

**STATUS AND CHALLENGES OF HAZARDOUS WASTE
MANAGEMENT AMONG HANDLERS AT THIKA LEVEL 5 HOSPITAL,
THIKA SUB-COUNTY, KIAMBU COUNTY, KENYA**

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Control) in the School of Public Health of Kenyatta University**

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DECLARATION

This is my original work and has not been presented for a degree in any other University or award.

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DEDICATION

To my loving husband, Mr. David Harrison for his priceless support; and my lovely daughters, Brendah and Belinda for their patience throughout the study period.

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DEFINITION OF TERMS

- Hazardous waste** -This is waste that has the potential to cause harm to human beings and the environment
- Incineration** -The controlled burning of waste to produce gases and residues containing little or no combustible materials.
- Segregation** - Any activity that separates waste materials for processing
- Hazardous waste handler-** Any person who comes into contact with hazardous waste
- Technician** - A person who is skilled in details of a subject
- Waste Management** - Means the activities, administrative and operational, that are used in handling, packaging, treatment, conditioning, reducing, recycling, reusing, storage and disposal of waste.
- Waste management** -This includes all activities from the point of waste generation, segregation, transportation, storage, treatment to the final disposal of all wastes

ABBREVIATIONS AND ACRONYMS

CCC	-Comprehensive Care Unit
CDC	-Centre for Disease Control
HBV	-Hepatitis B virus
HCF	-Health Care Facilities
HCV	-Hepatitis C virus
HIV	-Human Immunodeficiency virus
HW	-Hazardous waste
HWM	-Hazardous waste Management
JSI	-John Snow Inc.
MCH	-Maternal and Child Health
NBU	-Newborn Unit
NEMA	-National Environmental Management Authority
NGO	-Non Governmental Organization
OPD	-Outpatient Department
PPE	-Personal Protective Equipments
ROK	-Republic of Kenya
UNDP	-United Nations Development Program
UNEP	-United Nations Environmental Program
US	-United States
USAID	-United States Agency for International Development
WHO	-World Health Organization

ABSTRACT

Hazardous wastes are wastes that pose danger both to the public and the environment. Of the total waste generated in health care facilities, approximately 20% is hazardous. These wastes have both immediate and long term health effects including kidney problems, asthma, cancers and other diseases. Hazardous Waste Management (HWM) is a challenge both in the developed world and developing countries where wastes generated are not segregated at the point of generation. Hazardous waste requires special attention throughout all its stages of management. Proper management can significantly reduce the cost of treatment of wastes and diseases due to these wastes. The research aimed at assessing status and challenges of Hazardous Waste Management among handlers in Thika level 5 hospital. The study was cross sectional descriptive and was carried out in Thika level 5 hospital during the month of March, 2014. Data collection instruments included self administered questionnaires, key informant interviews and observation check lists. The sample size was 195 and was selected proportionate to number of hazardous waste handlers in each category. Pretesting of research tools was tested at Ruiru Sub-County hospital. Simple random sampling was used to select study participants. Data collected was managed using SPSS version 20. Results of the study were summarized using percentages, tables and charts. Chi square was used to test for association between variables at $p < 0.05$ significance level. A majority of the respondents had been trained on Hazardous Waste Management and 41.3% of the trained received training more than five years ago. The average amount of waste generated within the hospital was 642kg/day. Almost half (46.0%) of the waste was hazardous waste. There was significant statistical relationship between work experience and use of personal protective equipments ($p=0.012$), period of training and use of Personal Protective Equipments ($p=0.006$) and period of training and awareness of color codes ($p=0.011$). Other factors that were found to have significant relationships with Hazardous Waste Management were awareness of color codes and provider of Personal Protective Equipments. Qualitative analysis revealed that indiscriminate disposal of waste was attributed to inadequate waste bins and lack of clear labeling of bins. It is recommended that the hospital should provide continuous in-service trainings to its healthcare workers in order to equip them with up-to-date information on hazardous waste management. The hospital should ensure provision of adequate waste disposal bins in order to avoid indiscriminate waste disposal.

CHAPTER ONE: INTRODUCTION

1.1 Introduction

This chapter entails background to the study, statement of the problem, justification, research questions, null hypothesis, significance of the study, limitations of the study and conceptual framework.

1.2 Background to the study

Hazardous wastes result from activities undertaken in health care facilities. These activities include immunization, diagnosis and treatment which generate wastes that are dangerous and pose potential threats both to the public and the environment. They have both immediate and long term health effects such as asthma, allergic reactions, skin rashes, cancer and other long term diseases (WMR, 2006). Under Schedule five of Biomedical wastes, Legal Notice No. 121(WMR,2006) and UNEP (2009), hazardous wastes include materials that are flammable, reactive, toxic, ecotoxic, carcinogenic radioactive and corrosive. These wastes can either be liquids, gases, solids or sludges.

Globally, all health care services both in the rural and urban areas generate wastes and approximately 20% of this waste is considered hazardous. Annually, 16 000 million syringes are used but not all syringes and needles are disposed of properly (WHO, 2011). Chemicals and pharmaceuticals represent 3%, genotoxic, radioactive and heavy metals 1% while sharps represent about 1 % of the total waste. Sharps a major key source of disease transmission if not properly managed. Infectious and anatomic wastes represent 15% of the total waste. The average amount of hazardous waste generated in health care facilities in high income and low income countries is 0.5 and 0.2 kg per bed

per day respectively (WHO, 2011). In the United States, hazardous waste problem results from increased use of disposable items. The amount of waste produced by hospitals is over 5.9 million tons annually (Practice Green health, 2013).

In developing countries proper disposal of hazardous wastes is still a significant challenge (Harhay *et al.*, 2009). Hazardous waste is not often separated properly and this makes hazardous waste appear to be generated in large quantities. The unsanitary disposal of hazardous waste is putting millions of people at risk in developing countries. The situation is not only exacerbated by the increasing health care services but due to lack of financial and technological resources that ensure proper Hazardous Waste Management (HWM) in health care facilities (USAID, 2011). Lack of finances slackens efforts to follow up and routinely check health care facilities. In addition, health and safety in terms of hazardous waste is not included in most of training curricula for clinicians, nurses and laboratory technicians (Nkonge *et al.*, 2012). In Africa, the high cost of safety boxes for sharps' disposal affects the use of these boxes (UNDP, 2009). The cost of advanced technologies for treatment and disposal of hazardous waste is very high and most sub-Saharan Africa countries are yet to afford. Most of the medical waste is mostly dumped with general waste (Kumar *et al.*, 2007).

In Kenya, the most common practice of HWM is segregation of sharps while all other solid wastes are mixed together (Mazrui, 2010). Mazrui (2010) also shows that the amount of hazardous waste generated per day per patient is approximately 0.915 kilogrammes in health facilities in Kenya.

Therefore, the results are useful to hospital managements in improving HWM for better health. It is also significant to policy makers in developing policies related to hazardous waste management.

1.3 Problem statement

An assessment conducted by WHO in 2011 revealed that 18-64% of health facilities in 22 developing countries are lacking in Hazardous Waste Management (WHO, 2011). Kenya is still far below the recommended WHO standard that 80% of wastes should be non-infectious and should be disposed of as municipal waste while the remaining 20%, which is infectious require special attention (ROK, 2008). Despite the formulation of policies and regulations on proper management of hazardous wastes in Kenya, many health care facilities still lack enforcement of Hazardous Waste Management legislation. According to ROK (2008), most health facilities are lacking in Hazardous Waste Management with good segregation practice standing at 27% and use of wheelbarrows for waste transportation at 63%. Improper management of hazardous waste causes occupational injuries and diseases hence increase in disease burden (Mathur *et al.*, 2012).

Thika level 5 hospital is a 300-bed referral hospital serving Thika sub-county and other neighboring sub counties as well as counties. It is a very busy hospital dealing with a huge number of both inpatients and outpatients. This implies that the amount of hazardous waste generated within the hospital is very high. Hence, there is need to assess the status and challenges of Hazardous Waste Management within the hospital.

1.4 Justification

There are no studies that have been done in Level 5 hospitals in Kenya other than the teaching and referral hospitals. Thika level 5 hospital is one such hospital. Proper HWM is crucial in improvement of health which is one of the goals of County Governance. Results of the study are useful in addressing issues related to Hazardous Waste Management in health care facilities. Therefore, the study sought to assess the status and challenges of Hazardous Waste Management at Thika level 5 hospital.

1.5 Research questions

1. What type and amount of hazardous waste is generated at Thika level 5 hospital?
2. What methods of disposal are in place at Thika level 5 hospital?
3. What safety measures are put in place for protection against effects of hazardous waste?
4. How are color codes adhered to with respect to waste segregation in Thika level 5 hospital?
5. What challenges face Hazardous Waste Management at Thika level 5 hospital?

1.6 Hypothesis

Ho: There is no relationship between safety measures put in place and Hazardous Waste Management at Thika level 5 hospital

1.7 Objectives

1.7.1 Broad objective

To assess the status and challenges of Hazardous Waste Management among employees at Thika level 5 hospital, Thika sub-county.

1.7.1 Specific objectives

1. To determine the type and amount of hazardous waste generated at Thika level 5 hospital
2. To establish hazardous waste disposal methods at Thika level 5 hospital
3. To establish safety measures put in place by employees for protection against effects of hazardous waste
4. To establish compliance to color codes with respect to waste segregation among handlers at Thika level 5 hospital
5. To identify challenges facing Hazardous Waste Management among handlers at Thika level 5 hospital

1.8 Significance

The results of the study are of importance to planners at Thika level 5 hospital on issues related to hazardous waste management. They are useful to national, regional as well as international policy makers. Waste handlers will benefit by knowing how to properly handle hazardous waste and how to protect themselves from effects of hazardous waste. The study is beneficial to the community around Thika level 5 hospital through getting conversant with hazardous waste management, how to handle and how to protect themselves from effects of hazardous waste. In addition, the study is of importance to any other person interested in hazardous waste management.

1.9 Limitations and delimitations of the study

The research had limited control over sincerity of the respondents in giving correct responses. In addition, longitudinal design over long period of time like 5yrs would

have been better but similar studies have been done in countries such as Philippines, Ethiopia and India for 2 weeks, a month and 3 months.

1.10 Conceptual framework

The independent variables in the study include type and amount of hazardous waste, availability of disposal methods and safety measures. The dependent variable is status and challenges of hazardous waste management. Relationship between the variables is as shown in figure 1.1.

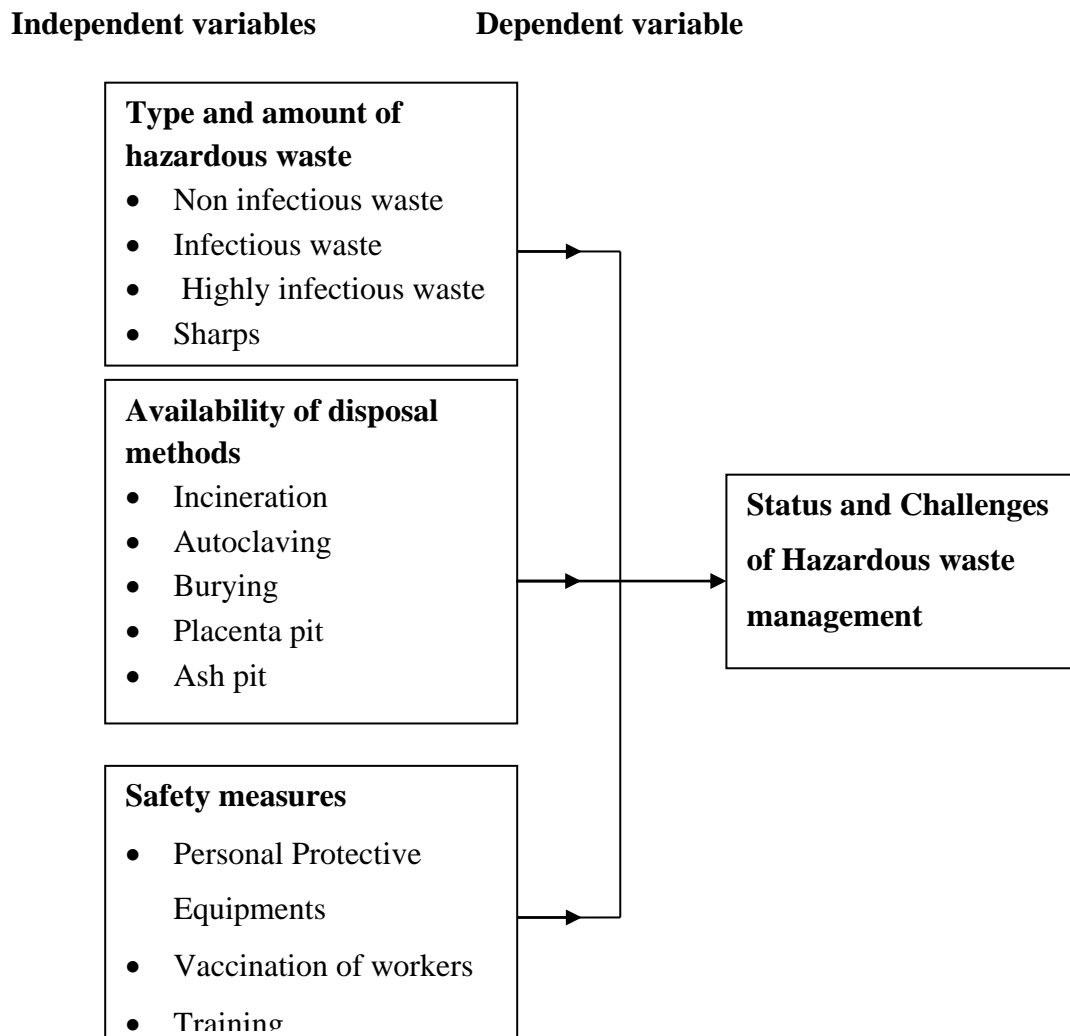


Figure 1.1 Conceptual framework. Source: Adapted from Rahman *et al.* (2013)

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter describes hazardous waste, its management, health risks associated with it and challenges in Hazardous Waste Management.

2.2 Hazardous wastes

Under Schedule seven of Biomedical wastes, Legal Notice No. 121(WMR, 2006), hazardous wastes include infectious wastes such as pathogenic materials, human anatomical waste, sharps, and pathological wastes such organs, tissues, body parts, fetuses, human flesh, blood and body fluids. There are other wastes that are hazardous but not infectious and they include uninfected needles, broken glasses, unused scalpels, knives, infusion sets, chemicals, radioactive materials, pressurized containers and pharmaceuticals.

2.3 Management of hazardous wastes

Environmentally sound management of hazardous wastes involves taking all practical measures to protect both humans and the environment from the harmful effects of wastes (Hopkins, 2012). This involves strict control and special attention to the management of hazardous wastes which cannot be disposed just like any other waste. If these wastes are not properly disposed, they can gain entry into the environment where they may cause significant harm to the public. HWM in hospitals is part of hospital hygiene and control of infections. Health care workers involved in HWM should understand the importance of hazardous waste in terms of humans' health and the environment (Nkonge *et al.*, 2012).

Waste management includes all activities from the point of waste generation, segregation, transportation, storage, treatment to the final disposal of all wastes. This aims at ensuring that safety is maintained at all stages of waste management for better health. Proper Hazardous Waste Management is key to environmental protection and prevention of nosocomial infections in health care establishments. Safer waste management procedures involve segregation of wastes at points of generation (Biswas *et al.*, 2011). Wastes should be disposed off according to their categories by use of color codes recommended by National Environmental Management Authority (NEMA). Yellow color is a code for infectious wastes, yellow puncture proof container for sharps, brown plastic container for chemical and pharmaceutical waste and black for non infectious wastes. In addition, WHO recommended the use of red color for highly infectious wastes (ROK, 2008).

2.3.1 Segregation of waste and color code system

The most important part of waste management is careful waste segregation regardless of waste disposal technique. This will ensure a clean stream of wastes. The waste streams can easily, safely and cost effectively be managed through land filling, incineration, recycling or composting. This is part of waste management and is done at the point of waste generation. In health care establishments, wastes are generated in labor wards, operation theatres, diagnostic service areas and all other patient care activity areas. Wastes generated should be segregated as per their categories. This is aided by labeling of waste receptacles in order to ensure easy identification of each waste category (ROK, 2008).

Table 2.1: Color code system used in Kenya

Type of waste	Color of container and markings	Type of container
Infectious	Yellow	Strong leak proof plastic bag with biohazard symbol
Highly infectious	Red (Marked Highly Infectious)	Strong leak proof plastic bag with biohazard symbol
Sharps	Yellow –marked sharps	Puncture proof
Chemical and pharmaceuticals	Brown	Plastic bag or container
Non-infectious/non hazardous (non clinical)	Black	Plastic bag or container
Radioactive		Lead box, labeled with radioactive symbol

Source: Waste Management Regulations. Legal Notice No. 121(WMR, 2006).

2.3.2 Waste collection

Waste collection should be done according to the specifications as outlined in Part VI of the Bio medical waste Legal Notice No. 121(WMR, 2006). Collected waste should not be stored for more than 7 days without written approval from NEMA whereas untreated pathological waste should be disposed within 48 hours. In addition, waste stores ought to be in a restricted or fenced area (ROK, 2008).

2.3.3 Waste transportation

Transportation of wastes within the hospital involves the use of trolleys and carts with specific ones for infectious wastes. The equipments should be thoroughly cleaned and

disinfected to ensure safety in case there may be spillages. Wheeled waste containers should be situated where the waste is easily loaded, secure during transportation and without sharp edges. In addition, these containers should be easy to clean and disinfect. Hazardous wastes requiring transportation to a far destination need to be kept in well labeled containers (WMR, 2006). Besides, vehicles for hazardous waste transportation should be specially constructed with a fully enclosed body which is lined internally with either aluminum or stainless steel. This provides a smooth lining that is impervious and easy to clean. In addition, the driver's compartment should be separated from the waste compartment with a bulkhead to avoid exposing the driver to adverse effects of these wastes. The load compartment is ventilated by provision of roof vents (ROK, 2008).

2.3.4 Treatment and disposal

Waste treatment is done for purposes of disinfection, reduction of volume and complete destruction of wastes. Treatment as well as disposal of wastes is critical in cost reduction and protection of the public from harm. The health care establishment that produces hazardous waste takes the responsibility of disposing it (WMR, 2006). There are various ways of getting rid of this waste safely. These ways include microwave and autoclave treatment, shredding and incineration for wastes such as chemicals with heavy metals, pharmaceuticals and sharps. Polythene bags made from chlorine compounds should not be incinerated because they release harmful gases into the atmosphere (NHMP, 2008). Pathological and infectious wastes could also be incinerated. The resulting ash from incinerators is disposed of in ash pits.

2.3.5 Safety measures

Hazardous Waste Management involves putting in place various safety measures. All generators as well as waste handlers at all stages of waste management should be aware of the nature of the waste they are handling and the risk associated with the waste (WMR, 2006). In case of accidents or spillages, there are set procedures to be followed to correct the problem without infection transmission. The provided protective equipments should be put on accordingly and their correct use adhered to. It is the responsibility of the management to provide and require the use of Personal Protective Equipments (OSHA, 2007). In addition, there are vaccinations that are necessary for health care workers. They include vaccination against diseases such as hepatitis B and tetanus (CDC, 2011).

According to Ministry of health, Kenya (2008), the standards for protection when handling hazardous waste include immunization against Hepatitis B and tetanus. Putting on Personal Protective Equipments such as disposable gloves for medics, heavy-duty gloves for other waste handlers, as well as overalls is a HWM standard. All waste handlers should also be given proper education on the risks associated with hazardous waste, how to protect themselves and how to manage wastes at various levels (Ramokate and Basu, 2009).

2.3.6 Training

Training of all health personnel and other employees on issues relating to proper waste management is important. According to OSHA (2007), employers should offer training to all workers on the risks they may encounter while handling hazardous wastes at any

level of waste management (Nkonge *et al.*, 2012). The training should be done comprehensively and all health care employees should be made aware of the risks associated with poor disposal of hazardous wastes (WHO, 2011).

2.4 Health risks associated with poor hazardous waste management

Poor management of hazardous wastes contributes to risk of nosocomial diseases to health care workers, inpatients, out patients as well as the surrounding community. Poor management of wastes such as needles and syringes could lead to scavenging and reuse of such leading to infections such as HIV, hepatitis B, hepatitis C and other related diseases (WHO, 2011). WHO (2013) shows that the risk of one infected needle stick injury is 30%, 1.8% and 0.3% for infection with HBV, HCV and HIV respectively per 1000. Hazardous wastes may transmit harmful micro organisms to health care workers, patients and the general public. Drug resistant micro organisms can also be transferred from health care facilities to the environment, which exposes the public to the pathogens. Other harmful effects include sharps inflicted injuries and poisoning and pollution by pharmaceutical products and toxic element (Ferdowsi *et al.*, 2011 and WHO, 2013).

In June 2000 in a dumpsite in Russia, children found glass ampoules containing expired small pox vaccine and they played with them and later developed a mild form of small pox (WHO, 2011). Though the disease was not life threatening, it shows how critical Hazardous Waste Management is. Radioactive wastes could cause serious radiation burns and even death. A radioactive accident in Goiania in 1988 resulted in 4 fatalities while 249 people had significant levels of the radioactive material in or on their bodies.

The accident resulted from a radiotherapy material that was stolen from an abandoned health care site in the city. The fatalities died of serious kidney and lung damage, internal bleeding, respiratory and lymphatic complications and heart damage (Cruz *et al.*, 1997).

Additional hazards due to poor HWM from health care establishments are a result of scavenging as well as manual sorting of wastes from the health care establishments. This may immediately expose the waste handlers to injuries from needle pricks and infectious materials. Incineration of waste containing chlorine generates dioxins and furans that are carcinogenic and are responsible for various adverse health conditions. Globally, it is estimated that approximately 10% of dioxin pollution occurs due to incineration of wastes containing chlorine (ROK, 2008). Incineration of heavy metals may also cause release of heavy metals into the atmosphere. Heavy metals, dioxins and furans are persistent and bio-accumulate in humans. These pollutants may impair the immune system, nervous system, endocrine system and reproductive system functions. Long term exposure to toxic metals may result in kidney failure, respiratory tract irritation, gastrointestinal disorders, suppression of hematological system, lungs and prostate cancer (UNEP, 2007).

2.5 Challenges in hazardous waste management

There are various challenges facing management of hazardous wastes in health care establishments. They include lack of segregation of wastes into hazardous and non-hazardous, lack of proper waste treatment and insufficient training of personnel on hazards associated with hazardous wastes. Others include absence of or poor waste

management systems, poor enforcement of regulations and disposal of hazardous wastes along with municipal wastes, inadequacy of financial resources as well as poor awareness on the importance of using personal protective equipment (Manyele and Lyasenga, 2010). Poor segregation leads to a large quantity of hazardous waste, which makes its treatment and disposal costly (Mazrui, 2010).

According to Government of Kenya (2010), the practice of indiscriminate dumping of wastes is rampant in most health care establishments. Incinerators are also limited, and where available, they are either broken down, improperly constructed or are not being used. There should be specific waste transportation devices for hazardous waste. Improper waste transportation is a challenge, which may result in contamination of all waste including general waste. UNEP and WHO (2005) require that hazardous waste and non hazardous waste are transported separately, using separate devices marked with the respective color. They should not be transported using the same device.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Introduction

This chapter describes how field work was carried out. It entails study design, study location, target population, study variables, sample size determination, sampling procedure, inclusion and exclusion criteria, research instruments, pre-testing of tools, data analysis and ethical consideration.

3.2 Research design

The study design used was cross sectional descriptive. The study design enables one to obtain information about the situation at hand at one specific time. It shows the current situation of the problem under study in the desired population.

3.3 Study variables

The independent variables in the study were type and amount of hazardous waste, disposal methods available and safety measures in place. Other variables included determinants such as availability of resources, awareness of risks, awareness and attitude of hospital management and employees towards hazardous waste management. The dependent variable was status and challenges of hazardous waste management.

3.4 Study location

The study was carried out in Thika level 5 hospital which is a 300-bed government hospital situated in Thika Sub-county, Kiambu County (Appendix 1). The sub-county lies between latitudes 3' 53" and 1' 45" South of the Equator and longitudes 36' 35" and 37' 25" East.

3.5 Study population

The study population was 434 waste handlers working at Thika level 5 hospital, Thika sub-county. These waste handlers come into contact with hazardous waste at one point from segregation to disposal.

3.6 Sampling technique and sample size

3.6.1 Sampling technique

The hospital of study was selected purposely and participants were selected proportionate to size in order to get a representative sample from all categories of healthcare workers in the hospital (Table 3.1). In each category, the participants were selected using simple random sampling technique. Every category of healthcare workers had a list of employees where individuals were randomly picked for the study.

Table 3.1: Sampling frame

Thika level 5 hospital		
Category of healthcare workers	Total number per Category of healthcare workers	Sample
Consultants	11	5
Medical officers	24	11
Pharmacists	12	5
Clinical officers	21	10
Laboratory technicians	22	10
X-ray technicians	7	3
Bio-medical engineers	8	4
Plaster technicians	6	3
Dental technicians	7	3
Mortuary technicians	3	1
Nurses	261	117
Public Health Officers	2	1
Casual workers	50	22
Total	434	195

3.6.2 Sample size

Sample size was determined using the formula as used by Fisher *et al.* (1998).

$$N = Z^2 pqD / d^2$$

Where;

N=the desired sample size when the population is more than 10,000

Z=standard normal deviate (1.96)

p=the proportion of the target population with the characteristic of interest (level of HWM in East African countries). Therefore, it will be 64% (0.64).

$$q = 1 - p = (0.36)$$

D=the design effect (1)

d=desired precision/margin of the error (set at 0.05)

$$\text{Therefore, } n = (1.96^2 \times 0.64 \times 0.36 \times 1) / 0.05^2 = 354$$

Where the population is less than 10,000, $n_f = n / (1 + n/N)$

$$\text{Therefore, } n_f = 354 / (1 + 354/434) = 195$$

The desired sample size was 195

3.8 Inclusion criteria

All the 434 employees who come into contact with hazardous waste were eligible for inclusion in the study. Twelve heads of departments and hospital management were also eligible for inclusion. Among these, only those who gave consent and were willing to participate in the study were included.

3.9 Exclusion criteria

Waste handlers and hospital management staff either absent or on leave were excluded.

3.10 Pretesting of tools

Pre-testing of research tools was conducted in Ruiru sub-County hospital. This was done to ensure validity and reliability of research instruments. 10% of the questionnaires were administered to hazardous waste handlers and corrections were made where necessary in order to make sure the questions asked provided the required information.

3.11 Data collection techniques

Data was collected using researcher administered questionnaires. The structured and semi structured questionnaires were administered to 195 waste handlers in the hospital. The researcher ensured that the questionnaires were correctly filled to avoid rejection of questionnaires during analysis. Key informant interviews were also conducted with 4 heads of department who were available during data collection period. They included in-charges of Public Health department, nursing department, clinical officers and x-ray department. Observation check list was used to ascertain waste segregation and adherence to color codes in waste segregation. Amount of hazardous waste was determined through measurement of waste before disposal. This was done by use of a weighing scale and measurements were recorded.

3.12 Ethical consideration

Ethical clearance was sought from Kenyatta University Ethics Committee and permit obtained from National Council for Science Technology and Innovation. Permission to conduct the study within the hospital was sought and granted from the hospital administration. Informed consent was sought from respondents in order to seek their voluntary participation. In addition, information obtained from the study was handled as

confidential and only the required data was collected and used for the intended purpose of study.

3.13 Data analysis

After data collection, the questionnaires were edited, coded and entered into the computer for analysis. Analysis was done using the Statistical Packages for Social Sciences (SPSS version 20). Chi-square was employed to test for association between variables at 5% significance level. Descriptive statistics such as percent (%), frequency distributions and charts were used to summarize the results of the study. Analysis of qualitative data was done by content analysis and some key points reported as stated by key informants.

CHAPTER FOUR: RESULTS

4.1 Introduction

This chapter is a presentation of the analyzed information which includes: socio demographic characteristics of respondents, type and amount of hazardous waste generated, waste disposal methods available, safety measures and adherence to color codes during waste segregation.

4.2 Socio Demographic Characteristics of Respondents

Attributes of gender, work experience, training on hazardous waste and period of training on hazardous wastes management are presented in Table 4.1.

Table 4.1 Socio demographic characteristics of the respondents

Variable	Frequency	Percent (%)
Gender		
Male	45	23.1
Female	150	76.9
Total	195	100.0
Work experience (Years)		
0-2	19	9.7
2-4	37	19.0
4-6	27	13.8
6-8	20	10.3
8-10	30	15.4
>10	62	31.4
Total	195	100.0
Ever trained on HWM		
Yes	177	90.8
No	18	9.2
Total	195	100.0
Period last trained on HWM n=177		
<2 years ago	65	36.7
2-5 years ago	39	22.0
>5 years ago	73	41.3
Total	177	100.0

A majority (76.9%) of the respondents were females. The largest proportion (31.4%) of the respondents had a work experience of more than 10 years while the least (9.7%) had worked for 0-2 years. A majority (90.8%) of the respondents has ever been trained on HWM and most of the trained (41.3%) were last trained more than 5 years ago. The least proportion (22%) was trained 2-5 years ago.

4.3 Type and amount of hazardous waste generated

There were various categories of hazardous wastes generated within Thika level 5 hospital. They included infectious, highly infectious, sharps, chemicals and pharmaceuticals, and radioactive waste. The study considered the amount of waste generated and recorded in the last 1 (one) year and the results were presented in Table 4.2.

Table 4.2 Waste generated for past 1 year (year 2013) and 1 month of data collection

Waste generated	General waste (kgs)	Hazardous waste				Total	Average waste (kg/day)
		Non-infectious	Infectious (kgs)	Highly infectious (kgs)	Sharps (kgs)		
Year 2013	66155 (39.3%)	505 (0.3%)	73975 (44.0%)	8194 (4.9%)	19457 (11.5%)	168286 (100.0%)	461
1 month of data collection	10406 (54.0%)	192 (1.0%)	6070 (31.5%)	732 (3.8%)	1869 (9.7%)	19271 (100.0%)	642

The average hazardous waste generated per day for the past one year was 461kg/day while the amount of waste generated observed during the period of study showed an average of 642 kg/day. The average amount of waste generated per day for one month during data collection was more than the amount generated per day during the past one year. In regard to this disparity, a key informant reported that, “there are wastes that were not being weighed until recently that the hospital started weighing all waste generated within the hospital.”

Non hazardous waste increased from 39.3% to 54.0% while hazardous waste decreased from 60.7% to 46.0% during the past one year and 1 month of data collection respectively as shown in Table 4.2. Non-infectious hazardous increased from 0.3% to 1.0% while highly infectious waste and sharps decreased slightly from 4.9% and 11.5% to 3.8% and 9.7% respectively. A notable decrease of the amount of infectious waste generated by 12.5% was observed (Table 4.2).

4.3.1 Hazardous waste generated per Department

There are various departments within the hospital that generate different categories of hazardous waste. These wastes differ in amount from one Department to the other as presented in Table 4.3.

Table 4.3 Amount of hazardous waste generated per Department

Department	Amount per day	Percent (%)
Inpatient	85.6	29
Casualty	26.2	8.9
Eye-ENT Unit	6.2	2.1
Laboratory	23.9	8.1
CCC	10.5	3.5
OPD/MCH	19.9	6.7
PCU	4.3	1.4
Theatre	32.7	11.1
Maternity	43.1	14.6
NBU	14.4	4.9
Dental	14.3	4.9
Mortuary	12.5	4.2
Pharmacy	1.2	0.4
X-Ray	0.6	0.2
Total	295.4	100

Most (29%) of hazardous waste was generated in the hospital wards. New born unit and dental department generated equal amount of waste with each generating 4.9% of the total waste. X-ray department generated the least amount of hazardous waste within the hospital. In inpatient department, the average amount of hazardous waste generated was 0.3kg/bed/day. The category of hazardous wastes generated per department varied from department to the other.

4.3.1.1 Non-infectious hazardous waste

Non-infectious hazardous waste included pharmaceuticals, chemicals and radioactive materials generated by various departments. The amounts generated per Department are as shown in Table 4.4.

Table 4.4 Non-Infectious hazardous waste generated per Department

Department	Amount (Kgs)	Percent (%)
Dental	1.6	21.7
Mortuary	1.6	21.7
Pharmacy	1.2	15.4
X-Ray	0.6	9.3
PCU	0.8	13.2
Laboratory	1.2	18.7
Total	6.4	100

The total amount of non-infectious hazardous waste generated was 6.4 kg/day. Mortuary and dental departments accounted for most (21.7%) of the waste where each generated 21.7% of the total non-infectious hazardous waste. The least (9.3%) amount was generated in the X-Ray department.

4.3.1.2 Infectious waste generated per Department

Infectious waste was generated by various departments. The waste included waste which contain pathogens or contaminated with blood and other human fluids and excreta. The average amount generated per day was 202 kilograms and amount generated per department was as presented in Table 4.5.

Table 4.5 Infectious waste generated per Department

Department	Amount (Kgs)	Percent (%)
Inpatient	65	32.2
Casualty	19.0	9.4
Eye-ENT Unit	4.2	2.1
Laboratory	9.6	4.8
CCC	9.2	4.6
OPD/MCH	15.2	7.5
PCU	3.5	1.7
Theatre	19.4	9.6
Maternity	27.3	13.5
NBU	11.5	5.7
Dental	7.2	3.6
Mortuary	10.9	5.3
Total	202	100

Most (32.2%)of infectious waste was generated in the inpatient followed by the maternity (13.5%0 while the least proportion (1.7%) was generated in the palliative care unit as shown in Table 4.5.

4.3.1.3 Highly infectious waste

Highly infectious waste including human tissues, fluids and biological entities was generated in three departments namely laboratory, maternity and theatre and the amounts generated were as presented in Table 4.6.

Table 4.6 Highly infectious waste generated per Department

Department	Amount (kgs)	Percent (%)
Laboratory	9.4	39.2
Maternity	7.7	32.1
Theatre	6.9	28.7
Total	24	100

The average amount of highly infectious waste generated within the hospital was 24 kilograms per day. Most (39.2%) of the waste was generated in the laboratory while the least (28.7%) amount was generated in the theatre (Table 4.6).

4.3.1.4 Sharps

Sharps were generated in several departments within the hospital and the average amount of sharps generated per day was 62 kilograms. The amount generated per department was recorded and presented in Table 4.7.

Table 4.7 Sharps generated per Department

Department	Amount (kgs)	Percent (%)
Inpatient	20.6	33.2
Casualty	7.2	11.6
Eye-ENT unit	1.9	3.0
Laboratory	3.7	6.0
CCC	1.2	2.0
OPD/MCH	4.6	7.4
Theatre	6.3	10.2
Maternity	8.1	13.1
NBU	2.9	4.6
Dental	5.5	8.9
Total	62	100

A third (33.2%) of the sharps was generated in the inpatient department while the least proportion (2.0%) was generated in the comprehensive care centre (CCC). The casualty (11.6%), theatre (10.2%) and maternity (13.1%) generated almost an equal amount of sharps (Table 4.7).

4.4 Hazardous waste disposal methods

There are various hazardous waste disposal methods used at Thika level 5 hospital and they include; incineration, ash pit, burying, placenta pit, steam sterilization and sewerage system. Awareness of respondents on the available hazardous waste disposal methods was as presented in Table 4.8.

Table 4.8 Awareness of disposal methods

Variable	Method	Response	Frequency	Percent (%)
Awareness of hazardous waste Disposal Methods N=195	Incineration	Yes	195	100.0
		No	0	0.0
	Autoclaving	Yes	23	11.8
		No	172	88.2
	Burying	Yes	7	3.6
		No	188	96.4
	Placenta Pit	Yes	173	88.7
		No	22	11.3
	Ash Pit	Yes	11	5.6
		No	184	94.4
	Sewerage system	Yes	1	0.5
		No	194	99.5

All (100%) respondents were aware of the incinerator as a method of hazardous waste disposal within the hospital. Placenta pit was reported by 88.7%, autoclaving 11.8%,

ash pit 5.6%, burying by 3.6% and the least (0.5%) known was the sewerage system (Table 4.8).

Hazardous wastes were disposed of by various methods as presented in Table 4.9.

Table 4.9 Hazardous waste disposed by method

Disposal method	Average amount disposed (kg/day)
Ash pit	15.0
Autoclaving	22.7
Incineration	295.4
Total	333.1

Incineration was the most commonly used method of hazardous waste disposal and the amount incinerated was 295.4 kilograms per day. Autoclaving was applied in treatment of infectious and highly infectious waste generated in the laboratory, which contributed 22.7 kilograms of hazardous waste. After autoclaving, the waste was incinerated to reduce it to ash. The average amount of ash resulting from the incinerator was 15 kilograms per day. However, the incinerator could not clear bottles and lacked devices for measuring levels of substances in the resulting smoke.

Hazardous waste disposed of by other disposal methods such as burying, placenta pit and sewerage system was not weighed. According to a key informant, burying was used in disposal of unclaimed bodies, fetuses and body parts. However, these wastes were not weighed. Placentas were disposed of in the placenta pit while liquid waste including

spilt blood, body fluids, spilt chemicals and other liquid waste was directed into a pre-treatment chamber. The treated waste was then released to the sewerage system.

4.5 Safety measures

This section is about safety measures put in place against effects of hazardous waste. They include training on hazardous waste, use of Personal Protective Equipments, immunization against hepatitis B and Tetanus.

4.5.1 Training on hazardous waste management

Most (90.8%) of the respondents had received a training on Hazardous Waste Management as shown in figure 4.1.



Figure 4.1 Training on HWM

All (100%) respondents agreed that poor management of hazardous waste can result in diseases. However, only 19% of the respondents correctly identified all diseases related to poor Hazardous Waste Management (Figure 4.2).

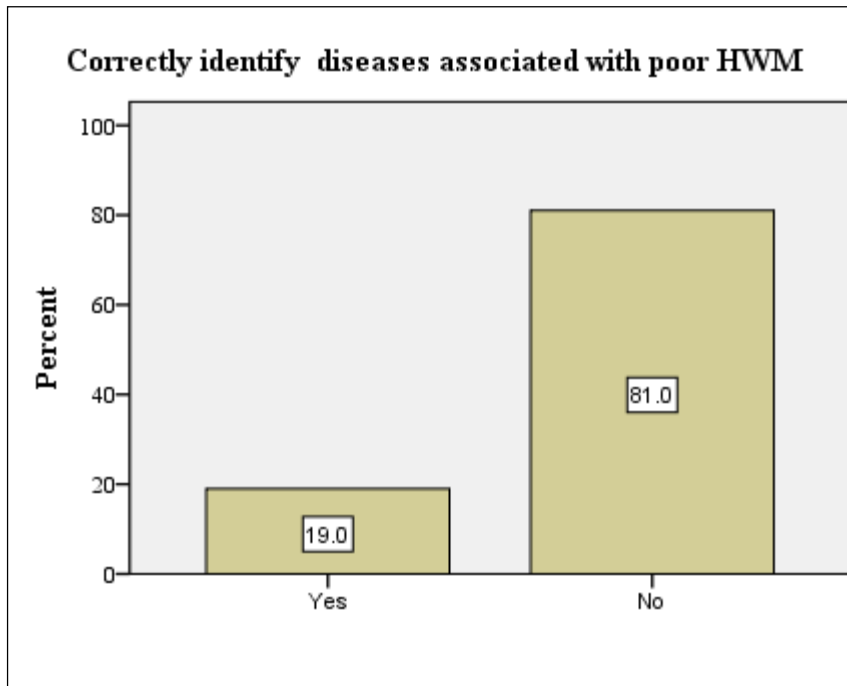


Figure 4.2 Awareness of diseases caused by poor hazardous waste management

Respondents who had been trained on Hazardous Waste Management were trained at different times as shown in Table 4.10.

Table 4.10 Period within which respondents were trained on HWM

Variable	Category	Frequency	Percent (%)
Period of training on HWM (n=177)	<2years ago	65	36.7
	2-5years ago	39	22.0
	>5years ago	73	41.3

Majority (41.3%) of the trained respondents were last trained more than 5 years ago, 36.7% less than 2 years ago and the least (22%) proportion trained 2-5 years ago.

Respondents who had received training on HWM were trained by different trainers as presented in Table 4.11. Respondents also gave their views on whether regular in-service trainings on Hazardous Waste Management were important (Table 4.11).

Table 4.11 Trainer on Hazardous Waste Management

Variable	Category	Frequency	Percent (%)
Where trained on HWM (N=177)	College	53	30.0
	Hospital	45	25.4
	Both college and Hospital	20	11.3
	NGO-JSI	59	33.3
Whether continuing on- job trainings on HWM are important (N-195)	Yes	194	99.5
	No	1	0.5

A third (33.3%) of the trained respondents was trained by an NGO known as John Snow Inc (JSI) and had not been trained elsewhere. Thirty percent of the respondents reported that they were trained only in college and had not received any in-service training on hazardous waste management. The least (11.3%) proportion was trained both in college and in service. Almost all (99.5%) respondents felt that it was important to be given in service training on a regular basis on Hazardous Waste Management.

Association between training and gender was considered and results presented in Table 4.12.

Table 4.12 Association between training and gender

Variable	Category	Ever been trained on HWM			Significance
		Yes	No	Total	
Gender	Male	39(86.7%)	6(13.3%)	45(23.1%)	$\chi^2 = 1.175$, df = 1, p = 0.278
	Female	138(92.0%)	12(8.0%)	150(76.9%)	

Study results showed that 92.0% of female respondents had been trained on HWM. 86.7% of male respondents had been trained on HWM. However, there was no significant statistical relationship ($\chi^2 = 1.175$, df = 1, p = 0.278) between gender and training. This implies that gender did not have any influence on training on issues related to hazardous waste management.

4.5.2 Use of Personal Protective Equipments

Personal Protective Equipments including gloves, gum boots, laboratory coats, dust coats and nose masks were provided for healthcare workers handling hazardous waste as shown in Table 4.13.

Table 4.13 Personal protective equipments (PPE) provided

Variable	Category	Frequency	Percent (%)
Personal Protective Equipments provided N= 223	Gloves	184	82.9
	Nose masks	11	4.9
	Laboratory coats	18	8.1
	Dust coats	6	2.7
	Gum boots	4	1.8
	Total		223

Most (82.9%) of the respondents were provided with gloves while the least (1.8%) were provided with gum boots. A majority (86.2%) of the respondents was provided with PPEs by the hospital while 7.7% provided themselves with PPEs and the least (6.2%) proportion by a contracted cleaning company. The cleaning company provided the hospital with casual workers. Some of the respondents were provided with more than one Personal Protective Equipments.

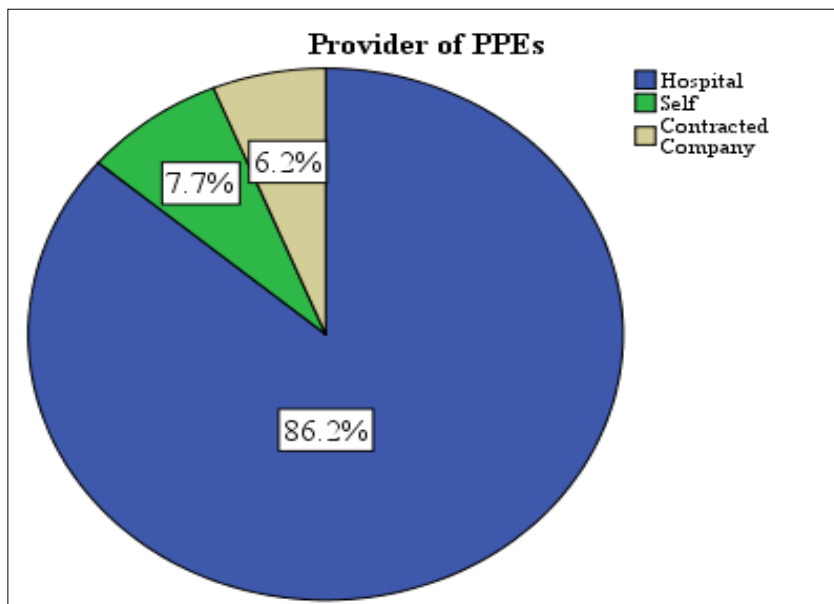


Figure 4.3 Providers of Personal Protective Equipments

Most (69.7%) of the respondents used PPEs when on duty and 62.7% of those who did not use PPEs when on duty reported that PPEs were not necessary. 22.0% reported that PPEs were not always available, 10.2% said that they were not in good condition while the least (5.1%) felt uncomfortable when they put on PPEs (Table 4.14).

Table 4.14 Use of Personal Protective Equipments

Variable	Response	Frequency	Percent (%)
Use PPEs when on duty (n=195)	Yes	136	69.7
	No	59	30.3
Reasons for not using PPEs when on duty(n=59)	Not always available	13	22.0
	Not in good condition	6	10.2
	Not necessary	37	62.7
	Feel uncomfortable	3	5.1

Relationship between use of Personal Protective Equipments and socio-demographic characteristics was considered and results were presented in Table 4.15.

Results of the study showed that among female respondents, 76.7% used PPEs when on duty compared to male respondents (46.7%) as shown in Table 4.15. There was a significant statistical relationship between gender and use of PPEs ($\chi^2 = 14.764$, $df = 3$, $p < 0.001$). Females were more likely to use PPEs compared to their male colleagues. This means that gender has an influence in use of PPEs as a safety measure against effects of hazardous waste.

Category of staff was considered in regard to use of PPEs and results showed that there was a strong statistical relationship ($\chi^2 = 14.753$, $df = 2$, $p = 0.001$) between category of staff and use of PPEs (Table 4.15). Nurses and laboratory technicians were more likely to use PPEs than health care workers in other categories within the hospital. This means that the nature of work could significantly influence use of PPEs.

Work experience was an important factor to consider. There was a significant statistical difference ($\chi^2 = 8.810$, $df = 2$, $p = 0.012$) between work experience and use of PPEs.

Respondents who had worked for more than 8 years were less likely to use PPEs unlike those with work experience of less than 8 years (Table 4.15).

Table 4.15 Association between use of PPE and socio demographic characteristics

Variable	Category	Use PPEs when on duty			Significance
		Yes	No	Total	
Gender	Male	21(46.7%)	24(53.3%)	45(23.1%)	$\chi^2=14.764$, df =1 p<0.001
	Female	115(76.7)	35(23.3%)	150(76.9%)	
Category of staff	Consultants, COs, MOs, Dental technicians	13(43.3%)	17(56.7%)	30(15.4%)	$\chi^2=14.753$, df =2, p =0.001
	Pharmacists, x-ray technicians, Bio-med engineers, plaster technicians, mortuary technicians, PHOs, casual workers	24(63.2%)	14(36.8%)	38(19.5%)	
	Nurses and laboratory technicians	99(78.0%)	28(22.0%)	127(65.1%)	
Work Experience (years)	0-4	43(75.4%)	14(24.6%)	57(29.2%)	$\chi^2= 8.810$, df = 2, p =0.012
	4-8	38(82.6%)	8(17.4%)	46(23.6%)	
	>8	55(59.8%)	37(40.2%)	92(47.2%)	
Trained on HWM	Yes	128(72.3%)	49(27.7%)	177(90.8%)	$\chi^2 =6.015$, df =1, p =0.014
	No	8(44.4%)	10(55.6%)	18(9.2%)	
Period of training on HWM (n=177)	<2 years ago	56(86.2%)	9(13.8%)	65(36.8%)	$\chi^2=10.150$, df =2, p = 0.006
	2-5 years ago	31(79.5%)	8(20.5%)	39(22.0%)	
	>5 years ago	42(57.5%)	31(42.5%)	73(41.2)	
Trainer on HWM (n=177)	College	34(64.2%)	19(35.8%)	53(29.9%)	$\chi^2=3.034$, df =3, p =0.386
	Hospital	35(77.8%)	10(22.2%)	45(25.5%)	
	NGO	17(85.0%)	3(15.0%)	20(11.3%)	
	Both college and hospital	43(72.9%)	16(27.1%)	59(33.3%)	

The study showed that there was a significant statistical relationship between training on Hazardous Waste Management and use of PPEs ($\chi^2 =6.015$, df= 1, p= 0.014).

Respondents who had been trained used PPEs more that those who had not been trained

on hazardous waste management. There was a significant statistical relationship between period of training and use of PPEs ($\chi^2=10.150$, $df =2$, $p =0.006$). This shows that the trained and those trained not long ago on Hazardous Waste Management are more likely to use PPEs unlike others hence training influenced use of PPEs by waste handlers. However, there was no significant statistical relationship ($\chi^2 =3.034$, $df =3$, $p=0.386$) between trainer of respondents and use of PPEs (Table 4.15).

As shown earlier, there were different providers of PPEs including hospital administration, contracted company and self. Association between provider and use of PPEs was considered and results presented in Table 4.16.

Table 4.16 Association between provider and use of Personal Protective Equipments

Variable	Category	Use of PPEs			Significance
		Yes	No	Total	
Provider of PPEs	Hospital administration	124(73.8%)	44(26.2%)	168(86.2%)	$\chi^2 =11.480$, $df =2$, p= 0.003
	Contracted company	7(58.3%)	5(41.7%)	12(6.2%)	
	Self	5(33.3%)	10(66.7%)	15(7.7%)	

There was significant relationship ($\chi^2 =11.480$, $df =2$, $p= 0.003$) between provider and use of PPEs. Respondents who were provided with PPEs by the hospital were more likely to use them unlike others. Those who acquired PPEs by their own means were less likely to use PPEs compared to other respondents.

4.5.3 Vaccination against Hepatitis B and Tetanus

Vaccination against hepatitis B and tetanus is a primary preventive measure against contraction of these diseases. It is recommended that healthcare workers who may be exposed to blood or body fluids should get a 3-dose series of hepatitis B vaccine while tetanus vaccine should be given and boosted after every 10 years (CDC, 2011). Respondents were asked whether they were aware of vaccines recommended for them and the results are presented in Figure 4.4.

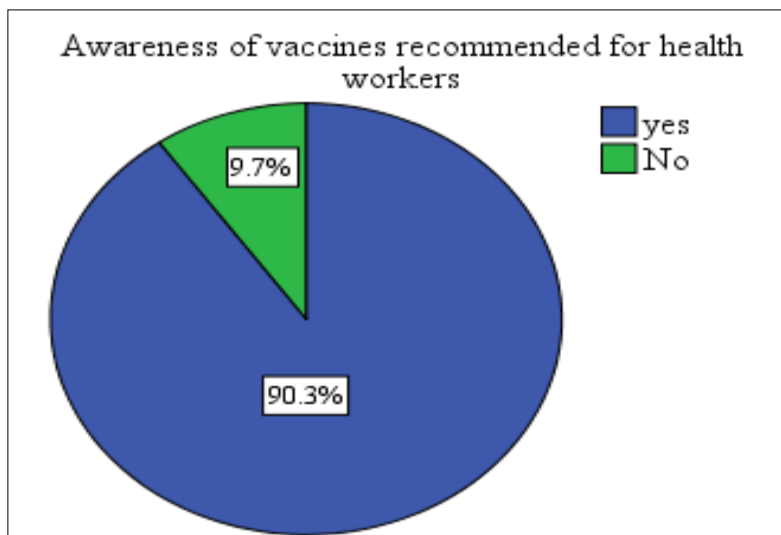


Figure 4.4 Awareness of vaccines recommended for healthcare workers

A majority (90.3%) of the respondents were aware of the vaccines recommended for healthcare workers. However, those who had been vaccinated against hepatitis B and Tetanus were less than those who were aware of the vaccines as shown in Table 4.17.

Table 4.17 Vaccination against Tetanus and Hepatitis B

Variable	Category	Frequency	Percent (%)
Vaccinated	Yes	129	66.2
	No	66	33.8
Vaccine given (n=129)	Tetanus	72	55.8
	Hepatitis B	0	0.0
	Both Tetanus and Hepatitis B	57	44.2

Most (66.2%) of the respondents had been vaccinated and among those vaccinated, 55.8% had been vaccinated against Tetanus. The rest had been vaccinated against both Tetanus and Hepatitis and no respondent had been vaccinated against Hepatitis B only.

Results of associations between vaccination and socio demographic characteristics were as presented in Table 4.18. A majority (70.7%) of female respondents were vaccinated unlike male (51.1%) respondents. There was a significant statistical relationship ($\chi^2=5.912$, $df=1$, $p=0.015$) between gender and vaccination. Female respondents were more likely to be vaccinated against Tetanus and Hepatitis B than male respondents. Most (65.4%) nurses and laboratory technicians had been vaccinated. However, there was no significant statistical relationship ($\chi^2=0.127$, $df=2$, $p=0.938$) between category of staff and vaccination. This could mean that category of staff did not have an influence on vaccination.

There was a significant statistical relationship ($\chi^2=7.283$, $df=2$, $p=0.026$) between work experience and vaccination. Respondents with a work experience of less than 8 years were more likely to be vaccinated than their counterparts who had worked for more than 8 years (Table 4.18).

Table 4.18 Association between vaccination and socio-demographic characteristics

Variable	Category	Vaccinated			Significance
		Yes	No	Total	
Gender	Male	23(51.1%)	22(48.9%)	45(23.1%)	$\chi^2=5.912$, df=1, p=0.015
	Female	106(70.7%)	44(29.3%)	150(76.9%)	
Category of staff	Consultants, MOs, COs, dental technicians	20(66.7%)	10(33.3%)	30(15.4%)	$\chi^2=0.127$, df=2, p=0.938
	Pharmacists, x-ray technicians, Bio-med engineers, plaster technicians, mortuary technicians, PHOs, Casual workers	26(68.4%)	12(31.6%)	38(19.5%)	
	Nurses and laboratory technicians	83(65.4%)	44(34.6%)	127(65.1%)	
Work experience (years)	0-4	42(73.7%)	15(26.3%)	57(29.2%)	$\chi^2=7.283$, df=2, p=0.026
	4-8	35(76.1%)	11(23.9%)	46(23.65)	
	>8	52(56.5%)	40(43.5%)	92(47.2%)	
Trained on HWM	Yes	118(66.7%)	59(33.3%)	177(90.8%)	$\chi^2=0.225$, df =1, p =0.635
	No	11(61.1%)	7(38.9%)	18(9.2%)	
Period trained (n=177)	<2 years ago	48(73.8%)	17(26.2%)	65(36.8%)	$\chi^2 =16.886$, df =2, p =0.001
	2-5 years ago	33(84.6%)	6(15.4%)	39(22.0%)	
	>5 years ago	36(49.3%)	37(50.7%)	73(41.2%)	

Approximately 67% of the trained respondents had been vaccinated against Tetanus and Hepatitis B. However, there was no significant relationship ($\chi^2=0.225$, df =1, p =0.635) between training and vaccination. Period of training was considered as shown in Table 4.18 above. Results showed that there was a significant association ($\chi^2=16.886$, df =2, p=0.001) between period of training and vaccination. Those who were recently trained

were more likely to get vaccinated unlike those who received training on HWM more than five years ago.

The vaccine administered was considered against training and the association was as presented in Table 19.

Table 4.19 Association between vaccine administered and training

Variable	Category	Ever been trained on HWM			Significance
		Yes	No	Total	
Vaccine administered (n=129)	Tetanus	66(91.7%)	6(8.3%)	72(55.8%)	$\chi^2= 0.008$, df=1, p=0.929
	Both Tetanus and Hepatitis B	53(91.4%)	5(8.6%)	57(44.2%)	
	No	47(26.6%)	12(66.7%)	18(30.3%)	

Training did not have a significant statistical relationship with the vaccine administered ($\chi^2= 0.008$, df =1, p=0.929). This implies that training of respondents did not have an influence on vaccination against a specific disease.

4.6 Segregation of waste and Color code system

A clean stream of waste is ensured by careful waste segregation with respect to color codes. The color codes as recommended by NEMA in Waste Management Regulation (ROK, 2008), yellow for infectious, red for highly infectious, yellow puncture proof container for sharps, brown for chemicals and pharmaceuticals, black for non hazardous and lead box labeled with radioactive symbol for radioactive waste. To test for awareness of color codes, respondents were asked to match the color with the respective waste. Only 20% of the respondents did it correctly (Figure 4.5).

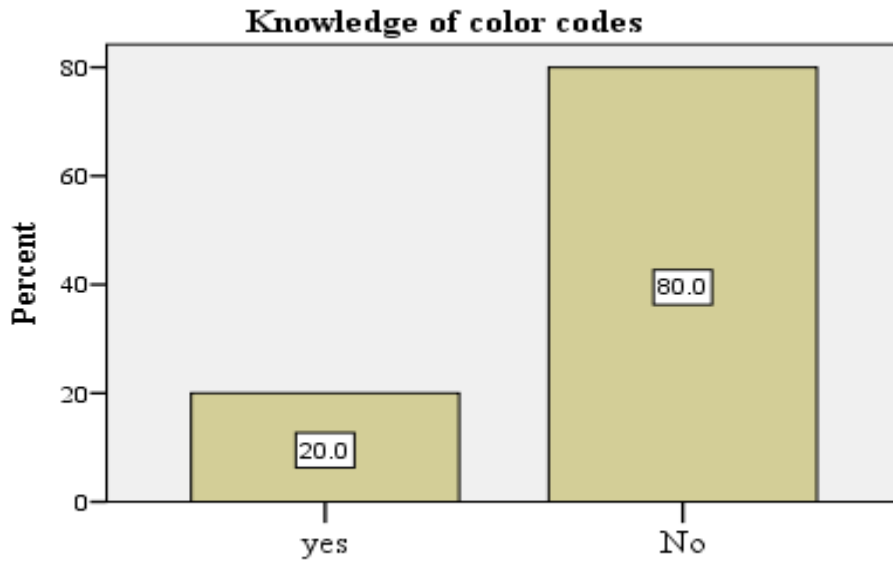


Figure 4.5 Awareness of color code system

When asked about levels of Hazardous Waste Management they dealt with, respondents responded as presented in Table 4.20.

Table 4.20 Levels of Hazardous Waste Management

Variable	Category	Frequency	Percent (%)
Level of HWM respondents deal with (n=195)	Segregation	5	2.6
	Both generation and segregation	179	91.8
	Transportation	3	1.5
	Storage	1	0.5
	Disposal	6	3.1
	All levels	1	0.5

Most (91.8%) of the respondents were involved in both generation and segregation of hazardous waste while the least (0.5%) proportion were involved in storage and all levels of Hazardous Waste Management (Table 4.20).

Relationship between awareness of color codes and socio demographic characteristics of respondents are presented in Table 4.21.

Table 4.21 Association between awareness of color codes and socio demographic characteristics

Variable	Category	Awareness of color codes			Significance
		Yes	No	Total	
Gender	Male	13(28.9%)	32(71.1%)	45(23.1%)	$\chi^2=2.889$, df =1, p=0.089
	Female	26(17.3%)	124(82.7%)	150(76.9%)	
Category of staff	Consultants, MOs, COs, dental technicians	9(30.0%)	21(70.0%)	30(15.4%)	$\chi^2=4.024$, df=2, p=0.134
	Pharmacists, x-ray technicians, Bio-med engineers, plaster technicians, mortuary technicians, PHOs, Casual workers	4(10.5%)	34(89.5%)	38(19.5%)	
	Nurses and laboratory technicians	26(20.5%)	101(79.5%)	127(65.1%)	
Work experience	0-4	16(28.1%)	41(71.9%)	57(29.2%)	$\chi^2=3.641$, df =2, p=0.162
	4-8	9(19.6%)	37(80.4%)	46(23.6%)	
	>8	14(15.2%)	78(84.8%)	92(47.2%)	
Trained on HWM	Yes	35(19.8%)	142(80.2%)	177(90.8%)	$\chi^2=0.061$, df=1, p=0.805
	No	4(22.2%)	14(77.8%)	18(9.2%)	
Period trained	<2 years ago	12(18.5%)	53(81.5%)	65(36.8%)	$\chi^2=9.012$, df=2, p=0.011
	2-5 years ago	14(35.9%)	25(64.1%)	39(22.0%)	
	>5 years ago	9(12.3%)	64(87.7%)	73(41.2%)	

Slightly above a quarter (28.9%) of male respondents and only 17.3% of female respondents were aware of color codes. However, there was no significant relationship ($\chi^2= 2.889$, df= 1, p= 0.089) between gender and awareness of color codes as shown in Table 4.21. This shows that the gender of respondents had no influence on awareness of color codes.

There was no significant relationship ($\chi^2 = 4.024$, $df=2$, $p=0.134$) between category of staff and awareness of color codes and between work experience and awareness of color codes ($\chi^2 = 3.641$, $df = 2$, $p=0.162$). This implies that neither the category of staff nor work experience had an influence on awareness of the color code system.

Training had no significant association ($\chi^2=0.061$, $df = 1$, $p=0.805$) with awareness of color codes. However, results showed that there was a significant difference ($\chi^2=9.012$, $df = 2$, $p=0.011$) between awareness of color codes and period of training. Period of training has an influence on awareness of color codes which in turn affects hazardous waste management.

4.7 Challenges facing hazardous waste management

Challenges faced by handlers during Hazardous Waste Management were divided into two including individual challenges and financial challenges.

4.7.1 Individual challenges

These refer to challenges that could be controlled by the waste handler. The challenges are as presented in Table 4.22.

Table 4.22 Individual challenges faced during hazardous waste management

Variable	Category	Frequency	Percent (%)
Are aware of color codes	Yes	39	20.0
	No	156	80.0
Aware of diseases caused by improper HWM	Yes	37	19.0
	No	158	81.0
Waste segregation is a challenge	Yes	123	63.1
	No	72	36.9

Only 20% of waste handlers were aware of color codes. Color code system is important in waste segregation whereby the color of the waste container determines the category of waste to be disposed in the container. Awareness of diseases caused by improper disposal of hazardous waste was noted where only 19% correctly identified health conditions due to improper HWM as shown in Table 4.22. A key informant reported as stated, “I am not aware of the Waste Management Regulations. Taking personal responsibility to ensure that health care workers under me use Personal Protective Equipments accordingly is not easy because most of the times I order for Personal Protective Equipments and can do nothing beyond that.”

A majority (63.1%) of the respondents agreed that waste segregation was a challenge (Table 4.22). Poor waste segregation was observed where all solid wastes whether infectious or non hazardous was mixed up in a yellow coded bin. This was evident even where color coded waste bins were available. Key Informant Interview revealed that waste segregation was a huge challenge because all (100%) the key informants reported that segregation was way below average and required urgent attention. Student population was mentioned in regard to waste segregation. It was reported that the huge student population affected waste segregation where most students were either unaware or less concerned about the color code system.

4.7.2 Financial challenges

Qualitative results revealed that inadequate finances were a challenge to proper hazardous waste management. A statement was recorded as stated by a key informant that, “inadequate resources have resulted in poor management of hazardous waste.” Use

of improvised waste bins was observed where a black container had a yellow liner. In Key Informant Interviews, it was reported that waste bins were less and bin liners were either too small or too light making waste segregation a difficult task.

Financial inadequacies were blamed for lack of regular on-job training on hazardous waste management. As shown earlier, 41.2% of the respondents were trained more than 5 years ago. Period of training had a significant statistical relationship with awareness of color codes ($\chi^2=9.012$, $df=2$, $p=0.011$), vaccination against Tetanus and Hepatitis B ($\chi^2=16.886$, $df=2$, $p=0.001$) and with use of PPEs ($\chi^2=10.150$, $df=2$, $p=0.006$). All these relationships show how important in-service training on HWM is. However, regular in-service training cannot be done unless there are adequate financial resources. According to a key informant, “in-service training was done last in the year 2007 and another one is yet to be done in the hospital.” The informant added that they were yet to source for funds from an NGO in order to conduct another training soon.

Transportation of all waste was done using wheelbarrows and there were no specific ones for specific waste. This is a challenge which may result in contamination of all waste including general waste. All (100%) key informants agreed that this was a challenge. 97.9% of the respondents were not aware that transportation of hazardous waste within the hospital was not in order. This shows that awareness of Hazardous Waste Management regulations was lacking greatly.

CHAPTER FIVE: DISCUSSION, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This section entails discussion, conclusion and recommendations on socio-demographic characteristics, type and amount of hazardous waste generated, hazardous waste disposal methods, safety measures and waste segregation.

5.2 Discussion

5.2.1 Socio-demographic Characteristics of Respondents

Socio-demographic characteristics are important in assessing hazardous waste management. Most of the respondents were females and a majority of the respondents has ever been trained while most of the trained received training more than five years ago. Gender of the respondents, work experience, category of staff, training and period of training on hazardous waste were considered. The socio-demographic characteristics had significant relationships with Hazardous Waste Management including use of PPEs, vaccination and awareness of color codes.

Gender of respondents as well as training was found to have a significant relationship with use of PPEs as a safety measure. Females were more likely to use PPEs than men. This finding is consistent with a study by Muluken *et al.*, (2013) which concluded that there existed a significant statistical relationship between socio demographic characteristics and HWM. There was a significant difference between category of staff and use of PPEs. Nurses and laboratory technicians were more likely to use PPEs unlike other healthcare workers. These finding were consistent with a study which concluded that nurses and doctors were more likely to use PPEs unlike other health care workers (Kumar *et al.*,

2013). This could be because nurses and laboratory technicians directly come into contact with hazardous waste.

There was a significant association between work experience and use of PPEs as well as vaccination. Interestingly, respondents who had worked for less than 8 years were more likely to use PPEs and be vaccinated unlike those with work experience of more than 8 years. This is inconsistent with a study by Muluken *et al.* (2013) where healthcare workers who had worked for a longer period were more likely to practice HWM unlike others. This may imply that the attitude of healthcare workers towards hazardous waste changes with time.

As shown earlier, the results of the study indicated a significant association between period of training and awareness of color codes. This implies that the recent the period of training, the clear the awareness of color codes compared to a person who was trained a long time ago hence poor knowledge of color codes.

5.2.2 Type and amount of hazardous waste generated

There were various categories of hazardous wastes generated within Thika level 5 hospital and they included; Infectious, highly infectious, sharps and non infectious hazardous waste. The study considered the amount of waste generated and recorded in the last 1 year, and the average hazardous waste generated per day was 461kg/day. During the 1-month period of data collection, the total amount of waste generated was 19271 kilograms which translated to an average of 642 kg/day. The average amount of waste generated per day differed between year 2013 and during one month of data collection. This disparity could be explained by response from a key informant that “most of the non- hazardous waste was

not being weighed until recently when weighing of all waste generated within the hospital started.

An average of 642 kg/day waste generation is consistent with a study conducted on Medical waste management in Bangladesh that showed that an average of 641kg/day of waste was generated in tertiary hospitals (Biswas *et al.*, 2011). The large amount of waste could be linked to the high load of patients together with referral patients. The large amounts of waste could also be attributed to poor promotion of waste minimization practices. Despite poor segregation practices, there were no visible littered hazardous wastes during data collection.

Laboratory department generated most of the highly infectious waste while the most of the sharps were generated in hospital wards. The finding is consistent with a similar study which revealed that most of the waste generated was generated in the inpatient department (Pandit *et al.*, 2007). This finding could be due to the consistent care that inpatients are given during both day and night.

The average amount of hazardous waste generated per bed per day was 0.3kg. This is consistent with WHO finding that in less developing countries, the average amount of hazardous waste generated per bed per day is 0.2kg (WHO, 2011). In Delhi, the average amount of waste generated per bed per day was 1.4-1.0kgs (Pandit *et al.*, 2007). However, this figure consisted of average solid waste generated including non hazardous waste. However, the finding is inconsistent with a similar study conducted in Kuwait which recorded at least 1.1kg/bed/day (Alhumoud and Alhumoud, 2007). This difference could be attributed to difference in periods of time.

Approximately half of the waste generated was hazardous. This was not consistent with WHO standard of 20% hazardous waste out of all healthcare waste. Results of studies done in Isfahan, Iran and Europe showed average generation of 40% and 69% hazardous waste per day respectively. These figures are way above the WHO standard of hazardous waste (Botelho, 2012 and Ferdowsi *et al*, 2011). Non hazardous waste should be 80% of all waste generated (WHO, 2011). However, this is not the case in Thika level 5 hospital where hazardous waste contributed almost half of total waste generated per day. Indiscriminate disposal of waste at points of generation is evident in the amount of various type of waste during weighing. This finding is consistent with a study conducted in India by Mathur *et al.*, (2012) revealing that segregation was not satisfactory.

There is a huge gap in terms of segregation and adherence to color code system during waste disposal. There was indiscriminate disposal of waste generated within the hospital where at one point both hazardous and non hazardous waste was mixed up in yellow coded waste bin. This result is consistent with a study conducted in India (Debere *et al.*, 2011 and Rao, 2008) which revealed that there was a huge gap in terms of waste segregation. This ultimately leads to use of incorrect waste disposal method making it expensive to dispose of various wastes as noted by Mazrui (2010).

According to WHO (2011), incineration of unsuitable materials results in release of harmful substances into the atmosphere. Materials which contain chlorine should not be incinerated because they release dioxins and furans which are carcinogenic (USAID, 2011 and WHO, 2011). Amount of sharps generated was inconsistent with WHO standard where sharps should account for 1% of the total waste. This figure could be as a result of

high flow of patients and too much invasive procedures including injectable medication instead of oral medication.

5.2.3 Hazardous waste disposal methods

There are various hazardous waste disposal methods at Thika Level 5 hospital: incineration, ash pit, placenta pit, steam sterilization, burying and sewerage system. However, the only waste measured within the hospital is waste meant for incineration. The main hazardous waste disposal method within the hospital was incineration. This is consistent with various studies which conclude that incineration is the most commonly applied mode of Hazardous waste disposal (Debere *et al.*, 2011). Most of the respondents were aware of incineration and use of placenta pit for hazardous waste management.

Incineration is applied to most wastes generated including sharps, infectious, highly infectious waste and non hazardous waste. The incinerator however could not clear bottles and produces a lot of smoke which is incomparable with the standard end product of incineration which is ash as outlined in Waste Management Regulation; Legal Notice No. 121 (ROK, 2008). The incinerator was not fitted with instruments for measuring the elements present in the smoke in order to ensure safety of the surrounding community. This finding is consistent with finding of a similar study conducted by Ferdowsi *et al.*(2011).The study concluded that absence of pollution detection devices is a set back because dioxins and furans could affect the neighboring community causing unexplained cancers. The resulting ash from the incinerator is disposed of in the ash pit in line with Waste Management Regulation; Legal Notice No. 121 (WMR, 2006).

The placenta pit is used for disposal of pathological waste such as the placentas. Presence of a placenta pit is consistent with a similar study which revealed that all the health care facilities surveyed had placenta pits for placentas (Muluken *et al.*, 2013). Steam sterilization was done for laboratory contaminated waste before transportation of the waste for incineration. Steam sterilization is a method of infectious waste treatment which is recommended under Waste Management Regulations (ROK, 2008). This treatment is done in order to completely kill all bacteria as well as other pathogenic organisms.

Liquid waste such as chemicals, spilt blood, spilt detergents and other liquid waste was drained into a pre-treatment chamber before it is released into the main sewer line. This result is consistent with UNEP and WHO, (2005). Unclaimed bodies, fetuses and body parts were disposed of by burying. The waste was not weighed prior to burying. Burying of this hazardous waste is consistent with a similar study conducted in Tanzania where a third of the hazardous waste generated was buried (Manyele and Anicetus, 2006).

5.2.4. Safety measures

a) Training

A majority of the respondents had been trained and most females had received training on Hazardous Waste Management. However there was no significant difference between training and sex. This is inconsistent with a study conducted by Ozder *et al.*, (2013) where the ratio of training on HWM was significantly higher in females unlike males. Most females had had training on HWM and all respondents agreed that poor waste management could lead to disease. This is consistent with results of other studies where a majority of the respondents agreed that improper HWM could cause various infections (Mathew *et al.*,

2011; Ramokate and Basu, 2009 and Yenesew *et al.*, 2012). However, less a fifth of the respondents correctly identified all named diseases related to poor waste management. This shows that most of the healthcare workers are aware that poor Hazardous Waste Management has health risks but are not sure of some diseases associated with it.

As indicated, the study showed that majority of the trained respondents use PPEs often when on duty. There was a strong association between training and use of PPEs which implies that training influences use of PPEs to a great extent. This is consistent with a study conducted by Nkonge *et al.* (2012) in two teaching and referrals hospitals in Kenya. The study showed that training on hazardous wastes significantly increases use of PPEs. This implies that training of health care workers plays a major role in use of PPEs hence the need for regular on job Hazardous Waste Management trainings.

The period during which respondents were trained influences practice of Hazardous Waste Management where most of those trained less than two years ago often use PPEs when on duty. This is evident by the strong relationship between period of training on hazardous waste and use of PPEs. This emphasizes the importance of continuous trainings on Hazardous Waste Management by health institutions as agreed upon by Nkonge *et al.* (2012) and Ozder *et al.* (2013). Regular in-service trainings could regularly give up-to-date information on HW and constant reminder about the impacts of improper HWM.

In regard to continuing in-service training, almost all respondents felt that regular trainings on Hazardous Waste Management were important. Qualitative research results showed that it was important to offer continuous education on HWM to every worker including security guards within the hospital. Studies by Nkonge *et al.* (2012), Kumar *et al.* (2013)

and Ozder *et al.* (2013) concluded that there is need for continuing education on waste management in health sectors in order to increase information levels of healthcare workers. Lack of regular in-service training in the hospital could be as a result of inadequate financial resources or low priority given to HWM.

b) PPEs (PPEs)

PPEs such as gloves, laboratory coats and nose masks were provided for waste handlers at Thika level 5 hospital. A majority of respondents were provided with PPEs and of these respondents were provided for by the hospital while the rest were provided for by a Contracted company that specializes in offering cleaning services. Contracting a company for human resource functions is advantageous when responsibilities need to be delegated and yet hiring a full-time employee is unaffordable. In addition, this helps when a need arises for conflict resolution where the hospital's liabilities are limited since this will be dealt with by the contracted company (Cicek and Ozer, 2011).

Most females often used PPEs than men and there was a significant relationship between gender and use of PPEs. There was a significant relationship between work experience and use of PPEs. Interestingly, respondents who had worked for more than 8 years were less likely to use PPEs unlike those with work experience of less than 8 years. This finding is inconsistent with a study that concluded that a health worker who has worked for several years is more likely to use PPEs unlike those with lesser years of service in the health sector (Kumar *et al.*, 2013).

There was significant relationship between provider of PPEs and use of PPEs. This finding is inconsistent with the results of a study on Health care Waste Management among Health

care workers in Ethiopia. The study revealed that health care workers were not provided with PPEs and were not using the PPEs (Muluken *et al.*, 2013). In Thika level 5 hospital, respondents who were provided with PPEs by the hospital were more likely to use them unlike others. Those who acquired PPEs by their own means were less likely to use PPEs compared to other respondents. This difference may be due to low enforcement by the responsible body and low sense of responsibility on the part of health care worker.

a) Vaccination against hepatitis B and tetanus

Vaccination against Hepatitis B and Tetanus helps in preventing healthcare workers from contracting these diseases (Amanullah and Uddin, 2008). It is required that all health care workers should be vaccinated against these diseases (UNEP and WHO, 2005). There was a significant relationship between gender and vaccination as female respondents were more likely to be vaccinated against Tetanus and Hepatitis B unlike male respondents. Most of the vaccinated respondents were nurses and laboratory technicians. However, there was no significant relationship between category of staffs and vaccination.

More than half of the trained respondents had been vaccinated against Tetanus and Hepatitis B. However, there was no significant relationship between training and vaccination. This finding is inconsistent with of a study conducted by Nkonge *et al.*(2012)which concluded that there was a significant association between training and vaccination. Results showed that there was a significant association between period of training and vaccination. This finding is consistent with a similar study which concluded that regular on job trainings on HWM could significantly improve HWM practices among health care workers (Muluken *et al.*, 2013). It was interesting to note that those who were

recently trained were more likely to get vaccinated unlike those who received training on HWM more than five years ago. This may mean that the current training on HWM is more effective due to the weight and emphasis given on importance of HWM in disease prevention.

5.2.5 Segregation of waste and Color code system

Awareness of color codes was an important factor considered to inform the decision of the researcher in regard to waste segregation. There was no significant relationship between category of staff and awareness of color codes and between work experience and awareness of color codes. This finding is consistent with another study conducted in Pakistan which showed that there was poor awareness of color code system among healthcare workers (Kumar *et al.*, 2013). Another study on healthcare waste management practice conducted in Ethiopia agreed with this finding where only 10% of the respondents were aware of color codes (Muluken *et al.*, 2013). This finding could be as a result of lack of regular in-service training and low priority given to HWM across all departments within the hospital.

More males than females were awareness of color codes. However, there was no significant relationship between gender and awareness of color codes. A similar study showed that waste segregation with regard to the recommended color codes was not satisfactory in developing countries (Kumar *et al.*, 2013). Poor awareness of color codes among health care workers implies that there could be low priority and participation by all health care workers in issues relating to Hazardous Waste Management.

Poor waste segregation was observed within the hospital. This result is consistent with a study done in Ethiopia where only 31.9% of healthcare workers reported that they segregate waste during generation by type (Muluken *et al.*, 2013). However, a study done in South Africa, where 97% reported to segregate waste into respective waste bins (Ramokate and Basu, 2009) is inconsistent with this finding. This could be because of low enforcement by the responsible body and irregular supervision. .

Sharps were segregated in sharps boxes but all other solid wastes whether infectious or non hazardous was mixed up in waste bins. This result is consistent with a study conducted on Occupation and Environmental safety associated with medical waste disposal in Dhaka, Bangladesh. The study found out that in most healthcare facilities, waste including blood contaminated waste was mixed with municipal waste (Patwary *et al.*, 2011).It was reported by a key informant that inadequate resources in the hospital had resulted in use of improvised waste bins because the bins were less. This finding is consistent with National Health Care Management Plan (UNEP and WHO, 2005). This could explain why there was mixing up of both infectious and non infectious waste.

In Thika level 5 hospital, some waste bins had no clear labels directing on the type of waste to be disposed. This finding is consistent with results of other related studies (Abah and Ohimain, 2011; Deneke *et al.*, 2011 and Patwary *et al.*, 2011). Most waste bins were unsuitable and had no clear labels, contrary to Code of practice according to WHO (2005). Lack of labels on waste bins could imply that the responsible body has been giving low priority to issues related to Hazardous Waste Management and low commitment by healthcare workers.

It was noted that Waste Management Regulations (Legal Notice No. 121) (WMR, 2006) was a strange document to some key informants noted by, “I am not aware of the Waste Management Regulations. However, segregation is a real challenge. Taking personal responsibility to ensure that health care workers under me use PPEs accordingly is not easy because most of the times I order for PPEs and if not provided on time, my hands are tied.” The result on awareness of Hazardous Waste Management Regulations is consistent with a study by Ozder *et al.* (2013), which indicated awareness deficiency of legislation among qualified hospital personnel. This could be explained by the irregularity in in-service training of health care workers in Hazardous Waste Management.

Period of training on HWM had a significant association with awareness of color codes. A statement of great concern from a key informant was “in-service training was done last in the year 2007 and another one is yet to be done in the hospital.” A study conducted by Manyele and Anicetus (2006), concluded that ongoing in-service training on HWM was important in order to equip employees with crucial knowledge on how to tackle issues related to HW in health facilities. Period of training has an influence on awareness of color codes which in turn affects Hazardous Waste Management. Lack of regular in-service trainings on HWM in Thika level 5 hospital could be due to inadequate finances and low commitment of key personnel in ensuring proper HWM. According to a key informant, the last in-service training on HWM conducted within the hospital was done in the year 2007.

5.2.6 Challenges of Hazardous Waste Management

Challenges faced during Hazardous Waste Management included inadequate finances and awareness of color codes. Inadequate finances as stated by a key informant were the main

contributing factor to poor management of hazardous waste. Qualitative results of this study showed that the hospital had no adequate and clearly labeled waste collection containers. In addition, the bin liners were either too small or of poor quality. There was inadequacy in terms of color coded waste bins which was evident since there was a black container lined with a yellow bin liner. This finding is consistent with a study conducted in Northwest Ethiopia which revealed that inadequacy in waste collection bins is a major challenge in waste segregation (Muluken *et al.*, 2013).

Unclearly labeled waste bins were observed and this poses a challenge to a person who is not aware of the color code system. According to WHO (2005), waste collection bins should be clearly labeled for ease of waste segregation. This requirement is consistent with the requirements of California Environmental Protection Agency (2002), that every generator of hazardous waste must clearly label hazardous waste collection containers with words “hazardous waste.” Inadequate or lack of labeling of waste containers is a challenge which must be minimized. This could imply lack of commitment on the part of the supervisory body.

Indiscriminate waste disposal was observed even where there were adequate color coded bins. This challenge is huge and the finding is consistent with similar studies where waste segregation was not satisfactory and need urgent attention (Abor, 2007; Mathur *et al.*, 2012; Mostafa *et al.*, 2007; Rijal and Deshpande, 2007). This implies that poor awareness of the color code system is partly responsible for poor waste segregation practice.

Qualitative results revealed that the last on-job training was done 7 years ago. This finding is similar to a study conducted in a Southern African hospital where the hospital had no

annual trainings on Hazardous Waste Management. The waste management practices of the hospital were below average and the study concluded that regular trainings could boost awareness of healthcare workers on how to properly manage hazardous waste (Abor, 2007).

According to qualitative results, awareness of Waste Management Regulations was a challenge where a key informant was not aware of the existence of the document. Regular on-job training is important in regard to awareness (Abor, 2007). According to Cuny (2000), it is the right and the need of employees to know the risks and preventive measures related to hazardous waste. However, this is not possible unless regular on-job training is conducted. Effective training will help employees to be informed hence the ability to modify their behavior and acquire crucial information on Hazardous Waste Management.

Poor passages were attributed to lack of a working cart for waste transportation. Qualitative results through observation confirmed one visible cart packed within the hospital but looked neglected and out of use. The use of improper waste transportation is consistent with a study done in India where hazardous waste was transported using hand driven open trolleys (Rijal and Deshpande, 2007). In addition, it is consistent with a study conducted in Tanzanian hospitals where use of wheelbarrows for movement of medical waste was evident in some hospitals (Anicetus and Manyele, 2006). According to Waste Management Regulations (ROK, 2008), hazardous waste should be transported using wheeled trolleys or carts for safety of waste transporters and to avoid spillages.

Inadequate finances was a major challenge that affected existence of most mentioned challenges including less waste bins, poor quality bin liners, lack of regular trainings and

use of wheelbarrows for waste transportation. This finding is consistent with other similar studies which concluded that meager finances contribute a lot to ineffective management of hazardous waste (Abdulla *et al.*, 2008; Biswas *et al.*, 2011 and Chethana *et al.*, 2013).

5.3 Conclusions

The socio demographic characteristics that were significantly associated with HWM included gender, work experience, training on HWM, period of training on HWM and category of respondents. The strong influence of training and period of training cannot be ignored when considering interventions to curb poor Hazardous Waste Management within healthcare facilities. Most of healthcare workers were trained more than 5 years ago.

Most of the waste generated within the hospital was non hazardous. However, hazardous waste contributed about half of the total waste which is 2 times the WHO standard of 20%. In addition, specific hazardous wastes were generated beyond the required standard. Indiscriminate disposal of waste was practiced in the hospital and transportation of waste generated was done using wheelbarrows.

Hazardous waste disposal methods available within Thika level 5 hospital include incineration, steam sterilization, placenta pit, ash pit, burying and sewerage system. The only waste weighed with respect to disposal method was wastes for autoclaving and incineration. The incinerator could not clear bottles and was not fitted with devices for detection of concentration of furans and dioxins.

Most of the respondents were provided with PPEs by the hospital. Respondents who used PPEs were more than half. However, more than a quarter did not consistently use PPEs. Regular in-service training could significantly increase use of PPEs. Use of PPEs had a significant statistical relationship with training and period of training, and category of staff. However continuous training was found to be lacking among most respondents. Nurses and laboratory technicians used PPEs more than other healthcare workers. More than a third of healthcare workers had not been vaccinated against Hepatitis B and Tetanus.

Awareness of color codes influences Hazardous Waste Management. Poor waste segregation was observed where both hazardous and non hazardous waste was mixed up in waste bins. Qualitative results showed that there were inadequate waste bins. It was observed that most waste bins had no clear labels. Awareness of color codes, regular trainings on HWM, provision of adequate bins and ensuring clear labels on waste bins could significantly boost waste segregation within the hospital.

Challenges facing HWM included inadequate finances which contributed to lack of regular on-job training, less waste bins, use of improvised waste bins and use of wheel barrows for waste transportation. Other challenges included poor waste segregation and awareness.

5.4 Recommendations

1. The hospital through the Public Health department should ensure proper waste segregation through provision of adequate clearly labeled waste bins to ensure clean streams of waste.
2. The hospital should ensure that the incinerator is fitted with a device for detection of high concentration of toxins in the emitted smoke in order to protect the public and the environment against effects of pollution.
3. The hospital in collaboration with Ministry of Health should organize for continuous in-service training of healthcare workers to equip them with up-to-date information on HWM with regard to use of PPEs, vaccinations and color code system. All healthcare workers including heads of departments and the management team should participate in regular trainings.
4. The relevant authority within the hospital should emphasize on waste segregation with respect to color codes especially where adequate waste bins are provided.

5.5 Further research

1. The amount of sharps generated was 9 times higher than the standard 1% of total waste generated as stated by WHO. It is indeed important to study what causes the huge difference.
2. Gender and use of Personal Protective Equipments were seen to have a significant association. Therefore, there is need to do research on how gender affects hazardous waste management.

3. The incinerator is not fitted with component level detection devices. Therefore, I suggest that research be done to ascertain components of that smoke and whether it is safe for both humans and the environment when released to the atmosphere.
4. Indiscriminate waste segregation was observed even where there were color coded bins. It is important to research on what actually influences waste segregation and the quality of training given to health care workers on HWM.

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APPENDICES

Appendix 1: Map of study area

Thika Level 5 Hospital



Appendix 2: Consent Form

My name is I am a Masters student from Kenyatta University. I am conducting a study on “Status and challenges of HWM among handlers at Thika level 5 hospital.” The information will be used by the Ministry of Health.

Procedures to be followed

Participation in this study will require that you fill in a questionnaire. You have the right to refuse participation in this study. Please remember that participation in this study is voluntary. You may ask questions related to the study at any time. You may refuse to respond to any questions and you may stop an interview at any time.

Risks

There are no risks whatsoever for participating in this study.

Benefits

If you participate in this study you will help the Ministry of Health to know how to improve Hazardous Waste Management in this hospital and therefore reduce the risks associated with poor hazardous waste management.

Confidentiality

You will fill the questionnaire on your own and your name will not be recorded on the questionnaire. The questionnaire will also be kept safe and everything will be kept private.

Contact information

If you have any questions you may contact Ms. Anne Towett on 0720077746, Dr. J. O. Osero on 0724869330 or Dr. P. Warutere on 0721993833 or the Kenyatta University Ethical Review Committee Secretariat on kuerc@ku.ac.ke.

Participant’s statement

The above information on my participation in the study is clear to me. I have been given a chance to ask questions and my questions have been answered to my satisfaction. My participation in this study will be entirely voluntary. I understand that my records will be kept private and that I can stop participation at any time.

Name of the participant

Signature

Date

Investigators statement

I, the undersigned, have explained to the volunteer in a language s/he understands the procedures to be followed in the study and the benefits involved.

Name of the interviewer: _____

Interviewer signature

Date

4. Which hazardous wastes do you usually come into contact with?

Infectious wastes	a) pathogenic materials	
	b) human anatomical waste	
	c) Used sharps	
Pathological wastes	d) organs, tissues, body parts, fetuses, human flesh, blood and body fluids	
Non-infectious hazardous	e) uninfected needles, broken glasses, unused scalpels, knives, infusion sets	
	f) chemicals	
	g) radioactive materials	
	h) pressurized containers	
	i) pharmaceuticals	

5. State whether the hazardous waste, color code and type of container match?

	Type of waste	Color of container and markings	Type of container	Tick (✓) where appropriate
a)	Infectious	Yellow	Strong leak proof plastic bag with biohazard symbol	
b)	Highly infectious	Red (Marked Highly Infectious)	Strong leak proof plastic bag with biohazard symbol	
c)	Sharps	Yellow –marked sharps	Puncture proof	
d)	Chemical and pharmaceuticals	Brown	Plastic bag or container	
e)	Non-infectious/non hazardous (non clinical)	Black	Plastic bag or container	
f)	Radioactive		Lead box, labeled with radioactive symbol	

6. What level of Hazardous Waste Management do you deal with?

a)	Waste generation	
b)	Waste segregation	
c)	Transportation	
d)	Storage	
e)	Treatment	
f)	Final disposal	

7. How you do find Hazardous Waste Management at the level(s) you deal with?

a) Easy ()

b) Difficult ()

Section B: Safety measures

8. Are you always provided with personal protective equipments (PPE)?

a) Yes () b) No ()

9. If yes, by who?

a) Hospital administration ()

b) NGO ()

c) Self ()

d) Others (specify).....

10. Which ones?

a) Lab coats ()

b) Gloves ()

c) Nose masks ()

d) Others (specify).....

11. Do you think these PPE are important in any way?

a) Yes () b) No ()

12. Do you always put them on when on duty?

a) Yes () b) No ()

13. If no, why?

a) Not always available ()

b) Not in good condition ()

c) Sometimes not necessary ()

d) Feel uncomfortable ()

e) Others (specify).....

14. Have you been vaccinated against diseases i.e hepatitis B and tetanus?

a) Yes () b) ()

15. If yes, specify

a) Hepatitis B () b) Tetanus ()

Section C: Knowledge

16. Which hazardous waste disposal methods are used in the hospital? Specify

.....

17. Are you aware of any health condition/disease associated with poor hazardous waste management?

a) Yes () b) ()

18. If yes which ones?

a) HIV ()

b) Hepatitis B ()

c) Hepatitis C ()

d) TB ()

e) Cuts/pricks ()

f) Cancers ()

g) Malaria ()

h) Others (specify).....

19. Have you ever been trained in hazardous waste (management)?

a) Yes () b) ()

20. If yes, where?

a) In college ()

b) By the hospital ()

c) By an NGO ()

d) Others (specify) ()

21. When were you trained last?

a) < 2 yrs ago ()

b) 2- 5 yrs ago ()

c) > 5yrs ago ()

22. Do you think it's important to have trainings on hazardous waste often?

a) Yes () b) ()

Thanks for your time.

Appendix 4: Key informant interview

Department:.....

1. Are you aware of the requirements outlined in the Waste management Regulations (Legal Notice No.121) on hazardous waste management?
2. Do you think HWM is adequate in terms of waste generation, segregation, transportation, storage, treatment to the final disposal?
3. Which hazardous waste disposal methods are available in the hospital?
4. Who must receive hazardous waste safety training, and how often must it be given?
5. Do you think safety measures (gloves, boots, nose masks, lab coats, etc) required for protection against risks associated with hazardous wastes are in place?
6. Do employees under you use these personal protective equipments adequately?
7. Do you take full responsibility to ensure that they fully utilize them?
8. What factors influence HWM in the hospital?

Appendix 5: HWM Observation check list

	Observation	Yes	No	N/A	Comments
a)	Clean compound- No littered hazardous waste				
b)	Good segregation of waste practice				
c)	Adherence of color codes in waste segregation				
d)	Clearly labeled (English and Kiswahili) waste receptacles for easy identification of each waste category				
e)	Use of trolleys and carts with specific ones for infectious wastes				
f)	Waste stores situated in a restricted or fenced area				
g)	Wheeled waste containers situated where the waste is easily loaded and without sharp edges.				
h)	Protective equipments put on accordingly all employees handling wastes				
i)	Presence of a properly constructed and working incinerator				

Appendix 6: Research Authorization by Graduate School, Kenyatta University



KENYATTA UNIVERSITY
GRADUATE SCHOOL

E-mail: kubps@yahoo.com
dean-graduate@ku.ac.ke
Website: www.ku.ac.ke

P.O. Box 43844, 00100
NAIROBI, KENYA
Tel. 8710901 Ext. 57530

Our Ref: P57/22970/11

Date: 15th November 2013

The Permanent Secretary,
Ministry of Higher Education, Science & Technology,
P.O. Box 30040,
NAIROBI

Dear Sir/Madam,

RE: RESEARCH AUTHORIZATION FOR MS. TOWETT ANNE CHEPNGENO- REG. NO. P57/22970/11

I write to introduce Ms. Towett Anne Chepngeno who is a Postgraduate Student of this University. She is registered for an M.P.H. degree programme in the Department of Community Health in the School of Public Health.

Ms. Chepngeno intends to conduct research for a thesis project entitled, "Status and Challenges of hazardous Waste Management Among Handlers at Thika Level 5 Hospital, Thika West District, Kiambu County."

Any assistance given will be highly appreciated.

Yours faithfully,

MRS. LUCY N. MBAABU
FOR: DEAN, GRADUATE SCHOOL



LNm/fwk

Appendix 7: Research Permit by Kenyatta University Ethics Review Committee



KENYATTA UNIVERSITY
ETHICS REVIEW COMMITTEE

Fax: 8711242/8711575
Email: kuerc.chairman@ku.ac.ke
kuerc.secretary@ku.ac.ke
Website: www.ku.ac.ke

P. O. Box 43844
Nairobi, 00100
Tel: 8710901/12
Tel: 8710901/12

Our Ref: KU/R/COMM/51/281

Date: 29th January, 2014

AnneChepng'eno Towett,
Department of Community Health,
Kenyatta University,
P.o Box 43844

APPLICATION NUMBER PKU/177/1 155 – “STATUS AND CHALLENGES OF HAZARDOUS WASTE MANAGEMENT AMONG HANDLERS AT THIKA LEVEL 5 HOSPITAL, THIKA WEST DISTRICT, KIAMBU COUNTY” - Version2

1. IDENTIFICATION OF PROTOCOL

The application before the committee is with a research topic “Status and challenges of hazardous waste management among handlers at Thika level 5 hospital, Thika west district, Kiambu County” dated 27th January, 2014.

2. DECISION

The committee has considered the research protocol in accordance with the Kenyatta University Research Policy (section 7.2.1.3) and the Kenyatta University Ethics Review Committee Guidelines **AND APPROVED** that the research may proceed for a period of **ONE year from 28th January, 2014.**

3. ADVICE/CONDITIONS

- i. Progress reports are submitted to the KU-ERC every six months and a full report is submitted at the end of the study.
- ii. Serious and unexpected adverse events related to the conduct of the study are reported to this board immediately they occur.
- iii. Notify the Kenyatta University Ethics Committee of any amendments to the protocol.
- iv. Submit an electronic copy of the protocol to KUERC.


When replying, kindly quote the application number above



PROF. NICHOLAS K. GIKONYO
CHAIRMAN ETHICS REVIEW COMMITTEE



I ANNE CHEPNG'ENO TOWETT..... accept the advice given and will fulfill the conditions therein.

Signature.....  Dated this day of..... 30/01/..... 2014.
cc. Vice-Chancellor
Director: Institute for Research Science and Technology

Appendix 8: National Commission for Science Technology and Innovation

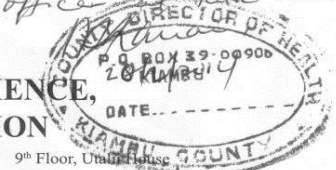
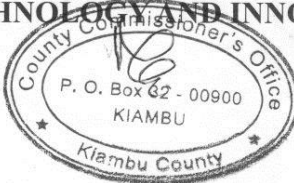
County Commissioner
KIAMBU
Scanned & Approved
21/02/2014



Dear and the County
Health management have
no objections
Contact the public
health office at Thika level 5.

**NATIONAL COMMISSION FOR SCIENCE,
TECHNOLOGY AND INNOVATION**

Telephone: +254-20-2213471,
2241349, 310571, 2219420
Fax: +254-20-318245, 318249
Email: secretary@nacosti.go.ke
Website: www.nacosti.go.ke
When replying please quote



9th Floor, Utalii House
Uhuru Highway
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No.

Date:

19th February, 2014

NACOSTI/P/14/4571/798

Anne Chepngeno Towett
Kenyatta University
P.O.Box 43844-00100
NAIROBI.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on *"Status and challenges of hazardous waste management at Thika Level 5 Hospital, Thika West District, Kiambu County,"* I am pleased to inform you that you have been authorized to undertake research in **Kiambu County** for a period ending **28th February, 2015.**

You are advised to report to **the County Commissioner, the County Director of Education and the County Coordinator of Health, Kiambu County** before embarking on the research project.

On completion of the research, you are expected to submit **two hard copies and one soft copy in pdf** of the research report/thesis to our office.

DR. M. K. RUGUTE, PhD, HSC.
DEPUTY COMMISSION SECRETARY
NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Copy to:

The County Commissioner
The County Director of Education
The County Coordinator of Health
Kiambu County.



Appendix 9: Research Authorization by Ministry of Education, Kiambu County

MINISTRY OF EDUCATION

Telephone: Kiambu (office) 020-2044686
FAX NO. 020-2090948
Email:directoreducationkiambu@yahoo.com
When replying please quote



COUNTY DIRECTOR OF EDUCATION
KIAMBU COUNTY
P. O. Box 2300
KIAMBU

KBU/CDE/CIR 9/Vol. I/58


24th February, 2014

TO WHOM IT MAY CONCERN

RE: RESEARCH AUTHORIZATION
CHEPNGENO TOWETT - KENYATTA UNIVERSITY

The above person who is a student of Kenyatta University is duly authorized to carry out research on *“Status and challenges of hazardous waste management at Thika Level 5 Hospital, Thika West Sub County”* for a period ending 28th February 2015.

You are requested to accord her any support needed.


COUNTY DIRECTOR OF EDUCATION
KIAMBU COUNTY
P. O. BOX 2300 00900 KBU.
BONIFACE N. GITAU
COUNTY DIRECTOR OF EDUCATION
KIAMBU COUNTY

Appendix 10: Research permit from Thika Level 5 hospital

