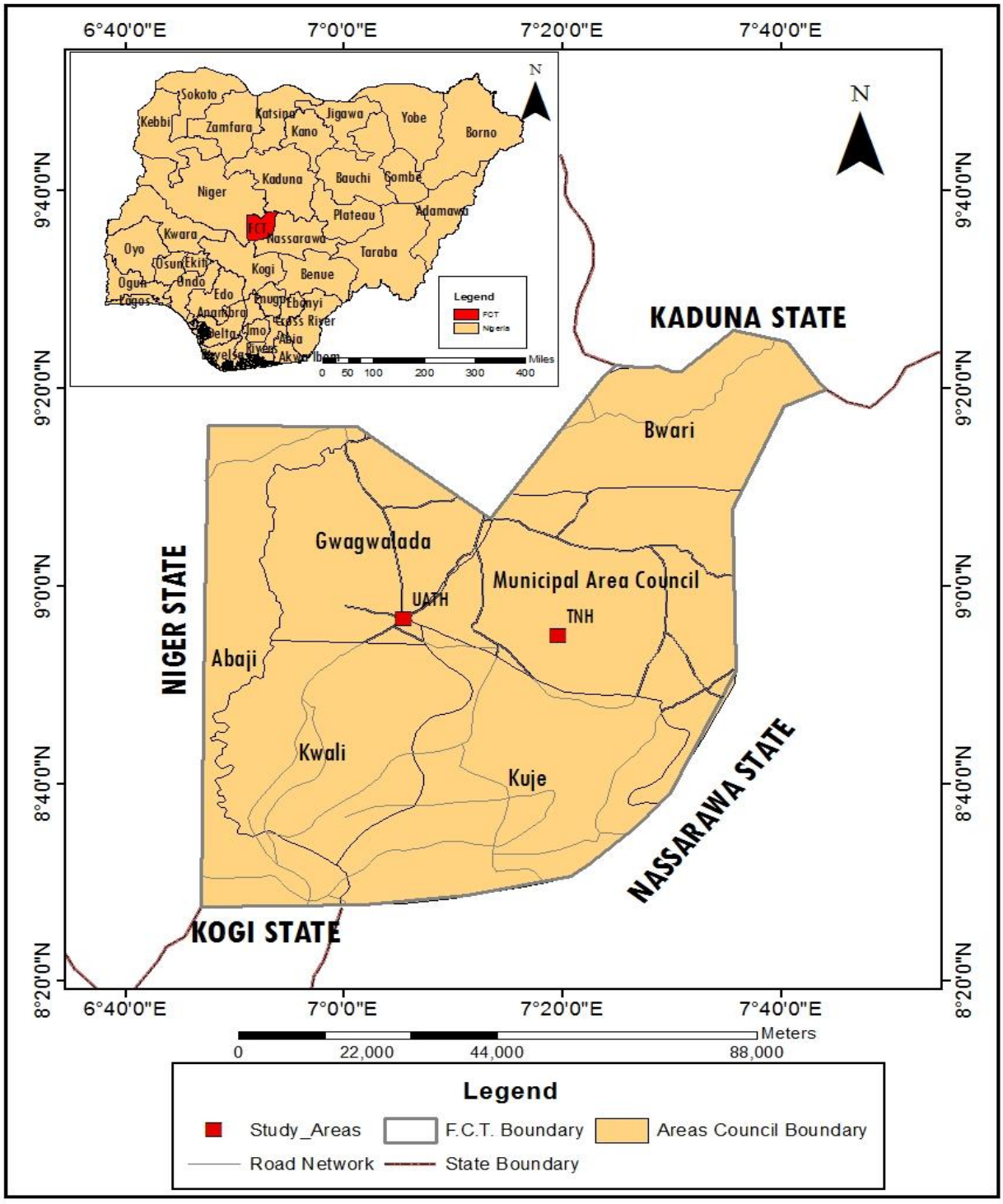


Figure 3.1: The Study Area

Source: Adapted from the Federal Ministry of Lands and Survey administrative map of Abuja 2013.

3.2.2: Relief and Drainage

Abuja, the Federal Capital Territory of Nigeria, is surrounded by hills, amidst undulating lowlands. The drainage pattern generally varies from trellis to dendritic. The area is drained by many rivers like Gwagwalada, Usmanu, Wupa and Wosika. Other smaller but seasonal and southerly-flowing streams form the tributaries and drain the study area. They get recharged in the wet season, as such, their regimes are high as the rains get established and decrease appreciably in the dry season (Abam and Ngah, 2013).

3.2.3: Climate and Vegetation

Abuja under Köppen climate classification features a tropical wet and dry climate. The FCT experiences three weather conditions annually. This includes a warm, humid rainy season and a dry season. In between the two, there is a brief interlude of harmattan occasioned by the northeast trade wind, with the main feature of dust haze, intensified coldness and dryness.

The rainy season begins from April and ends in October, when daytime temperatures reach 28 °C (82.4 °F) to 30 °C (86.0 °F) and nighttime lows hover around 22 °C (71.6 °F) to 23 °C (73.4 °F). In the dry season, daytime temperatures can soar as high as 40 °C (104.0 °F) and nighttime temperatures can dip to 12 °C (53.6 °F). Even the chilliest nights can be followed by daytime temperatures well above 30 °C (86.0 °F). The high altitudes and undulating terrain of the FCT act as a moderating influence on the weather of the territory. Rainfall in the FCT reflects the territory's location on the windward side of the Jos plateau and the zone of rising air masses with the city receiving frequent rainfall during the rainy season from March to November every year.

The FCT has two distinct seasons, namely the rainy season that begins around March and runs through October and the dry season which begins from October and ends in March. Weather conditions in Abuja are influenced by its location within the Niger ¬Benue trough on the windward side of the Jos Plateau and at the climate transition zone between the essentially 'humid' south and the 'sub-humid' north of the country. The climatic dictates of the FCT are essentially from the South-West to the North-West due to the rising elevation from the Gurara valley in the south west, to the Bwari-Aso hills and the Agwa ¬Karu hills to the north east. The high temperatures and the relative humidity in the Niger ¬Benue trough give the Federal Capital Territory a heating effect but the increasing elevation towards the north east reduces the heat in areas like on the Gwagwa plains where the Federal Capital City (FCC) is sited than on the Iku-Gurara plains to the west.

The FCT falls within the Guinean forest-savanna mosaic zone of the West African sub-region. It is a zone of fusion between the Savanna grassland and the Guinea Savannah. Patches of gallery forest along rivers, valleys and the Gwagwa plains, especially in the rugged terrain to the south southeastern parts of the territory are found. These areas of the Federal Capital Territory (FCT) form one of the few surviving occurrences of the mature and undisturbed vegetation in Nigeria.

3.2.4: Land Use

Abuja the new capital of Nigeria came into existence by virtue of the Federal Capital Territory Act, of 1976. The Territory covers a total land area of approximately 8,000 square kilometers, while the City proper is to cover a total land area of 250 square kilometers. Efficient control, administration and management of the entire FCT landmass became the key to successful implementation of the Abuja Master Plan and the orderly development of a “City-beautiful”

envisaged by the Master Plan itself (Jibril, 2006). This cannot be achieved successfully without a reliable and up to date cadastral and land records.

Gaza (1990), examined the socio-spatial changes and rural transformation induced by the creation and development of the new Federal Capital, Abuja. His findings revealed that certain problems and implications arising from the changes induced by the development of the Capital are imminent. Examples of such problems are population growth, migration, unemployment, inadequate provision and distribution of social, institutional and communal facilities, utilities and services. There is also uncontrolled development and land appropriation. The study further revealed that there area however, positive changes that could enhance and improve standard of living of the inhabitants of the study area. These include increased number of educational and health institutions, increased income, improved accessibility of rural areas and consequently relative involvement in standard of living.

3.2.5: Population and Settlement

Abuja is the capital city of Nigeria, it is located in the center of the country, within the Federal Capital Territory (FCT). Abuja is a planned city and was built mainly in the 1980s and officially became Nigeria's capital on 12 December 1991, replacing Lagos, which is still the country's most populous city. Abuja had a population of 1,406,239 in 2006 (National Population Commission, 2009) with a population density of 192 people per square kilometer but given the daily influx of people into the territory, the population today could be well over 8 million people as quoted by Samaila (2012).

However, Abuja has witnessed a huge influx of people into the city which has led to the emergence of satellite towns such as Karu Urban Area, Suleja, Gwagwalada, Lugbe, Kuje and smaller settlements to which the planned city is sprawling towards, the unofficial metropolitan area of Abuja is well over three million. According to Dermographia, the population of Abuja's Urban Area as of 2012 is 2,245,000, making it the fourth largest urban area in Nigeria only surpassed by Lagos, Kano and Ibadan. While Port Harcourt's urban area which is projected to be almost 2,000,000 is the fifth most populous urban area in Nigeria.

3.2.6: Health and Social Services

The case study hospitals, are University of Abuja Teaching Hospital (UATH), Izom Road, Gwagwalada, and the National Hospital, Abuja, Nigeria. Both hospitals enjoy case referral relationship with each other and are both accredited by the National Health Insurance Scheme.

University of Abuja Teaching Hospital (UATH), Gwagwalada, is one of the biggest teaching hospitals in Nigeria, located 45 kilometres away from the Abuja city-centre. UATH has a 350-bed complex with facility for expansion to 500 beds. During the first year of its existence, the hospital functioned as a General Hospital under the Federal Capital Development Authority after which it was taken over by the Federal Ministry of Health to function as a Federal Medical Centre. In September 2006, the hospital was upgraded to a teaching hospital of the University of Abuja. In 2012, the hospital's mission continues to be the rendition of qualitative and prompt clinical services, teaching and research as applicable in modern medicine. UATH's vision is to develop a well-equipped hospital with modern medical facilities and dedicated manpower to meet the medical needs of Nigerians. Its facilities was upgraded by the FMOH towards making it a first-class teaching hospital.

3.3: RESEARCH METHODOLOGY

3.3.1: Reconnaissance Survey

Reconnaissance Survey was undertaken on September 15th ,2013 to obtain firsthand information and to familiarize the researcher with the study area. During the reconnaissance survey the researcher was able to locate the dumpsites in both hospitals and also observed that the proximity of the dumpsites from the main hospital building differs.

3.3.2: Research Design

The study was a cross sectional survey using case studies and observational techniques guided by a questionnaire.

3.3.3: Population of the Study

The target population of this study are the entire staff and patients of both hospitals. The population of UATH and TNH as at the time of this research for both staff and patients is shown in table 3.1 below.

Table 3.1: Study population according to ward/departments in the two hospitals

S/N	Ward/Department	No of Patients in the ward	No of Staff in the ward
1	Out-Patient Department	6	10
2	Ophthalmology	12	8
3	Obstetrics and Gynecology	14	6
4	Internal Medicine	16	15
5	Paediatrics	8	13
6	Physiotherapy	4	8
	TOTAL	**60**	**60**

Source: Field Survey, 2014.

3.3.3.1: Sample size and Sampling Technique

Purposive sampling technique was used to select respondents in both hospitals. The respondents are drawn from patients and staff of university teaching hospital and national hospital .In addition, the departments from where the respondents were sampled were all relevant and accordingly noted as well included in the study.

3.3.4: Instruments for Data Collection

The instruments used for data collection are the questionnaire and focus group discussion. The questionnaire was used to collect data on respondent's profile, waste management practices such as collection method, frequency of waste collection as well as transportation and disposal method adopted by the hospitals. The questionnaire is of two types one each for the staff and the patients in the hospitals. Focus group discussion was conducted to enquire on staff and patient's familiarization with waste collection, sorting and disposal practices in the hospitals. Also possible effects of the waste management practices on health and the environment was also discussed.

3.3.5: Data Sources

Data for this study was obtained from primary source.

Primary Sources

In the collection of primary data, structured questionnaire was used together with formal interviews for some selected respondents. The sampled participants will be drawn from staff and patient for this study and would be chosen based on the identified role played in the hospital etc. In some instances the questionnaires tended to be read out to guides some of the respondents who do not know how to read or write and are willing to respond to the questions in questionnaires in the presence of the researcher

3.3.6: Procedure for Data Collection

When permission for data collection was granted, data was collected via primary source using focus group discussion, interview and questionnaire. Check list was used as guide for collection of data. Using focus group discussion, ten staff were selected. Questions on biomedical waste disposal was discuss by the group. In the process of interview, the head of environmental personnel, somestaff and patients were interviewed on the subject matter.

Questionnaire was administered to staff and patient sampled for the study. For those who could not read, it was read out to them especially on the part of the patient. A high resolution digital camera was used to capture relevant photographs of biomedical waste collection, storage and disposal in relation to environmental aesthetics in the two hospitals.

All the bed side bin were weighed empty and then alongside the content of each bin. This procedure provided the average weight (in kg) of BMW generated by each department/unit/week for the period. EIQ was used as a guide in assessing the environmental aesthetics of the surrounding study area.

3.3.7: Methods of Data Analysis

Analysis of data collected for this study was carried out as outlined below.

Objective 1: Identification and characterization of the BMW generated in the tertiary hospital

To achieve objective one, the data from the questionnaire were analyzed using mean to answer research question one. Any item with a mean score of 1.0 and above was regarded as generated

while any mean below 1.0 was regarded as rejected. The identified waste were then categorized into degradable and non-degradable.

Objective 2: Examining the methods of BMW disposal in each of the Tertiary Health Care Centers

Responses of the Focus Group Discussions and Interviews about their views concerning waste disposal methods of BMW of THCCs were discussed extensively open burning, how they sort their waste.

Objective 3: Examining the effect of the BMW on the environmental aesthetics of the surrounding health care centers

Examined the effect of the BMW on the environmental aesthetics of the surrounding health care centers. The effect of the method of waste management adopted in the hospitals to the aesthetics of the environment was analyzed descriptively with the aid of photographs from the dump sites of the wastes.

Objective 4: Identification of the methods of BMW collection and disposal in the two hospitals with its effectiveness

Result obtained from questionnaire were subjected to descriptive statistics to show the frequency and distribution through waste sorting, waste treatment and open burning

Objective 5: Comparing the perception of staff and patients in the BMW of the hospitals

The null hypothesis was analyzed using Spearman rho test at the $P \leq 0.05$ levels of significance with SPSS package.

CHAPTER FOUR

RESULTS, ANALYSIS AND DISCUSSION

4.1. INTRODUCTION

This chapter entails the outcome of the research conducted as well as detailed analysis of the stated results. The chapter is concluded with discussions on the results obtained in relation to the research questions highlighted in chapter one of this study.

4.2. RESULTS

Table 4.1: Types of waste generated in the both hospital

Variables	Mean	Remarks
Used syringes and needles	1.0	Agreed
Broken bottles	1.0	Agreed
Used blade	1.0	Agreed
Cotton swabs	1.0	Agreed
Bandage and gauze	1.0	Agreed
Chemicals	1.0	Agreed
Paper	1.0	Agreed
Polythene bags	1.0	Agreed
Food remnants	1.0	Agreed
Used diapers and tissues	1.0	Agreed
Plastics	1.0	Agreed

***Source;* Field study,2014.**

Table 4.1 shows that the respondents agreed that all the listed items are generated as waste in the hospitals. This is concluded because all the items met the cut-off point of 1.0 and above. This therefore implies that all the listed items are forms of waste generated in the two hospitals. The identified waste were further categorized into degradable and non-degradable waste as shown in table 4.2.

Table 4.2: Categories of BMW in the both hospitals

Degradable	**Non-Degradable**
Papers	Syringes and needles
Bandages	Broken bottles
Cotton swabs	Used blades
Used diapers and tissue	Plastic

Source: Field study, 2014.

The results from the type and categories of BMW showed in both hospitals are generated by all irrespective of age and socioeconomic or status because of their numerous uses. Further, all degradable wastes are known for their offensive odour and often constitute toxic leachate from the decomposed materials that ends up contaminating both soil and ground water.

Table 4.3: Demographic Characteristics of Respondents

Variables	**Frequency (N=60)**	**Percentage (%)**	**Frequency (N=60)**	**Percentage (%)**
Sex	UATH	UATH	TNH	TNH
Male	33	55	31	51.7
Female	27	45	29	48.3
Age				
20-29	9	15	15	25
30-39	21	35	20	33.3
40-49	19	31.7	22	36.7
50 and Above	11	18.3	3	5
Marital Status				
Single	7	11.7	11	18.3
Married	43	71.7	41	68.4
Divorced	6	10	5	8.4
Widowed	4	6.7	3	5
Educational Qualification				
Qu'aranic	3	5	5	8.4
Primary	7	11.7	9	15
Secondary	17	28.3	13	21.7
Tertiary	28	46.7	31	51.7
None	5	8.4	2	3.4
Income Level of Respondent in Naira				
20,000 Naira and below	4	6.7	5	8.4
21,000-30,000	4	6.7	2	3.4
31,000-40,000	3	5	5	8.4
41,000-50,000	8	13.3	11	18.3
51,000 and above	41	68.4	37	61.7

Source: Author's Field Survey, 2014

Table 4.3 indicate that 55 % (UATH) and 52% (TNH) respondents are said yes to be male while 45% to 48% correspondents are said to be female. The table also reveals that 15%(UATH) and 25%(TNH) are within the age of 20-29 respondents while 30-39 are within the age of 35% (UATH)and 33 % (TNH) while 32% (UATH) and 37% (TNH) fall within the range of 40-49 while 50 and above fall within 18% (UATH) and 5% (TNH). Table also indicate that

12%(UATH) and 18%(TNH) respondents are said to be single while 77% and 68% are said to be married while 10% (UATH) and 8%(TNH) respondents are divorced while 7% (UATH) and 5%(TNH) respondents widowed.

Table indicate that 5%(UATH) and 8%(TNH) respondents are graduates of Qur'anic while 12% (UATH) and 15% (TNH) are said to have acquired primary education while 28% (UATH) and 22% (TNH) respondents are said have acquired secondary certificate while 8%(UATH) and 3%(TNH) respondents said to have non academic qualification.

Table indicate that 7%(UATH) and 8%(TNH) respondents receive income below 20,000 while 7% (UATH) and 3% (TNH) respondents receive 21,000 to 30,000 while 5% (UATH) and 8% (TNH) respondents receive 31,000 to 40,000 while 13%(UATH) and 18%(TNH) respondents receive 41,000 to 50,000 while 68% (UATH) and 62% (TNH) respondents receive 51,000 and above.

Looking at the variability in age range of respondents from the two hospitals, it can be deduced that the UATH is more accessible to those of younger age while the TNH is accessible to the older age respondents.

It is believed that married people obey and adhere to hygienic/sanitary practices than other groups. It is therefore expected that the hospitals should be seeing good sanitary practices than bad within the hospital premises.

The high number of respondents who attended tertiary institutions is not surprising. This is because all the staff administered questionnaires are definitely had to be learned especially as the health sector is of paramount importance. It also implies that enlightened people visit tertiary hospitals more than those that are not enlightened.

4.2.1. Methods of disposing Biomedical Waste in the study area

Data from the study indicates that biomedical waste disposal method employed by both hospitals wasopen dumping and eventual burning. However, periodic land filling was reported to be practiced in UATH. The dumpsite of the hospital was largely an open space where the BMW wasfinally disposed and opening burning effected.

Table 4.4: Distribution by collection, sorting and storage of BMW

Variables	**Frequency (N=60)**	**Percentage (%)**	**Frequency (N=60)**	**Percentage (%)**
Availability of waste bin by bed/office	UATH	UATH	TNH	TNH
Yes	58	96.7	55	91.7
No	2	3.4	5	8.4
Availability of waste storage container in the hospital				
Yes	59	98.4	58	96.7
No	1	1.7	2	3.4
Frequency of waste disposal into the storage container				
Twice daily	15	25	13	21.8
Daily	43	71.7	45	75
Twice weekly	2	3.4	1	1.7
Weekly	0	0	1	1.7
Sorting of waste at storage point				
Yes	47	78.4	41	68.4
No	13	21.7	19	31.7
Average storage period				
Daily	8	13.3	6	10
Twice a week	21	35	20	33.3
Thrice a week	18	30	19	31.7
Weekly	13	21.7	15	25

Source: Author's Field Survey, 2014

Table 4.4 indicates that about 97%(UATH) and about 92% (TNH) respondents agreed to availability of waste bin either by the bed side(patient) or their office(staff) while 3% to 8% respondents said no. Table 4.4 also reveals that 98%(UATH) and 97%(TNH) respondents said

yes to the availability of waste storage container in the hospitals while 2%(UATH) and 3% (TNH) said no. The table also indicates that 72%(UATH) and 75%(TNH) respondents agreed that the frequency of waste disposal was on a daily storage while 21% (UATH) and 25%(TNH) respondents said it twice daily, 2%(UATH) and 3%(TNH) respondents said it twice weekly while about 3%(UATH) and 2%(TNH) respondents said weekly. The table also reveals that 78%(UATH) and 68%(TNH) respondents said yes that there was sorting of waste at the storage point while 22%(UATH) and 32%(TNH) respondents said no. The table equally indicates that 13%(UATH) and 10%(TNH) respondents agreed to daily waste average storage period while 35%(UATH) and 33%(TNH) respondents it was twice a week followed by 30%(UATH) and 32%(TNH) respondents that agreed with thrice a week while 22%(UATH) and 25%(TNH) respondents agreed that it was only weekly on the average storage period.

In the present study, the responses on availability of waste bin and storage container in the hospital implies that measures were put in place by the hospitals sanitation units to manage generated waste in the hospital.

A high volume of waste was generated from the hospitals on a daily basis. This could be attributed to the size of the hospitals which enables accommodation of many people (patient and staff).

The twice a week disposal of waste from the storage container could be linked to the generation of high volume of waste by the hospitals on a daily basis as seen in the frequency of waste disposal into the storage facility. This is in agreement with Omrani (1998), who stated that there has been an increase in waste volume due to the use of more disposable products. If the generated waste was not disposed of quickly, it could cause discomfort (bad odors) and even

havoc. Although it seems to contradict Singh (2014), who stated that unprocessed bio-medical waste should not be stored for more than 48 hours.

4.2.2. Effectiveness of the Biomedical Waste Disposal

Table 4.5: BMW transportation method in both hospitals

Mode of transport	**Frequency (N=60)**	**Percentage (%)**	**Frequency (N=60)**	**Percentage (%)**
	UATH	UATH	TNH	TNH
Enclosed vehicles	21	35	24	40
Open vehicles	19	31.7	16	26.6
Wheeled vehicles	6	10	7	11.7
Trucks	14	23.3	13	21.7

Source: Author's Field Survey, 2014

Table 4.5 reveals that 35%(UATH) and 40% (TNH) of the respondents agreed that BMW transportation method was done with enclosed vehicles, followed by 32%(UATH) and 27%(TNH) respondents that agreed that it was open vehicles while 10%(UATH) and 12%(TNH) respondents agreed that BMW was been transported through wheeled vehicles while 23%(UATH) and 22%(TNH) respondents agreed that trucks were used to transport BMW.

The method of transportation in both hospitals was not adequate for transporting BMW wastes, the hospitals must take immediate and urgent steps to evolve an environmentally friendly approach to the transportation system of waste based on international standard.

Table 4.6: Distribution by final method of BMW disposal in the both hospitals

Variables	**Frequency (N=60)**	**Percentage (%)**	**Frequency (N=60)**	**Percentage (%)**
	UATH	UATH	TNH	TNH
Shredding	2	3.4	3	5
Incineration	10	16.7	9	15
Open dump burning	40	66.7	38	63.4
Burying	5	8.4	6	10
Landfills	3	5	4	6.7
Total	60	100	60	100

Source: Author's Field Survey, 2014

Table 4.6shows that 3%(UATH) and 5%(TNH) said shredding method of disposal of BMW was used while respondents of about 17%(UATH) and 15%(TNH) agreed that incineration method was used, 67%(UATH) and 63%(TNH) said open dump burning was the major BMW disposal method applied, 8% to 10% respondents agreed with burying method and about 5%(UATH) and 7%(TNH) respondents agreed with the landfill as the final BMW disposal method

At the UATH, the existing open dump sites should be closed down and the sites protected. It is also suggested that crops grown on and around the dump site should not be consumed. This is as a result of the fact that these crops might have absorbed chemical elements identified that might be in the soil. Similarly, farming activities should not be allowed around this disposal sites until an audit of the soil and water have been carried out.

This is whatSrivastav, Majahan and Mathur (2012) revealed that some hospitals did not have incinerators for effective and efficient waste disposal. This method ofopen waste dumping and burning disposal as shown in plate 4.1 brings about risk to man and the environment at varying levels and degrees as asserted by Algoz and Kocasay (2007).



Plate 4.1: Biomedical Waste Dumpsite andopen burningat UATH (2014)

Plate 4.1 shows the open dumpsite and burning at the UATH. It can be discerned that some BMW burnt while others did not burn.

4.2.3. Effect of BMW on the Aesthetics of the Study Area

This includes the site of waste generation and collection at the patients' bed, down to the final destination of the wastes. Visual inspection by the researcher at TNH shows that the hospital has

a sound biomedical waste management system and waste eye filthiness was not observed with the environment highly cleaned.

The researcher discovered that the dumpsite of UATH was situated at the extreme rear of the hospital, and there was a foot path along the dumpsite that led to a neighboring village. This path served as a route through which some of the workers and community members access the hospital. Farming was also observed around the dumpsite by the nearby community. Coupled with the fact that the dumpsite was an open space, and posing high risk of health to the wellbeing of the people around the hospital and the neighboring community, the dumpsites was an eye sore and it presented an unkempt environment.

4.2.4. Perception of Respondents on Aesthetics of the Study Area

The level of perception of respondents (staff and patients) on biomedical waste disposal methods in TNH is as shown in table 4.7. All the six parameters that concern biomedical waste disposal were put into consideration.

Table 4.7: Correlation co-efficient table on perception of Respondents on Biomedical Waste disposal in the National Hospital, Gwagwalada.

	q1p	q1s	q2p	q2s	q3p	q3s	q4p	q4s	q5p	q5s	q6p	q6s	q7p	q7s	q8p	q8s
q1p	1															
q1s	-0.035 0.85	1														
q2p	-0.03 0.86	1.00* 0.00	1													
q2s	-0.03 0.86	-0.03 0.86	-0.03 0.86	1												
q3p	-0.03 0.87	-0.03 0.87	-0.03 0.87	-0.03 0.87	1											
q3s	0.43* 0.02	-0.05 0.79	-0.05 0.79	-0.05 0.79	0.34 0.07	1										
q4p	0.37* 0.04	0.37* 0.04	0.37* 0.04	-0.31 0.10	0.06 0.75	0.24 0.20	1									
q4s	0.37* 0.04	0.37* 0.04	0.37* 0.04	-0.31 0.10	0.06 0.75	0.24 0.20	1.00* 0.00	1								
q5p	-0.09 0.63	-0.09 0.63	-0.09 0.63	-0.09 0.63	0.28 0.13	0.27 0.16	0.18 0.34	0.18 0.34	1							
q5s	0.23 0.21	0.23 0.21	0.23 0.21	-0.13 0.49	0.21 0.26	0.34 0.06	0.20 0.28	0.20 0.28	0.74* 0.00	1						
q6p	0.07 0.72	0.07 0.72	0.07 0.72	0.25 0.18	0.06 0.75	0.10 0.60	- 0.60* 0.00	- 0.60* 0.00	0.19 0.32	0.39* 0.03	1					
q6s	0.23 0.23	0.23 0.23	0.23 0.23	-0.12 0.53	0.21 0.27	0.38* 0.03	0.31 0.09	0.31 0.09	0.82* 0.00	0.92* 0.00	0.30 0.10	1				
q7p	0.28 0.14	0.28 0.14	0.28 0.14	-0.14 0.47	0.30 0.11	0.39* 0.03	0.06 0.74	0.06 0.74	0.55* 0.00	0.87* 0.00	0.50* 0.00	0.77* 0.00	1			
q7s	-0.09 0.63	-0.09 0.63	-0.09 0.63	-0.09 0.63	0.40* 0.03	0.36 0.05	0.18 0.34	0.18 0.34	0.9862* 0.00	0.73* 0.00	0.19 0.33	0.80* 0.00	0.57* 0.00	1		
q8p	-0.06 0.75	-0.06 0.75	-0.06 0.75	-0.06 0.75	-0.26 0.17	-0.03 0.86	0.12 0.53	0.12 0.53	0.68* 0.00	0.49* 0.01	0.12 0.51	0.61* 0.00	0.25 0.19	0.57* 0.00	1	
q8s	-0.06 0.75	-0.06 0.75	-0.06 0.75	-0.06 0.75	-0.26 0.17	-0.03 0.86	0.12 0.53	0.12 0.53	0.68* 0.00	0.49* 0.01	0.12 0.51	0.61* 0.00	0.25 0.19	0.57* 0.00	1.00* 0.00	1

Key:

q1	=	Presence of waste bin(s) around bed	q7	=	Practice of waste treatment
q2	=	Frequency of emptying bin(s)	q8	=	Practice of Open dumping/burning
q3	=	Inference of BMW with water supply			
q4	=	Inference of BMW with human dwelling	s	=	staff
q5	=	BMW management personnel are protected	p	=	patience
q6	=	Practice of waste sorting			

Table 4.7 reveals the spearman correlation of perception of patients and staff in National Hospital (TNH). However, from the significant correlated variables, a perfect positive relationship is observed between the response on Inference of BMW with human dwelling and also response on practice of open dumping and burning. These are recorded with (r = 1.00, p-value = 0.00). Also, a strong positive relationship is observed between the response of both staff and patients on BMW management personnel were protected as recorded with (r = 0.74*, p-value = 0.01) while average positive correlation is observed between the response of both staff and patients on practice of waste treatment, this is recorded with (r = 0.57*, p-value = 0.01).

The study rejects the hypothesis because there is a significant correlation between the subjects' responses and the BMW management.

The Spearman correlation test for HO1 yielded an r value of 0.43 for perception on interference on water supply, while an r value of 0.59 was recorded as regards perception on interference with human environment and an r value of 0.49 regarding to perception on waste sorting. Thus, the r values obtained signify the rejection of the null hypothesis 1. It can then be stated conclusively that there is significant relationship between the perception of staff and patients on BMW disposal and the environmental aesthetics of the THCCs.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1. INTRODUCTION

This chapter summarizes the major findings discovered through this research and outlines conclusive remarks on the research topic. Recommendations were also highlighted on areas which require further research in relation to this research topic, and also contributions of this research work to knowledge.

5.2. SUMMARY OF MAJOR FINDINGS

- The findings of this study revealed that enormous biomedical wastes are generated in the study area and there is low level of waste sorting in, thus the advantages of waste sorting outlined earlier are thereby eliminated. This study has also realized that the two hospitals assessed lack the various levels of training and regulations on the management of biomedical waste, as well as levels of awareness of biomedical waste management. Both hospital have minimal appropriate practices when it comes to handling and disposal of these wastes, starting from the personnel responsible for collection and storage through to the final disposal of the wastes. Though regulation exists, but there is no implementation and enforcement.
- Findings revealed that constituents of biomedical waste found in both hospitals were degradable such as papers, bandages and cotton swabs while others were non-degradable such as needles and syringes, bottles, used blades and plastics. More than 90% of the respondents in both hospitals agreed that waste bin and storage container exist and 70% then said waste collection is daily. However, their transportation to disposal points

wereineffective as they were either transported by open vehicles, wheeled vehicles or trucks as attested to by 65% in UATH and 60% in TNH

- The study also shows that both hospitals still engage in poor management practices such as open burning of their biomedical wastes. The predominant method employed for BMW disposal in both hospitals was open burning as attested to by 66.7% in UATH and 63.4% in TNH. The dumpsite of the hospital is largely an open space where the BMW is finally disposed and incinerated. This makes it prone to erosion and other possibility of pollution and contamination.

- To measure the effectiveness of open burning method in UATH, findings revealed that open burning is not a completely reliable and economic method of disposal for the hospital. There were mass reduction in quantity of the waste after open burning, absolute destruction of diseases causing organisms and low cost of management among other benefits of this method to the tertiary health center. However, there were massive smoke produced during open dumping/burning, which causes serious air pollution as narrated by the head of environmental unit. There were also risk of damage to crops of the nearby farmlands due to chemical constituents of the hospital's waste placed at the dumpsite prior to open dumping/burning.

5.3. CONCLUSION

Open dumping/burning, it is common sense that the bevel part of needles which is made of steel would remain unburnt, thus still liable to cause injury/puncture to human or animal. The farming activities reported to ensue around the dumpsite of UATH may benefit from BMW open

dumping/burning through soil absorption of manure from burnt organic matter, in contrast, there may be certain toxic chemicals that would seep to the crops from the waste dumpsite.

Environmental, health and esthetic factors are only affected by BMW management in the study area, through various means and at varying extent. There is plenty of room for improvement on management of such wastes in the study area, so as to safeguard the health and wellbeing of humans, and other forms of life.

5.4. RECOMMENDATIONS

Based on the findings of this study, Biomedical wastes management in the study area can be improved in order to achieve sustainability in waste management and maintain environmental aesthetics. Therefore the following recommendations are;

- A reliable, efficient, sustainable and environmentally method of BMW needs to be urgently put in place at both clinics.Which provides updated knowledge about the process of wastemanagement and associated health risks. Because of the massive smoke described as a result of open dumping/burning, and risk of environmental pollution through water erosion and smoke emission, safer methods of biomedical waste disposal should be considered such as autoclaving, microwaving, chemical disinfection and sanitary land filling. These methods come with added advantage of recycling of waste components in contrast to open dumping/burning which is generally a complete destruction of materials that may otherwise be recycled. The environmental management department of the tertiary healthcare center should consider the choice of alternative waste disposal methods so as to reduce this effect.

- Government should support the hospitals with modern waste disposal systems and equipment and there should be employment of more health workers for day - to - day cleaning of the hospitals.
- Training of more hospital health workers through attending conferences, seminars and workshops in order to increase their knowledge about hospital waste, its risks and sanitation and government should enforce environmental sanitation by employing more health workers, and support them with materials and equipment for the day-to-day operation in environmental cleaning exercise in the state.

SUGGESTIONS FOR FURTHER STUDIES

- Further research should be carried out to analyze the effect of waste on water quality in the surrounding area.
- A research can be carried out on health implication of the dumpsites on agricultural farmlands.
- Effects on the dumpsites can be investigated by testing the quality of soil, water, and air quality.

REFERENCES

Adegbita M.A, Nwafor S.O, Afon A, Abegunde A.A, Bamise C.T (2010). Assessment of dental waste management in a Nigerian tertiary hospital. *Waste Management Resource,* 28: 769-777.

Abah S.O, Ohimain E.I (2010). Assessment of Dumpsite Rehabilitation Potential using the Integrated Risk Based Approach: A case study of Eneka, Nigeria. World Appl. Sci J., *8(4): 436-442.*

Abah S.O, Ohimain E.I., (2011). Health care waste management in 26. Nigeria: a case study. *Journal of Public Health Epidemiology*.

Acharya D.B, Meeta S, (2000) *Hospital Waste Management. Minerva Press*, New Delhi 2000,pp 15,47.

Afon, A.O., 2005. Solid waste management in selected cities of Oyo State, Nigeria. Unpublished Ph.D. Thesis, Department of Urban and Regional Planning, ObafemiAwolowo University, Ile-Ife, Nigeria, pp:289-306.

Alagoz B.A.Z. and Kocasoy G (2007). Treatment and disposal alternatives for health care wastes in developing countries-A case study in Istanbul, Turkey. Waste Management Resource, 25: 83-89

Allen C, (2011). Environmental aesthetics. In E. Craig (Ed.), *Routledge Encyclopedia of philosophy*. London: Routledge.

Allsopp M, Costner P and Johnson P (2001). Open dumping/burning and human health. Uk: GreenpeaceResearch Laboratories, University of Exeter.

Askarian M, Vakili M, Kabir G (2006). Results of a Hospital Waste Survey in Private Hospitals in Pars Province, Iran. Pp. 7-11.

Askarian M, Vakili M, Kabir G (2004). Results of a hospital waste survey in private hospitals in Fars province, Iran. Waste Manage. 24(4): 347-352.

Babatola, J.O., (2008). A Study of Hospital Waste Generation and Management Practice in Akure, Nigeria. An International *Multidisciplinary Journal, Ethiopia* ***2(3):****291-305* ISSN 1994-9057. ISSN 2070—0083

Baccini P, Brunner P, (1991) *The Metabolism of the Anthroposphere*, Springer Verlag, Berlin,

Baveja G, Muralidhar S, Aggarwal P (2000). Hospital waste management– an overview. *Hospital Today*, 5(9): 485–486.

Becher, S. and H. Lichtnecker, (2002). Immunological aspects and affections of rubbish collectors caused by bioaerosols. J. Occup. Health, 44: 125-130, doi:10.1539/joh.44.125.

Bdour A, (2004) Guideline for the Safe Management of Medical, Chemical, and Pharmaceutical Waste. *National Institute for Environmental Training,* Riyadh, Saudi Arabia.

Block, S.S. (1977). *Disinfection, Sterilization and Preservation*. 2nd edition. U.S.A: Lea and Febiger.

Brady E, (2006). Aesthetics in Practice: Valuing the Natural World. Environmental Values **15**277–91

Burd M, (2005) Reducing the risks related to the handling and disposal of healthcare waste. *Professional Nurses* **20**, 40–42.

Caspari S, Erikssonb K and Naden D (2006). The aesthetic dimension in hospitals− An investigation into strategic plans. International Journal of Nursing Studies 851−859. 0020-7489/$ - see front matter r 2006 Elsevier Ltd. All rights reserved.

Chauhan, Maya Singh and Kishore Malviya (2002): *Existing solid waste management in hospitals of Indore city.* Indian J. Environ. Sci., 6: 43-49.

Cheng, Y.W., F.C. Sung, Y. Yang, Y.H. Lo, Y.T. Chung and K.C. Li, (2009). Medical waste production at hospitals and associated factors. Journal of Waste Manage., 29: 440-444.

Chitnis V, Chitnis S, Patil S, Chitnis DS, (2003) Treatment of discarded blood units: disinfectionwith hypochlorite/formalin verses steam sterilization. *Indian J Med Microbiol*21**,** 265-267

Chitnis V, Patil S, Chitnis DS, (2000) Ravikant Hospital Effluent: A Source of Multi drug Resistant Bacteria. *Current Sciences* 79, 535-540.

Christen, J. (1996). *Solid Waste Management in Developing Countries*. Sweden: Icon Publishers.

Cointreau, S.J (1997). *Waste Issues: Urban Problems*. England: Lowden Publications.

Coker A.O (2009). Medical waste management in Ibadan, Nigeria: Obstacles and Prospects. February 2009. Waste Manage. 29(2): 804-81

Da Silva C.E, Hoppe A.E, Ravanello M.M and Mello N, (2005) Medical wastes management in the South of Brazil. *Waste Management* 25: 600-605.

Echegaray M, Rodriguez, R.A, Udaquiola S.M, Hektor K (2002). Heavy metals in the ash fraction of medical waste open dumping/burning. *Ingenieria Quim*.,21: 12-17

Farzadika M, Moradi A, Mohammadi M.S (2009).Hospital Waste management status in Iran: A case study in the teaching hospitals in Iran University of Medical Sciences. Waste Manage. Res., 27: 384-389

Ferreira A.P and Veiga M.M (2003). Hospital waste operational procedures: A case study in Brazil. Waste Manage. Res., 21: 377-382Fjeld, T (1998). planteriinnemiljø−en veitil helse (Plants in interior surroundings−a source to health). gartneryrket 13 (15).

Gordon J.G., Rein Hardt P.A., and Denys, G.A. (2004) 'Medical waste management', in C.G. Mayhall (Ed.) Hospital epidemiology & infection control, Lippincott Williams and Wilkins Publication: 1773-85.

Gupta S.P, (1998) *Statistical Methods*, Revised & Enlarged, S. Chand & Sons, New Delhi, India.

Gupta S, Boojh R, Mishra A, Chandra H. Rules and management of biomedical waste at Vivekananda Polyclinic: a case study. *Waste Manag*2009; *29* : 812-9.

Habibur M.R, Ahmed S.N and ShehabM.U(1999). A Study on Hospital Waste Management in Dhaka City; 25th WEDC Conference, Integrated Development for Water Supply and Sanitation, Addis Ababa, Ethiopia.

Halbwichs, H. (1994). Solid Waste Disposal in District Health Facilities. *World Health Forum* 15: 363-367.

Hall, S.K. (1989). Infectious Waste Management: A Multifaceted Problem. *Journal of Pollution Engineering* 21 (8), 74 -78.

Hershkowitz, A. (1990). Without A Trace: Handling Medical Wastes Safely. *Technology Review*, 93(6): 35-40.

ICRC; International Committee of the Red Cross (2011), Medical Waste Management.19 avenue de la Paix 1202 Geneva, Switzerland

Jimoh, M.A. (2003) Analysis of plants from refuse dump sites for presence of heavy metals. In Adekunle, V., Okoko, E., and Adeduntan, S. (eds): *Challenges of Environmental Sustainability in a Democratic Setting. Proceedings of a National Conference organized by Environment and BehaviourAssociation of Nigeria*, held at Federal University of Technology, Akure, Nigeria. Environment and Behaviour Association of Nigeria, Akure.

Kuroiwa C, Suzuki A, Yamaji Y, Miyoshi M (2004). Hidden reality on the introduction of auto

disable syringes in developing countries. *Southeast Asian Journal of Tropical Public Health*, 35: 10-23

Longe E.O and Williams A (2006). A preliminary study of medical waste management in Lagos metropolis, Nigeria. *Iranian Journal of Environmental Health Science vol. 3,* 2: 133-139

Madhu N, Hina K, Puttaiah E.T and Thirumala S., (2013). *Assessment of Biomedical waste of various hospitals in Mysore City Karnataka, India.*International Journal of Current Microbiology and Applied Sciences, ISSN: 2319-7692 vol 2 3:1-5 Available at http://www.ijcmas.com

Manohar D, Reddy P.R, Kotaih B, (1998) Characterization of solid waste of a super speciality hospital – a case study. *Ind. J. Environ. Health,* **40**, 319-326.

Manyele S.V, (2004). "Medical/hazardous Waste Management for Practitioners", Course notes for the BICO Professional Development Program, Prospective College of Engineering and Technology, University of Dar esSalaam,Tanzania.

Mehta, G. (1998) Hospital Waste Management, National Guidelines (Draft) prepared for GOI/WHO project IND EHH 001,LadyHardinge Medical College and Associated Hospitals, New Delhi.

Mokuolu O.A, (2008). Health-Care Waste Management in Nigeria. A case study of UITH. M.EngThesis,Dept., of Civil Engineering, University of Ilorin, Nigeria.

Ndidi N, Ochekpe N, Odumosu P, John S.A (2009). Waste management in health care establishments within Jos Metropolis, Nigeria. African Journal on Environmental Science Technology, 3(12): 459-465

NEERI, (1995) National Environmental Engineering Research Institute in Nagpur Comprehensive Characterization of Municipal Solid Waste at Calcutta.

Ogbonna D.N, Amangabara G.T and Ekere T.O (2007). Urban solid waste generation in Port Harcourt metropolis and its implications for waste management. *Management of Environmental Quality: An InternationalJournal*18(1): 71-88

Ogbonna D.N (2011).*Characteristics and waste management practices of medical wastes in health care institutions in Port Harcourt, Nigeria*. Journal of Soil Science and Environmental Management 2(5): 132-141

Oke I.A (2008). Management of immunization solid wastes in Kano state, Nigeria. Waste Manage.,28: 2512-2521

Olubukola B.O (2009). Comparative Analysis of Health Care Waste Management Practice in

Two General Hospitals in Nigeria. Available at http://www.eco-web.com/edi/index.htm.

Omojasola P.F, Adetitun D.O, Oshin O.O and Omojasola T.P, (2009). *Environmental Health Hazard Assessment of Hospital Wastes in Ilorin Metropolis. Nigerian Journal of Microbiology,* 23(1);1882 – 1889

Oyeniyi B.A (2011). Waste Management in Contemporary Nigeria: The Abuja Example. International Journal of Politics and Good Governance Volume 2, No 2.2, Quarter II 2011 ISSN : 0976 - 1195

Patil G.V, Pokhrel K, (2004) Biomedical solid waste management in an Indian hospital: a case study. *Waste Management*, **25**, 592–599.

Patil A.D and Shekdar A.V (2001). Health-care waste management in India. J. Environ. Manage. 63(2): 211-220.

Rao, H. V. N. (1995) Disposal of hospital wastes in Bangalore and their impact on environment.In The Third International Conference on Appropriate Waste Management Technologies for Developing Countries. Nagpur, February 25–26, pp. 839–842.

Rao,S.K.M., and Garg, R.K.(1994) A study of Hospital Waste Disposal System in Service Hospital. Journal of Academy of Hospital Administration, July ,6(2) pp.27-31.

Rasheed, S., Iqbal, S.,andBaig, L.A. (2005)Hospital waste management in the teaching hospitals of Karachi. J. Pak. Med. Assoc, 55 (5), pp.192–195.

Ravikant, C.V., Jaiswal, S.P., Vaidya K., Chitnis, D.S. (2002) Effluent Treatment Plant: Why and How?. Journal of Academy of Hospital Administration, 14(1) pp. 33-37.

Reinhardt G. (1992). Feasibility Report on Hazardous Waste Management in African Cities, Volume 1.

Rhodes G, Huy G, Swings J, McGann P, Hiney M, Smith P, Pickup W.R (2000). *Distribution of oxytetracycline resistance plasmids between Aeromonads in hospital and aquaculture environments: Implications of Tn172 in dissemination of the tetracycline resistance determinant Tet* A. Appl. Environ. Microbiol. 66(9): 3883-3890.

Philipp, R., Pond, K., Rees, G., and Bartram, J. (1999a). The association of tourist health with aesthetic quality and environmental values. pp.195-199. In: Mobility & Health: From Hominid Migration To Mass Tourism. Proceedings of European Conference on Travel Medicine, Venice, 25-27 March 1998. pub. WHO Collaborating Centre for Tourist Health and Travel Medicine, and Regione Veneto; 381pp.

Pruss A, Giroult E, Rushbrook P, (1999) *Safe Management of Wastes from Health-care Activities*. Geneva,WHO

Pruthvish S, Gopinath D, Rao J.M, Girish N, Bineesha P and Shivaram C, (1998) Health-*Care Waste Management Cell, Department of Community Medicine*, M.S. Ramaiah Medical College.Bangalore, India. Information Learning Units for Health-Care Waste.

Saad S.G (2007) *Water and sanitation in hospitals integrated Environmental management*: Eleventh international water technology conference, IWTC11, Egypt 695.

Saini, R. S., and Dadhwal, P. J. S. (1995) Clinical waste management: a case study. Journal of Indian Association for Environmental Management, 22, pp. 172–174.

Sangodoyin, A.Y. (1995). Assessment of the adequacy of by-plant monitoring. *International Journal of Environmental Studies*, 48, 257 – 262.

Seymour Block S (2001). Disinfection, sterilization and preservation. 5th ed. Lippincott Williams and Wilkins publication.

Shah, S., Mehta, M., Mukherjee, M.D. (2001) Occupational Health Hazards Encountered at Health Care Facility and Medical College in India. American Industrial Hygiene Association.

Silva C.E, Hoppe A.E, Ravanello M.M, Mello N, (2005) Medical waste management in the south of Brazil. *Waste Management*, **25**, 600–605.

Singh H, Rehman R and Swapnil S Bumb S.S (2014). Management of biomedical waste: a review. Int J Dent Med Res 2014;1(1):14-20

Sharma S and Chauhan S.V.S. (2008). *Assessment of bio-medical waste management in three apex government hospitals of Agra*. *Journal of Environmental Bio.* 29(2):159-162.

Sharma S (2010). Awareness about Bio-Medical Waste Management among Health Care Personnel of Some Important Medical Centers in Agra.

Singh, I.B., and Sarma, R.K. (1996) Hospital Waste Disposal System and Technology. Journal of Academy of Hospital Administration, July, 8(2), pp. 44-48.

Strati, A., 1998. Organization and Aesthetics. Sage Publishing House, London.

Srivastav S, Mahajan H, Mathur B.P, (2012). *Evaluation of bio-medical waste management practices in a government medical college and hospital.* National Journal of Community Medicine Vol 3 Issue 1. pISSN: 0976 3325 eISSN: 2229 6816

Tamplin, S. A. 2004. Issues and options for the safe destruction and disposal of used injection materials. Waste Management, 24: 359-364.

The Bio Medical Waste (Management and Handling) Rules, 1998. New Delhi, India.

Tudor T.L, Noonan C.L, Jenkin L.E.T, (2005). Health care waste management: a case study from the National Health Service in Cornwall United Kingdom. *Waste Management*, 25, 606–615.

Ubani N.J (2004). Assessment of hospital waste management in Port Harcourt metropolis. M. Phil Thesis, Environmental Management, Rivers State University of Science &Technology Port Harcourt, Nigeria.

Ulrich, R.,(2001). Effects of healthcare environmental design on medical outcomes. In: Dilani, A. (Ed.), Art, Design & Health. SvenskByggtja¨ nst, Stockholm.

United Nations Environment Program (UNEP)/SBC and World Health Organization (2005). Preparation of national health care waste management plans in subsaharan countries – Guidance Manual. WHO document production services, Geneva, Switzerland.

US EPA. *Latest Findings on National Air Quality -- Status and Trends through 2006*.

The University Of Maine (2009). Biomedical Waste Management Plan Department: The University of Maine Safety and Environmental Management Department. MP11190, 1/22/09, Rev 2

Wikström B, Westerlund E and Erkkilä J (2012). The healthcare environment—The importance of aesthetic surroundings: Health professionals' experiences from a surgical ward in Finland. Open Journal of Nursing, 2012, 2, 188-195. http://dx.doi.org/10.4236/ojn.2012.23029

World Health Organization (1999). Unsafe injection practices and transmission of blood borne pathogens. Bull. World Health Org. 77: 787-819.

World Health Organization (2004). Safe Health care Waste Management, Policy paper, Fact sheet. Geneva. Available at http//www.who.int/entity/immunization_safety/publications/waste_management/en/HCWM_policy_paper_E.pdf

World Health Organization (WHO) (2011). Wastes from health-care activities. *Factsheet*No.253, November 2011. Available from:*http://www.who.int/mediacentre/factsheets/fs253/en*

Yadav M (2001). Hospital Waste - A Major Problem.From the Department of Forensic Medicine ACOMS and Hospitals, Sidhra Jammu (Yadav). JK-Practitioner; (4): 276 – 202

APPENDIX I

QUESTIONNAIRE FOR STAFF

DEPARTMENT OF GEOGRAPHY

FACULTY OF SCIENCE

AHMADU BELLO UNIVERSITY, ZARIA.

M.Sc Environmental Management

Dear respondent(s),

I am currently carrying out a study on **BIOMEDICAL WASTE DISPOSAL AND ENVIRONMENTAL AESTHETICS OF TERTIARY HEALTH CARE CENTERS IN FEDERAL CAPITAL TERRITORY, ABUJA-NIGERIA.** This study is an academic research leading to the award of **Master of Science Degree in Environmental Management** in the above named institution. All information and data gathered in the course of this study shall strictly be used for academic purposes, therefore your responses will be treated in that regard with utmost confidentiality and anonymity.

Thank you.

Marcel OgolowaOgie

M.Sc/SCI/21229/2012-2013

PART A: RESPONDENT'S PROFILE (Staff)

Job title: _____

Position of respondent: _____

Name of Hospital: _____

PART B: DEMOGRAPHIC CHARACTERISTICS OF RESPONDENT

Gender: Male { } Female { }

Age: 20-29 { } 30-39 { } 40-49 { } 50 and Above { }

Marital Status: Single{ } Married{ } Divorced{ } Widowed { }

Educational Qualification: Qu'aranic { } Primary{ } Secondary { }Tertiary { } None **{ }**

Income Level: 20,000 &below { }21,000-30,000 { } 31,000-40,000 { }

41,000-50,000 { } 51,000 and above { }

Please indicate the appropriate answer to the questions below as they apply to your hospital, note that some questions only require a YES or NO.

1. Do you have waste bin within your hospital? YES { } NO { }
2. How are they distributed? …….
3. How often are these waste bins emptied?

   Daily { } Weekly { } Monthly { } Any other……..
4. Is there a waste dump site being used by your hospital? YES { } NO { }
5. Does the dumpsite has any interference or relationship with water supply in the hospital? If yes, briefly describe how and to what extent. YES { } NO { }

---

6. For how long is waste been stored in the hospital's dumpsite prior to evacuation?

   YES { } NO { }

7. How many times is waste at the dump site been evacuated in a:

   Day_____ Week_____ Month_____? (Only indicate the number of times)

8. Are there human dwelling places (e.g. wards, laboratory, offices, rooms or homes) in close proximity to the dumpsite? YES { } NO { }

9. Is there any medical waste management programme or policy being implemented in the hospital? YES { } NO { } If yes please state……..

10. Are there specific personnel assigned to the management of medical waste in the hospital? YES { } NO { }

11. Is there a regular or periodic training for the personnel involved with waste management?

    YES { } NO { }

12. Is there provision for protective clothing such as apron or boots, gloves e.t.c. for the personnel involved directly with waste management? YES { } NO { }

13. If yes, to what extent do you think the above provision provides the protection desired?

    _____

14. Do healthcare personnel carry out sorting of wastes prior to storage or disposal?

YES { } NO { }

15. If yes, briefly describe how and on what basis the sorting of medical waste is done in the hospital.

_____

_____

_____

16. Is waste treatment being carried out by the hospital? YES { } NO { }

17. If yes, briefly describe the means of achieving this. _____

_____

18. Is open dumping/burning method being practiced at the dumpsite? YES { } NO { }

19. Who are the people responsible for waste disposal, are they hospital personnel or contractors? _____

20. Where is the waste being transported from the hospital? _____

21. Is waste recycling being carried out in your hospital? If yes, describe ways of achieving such. YES { } NO { }

_____

_____

PART C: 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?		

PART D: DEGRADABLE AND NON-DEGRADABLE

	Present of degradable and non-degradable waste	Agreed	Disagreed
11	Is there any presence of syringes, needles, broken bottles, used blades and plastic in your hospital?		
12	Is there any presence of paper, bandage and cotton swabs?		
13	Used diapers and tissue?		

PART 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?		

PART 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?		

PART 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) *****		

Key Informant Interview

Questions to be asked during the interview will include:

- Patient capacity of the hospital
- Staff population in the hospital
- Monetary budget for biomedical waste management
- Training and retraining of staff on waste management

- Control of waste management in relation to public health concern

APPENDIX II : QUESTIONNAIRE FOR PATIENTS/CARETAKERS

DEPARTMENT OF GEOGRAPHY

FACULTY OF SCIENCE

AHMADU BELLO UNIVERSITY, ZARIA.

M.Sc Environmental Management

Dear respondent(s),

I am currently carrying out a study on **BIOMEDICAL WASTE DISPOSAL AND ENVIRONMENTAL AESTHETICS OF TERTIARY HEALTH CARE CENTERS IN FEDERAL CAPITAL TERRITORY, ABUJA-NIGERIA.** This study is an academic research leading to the award of **Master of Science Degree in Environmental Management** in the above named institution. All information and data gathered in the course of this study shall strictly be used for academic purposes, therefore your responses will be treated in that regard with utmost confidentiality and anonymity.

Thank you.

Marcel OgolowaOgie

M.Sc/SCI/21229/2012-2013

PART A: RESPONDENT'S PROFILE (Patients/caretakers)

Patient's stayed-duration in the hospital: _____

Name of Hospital: _____

PART B: BIOMEDICAL WASTE MANAGEMENT PRACTICE (BMWMP)

Gender: Male { } Female { }

Age: 20-29 { } 30-39 { } 40-49 { } 50 and Above { }

Marital Status: Single{ } Married{ } Divorced{ } Widowed { }

Educational Qualification: Qu'aranic { } Primary{ } Secondary { }Tertiary { } None **{ }**

Income Level: 20,000 &below { } 21,000-30,000 { } 31,000-40,000 { } 41,000-50,000 { } 51,000 and above { }

Please indicate the appropriate answer to the questions below by ticking the appropriate space as they apply to your hospital.

1. What is your level of familiarization with the hospital and it's environs?

   Poor { } Weak { } Fair { } Good { } Excellent { }

2. Is there waste bin(s) around your bed? YES { } NO { }

3. How often are these waste bins emptied?

   Daily { } Weekly { } Monthly { } Any other……..

4. Is there a waste dump site being used by the hospital? YES { } NO { }

5. Does the dumpsite has any interference or relationship with water supply in the hospital? If yes, briefly describe how and to what extent. YES { } NO { }

6. How many times is waste disposal being carried out from the waste bins in a:

   Day_____ Week_____ Month_____? (Only indicate the number of times)

7. Are there human dwelling places (e.g. wards, laboratory, offices, rooms or homes) in close proximity to the dumpsite? YES { } NO { }

8. Are there specific personnel assigned to the management of medical waste in the hospital? YES { } NO { }

9. Is there provision for protective clothing such as apron or boots, gloves e.t.c. for the personnel involved directly with waste management? YES { } NO { }

10. Do health care personnel carry out sorting of wastes prior to storage or disposal?

    YES { } NO { }

11. Is waste treatment being carried out by the hospital? YES { } NO { }

12. If yes, briefly describe the means of achieving this. _____

13. Is open dumping/burning being practiced at the dumpsite? YES { } NO { }

14. Who are the people responsible for waste disposal, are they hospital personnel or contractors? _____

APPENDIX III



Plate 1: Dumpsite of the University of Abuja Teaching Hospital (2014)



Plate 2: Transportation of Biomedical Waste to a Dumpsite at University of Abuja Teaching Hospital (2014).



Plate 3: Secondary Waste bin along the corridor in University of Abuja Teaching Hospital (2014).



Plate 4: Primary Waste bin close to patients' bed in University of Abuja Teaching Hospital (arrow pointing at bin). 2014



Plate 5: Secondary Waste bins in the University of Abuja Teaching Hospital (2014)