EVALUATION OF BIOMEDICAL WASTE MANAGEMENT: A CASE STUDY OF THE MATER HOSPITAL IN NAIROBI COUNTY - KENYA

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DECLARATION

I, Evelyne Atieno Othigo, declare that this project report is my original work and has not been submitted for the award of a degree in any other university.

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This project report has been submitted for examination with our approval as University supervisors.

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DEDICATION

This project report is dedicated to my husband Fredrick who gave me both moral and financial support as I studied, encouraging me that I would make it despite all the challenges in life. Also for our children Josemaria, John Chrys, Joy Catherine and Justin Manuel who wished I could be there with them all the time, but I had to leave them at home as I went to study.

It is also dedicated to Dr. Alice Odingo who has been an inspiration to me to follow in her footsteps from the time when I was in standard two.

LIST OF ABBREVIATIONS

AFRICASTI – Africa Science and Technology Information

AFUM - African Foundation for Urban Management

BMW – Biomedical Waste

BMWM – Biomedical Waste Management

CCME - Canadian Council of Ministers of the Environment

EHP – Environmental Health Perspective

EHS – Environmental Health and Safety

EMCA – Environmental Management and Coordination Act

EPA – Environment Protection Agency

ESA – Environmentally Sensitive Area

EU – European Union

GOK – Government of Kenya

GNWT - Government of the Northwest Territories

HCI – Healthcare Institutions

HCW – Healthcare Waste

HIV – Human Immunodeficiency Virus

IAGU - African Institute for Urban Management

ICU- Intensive Care Unit

MDG – Millennium Development Goal

NEMA – National Environment Management Authority

NGO – Non Governmental Organization

NWT – North West Territories

OECS – Organization of Eastern Caribbean Islands

OHA – Ontario Health Association

OMOE – Ontario Ministry of Environment

UMP - Urban Management Program

UNEP – United Nation Environmental Program

UN-HABITAT – United Nations HABITAT

U.S – United States

WHO – World Health Organization

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ABSTRACT

The research study was based on evaluation of biomedical waste management and was carried out at the Mater Hospital in Nairobi County and the main objective of the study was to examine the policies and regulations regarding biomedical waste management of the Mater Hospital. The specific objectives were to: a) Evaluate the types of biomedical wastes generated by the Mater Hospital, and know the existing practices regarding biomedical waste and its management at the Mater Hospital, b) Assess compliance of the facility's activities with Environmental Management and Coordination Act 1999 as well as Environmental Management and Coordination (Waste Management) Regulations 2006, c) Evaluate the awareness in hospital personnel regarding bio-medical waste and its management, d) Assessment of health and safety practices for the health care personnel involved in Bio-Medical Waste Management.

Both primary and secondary data were used. Secondary data was obtained from the hospitals' documents, published hospital magazines and booklets as well as the hospital website. Primary data was collected using questionnaire, informal interviews, key informant and observation checklist to check the waste categories, quantities and how they were handled; existence of BMWM plan and policies; BMW treatment methods and protective gears available for the waste handlers. The visits took 10 days between 7th and 16th of July 2013 and photos were taken where necessary to accompany the findings during the field research. The respondents were sampled using stratified sampling across the different departments in eight categories which included 8 doctors, 9 nurses, 4 radiologists, 4 pharmacists, 10 lab assistants, 6 administrative staff, 5 teaching staff and 7 support staff totaling to 53 respondents. The doctors and nurses were sampled from different departments having 1 doctor and 1 nurse from each department which were casualty, wards, consultants' clinic, theatre, dental unit, well mother clinic, well baby clinic and dialysis unit with an extra nurse from ICU.

Data was analysed using the Statistical Package for Social Sciences (SPSS) and hypotheses tested using Chi square technique. The results indicated that "Biomedical waste management practices are dependent of staff awareness".

Even though the hospital failed to provide information on the quantity of waste the hospital generated, it was concluded that there was adequate training of personnel, and awareness

regarding the proper ways of handling biomedical wastes though some of the waste handlers did not segregate wastes but mixed them up and a large amount was incinerated including the wastes that would otherwise have been noninfectious. The study concluded that regular orientation and re-orientation training programs should be organized for hospital staff and strict implementation of guidelines of biomedical waste management, to protect themselves and hospital visitors.

The study therefore recommends a training program for different levels of hospital staff in BMW management; Improving waste minimization and management; measure and quantify the amount of medical waste generated in each unit of the hospital periodically; avail the BMW management plan to all departments then a regular program of inspection and review can be undertaken within the hospital.

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CHAPTER ONE

INTRODUCTION

1.0 Background of the study

Whether in India, Tanzania, the United Kingdom, or the United States, countries around the world are coping with the proper disposal of medical waste (Globalization 2010).

Hospitals are health institutions providing patient care services. It is the duty of hospital and healthcare centers to take care of the public health. This may directly be through patient care or indirectly by ensuring a clean, healthy environment for their employees and the community (Patil & Pokhrel, 2005). In the process of healthcare delivery, healthcare waste is generated which was in the past regarded as hazardous and as such needed to be incinerated before disposal. The incineration of health care waste (HCW) results in the emission of dangerous chemicals that threaten public health and the environment (Gabela 2007).

Health facilities generate a complex array of wastes which may be broadly grouped into two categories; biomedical wastes which are direct products of activities of health facilities and other conventional wastes from health support operations such as facility construction, operation, maintenance and demolitions, food service and administrative functions (EHP 2000). Biomedical wastes are in the form of solid and liquid wastes generated in the diagnosis, treatment or immunization of human beings or animals; in medical research; or in production of vaccines or other substances produced from living organisms. They are commonly generated by hospitals, medical or research laboratories, clinics, offices of physicians and dentists, veterinarians, long term-care facilities (for example, nursing homes) and funeral homes. These wastes are simple to identify, to separate, and to treat properly. (Abor 2012)

Biomedical waste (BMW) is a potential health hazard to health care workers, the public, and the flora and fauna of the area (Askarian, Vakili, & Kabir, 2004). Eighty percent of total BMW generated by health care activities can be disposed of through regular pubic waste disposal methods. The remaining 20% is considered hazardous (U.S. EPA 2004); (WHO), 2004).

Biomedical waste may be classified into different types according to the source, type and risk factors associated with their handling, storage and ultimate disposal. The European Union has

been making a special effort to standardize waste classification through the establishment of the Waste European Catalogue (Alvim-Ferraz & Afonso, 2005).

Throughout the world, healthcare is one sector that has witnessed significant improvement. However, it seems that the fraction of waste generated at healthcare institutions has not attracted the same level of attention as other types of wastes, despite its serious health implications (Coad, 1992; WHO, 1999; Oweis *et al*., 2005). The wide variety of activities at healthcare facilities generates different types of waste and there is always a danger of spreading infection due to mishandling of infectious waste or sharps (Chaerul *et al*., 2008). Till recently disposal of hospital waste was being practiced without uniform standards and policies. In order to prevent health hazards, proper hospital waste management and codification was required to be formulated urgently (Bid & Mistry 2013).

Biomedical waste management 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, in most cases, initial segregation and storage activities are the direct responsibility of nursing personnel. If the infectious component gets mixed with the general non-infectious waste, the entire mass becomes potentially infectious. It is the responsibility of hospitals and other healthcare institutions to ensure that there are no adverse health and environmental consequences as a result of their waste handling, treatment and disposal activities (Patil & Pokhrel, 2005).

1.1 Statement of the Problem

In waste management; healthcare wastes hold higher priority due to their hazardous nature. According to World Health Organization (WHO) some part of healthcare wastes are considered most hazardous that can affect human health and pollute the environment badly. In a working environment that have unsafe health care waste management practices may result an exposure to infectious wastes by healthcare workers (HCWs), patients, clients that could in turn create infection due to blood borne pathogens (Muluken *et al* 2013).

Thousands of tons of biomedical wastes originate from hospitals, nursing homes, and medical clinics in the form of cotton swabs and bandages, IV fluid bags, needles, catheters, and human body parts, and continue to be dumped in open garbage bins and on the roads (Francis, 2000).

With apparently no administrative machinery for ensuring safe disposal of biomedical wastes generated, the problem of safe disposal of these dangerous wastes is only expected to increase (Patil & Shekdar, 2001; Silva, Hoppe, Ravanello, & Mello, 2005).

Biomedical waste rules are not followed by many hospitals, and most of them dispose of every kind of biomedical wastes in nearby public waste disposal systems without any pretreatment. Disposable syringes, needles, blood soaked pads, used blood bags, and other such materials are simply thrown in the open trash can. Sometimes liquid hospital wastes are disposed of directly into the public sewer system and Chemicals used in hospitals are a potential source of water pollution (WHO, 2004). The disposal of such hazardous wastes from hospitals into public waste disposal systems exposes people to serious health risks (Rushbrook, Chandra, & Gayton, 2000).

Even after the formulation of policies and laws on health care waste management, many health care establishments in Kenya still lack enforcement of legislation for handling, and disposal of health care waste. Furthermore, improper treatment or disposal of HCW such as open-air burning can constitute a significant source of pollution to the environment through the release of substances such as dioxins, furans or mercury (GOK 2010).

The unauthorized recycling by scavengers has become a profession in itself. Scavengers try to recycle material from dumps, putting themselves at risk from sharp objects, pharmaceuticals, and chemicals, and by coming into direct contact with infectious materials. Recycling of infectious objects poses a serious health hazard to users. Scavengers engaged in recycling mostly are extremely poor, ill educated, and unaware of harmful consequences of exposure of contaminated and hazardous wastes. Scavengers evidently suffer injuries from sharps and broken glass, among other things, as well as suffering from worm infestations, skin disease, diarrhea, chronic dysentery, and viral hepatitis (Bansal *et al* 2011)

Mater Hospital is one of the largest private hospitals in Nairobi visited by many patients daily together with the patients in the wards and therefore produces a huge amount of biomedical wastes. It has several departments that deal with a wide number of health issues which means that the types of wastes produced are also varied and believed to be hazardous or infectious. Every year the hospital conducts several heart procedures as it is well equipped with a heart unit

and catherization lab, which produces a substantial amount of wastes. The Hospital also runs a Nursing School enrolling many students every year. These students in their studies get involved in activities that produce biomedical wastes in large amounts.

This study therefore sought to understand the role of the Mater Hospital in as far as biomedical waste management is concerned. It therefore asked the following research questions:

i. How does the hospital manage its biomedical waste?

ii. Does the hospital follow the policy and guidelines on biomedical waste management?

iii. Are the staff members aware of the biomedical waste management processes in the hospital?

iv. How does the hospital protect the staff and visitors to the hospital from infection by infectious or hazardous waste?

1.2 Goals and Objectives

Examine the policies and regulations regarding biomedical waste management of the Mater Hospital.

1.2.1 Specific Objectives

i. Evaluate the types of biomedical wastes generated by Mater Hospital, and the existing practices regarding biomedical waste and its management at the Mater Hospital.
ii. Assess compliance of the facility's activities with Environmental Management and Coordination Act 1999 as well as Environmental Management and Coordination (Waste Management) Regulations 2006.
iii. Assess the awareness in hospital personnel regarding bio-medical waste and its management.
iv. Evaluate the health and safety practices for the health care personnel involved in Bio-Medical Waste Management.

1.3 Hypotheses

The study was able to test one hypothesis as highlighted below which was associated with objective three since the other objectives were achieved by use of observation check list.

H_o Biomedical waste management practices are independent of staff awareness.

H_1 Biomedical waste management practices are dependent of staff awareness.

1.4 Justification of the Study

The study on evaluation of biomedical waste management at the Mater Hospital was justified because biomedical waste handling and proper disposal has become a significant concern for both the medical and the general community as improper management poses risks to the health care workers, waste handlers, patients, community in general and the environment at large. Adequate awareness among the hospital staff concerning good practices in biomedical waste management is crucial to prevent these hazards.

Healthcare waste management (HCWM) has been identified as a major problem confronting developing countries. The situation is even more critical in Africa where healthcare waste is said to be poorly managed. In spite of this challenge, very little empirical studies exist in this regard. The few studies in the area have tended to focus on South Africa, Nigeria, Tanzania, Jordan, Brazil and India (Leonard, 2004; Longe & Williams, 2006; Manyele, 2004, Patil & Pokhrel, 2005; Oweis *et al*. 2005; Da Silva, 2005; Abor and Bouwer, 2007; Yadavannavar, 2010). In Kenya the existing studies on HCWM are too general; An assessment of the status of HCWM in Kenya(Tito 2008); Assessment of HCWM in non-government health care facilities in Nairobi province (Njogu 2009); the situation of waste management in Kenya (GOK 2010). Keeping this in view, bio-medical waste management at this healthcare set up was studied focusing on a specific area.

The research identified significant points to be corrected in the management of BMW. It will help in establishing information on the BMW of a major health care center like the Mater Hospital. The results of this study are relevant in most cities in Kenya, where BMW regulations are not strictly implemented. The study specifically examined the policies and regulations regarding healthcare waste management of the hospital. The study also examined the waste types

generated at the hospital and its healthcare waste management practices, as well as awareness among the staff on waste management.

Therefore there was need for carrying out the study to provide a basis for assessing and improving management systems and to identify and resolve environmental issues before they become problems, hazards, or risks. It is important to sensitize the workers on need of recycling and other management ways as Kenya is facing problems of degradation of the environment and the problem could worsen if the necessary measures are not put in place.

The Mater Hospital was chosen because it is one of the large hospitals in Nairobi and represents the challenges faced by large hospitals in biomedical waste management. The hospital's surrounding makes it suitable for the research as it is a mixture of residential area, industrial land uses and the Hospital is located near river Ngong which is a sensitive environment. The other branches of the Mater Hospital were not included in the study because the main hospital has more departments and deals with more cases compared to the branches that only handles outpatient cases and would not give a clear representation of the true situation at the hospital.

1.5 The Scope of the Study

The study focused on the Mater Hospital in industrial area in Nairobi Kenya, not considering the other sub-branches. Neither did it consider other hospitals nearby whether public or private. It mainly covered the healthcare wastes generated at the hospital and the management practices implored at the facility, assessing its compliance with EMCA regulations. This also included the general wastes from the offices, public area and the kitchen within the hospital but not wastes outside the facility. Therefore, the waste management practices of the waste handling company subcontracted by the facility to dispose of the wastes outside the facility were not considered.

Various departments of the facility were covered including the casualty, wards, consultants' clinics, doctors' plaza, theatres, dialysis unit, laboratories, x-ray, pharmacy, administration offices, nursing school, laundry and kitchen.

In accordance with the regulations underlined by EMCA (1999), the Waste Management Regulations (2006) and other subsequent regulatory guidelines the focus was on the issues concerning: land and soil pollution, general waste management, bio-medical waste management, occupational health and safety, effects to neighboring land uses, and hospital auxiliary units.

1.6 Operational Definitions

Biomedical Waste: is waste generated during diagnosis, treatment or immunization of human beings or animals

Biomedical waste management: is a process that helps ensure proper hospital hygiene and safety of health workers and communities.

Disinfection: is the process of killing pathogenic organism or rendering them inert**.**

Disposable Medical Supplies: assorted products used in healthcare practices that are not re-useable.

Environmental Exposure: is coming into contact with substances that may be harmful

Hazard: a situation that posses a level of threat to life, health, property or environment.

Infectious Wastes: wastes suspected to contain disease causing organisms

Needle Stick Injuries: a piercing wound typically set by a needle point or other sharp objects.

Vaccine: is a biological preparation that improves immunity to a particular disease

1.7 Research Limitations

There were many limitations during the field research as the hospital management took too long to allow the researcher to start the field work since there are specific dates set for looking at the research project requests. The researcher was also expected to visit the hospital on specific days when the Quality Assurance manager and key informant interview guide (head of housekeeping) were available according to their schedule which brought a lot of delays as the researcher also was on fulltime employment and had to ask for leave in order to make the field visits. Some departments were also restricted and the researcher could not take photos like the theatre, wards and the dialysis unit, and the researcher could only take notes on the information given.

Many questionnaires got lost and had to be replaced many times since the researcher was not allowed to distribute them directly to the respondents but only given by the head of department through the Quality Assurance manager and sometimes the respondents failed to return them.

Because of this, it was expensive to produce many questionnaires for replacement and it was also not possible to follow up with the respondents when they left gaps in the questionnaires.

Because of restrictions by the hospital, research assistants were not permitted and the researcher's visit to the hospital was limited and all the necessary work had to be done within the visiting time allowed. At the same time, the methods of waste treatment were applied at specific times which did not coincide with the times when the researcher visited the facility and the researcher had to follow up many times to be able to observe all the methods applied in BMWM. In some instances the researcher could not have informal interviews with the waste handlers especially the doctors and the nurses when they were doing a procedure on the patients but had to rely on the tour guide to give explanations on their behalf.

The Hospital management was reluctant to avail some of the documents that were useful in carrying out the research according to the researcher's check list such that the researcher had to make use of the information posted on the notice boards of the different departments or the Hospital website.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This section covers the BMW categories, waste management regulations, legal framework for BMW management, biomedical waste management, waste minimization, BMWM in the West, EU and Eastern Caribbean Islands, BMWM in Middle East and Asia, BMWM in Africa, BMWM in Kenya and Conceptual framework.

2.1 Categories of Biomedical Waste as Per the Act

The categories of bio-medical waste that was used in this project report fall under the seventh schedule of the EMCA (Waste Management) Regulations 2006, Regulation 38.

Table 2.1: Waste categories

Type of Waste	Description	Sources and examples
Infectious Waste	Waste suspected to contain pathogens	Laboratory cultures, waste from isolation wards, tissues (swabs),materials, or equipment that have been in contact with tubing, catheters, IGS toxins, live or attenuated vaccines, soiled plaster costs and other materials contaminated with blood infected patients, excreta.
Pathological waste	Human and animal tissues or fluids	Body parts blood and other body fluids, fetuses, animal carcasses.
Sharps	Sharp waste	Needles, infusion sets, scalpels, knives, blades, broken glass that may cause puncture and cuts. This includes both used and unused sharps.
Pharmaceutical waste	Waste containing pharmaceuticals	Pharmaceuticals that are expired or no longer needed; items contaminated by or containing pharmaceuticals (bottles, boxes).
Genotoxic Waste	Waste containing substances with genotoxic properties	Waste containing cytostatic drug (often used in cancer therapy), genotoxic chemicals.
Chemical waste	Waste containing chemical substances	laboratory reagents; film developer, disinfectants,(disinfectants) that are expired or no longer needed solvents
Heavy metal waste	Waste with high content of heavy metals	Batteries, broken thermometers, blood-pressures gauges
Pressurized wastes	Wastes of Pressurized	Gas cylinders, gas cartridges, aerosol

	containers	cans
Radioactive waste	Waste containing radioactive substances	unused liquids from Radio-therapy or laboratory research, contaminated glassware, packages, or absorbent paper, urine and excreta from patients treated or tested with unsealed radionuclide, sealed sources.
General solid waste	Waste generated from offices, kitchens, packaging material from stores	Paper, food, boxes, bottles
Microorganisms	Any biological entity, cellular or non-cellular capable of replication or of transferring genetic material	

Source: EMCA (Waste Management) Regulations 2006

2.2 Waste Management Regulations (2006)

The Waste Management Regulations (2006) are of particular importance to this evaluation and they can be enforced through Section 42 (4) of EMCA, 1999. They cover the various areas of significance to biomedical waste management:

a) Approval of biomedical waste generating facility

Any person who generates biomedical waste shall ensure that the generating facility has been approved by the appropriate lead agency and Local Authority.

b) Segregation of biomedical waste

Any person who generates biomedical waste shall at the point of generation and at all stages thereafter segregate the waste in accordance with the categories provided under the Seventh Schedule to these Regulations

c) Securing and packaging of bio-medical waste

All biomedical waste shall be securely packaged in biohazard containers which shall be labeled with the symbols set out in Part I and II of the Eighth Schedule to these Regulations.

d) Treatment of biomedical waste

Any person who generates waste shall treat or cause to be treated all biomedical waste in the manner set out in the Ninth Schedule to these Regulations, before such biomedical waste is stored or disposed of.

e) Storage of biomedical waste

No person shall store biomedical waste above 0º C for more than seven days without the written approval of the relevant lead agency, provided that untreated pathological waste shall be disposed of within 48 hours.

2.3 Existing Legal Framework for Biomedical Waste Management in Kenya

1. Public Health Act Cap 242
2. Radiation Protection Act Cap 243
3. Management of Hazardous Waste
4. Poisonous Substances Act 247
5. Food Drug and Substances Act 254
6. Medical Practitioners and Dentist Act 253
7. Environmental Management and Coordination Act 1999
8. Water Act 2002
9. Land Control Act Cap 406
10. Environmental Management and Regulations (Waste Management Regulations 2006)

2.4 Biomedical Waste Management

The disease causing potential of biomedical waste is greatest at the point of generation and naturally tapers off after that point, thus presenting more of an occupational concern more than a generalized environmental concern. Risk to the public of the disease caused by exposure to medical waste is likely to be much lower than risk by occupationally exposed individual. There is no scientific evidence of disease transmission from medical waste via environmental media. Several factors limit the potential for disease transmission from biomedical health facility wastes (EHP 2000).

Biomedical waste management is a process that ensures proper hygiene in the health institution and safety of healthcare workers and communities (Sanitation Connection, 2002). Johannessen *et al.* (2000) opine that proper management of medical waste can minimize the risk, both within and outside healthcare facilities. The first priority is to segregate wastes, preferable at the point of generation into reusable and non-reusable, hazardous and non-hazardous components. The identified important steps are, the institution of a sharps management system, waste reduction, avoidance of hazardous substances wherever possible, ensuring worker safety, providing secure methods of waste collection and transportation, and installing safe treatment and disposal mechanisms (Abor 2012).

There are generally four key steps to medical waste management (Johannessen *et al*. 2000):
(1) Segregation into various components, including reusable and safe storage in appropriate containers;
(2) Transportation to waste treatment and disposal sites;
(3) Treatment; and
(4) Final disposal.

The medical waste management processes include handling, segregation, mutilation, disinfection, storage, transportation and final disposal. These are vital steps for safe and scientific management of medical waste in any establishment (Acharya & Singh 2000). The key to minimization and effective management of medical waste is segregation (separation) and identification of the waste. The most appropriate way of identifying the categories of medical waste is by sorting the waste into color-coded plastic bags or containers. Medical waste should be segregated into containers/ bags at the point of generation Rao *et al*. (2004).

The WHO suggests that hospitals should provide plastic bags and strong plastic containers for infectious waste, such as empty containers of antiseptics used in the hospital (Pru¨ss *et al*., 1999). General waste like garbage, garden refuse etc. should join the stream of domestic refuse. Sharps should be collected in puncture-proof containers. Bags and containers for infectious waste should be marked with Biohazard symbol. Highly infectious waste should be sterilized by autoclaving. Cytotoxic wastes are to be collected in leak proof containers clearly labeled as cytotoxic waste. Needles and syringes should be destroyed with the help of needle destroyer and syringe cutters

provided at the point of generation. Infusion sets, bottles and gloves should be cut with curved scissors (Acharya & Singh 2000).

Disinfection of sharps, soiled linen, plastic and rubber goods, is to be achieved at point of generation by usage of sodium hypochlorite with minimum contact of an hour. Fresh solution should be made in each shift. On site collection requires staff to close the waste bags when they are three quarters full either by tying the neck or by sealing the bag. The storage area needs to be impermeable and hard standing with good drainage. It should provide an easy access to waste collection vehicle (Srivastava 2000). According to scientific standards, the infectious wastes in the tropical area can be kept in a temporary storage area for 24 h during the hot season and up to 48 h in cooler seasons (Pru¨ss *et al*., 1999).

Medical waste should be transported within the hospital by means of wheeled trolleys, containers or carts that are not used for any other purpose. The trolleys have to be cleaned daily. Off site transportation vehicle should be marked with the name and address of carrier. Biohazard symbol should be painted and suitable system for securing the load during transport should be ensured. Such a vehicle should be easily cleanable with rounded corners. Transportation of medical waste on public roads must be carried out by trained staff in a dedicated vehicle with closed containers (Johannessen *et al*. 2000)

All disposable plastic should be subjected to shredding before disposing off to vendor. Final treatment of medical waste can be done by technologies like incineration, autoclave, hydroclave or microwave (Rao *et al*. 2004). Some of the more common treatment and disposal methods utilized in the management of infectious healthcare wastes in developing countries are: autoclaves and retorts; microwave disinfection systems; chemical disinfections; combustions (low, medium, and high technology); and disposal on land (dump site, controlled landfill, pits and sanitary landfill) (Diaz *et al*. 2005).

2.5 Improving Biomedical Waste Minimization and Management

The potential for exposures of employees, patients, visitors and waste management personnel to safety, fire and health hazards associated with waste is reduced with improved BMW minimization and management. Greater emphasis on source reduction (waste avoidance)

practices eliminates or reduces waste generation and its hazards. Other minimization practices reduce the volume and toxicity of unavoidable wastes and improvement in transportation, storage treatment and disposal of wastes reduce hazards by ensuring containment of hazardous material and prompt removal of the materials from the work place. Environmental impacts can be prevented by elimination of waste at the source i.e. pollution prevention

A complex framework of state, regional and local laws, licenses and permits govern virtually all aspects of waste management from "cradle to grave". Severe penalties may be levied against both facility and individuals for noncompliance. These may include civil or criminal action leading to restriction or revocations of facility operating permits, fines and imprisonment. Liability for cost relating remediation for environmental damage from biomedical waste may be catastrophic. Generators retain liability and may be responsible for damages found years later. Costs associated with management of biomedical wastes may consume a significant amount of health facility funds. For many facilities avoidance of these costs provides ample justification of implementation of comprehensive source reduction and minimization program. Waste management issues are major source of public concern. Misinformation on waste management can create misperception about health facilities' operations (EHP 2000).

The methods of source reduction of wastes may include: reprocessing and reuse of disposable medical supplies, donation of unused or reprocessed medical supplies, reduced use of disposables and excess packaging, use of dissolvable gowns and other medical supplies.

2.6 Biomedical Waste Management in the West, EU and Eastern Caribbean Islands

In developed countries, legislation and good guidelines state the various ways for the collection, transport, storage, and disposal of BMW (Gupta & Boojh, 2006). Furthermore, the best available technologies are used for developing alternatives for proper disposal of BMW (Bdour, 2004; Tudor, Noonan, & Jenkin, 2005). Developed countries face challenges with the sheer volume of waste from the use of disposable items.

Systematic efforts to mitigate risks associated with HCWs are fairly recent. In the United States, public outcry over the discovery of hypodermic needles and other BMWs littering the New Jersey beaches in the summer of 1988 triggered legislative measures at the federal and state levels. Following the U.S. trend, other industrial and most developing countries initiated a wave of regulatory actions on HCW management (Onursal 2003)

A National Leadership Conference on Biomedical Research and Environment held in Bethesda Maryland USA in 2000 reported that in the USA, Biomedical waste generating facilities contribute a small fraction of the total amount of waste generated and the rate of generation seemed to be decreasing. Significant reduction in BMW generation was reported even at facilities that were rapidly expanding and greater emphasis on waste minimization (volume and toxicity reduction) explained the declining trend in generation. The potential for uncontrolled releases of biomedical wastes and adverse impacts on the general environment from these wastes appeared to be low. Wastes were subject to numerous regulatory requirements and were contained and managed in a manner protective of the environment.

In Ontario Canada, Ontario's Ministry of the Environment (OMOE), in conjunction with the Health Ministry and the Ontario Hospital Association (OHA) in 1992, proposed an integrated strategy for the management of biomedical waste for the province. The major focus of the initiative was the formulation of a regional approach to biomedical waste management. The proposal aimed at making Ontario self-sufficient in the management of its biomedical waste by constructing new regional incineration facilities to treat anatomical and pharmaceutical wastes. In addition, the feasibility of employing non-incineration technologies for the treatment of non-anatomical wastes was investigated. The biomedical waste incinerators that lacked air pollution-control devices were phased out as new regional facilities became operational.

The disposal of wastes, which includes biomedical wastes, is primarily subject to provincial control within Canada. As such, a number of statutes have evolved within Saskatchewan, which presently either directly or indirectly governs the treatment and disposal of these wastes in the province. These include: *The Environmental Management and Protection Act, 2002*, The Municipal Refuse Management Regulations, The Water Regulations 2002, *The Clean Air Act* and Regulations, The *Occupational Health and Safety Act* and Regulations, The *Transportation of Dangerous Goods "Clear Language Act* and Regulations" and pertinent municipal bylaws. While no direct reference to disposal of waste is made in *The Public Health Act, 1994*, it does provide power to local authorities (i.e., Regional Health Authorities) to abate health hazards, which under certain circumstances could include facility disposal practices.

The Canadian Standards Association under the direction of the Canadian Council of Ministers of the Environment (CCME) prepared a national guideline document for the management of biomedical waste in Canada. Structural changes to the CCME document have been made however, and special provisions have been added or certain management options deleted to address the unique conditions of the NWT. Section 2.2 of the *Environmental Protection Act* (EPA) gives the Minister of Environment and Natural Resources of the Government of the Northwest Territories (GNWT) the authority to develop, coordinate and administer guidelines. This guideline complements existing acts and regulations concerning hazardous waste, which should be consulted for interpretation and application.

An assessment of biomedical waste situation in hospitals of Dolj District Romania in 2008 showed that during the study, it was observed that the Dolj District Hospitals had been properly managing their biomedical waste. The hospitals had been segregating the biomedical waste every day, in accordance with the biomedical waste categories, collected in the appropriate type of container and specified color coding, in accordance with the legislation. The hospitals also followed the tables given in the legislation. The hospitals had maintained the practice of decontamination of biomedical waste before disposal or storing of the waste for 48 hours.

A report of a situational audit of the current status of biomedical waste management practices in the Eastern Caribbean islands that form the Organization of Eastern Caribbean States (OECS) is a nine member grouping comprising seven full members—Antigua & Barbuda, Commonwealth of Dominica, Grenada, Montserrat, St Kitts (Christopher) & Nevis, St. Lucia and St Vincent & the Grenadines—and two associate members, Anguilla and the British Virgin Islands, visited between the period July to November, 2007.), showed that While there were some laws and regulations that specifically address the issue of biomedical waste management, by and large, the OECS region lacked a clear and consistent legislative framework to effectively manage this issue. As a result of such a legislative vacuum, each island had developed on an ad hoc basis, its own way of handling biomedical waste.

Several positives were noted. In almost all the health care facilities visited, some degree of waste segregation was taking place, particularly with respect to sharps. Most health care personnel were at least aware of and appreciated the importance of proper biomedical waste management. Further, they were familiar with the most common ways (e.g., using sharp containers, color-

coded bags, etc.) to effect such. Several notable deficiencies were observed as well. For example, formal, regular, and specific training in best biomedical waste management practices was not common. Systems to quantify and track biomedical waste from cradle (source) to grave (final disposal) were, by and large, non-existent. Internal and external auditing procedures and mechanisms to monitor how well health care institutions were managing their biomedical waste were also not found in most health care institutions operating in the OECS region.

With respect to the methods most commonly employed to dispose of biomedical waste, the two most prevalent methods used in the region were incineration and burial in landfill sites. Both approaches were problematic and came with significant drawbacks. The use of incinerators was being steadily phased out in developed countries and replaced by treatment modalities that were less harmful to the environment and public health. The burial of biomedical waste in landfills was not being done consistently and properly in most OECS member islands, thereby increasing the risk to those who worked in this environment. Additionally, besides landfill operators, several OECS landfill sites permitted waste pickers to scavenge for items and so these, too, were exposed to potentially significant health and safety hazards arising out of non- or poorly-buried biomedical wastes.

2.7 Biomedical waste management in Middle East and Asia

A report on HCWM in India in 2003 described India's steep learning curve in the management of HCWs in the last decade and drew a number of lessons from India's experience. Since 1995, India has made great progress in managing HCWs, notwithstanding delays caused by weaknesses in the country's legal and institutional framework for HCW management. The national government promulgated Biomedical Waste Rules, prepared national guidelines, and implemented a national training program. States devised their own HCW management strategies and guidelines and provided assistance to government hospitals in implementing HCW management initiatives. Nongovernmental organizations (NGOs) played a major role in bringing the HCW management agenda to the attention of government officials, creating public awareness of HCW issues and training health care facility personnel.

The culture at many health care facilities changed to recognize the importance of adopting good HCW management practices, and the private sector became increasingly involved in providing

HCW management services both on and off the premises of health care facilities. India can now build on this initial HCW management experience to improve legislative and practical approaches. Coupling the current HCW management knowledge base with more effective use of information technology could help health care facilities in India internalize good HCW management practices as an essential component of their operation.

A review of HCW management practices at government hospitals in India in 2003 revealed wide differences in practices among hospitals in different states. State-level HCW management guidelines were sometimes prepared by local consultants and NGOs with no or little experience in other states, and such consultants and NGOs varied in their interpretations of the Biomedical Waste Rules, which were themselves inconsistent. Hospital-specific HCW management plans were also prepared by local private consultants or NGOs that varied in their interpretations of state-specific HCW management guidelines.

A study in 2007 reported that hospital waste makes up approximately 30 percent of all the hazardous waste generated in Kuwait. Segregation of the different types of wastes is practiced in nearly all of the hospitals. All infectious/medical wastes are finally disposed of through incineration. Studies show that some hospitals do not organize training courses on hospital waste management and the hazards associated with them. There is a need to establish a detailed database regarding the quantity and quality of the waste generated by the various hospitals.

In 2011, a survey on medical wastes generation, and methods adopted in hospitals of Shiraz, the largest city in the southern part of Iran and capital of the Fars province, which served as a referral center for about one quarter of Iran's medical cases reported that, in Iran, as in many other developing countries, no proper and efficient rules had been legislated as yet and also there was no useful information about medical waste management. The results revealed that in all hospitals, the wastes were collected at the end of each shift, and then collected wastes were transported to a temporary storage area by the hospital staff. The medical wastes were collected by trolley. One teaching hospital had shooting system that used only for some infectious and sharp waste, and all noninfectious wastes and other infectious waste such as pathological wastes and placenta and bloody infectious waste handling by trolley. The staff employed for handling the wastes in all hospitals used personal protective equipment included 11.1 percent trousers with

gloves, 77.8 percent trousers with mask and gloves11.1 percent trousers with boots and gloves. This study revealed that the workers used apron only sometimes for washing something in units.

Ministry of Health Malaysia in 2012 reported that hospital waste in Malaysia comprised of the general waste, clinical waste, pharmaceutical waste, hazardous chemicals, and radioactive waste where clinical waste is reported together with pharmaceutical waste. A continuous proper management of clinical waste in the hospitals cannot be practiced as there are some deficiencies and weaknesses in the management. From the research findings, the problems confronting the hospitals include lack of instructions on the aspects of clinical waste segregation and practices by nurses and intermingling of clinical waste with general waste.

A study conducted on knowledge, practices and attitude regarding BMWM among staff of a tertiary health care centre in coastal Karnataka India in January 2014 reported that the knowledge of the junior residents was the strongest (90.2%), followed by that of laboratory technicians (80%), consultants (70%), nurses (62.4%) and housekeeping staff (54%). The junior residents showed the best attitudes (94.1%), followed by the laboratory technicians (90%), consultants (88%), housekeeping staff (86.5%) and nurses (80.9%). Many consultants (24%), followed by nurses (23.3%), housekeeping staff (21.6%) and junior residents (17.6%) were not following various precautionary measures like getting immunized against hepatitis B, disinfecting sharps at the point of generation and that many had not undergone any formal training on biomedical waste management.

2.8 Biomedical Waste Management in Africa

In developing countries, medical waste materials have not received sufficient attention therefore the management of biomedical waste is still a major challenge to the hospitals (Silva, Hoppe, Ravanello, & Mello, 2005).This is because, very often, health issues compete for the very limited resources. In many countries, hazardous and medical wastes are still handled and disposed together with domestic wastes, thus creating a great health risk to municipal workers, the public and the environment. Medical waste must be separated from municipal waste, but in many parts of Africa it tends to be collected along with the rest of the waste stream (Kgathi and Bolanee, 2001; Taru, 2005).

In the preceding time, many efforts have been directed toward proper and safe management of hazardous healthcare waste for less developed countries by different organizations, particularly WHO. However, inadequate management practices are often implemented in most healthcare facilities (HCFs). A number of studies on healthcare wastes management reported that health and environmental risk posed by healthcare waste can be reduced by having careful planning, proper guideline and full participation of HCWs. Many findings in developing countries on healthcare wastes management revealed that segregation, collection of waste using recommended color coding container and storage of waste in isolated area were not satisfactory. Personal protective equipment and accessories were not provided and not used by HCWs. Moreover, healthcare wastes originating from HCFs dumped either into their backyard in a simple pit or put in open garbage to bins on the roads (Muluken *et al* 2013)

The factors behind West Africa's problems with biomedical waste stem from poor infrastructure and poor risk awareness. Due to an absence of sorting at the source, all types of waste get mixed up together along the whole disposal chain, from collection to transportation to elimination. Similarly, the risks entailed by biomedical waste remain largely ignored by all those involved, from government authorities to healthcare professionals and the wider public (Seck 2006).

In 1998 the African office of UN-HABITAT's Urban Management Program (UMP) mandated Dakar's African Institute for Urban Management (IAGU) to hold urban consultations on biomedical waste issues in four major West African cities: Dakar, Bamako (Mali), Cotonou (Benin), and Ouagadougou (Burkina Faso). IAGU conducted the program in close co-operation with the African Foundation for Urban Management (AFUM). The UMP-IAGU program focused on four activities: assessing the situation through an inclusive, participatory approach, raising awareness among local authorities and the public, identifying priority actions to improve the situation, and deploying a network of experts (UN-HABITAT 2006).

An examination of the medical waste management practices of a hospital in Southern Africa in 2007 revealed that the hospital did not quantify medical waste. Segregation of medical wastes into infectious medical waste and non-infectious medical waste was not conducted according to definite rules and standards. Separation of medical waste and municipal waste was however practiced to a satisfactory extent. Wheeled trolleys were used for on-site transportation of waste

from the points of production to the temporary storage area. Staff responsible for collecting medical waste used almost complete personal protective equipment. Offsite transportation of the hospital waste was undertaken by a private waste management company. Small pickups were mainly used to transport waste daily to an off-site area for treatment and disposal. The main treatment method used in the final disposal of infectious waste was incineration. Noninfectious waste was disposed off using land disposal method. The study showed that the hospital did not have a policy and plan in place for managing medical waste. There were a number of problems the hospital faced in terms of medical waste management, including; lack of necessary rules, regulations and instructions on the different aspects of collections and disposal of waste, failure to quantify the waste generated in reliable records, lack of use of colored bags by limiting the bags to only one color for all waste, the absence of a dedicated waste manager, and no committee responsible for monitoring the management of medical waste.

A Situational Analysis and Intervention Strategy on Health Care Waste Management in Public Clinics in the ILembe District of South Africa in 2007 showed that HCW was not adequately managed in the district. The amount of HCW generated in ILembe differed from World Health Organization norms and this is attributed to improper segregation of waste categories. Sharp waste, however, was given special treatment and properly segregated and managed. It was evident that public health sector clinics had not implemented a proper HCW management plan.

A comparative study of public and private hospitals in Ghana in 2012 indicated that managing healthcare waste is essential and must be seen as such by hospitals in Ghana. The current waste management practices are not the best and there is more room for improvement in managing healthcare waste in Ghana. Awareness needs to be created on the policies and legislative instruments that guide the handling, treatment, and final disposal of healthcare waste. It would be useful to develop an effective system of waste characterization in both public and private hospitals. Hospitals – especially the private ones – need to consider adopting a good waste segregation system. The hospitals must institute regular training regime for their staff members in charge of healthcare waste management.

A study on healthcare waste management practices among healthcare workers in healthcare facilities of Gondar town, Northwest Ethiopia in 2013 indicated that there was no waste

segregation in most studied HCFs. Healthcare wastes were stored, transported, treated and disposed inappropriately at all surveyed HCFs. Again, HCFs are becoming greater than ever to address the basic health needs of the society and to achieve the Millennium Development Goal (MDG). Previous studies focused on healthcare waste management at facility level without identifying the role of each actor on healthcare waste management practices such as HCWs, waste handlers and health managers. Credible evidence show that Healthcare waste management practices of HCWs across Ethiopian health institutions was inadequate.

2.9 Biomedical Waste Management in Kenya

In spite of the increased expansion of the health facilities very little focus has been diverted towards biomedical waste management hence contributing greatly to the deplorable state of biomedical waste management (GoK 2005).

In Kenya, mostly in the slums there are private clinics many of which lack proper management systems for medical wastes. It is not uncommon to find wastes such as syringes, needles, blades and cotton wool disposed freely at local garbage points where scavengers frequent unaware of health risks involved. The problem of medical waste disposal lies in the community especially estate clinics that are difficult to follow up when it comes to waste management. Healthcare waste is a challenge in the country due to increased amounts of waste produced and a lack of proper capacity to manage. The main mode of medical waste management is incineration, open pit burning and burying. Waste handlers risk infections such as HIV and hepatitis from needle pricks while open burning produces harmful gases resulting in respiratory problems, cancer and reproductive health problems. Kenya has legislation in place that prohibits the production of biomedical waste without the approved facility to manage it. However budgetary constraints slacken follow up of institutions within the community. (AfricaSTI 2011)

An assessment of the status of healthcare waste management in Nyanza Province in 2008 showed that there was inadequate or lack of segregation of HCW; there were lack of HCWM strategies, inadequate HCW receptacles, inappropriate internal HCW storage facilities, inappropriate internal transport facilities, delay in HCW collection, lack of budgetary allocations for HCW, tedious procurement approval process, lack of Personal Protective Equipments (PPE), lack of pre-treatment of HCW before final disposal. However in all HCFs sampled, the waste that was properly segregated was sharps, which were placed in sharp boxes. At the HCW

treatment plants, most of the HCFs had broken dilapidated "incinerators", there was lack of back up incinerators in cases of failure, broken down auto clave equipments, small capacity of incinerator and low incinerator stacks. The study findings revealed that the status of health care waste management in Nyanza province was low and contributed to environmental, social and health impacts.

An assessment of HCW in non-government HCFs in Nairobi Province in 2009 found that no facility had a HCWM plan and only (12.5%) of HCFs had a waste management team headed by a waste management officer. Waste segregation was found to be inadequate as no facility had a general waste category hence all the waste produced within these facilities were considered hazardous and had to be treated prior to disposal. Waste storage facilities were not adequate as they were easily accessible and not secure. Waste was transported manually in (88%) of the facilities, putting the waste handlers at risk of injuries and infections.

The only treatment method found to be in use within the facilities was incineration and only (54%) of the facilities were found to have functioning incinerators. The incinerators were the De Montfort type and there were no measures for emission control in place and could therefore be source of air pollution putting community at risk of disease. Private collectors were used by 2/3 of the facilities to dispose their wastes while the rest disposed them within their premises by means of a landfill or open pit. There was no specific budget allocation of HCWM except in the cases where the services of private waste collectors were used.

The knowledge of health workers on HCWM was found to be inadequate, but their attitude was found to be positive. ¾ of health workers re-cap used needles. They had low immunization rates against tetanus and Hepatitis B virus and the rate of needle prick injuries was low at 6% in the previous one month. 88% of the facilities provided personal protective equipments (PPE) for their waste handlers and the waste handlers had high levels of compliance in the usage of PPE. Immunization status and needle prick injuries among the waste handlers were also low.

A report by Government of Kenya on assessment of the situation of waste management in Kenya in 2012 revealed that good segregation practice was at only 27%, with most hospital departments mixing their waste. The wanting segregation practices coupled with lack of color coded bags,

poor labeling practices and inadequately provided bins for waste containment encouraged the mixing of waste. Poor transport facilities (mainly wheelbarrows) used also encouraged the spillage (in 63% of hospitals visited) of waste and only helped to make the situation deplorable and an obvious potential for injury and infection. It was clear that most waste disposal and storage areas were not secured from unauthorized entry. This meant that risks existed especially to people who eked their living from salvaging items for resale and who even retrieved food waste to eat. It was apparent therefore that health and safety at the workplace and environmental awareness is a crucial responsibility for all in the interest of all.

2.10 Research Gaps

During last few decades, the need for better health- care has been felt globally and to cater the needs and demands of the increasing population, a rapid mushrooming of hospitals, both in private and Government sector has occurred. Consequently there has been a proportionate increase in the quantum of waste generated by these health care centers but it is ironic that the health care settings, which are meant to restore and maintain community health, are also threatening their well-being. It was important to research in this area find out what the situation is like.

Existing research in Kenya has not explored the management of biomedical waste extensively and the existing studies are too general. This research attempted to present the concept in an elaborate manner. Moreover, biomedical waste management practices are not static and new ideas are emerging every day trying to strengthen sound biomedical waste management practices to achieve sustainable development.

Like other types of wastes, healthcare waste is caught in the middle of the "waste crisis" facing the world. This is due primarily to increased generation of medical waste and escalating costs of the handling, transport, and disposal of medical waste. The proper disposal of medical waste has become a controversial issue. Therefore it was important to have the research done so as to create awareness among the staff and sensitize on need of proper biomedical waste handling.

It was also necessary to push for the implementation of the policies and rules that exist but are not put into practice or just partly practiced.

2.11 Conceptual Framework

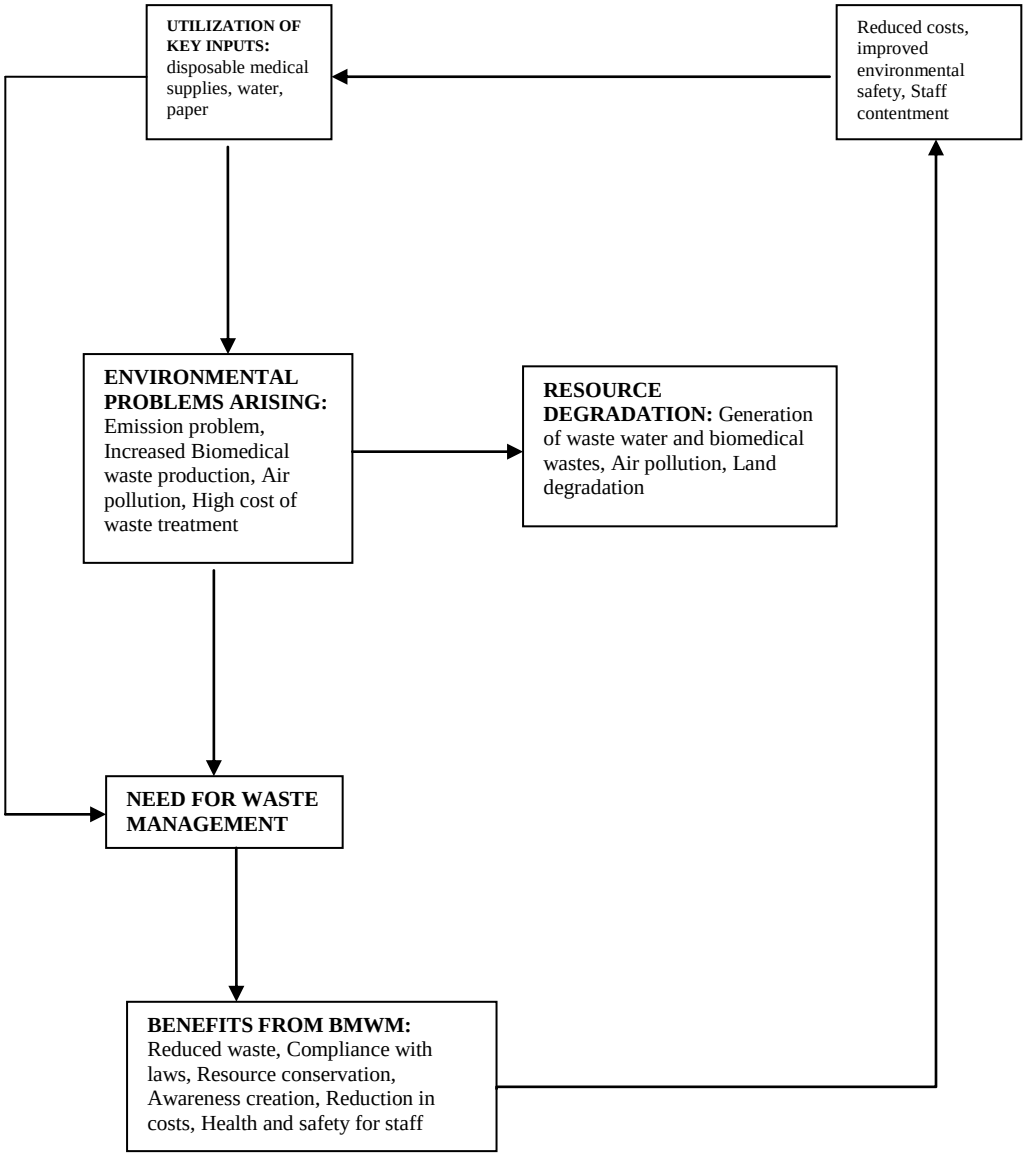

Fig 2.1: Conceptual Framework

Source: Adopted from Parita 2008

Bio-Medical wastes generated in hospitals can be hazardous or infectious. They can be injurious to humans or animals and deleterious to environment. Land and soil pollution through disposal of biomedical waste can have an immense negative environmental impact if not mitigated. These

include the contamination of ground water resources through the infiltration of hazardous pollutants to water and contamination of soil by non-biodegradable substances.

Poor waste management practices pose a huge risk to the health of the public, patients, professionals and contribute to environmental degradation since healthcare institutions generate tons of biomedical waste each year. Due to the lack of investment and infrastructure, in some cases, waste water discharged from hospitals often runs directly into nearby water bodies and improperly discharged wastes to sewers generates waste water potentially dangerous to handlers.

It is mandatory requirement for all hospitals to treat all the categories of BMW generated out of the hospital before it is finally disposed. The technologies involved such as chemical treatment, sterilization by autoclave, microwave, and incinerator are very expensive and beyond the reach of most hospitals. The cost containment measures of BMW are going to have a great impact on economics of hospital in general and in this perspective, on waste management pertaining to environmental aspects.

A solution is therefore required and one aspect is waste reduction. Implementing waste reduction strategies leads to a source-reduction approach to waste management whereby the creation of waste is avoided and its by-products are recycled as much as possible. Waste reduction means cost reduction. One should limit the waste management cost by cutting waste generation. There are many new and exciting waste minimization programs being offered to health care facilities. If possible, reusable biomedical supplies can be made and used rather than using the disposables ones. Segregation at the point of generation is the essence of BMW management. If the BMW is not segregated at the point of generation, the whole hospital waste will be infectious - BMW that requires high cost of treatment. Therefore a segment of waste can be removed from the contaminated stream, potentially reducing hospital costs and improving the environment.

An effective program of hospital waste management can have distinct economic benefits such as cost saving linked to waste reduction and improved purchasing power. Besides, there are other supporting advantages like improvement of environmental safety, public image and staff contentment, and potential economic benefits such as less cost to be paid for energy and water consumption. For the facilities to make an effort to improve minimization and waste

management there should be regulatory compliance and avoidance of high disposal costs and liabilities associated with generation of biomedical wastes.

CHAPTER THREE

STUDY AREA

3.0 Introduction

This chapter gives details on the study area, specifying its location, history, physical configuration and staff.

3.1 Location

The Mater Hospital is located in the Industrial area in South B location under Starehe constituency in Nairobi County. It is located along Dunga road in South B. Mater is known for dealing with heart problems and many other human body diseases. To the East of the hospital across the road there is a school called Saint Catherine primary, a VCT centre called Mary Immaculate Rehabilitation Centre, a Kobil petrol station and a motor garage, surrounded by several dealers in motor spare parts. To the West there is an extensive slum "Mukuru Fuata Nyayo" which begins right from the wall of the hospital with a few slum dwellers using the hospital concrete wall as part of their wall.

On the Northern side of the hospital is a private piece of land that has been leased to a motor car dealer who shares the hospital's live fence. Next to it is a car tracking company, a motor garage, car wash, and a small farm also sharing part of the live fence with the hospital. Farther still is river Ngong which is about 100 meters from the hospital fence. The Southern side of the hospital across the road is a mushrooming slum together with some stalls and shops made of iron sheet just a few meters from the hospital fence and a few meters from the slum is the flats of Mariakani estate. On the same side of the road about 30meters from the hospital is the chief's camp South B location together with the Administration Police station and Kenya Red Cross community disaster response team within the same compound.

3.2 The Mater Hospital

The Mater Hospital was founded in 1962 by the sisters of Mercy, (a Catholic Order of Nuns originating from Ireland) it was converted to a non-profit Trust and the sisters continue to oversee the administration of the Hospital as Trustees and to participate in the Governing meetings and various operational parts of the Hospital. The Hospital lies in a 12acre land in Industrial area in Starehe Constituency in Nairobi.

The key interested stakeholders of the Mater Hospital include: the Ministry of health through the Provincial Medical Officer (Nairobi County), the District Medical Officer (MOH), the local

Catholic Diocese, the Provincial Director of the Environment (Nairobi County), the District Environmental Officer, Local political structures (Governor, Senator, MP, County Representatives) and Provincial Administration. The hospital medical support activities include: Medical Support Services (outpatients and inpatients), Dental Support Services, Diagnostic Support Services, Pharmaceutical Support Services, Physiotherapy Services, Consultancy Services and mortuary.

The Mater Hospital staff structure is composed of 485 staff members categorized as doctors, nurses, pharmacists, lab technicians, radiologists, teaching staff, administrative staff and support staff. There are also a number of doctors and consultants who work part time at the hospital. Others include the Doctor's plaza for private practicing doctors, a nursing school run by the hospital, a restaurant and a catholic chapel.

The hospital's bed capacity is 216 and receives many outpatient and emergency cases that their numbers were not disclosed to the researcher. Due to the large number of patients and visitors who visit the facility, the hospital faces a parking problem such that every little space is used for parking even right in front of the incinerator.

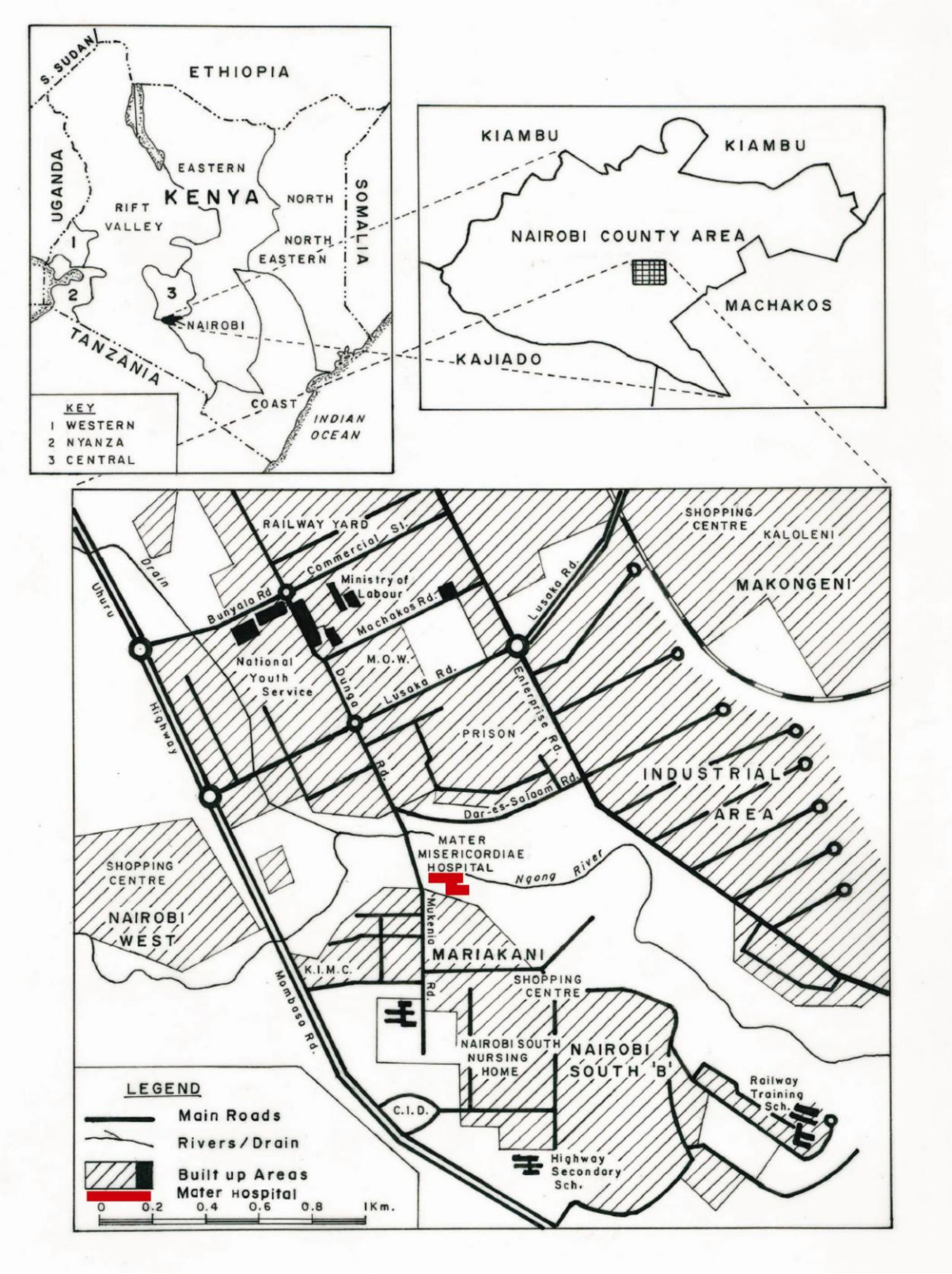

Figure: 3.1 Location of the Mater Hospital in Nairobi County

Sources: Survey of Kenya, GIS 2013

3.3 Hospital Neighborhood

The Mater Hospital's neighborhood has a mixture of Industrial land use, small scale businesses, settlement and schools. The Mater Hospital has a neighborhood that includes South B estate which is middleclass neighborhood located in Makadara division. It's also densely populated with Mukuru Fuata Nyayo slum starting next to the hospital. Easily noticeable are many retail shops that stock groceries, clothes, shoes and other such like items. There is a shopping centre and capital centre along Mombasa road. Also noticeable are bank branches and restaurants. There are also guest houses, hotels, educational institutions, places of worship and medical clinics.

3.3.1 Land Tenure

The land tenure around Mater Hospital is mixed with private land ownership, government land as well as Open access which is free for all. The land occupied by the slum dwellers belong to the government but has been converted to an open access by the occupants who have acquired the land illegally or rented from land-loads who acquired the land illegally. It has become open to exploration and has been used for settlement, small scale business and also for institutions of learning. The private land around the hospital has been used for settlement or rental and other commercial purposes with a small section next to the hospital used for agricultural purposes.

3.3.2 Land Use Zones

There is segregation of land use into different areas for each type of use: agricultural, industrial, residential, recreational etc. The land uses include Nairobi's Industrial district together with homes made of corrugated iron shucks situated close to manufacturing industries. Others operate small-scale businesses selling vegetables and fruits or hawking various items. A small section of land is also used for agriculture where food crops like maize, beans and potatoes are planted.

3.3.3 Sensitive Environments

Environmentally sensitive areas (ESA) are land and water areas containing natural features or ecological functions of such significance as to warrant their protection in the best long-term interest of the people and environment. One of such is river Ngong which runs through industrial area about 100meters from the Mater Hospital fence. The river at this point is polluted and very little research could be carried out to determine whether the operation of the Matter hospital

contributed to the rivers pollution since there were many manufacturing companies surrounding the area together with motor vehicle mechanics.

It would also be uncertain to tell whether some of biomedical waste that could be found around or inside the river could come from Mater since there are many other health facilities around the area as well as private clinics.

CHAPTER FOUR

RESEARCH METHODOLOGY

4.0 Introduction

This chapter gives details on the research design the study employed, sampling procedures as well as source used to generate data.

4.1 Research Design

This study examined the biomedical waste management practices of the Mater Hospital in Nairobi, and planned as a single case study of the facility. It adopted an observational and descriptive research design. This design described the current situation of the Hospital if the hospital is complying with the biomedical waste management rules and regulations as described in the Environmental Management and Coordination Act 1999 as well as Environmental Management and Coordination (Waste Management) Regulations 2006.

This involved surveys and fact-finding of different kinds.

4.2 Sample Size and Sampling Procedures

A stratified sampling technique was employed, the participants being stratified according to their designation and from various departments within the hospital in eight categories which included 8 doctors, 9 nurses, 4 radiologists, 4 pharmacists, 10 laboratory assistants, 6 administrative staff, 5 teaching staff and 7 support staff totaling to 53 respondents. The doctors and nurses were sampled from different departments having 1 doctor and 1 nurse from each department which were casualty, wards, consultants' clinic, theatre, dental unit, well mother clinic, well baby clinic and dialysis unit with an extra nurse from ICU. It was not possible to get the target population as many health workers worked on part time basis especially the doctors and the numbers varied. Some private consultants also admitted their patients at the hospital.

The first stage in methodology involved an examination of the rules, procedures, and regulations set forth by the hospitals' directory to be followed by the personnel regarding the management of biomedical waste generated at the hospital. The second stage included visiting the different departments of the hospital recording observations and writing notes about the practices of the biomedical waste management by staff responsible for waste management. On completion of data collection, all checked questionnaires were sent to a statistician for processing. SPSS software was used for data analysis.

Table 4.1: Sampling Component from the Hospital

Population components	No. of units in the sample
Doctors	8
Nurses	9
Pharmacists	4
Lab Technicians	10
Radiologists	4
Teaching Staff	5
Administration Staff	6
Support Staff	7
Total	53

Source: Fieldwork 2013

4.3 Sources of Data

Both primary and secondary data were used. Primary data was collected using questionnaires, informal interviews, key informant (head of housekeeping) and by observation for 10 days between 7th and 16th of July 2013. Photos were taken where necessary to accompany the findings during the field research. These visits were made to the casualty, wards, consultants' clinics, doctors' plaza, theatres, dialysis unit, laboratories, x-ray, pharmacy, administration offices, nursing school, laundry and kitchen. Secondary data was obtained from the hospitals' documents mainly on the notice boards of various departments, published hospital magazines and booklets as well as the hospital's website on internet.

4.3.1 Primary Data

Primary data was generated using questionnaires, informal interviews, observation checklist and key informant interview guide.

4.3.1.1 Questionnaire Survey

The questionnaire and interview guide were, however, pre-tested in order to inform the shaping of the final questionnaire. Considering the sensitive nature of such questions, the pre-testing exercise was important. Prior approval was gotten from the management of the hospital in obtaining information for the study. The results obtained were discussed to ascertain the extent to which biomedical wastes are handled in the light of written policies and the established international standards in this regard. Precautions like wearing an apron, use of thick impermeable gloves, wearing a face mask, and so forth, were taken.

4.3.1.2 Informal Interviews

Informal interviews were conducted among the staff members of various departments concerning the management of biomedical wastes in their departments. It also focused on staff awareness of the policies and regulations applied in biomedical waste management.

For the neighboring land users, informal interviews were conducted among a few residents and business operators in the area together with the chief and administration police from the chief's camp. The main issues addressed were concerning environmental management activities carried out in collaboration with the Mater Hospital and the impacts due to the hospital's operation in the area.

4.3.1.3 Observations

Throughout the field research, observations were made concerning the biomedical waste handling by the waste handlers at the hospital. Photographs were taken where necessary to accompany the results.

4.3.1.4 Checklist and Key informant Guide

Using a checklist prepared by the researcher, a key informant guide who is the head of housekeeping took the researcher to various departments and also gave the necessary information needed as regards the biomedical waste handling at the hospital.

4.3.2 Secondary Data

Secondary data was obtained from the hospitals' documents that were available mainly on the notice boards of various departments guiding the employees' activities on biomedical waste management as directed by the hospital's management, published hospital magazines and booklets as well as the hospital website on internet.

4.4 Data analysis

Data collected through the questionnaires, observations, informal interviews and key informant were taken for data analysis. All data collected was documented and subjected to statistical analysis in order to draw conclusions and make recommendations. SPSS software was used to interpret the result. These were presented in pie charts and bar charts for easy understanding of the results.

4.5 Chi-Square

Chi-square, (χ^2) is a statistical measure used in the context of sampling analysis for comparing a variance to a theoretical variance. As a non-parametric test, it can be used to determine if categorical data shows dependency or the two classifications are independent. It can also be used to make comparisons between theoretical populations and actual data when categories are used.

In the table, there are five categories of awareness which include awareness of general practices, safety practices, reports, resource allocation and quality control. There is the observed negative response and observed positive response. The calculations are shown below in table 4.1.

Table 4.1: Calculation of Chi - square

Awareness category	**Negative response**			**Positive response**			**Total**
	Observed (O)	Expected (E)	$(O-E)^2/E$	Observed (O)	Expected (E)	$(O-E)^2/E$	
General	48	22	30.7	5	31	21.81	53
Safety	25	22	0.41	28	31	0.29	53
Reports	13	22	3.68	40	31	3.90	53
Resource allocation	7	22	10.23	46	31	7.26	53
Quality Control	16	22	1.64	37	31	1.16	53
	109		**46.66**	**156**		**34.4**	**265**

Sample size, N = 265

Expected values:

Negative response = $\frac{(53)\,(109)}{265} = 22$

Positive response = $\frac{(53)\,(156)}{265} = 31$

$$\chi^2 = \sum \frac{(O-E)^2}{E}$$

Positive response

$$\chi^2 = \sum \frac{(O-E)^2}{E} = 46.66$$

Negative response

$$\chi^2 = \sum \frac{(O-E)^2}{E} = 34.4$$

Calculated Chi-Square χ^2= 46.66 + 34.40 = 81.66

Degree of freedom is here given by the formula (rows-1) (columns-1) = (4-1) (2-1) = 4

Critical value of chi-square using tables at 0.05 confidence level gives 9.49, i.e.

χ^2 critical = χ^2 0.05, 4 = 9.49

Since chi-square calculated is greater than chi-square critical, the H_0 is rejected in which case the conclusion is that Mater is well run, and "Biomedical waste management practices are dependent of staff awareness."

CHAPTER FIVE

RESULTS AND DISCUSSION

5.0 Introduction

This chapter presents analysis and findings of the study as set out in the research methodology. The research data was gathered through questionnaires as the primary research instrument, informal interviews, tour guide interview and observation using a checklist.

5.1 Types of biomedical wastes in Mater Hospital

The categories of bio-medical waste that were used in this BMWM evaluation report fall under the seventh schedule of the EMCA (Waste Management) Regulations 2006, Regulation 38. The various waste types indicated in table 5.1 are categorized according to the waste sources within the facility. They are divided into patient services, laboratories and support services. The waste categories included: general, pathological, infectious, radioactive, pharmaceutical, chemical, pressurized and sharps.

The general wastes were found in all departments in different forms and were segregated in black bins and liners. Sharp wastes were segregated in sharp boxes in all departments except radiology department and support services since no sharp objects are used in these places, but laundry which is under the support services was found to have sharps and even infectious wastes because the linens and protective gears from different departments sometimes went with some of the wastes that were not disposed of properly.

Most of the departments apart from the support services produced the different types of waste but the radiology unit had only general, chemical and radioactive wastes because of the nature of the procedures done there. However, the wastes in the pharmacies varied depending on which department it served. The pharmacy serving Doctor's plaza and consultant's clinic only produced general wastes, while the pharmacy serving the wards and emergency cases in the outpatient sometimes in addition had sharps and pharmaceuticals because of returns of what patients did not utilize fully that required disposal. The laboratory produced most waste categories as it handled many procedures.

Table 5.1: Types of waste generated in the hospital

Sources	General	Pathological	Radioactive	Chemical	Infectious	Sharps	Pharmaceutical	Pressurized Containers	Est. Quantity kg/day
Patient services									
Medical	X	X			X	X	X		0
Sluice Room	X			X	X	X	X		0
Operating theatre(s)	X	X		X		X		X	0
Wards	X				X	X	X		0
Isolation ward	X	X		X	X	X	X		0
Dialysis unit	X	X	X	X	X	X	X		0
Dental unit	X					X	X		
Emergency	X	X			X	X	X		0
Outpatient clinic	X	X			X	X	X		0
Autopsy room	X	X		X	X	X			0
Radiology	X		X	X				X	0
Laboratories									
Microbiology	X	X		X	X	X			0
Pathology	X	X		X	X	X			0
Support services									
Laundry	X	X			X	X			0
Kitchen	X								0
Engineering	X								0
Administration	X								0
Public areas	X								0

X - Indicates type of waste generated at different sources in the hospital

0 – Indicates that the quantity is not known

Source: Field work 2013

Even though it is a requirement that all wastes from the hospital should be quantified, the Mater Hospital did not quantify its wastes and it was not possible to tell which department produced the most wastes and which type of waste was produced most at the facility.

5.2 Biomedical Waste Management Practices in Mater Hospital

In all departments, waste was found to be segregated using color coding according to the directions given by the hospital management, but some staff members did not follow this due to either lack of awareness or forgetfulness because of not being reminded after the initial introduction. Wastes from different departments then sometimes got mixed up and whatever would have been safely disposed of without treatment either became infectious or hazardous and had to be incinerated first before final disposal. The quantity of waste that required treatment then went up and that means that the cost of treatment is also up and rate of pollution caused by the incinerator is also high.

5.2.1 Management of General Wastes

General waste from the hospital consists of: organic waste-mostly food remains and kitchen related by products, paper waste, plastic waste, bottles. Every department from the hospital generates general waste which is mostly gathered in a green bin and lining, and when the bin is full the housekeeping personnel in charge collects the waste to be put in black polythene bags awaiting final disposal by the contracted waste disposal company that disposes wastes for the Mater Hospital.

The Kitchen which produces general wastes from food remains is located on the ground floor of the main building where the wards are and the Administration block. It has two doors, one opening into the corridor of the wards and the other one opens into an open space near the hospital's dining hall for the staff. It is a very spacious room well equipped with modern kitchen facilities that use either gas or electricity for heating. No charcoal or firewood is used for heating and therefore there is no air pollution caused by smoke.

The hospital has however contracted a catering company (NAS cuisine) to provide for the food and drinks used at the hospital by patients and staff. The food is prepared at the company's headquarters at the Jomo Kenyatta International Airport and transported to the hospital using a

vehicle. The cookers in the kitchen are only used for warming food already prepared or for boiling milk.

All the wastes from the kitchen are collected in white plastic bins with liners, and then transferred to a big black bin just outside the kitchen awaiting collection by the NAS Company's vehicle that collects the wastes everyday to be taken to the headquarters for segregation and final disposal. The food remains from the wards is normally dumped together with the aluminum foil and polythene paper used for covering the food when serving as well as used serviette papers. There is no waste segregation at all for the kitchen waste. Any food that is not served to the patients or staff is kept in the fridge at a specified temperature but if it overstays is taken back to the headquarters for disposal.

Plate 5.1: The black bin outside the kitchen

Source: Field work 2013

5.2.2 Management of Mixed Wastes

The Mater Hospital faces a challenge of dealing with mixed wastes from different departments due to neglect by various waste handlers. The laundry is housed adjacent to the wards and uses the washing machines and a steamer and handles the cleaning of linens and staff protective clothes. The wastewater from this source is recycled and used in the steamer. The laundry receives linens from all the departments and is always faced with the problem of receiving mixed wastes left in the pockets or wrapped in the linens from different departments. These wastes

always have to be taken for incineration because they all get infectious after being mixed. The staff members are also in danger of being injured with the sharps that are left in the linens.

Some waste handlers also mixed wastes despite the presence of the color coded containers for the segregation of wastes in different departments. It was either due to neglect or lack of awareness by some staff members who had either not been trained in safe waste handling or had forgotten about the management practices.

5.2.3.1 Waste Segregation using disposal color codes

At the Mater Hospital, all departments are directed to use the color codes for separating wastes as guided by the hospital management depending on the type of waste that is handled by that particular department as shown below:

Table 5.2: Waste disposal color code

Color Code	**Type of Wastes**
Red Dustbins	All used swabs, used catheters, used gloves, I.V giving sets, body tissues, contaminated papers, vacutaners and ampoules.
Black Dustbin and Liner	Plastic papers, Empty I.V bottles, Empty medicine bottles, All types of papers, Paper hand towels
Yellow Bins	Syringe, Needles, Branulas, Surgical bottles, Ampoules, Vials, Cuvettes
Green Bins	Kitchen wastes

Source: Field work 2013

These colors codes are now in the process of being changed like the kitchen is already using White bins with white liners for the collection of wastes instead of green. Through all the departments except the administration and the public area, the different color codes are used for the segregation of waste before transportation for final disposal. In the public area there are metallic bins used for general wastes, even though sometimes you find things like diapers dropped in by patients after changing their babies.

The color coding practice is being followed by most departments at the hospital but a few individuals are still found to be neglecting the use of color codes. The waste that is better handled and in just a few instances get mixed up with other wastes are the sharps that put in sharp boxes made of cardboard.

Plate 5.2: Cardboard box used for sharps

Source: Field work 2013

The sharps are put in cardboard boxes placed in all departments that produce sharps.

5.2.3.2 Storage

A storage location for health-care waste should be designated inside the health-care establishment or research facility. The waste, in bags or containers, should be stored in a separate area/room, or building of a size appropriate to the quantities of waste produced and the frequency of collection.

At the Mater Hospital, each unit has a Sluice room where all the wastes segregated are stored before disposal. The room is big enough to hold all the wastes from the unit that it is serving. These wastes are collected by the housekeeping staff on duty from the point of waste production and taken to the sluice room for further management.

5.2.3.3 On-site transport

Health-care waste should be transported within the hospital or other facility by means of wheeled trolleys, containers, or carts that are not used for any other purpose and meet the following specifications: easy to load and unload; no sharp edges that could damage waste bags or

containers during loading and unloading; easy to clean. All waste bag seals should be in place and intact at the end of transportation.

The Mater Hospital has provided wheeled trolleys and carts for transporting wastes within the facility and each unit has its own trolleys and carts. They meet the specifications of the trolleys.

Plate 5.3: Sluice room with different waste bins and used linen bag

Source: Field Work 2013

Plate 5.4: Wheeled trolley used for onsite transportation

Source: Field Work 2013

5.2.3.4 Labeling

All waste bags or containers should be labeled with basic information on their content and on the waste generator. This information may be written directly on the bag or container or on preprinted labels, securely attached. According to the eighth schedule regulation 39 of the waste management regulations 2006 (WHO recommendations for classifying substances), the indications should appear on preprinted labels, securely attached.

At the Mater Hospital, the sharp boxes were clearly labeled with bio safety hazard and sharps, but the other containers or bags were not labeled, though the colors indicated what type of waste it contained and each unit had its own internal storage which made it easy to tell the source of the wastes.

5.2.3.5 Collection

The housekeeping staff should ensure that waste bags are tightly closed or sealed when they are about three-quarters full. Bags should not be closed by stapling. Sealed sharps containers should be placed in a labeled, yellow infectious health-care waste bag before removal from the hospital ward or department. Wastes should not be accumulated at the point of production. A routine program for their collection should be established as part of the health-care waste management plan.

Table 5.3: Bio-medical Waste labeling handling and storage

	Type of Waste	**Color of Container and Markings**	**Type of Container**	**Compliance**
1.	Infectious	Red	Strong leak proof-plastic bag	Use of red leak proof bags.
2.	Pathological	Red	Strong leak proof-plastic bag	Use of red leak proof bags.
3.	Sharps	Yellow– (marked sharps)	Puncture proof	Use of cardboard marked sharps
4.	Chemical	Yellow	Plastic bag or container	Use of yellow plastic bags
5.	Non-infectious/non hazardous (Non-clinical	Black	Plastic bag or container	Use of black plastic bags
6.	Radioactive waste	-	Lead box, labeled with radioactive symbol	Use of lead box, labeled with radioactive symbol

Source: Field work 2013

It is recommended that the ancillary workers in charge of waste collection to adhere to the following:

a) Waste should be collected daily (or as frequently as required) and transported to the central designated management site.
b) No bags should be removed unless they are labeled according to their source of generation (e.g. general waste, bio-medical waste, organic waste etc) and contents.
c) The bags or containers should be replaced immediately with new ones of the same type.

A supply of fresh collection bags or containers should be readily available at all locations where waste is produced.

At the Mater Hospital all these are observed except that the bags were not labeled according to the source and sometimes in some departments wastes were not collected frequently for transportation to the designated management site until the bins overflowed with wastes. However, the sections that followed the directions had the wastes collected frequently in different color coded bags when not yet full and there were no spillages. The waste were then transferred to the sluice room awaiting the necessary form of treatment before transporting to the central waste receptacle in black bags for final disposal by the private waste collecting company.

Plate 5.5: Wastes in black polythene bags inside the central waste receptacle .

Source: Field Work 2013

5.4 Compliance of Mater Hospital to EMCA

This is with respect to the Environmental Management and Coordination Act 1999 as well as Environmental Management and Coordination (Waste Management) Regulations 2006.

The table below shows the level of compliance of the Mater Hospital to EMCA. The hospital has adhered to the EMCA regulations even though segregation is not fully done by some waste handlers in selected cases.

Table 5.5: Level of compliance to the Environmental Management & Co-ordination Act (1999)

Guideline item	Action taken	Compliance
Approval of biomedical waste generating facility	Any person who generates biomedical waste shall ensure that the generating facility has been approved by the appropriate lead agency and Local Authority.	The facility was approved for operation
Segregation of biomedical Waste	Any person who generates biomedical waste shall at the point of generation and at all stages thereafter segregate the waste in accordance with the categories provided under the Seventh Schedule to these Regulations	All wastes segregated using color code
Securing and packaging of Biomedical waste.	All biomedical waste shall be securely packaged in biohazard containers which shall be labeled with the symbols set out in Part I and II of the Eighth Schedule to these Regulations	All BMWs packaged in containers marked biohazard
Treatment of biomedical Waste	Any person who generates waste shall treat or cause to be treated all biomedical waste in the manner set out in the Ninth Schedule to these Regulations, before such biomedical waste is stored or disposed of.	Different methods of treatment used for different waste categories

Storage of biomedical waste.	No person shall store biomedical waste above 0º C for more than seven days without the written approval of the relevant lead agency, provided that untreated pathological waste shall be disposed of within 48 hours.	All wastes treated and collected daily by the private waste company contracted

Source: Field work 2013

5.4.1 Treatment Methods of Bio-Medical Wastes

As per the Ninth Schedule, Regulation 40 the treatment methods of Bio-Medical Wastes are as summarized in the table below:

Table 5.6: Treatment methods of biomedical wastes

Waste category	**Treatment method**	**Action Taken** (treatment as per requirement by waste Management regulations
Contaminated bodies	Incineration	Incinerated
Cultures and stock	Steam sterilization	Steam sterilized
Contaminated bedding/patient care waste	Steam sterilization or Incineration	Steam sterilized
Contaminated small equipment	Steam sterilization or Incineration	Steam sterilized
Contaminated large equipment	Formaldehyde decontamination	Decontaminated with formaldehyde
Waste biological	Steam sterilization or Incineration	Incinerated
Surgery waste	Steam sterilization or Incineration	Incinerated
Human blood	Steam sterilization or Incineration	Incinerated
Autopsy waste	Incineration	Incinerated

Human blood products	Steam sterilization or Incineration	Incinerated
Contaminated laboratory waste	Steam sterilization	Incinerated
Pathological waste	Steam sterilization or Incineration	Incinerated
Dialysis unit waste	Steam sterilization	Incinerated
Contaminated and unused sharps	Steam sterilization or Incineration	Incinerated
Anti-neoplastic drug waste	Incineration	Incinerated

Source: field work 2013

All the wastes produced by the hospital except the general waste gets to be treated before disposal and the main method used is incineration as the table shows above. Some waste that require steam sterilization, microwaving or autoclaving is exposed to these processes where necessary particularly in the laboratories, dental unit and the theatres. However, a lot of noninfectious waste sometimes end up being incinerated after being mixed up with the infectious wastes.

Plate 5.6:Autoclaving machine used in the laboratory

Source: Field Work 2013

Plate 5.7: The new and old incinerators

Source: Field Work 2013

In order to handle the biomedical waste at the hospital well, the Mater Hospital has installed a new incinerator that handles large volume of wastes compared to the old one.

5.4.2 Standards for Biomedical Waste disposal sites

According to regulation 47 no person shall be issued with a license to operate a biomedical waste disposal site or plant unless such site or plant complies with the requirements set out in the Third and Tenth Schedule to these Regulations. The Mater Hospital does not have a biomedical waste disposal site as all the waste segregated or treated either by incineration, chemical treatment or autoclaving is usually disposed of by a contracted private waste company and there are no burial sites and neither do wastes get burnt openly at the premises.

Policies and procedures should be made available to all waste handlers and should include the following:

a) Strategies for minimizing the quantities of biomedical waste generated and disposed of;

b) Methods of segregating, packaging, labeling, moving, storing, treating, and transporting the various waste types (both on- and off-site, as appropriate);

c) Methods for keeping records of the quantities of biomedical waste generated, treated, and disposed of;

d) A list of all regulations and legislation concerning biomedical waste that is applicable.

e) A list of those responsible for managing biomedical waste in the event of an accident or spill; and

f) Provision for regular, ongoing staff instruction about proper handling and potential hazards of biomedical waste.

5.5 Awareness of Hospital staff in waste management practices

This section assesses the awareness of the hospital personnel regarding the biomedical waste management practices at the hospital.

5.5.1 Staff awareness of policies regarding BMW management

In assessing the awareness among the respondents concerning the different policies that address environment, health and safety at work place, the results show that 24.5% gave no response indicating that they were not aware of any policy. However, 34% were aware of the Mater EHS policy, 18.9% policy on segregation, 7.5% policy by NEMA, 5.7% needle prick policy and policy on recycling with the lowest 3.8% waste disposal policy. The results show that majority of the respondents 75.5% were aware of some policy to be adhered to at work place.

Mater Hospital has an Environmental Health and Safety Policy (EHS) which states that "The Mater Hospital manages its operations in a manner demonstrably protective of human health and the environment and with compliance with all applicable laws. We encourage innovative and creative ideas to meet our environmental goal through conservation, reduction, re-use and recycling programs. We are committed to improving and safeguarding the environment by partnering with others in our community. We also strive to protect all our staff and clients from any health occupational hazards".

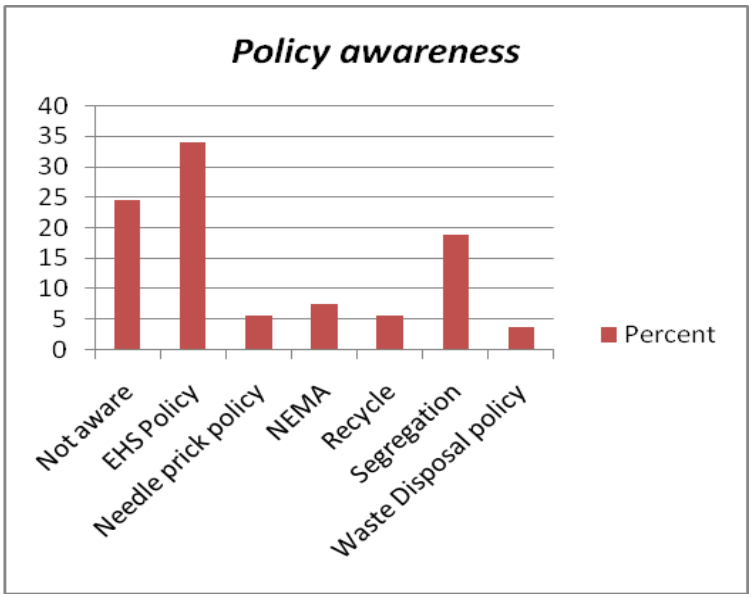

Figure 5.1: Staff awareness of policies regarding BMW management

Source: Field Work 2013

5.5.2 Awareness of staff concerning biomedical waste handling and disposal

Concerning awareness on various forms of bio-medical wastes handling and disposal in different sections 15.1% were not aware of the methods at all while 64.2% were aware about segregation at source using color coded bins. 13.2% were aware that incineration was the method used for treating wastes both sharps and infectious wastes while 3.8% were aware of the methods as guided by the hospital policy. 1.9% had no BMW in the section and did not need any form of waste handling and disposal, and another 1.9% knew about the x-ray films being sold out to companies that reused them. The results indicate that the awareness on waste handling and disposal is high at 84.9%.

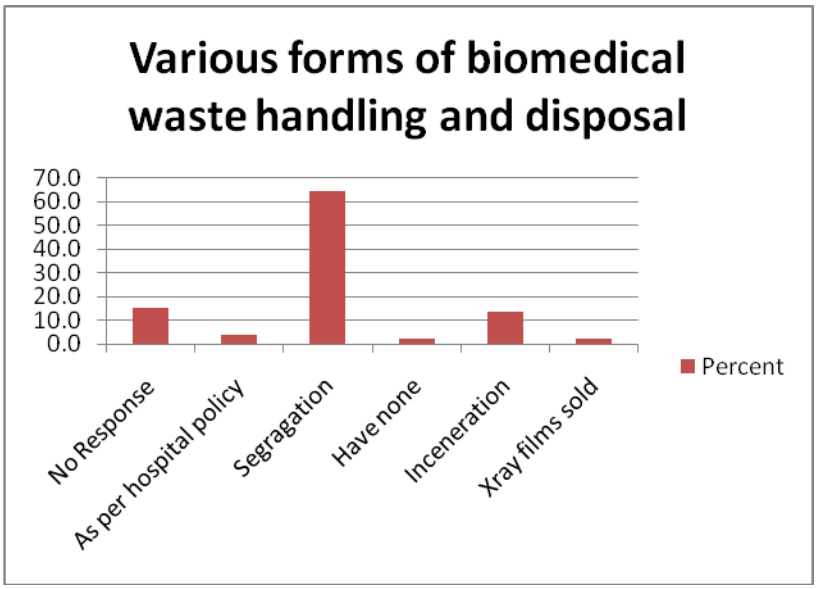

Figure 5.2: How various BMW are handled at the Mater Hospital

Source: Field Work 2013

5.5.3 How the hospital handles large volumes of waste

In assessing awareness on how the hospital controls the large volume of waste that would require the use of most of the land available on landfills 49% of the respondents are aware that the waste is incinerated but 43% do not know how the waste is handled. The remaining 8% split in 2% for

each category are aware that there should be no wastage of paper particularly the hand paper towels, recycling and manure generation and private waste disposal. The results indicate that a satisfactory percentage of the staff 57% are aware of the means to waste reduction and offsite disposal which does not allow for landfill usage at the hospital.

From observations and informal interviews, it was noted that Mater Hospital has an online system used for all stages of patient's services that is paperless and therefore minimizes the amount of paper used. However this system is not used in the consultant's clinic and the doctors' plaza. Paper waste which mainly came from packaging and writing materials was shredded at the hospital then collected by the private waste company for recycling. As the hospital does not have a BMW disposal site or plant, the large volume of waste that has been given the necessary treatment is collected daily by the private waste disposal company and there is no BMW heaped up at the hospital therefore, does not pose any environmental threat at the facility.

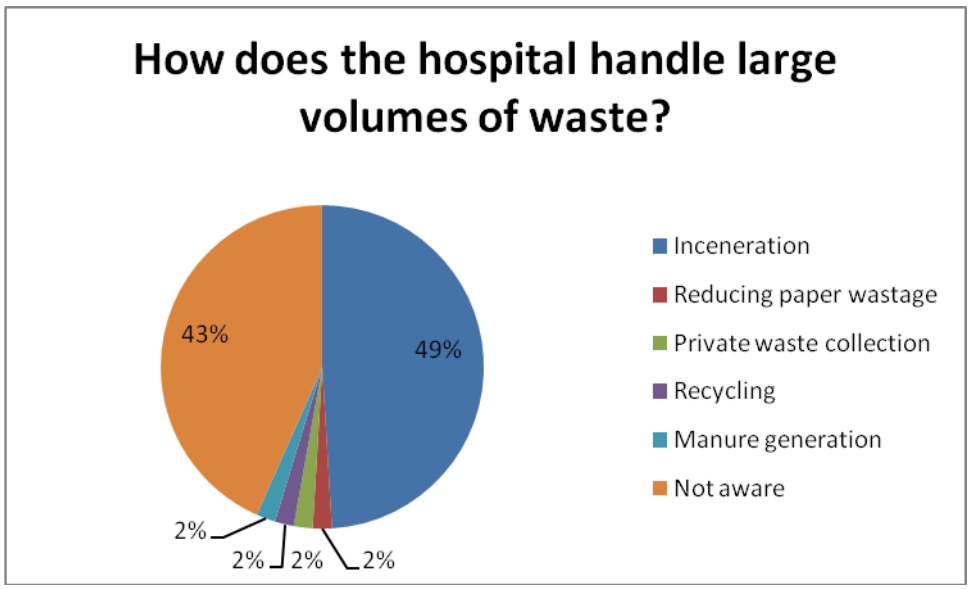

Figure 5.3: How the hospital handles large volumes of waste

Source: Field Work 2013

5.5.4 Challenges of Waste Management in Various Sections

Apart from the departments that only handle general waste or have fewer waste types, the biggest challenge faced by most sections of the Mater Hospital concerning waste management is mixing of waste at 35.8% although 26.4% were not aware if there were challenges faced in their section

with regard to the management of biomedical wastes, and 15.1% did not produce BMW in their section and had no challenges. 9.4% were aware that waste spillage was a challenge since the bins were not emptied regularly and led to overflow. Some waste handlers also ignored the procedures either due to lack of awareness because of lack of training or because of negligence, and 7.5% were aware of this though 3.8% attributed it to lack of awareness. Other challenges were lack of color coded bins at 1.9%. These results indicate that a large percentage at 73.6% is aware of the challenges faced in their sections concerning BMWM.

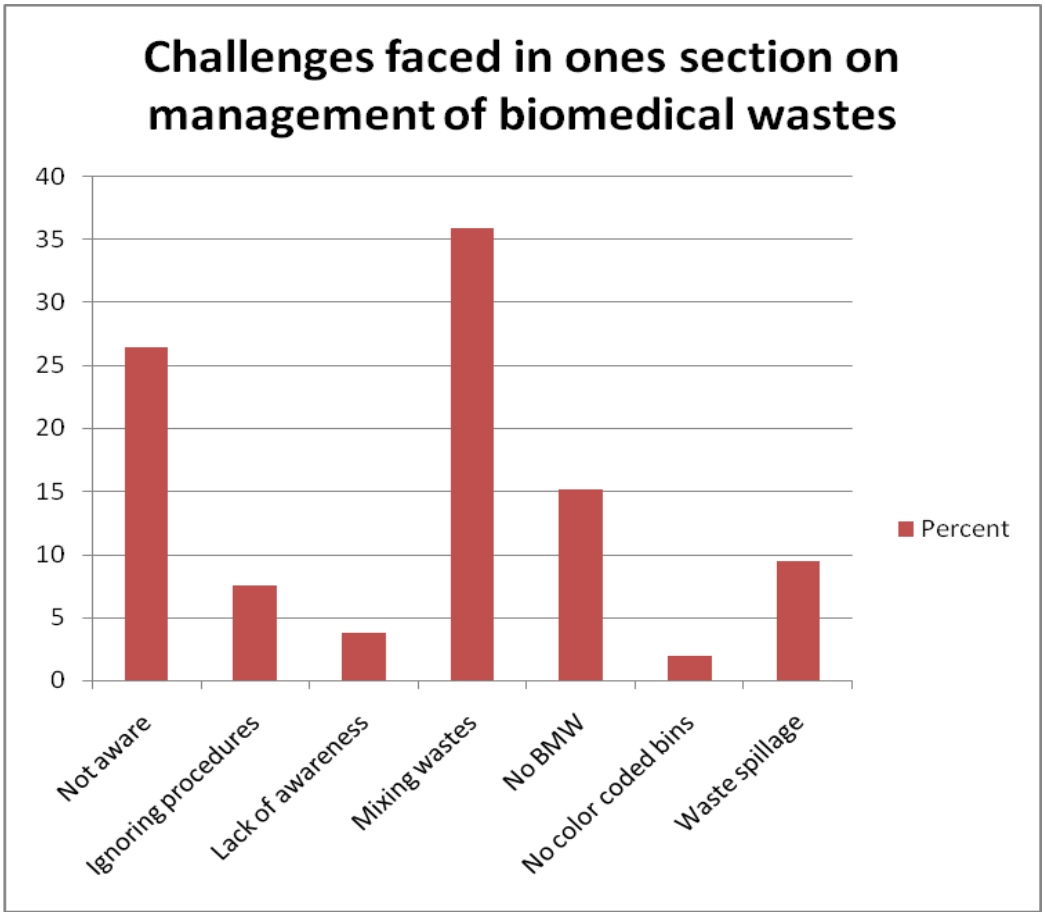

Figure 5.4: Challenges of Waste Management in Various Sections

Source: Field Work 2013

5.5.5 Solution to the Challenges of Biomedical Waste Management

The results show that 41.9% of the respondents were not aware of any solution to the problems, either because they are not aware of the challenges or did not have any challenges. 30.2% of the

respondents were aware that there was need of more training for staff concerning biomedical waste management and 13.2% were aware that creating staff awareness on policy was needful. 7.5% were aware of the need of prompt waste collection from the section to the internal storage facility while 1.9% in each remaining categories were aware of need to have close monitoring and adherence to standards, recycling, reducing color codes for ease of identification and allocating more resources for BMWM.

This means that 58.1%% of the staff is aware of the various solutions to the challenges faced by the various departments on BMWM.

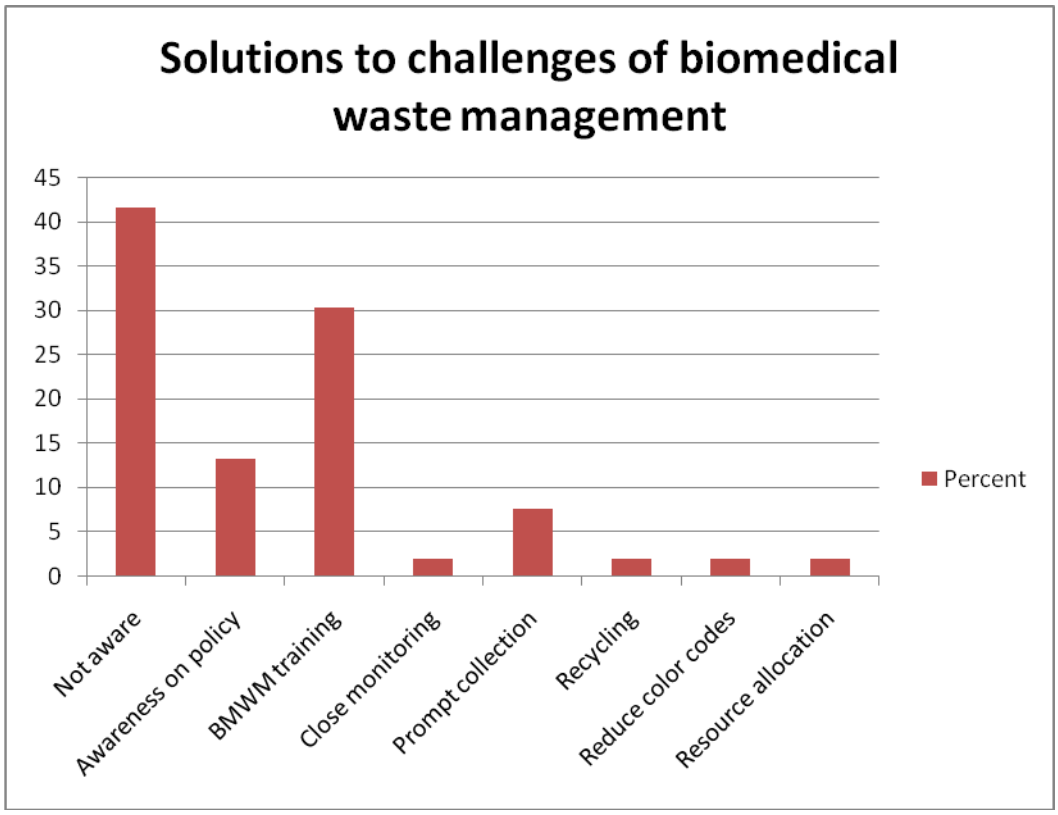

Fig: 5.5 biomedical waste management

Source: Field Work 2013

Plate 5.8: Shredded paper awaiting collection for recycling

Source: Field Work 2013

Plate 5.9:The central waste receptacle bin

Source: Field Work 2013

5.6 Health and safety practices regarding BMWM in Mater Hospital

This section addresses safety precautions taken by the hospital to protect those who handle the biomedical wastes at the hospital as well as the hospital visitors.

The Mater Hospital has taken safety precaution in areas of the hospital with hazardous materials by putting a hazard caution indicated at the entrance or the wall near the point of danger. In the laboratory, a hazard caution can be seen at the entrance and there is a section that only laboratory staff can enter when in protective gears.

Plate 5.10:Hazard caution in the laboratory

Source: Field Work 2013

In various sections, different color codes signify danger and the waste handlers are aware that they should take precautions when handling such wastes. The red bin and liner signify that the waste in question is infectious or hazardous like shown in the plate 5.11 below.

Plate 5.11: An expired bloob from blood bank awaiting disposal

Source: Field Work 2013

5.6.1 How Accidental Needle Stick Injuries is Handled

According to the results on handling of needle stick injuries, it shows that there are several ways of handling needle prick injuries even though 11% of the respondents do not know what should be done. 85% shows that the hospital has a policy on needle stick injuries with different precautions which include washing the affected area with plenty of water, reporting to the in charge and being given post exposure treatment. 4% were found not to handle needles at work.

The hospital therefore takes precautions in order to protect the waste handlers to prevent any dangers of being exposed to the infectious or hazardous wastes. It however should create awareness among those who are not aware of the existence of these protective measures.

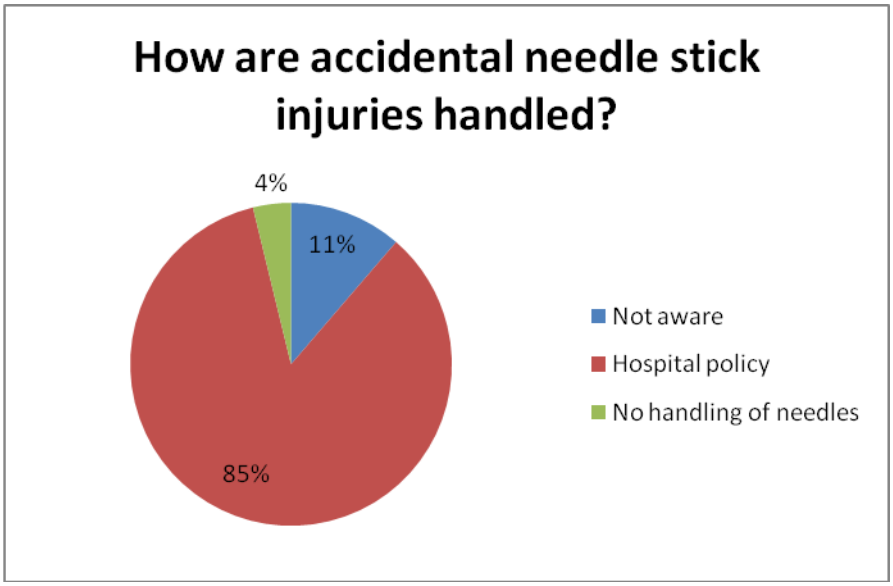

Fig 5.6: How accidental needle stick injuries are handled

Source: Field Work 2013

5.6.2 Use of Protective Gear Provided by the Hospital

Waste haulers and handlers should always be appropriately clothed and wear personal protective equipment so that harmful agents, whether physical, chemical, or infectious, are prevented from gaining access to open wounds, cuts, or by absorption through the skin. Personal protective equipment may include gloves, gowns, safety glasses, protective footwear, etc.

The Mater Hospital provides its workers with protective gears at work. Depending on the activity, different staff will use different protective gears while working.

Table 5.6: Protective Gear in use in the health care treatment facility

Protective Gear in use in the health care treatment facility	Percentage Usage
(a) Surgical head scarf.	100% depending on the operation
(b) Face masks-depending on operation.	100% depending on the operation
(c) Eye protectors (safety goggles)-depending on operation	100% depending on the operation
(d) Overalls (coveralls)-obligatory.	100% depending on the operation
(e) Industrial aprons-obligatory.	100%
(f) Lead Apron – X-ray Room	100% dependant of X-Ray activity
(g) Leg protectors and/or industrial boots-obligatory.	100%
(h) Disposable gloves (medical staff)	100% depending on the activity
(i) Heavy-duty gloves (waste workers)-obligatory.	100% handling of bio-medical waste

Source: Field Work 2013

Plate 5.12: Waste handler wearing protective gears while at work.

Source: Field Work 2013

5.6.3 Occupational health risk exposure policy to potentially infectious diseases.

In assessing whether there was an occupational health risk exposure policy to potentially infectious diseases (HIV, Hepatitis B and infected body fluids) and what the practice was, 34% did not know what the procedure was. However, 24.5% indicated that there was an infection control policy to be followed, 13.2% knew about the procedure followed by the hospital, 18.9% reported that the victims were vaccinated, 5.7% prophylaxis treatment was given and 3.8% awareness was created among the staff on precaution to take. 66% of the findings show that there

is an occupational health risk exposure policy to potentially infectious diseases (HIV, Hepatitis B and infected body fluids) and procedure to be followed.

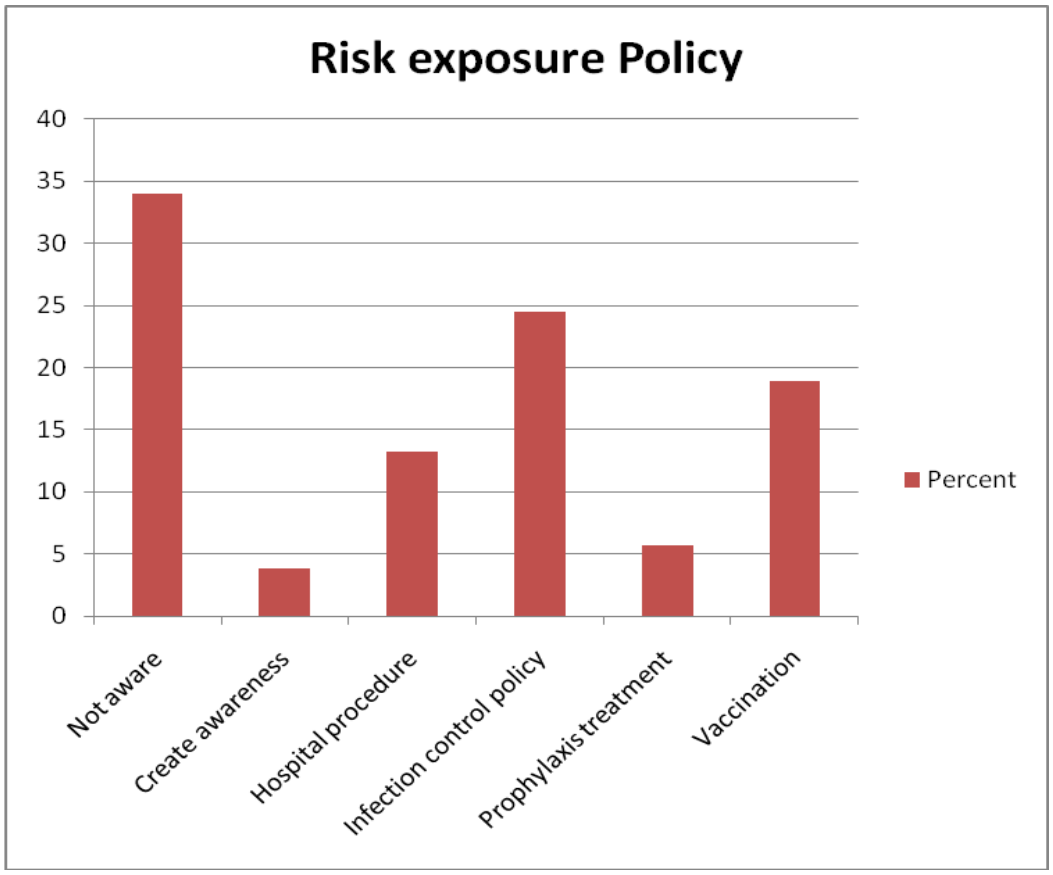

Fig 5.7: Occupational health risk exposure policy to potentially infectious diseases

Source: Field Work 2013

Employee training programs should be continually assessed and reinforced, and their content periodically reviewed and updated as necessary. Consideration should be given to adapting the training programs to suit personnel who may not be fluent in the official language of predominant use or who may not be fully literate.

To minimize the occupational health risks associated with the handling and disposal of biomedical waste, occupational health care programs should: include a regular assessment of waste management procedures to assure compliance with applicable standards, regulations and legislation; provide appropriate personal protective equipment and hand washing facilities for workers involved in various stages of waste handling and disposal; include a written procedure to

handle and report needle stick injuries and other waste-handling incidents. Injuries caused by needle sticks and sharp instruments should be documented, reviewed, and changes implemented to prevent similar incidents in the future; review handling practices to determine if problems are the result of excessive or inappropriate handling. If so, modify the handling techniques; and consult with employees being affected by inappropriate handling techniques and invite their participation in determining effective solutions.

5.7 Discussion

The present study was conducted at the Mater Hospital and the study was to establish whether waste management of Mater Hospital complied with EMCA rules and regulations on BMWM and the study found that Mater Hospital complied with the EMCA rules and regulations of BMWM.

The different categories of bio-medical wastes generated at the Mater Hospital all fall under the seventh schedule of the EMCA (Waste Management) Regulations 2006, Regulation 38. The study results were different from those of (Njogu 2009) on assessment of HCW in non-government HCFs in Nairobi Province which reported that waste segregation was found to be inadequate as no facility had a general waste category hence all the waste produced within these facilities were considered hazardous and had to be treated prior to disposal.

The results of the study were found to be similar to those of (Aurora *et al* 2008) on assessment of biomedical waste situation in hospitals of Dolj District Romania which showed that during the study, it was observed that the hospital had been properly managing its biomedical waste by segregating the biomedical waste every day, in accordance with the biomedical waste categories, collected in the appropriate type of container and specified color coding, in accordance with the legislation. The hospital had maintained the practice of decontamination of biomedical waste before disposal or storing of the waste for 48 hours.

It was also found out that the Mater Hospital applied the different types of waste management practices appropriately and majority of the medical workers were found aware about the biomedical waste management, including color coding and segregation except for a few individuals who did not follow the correct ways of waste management. The knowledge regarding segregation is important to prevent the mixing of hazardous and non-hazardous waste. In this

study, it was noted that some waste handlers did not seem to pay much attention to BMW. This was due to a combination of insufficient knowledge and their lack of interest in BMW management. They were also not fully aware of the BMW management rules. Therefore, inappropriate practices were observed at the source of generation during separation of BMW. These practices contaminated noninfectious waste, which could pose a serious threat to the people and the environment. Collection to the internal storage was also delayed in some cases causing spillage.

The study also noted that the most preferred mode of waste treatment was the incineration common in most HCFs as different studies reported around the world. However, the hospital also applied other treatment methods in waste treatment like, autoclaving, microwaving, chemical treatment and steam sterilization.

Disposal of BMW by means of landfill within the facility's premises was not practiced as the hospital contracted a private waste management company that collected waste by means of track for offsite disposal.

The results on different categories of awareness of hospital staff in waste management practices show that75.5% are aware of various policies to be adhered to at work place; 84.9% are aware of waste handling and disposal practices; 57% are aware of the means to waste reduction and offsite disposal which does not allow for landfill usage at the hospital; 73.6% are aware of the challenges faced in their sections concerning BMWM and 58.1% are aware of the various solutions to the challenges faced by the various departments on BMWM

The hospital was found to have health and safety practices regarding BMWM taking precautions in order to protect the waste handlers to prevent any dangers of being exposed to the infectious or hazardous wastes. These included presence of EHS policy, needle stick injuries policy, occupational health risk exposure policy to potentially infectious diseases (HIV, Hepatitis B and infected body fluids) and procedure to be followed, hazard cautions in areas with hazardous or infectious wastes and the provision of protective gears for staff which are 100% used when handling wastes.

It is hoped that these findings would help to enhance the effectiveness of orientation or refresher training programs targeted at these individuals and help make them more focused, relevant and goal-oriented. Thus, the effective reuse, appropriate destruction of biomedical wastes as well as the safety of the environment in not only this healthcare institution but elsewhere too, would be brought about, as this knowledge would diffuse to other parts of the country through this human resource.

CHAPTER SIX

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

6.0 Introduction

This chapter provides summary of the findings from chapter five, it also gives conclusions and recommendations of the study based on study objectives.

6.1 Summary of findings

The following were major findings of the study:

The Mater Hospital generated wastes of different categories across different departments. The hospital has successfully managed appropriately handling, treatment, and disposal of waste by type to improve and protect public health. "Segregation of waste should always be the responsibility of the waste producer, should take place as close as possible to where the waste is generated, and should be maintained in storage areas for ease of transport to safe disposal sites". All those stages of waste management have been handled well by the hospital except that:

a) There is still a big problem of mixing of waste and the hospital ends up incinerating the mixed waste that is not segregated which increases the cost of waste management.
b) There is failure to quantify the waste generated in reliable records.
c) Insufficient education and training on medical waste management to staff.
d) It is not clear whether the hospital has a BMW management plan as it was not made available to the researcher and the employees were not clear about what a BMW management plan is.
e) Even though the hospital has put in place different policies on health safety and BMWM, the percentage that represent the population that is not aware of the procedures due to lack of training or ignorance is quite high.

6.2 Conclusions

a) The Mater Hospital is well managed and operates efficiently to meet the need for medical services to its patients. However the report has made essential recommendations to improve on waste management that should be implemented by the Hospital.

b) The hospital generates different waste categories and they are to some extent managed within acceptable standards as all the wastes get segregated at source of production, and go through different stages of waste management prior to final disposal.

c) It has also adhered to national regulatory framework governing the facility as outlined, in BMWM.

d) The staff awareness on different aspects of the hospital's practices with regard to waste handling, policies and environmental health safety and protection is satisfactory.

e) The hospital is also sensitive to the needs of the staff and its visitors by making available some form of protection from dangerous items of hazardous nature.

6.3 Recommendations

The study indicates a need for training programs for different levels of hospital staff in BMW management, mandatory staff training and education programs in BMW segregation, strict implementation, and monitoring of BMW management will help change the current practices. Training programs on biomedical waste management for healthcare professionals need to focus on empowering them with sufficiently broad and practical knowledge.

a) Improving waste minimization and management: If proper segregation is achieved, the volume of infectious wastes can be effectively reduced, while the volume of recyclable wastes would increase. By managing BMW properly, risks can be minimized.

b) It is important to measure and quantify the amount of medical waste generated in each unit of the hospital periodically to ascertain which unit or department generates the

highest and lowest amount of wastes. This could have implications for resource allocation in managing medical wastes.

c) The BMW management plan should be availed to all departments then a regular program of inspection and review can be undertaken within the hospital. After the BMW guidelines are explained, proper management of BMW should improve and segregation of BMW should be much better than before.

d) A written biomedical waste management program must be included in a health care facility's policy and procedure manuals. It must also be included in the facility's in-house education, occupational health and safety, and orientation programs for all employees. This program must be regularly reviewed and updated by an appropriate review committee, which includes waste handlers as members. The health care facility must appoint a person or persons to be responsible for the biomedical waste management program. This person or persons must have suitable training and experience, relating to waste management, occupational health and safety, infection control, etc., and be aware of the hazards associated with managing biomedical waste.

e) Certain basic elements must be embodied in any biomedical waste management program to ensure that biomedical waste is handled and disposed of safely and efficiently. Health care facilities must prepare contingency plans for dealing with: the storage of refrigerated or frozen biomedical waste, if excess waste is produced; disposal facilities or equipment becoming inoperative; refrigeration or freezing facilities or equipment becoming inoperative; and the disposal of biomedical waste if disposal services are disrupted. The effectiveness of waste disposal policies and procedures should be assessed regularly. The assessment process should be described in the policy and procedure manuals and should reflect the quality assurance requirements used in other areas of facility management. Table 6.1 shows the recommended BMW management plan.

Table 6.1: Recommended Biomedical Waste Management Plan

Environment Al Concerns	Mitigation	Responsibility During Rehabilitation	Maintenance	Time Frame
General waste Management	Ensure waste segregation for separate management of the various categories of general waste	Hospital Management Committee	Hospital waste Management Officer	Immediate and thereafter continuously
	Recycle paper and wastewater from the Laundry.			
Legislative & Regulatory Guidelines	Adhere to national bio-medical waste regulations 2006 and EMCA 1999 as provided in this report	Hospital Management Committee	Hospital Maintenance Manager	Continuous
Bio-medical waste Recording & Management No formal record keeping books have been put in place to monitor biomedical waste	Create records for monitoring daily rate of bio-medical generation and waste disposal	Hospital Management Committee	Hospital waste Management Officer	Immediate and thereafter continuously
	Make sure that all your employees know how to manage each type of waste according to the hospital's procedures			
Health Safety and Welfare	Environment, Occupational Health and Safety policy for employees Maintain high standards on Occupational Health and Safety	Hospital Management Committee	Hospital Maintenance Manager	Immediate and thereafter continuously
Resource Conservation	Make sure that all your employees are aware of their environmental policy and associated responsibilities.	Hospital Management Committee	Hospital Maintenance Manager	Immediate and thereafter continuously

Environmental Auditing of Facility	Ensure annual external environmental audits are conducted to ensure recommendations of the environmental management plan are implemented	Hospital Maintenance Manager	Hospital Maintenance Manager	Immediate and thereafter continuously

Source: Researcher 2013

f) The BMW management Plan is necessary for improved BW source reduction and management strategies. To be able to achieve this, (EHP 2000) recommends that a multidisciplinary team is required which must be capable of:

g) Conducting an environmental health and safety audit; Using survey methods to collect baseline data on the quantities and types of wastes generated by the facility; Developing and implementing a system to both identify source reduction action items and track progress; Ensuring staff training

h) To be effective the extent of the program must be tailored to fit the size of the facility and the total amount of waste generated. Early involvement of the employees in the planning process and continuous staff training is critical elements of successful medical waste minimization programs. Employees must be fully aware of the contents of the facility's waste management plan including regulations that apply, how to segregate the type of waste the facility generates, how to choose environmentally preferable materials and how to properly dispose of infectious and hazardous wastes. There also should be a feedback system such that a facility can direct, investigate and correct deficiencies and problems with the plan itself.

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APPENDICES

APPENDIX 1: QUESTIONNAIRE I

Used for getting information from personnel in Medical, Pharmaceutical, X-ray, Laboratory services, Administration, Teaching staff, and Support Staff (A total of 40 respondents, 5 from each category)

1. Gender of respondent

    1) Male □

    2) Female □

2. Occupation of the respondent

1. Medical Doctor □
2. Nurse □
3. Pharmacist □
4. Radiologist □
5. Laboratory Technician □
6. Administration Staff □
7. Teaching Staff □
8. Support Staff □

3. Number of employment years in hospital ---------

4. Are you aware of any hospital policy which addresses environment, health and safety in your work place?

    1. Yes □
    2. No □

If yes, what is the procedure?

_____

_____

5. Do you know the relevant laws, standards and regulations that your facility is to comply with when in operation?

1. Yes □
2. No

If yes, name them.

_____

_____

_____

6. Do you have a comprehensive Medical Waste Management Policy that guide all the staff as to what course of action to take on issues related to management of medical waste?

1. Yes □
2. No

If yes, does the policy address issue like:

i) Identification of all the stages of the waste stream;

ii) Measures to be undertaken to ensure waste prevention;

iii) The different types of waste and how to handle each type;

iv) Classification of wastes from the point of production as recommended by WHO by segregating, labeling, handling and storage before final disposal.

v) Compliance with existing laws and regulations as well as a clear definition of principles to be followed.

vi) Identification of all the possible risks related with medical waste management and guidance on how to manage those risks.

7. Is there a documented internal medical waste control system in the hospital with written uniform guidelines by the hospital management regarding the management of waste, allocating responsibilities to specific staff members regarding their respective roles concerning the management of medical waste?

1. Yes □
2. No □

8. Is Environmental Management Plan available with you?

1. Yes □
2. No □

9. Are you aware of the findings of the previous Environmental Audits and regulations for bio-medical waste management in the hospital?

1. Yes □
2. No □

10. How often does the relevant lead agency monitor the treatment of the biomedical waste, to ensure that such waste is treated in a manner that will not adversely affect public health and the environment?

_____

11. Do you keep waste management records maintained by hospital, by which one can ascertain the quantities of waste generated by the hospital and whether it has all been disposed of in the recommended way?

1. Yes □
2. No □

12. How do you handle accidental needle stick injuries?

_____

_____

13. Is there an occupational health risk exposure policy to potentially infectious diseases (HIV, Hepatitis B and infected body fluids)?

1. Yes □
2. No □

If yes, what is the procedure?

_____

_____

14. Does the hospital provide any supervisory in-house training for staff on occupational health and safety?

1. Yes □
2. No □

15. Which protective gears does the hospital provide you with, and do you put them into use all the time?

_____

_____

_____

_____

16. How are the various forms of bio-medical wastes handled and disposed in your section?

_____

_____

_____

17. How do you handle the expired biomedical products under your care?

_____

_____

18. Do you have a designated waste receptacle?

1. Yes □
2. No □

19. Does your waste treatment/disposal facility allow for waste recycling?

1. Yes □
2. No □

If no, how does the hospital control the large volume of waste that would require the use of most of the land available on landfills?

_____

_____

_____

20. Are you aware where is the nearest fire extinguisher located within your work station?

21. Do you know how to operate the fire extinguisher in case of a fire in your section?

22. How many emergency drills have you been involved in during your tenure at Mater Hospital?

23. What challenges do you face in your section with regard to the management of biomedical wastes?

24. What options can you suggest for dealing with the above challenges?

APPENDIX 2: QUESTIONNAIRE II

Used for getting information from the neighboring land users within 100 meters from the hospital fence (A total of 30 residential respondents and 10 employment respondents)

1. Gender of respondent

1) Male □

2) Female □

2. Location of the respondent to the hospital

1. East □
2. West □
3. North □
4. South □

3. Distance of the respondent from the hospital fence

1. Less than 30 meters □
2. 31-50 meters □
3. 51-70 meters □
4. 71-90 meters □
5. 91-100 meters □

4. Age category

1. less than 14 years □
2. 15-24 years □
3. 25-35 years □
4. 36-45 years □
5. above 45 years □

5. Highest level of education

1. None □
2. Primary level □

3. Secondary level □
4. College level □
5. University level □
6. Other □ Specify_____

6. How long have you been at this location?

7. What do you do in this location?

8. How do you benefit by being near to this hospital?

_____

_____

9. What are the problems you experience because of being near to the hospital?

_____

_____

_____

10. Do you get to use some of the scavenged materials from the hospital's dumping site?

1. Yes □

2. No □

If yes, what are the materials and what do you use them for?

_____

_____

_____

11. List the types of ailments for which you may have sought medical attention this year.

_____

_____

_____

12. Have you or anyone you know benefited from any form of environmental education and awareness or environmental clean-up by the hospital?

1. Yes □
2. No □

If yes, what kind of training was it and has it been of help?

_____

_____

13. How many times has the hospital management or any other person consulted you on the state of environment in this neighborhood?

14. Name any activities that you carry out in collaboration with the hospital that promote development in the community.

15. What can the hospital management do in order to improve the state of local environment in your area?