

**TYPES OF BIOMEDICAL WASTE GENERATED AND
FACTORS ASSOCIATED WITH BIOMEDICAL WASTE
MANAGEMENT PRACTICES AMONG HEALTHCARE
PERSONNEL AT MBAGATHI HOSPITAL
NAIROBI COUNTY, KENYA**

SATAWA MOHAMED ADAN

MASTERS OF SCIENCE

(Public Health)

**JOMO KENYATTA UNIVERSITY OF
AGRICULTURE AND TECHNOLOGY**

2019

**Types of biomedical waste management and factors associated with biomedical
waste management practices among healthcare personnel at Mbagathi Hospital
Nairobi County, Kenya**

Satawa Mohamed Adan

**A thesis submitted in partial fulfilment for the degree of Master of
public health in the Jomo Kenyatta University of
Agriculture and Technology**

2019

DECLARATION

This thesis is my original work and has not been presented for the academic award of a degree in any other university.

Signature_____

Date_____

Satawa Mohamed Adan

This thesis has been submitted with our approval as the university supervisors,

Signature_____

Date_____

Prof.Gideon Kikuvi

JKUAT, Kenya

Signature_____

Date_____

Dr.Joseph Mutai

KEMRI, Kenya

DEDICATION

This thesis is dedicated to my family for their prayer, support and encouragement throughout the study period. Special thanks goes to my wife Hawo Sharamo and my son Faris Mohamed and Fahim Mohamed for their endless love. To my mother Darmi Adan and my late father Adan Satawa were it not your guidance I would not have reached this far.

ACKNOWLEDGEMENT

I give all the glory to Almighty Allah for continued strength and good health during entire period of my research process and I express my sincere thanks to many individuals who supported me along the way during my research journey.

Most importantly, I express my appreciation and countless thanks to my mentors and supervisors Prof. Gedion Kikuvi and Dr. Joseph Mutai for their endless support and encouragement from the day this thesis idea was suggested, I salute you all.

Many thanks to the co-coordinator ITROMID, Medical superintendents Mbagathi Hospital and departmental in charges that assisted me at the course of my research.

Finally, I express my gratitude to my family for their constant inspiration.

TABLE OF CONTENTS

DEDICATION	iii
ACKNOWLEDGEMENT	iv
TABLE OF CONTENTS	v
LIST OF TABLES.....	viii
LIST OF FIGURES.....	x
LIST OF APPENDICES.....	xi
LIST OF APPENDICES.....	xi
ABBREVIATION AND ACRONYMS.....	xii
DEFINITION OF OPERATIONAL TERM.....	xiv
ABSTRACT	xv
CHAPTER ONE.....	1
1.0 INTRODUCTION.....	1
1.1 Background of the study.....	1
1.2 Statement of the problem.....	4
1.3 Justification.....	6
1.4 Research questions.....	7
1.5 Broad objective.....	8
1.5.1 Specific objectives.....	8
CHAPTER TWO.....	9
2.0 LITERATURE REVIEW.....	9
2.1 Global aspect of biomedical waste management practices.....	9
2.2 African aspect of biomedical waste management.....	11
2.3 Kenyan aspect of biomedical waste management.....	13
2.4 Types of waste disposal and management.....	15
2.5 Individual level factors associated with biomedical waste management practices.....	18
2.5.1 Knowledge on biomedical waste management.....	18
2.5.2 Attitude on biomedical waste management.....	19
2.5.2.1 Training.....	19
2.6 Biomedical waste management practices.....	20
2.6.1 Processes of waste management.....	23

2.6.2 Policies for occupational safety and employee health.....	23
2.6.3 Improving compliance.....	24
2.7.1 Infection associated with waste management.....	25
2.8 Conceptual framework.....	27
CHAPTER THREE.....	31
3.0 MATERIALS AND METHODS.....	31
3.1 Study site.....	31
3.2 Study design.....	31
3.3 Study population.....	32
3.4 Inclusion criteria.....	32
3.5 Exclusion criteria.....	32
3.6 Sample size determination.....	33
3.7 Sampling technique.....	34
3.8 Data collection.....	35
3.9 Criteria for assessment.....	35
3.10 Research variables.....	36
3.11 Data management and analysis.....	36
3.11.1 Data management.....	36
3.11.2 Data analysis.....	36
3.12 Ethical considerations.....	37
CHAPTER FOUR	38
4.0 RESULTS.....	38
4.1 Quantitative Analysis.....	38
4.1.1 Demographic characteristics of study participants.....	38
4.1.3 Individual level factors associated with biomedical waste management practices.....	40
4.1.3.1 Overall knowledge of biomedical waste management.....	40
4.1.4 Attitude towards biomedical waste management practices.....	45
4.1.5 Practices of biomedical waste management.....	47
4.1.6 Factors associated with biomedical waste management practices.....	55
4.2 Qualitative Thematic Results.....	62

4.2.1 Focused Group Discussion.....	62
5.0 DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS.....	67
5.1 Discussions.....	67
5.1.1Types of biomedical wastes generated.....	68
5.1.2Individual level factors associated with biomedical waste management practices.....	70
5.1.3 Biomedical waste managementpractices.....	74
5.1.4 Factors associated with biomedical waste management practices.....	76
5.2 Conclusions.....	79
REFERENCES	83
APPENDICES.....	94

LIST OF TABLES

Table 1. 1 Description of waste categories.....	17
Table 2. 1: Colour code for biomedical adopted from WHO.....	21
Table 2. 2: Average daily quantities (Kg) of health care waste by categories generated from different types of health care facility.....	27
Table 3. 1: Proportion allocation was applied to determine sample size of each cadre	34
Table 4. 1: Socio-demographic characteristics of study participants	39
Table 4. 2: Distribution of biomedical waste generated by study participant	40
Table 4. 3: Distribution of knowledge of study participant in relation to categorize specific biomedical waste.....	43
Table 4. 4: Distribution of knowledge of health personnel in relation to recognizing specific biomedical waste.....	45
Table 4. 5: Distribution of respondent by Attitude towards biomedical wastes management.....	47
Table 4. 6: Category-wise groups of practices related to biomedical waste management.....	52
Table 4. 7: Practices related to recommended disposal of biomedical waste management.....	53
Table 4. 8: Socio-demographic factors associated with biomedical waste management.....	55
Table 4. 9: Waste generation in relation to biomedical waste management	56
Table 4. 10: knowledge of study participant in relation to biomedical waste management.....	58

Table 4. 11: Practices of study participant in relation to biomedical waste management.....	60
Table 4. 12: Independent variables associated with proper biomedical waste management.....	62

LIST OF FIGURES

Figure 4. 1: Overall knowledge score of biomedical waste management.....	41
Figure 4. 2: Distribution of study participant by knowledge on biomedical waste management.....	42
Figure 4. 3: Distribution of knowledge when to seal waste bins.....	44
Figure 4. 4: Overall score in the attitude towards proper biomedical waste management.....	46
Figure 4. 5: Overall score regarding practices of biomedical waste management	48
Figure 4. 6: Overall mean percentage score for practices related of biomedical waste management among study participant.	48

LIST OF APPENDICES

Appendix 1. Informed consent	94
Appendix 2. Questionnaires	98
Appendix 3. Focus group discussion guide	104
Appendix 4. Map of Langata District.....	106
Appendix 5. Approval Letter by the County Health Office, Nairobi County	108
Appendix 6. Approval Letter by the Medical Superintendent Mbagathi Hospital.	109
Appendix 7. Approval Letter by Ethics & Research Committee –KNH/UON.....	111
Appendix 8. Manuscript Publication	112

ABBREVIATION AND ACRONYMS

BWM	Biomedical Waste Management
CI	Confidence Intervals
DF	Degree of Freedom
EMCA	Environmental Management Coordination Act
ERC	Ethical Review Committee
EU	European Union
FGD	Focus Group Discussions
HAI s	Hospital Acquired infections
HBV	Hepatitis B Virus
HCF	Health Care Facilities
HCV	Hepatitis C virus
HCW	Health Care Workers
HCWMP	Healthcare Waste Management Plan
HCWSP	Health Care Waste Management Strategic Plan
HIV/AIDS	Human Immunodeficiency Virus Infection / Acquired Immunodeficiency Syndrome
IDH	Infectious Disease Hospital
IPC	Infection Prevention and Control
ITROMID	Institute of Tropical Medicine and Infectious Disease
IQR	Inter Quartile Range
JKUAT	Jomo Kenyatta University of Agriculture and Technology
KEMRI	Kenya Medical Research Institute

KAP	Knowledge Attitude and Practices
KNH	Kenyatta National Hospital
MDH	Mbagathi District Hospital
MEF	Ministry of Environment and Forest
MOH	Ministry of Health
MPHS	Ministry of Public Health and Sanitation
MWM	Medical Waste Management
NEMA	National Environment Management Authority
OR	Odds Ratios
OSHA	Occupation Safety and Health Act
PEP	Post–Exposure Prophylaxis
POPs	Persistent Organic Pollutants
PPE	Personal Protective Equipment
SD	Standard Deviation
SPSS	Statistical Package for Social Studies
UNDP	United Nation Development Plan
UoN	University of Nairobi
USA	United State of America
WHO	World Health Organization.
TB	Tuberculosis
GAVI	Global Alliance on vaccine initiative

DEFINITION OF OPERATIONAL TERM

Association: Statistical dependence between two or more events, characteristics or other variables. An association is present if the probability of occurrence of an event or characteristics or quantity of a variable depends upon the occurrence of one or more variables

Confidence

Interval The computed interval with a given probability e.g 95% that the true value of a variable such as a mean proportion or rate is contained within interval.

Independent

Variable The characteristics being observed or measured that is hypothesized to influence an event or manifestation (the dependent variable) within the defined area of relationship under study

Informed

Consent Voluntary consent given by a subject for participation in a study

Obsolete

Chemicals This are chemicals which have expired or those which are of no use even if they are still chemically active.

Odd Ratio This is a relative measure of effect, which allows the comparison of the intervention group of a study relative to the comparison group

Persistent Organic

Pollutants This are organic compounds that are toxic to both human and animals. They persist in the environment for long periods of time since they are resistant to photolytic, chemical and biological degradation.

Sampling The process of selecting a number of subject from all in a particular group or universe

ABSTRACT

Medical care is vital for life and health, but the waste generated from medical activities presents a problem to human health. Mbagathi Hospital generates 210-341kg infectious and highly infectious waste per day. This study determined factors associated with biomedical waste management practices among healthcare personnel at Mbagathi Hospital, Nairobi County. Descriptive cross sectional study employing mixed method to gather relevant data. Stratified sampling was used to sample 195 healthcare personnel as study subject. Quantitative data were collected using structured self-administered questionnaires and analysed using Statistical Package for Social Scientists version 20 (SPSS) while focused group discussions guide was used for qualitative data which were analysed thematically. Descriptive analysis was used to summarise the data and association between variables were tested using chi-square, multivariate and bivariate statistical test. P-values were considered significant at < 0.05 . Among the surveyed healthcare personnel, the mean age (\pm SD) was 31.9 (7.5) years, (86.2%) had tertiary level education and (48.7%) were nurses. Significant voluminous waste was generated: (96.9%) sharps, (91.3%) pharmaceutical, (90.3%) pathological, (81%) kitchen, (68.7%) incineration ash while the least produced waste reported (64.6%) radioactive wastes. Significant number of study participants (22.6%) had inadequate knowledge on biomedical waste management, Sanitary staff scored significantly low (71.4%) with regards to the knowledge of biomedical waste management compared to other healthcare personnel ($P = 0.001$), 31% of study participant did not know when to seal safety bins. 28.2 %, 3.1% of the study participants disagreed and strongly disagreed respectively on proper management of the biomedical waste at the facility ($P = 0.005$). 6.7% had not agreed on recommended practices on biomedical waste management at the hospital ($P = 0.001$). Uses of biomedical waste bins was significantly associated with practicing recommended biomedical waste management. Waste generated at various departments are source of infection that healthcare personnel and patient are exposed to and variation of knowledge among healthcare personnel is an indication of inadequate knowledge as far as biomedical waste management is concerned. Periodic sensitization of staff using existing friendly channel to convey messages and environmental and occupation health unit to be incorporated in all curriculum for early exposure so as to address concern arising from biomedical waste management in health facilities.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the study

Biomedical Waste (BW) is any waste which is generated during diagnosis, treatment or immunization of human being or animals in research activities. Biomedical waste management has recently emerged as an issue of major concern not only to hospitals, nursing home authorities but also to the environment. The biomedical wastes generated from healthcare units depend upon a number of factors such as waste management methods, types of healthcare units, occupancy of healthcare units, specialization of healthcare units, ratio of reusable items in use, availability of infrastructure and resources (Mandalet *et al.*, 2009).

Waste from healthcaresettings ranges from general waste such as paper and food remains, to infectious waste such as syringes and needles to highly infectious waste such as anatomical body parts to special waste such as mercury from broken thermometers and body imaging films, waste generated within healthcare facilities, research centres and laboratories related to medical procedures. In addition, it includes the same types of waste originating from minor and scattered sources, including waste produced in the course of health care undertaken in the home (WHO, 2014).

The proper management of biomedical waste has become a worldwide humanitarian topic today. Although hazards of poor management of biomedical waste have aroused the concern world over, especially in the light of its far-reaching effects on human, health and the environment (Singh *et al.*, 2007).

Countries around the globe are coping with the proper disposal of medical waste due to lack of landfill. Developed countries face difficulties with the sheer volume of waste matters from the utilization of disposable items. On the other hand, developing countries, whose supplies are restricted, are managing challenges of segregation and disposing of every types of biomedical waste in a classified manner. Considering that medical waste these problem is the third largest sources of waste in the United States, with more than two million tons of hospitals waste discarding annually.

Georgescu (2011) reports that in health facilities establishments where risky biomedical waste is burned, open burning and far reaching inadequacies in the activities and management of small-scale medical waste incinerators results in deficiency waste destruction, inappropriate ash disposal and dioxins discharges, which can be even 40,000 times higher than emission limits set in global conventions.

Biomedical waste issues in the developing world are associated with poor financing and the absence of government guidelines for the sanitary disposal of waste. In India, the government passed the biomedical waste management and handling rules, 1998, which outlines how medical waste ought to be collected, transported and disposed. In spite of this enactment, most of the medical waste in India is dumped in the open and collected with the general waste (Godduet *al*, 2007).

It is estimated that annually about 0.33 million tonnes of hospital waste is generated in India. The waste generation rate ranges from 0.5 to 2.0 kg per bed per day. Wherever generated, a safe and reliable method for handling of biomedical waste is essential. Effective management of biomedical waste is not only a legal necessity but also a social responsibility. In developing countries, the waste is carried to the outskirts of the city and dumped indiscriminately in insanitariest way. In addition to this, new healthcare institutions are built without any consideration for waste handling and management (Verma, 2008).

For developing nations, the unsanitary disposal of biomedical waste has put millions of lives at danger because of crude dumping sites are regularly visited by individuals searching for products. Developing nations face various health issues emerging from the burning of the biomedical waste. Incinerators are yet the fundamental strategies for discarding of biomedical waste in many developing world, particularly in sub-Saharan Africa.

Studies conducted earlier in Kenya by Japan International Cooperation Agency and the Kenya Expanded Programme on Immunization in conjunction with WHO which revealed that the health care waste management practices in most of the health care facilities do not comply with the international requirements to guarantee a safe and environmentally sound management of HCW (Rushton, 2003).

A study conducted in Kenya showed that the country was still way below the World Health Organization (WHO) recommended standards, where 80% of waste should be non-infectious and can be recommended to join the municipal waste stream,

while 20% is the infectious waste that requires special waste treatment methods (Republic of Kenya, 2009).

Availability of sufficient and accurate information is fundamental step in any waste management process. This is important in understanding the generation, waste management criteria, risks and impacts (Agnes *et al*, 2006 – 2007).

According to WHO, (2001), when types of biomedical waste generated is not overseen appropriately, the healthcare personnel is exposed to contamination risk, occupational accidents and sicknesses for being always exposed to microorganisms. Biomedical waste generation source, classification, quantity and quality are the bottom line problemson deciding an effective biomedical waste management practices (Adnaneet *al*, 2013).

1.2 Statement of the problem

Major issue related to current biomedical waste management in many hospitals is unsatisfactory implementation of biomedical waste regulation as some hospitals are disposing waste in a haphazard, improper and indiscriminate manner. Lack of segregation practices results in mixing of hospital wastes making the whole waste stream hazardous leading to potential disease outbreaks. Inappropriate segregation ultimately results in an incorrect method of waste disposal.

Types of biomedical waste generated, individual level factors and biomedical waste management practices exposed health workers into health hazard subjecting them to prolong suffering and pains subsequently results to death and impairment. Individual level factors largely attributed by management practices such as lack of standard

operating procedure, personal protective equipment, lack of equipment, health workforce among others exposing health workers to more risk which can compromise the quality of life resulting in conditions that may permanently or partially affects their health and general performance

According to WHO (2014) contaminated syringes were responsible for up 33,800 new infections through needle pricking, 1.7 million hepatitis infections and 315,000 hepatitis C infection worldwide in 2010.

Inadequate biomedical waste management causes environmental pollution, unpleasant smell, growth and multiplication of vectors like insect, rodents and worms and may lead to the transmission of disease like typhoid, cholera, hepatitis B and C and AIDS through injuries from syringes and needles which are contaminated (MOH, 2005).

According to Saini (2005), though legal provisions management and handling rules exist to mitigate the impact of hazardous and infectious hospital waste on the community. Still these provisions are yet to be fully implemented. The absence of proper waste management, lack of awareness about the health hazards from biomedical wastes, insufficient financial and human resources, and poor control of waste disposal are the most critical problems connected with healthcare waste. Lack of work place guideline in many hospitals in developing countries, the implementation of biomedical waste regulations is still below the recommended threshold

The problem of biomedical waste disposal in the hospitals and other healthcare establishments has become an issue of increasing concern, prompting hospital administration to seek new ways of scientific, safe and cost effective management of the waste, and keeping their personnel informed about the advances in these area. The need of proper hospital waste management system is of prime importance and is an essential component of quality assurance in hospitals.

1.3 Justification

There is potentiality of injuries from sharps leading to infection to all categories of healthcare personnel and waste handlers. Nosocomial infections in patients from poor infection control practices and poor waste management. Risk of infection outside hospital for waste handlers, scavengers and general public living in the vicinity of hospitals, risk associated with hazardous chemicals to persons handling wastes at all levels. The hospital serves the urban poor hence due to its accessibility and affordability of healthcare services, leads to generation of voluminous waste.

Every day, relatively large amount of potentially infectious and hazardous waste is generated in the health care facilities around the world. Indiscriminate disposal of biomedical waste and exposure to such waste possess serious threat to environment and to human health that requires specific treatment and management prior to its final disposal. There is insufficient information about biomedical waste management which is essential for identifying opportunities to improve and sustain medical waste management's systems.

According to WHO, around 80% of HCW is nonhazardous and 15% is infectious. The remaining 5% is made up of sharps (1%), toxic chemicals, pharmaceuticals (3%), genotoxic, and radioactive waste (1%). These traditional estimates are not consistent for many developing countries. For instance, 25% of HCW produced in Pakistan is hazardous, 26.5% in Nigeria, and 2%–10% in other sub-Saharan Africa countries. In Kenya, due to poor segregation practices, it is common to find that up to 50% of waste in some facilities are infectious (HCWSP, 2015-2020). Although there are many literatures available on the biomedical waste management in general, only limited studies have been done to find out the exact reasons for higher generation and patterns of biomedical wastes (Tudor, 2009). The findings of this study will open up opportunities for many more studies, sensitizing the healthcare managers and guiding policy makers on the best way possible. This will encourage partnership between public and private hospital to facilitate for proper management of biomedical waste so that there will be best practices among healthcare personnel. It will also form management strategies and guideline which will equip health care facilities with modern equipment to manage biomedical waste in Kenya and other developing countries. All these will lead into conducive working environment which will provide quality of life for healthcare personnel.

1.4 Research questions

1. What are the types of biomedical wastes generated by the healthcare personnel at Mbagathi Hospital?
2. What are the individual level factors associated with biomedical waste management practices among healthcare personnel at Mbagathi Hospital?

3. What are biomedical waste management practices among healthcare personnel at Mbagathi Hospital.?

1.5 Broad objective

To determine types of biomedical waste generated and factors associated with biomedical waste management practices among healthcare personnel at Mbagathi Hospital.

1.5.1 Specific objectives

1. To identify the types of biomedical wastes generated by the healthcare personnel at Mbagathi Hospital.
2. To determine biomedical waste management practices among healthcare personnel at Mbagathi Hospital.
3. To determine individual level factors associated with biomedical waste management practices among healthcare personnel at Mbagathi Hospital.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Global aspect of biomedical waste management practices

Great strides have been made in the field of healthcare system over the years. Ironically, along with restoring and maintaining community health, health care settings also threaten their well-being. The health of public, patients and professionals are affected by poor waste management practices (Shinee *et al.*, 2008). Under the biomedical waste rules, it is imperative that the concerned health care personnel should have a proper knowledge and practice of handling and disposal of biomedical waste. Due to laxity in implementation of the rules and inadequate training of healthcare personnel, there is indiscriminate disposal of biomedical waste. This will seriously jeopardize the health of the community and have a significant impact on the environment. Studies carried out showed that the awareness and practices on biomedical waste management among health care personnel is far below the acceptable level (Mathur *et al.*, 2011).

Medical waste contains different items making it a special type of mixed waste. If not properly sorted, its handling becomes even more difficult. It can contain soiled or blood soaked bandages, culture dishes and glassware, discarded surgical gloves and surgical instruments. Waste from operation theatres will also contain removed body organs, which renders the medical waste scary, and nuisance. Medical waste will also contain lancets. However, during immunization campaign, medical waste will contain safety and empty boxes, cotton wool and bandages (Lloyd, 2003). In developing countries an estimated 0.1 to 4.5 kg's of waste is generated per bed each day (Khajuria, 2007).

This range varies widely depending on per bed waste generation and the method of estimation used. In Karnataka around 80,000 kg's of biomedical waste is produced each day and about 1 kg of biomedical waste is produced per bed (MEF, 2003).

It is estimated that 10-25% of healthcare waste is hazardous, and if it is not properly segregated the entire 100% will be converted into hazardous. Biomedical waste collection and proper disposal has become a significant concern for both the medical and the general community (MEF, 1996).

An Indian and International Perspective reported that difficulty of repair and maintenance of incinerators are key challenges particularly in developing countries. Complete burning means that the machine is designed, constructed and meets the required conditions and standards for well-functioning incinerator. This allows the combustion chambers for turbulence, adequate air that leads to sufficient combustion temperature and complete combustion. (Srishti, 1998).

According to the (Mathur, 2011) hospitals recorded 253,700 work-related injuries and illnesses in 2011, in the US which are 6.8 work-related injuries and illnesses for every 100 full-time employees. The injury and illness rate in hospitals is higher than the rates in construction and manufacturing – two industries that are traditionally thought to be generating relatively higher hazardous wastes.

Health care settings produce infectious waste that may lead to Hospital Acquired Infections (HAIs), Hepatitis B, C and HIV/AIDS among health care personnel , waste handlers, and patients. HAIs have been a major contributor to morbidity and

mortality burden in the developing world. In Kenya, the actual burden of HAIs has not been accurately quantified, but it is projected to account for about 10% to 25% of hospital admissions in government health facilities, 2.5% of HIV infections in health care workers, 32% of hepatitis B cases, and 40% of hepatitis C cases (HCWMP 2016 - 2021). In addition, it is important to note that viral haemorrhagic fevers (e.g., Ebola) and multi drug resistant TB pose a great threat to the health workforce and the general public.

2.2 African aspect of biomedical waste management

No doubt that the number of health care facilities has increased significantly over the last decade due to demographic development but mainly to global aid from international commitment to eradicate and control many diseases (Global funds, Clinton Health Access Initiative, GAVI alliance) making the issue a serious rising problem. Due to no incinerator or that the one existing is broken down, there are heaps of HCW within the hospital. If we can say that a nurse in a health post is not well trained to intuitively dispose HCW in a safer manner, that even in some teaching hospital where there are highly educated health personnel there is still little care about safely disposal of HCW. Commonly, heaps of wastes are being burned here and there but rarely completely burned (Glenn, 1999).

Assessment of health care facilities in 22 developing countries of sub-Saharan African region, showed that 18-64% of Health care facilities do not use proper waste disposal methods (WHO, 2000).

The United Nations Development Program's (UNDP) Global Healthcare Waste Project is researching ways to help Sub-Saharan Africa better dispose of medical waste. Most of the countries surveyed lacked legal policy for medical waste management and lacked proper sanitary landfills. For example, Eritrea, Lesotho, and Ghana have no legislation for health care waste management, while Kenya, Nigeria, and Gambia are signatories to the Stockholm Convention and have some relevant laws on the books. (UNDP, 2009) The lack of sanitary landfills has led to the increased use of incinerators. Gambia, Ghana, Lesotho, Nigeria, Senegal, Tanzania have no sanitary landfills; while Kenya and Zambia only have crude dumpsites. It is estimated that there are more than 1000 incinerators in Africa; many of which have been reported to be inoperative or operating below standards. (UNDP, 2009) One of the biggest risks for African healthcare facilities is the disposal of sharps (needles, scalpel blades, blood vials, glassware) that are in contact with infectious germs. The high cost of safety boxes for proper disposal of sharps limits the use of these boxes. Asian countries have started to produce these boxes locally, bringing down the cost, but African countries are still buying them from outside vendors. Nonetheless, all the countries surveyed by the UNDP did not allow sharp waste to be disposed of at the dump sites and some hospitals had separate sharp pits. While additional funding would certainly help developing countries better dispose of medical waste, relevant legislation is also needed to insure that waste is disposed of properly. Environmental exposure and public health impacts of poor clinical waste treatment and disposal in Cameroon, reported resources allocation, awareness and training and incinerator capacity as the key challenges in waste management in developing countries (Mochungong, 2009).

2.3 Kenyan aspect of biomedical waste management

In Kenya There are approximately 4,214 health care facilities in country serving about 32.2 million people. These facilities often have drugs and laboratory reagents that are expired due to long storage periods. Furthermore, more of these facilities lack appropriate disposal technologies leading to the accumulation of stockpiles of obsolete chemicals. Medical waste is potentially dangerous to human health and the environment and may include biological, infectious, sharps, chemical, excreta (body fluids and cytotoxic waste (NEMA,2005).

In Kenya, the Environmental Management and Coordination Act (EMCA) of 1999 was developed to provide a legal framework for health care waste management practices in the country (Mary *et al*, 2014).

A study conducted by the University of Nairobi revealed that 61%of 214 nurses sampled within Nairobi province had needle pricks. Two main risks associated with health care wastes are infection or injury caused to healthcare workers and handlers of waste material as well as risks to the environment. A large number of health facilities do not pre-treat their waste before disposal. It is also apparent that most of the facilities do not have medical waste management systems as some of them are not registered and operate without the knowledge of the MOH (NEMA, 2005).

National Health Care waste management standard practices; Kenya Quality Model to regulate standards and a training programme known as “DO NO HARM” for all health workers in both public and private facilities in Health Care Facilities were also launched in 2008 to compliment the framework (Mary *et al*, 2014).

The EMCA law of 1999 insists that medical waste should either be packaged in clearly labeled bags or sterilized before disposal into any of the licensed incinerators. It further stipulates that the waste separation and packaging should be done at the health facility and that it is the responsibility of facilities to properly manage their hospital waste (Mary *et al*, 2014).

Despite these guidelines, mixing of different categories of waste, crude dumping and poor handling of waste are still common in public health facilities in Thika Sub County (Patil, 2005). Thika Sub County generates 560 Kgs of waste daily, which is risk to the many patients (admission rate of 26%) which is a very high quantity and poses a potential risk to the environmental (Republic of Kenya, 2009).

According to a study done by the Ministry of Health (2008), in which hospitals were randomly selected from each province in Kenya, it revealed that provision of personal protective equipment (PPE) was poor at 37% (Republic of Kenya,2009).

In many waste treatment sites where waste handlers had PPE; most of those found handling waste did not have them on but wore them on noticing visitors. According to evaluation done on 17 health facilities in Thika Sub-county, waste handlers and nurses registered a higher proportion (78%) compared to (32%) other cadres in mismanagement of waste (Agnes *et al*,2008). Medical waste affects the health workers, patients, waste handlers and the community at large (Republic of Kenya, 2008).

The Waste handlers and nurses are not adhering to the waste disposal guidelines despite the clear policy. However, the reasons as to why, are not known (John,2006).

2.4 Types of waste disposal and management

Owing to rapid population growth, the demand for health-care has increased significantly. Simultaneously, the numbers of hospitals, small and medium scale nursing homes and clinics have rapidly increased, generating large quantities of infectious waste. The problem is aggravated due to the marked increase in disposable health-care materials (Park, 2011).

The average clinical waste in developing countries per day per patient is very high compared to developed countries (Rao, 2008).

According to the World Health Organization (WHO, 2013), high-income countries generate on average up to 0.5 kg of hazardous waste per hospital bed per day. Although the figure for low-income countries is only 0.2 kg per hospital bed per day, healthcare waste is often not separated into hazardous or non-hazardous wastes, making the real quantity of hazardous waste potentially much higher.

Medical waste is material produced in the course of health protection, medical treatment and scientific research (Dehghani *et al.*, 2008). It consists of a broad range of materials from used needles and syringes to soiled dressings, body parts, diagnostic samples, blood, chemicals, pharmaceuticals, medical devices and radioactive materials. Recognizing the dangers and the negative impact of hospital waste on the public health and the environment, many countries have developed legal frameworks to guide the management of healthcare waste treatment (Bui, 2011).

Now it is a well-established fact that there are many adverse and harmful effects to the environment including human beings which are caused by the hospital waste generated during the patient care. Hospital waste is a potential health hazard to the health care workers, public and flora and fauna of the area. The problems of the waste disposal in the hospitals and other healthcare institutions have become issues of increasing concern (Hem, 1999).

Medical waste is an issue of growing concern since it is a source for contamination and pollution, capable of causing diseases and illness either through direct contact or indirectly by contamination of soil, ground water, surface water and air. The health care establishments are an integral part of the life support system. Improper disposal of waste generated from such establishments can have direct and indirect health impacts as well as posing a potential threat to the surrounding environment, people handling it and the public in general. There is an urgent need to improve upon the medical waste management practices in the country based on systematic and scientific planning of medical waste management (Ali *et al.*, 2012).

Medical waste is the second most hazardous waste after radioactive waste. Hazardous waste are combination of solid wastes, which because of its quantity, concentration, physical, chemical and infectious characteristics significantly contribute to an increase in illness, mortality, pose a potential hazard to human health, the environment when improperly treated, stored, transported and disposed (MOH/USA, 2005). Applying more comprehensive waste management approach will help to ensure environmentally sound and economically feasible waste

practices. At a minimum, it should be noted that there is no single management scenario that can solve all medical waste problems; rather, each medical waste management problem must be assessed independently to develop a viable and sound solution (Patil *et al.*, 2001).

Table 1. 1Description of waste categories

Waste category	Descriptions
Hazardous health-care waste	
Sharps waste	Used or unused sharps
Infectious waste	Waste suspected to contain pathogens and that poses a risk of disease transmission
Pathological waste	Human tissues, organs or fluids; body parts; fetuses; unused blood products
Pharmaceutical waste, Cytotoxic waste	Pharmaceuticals that are expired or no longer needed Cytotoxic waste containing substances with genotoxic properties (e.g. waste containing cytostatic drugs – often used in cancer therapy, genotoxic chemicals)
Chemical waste	Waste containing chemical substances (e.g. laboratory reagents, disinfectants that are expired or no longer needed, solvents, waste with high content of heavy metals,
Radioactive waste	Waste containing radioactive substances (e.g. un-used liquids from radiotherapy or laboratory research)
Non-hazardous or general health-care waste	Waste that does not pose any particular biological, chemical, radioactive or physical hazard

Source: WHO, 2014

2.5 Individual level factors associated with biomedical waste management practices

2.5.1 Knowledge on biomedical waste management

The healthcare personnel while providing services, curative, promotive or preventive inevitably generate waste which itself may be hazardous to health. It carries a higher potential for infection and injuries than any other type of waste. Inadequate and inappropriate knowledge of handling of healthcare waste may have serious health consequences and a significant impact on the environment as well (Rao, 2008).

Hazardous waste are substance that pose potential threat and are inherently dangerous to the public health and the environment. They generally exhibit toxicity, corrosively ignitability, reactivity, irritability or radioactivity characteristic. Types of hazardous wastes identified includes persistent organic pollutants (POPs), non-ionizing and ionizing radiation, obsolete chemicals and pharmaceuticals medical waste (NEMA, 2005).

Adequate knowledge about the health hazard of hospital waste, proper technique and methods of handling the waste, and practice of safety measures can go a long way toward the safe disposal of hazardous hospital waste and protect the community from various adverse effects of the hazardous waste (Shafee, 2010). Healthcare workers have inadequate knowledge on health and safety in management of medical waste (MOH, 2005).

Although there is an increased global awareness among health professionals about the hazards and also appropriate management techniques the level of awareness is found to be unsatisfactory. The health and safety at work act and control of substances hazardous to human health regulations requires the healthcare providers to perform risk assessments for determining and minimizing any subsequent risks to staff, patients and the environment (EU, 2000).

2.5.2 Attitude on biomedical waste management

2.5.2.1 Training

All healthcare facilities should develop and implement appropriate orientation and in service training programmes for new employees and ongoing in-service training for existing employees (MPHS, 2010).

- i. Training should be designed to cover all cadres of staff, including doctors, nurses, clinical officers, laboratory technologist and sanitary staff
- ii. Training should highlight the employees' roles and responsibility with respect to IPC
- iii. Health and safety training should ensure that workers knows and understand the potential risks that are associated with waste from health care facilities, the value of immunization against HBV, and the importance of using the PPE available to them.

The sound management of hazardous infectious waste is the first step in health risk reduction. When the infectious waste cannot be minimized or eliminated at the source, it must be treated. The objectives of effective infectious waste management

program is to produce protection to human health and the environment from hazards posed by the infectious waste. Proper management must ensure that the waste is handled in accordance to well established procedures from the time of generation through treatment of the waste and its ultimate disposal (Mostafaet *al.*, 2009).

2.6 Biomedical waste management practices

Improper management of waste generated in health care facilities causes a direct health impact on the community, healthcare workers and on the environment (Rutala, 1992). Hospital waste mainly consists of the following three groups of waste: medical waste, infectious waste and domestic waste. Medical waste are materials accumulated as a result of patient diagnosis, treatment or immunization of human beings. Infectious waste are portion of medical waste that is in contact with a patient who has infectious disease and it is capable of producing an infectious disease. Most of the time medical waste and other waste are not collected separately is considered to be infectious waste. Traditionally, hospital wastes have been disposed of with the municipal wastes in landfills. However, since the late 1980's, the spreading trend of Human immunodeficiency virus (HIV), hepatitis B virus (HBV) and other agents associated with blood borne diseases has raised public awareness and concerns of the disposition of medical waste. As a result, medical waste is required to be treated in a special way and not to be mixed with municipal waste. Proper medical waste management requires special treatment of medical waste such as incineration or hazardous waste landfill facilities (Lee *et al.*, 1993).

Transportation of medical waste from the point of generation to disposal sites ranges from individual pottering to the use of wheelbarrows and tractors drawn trailers.

Some institutions have put up incinerators for the incineration of infectious and toxic medical wastes although most of them lack temperature monitors. Most institutions especially in the rural areas practices open dumping and burning and have pits for the disposal of material such as sharps and placentae. Waste handling is also managed by provision of protective gear for the waste handlers. However most institutions do not provide adequate protective gear for their waste handlers and in certain cases where this is provided, there is improper use(NEMA,2005).

Primarily, this study evaluated three broad functions carried out in hospital regarding biomedical waste management practices on colour-code; black, yellow, red and blue waste bins which are lined on inner side by similarly coloured waste bags, segregation of waste, disinfection and disposal of various categories of waste.

Table 2. 1: Colour code for biomedical adopted from WHO

	Type of waste	Colour of container and markings	Type of container
1.	Chemical and Pharmaceutical	Brown	Plastic bag or container
2.	Sharps	Yellow (Marked 'Sharps)	Puncture proof
3.	Infectious	Yellow	Strong leak proof plastic bag with biohazard symbol
4.	Highly infectious	Red(Marked highly infectious)	Container capable of being autoclaved
5.	Non-infectious /Non-hazardous(non-clinical)	Black	Plastic bag or container

Source: (WHO,1999)

Health care facilities can decrease their greenhouse gas contribution by recycling and buying recycling products, reducing, preventing the waste generation and providing on site treatment of waste. The argument here is that the waste management policy should target more on waste minimization. Also, the perception of health care staff is highly critical towards waste minimization (Shafee, 2010).

There has been a growing interest among the various hospitals to find out different strategies to reduce the amount of biomedical waste generated. Also, there has been increase in the development of recycling programs for health care wastes in recent years. (Wen *et al.*, 2003).

One reason might be that the waste generation pattern will be different for different hospitals depending on the facilities and services it offers. The concept of sustainability is lacking in the healthcare systems (Ferraz *et al.*, 2000).

According to Tudor (2009), there is a lack of research and accurate data about the generation patterns of healthcare waste in order to provide an evidence base for future decision making. The various reasons towards the poor waste management practices around the globe are: -The absence of waste management, lack of awareness about the health hazards, insufficient financial and human resources, poor control of waste disposal, lack of strict and appropriate regulations, the clear attribution of responsibility of appropriate handling and disposal of waste.

According to the 'polluter pays' principle, this responsibility lies with the waste producer, usually being the healthcare provider, or the establishment involved in

related activities. The technology, regulations, education, training and waste management policies in developed countries are at an advanced stage than in developing countries. There are strict legislations at the local, regional and national levels which are geared towards the proper management of hazardous clinical waste generated in developing countries (WHO, 2007).

According to Saini *et al.*,(2005) they found that by the careful segregation of items like paper, card boards, plastics and bio degradable wastes the biomedical waste stream can be reduced by 60%. The literature shows that the lack of knowledge and inefficient waste management practices are the reasons for high generation of wastes.

2.6.1 Processes of waste management

2.6.2 Policies for occupational safety and employee health

All health care facilities should institute as many engineering and work place practices, to eliminate or minimize employees' exposure to blood, body fluids and other potentially infectious materials (MPHS, 2010).

- All HCWs should be knowledgeable about specific operating procedure pertinent to their work area.
- All supervisors should be responsible for informing HCWs of any special precautions pertinent to their areas of work.
- All HCWs should adhere to standard precautions and to additional precautions as necessary.
- All health care facilities should have PEP procedures in place.

- All HCWs should immediately report an incident of contact with blood or other potentially infectious material that is sustained during the course of occupational duties, according to the PEP procedures.
- Susceptible workers, including pregnant women, should not care for patients with chicken pox, herpes zoster or rubella.
- Responsibility for compliance with IPC policies and guidelines including PEP, rest with the supervisor and individual employee.
- HBV vaccine should be offered to all HCWs whose occupational tasks place them at risk of exposure to blood or other potentially infectious material.

2.6.3 Improving compliance

According to MPHS (2010), the following recommendations are intended to improve compliance with procedures and eliminate the risk of health care associated infections.

1. Establishing engineering controls in health care facilities
2. Make available and use appropriate supplies and equipment
 - Readily accessible hand washing facilities.
 - Puncture resistant, leak proof, labeled or colour coded sharps containers that are located as close as possible to their places of use.
 - Leak proof containers for specimens and other regulated wastes that are properly labeled or colour coded.
 - Appropriate equipment specific to the type of work involved
 - An easily accessible first aid kit in all department

3. Implement controls for work practices

- Prohibit eating, drinking smoking applying cosmetics and handling contact lenses in the work areas and on work surfaces that carry an inherent potential for contamination.
- Wash hands and other skin surfaces that become contaminated with blood or other potentially infectious material immediately and thoroughly with soap and running water.

2.7 Factors associated with biomedical waste management practices

2.7.1 Infection associated with waste management

The healthcare personnel generate wastes which are considered as hazardous materials due to the higher potential of infection and injury possessed by these wastes than any other types of waste though they aim to reduce the health problems and prevent the potential risks to the health of the community. The healthcare waste management is an integral part of healthcare services, and can generate harm through inadequate waste management; thus reducing the overall benefits provided by healthcare centre (Hosny *et al.*, 2005).

Healthcare workers are exposed to many hazards that can adversely affect their health and well-being. Long hours, changing shifts, physically demanding tasks, violence, and exposures to infectious diseases and harmful chemicals are examples of hazards that put these workers at risk for illness and injuries (OSHA, 2014).

Healthcare workers are exposed to blood and other body fluids in the course of their work. Consequently, they are at risk of being infected with blood borne viruses

including HIV, HBV and HCV, In addition, they are at risk of contact diseases and respiratory infections. Risk of infection for HCWs depends on the prevalence of disease in the patient population, the nature and frequency of exposure and their vulnerability. To eliminate or minimize the risk of infection, health care facilities must institute good health and safety measures and ensure that all HCWs adhere to. These measures include relevant IPC training for HCWs, Issuing PPE to HCWs and establishing an effective occupational health programme that includes immunization, PEP and medical surveillance (MPHS, 2010).

There is greater need of hospital waste management due to injuries from sharps leading to infections to all categories of hospital personnel and waste handlers. Nosocomial infections in patients from poor infection control practices and poor waste management. risk of infection outside hospital for waste handlers and scavengers and at time general public living in the vicinity of hospitals, risk associated with hazardous chemicals, drugs to persons handling wastes at all levels, disposable being repacked and sold by unscrupulous elements without even being washed. Drugs which have been disposed of being repacked and sold off to unsuspected buyers and risk of air, water and soil pollution directly due to waste, defective incineration emissions and ash(Mostafa *et al.*, 2009).

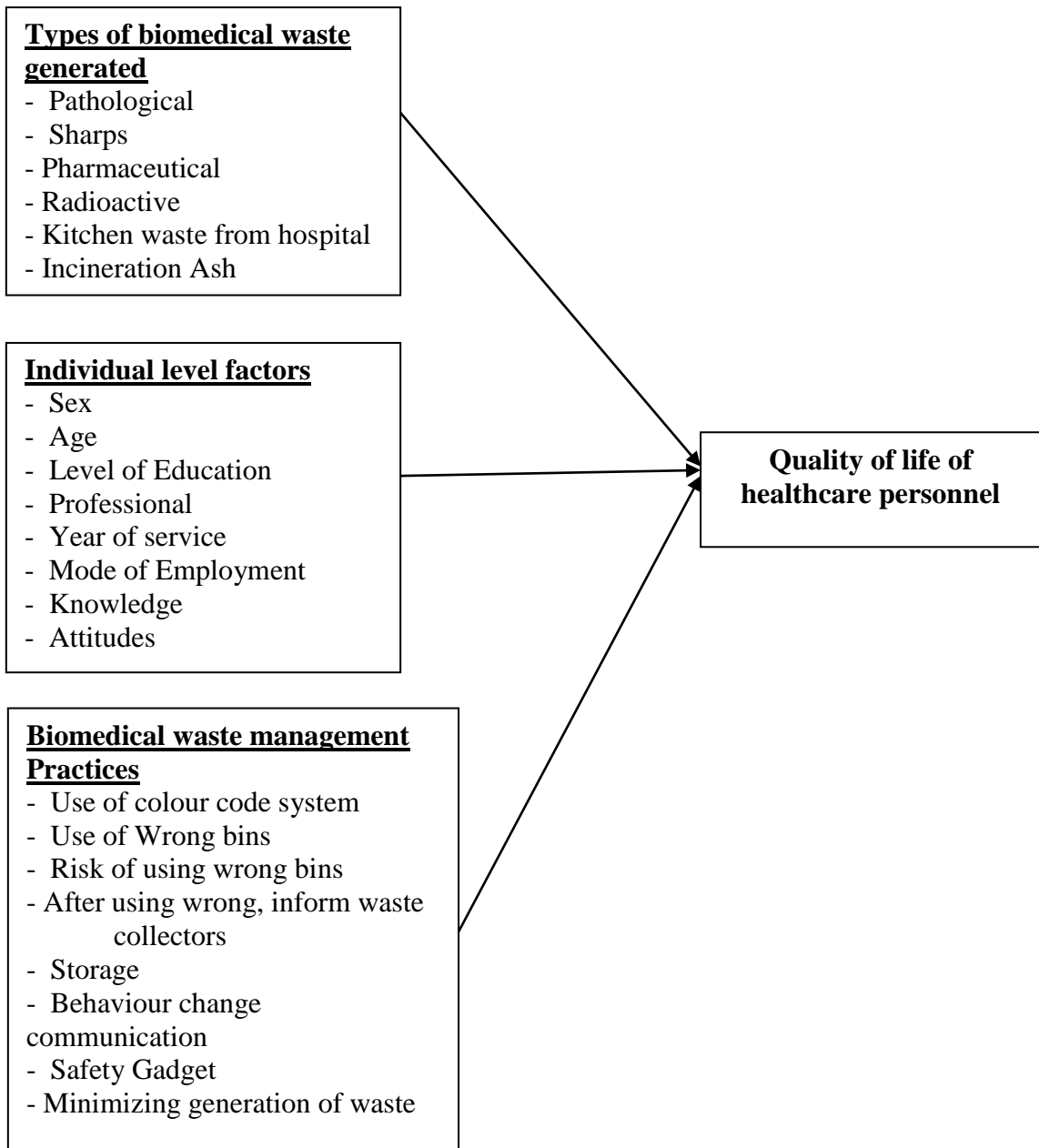
Table 2. 2: Average daily quantities (Kg) of health care waste by categories generated from different types of health care facilities.

Type of HCF	Type of wastes				
	Infectious	Pathological	Sharps	General	Cytotoxic
National Hospital	561.8	331.4	9.0	21.6	-
Referral Hospital	703.4	56.4	16.0	459.9	-
Provincial Hospital	127.6	30.5	13.8	71.0	-
District Hospital	42.8	8.7	9.4	-	3.3
Health centres	4.6	2.4	1.7	3.3	-
Dispensaries	-	0.3	1.0	4.1	-
Private clinic	-	0.1	1.7	0.1	-
Total	1445.1	429.9	52.6	560.0	-

Source: HCW survey report December, 2005

2.8 Conceptual framework

Conceptual framework is diagrammatic representation indicating the relationship between independent variables on one side and dependent variable on the other side (Wallima, 2011). In this study, components of biomedical waste studied constitutes the independent variables side which influence the biomedical waste management practices in Mbagathi constitute dependent variable as illustrated in figure 2.1.



Independent Variables

Dependent variable

Figure 2.1 Conceptual framework

2.9 Summary of literature review

The literature reviewed types of biomedical waste and factors associated with biomedical waste management practices. These includes types of biomedical waste

generated, individual level factors and biomedical waste management practices. Reviewed literature concurred generally with these attributes affect biomedical waste practices. Research has revealed that biomedical waste management practices has positive impact towards surrounding environment and disease prevention.

Types of biomedical waste generated benefits institution in various ways for instant segregation of biomedical waste helps in infection prevention control, assist in reducing, recycling and reuse of waste generated that will pose danger to patients, environment and scavengers at the final disposal site. Individual level factors for example education, year of service, knowledge and attitude will result to performance influence, safety and implementation of work place guidelines towards biomedical waste management practices. Biomedical waste management practices are vital as far as biomedical waste is concern. This provides reliable methods for handling biomedical waste management, information that will benefit and interlink health institution to other stakeholders to their compliance of rules and regulation

2.10 Research gaps

Literature has showed wide gaps in their methodologies in respect to study population in responding to management of biomedical practices. The literatures in Kenya have largely been on generation awareness and practices regarding biomedical waste management. Their recommendation have therefore been very general and not specific lacking clear action points needed to make a meaningful impact.

Literature has zeroed in actual response of perception of participants. This has excluded the managers of specific key sections that generate various types of biomedical waste in typical public health facilities.

This study intends to fill these pertinent gaps in literature by studying the selected independent variables for example types of biomedical waste generated, individual level factors, biomedical waste management practices and comprehensive representative of all cadres. This study will add value to literature that already exist and also provide evidence on vital roles played by healthcare personnel towards biomedical waste management practices.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study site

This study was conducted at Mbagathi Hospital, Nairobi County. The Hospital is located in Woodley Kenyatta Golf Course ward, Dagoretti division off Nairobi west District.

This hospital has the largest catchment area of about one million people, mainly comprising of the urban poor. It is bordering the KNH, Kenyatta city council market, Defense forces memorial hospital, KEMRI and the sprawling Kibra slums.

It is accessible and offers affordable healthcare services. Therefore, because of its location it is the one of the facility within Nairobi that the Ministry can rely on in its quest to decongest the KNH which should concentrate on referral cases only.

Mbagathi Hospital was originally known as “Infectious disease Hospital” (IDH). It was built in the 1950s to offer health services, mainly diseases which required isolation such as tuberculosis, measles, meningitis and leprosy.

In the year 1995, IDH was carved from KNH and transformed into autonomous District Hospital for Nairobi. Today Mbagathi Hospital, it's offering to the public most health care services that can be found in any other county hospital in the country. Hospital registers 1098 and 15,127 as inpatients and outpatient cases respectively a month as per the hospital workload during the study period.

3.2 Study design

A descriptive cross-sectional study design was adapted employing mixed methods – Quantitative and qualitative approaches. This design is used to capture information based on condition and potentially related factors on which data was gathered for a

specific point in time for a defined population. The data was collected from healthcare personnel at Mbagathi Hospital Nairobi County with varied characteristics and demographics. Study findings in this design help to remove assumptions and replaces them with actual data on the specific variable studied during the time period as accounted for in the cross-sectional study.

3.3 Study population

The hospital has three hundred and ninety five healthcare personnel (Doctors, Clinician, Nurses, laboratory and sanitary staff) working at Mbagathi Hospital.

3.4 Inclusion criteria

1. Healthcare personnel (doctors, clinicians, nurses, laboratory technicians and sanitary staffs) who were working at Mbagathi Hospital.
2. Healthcare personnel who were work at Mbagathi hospital
3. Healthcare personnel who were willing to participate in the study
4. Healthcare personnel who were on duty during data collection

3.5 Exclusion criteria

1. Other Healthcare personnel apart from (doctors, clinician, nurses, laboratory technicians and sanitary staffs) who were working at Mbagathi Hospital
2. Non Mbagathi hospital healthcare personnel who work at hospital
3. Healthcare personnel who werenot willing to participate in the study.
4. Health care personnel who were off duty during data collection

3.6 Sample size determination

The minimum sample size was determined using the (Cochran's 1977) formula. A prevalence of 50% with appropriate knowledge on biomedical waste management was used. A true proportion was determined at 95% confidence level.

$$n = \frac{Z^2 p q}{d^2}$$

Where

n = Desired sample size

Z= Standard normal deviate (1.96) at 95% confidence interval.

P= Proportion of all health care personnel in Mbagathi Hospital with appropriate knowledge on biomedical waste management.

q = (1-p) Proportion of all health care personnel in Mbagathi Hospital with no appropriate knowledge on biomedical waste management.

d = The level of accuracy desired set at 0.05 (5% absolute precision)

$$n = \frac{1.96^2 \times 0.5 \times (1-0.5)}{(0.05)^2} = 384.16$$

Since the target population is below 10,000 a finite correction formula was applied to get a working sample size (Yamane,1967).

$$n_f = \frac{n}{1 + n/N} = \frac{384}{1 + 384/395} = 195$$

Where n is the sample size, N is the population size

Proportion allocation according to size was then be applied to determine sample size (Lemeshow, 1990) for each cadre; Doctors, Clinical Officers, Nurses, Laboratory technicians and Sanitary staff.

N

$$P = [(\sum Y_i) / N] n_i$$

i=1

P = Population proportion

Y =The value of characteristic in elementary

N = Total number of elementary unit in a population

Y_i = Y in the ith elementary unit

Table 3. 1: Proportion allocation was applied to determine sample size of each cadre

Personnel at MDH	Doctors	Clinicians	Nurses	Laboratory Technologist	Sanitary Staff	Total
Total Population = N	84	44	192	18	57	395
Sample size = n	41	22	95	9	28	195

Source: Mbagathi Hospital2015

3.7 Sampling technique

Stratified proportionate to size sampling techniques was used to select the study participants for this study. Healthcare personnel in the hospital list were treated as sample frame then sample sizes from stratified cadres were selected using simple random sampling.

3.8 Data collection

This study population was healthcare personnel at Mbagathi Hospital, Nairobi County. Data was collected using questionnaires and focus group discussion. Self-administered Questionnaires were administered to doctors, nurses, laboratory technologist and sanitary staff. Quantitative data was collected using structured questionnaires to capture issues such as socio-demographic data, types of biomedical waste generated, knowledge, attitude and practices on biomedical waste management (Appendix 2). Due to the nature of their work in the facility, an agreeable time to pick-up the filled in questionnaires was agreed upon.

Qualitative data was collected using two focus group discussions comprising of 11 and 12 members. Participants were randomly selected to participate in each of the group. First group had eleven participants of nurses which were composed of 6 males and 5 females who participated in the discussion that lasted for about 45 minutes. Second group involved 12 participants of sanitary staff which comprised of 4 males and 8 females with their discussions taking approximately 49 minutes. The principal investigator moderated the discussions while the field assistant assisted in recording the proceedings and writing notes as back-ups. A guide was used to capture issues such as types of biomedical waste generated, individual level factors, practices and factors associated with biomedical waste management (Appendix 3).

3.9 Criteria for assessment

Knowledge assessment was based on a set of sixteen (16) questions which was scored low for those who answered less than ten questions correctly, moderate for those who answered between 11-15 questions correctly and high for those who

answered above 15 questions correctly. Attitude was assessed using liker scale; strongly agree, agree, disagree and strongly disagree. Each desirable observation for twenty (20) set of practice was assigned '1' mark and each undesirable observation was assigned '0' mark.

3.10 Research variables

3.10.1 Dependent variable are: Quality of life of healthcare personnel

3.10.2 Independent variables are: Types of biomedical waste, individual level factors, and biomedical waste management practices.

3.11 Data management and analysis

3.11.1 Data management

Data was stored in electronic storage devices like flash disk, hard disk and the files containing the data were password encrypted. This storage was maintained before and after analysis.

3.11.2 Data analysis

Quantitative and qualitative approaches were used for data analysis. Quantitative data from questionnaires was coded and entered into the computer using Excel spread sheet for computation of descriptive statistics (frequency and cross tabulations). Statistical Package for Social Scientists (SPSS) version 20 for analysis. Chi-square test, bivariate and multivariate analysis was used to determine the associations between the study variables. P -value was considered statistically significance at < 0.05 . Qualitative data was categorized in themes according to the objectives after transcription and translation into English languages (where applicable), results was categorized into themes and presented in verbatime forms.

3.12 Ethical considerations

Approval for Scientific and Ethical clearance was sought from the KNH-UON Scientific Ethical Review Committee **Ref (P610/09/2015)**. The copy of approval letter and proposal was presented to the Hospital administration (Medical Superintendent) who cleared the researcher to carry out the study in the Hospitals. Respondents were assured that their participation was voluntary and that they were free to withdraw from the study at any time. Informed consent was obtained before administration of questionnaires and all the participants requested to allow the use of a tape recorder during the focus group discussion.

3.13 Limitation of the study

Some of study subjects felt that it was time consuming to respond to questions and issues in the questionnaires as they had to carry out their daily activities.

CHAPTER FOUR

4.0 RESULTS

4.1 Quantitative Analysis

A total of (195) participants working as healthcare personnel at Mbagathi Hospital who met the inclusion criteria were recruited into this cross-section study.

4.1.1 Demographic characteristics of study participants

The mean age (\pm SD) of the study participants was (7.5) years with median of 30 years (range 22 to 59 years). Significantly high number of participants (45.1%) were aged between 31-40 years followed by 41% aged between 21-30 years, while the least (13.8%) were aged \geq 41 years. ($P = 0.001$).

There was nearly equal distribution of participants by gender(55.4%) were females compared to 44.6% male. In this study the number of participants with tertiary level education was significantly higher (86%)($P = 0.001$). The number of nurses was significantly higher than the other participant (48.7%)($P = 0.001$).

Furthermore, results indicated that significant high number of participants (46.7%) got employed as a results of internal advertisement followed by (41.5%) based on external advertisement. Significant high number(53.3%) of study participants had worked for a period of 1 to 5 years, followed by (23.6%) who had served for between 6 to 10 years while the least 23.1% had served for a duration of \geq 11 years (Table 4.1).

Table 4. 1:Demographic characteristics of study participants

Variables	Frequency	Percentage	c ₂	df	P
Age					
Mean (± SD)	31.9	(±7.5)			
Median (IQR)	30	(27-36)			
Range	37	(22-59)			
21-30	80	41.0			
31-40	88	45.1	33.815	2	0.001
>41	27	13.8			
Gender					
Male	87	44.6	2.262	1	0.152
Female	108	55.4			
Education Level					
Primary	6	3.1			
Secondary	21	10.8	246.554	2	0.001
Tertiary	168	86.2			
Occupation					
Doctors	41	21.0			
Clinician	22	11.3			
Nursing	95	48.7	114.103	4	0.001
Laboratory technician	9	4.6			
Sanitary staff	28	14.4			
Mode of Employmnt					
Internal advertisement	91	46.7			
External advertisement	81	41.5	41.477	2	0.001
Through friends	23	11.8			
Years of service					
1 - 5	104	53.3			
6 - 10	46	23.6	35.108	2	0.001
>11	45	23.1			

C₂ - Chi square; df - Degree of freedom; P - Level of significance; P ≤ 0.05 indicates the relationship is significant

4.1.2 Types of biomedical wastes generated

In overall, Significantly high voluminous of infectious and highly infectious of waste was generated such as; 96.9% sharps, (91.3%) pharmaceutical and (90.3%)

pathological, kitchen waste 81% and radioactive waste at 46% which was inform of used and unused liquids from radiotherapy A cross healthcare personnel significantly high number of the sanitary staff (96.4%) confirmed that voluminous sharps waste were being generated at Mbagathi Hospital. (Table 4.2).

Table 4. 2: Categories of biomedical waste generated by study participants

Type Biomedical Waste	Overall	Healthcare Personnel				
		Doctors Yes (%)	Clinician Yes (%)	Nursing Yes (%)	Technician Yes (%)	Sanitary Yes (%)
Sharps	189 (96.9)	37(90.2)	22(100)	94(98.9)	9(100)	27(96.4)
Pharmaceutical	178 (91.3)	39(95.1)	20(90.9)	89(93.7)	4(44.4)	26(92.9)
Pathological	176 (90.3)	33 (80.5)	22 (100)	87 (91.6)	8 (88.9)	26 (92.9)
Kitchen	158 (81)	29(70.7)	16(72.7)	82(86.3)	4(44.4)	27 (96.4)
Incineration Ash	134 (68.7)	22(53.7)	8(36.4)	74(77.9)	4(44.4)	26(92.9)
Radioactive	126 (64.6)	20(48.8)	8(36.4)	69(72.6)	4(44.4)	25(89.3)

4.1.3 Individual level factors associated with biomedical waste management practices

4.1.3.1 Overall knowledge of biomedical waste management

In overall, significantly high number of study participants(58.9%) scored moderate between moderate and 18.5% scored high $\geq 75\%$ translating to adequate knowledge on biomedical waste management against 22.6% who scored low meaning inadequate knowledge (P = 0.001) (Figure 4.1).

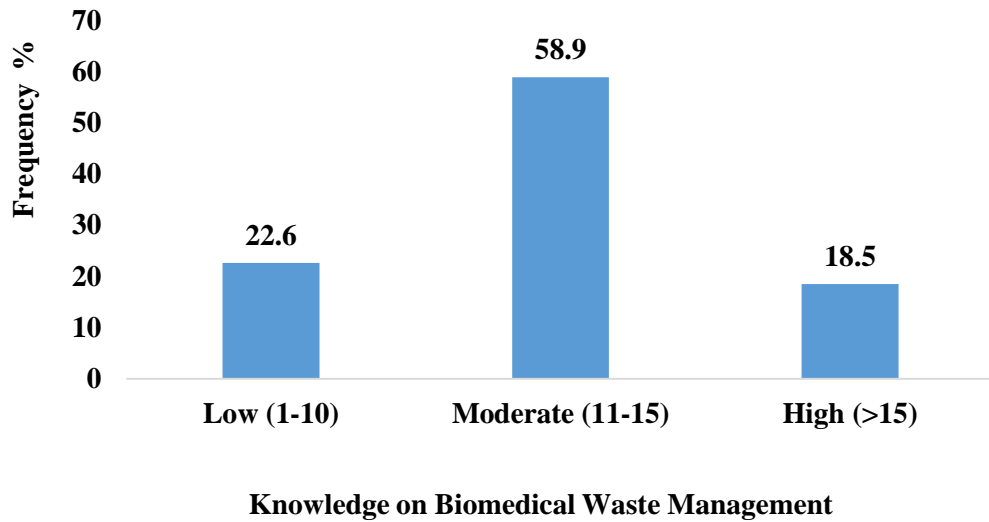


Figure 4. 1:Overall knowledge score of biomedical waste management

4.1.3.2 Knowledge of biomedical waste management among respondents

On evaluating knowledge on biomedical waste management by study participants, 71.4% of sanitary staff and 39% of doctors scored significantly low while significantly number of doctors (41.5%), clinician (63.6%), nurses (71.5%), laboratory technicians (88.9%) and sanitary staff (28.6%)scored moderate (P =0.001) (Figure 4.2).

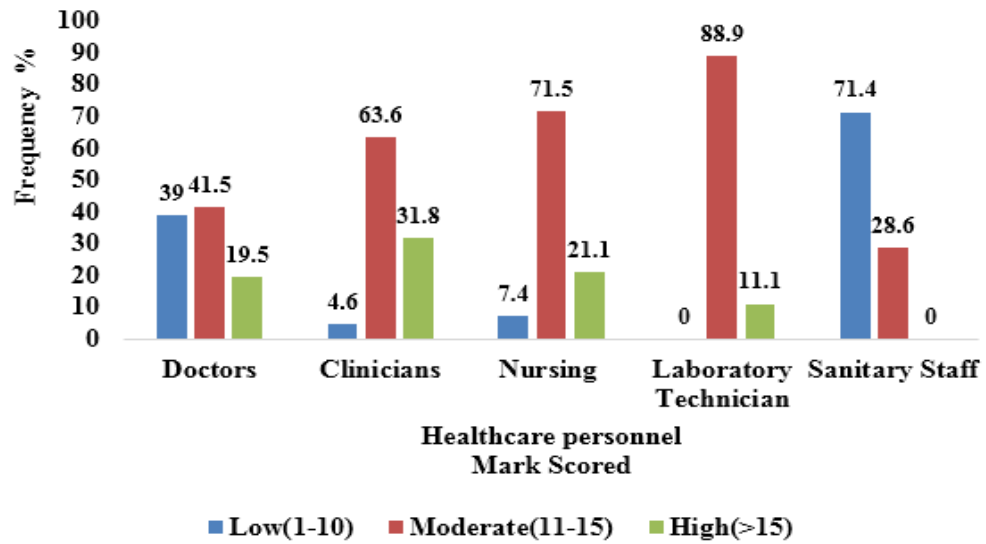


Figure 4. 2: Distribution of study participants by knowledge on biomedical waste management

4.1.3.3 Categorization of specific biomedical waste items

Significantly high number of the study participants was able to categorize waste that was generated at facility. Sanitary staff scored least in categorization of chemical (32.1%) and pharmaceutical waste (10.7%)($P=0.001$) (Table 4.3).

Table 4. 3: Distribution of knowledge of study participant in relation to categorize specific biomedical waste

Knowledge on Biomedical waste management	Healthcare Personnel						P
	Overall N (%)	Doctors N (%)	Clinician N (%)	Nursing N (%)	Technician N (%)	Sanitary N (%)	
Knowledge in categorization of biomedical waste							
Kitchen wastes from the hospital	181(92.8)	35(85.4)	22(100)	88(92.6)	9(100)	27(96.4)	0.173
Radioactive materials	180(92.3)	35(85.4)	22(100)	87(91.6)	8(88.9)	28(100)	0.127
Chemicals	151(77.4)	33(80.5)	18(81.8)	84(88.4)	7(77.8)	9(32.1)	0.001
Pathology materials	145(74.4)	25(61.0)	14(63.6)	72(75.8)	9(100)	25(89.3)	0.02
Pharmaceutical	60 (30.8)	19(46.3)	12(54.5)	21(22.1)	5(56.7)	3(10.7)	0.001

N - Number of personnel; % - Percentage; P - Level of Statistical significance; Bold shows statistical significance

4.1.3.4 Knowledge on when to seal waste bins

4.1.3.4.1 Overall knowledge on biomedical waste management

In overall, the high significant number of study participants (69%) were able to recognize that waste bins should be sealed when three quarters full (24%) said when completely full (4%) said don't know and 3% said should be sealed when half full.

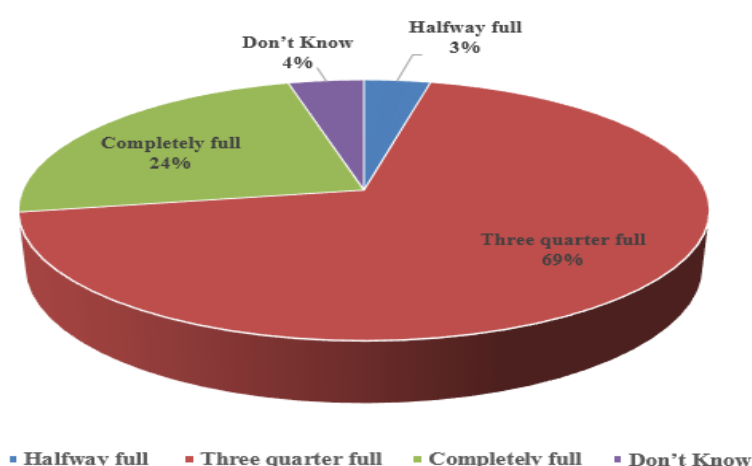


Fig 4.3 Overall knowledge on when to seal waste bins

4.1.3.4.2 Knowledge on when to seal waste bins

Across study participants significant high number of (53.6%) doctors, (72.8%) clinician, (88.4%) nursing and (88.9%) laboratory technician were able to recognize that waste bins should be sealed when three quarter full unlike (14.3%) sanitary staff who said when three quarter full.

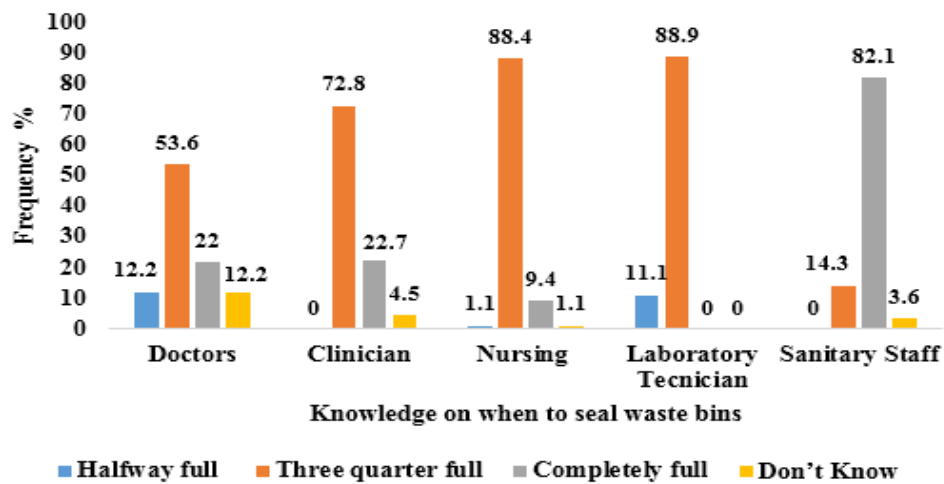


Figure 4. 3: Distribution of knowledge when to seal waste bins

4.1.3.5 Recognition of specific biomedical waste items

In recognition of hazardous biomedical waste, no difference was observed between healthcare personnel in these waste items; paper, carton and boxes, body fluids, radioactive material, kitchen waste and pharmaceutical waste. On the contrary, differences were seen in recognizing the hazardous nature of the following waste items; unused medicine, dressing cotton and plasters, pressurized containers and chemicals (table 4.4).

Table 4. 4: Distribution on recognition of specific biomedical waste items study participants

Knowledge on Biomedical waste management	Healthcare Personnel					
	Overall N (%)	Doctors N (%)	Clinician N (%)	Nursing N (%)	Technician N (%)	Sanitary N (%)
Recognition of hazardous biomedical waste						
Paper, cartons, boxes	174(89.2)	35(85.4)	19(86.4)	87(91.6)	7(77.8)	26(92.4)
Pathology materials	174(89.2)	32(78.0)	18(81.8)	90(94.7)	8(88.9)	26(92.9)
Body fluids	168(86.2)	33(80.5)	16(72.7)	87(91.6)	8(88.9)	24(85.7)
Radioactive materials	161(82.6)	31(75.6)	18(81.8)	76(80)	8(88.9)	28(100)
Kitchen wastes from the hospital	150(76.9)	29(70.7)	72.7	73(76.8)	7(77.8)	25(89.3)
Unused medicines	142(72.8)	25(61.0)	15(68.2)	76(80)	3(33.3)	23(82.1)
Dressings cotton, plasters	105(53.8)	17(41.5)	20(90.9)	55(57.9)	8(88.9)	5(17.9)
Pressurized containers	76 (39)	9(22.0)	0	44(46.3)	2(22.2)	21(75.0)
Chemicals	74 (37.9)	20(48.8)	16(72.7)	26(27.4)	6(66.7)	6(21.4)
Pharmaceutical	12 (6.2)	3(7.3)	(3)13.6	3(3.2)	1(11.1)	2(7.8)

N - Number of personnel; % - Percentage; Bold shows statistical significance

4.1.4 Attitude towards biomedical waste management practices

Significantly, high number of study participant (24.1%) strongly agreed and 44.6% agreed with biomedical waste management at the hospital. (Figure 4.4).

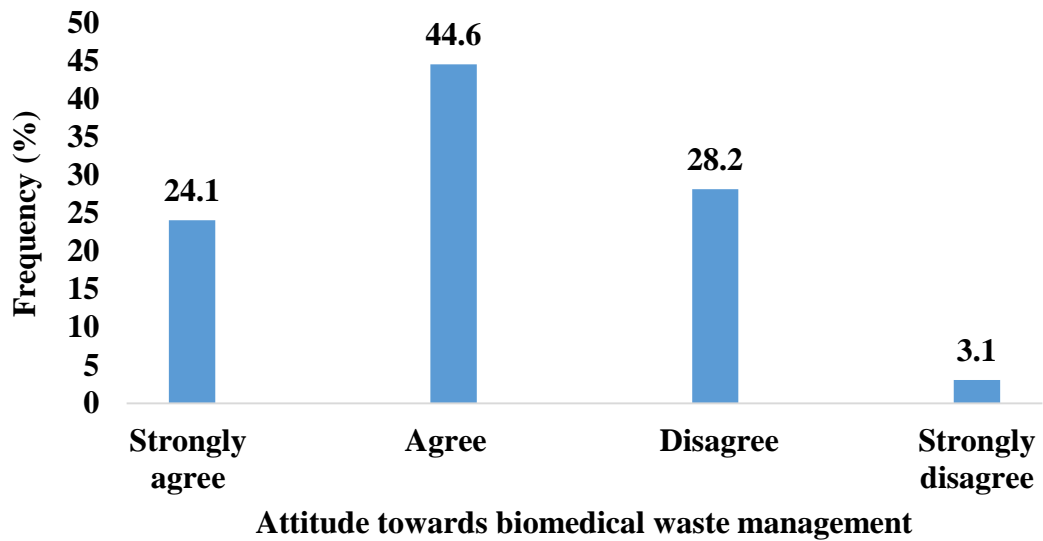


Figure 4. 4: Overall score in the attitude towards biomedical waste management practices

4.1.4.1 Distribution of study participants by Attitude towards biomedical waste management

Significantly high number of clinician strongly agreed on biomedical waste management against sanitary staff who none of them strongly agreed. Quite high number of nurses and sanitary staff (5.3%, 3.6% respectively)strongly disagreed with biomedical waste management while none of the doctors, clinicians and laboratory technicians had strongly disagreed The mean (\pm SD) 2.2 (\pm 0.79) and median (IQR) 2(1) of the summarized attitude Liker scaled data towards biomedical waste management further suggest consensus, that most healthcare personnelindicated agreementtowards proper biomedical wastes management in the hospital (Table4.5).

Table 4.5: Distribution of study participants by Attitude towards biomedical wastes management

Variable	Attitude towards proper biomedical waste management				P
	Strongly agree N (%)	Agree N (%)	Disagree N (%)	Strongly Disagree N (%)	
Medical care workers					
Doctors	13(31.7)	13(31.7)	15(36.6)	0	0.005
Clinician	10(45.5)	8(36.4)	4(18.2)	0	
Nursing	22(23.2)	39(41.1)	29(30.5)	5(5.3)	
Laboratory technician	2(22.2)	5(55.6)	2(22.2)	0	
Sanitary staff	0	22(78.6)	5(17.9)	1(3.6)	
Gender					
Male	19(21.8)	42(48.3)	24(27.6)	2(2.3)	0.768
Female	28(25.9)	45(41.7)	31(28.7)	4(3.7)	

N - Number of personnel; % - Percentage; P - Level of Statistical significance; Bold shows statistical significance

4.1.5 Practices of biomedical waste management

The overall mean percentage score for practices related to biomedical waste management was 2811/3900 (72.1%). Significantly high number of study participants (53.3%) scored between 50 - 75% marks of the overall practices regarding biomedical waste management (40%)scored $\geq 75\%$ marks and (6.7%)scored between 25 - 50% marks (P = 0.001) (Figure 4.4).

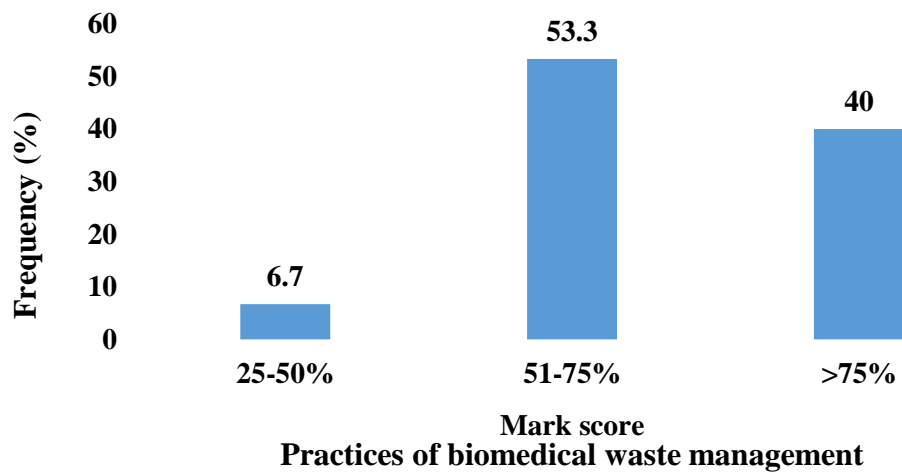


Figure 4. 5: Overall score regarding practices of biomedical waste management

4.1.5.1 Practices related of biomedical waste management among study participants

In across study participants, practices related to biomedical waste management study revealed that for those who scored 25-50% were 12.2% of doctors, 9% of clinician and 6.5% were nurses. Participants who scored significantly high number between 51-75% marks were, 89.3% (sanitary staff), 77.8% (laboratory technology), 48.4% (nurses), 45.5% (clinician) and 41.5% (doctors).Sanitary staff scored significantly high (89.3%) compared to other study participant regarding various practices related to biomedical waste management (P = 0.001) (Figure 4.6).

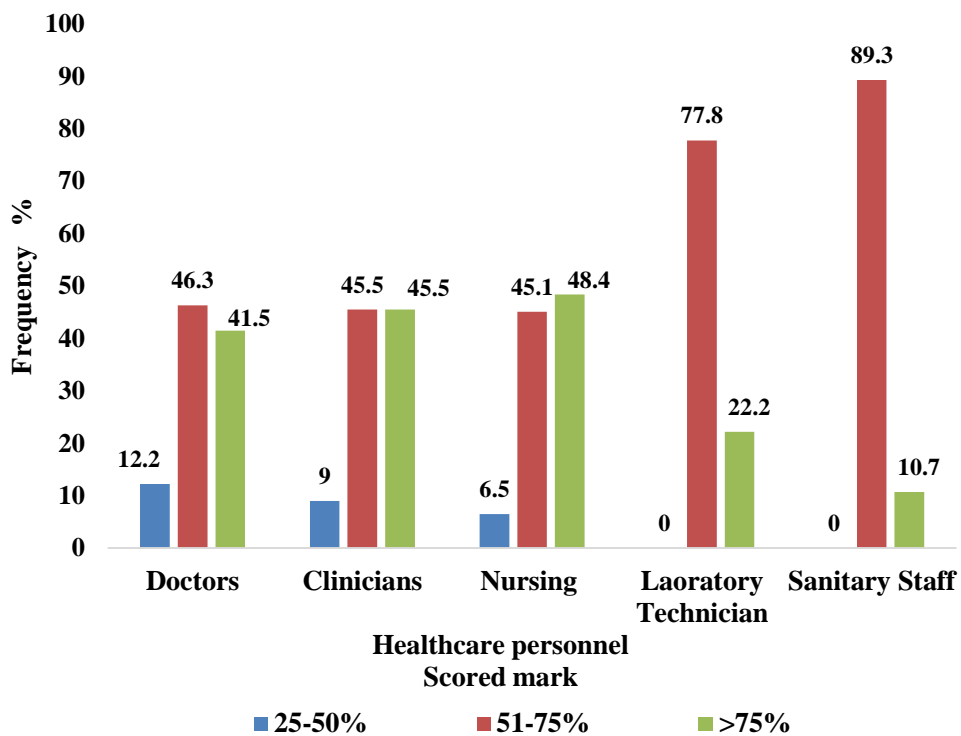


Figure 4.6: Practices of biomedical waste management among study participants.

4.1.5.2: Category-wise groups of practices related to biomedical waste Management

Significantly, high number (64.1%) of study participants were able to use the recommended colour coded bins for waste segregation with 11.3% found it is not easy to use colour coded bins. Comparing the ease of using recommended colour coded bins across healthcare personnel the study reveals that significant high number of clinicians, nurses, doctors, and laboratory technician were able to use the recommended colour coded bins for waste segregation compared to 71.4% sanitary staff, who reported not easy in using correctly the colour coded waste bins (P = 0.001).

There was nearly equal distribution of study participants who frequently, quite often and not at all (30.8%, 33.3% and 35.9% respectively) used wrong biomedical bins ($P = 0.698$). Comparing the frequency of using wrong biomedical waste bins across healthcare personnel showed significant high number (46.3%) of nurses, (31.7%) doctors, (45.5%) clinicians and (22.2%) laboratory technicians used correct biomedical waste bin against 82.1% of sanitary staffs who frequently reported use of wrong biomedical waste bins ($P = 0.001$).

Significant high number (96.4%) of study participants agreed that it was highly risky to use wrong biomedical waste bins compared to 0.5% who found no risk in using the wrong biomedical waste bins ($P = 0.001$). Across study participant, there was consensus that it is very risky in using wrong biomedical waste bins ($P = 0.692$).

The majority (87.7%) of study participants did not inform biomedical waste collectors if they used wrong bin to discard waste compared to only 12.3% who inform waste collectors ($P = 0.001$). Across study participants significant high number of reported that they did not inform biomedical waste collectors if they used wrong bin to discard waste ($P = 0.005$).

In overall, there was no significant difference between the study participants on storage of biomedical waste (49.2%) against those not stored biomedical waste (50.8%) ($P = 0.886$). Across study participants, there was significant variation between those storing biomedical waste against those who did not store biomedical waste ($P = 0.001$).

Significantly high number(73.8%) of study participants received communication about waste management compared to 26.2% who reported not received communication on waste management ($P = 0.001$). Across study participants, there was significant variation between those who had received communication on waste management and those who did not receive communication, (44.4%) laboratory technicians, (35.7%) sanitary staff, (31.7%) doctors (22.7%) clinician and (20%) nurses ($P = 0.237$).

Significantly high number(90.3%)of study participant had safety gadgets during biomedical waste handling compared to only 9.7% who did not have safety gadgets ($P = 0.001$). Across study participant, there was significant variation between those who had safety gadgets during handling of biomedical waste against those who did not have (33.3%) laboratory technicians, (22.0%) doctors, (9.1%) clinician, (4.2%) nurses and (3.6%) sanitary staff($P = 0.002$).

Significant high number of study participant (80.5%) agreed on minimization of biomedical waste generated ($P=0.001$). Across study participant there was significant variation on minimization of biomedical waste generated(22.2%) laboratory technicians,(22.7%) clinician, (22.0%) doctors, (18.9%) nurses and (17.9%) sanitary staff ($P=0.993$) (Table 4.6).

Table 4. 6: Category-wise groups of practices related to biomedical waste management

Practices regarding Biomedical waste management	Overall N (%)	P*	Healthcare personnel					P
			Doctors N (%)	Clinician N (%)	Nursing N (%)	Technicia n N (%)	Sanitary N (%)	
Ease of using colour coded bins								
Very easy	125(64.1)		28(68.3)	19(86.4)	65(68.4)	8(88.9)	5(17.9)	
Slightly easy	17 (8.7)	0.001	7(17.1)	0	8(8.4)	0	2(7.1)	0.001
Easy	31 (15.9)		5(12.2)	2(9.1)	22(23.2)	1(11.1)	1(3.6)	
Not easy	22 (11.3)		1(2.4)	1(4.5)	0	0	20(71.4)	
Frequency using wrong biomedical waste bin								
Frequently	60(30.8)		9(22.0)	3(13.6)	25(26.3)	0	23(82.1)	
Quite often	65 (33.3)	0.698	19(46.3)	9(40.9)	26(27.4)	7(77.8)	4(14.3)	0.001
Not at all	70 (35.9)		13(31.7)	10(45.5)	44(46.3)	2(22.2)	1(3.6)	
Risk of using wrong biomedical waste bin								
Highly risky	188(96.4)		38(92.7)	21(95.5)	92(96.8)	9(100)	28(100)	
Moderately risky	6 (3.1)	0.001	2(4.9)	1(4.5)	3(3.2)	0	0	0.692
Not risky	1 (0.5)		1(2.4)	0	0	0	0	
Inform biomedical waste collectors if use wrong bin								
Yes	24 (12.3)	0.001	4(9.8)	5(22.7)	11(11.6)	4(44.4)	0	0.005
No	171 (87.7)		37(90.2)	17(77.3)	84(88.4)	5(55.6)	28(100)	
Practice recommended waste storage								
Yes	96 (49.2)	0.886	18(43.9)	9(40.9)	41(43.2)	1(11.1)	27(96.4)	0.001
No	99 (50.8)		23(56.1)	13(59.1)	54(56.8)	8(88.9)	1(3.6)	
Communication on recommended waste management								
Yes	144(73.8)	0.001	28(68.3)	17(77.3)	76(80)	5(55.6)	18(68.3)	0.237
No	51 (26.2)		13(31.7)	5(22.7)	19(20)	4(44.4)	10(35.7)	
Provided with safety gadget during biomedical waste handling								
Yes	176(90.3)	0.001	32(78.0)	20(90.9)	91(95.8)	6(66.7)	27(96.4)	0.002
No	19 (9.7)		9(22.0)	2(9.1)	4(4.2)	3(33.3)	1(3.6)	
Minimize generation of biomedical waste								
Yes	157(80.5)	0.001	33(80.5)	17(77.3)	77(81.1)	7(77.8)	23(82.1)	0.993
No	38 (19.5)		8(19.5)	5(22.7)	18(18.9)	2(22.2)	5(17.9)	

N - Number of personnel; % - Percentage; P-Level of Statistical significance (P* overall and P among health personnel) Bold shows statistical significance

4.1.5.3 Biomedical waste management practices

Significantly high number (76.4%) of study participants who handle dispose pathological waste compared to 23.6% who did not handle disposal of pathological waste ($P = 0.001$). There was significant differences across study participants on disposal of pathological waste ($P = 0.03$).

Significant high number (94.9%) of study participants who dispose sharp waste compared to 5.1% who did not handle disposal of sharp waste ($P = 0.001$). There was no significant differences across study participants on disposal of sharp waste ($P = 0.459$).

Significantly high number (88.7%) of study participants who dispose the pharmaceutical waste compared to only 11.3% who did not handle disposal of pharmaceutical waste them ($P = 0.001$). Across study participants there was no significant differences in disposing pharmaceutical waste ($P = 0.347$).

Significant high number (82.6%) of study participants who dispose the radioactive waste compared to 17.4% who did not handle disposal of radioactive waste them ($P = 0.001$). Across study participants there was no significant differences in disposal of radioactive waste ($P = 0.062$).

Significantly high number (88.2%) of study participants who dispose the hospital kitchen waste compared to 11.8% who did not handle disposal hospital kitchen waste ($P = 0.001$). Across study participants there was no significant differences in disposal hospital kitchen waste ($P = 0.1$) (Table 4.7).

Table 4. 7:Practices related to recommended disposal of biomedical waste management

Practices regarding Biomedical waste management	Overall N (%)	P*	Healthcare personnel				Sanitary N (%)	P
			Doctors N (%)	Clinicia n N (%)	Nursing N (%)	Technicia n N (%)		
Disposal of pathological waste								
Yes	149(76.4)	0.001	26(63.4)	14(63.6)	76(80)	7(77.8)	26(92.9)	0.03
No	46 (23.6)		15(36.6)	8(36.4)	19(20)	2(22.2)	2(7.1)	
Disposal of sharps waste								
Yes	185(94.9)	0.001	37(90.2)	22(100)	90(94.7)	9(100)	27(96.4)	0.45 9
No	10(5.1)		4(9.8)	0	5(5.3)	0	1(3.6)	
Disposal of pharmaceuticals waste								
Yes	173(88.7)	0.001	34(82.9)	20(90.9)	83(87.4)	9(100)	27(96.4)	0.34 7
No	22(11.3)		7(17.1)	2(9.1)	12(12.6)	0	1(3.6)	
Disposal of radioactive waste								
Yes	161(82.6)	0.001	29(70.7)	20(90.9)	78(82.1)	7(77.8)	27(96.4)	0.06 2
No	34(17.4)		12(29.3)	2(9.1)	17(17.9)	2(22.2)	1(3.6)	
Disposal of Kitchen waste from hospital								
Yes	172(88.2)	0.001	37(90.2)	17(77.3)	87(91.6)	6(66.7)	25(89.3)	0.1
No	23(11.8)		4(9.8)	5(22.7)	8(8.4)	3(33.3)	3(10.7)	

N - Number of personnel; % - Percentage; P-Level of Statistical significance (P* overall and P among healthcare personnel)

Bold shows statistical significance

4.1.6 Factors associated with biomedical waste management practices

The factors associated with biomedical waste management practices was determined based on the overall score for practices related to biomedical waste management. The study participants that scored between 50 to 75% marks was considered as practicing adequate biomedical waste management.

4.1.6.1 Socio-demographic as a factor to biomedical waste management practices

In the bivariate analysis, none of the socio-demographic factors associate with biomedical waste management (Table 4.8).

Table 4. 8: Socio-demographic as a factors associated with biomedical waste management practices

Socio-Demographic Variables	Total	50 to 75% Practical score of biomedical waste management		Bivariate OR (95% CI)	P
		No	%		
Age					
21-30	80	48	60	0.01(0.09-7.5)	0.982
31-40	88	45	51.1	0.02(0.06-6.9)	0.982
>41	27	19	70.4	Reference	Reference
Gender					
Female	108	64	59.3	0.9(0.7-1.4)	0.966
Male	87	48	55.2	Reference	Reference
Education Level					
Primary	6	6	100	0.01(0.05-12.5)	0.984
Secondary	21	18	85.7	0.02(0.05-10.1)	0.984
Tertiary	168	88	52.4	Reference	Reference
Years of service					
1 - 5	104	65	62.5	0.002(0.4-1.31)	0.984
6 - 10	46	21	45.7	0.001(0.05-10.1)	0.983
>11	45	26	57.8	Reference	Reference

No - Number; % - Percentage; OR - Odds ratio; CI - confidence interval; ND - Not done

4.1.6.2 Types of biomedical waste generated as a factor to biomedical waste management practices

Type of biomedical waste generation is a factor associated with practicing adequate biomedical waste management practices. In bivariate analysis, study participants recognized that hospital generated kitchen waste (OR 0.3, 95% CI 0.1 to 0.7) were less likely to have adequate biomedical waste management practices than those who did not believe that kitchen waste generation was not substantial.

On the contrary study participants that recognized the generation of incineration ash (OR 3.7, 95% CI 1.4 to 9.5) were more likely to practice adequate biomedical waste management than those who did not state incineration ash as significant waste generated by the hospital (Table 4.9).

Table 4. 9: Waste generation in relation to biomedical waste management practices

Type of biomedical waste generation	50 to 75% Practical score of biomedical waste management			Bivariate OR (95% CI)	P
	No	%			
Kitchen wastes from the hospital					
Yes	158	81	51.3	0.3(0.1-0.7)	0.004
No	28	24	85.7	Reference	Reference
Radioactive materials					
Yes	126	69	54.8	0.6(0.3-1.2)	0.187
No	60	36	60	Reference	Reference
Pathology materials					
Yes	176	98	55.7	1.2(0.6-2.5)	0.643
No	11	8	72.7	Reference	Reference
Incineration					
Yes	134	77	57.5	3.7(1.4-9.5)	0.008
No	51	29	56.9	Reference	Reference
Pharmaceutical					
Yes	178	97	54.5	0.8(0.4-1.5)	0.455
No	11	11	100	Reference	Reference

No - Number; % - Percentage; OR - Odds ratio; CI - confidence interval; ND - Not done

4.1.6.3 Knowledge as a factor associated with biomedical waste management practices

In bivariate analysis, the overall knowledge on biomedical waste was not associated with practicing adequate biomedical waste management practices. On the contrary various aspect of knowledge on biomedical waste were significantly associated with practicing adequate biomedicalwaste management these include, knowledge on when to seal biomedical waste disposal bins, categorization of chemical wasteand pathological waste.

In recognition of biomedical waste which are hazardous, the following were significantly associated with practicing adequate biomedical waste management, Paper, cartons, boxes, kitchen waste from hospital, unused medicine and dressing cotton, plasters (Table 4.10).

Table 4.10: Knowledge of study participants in relation to biomedical waste management practices

Knowledge related to Biomedical waste	Total	50 to 75% Practical score of biomedical waste management		Bivariate OR (95% CI)	P
		No	%		
Overall Knowledge					
≤50% Score	44	38	86.4	0.008(0.06-13.2)	0.986
50-75% Score	115	72	62.6	0.006(0.04-9.8)	0.986
≥75% Score	36	2	5.6	Reference	Reference
Knowledge in categorization of biomedical waste					
Sealing of waste bin					
Yes	134	62	46.3	0.6(0.4-0.8)	0.003
No	61	50	82	Reference	Reference
Radioactive materials					
Yes	180	105	85.3	1.3(0.6-2.7)	0.568
No	15	7	46.7	Reference	Reference
Chemicals					
Yes	74	39	52.7	0.6(0.4-0.8)	0.009
No	121	73	60.3	Reference	Reference
Pathology materials					
Yes	145	95	65.5	1.9(1.2-3.2)	0.013
No	50	17	34	Reference	Reference
Pharmaceutical					
Yes	60	32	53.3	0.9(0.6-1.5)	0.614
No	135	80	59.3	Reference	Reference
Recognition of hazardous biomedical waste					
Paper, cartons, boxes					
Yes	174	93	53.4	0.6(0.4-0.9)	0.037
No	21	19	90.5	Reference	Reference
Pathology materials					
Yes	174	100	57.5	1.1(0.6-1.8)	0.985
No	21	12	57.1	Reference	Reference
Body fluids					
Yes	168	98	58.3	1.2(0.7-1.9)	0.68
No	27	14	51.9	Reference	Reference
Kitchen wastes from the hospital					
Yes	150	74	49.3	0.6(0.4-0.9)	0.007
No	45	38	84.4	Reference	Reference
Unused medicines					
Yes	142	70	49.3	0.6(0.4-0.9)	0.015
No	53	42	79.2	Reference	Reference
Dressings cotton, plasters					
Yes	105	40	38.1	0.5(0.3-0.7)	0.001
No	90	72	80	Reference	Reference

No - Number; % - Percentage; OR - Odds ratio; CI - confidence interval

4.1.6.4 Practices of study participants as a factor to biomedical waste management

The following practices on biomedical waste management were associated with practicing of biomedical waste management among study participants. The study participants who frequently and quite often reported placing of waste in a wrong bins, storage of biomedical waste, communication on waste management, minimization of biomedical waste, disposal of pathological, radioactive waste and incineration ashes (Table 4.11).

Table 4. 11: Practices of study participants in relation to biomedical waste management

Variables	Total	50 to 75% Practical score of biomedical waste management		Bivariate OR (95% CI)	P
		No	%		
Overall attitude towards biomedical waste management					
Strongly agree	47	15	31.9	0.6(0.2-1.7)	0.364
Agree	87	63	72.4	1.2(0.5-2.8)	0.723
Disagree	55	31	56.4	0.9(0.4-2.2)	0.796
Strongly disagree	6	3	50	Reference	Reference
Frequency using wrong biomedical waste bin					
Frequently	60	54	90	4.5(2.5-8.1)	0.001
Quite often	65	44	67.7	3.4(1.8-6.2)	0.001
Not at all	70	14	20	Reference	Reference
Risk of using wrong biomedical waste bin					
Highly risky	188	108	57.4	0.6(0.08-4.1)	0.581
Moderately risky	6	3	50	0.5(0.05-4.8)	0.548
Not risky	1	1	100	Reference	Reference
Inform biomedical waste collectors if use wrong bin					
Yes	24	15	62.5	0.8(0.6-1.2)	0.257
No	171	97	56.7	Reference	Reference
Practice proper waste storage					
Yes	96	43	44.8	0.6(0.4-0.9)	0.023
No	99	69	69.7	Reference	Reference
Communication on proper waste management					
Yes	144	67	46.5	0.5(0.4-0.8)	0.001
No	51	45	88.2	Reference	Reference
Minimize generation of biomedical waste					
Yes	157	77	49	0.5(0.4-0.8)	0.002
No	38	35	92.1	Reference	Reference
Proper disposal of pathological waste					
Yes	149	72	48.3	0.6(0.4-0.8)	0.003
No	46	40	87	Reference	Reference
Proper disposal of radioactive waste					
Yes	161	84	52.2	0.6(0.4-0.9)	0.036
No	34	28	82.4	Reference	Reference
Proper disposal of Kitchen waste from hospital					
Yes	172	93	54.1	0.6(0.4-1.1)	0.092
No	23	19	82.6	Reference	Reference
Proper disposal of Incineration ashes					
Yes	53	41	77.4	1.5(1.1-2.3)	0.026
No	142	71	50	Reference	Reference

No - Number; % - Percentage; OR - Odds ratio; CI - confidence interval

4.1.6.3 Independent variables associated with biomedical waste management practices

In multivariate analysis; the study participants who were able to identify accurately the hazardous nature of dressings cotton, plasters were independently less likely to practice adequate biomedical waste management compared to those who were not able to identify hazardous nature of dressings cotton, plasters (OR 0.5, 95% CI 0.3 to 0.8).

Similarly, the study participants who stated that they had behaviour change communication regarding biomedical waste management practices were independently less likely to practice adequate biomedical waste management compared to those who had no such communications (OR 0.6, 95% CI 0.4 to 0.9).

On the contrary, the study participants who reported frequently of placing the biomedical waste in a wrong bins, were independently associated with practicing adequate biomedical waste management (Table 4.12).

Table 4. 12: Independent variables associated with biomedical waste management practices

Variables	Total	50 to 75% practical score of biomedical waste management		Multivariate OR (95% CI)	P
		No	%		
Dressing cotton, plasters					
Yes	105	40	38.1	0.5(0.3-0.8)	0.004
No	90	72	80	Reference	Reference
Frequency of using wrong biomedical waste bin					
Frequently	60	54	90	3.7(1.8-7.2)	0.001
Quite often	65	44	67.7	2.9(1.6-5.6)	0.001
Not at all	70	14	20	Reference	Reference
Communication on proper waste management					
Yes	144	67	46.5	0.6(0.4-0.9)	0.037
No	51	45	88.2	Reference	Reference

No-Number, %-Percentage; OR-Odds ratio; CI-Confidence interval

4.2 QUALITATIVE THEMATIC RESULTS

4.2.1 Focused Group Discussion

4.2.1.1 Introduction

Two focused group discussions were conducted at Mbagathi Hospital that comprised of both male and female discussant. The first group comprised of 11 participants (6 male and 5 female), while the second group comprised of 12 participants (4 males and 8 females). This was critical to enable the study give realistic findings upon which the emerging discussions and recommendations would be anchored. The exercise took during the month of February, 2016. The Researcher moderated the interviews while the assistant took note and noted the questions from the discussants. Both group was tape recorded after they all consented to undertake the discussion. Each FGD took approximately 35 and 40 minutes respectively after which translation and transcription was done manually.

The study explored the views of discussants extensively on factors associated with biomedical waste management practices. The themes emerging from types of biomedical waste management, Individual level factors, and facility level factors were discussed below

Type of biomedical waste management

Categorization of biomedical waste generated, most respondents noted that various types of waste are generated in the facility as observed in the two group;

“The waste that we generate here are voluminous and most likely they are Infectious waste” (FGD 1)

“Waste we normally handle are highly infectious and other are Non – infectious such that, once we start transporting to disposal point, we are exposed to risks” (FGD 2)

Knowledge on biomedical waste management

Regarding biomedical waste management; many respondents identified various weakness in the management of waste in the facility as observed;

“Sometime the needles, food waste and other waste are not segregated at the source”(FGD 1)

“Hospital has left waste management to company which won the tender therefore they don't care whether standard operating procedure is being followed or not”(FGD 2)

Sealing of biomedical waste disposal bin was also noted as one of the key issue associated with management of waste;

“Waste bins are occasionally filled to the brim”(FGD 1)

“The safety boxes are not properly used as the waste are just dumped besides safety boxes and yet they are not full”(FGD 2)

“Disposal bin should be sealed and replaced when it is three quarter full but generally this is not always observed”(FGD 2)

Attitude on biomedical waste management

Segregation of waste at source

“Mis-segregation is common, When you see black smoke is produced at incinerate, it’s an indication of poor segregation especially wet waste i.e placenta, lack of draining drips” (FGD 1).

“You find that the food waste are placed in carton box and yet the correct containers are available” (FGD 1).

“Waste are segregated but not in a right colour coded bins, sometime we use different liner for wrong type of waste because the appropriate liner is not available” (FGD 2)

Decontamination of biomedical waste

“For us we didn’t experience the decontamination of waste”(FGD 1)

“We just take it as it is and then dispose it directly”(FGD 1)

Occupation safety of waste handlers

“We don’t have any protective garment during incineration or burning of waste” (FGD 2)

“No heat resistant apron and safety boot, we use gumboot should not be used because it is good conductor of heat and it affect us”(FGD 1)

“The trolley that we use is too small to carry voluminous waste, the one we have are hard to move around while transporting”(FGD 1)

Practices on biomedical waste management

Roles of each cadre in biomedical waste management

“To make sure the hospital premise is clean and neat by placing the wastes into their respective bins as long as you generate it”(FGD 1)

Biomedical waste in a wrong bin

“The hospital visitors place the wastes in a wrong bin without observing the colour code” (FGD 2)

“Nurses and clinician do not drain drips(DNS) or remove needle once the patient died making our work difficult, so we drain by myself” (FGD 2)

“Some of the staffs are ignorant concerning waste segregations at the source so we segregate by myself”(FGD 1)

“The hospital staffs are constantly placing non - infectious waste in a wrong bin and they blame on visitors”(FGD 1)

Transportation of biomedical waste

“For us we have disposed amputees wastes wrapped in paper bag with my bare hands”(FGD 2)

Storage of biomedical waste

“The reason for storing the waste is lack of fuel to burn them, once the fuel is available the wastes are burnt immediately” (FGD 1)

Disposal of biomedical waste

“The kitchen wastes are carried away and disposed in a municipal council dump site”(FGD 1)

“The waste bins sometimes leak which make it a challenge for us to dispose” (FGD 2)

Improvement of current biomedical waste management practices, Perception and preparedness

“If possible all the health care workers should place the waste into their respective places instead of dumping them any howly”(FGD 1)

“Doctors and clinician who are interns should be reminded on disposal waste” (FGD 1)

“Ignorance is common especially among doctors and nurse, they often do not dispose the waste properly”(FGD 2)

“Hospital should provide every patient with their own container to spit on” (FGD 2)

CHAPTER FIVE

5.0 DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 DISCUSSIONS

Biomedical waste is defined as waste related to human or animal health services, including home care and fieldwork services, analytical laboratories for health products, morgues, funeral homes and embalming services, drugstores and pharmacies, educational and health research facilities, zoonosis control centres, mobile health units, and acupuncture services (Datta *et al.*, 2018). Although only about 10%–25% of biomedical wastes is hazardous and the remaining 75%–95% is non-hazardous, the hazardous part of the waste presents physical, chemical and microbiological risk to the general population and healthcare personnel associated with handling, treatment, and disposal of waste (Li and Jenq, 1993). Reduce, recycle, and reuse are the basic principles of good biomedical waste practice (Datta *et al.*, 2018).

The best biomedical waste management methods aim at avoiding generation of waste or recovering as much as waste as possible, rather than disposing. Therefore, the various methods of biomedical waste management disposal, according to their desirability, prevent, reduce, reuse, recycle, recover, treat, and lastly dispose. Hence, the waste should be tackled at source rather than “end of pipe approach (Chartier *et al.*, 2014). Hospitals and other healthcare establishments therefore have a significant role to care for the environment and for public health, and have particular responsibilities in relation to the biomedical waste they produce. Negligence, in terms of biomedical waste management, significantly contributes to polluting the environment, affects the health of human beings, and depletes natural and financial

resources. Against this backdrop this study established the factors associated with biomedical waste management practices among healthcare personnel at Mbagathi Hospital in Nairobi County.

5.1.1 Types of biomedical wastes generated

The types of biomedical waste generated by the healthcare personnel at Mbagathi Hospital was pharmaceutical and radioactive wastes this is in line with WHO Townend (1999) biomedical wastes generated that include pharmaceutical, radioactive and chemical waste, which pose a variety of health and environmental risks found that 10 –25% of healthcare waste in general was termed as infectious. In France (Mohee, 2005) and USA(Lee and Huffman, 1996), approximately 15–20, 5% of medical waste respectively was found to be infectious waste. In Bangladesh Hassan *et al* (2008) reported common biomedical waste generation in this order; general waste (77.5%), infectious waste (14.8) sharps (1.2%) and liquids at 3.4%. Study has shown that infectious wastes, especially piercing and cutting wastes, are the main categories responsible for occupational accidents (Marziale *et al.*, 2013).It was noted in one FGD;

“The waste that we generate here are voluminous and most likely they are Infectious waste” (FGD 2)

While another group observed;

“Waste we normally handle are highly infectious and other are Non – infectious such that, once we start transporting to disposal point, we are exposed to risks” (FGD 1)

In seven different hospitals in Nigeria Awodele *et al.*, (2016) reported similar wastes generated in health facilities of Mbagathi level status including cultures,

stocks of infectious agents, pathological, blood and other fluids, sharps, surgery and laboratory wastes, wastes from food preparation, radioactive wastes, wastes from dialysis procedures, biological wastes, cardboard, paper documents and discarded linens. In Brazil, Paizet *al.*, (2014) observed variation in the type and amount of biomedical waste generated in facilities of similar status depending on the month of the year. However, in the month of May more than 50% of the waste segregated were recyclable organic wastes. They noted that such waste type reduces the quality of recyclable waste destined for sorting centres, attracts vectors, and interferes in the work of waste collectors. It also increases the costs of recycling because it is necessary to re-categorize the waste for allocation to a landfill (Paizet *al.*, 2014).

Although study has shown that between 75 and 90 % of the waste produced by health-care facilities is non-risk or general health-care waste (Li and Jenq, 1993) and that the mixture of infectious with general or common waste is very minimal, should such mixing occurs it is shown to contaminate the entire waste, as once infectious waste comes into contact with other waste, the entire mass becomes infectious and must be treated as such, this contamination results in increased environmental and health risks, both inside the hospital (health professionals, patients and cleaning crew) and outside the hospital (workers involved with external waste collection, treatment and final disposal) (Pereira *et al.*, 2013). This follows therefore that caution must at all times be exercised when handle these biomedical wastes and significant resource must be invested to achieve recommended biomedical waste management. This biomedical waste management has been shown to depend on a dedicated waste management team, good administration, careful planning, sound

organization, underpinning legislation, adequate financing and full participation by trained staff because it remains a significant challenge to identify the 25 % of biomedical waste regarded as hazardous (WHO, 2005).

5.1.2 Individual level factors associated with biomedical waste management practices

This section highlights participants knowledge and attitudes as a factor associated with biomedical waste management practices.

5.1.2.1 Knowledge towards Biomedical Waste Management

In overall majority of (22.6 %) study participants had low knowledge while across study participants (71.4%) of sanitary staff had low knowledge. In Bangladesh, inadequate knowledge was observed more among technologies and cleaning staff than medical doctors and nurse (Sarker *et al.*, 2014). This inadequate knowledge could be due to low level of general education and, in particular, the basic understanding regarding biomedical waste management. Moreover, it was reported in a study that improper waste management was attributed more to the negligence of local health care professional (Halbwachs, 1994). This study also found that medical doctors had better knowledge than other professional groups, whereas cleaning staff had disquietingly inadequate knowledge. These findings are in line with previous studies (Amanullah and Uddin, 2008; Mathur *et al.*, 2011). One of group observed;

“Sometime the needles, food waste and other waste are not segregated at the source” (FGD 1)

The study also shows that about 69% of the health care personnel were able to know when waste bins should be sealed against 31% of the personnel who did not know when the bins were to be sealed. This was backed up by groups which noted;

“Waste bins are occasionally filled to the brim” (FGD 1)

While another group observed;

“The safety boxes are not properly used as the waste are just dumped besides safety boxes and yet they are not full” (FGD 1)

“Disposal bin should be sealed and replaced when it is three quarter full, but generally this is not always observed” (FGD 2)

The first medical waste study conducted in 1989 by the Washington Department of Ecology, reported that 85% of hospitals in Washington segregated medical waste (Diaz *et al.*, 1996), and a second survey of 955 hospitals reported that 95.4% of hospitals segregated medical waste (Turnberg, 1989). In these studies, similar to the findings of this study, nurses were more knowledgeable on management of highly infectious waste, infectious waste and toxic waste. This may be attributed to specialized training and practice of nurses. In a tertiary care teaching hospital in India Pandey *et al.*, (2016) showed that knowledge regarding segregation of biomedical waste was observed in approximately 90% of the health care personnel. In Thika Sub-county- Kenya Mawaniki *et al.*, (2015) reported over 75% of the healthcare personnel demonstrated some knowledge of waste segregation with diseases prevention, avoiding needle pricks/injury and aesthetic values as the central reasons for segregation while few named recycling. Majority of the respondents who

adopted colour coding method, full and partial adhered to the guidelines (Mawaniki *et al.*, 2015).

In Nigeria Awodele *et al.*, (2016) showed a satisfactory knowledge of colour coding of wastes which is an essential factor for the proper segregation of waste. Proper segregation is achieved by making use of actual coloured containers or coloured liners to effectively separate infectious waste from general/domestic waste. WHO (2006), proposed that hospitals should provide either plastic bags or strong plastic containers for medical wastes and that they should make use of different coloured liners namely, Black, Yellow and Red (three bin system) for general, infectious and highly infectious waste respectively. Bags and containers for highly infectious waste should be marked with Biohazard symbol (WHO, 2006; Abdullah *et al.*, 2013). The use of a brown liner is also encouraged by WHO for pharmaceutical waste (expired drugs) but this is rarely used. In Nigeria Awodele *et al.*, (2016) further showed a statistical significant association between the profession of the respondents and the ability to identify the colour coding for pathological wastes with highest association amongst the nurses and this is also due to the training received.

The result in this study as in many studies in developing countries are typified by the shortcomings associated with use of infectious waste guidelines, waste segregation procedures, adoption of prevention of air pollution and appropriate waste transport. Similar situations have been reported in Iran (Vrijheid, 2000), where segregation is weak and ineffective; Nigeria (Taghipour and Mosafiri, 2009), where infectious and non-infectious wastes are collected in the same dustbin; Botswana (Oke, 2008), where disposal techniques vary from one centre to another.

5.1.2.2 Attitude towards Biomedical Waste Management practices

Majority of clinicians (45.5%) had strongly agreed in existence of waste management, clinicians followed by (31.7%) of doctors, (23.2%) of nurses and (22.2%) of laboratory technicians. Similar to the findings of this study, doctors and clinicians had better attitude towards biomedical waste compared to laboratory and auxiliary staff. In India, a study reported that staffs had good attitude towards waste management (Rudraswamy *et al.*, 2012). On the contrary, Sood and Sood (2011) showed many doctors had the knowledge about waste management but they lacked in attitude and practice recommended for good biomedical waste management. One of the group noted;

“You find that the food waste are placed in carton box and yet the correct containers are available” (FGD 1)

The other group observed;

“Waste are segregated but not in a right colour coded bins” (FGD 2)

According to World Health Organization, human element is more important than any technology employed to manage biomedical waste. Almost any system of treatment and disposal that is operated by well-trained, and well-motivated staff can provide more protection for staff, patients and the community than an expensive or sophisticated system that is managed by staff who do not understand the risks, and the importance of their contribution (WHO, 2000). For effective management of hospital waste, it is essential that personnel hold positive attitude towards care of the environment, occupational health and safety and teamwork. Hospital waste management has major attitudinal and behavioural components (Rasheed *et al.*, 2005).

Literature has shown poor knowledge, attitude and practices of biomedical waste management among staff and have reported that there is urgent need to train and educate all the staff, in order to adopt an effective waste management practice (Saini *et al.*, 2005). A chain is as strong as the weakest link in it, thus the entire staff involved in waste management at some point or the other should be trained properly (Saini *et al.*, 2005). Before providing the training program, it is mandatory to understand the existing gaps and deficiencies in the study participants' knowledge, perceptions, behavior towards hospital waste management. Knowledge, attitude and practices of the personnel play an important role (Rudraswamy *et al.*, 2012). Lack of these, even with good infrastructure and technology, is of little or no use in proper waste management. Knowing this, the training program can be aimed to make participants understand-environment friendly, healthy and economically viable in-house management systems, to ensure that the waste is carried responsibly from cradle to grave (Rudraswamy *et al.*, 2012).

5.1.3 Biomedical waste management practices

This study reveals that (11.3%) of study participants found not easy to use the recommended colour coded bins for waste segregation while (30.8%) of healthcare personnel frequently used wrong biomedical bins for waste disposal. Segregation is the main step which is not being practiced in the hospitals by health staff. One possible reason is lack of training (Paudel and Pradhan, 2010).

In Pakistan a study also suggested that the practices of health care workers are not up to the standards which lead to major threats of environmental pollution (Kumar *et al.*, 2015). A study has also reported that the waste management practices even

among general practitioners were not appropriate, hence this group too needs to be trained (Qaiser, 2012). One of the discussant confirmed this by noting;

“The hospital visitors place the wastes in a wrong bin without observing the colour code” (FGD 1)

While other respondents observed the following;

“In fact some of the staffs are ignorant, for how long are going to concern about waste segregations at the source” (FGD 1)

“The hospital staffs are constantly placing non - infectious waste in a wrong bin and they blame on visitors” (FGD 2)

“The reason for storing the waste is lack of fuel to burn them, once the fuel is available the wastes are burnt immediately” (FGD 1)

“Hospital should provide every patient with their own container to spit on” (FGD 2)

In congruent to the findings of the study, poor practices of waste management are reported in India, China and Bangladesh, resulting in environmental threats to the populations as well as major occupational risk (Harhayet *al.*, 2009). In Bangladesh about half of medical doctors (44.0%) and cleaning staff (56.0%) had poor practices (Sarkeret *al.*, 2012).

In Bangladesh, poor practice was observed among medical doctors, technologists, and cleaning staff (Sarkeret *al.*, 2012), which is in line with a previous study (Mostafaet *al.*, 2009). Just as in this study approximately 30-35% health care practitioner did not practice segregation resulting into mixing of the infectious waste with general waste which is definitely a matter of concern because the hospital wastes contain infectious wastes which if not properly disposed of pose a great

health risk to the public (Mostafa *et al.*, 2009). Various reasons were given for the non-compliance such as location of bins away from working area, time pressure due to too much work load, work pressure due to unexpected staff leave, casual attitude because nobody is watching you. It was observed that the health care personnel passed the blame of improper segregation of biomedical waste generally to staff on night duty. In other studies, besides the staff, mixing of the general waste with the infectious waste was also being done by patients care givers in different areas of the hospital. Thus, emphasizing the need to even educate the patients care givers about biomedical waste management, which is a herculean task due to floating patient population. Therefore implementation of biomedical waste management in in any hospital like ours, is a huge responsibility and a non-rewarding area both for the ICT and the management.

5.1.4 Factors associated with biomedical waste management practices

5.1.4.1 Socio-demographic factors

In this study, the socio-demographic factors such as age, gender, education level, occupation, mode of employment, and years of service were not associated with biomedical waste management. A study conducted in Ethiopia found a similar finding where in the binary logistic regression analysis, sex, age, occupation, working experience, kind of health organization, salary of health care workers and injury during healthcare waste management were found to be non- associated with practice towards healthcare waste (Yenesew *et al.*, 2012). This could be the fact that all the training, attention or any other required consideration for waste management are given to all staff regardless of age, gender, education level, occupation type and

the years of service. This finding was in agreement with study done in Hawassa city of Ethiopia and in Nigeria (Rao, 2008; Abah *et al.*, 2011).

According to WHO (2012), the rational model of health promotion believed high knowledge, will translate to positive attitude and subsequently good behavior, though in reality, the transition is not straight forward but depended on several factors. In this regard, in Nigeria, a study compared the distribution of respondents by performance on composite knowledge, attitude and practice of biomedical waste management (Aluko, *et al.*, 2016). The Aluko *et al* (2016), study, showed about two-fifth (38 %) had positive rating in KAP while 7 % had negative rating in KAP scales. On relationship among variables, the respondents' occupation and sex categories were significantly associated with knowledge and attitude while education was also associated with knowledge, where it was concluded that the level of education influences the level of knowledge in health and biomedical waste (Tziaferiet *al.*, 2011). This meant that those with high knowledge had better education, in agreement with the rational model (WHO, 2012). In like manner, marital status and religion of respondents influence practice while ethnicity, sex and religion influence their attitude. To engender biomedical waste precautions that will decimate the prevalence of occupation hazards in the HCF, attention should be focused on knowledge-based awareness creation disseminated around marriage relationship and religion, to achieve desired results. Conversely, respondents' practices were not influenced by sex and education while knowledge on occupational hazards and safety practice was not influenced by marital status and religion. Also, hand washing practice was not influenced by education and marital

status. The above findings were in agreement with Tziaferi *et al.*, (2011) where the authors concluded that level of education and professional specialty influenced their perception of risk level at a statistically significant level.

5.1.4.2 Types of waste generation

The type of waste generated influenced recommended biomedical waste management practices. Generation of kitchen waste was less likely to have adequate recommended biomedical waste practices while the generation of incineration ash was associated with recommended biomedical waste management practices. Study have associated enforcement of biomedical waste with the type of waste generated. Non-infectious waste generation has been known to be handle less stringent while any infections waste in many laboratories recommended waste management guidelines are available and are adhered to in such laboratories (Yenesew *et al.*, 2012).

5.1.4.3 Knowledge on biomedical waste management

Various specific aspect of biomedical waste knowledge was significantly associated with practicing recommended biomedical waste management these included; knowledge as to when the biomedical waste disposal bins should be sealed, categorization of chemical and pathological waste. Further, identification of the hazardous nature of non-infectious waste such as paper, cartons, boxes and kitchen waste and recognition of hazardous nature of infectious waste such as unused medicine, dressing cotton, plasters were significantly associated with practicing recommended biomedical waste management. In Ethiopia (Yenesew *et al.*, 2012)

found concurring outcomes. The healthcare personnel working department (handling non-infection and infectious waste), knowledge on healthcare waste type and knowledge on diseases transmission with healthcare waste showed statistically significant association with biomedical waste management.

In this study, knowledge to recognize kitchen and incineration ash waste were significantly associated with biomedical waste management. Most study findings from different scholars reported that knowledge on healthcare waste type and diseases transmission with the contact of infectious waste had an influence on the risk perception of health care workers (Wasee *et al.*, 2007; Deneke *et al.*, 2011). The study by Yenesew *et al.*, (2012) showed that the odds of adequate risk perception among health care workers who had higher and moderate knowledge on healthcare waste type were significantly associated with practicing biomedical waste management than those who had low knowledge on healthcare waste type.

5.1.4.4 Specific practices of biomedical waste management

In this study healthcare personnel use of biomedical waste bins, proper storage of biomedical waste, communication on biomedical waste management, handling and proper disposal of pathological, radioactive and incineration ashes were significantly associated with practicing recommended biomedical waste management.

5.2 Conclusions

Based on the specific objectives of this study the following conclusions are drawn;

Socio-demographic characteristic: Majority of the Study participants at Mbagathi Hospital were female professionals, some of the study subject had only primary

level of education (3.1%), some were employed through friends and significant high number of them had served between 1-5 years.

Types of biomedical waste: The healthcare personnel at Mbagathi Hospital generated various types of biomedical waste. This waste was quite voluminous and are source of nosocomial infection to healthcare personnel and patients, this is in line with other studies done in Kenya.

Individual level factors: In general about 59% of healthcare personnel had the knowledge on biomedical waste management. The current study revealed that (22.6%) of study participants have inadequate knowledge towards biomedical waste management and this majorly affected sanitary staff than any other healthcare personnel.

The study also revealed that 28.2% and 3.1% of study participants disagree and strong disagree respectively with biomedical waste managements at the study site

Biomedical waste management practices: The overall mean percentage score for practices related to biomedical waste management was significantly high with the majority of the healthcare personnel scoring between 50 to 75% marks. 6.7% of study participants had poor practices towards biomedical waste management.

Factors associated with biomedical waste management practices: Independent factors associated with biomedical waste management includes: identification of hazardous waste, receiving communication on biomedical waste and use of waste bins.

5.3 Recommendations

Based on the conclusions of this study, this study recommends that;

Periodic sensitization of staffs using existing friendly channels to convey health messages, to create awareness through health education and promotion in all departments should be done routinely by hospital management using appropriately and relevant channels of communication.

Timely collection and disposal of all types of waste should be determined and functional disposal units should be availed by hospital management to effectively minimize spread of infections from waste.

Arising from the many types of waste generated in such settings specialized personnel should be trained or employed by the Ministry of Health to effectively handle biomedical waste at the health facility level.

Ministry of health to effectively develop policies and guidelines with realistic approaches and engage county governments and other stakeholders with a view to develop practical framework including robust monitoring and evaluation indicators on the biomedical waste management practices in health facilities.

Environmental and occupation health units should be strengthened by the Ministry of Health to incorporate the ever changing needs in curriculums in all training institutions for early exposure in order to gain skills and knowledge to address the concern arising from biomedical waste management in healthcare facilities.

Further research to be conducted on a comparative basis regarding assessment on gaps in biomedical waste management in public and private facilities and its impact to their surrounding environments.

REFERENCES

- Abah S.O,& Ohimain E.I. (2011) Healthcare waste management in Nigeria: A case study. *Journal of Public Health and Epidemiology* 2011; 3:99-110.
- Abdullah M.K,& Al-MukhtarSalwa (2013) Assessment of medical waste management in Teaching hospitals in Mosul City. A descriptive study. *Mosul Nursing Journal*. 2013; 1(1):1–8.
- Abdul-Salam, K. (2009) Assessment of Medical Waste Management in Jenin District Hospitals, Nablus-Palestine, Unpublished Master thesis submitted to School of Environmental Science-An-Najah National University.
- Adnane, M.I., Belkacem K., Abdelkarim E., &Mohamed B.(2013)Medical Waste Management A case study of the Souss-Massa-Drâa Region, Morocco. *J Environ Prot*.2013;4:9149. <http://dx.doi.org/10.4236/jep.2013.49105>.
- (<http://www.scirp.org/journal/jep>)
- Agnes, W. K., Gathogo, A., Mbua, T., Ndungu, N.,&Karani, A.(2008)Retrospective study on overcrowding in Thika and Kiambu District Hospitals Medical Wards 2006 – 2007. *Kenya Nursing Journal Dec*; 33(2):28–30.
- Ali, F., Masoud, F., Zeinab, M., &Parisa, N. (2012) Waste Management Practices in Isfahan, *Iran*S176–S185.
- Aluko, O. O., Adebayo, A. E., Adebisi, T. F., Ewegbemi, M. K., Abidoeye, A. T&Popoola, B. F.(2016). Knowledge, attitudes and perceptions of occupational hazards and safety practices in Nigerian healthcare workers. *BMC Research Notes*, 9, 71.

- Amanullah, A.S., & Uddin, J. (2008) Dynamics of health behavior regarding hospital waste management in Dhaka, Bangladesh: a dysfunctional health belief model. *International Community Health Education*, 29(4): 363–80.
- Awodele, O., Adewoye, A.A., & Oparah, A.C., (2016). Assessment of medical waste management in seven hospitals in Lagos, Nigeria. *BMC Public Health*. 16:269.
- Biswas, A., Amanullah, A.S.M., & Santra, S.C., (2011) Medical Waste Management in the Tertiary Hospitals of Bangladesh: An Empirical Enquiry. *ASA Univ Rev*;5(2):10.
- Bui, T. T. (2011) Market Analysis and developing a Competitive Marketing Strategy for selling medical solid Waste & Wastewater Treatment equipment to Customers in Vietnam, Unpublished Master's thesis submitted to Lahti University of Applied Sciences.
- Chartier, Y, Emmanuel, J., Pieper, U., Prüss, A., Rushbrook, P., & Stringer, R. (2014) editors. 2nd. Geneva, Switzerland: WHO Press; 2014. Safe Management of Wastes from Health-Care Activities; pp. 1–146.
- Daniel, W. W. (1999) *Biostatistics: a foundation for analysis in the health sciences*. New York: John Wiley and Sons.
- Datta, P., Mohi, G.K., & Chander, J. (2018) Biomedical waste management in India: Critical appraisal. *Journal of Laboratory Physicians*;10(1):6-14.
- Dehghani, M., Azam, K., Changani, F., & Dehghani, F. (2008) Assessment of Medical waste Management in Educational Hospitals of Tehran University Medical Science. *Iran Journal Environmental Health Science Eng*;5:131–136.

- Deneke, I., Aquiet, M., Desalegn, B., & Atebha, H. (2011) Assessing the management of healthcare waste in Hawassa city, Ethiopia. *Waste management and research*; 29(8):854-862.
- Diaz, L. F., Savage, G. M., Eggerth, L. L., & Golueke, C. G. (1996). Solid waste management for economically developing countries, Hercules, CA: Cal Recovery Inc.
- European Union, (2000). *Waste Framework Directive. 75/442/EEC as amended 2000/98/EC*. Office of European Communities, Brussels, Belgium.
- Everson, M. (2010) Resolving global medical waste Earth 911.
- FerrazAlvim, J.I., Barcelos, C., & Ribeiro, P. (2000). Concentration of atmospheric pollutants in the gaseous emissions of medical waste incinerators. *J. Air and Waste Manage. Assoc*, 50 pp. 131–136.
- Fisher, R.A., Carbet, A.S., & Williams, C.B. (1998). *The relation between the number of species and the number of individuals in a random sample of an Animal population*. *Journal of Animal Ecology*. 12:42-58.
- Georgescu, C. (2011). The adverse effects of the movement and dumping of toxic and dangerous products and wastes on the enjoyment of human rights. UN, Human rights council 8th session agenda item
- Goddu, V. K., Kavita D., & Vidya K. B. (2007). A critical Analysis of healthcare waste management in developed and developing countries: Case Studies from India and England” International conference on sustainable solid waste management 5-7, Chennai, India.

- Glenn, McR. & Garwal, R. (1999). An analysis with a Case Study of India and a critique of the Basle- TWG Guidelines. Clinical waste in Developing Countries.
- Gupta, S., Boojh, R., Mishra, A.& Chandra, H. (2009). Rules and management of biomedical waste at Vivekananda Polyclinic: A case study. Waste Manag. 29(2):812-9.
- Halbwachs, H. (1994).Solid waste disposal in district health facilities. World Health Forum,15(4): 363–67.
- Harhay, M.O., Halpern, S.D., Harhay, J.S. &Olliaro, P.L. (2009).Health care waste management: a neglected and growing public health problem worldwide. Trop Med Int Health; 14(11):1414–7.
- Hem, C.(1999). Hospital Waste an Environmental Hazard and Its Management.
- Hosny, G.1.,& El-Zarka, E.M. (2005).A comparative study on the medical waste disposal in some hospitals in Alexandria 80 (5-6):607-28.
- Khajuria, A.,& Kumar, A. (2007). Assessment of healthcare waste generated by Government hospital in Agra city, India. Our Nature; 5:25-30.
- Kumar,R., Somrongthong, R.,& Shaikh,T. (2015).Effectiveness of intensive healthcare waste management training model among health professionals at teaching hospitals of Pakistan: aquasi-experimental study. BMC Health Services Research. 15:81.
- Lee, C.C., & Huffman, G.L. (1996). Medical waste management/incineration. Journal of Hazardous Materials; 48: 1–30.
- Lee, C.C., Huffman, G. L.,& Nalesnik, P. R. (1991). Medical Waste Management, *Environmental Science and Technology*, 25(3), 360.

- Li, C.S., & Jenq, F.T. (1993). Physical and chemical composition of hospital waste. *Infect Control Hosp Epidemiol*; 14:145–50.
- Llyod, L. (2003). “*Working Paper on Small-Scale Incineration*”, Paper Presented to the East & Southern Africa Healthcare Waste Management Meeting, Peacock Hotel, Dar es Salaam, 9th-11th June.
- Maina, S. M., Andrew, N.K., & Caroline, W. N. (2016). Assessment of Level of Knowledge in Medical Waste Management in Selected Hospitals in Kenya.
- Mandal, S. K., & Dutta, J. (2009). Integrated Bio-Medical Waste Management Plan for Patna City, Institute of Town Planners, *India Journal* 6-2: 01-25.
- Mathur, V., Dwivedi, S., Hassan, M.A., & Mishra, R.P. (2011). Knowledge, attitude and practice about biomedical waste management among healthcare personnel: A cross-sectional study. *Indian J Community Med*; 36(2):143-5,45.
- Marziale, M.H.P., Rocha, F.L.R., Robazzi, M.L., Cenzi, C.M., Santos, H.E., & Trovó, M.E. (2013). Organizational influence on the occurrence of work accidents involving exposure to biological material. *Rev. Latino-Am. Enfermagem* 21:199-206.
- Meenu, K., Amrit, V., Gupta, B.P., & Jasdeep, S. (2014). Biomedical waste management practices in a tertiary-care hospital in Punjab
- Ministry of Environment and Forest, Government of India. (2003). State of the environment report 146-51
- Ministry of Environment and Forest, (1996). Environmental standard and guidelines for management of hospital waste. New Delhi.

- Ministry of Health, (2016–2021).Health Care Waste Management Plan.
- Ministry of Health, (2015 – 2020).National Health Care Waste Management Strategic Plan.
- Ministry of Health, (2005). Kenya National Health care waste management plan draft, Report by Environmentalist Sans Frontiers Consultants.
- Ministry of Health.,& United States Agency for international Development, (2005). Family planning, HIV/AIDS disposal practices in Kenya.
- Ministry of public health and sanitation, (2010). National infection prevention and control. Guidelines for health care services in Kenya.
- Mohee, R. (2005). Medical wastes characterisation in healthcare institutions in Mauritius. *Waste Management*; 25: 575–581.
- Mostafa, G.M., Shazly, M.M.,& Sherief, W.I., (2009). Development of a waste management protocol based on assessment of knowledge and practice of healthcare personnel in surgical departments. *Waste Management*;29 (1):430–439.
- Mwaniki, N.P., Solomon, C.,& Shadrak, O. (2005). Adherence to Healthcare Waste Management Guidelines among Nurses and Waste Handlers in Thika Sub-county- Kenya. *Ethiop J Health Sci.* 25: 295-303.
- Naman, L.,& Sumeet, D. (2017).biomedical waste management practices in a tertiary care hospital.
- National Environment Management Authority, (2005). State of environment report, Kenya, Pollution and waste management
- Njiru, M. W. (2013).Awareness and practice on biomedical waste management among health care personnel in Kenyatta National Hospital.

- Oke, I. A., (2008).Management of immunization solid wastes in Kana State, Nigeria
Waste Management; 12(25); 12-21.
- Occupational Safety and Health Administration, (2014). Facts About Hospital
Worker
Safety.https://www.osha.gov/dsg/hospitals/documents/1.2_Factbook_508.pdf
- Paiz, J.C., Bigolin, M., Schneider, V.E.,& Stedile, N. (2014).Applying Nightingale
charts to evaluate the heterogeneity of biomedical waste in a Hospital. *Rev.
Latino-Am. Enfermagem*. 22(6):942-9.
- Pandey, A., Ahuja, S., Madan, M.,& Asthana, A.K. (2016). Bio-Medical Waste
Management in a Tertiary Care Hospital: An Overview. *Journal of Clinical
and Diagnostic Research* 10(11): DC01-DC03.
- Park, K.(2011). Textbook of Preventive and Social Medicine. 20th ed. Bhanot p.
694-99.
- Patil, A.D.,& Shekdar, A.V. (2001). Health-care waste management in India.
Journal of Environmental Management; 63:211-20.
- Patil. G.V.,& Pokhrel, K., (2005). “Biomedical Solid Waste Management an Indian
Hospital”: A Case Study. *Waste Management*, 25: 592–599.
- Paudel, R.,& Pradhan, B. (2010). Health care waste management practice in a
hospital. *J Nepal Health Res Counc*;8(2):86–90.
- Pereira, M.S., Alves, S.B., Souza, A.C.S., Tipple, A.F., Rezende, F.R.,& Rodrigues,
E.G.(2013). Gerenciamento de resíduos em unidades não hospitalares de
urgênciemergência. *Rev. Latino-Am. Enfermagem*. 21(Spec):259-66.
- Qaiser. S. (2012).Survey of sharp waste disposal system in clinics of New Karachi. *J
Pak Med Assoc*;62(2):163–4.

- Rahman, M., Shahab, S., Malik, R., & Azim, W. (2001). A study of waste generation, collection, and disposal in a tertiary hospital. *Pakistan J Med Res*; 4(1):5.
- Rao, P.H. (2008). Report: Hospital waste management-awareness and practices: a study of three states in India. *Waste management and research*; 26:297-303.
- Rasheed, S., Iqbal, S., Baig, L.A., & Mufti, K. (2005). Hospital waste management in the teaching hospitals of Karachi. *J Pak Med Assoc*.55:192–5.
- Republic of Kenya,(2009). District Medical Officer of Health (DMOH) Thika District, and “Annual reports Government of Kenya.
- Republic of Kenya, (2008). Ministry of Health, author. “The National Health care waste management plan” 2008–2012.
- Republic of Kenya, (2008). District Health management Team-Thika district.
- Rudraswamy, S., Sampath, M., & Doggalli, N. (2012). Staff’s attitude regarding hospital waste management in the dental college hospitals of Bangalore city, India. *Indian J Occup Environ Med*.16:75-8.
- Rushton. L. (2003).Health hazards and waste management.68:183–197.
- Rutala, A.W., & Mayhall, G. (1992). Medical waste, infection control Hospital Epidemiology, PP 38-48.
- Saini, S., Nagarajan, S.S., & Sharma, R.K. (2005). Knowledge, Attitude and practices of bio-medical waste management amongst staff of a tertiary level Hospital in India. *J Acad Hosp*.17: 2,54–9.
- Sarker, M. A., Harun, M., Hirosawa, T., Hai, M. S., Siddique, M. R., Sakamoto, J, & Hamajima, N. (2014).Evaluation of Knowledge, Practices, and Possible Barriers among Healthcare Providers regarding Medical Waste Management

- in Dhaka, Bangladesh. *Medical Science Monitor : International Medical Journal of Experimental and Clinical Research*, 20, 2590–2597.
- Shafee, M., Kasturwar, N.B., & Nirupama, N. (2010). Study of knowledge, attitude and practices regarding biomedical waste among paramedical workers. *Indian Journal of Community Medicine*; 35:369-70.
- Shinee, E., Gombojav, A., Nishimura, N., & Hamajima, K. (2008). Healthcare waste management in the capital city of Mongolia, *Waste Management* 28(2008), pp. 435–441.
- Singh, V.P., Biswas, G., & Sharma, J. J. (2007). Biomedical Waste Management - An Emerging Concern in Indian Hospitals *Indian Journal of Forensic Medicine & Toxicology*, Vol. 1, No. 1.
- Sood, A.G., & Sood, A. (2011). Dental perspective on biomedical waste and mercury management: A knowledge, attitude and practice survey. *Indian J Dent Res*. 22:271-5.
- Srishti, (1998). Medical Waste Update Campaign for Proper Medical Waste Disposal.
- Taghipour, H., & Mosaferi, M. (2009). Characterization of medical waste from hospitals Tebriz, Iran. *Science of the Total Environment*; 407; 1527-1535.
- Townend, W.K. (1999). Safe management of wastes from health care activities. World Health Organization: 171–171.
- Tudor, T. L., Townend, W. K., Cheeseman, C. R., & Edgar, J. E. (2009). An overview of arising and large-scale treatment technologies for healthcare waste in the United Kingdom. *Waste management & research: the journal*

- of the International Solid Wastes and Public Cleansing Association, ISWA, 27(4), 374-83.
- Turnberg, W.L. (1989). Survey of Infectious Waste Management Practices Conducted by Medical Facilities in Washington State; Washington State Infectious Waste Project, Washington Department of Ecology.
- Tziaferi, S.G., Sourtzi, P., Kalokairinou, A., Sgourou, E., Koumoulas, E.& Velonakis, E.(2011). Risk assessment of physical hazards in greek hospitals combining staff's perception, experts' evaluation and objective measurements. *Saf Health Work J*;2(3):260–272.
- Verma, L.K., Mani, S., Sinha, N.,& Rana, S. (2008).Biomedical waste management in nursing homes and smaller hospitals in Delhi. *Waste Manage Res*; 28-34.
- Vrijheid, M. (2000). Health effects of residence near hazardous waste landfill sites: a review of epidemiological literature. *Environment Health Perspective*; 108; 101-112
- Walliman, N. (2011). *Research methods: The basics*. New York: Routedledge
- Wasee, Q., Hassan, G., Baba, A., Kadri, S.M.,& Nazi, K., (2007).Awareness of biomedical waste management amongst staff of the government S M H S hospital, Srinagar a Tertiary level hospital in Kashmir valley. *JK-Practitioner*; 14(1):60-66.
- World Health Organization, (2015). Status of health-care waste management in selected countries of the Western Pacific Region.

- World Health Organization, (2014). Interim manual - Ebola and Marburg virus disease epidemics: preparedness, alert, control and evaluation http://www.who.int/csr/disease/ebola/manual_EVD/en/
- World Health Organization, (2014), Safe Disposal
- World Health Organization, (2013). *Waste from health-care activities. Fact sheet No. 253, November.* (<http://www.who.int/mediacentre/factsheets/fs253/en/>)
- World Health Organization, (2012). Health education: theoretical concepts, effective strategies and core competencies: A foundation document to guide capacity development of health educators
- World Health Organization, (2007). Application of treatment and disposal methods to healthcare waste categories.
- World Health Organization, (2006). Management of waste from injection activities at district level. Guidelines for district health managers. 2006. ISBN 9241594284.
- World Health Organization, (2005). Preparation of National Healthcare Waste Management Plans in sub-Saharan countries. Guidance manual. Secretariat of the Basel convention and World Health Organization.
- World Health Organization, (2001). Safe Health Care Waste Management. WHO core principles for achieving safe and sustainable management of healthcare wastemanagement.
- World Health Organization, (2000). Suggested guiding principles and practices for sound management of hazardous hospital waste. New Delhi: Regional Office for South-East Asia, World Health Organization; World Health Organization; pp. 3–5.

World Health Organization,(2000).Management of Waste from Hospital and other Health Care Establishment; pp. 94–96. “Needs Assessment for Hospitals in African Countries in Relation to Infectious Waste Treatment Final Report” UNDP.

Yamane, T. (1967). *Statistics, An Introductory Analysis*, 2nd Ed., New York: Harper and Row.

Yenesew, M. A., Moges, H.G.,& Woldeyohannes, S.M. (2012). A cross sectional study on factors associated with risk perception of healthcare workers toward healthcare waste management in health care facilities of Gondar Town, Northwest Ethiopia.

APPENDICES

Appendix 1. Informed consent

Study Title: Types of biomedical waste generated and factors Associated with biomedical waste management practices among healthcare personnel at MbagathiHospital, Nairobi County

Researcher	Institutions	Contact
Mohamed Adan Satawa	Jomo Kenyatta University of Agriculture and Technology (JKUAT) Kenya Medical Research Institute	+254-720-944-804

My name is Mohamed Adan. I am pursuing degree of Master of Science in Public Health from Jomo Kenyatta University of Agriculture and Technology (JKUAT). You are invited to take part in research about biomedical waste management. You are a potential participant because you are a staff at Mbagathi Hospital. I ask you to read this form before agreeing to be part of the research. If you cannot read, you can request the researcher or a member of the staff to read for you.

Purpose

The purpose of the research is to assess hospital biomedical waste management. To determine staff exposure to hazards that can adversely affects their health and how this waste can be eliminated or minimized. As such, the issues of risk of infection should become a priority to policy makers. The study therefore will attempt to reveal the significance of proper hospital biomedical waste management.

Procedure

If you agree to take part in this research, sign the consent form. My assistant and I will describe the questions you will be asked. The questions would take only 20 – 30 minutes of your time.

Risk and Benefit of the study

The study has no direct benefits to you but transport reimbursement of Ksh 200 will be given out for each participant of focus group discussion and the risk level of this research is considered to be very minimal.

Confidentiality

The records of this study will be kept private. Anything you tell us will remain confidential in any sort of report of the study. We will not include any information that may reveal your identity such as your name, address or phone number. The surveys will be kept in a locked file and only the researchers for this study will have access to the records.

Voluntary nature of study

Your decision whether or not to participate will not prejudice your future relations with Mbagathi Hospital, Kenya Medical Research Institute, Jomo Kenyatta University of Agriculture and Technology and staff helping with this study. If you do not wish to take part or you do not want to answer some of the questions, you do not have to give us a reason. Even if you sign the consent form, you are free to stop at any time.

Contact

The researchers conducting this study are Mohamed Adan and his assistant. You may contact the researchers at any time.

Mohamed Adan
Po Box 62938 00200, Nairobi
Cell phone Number: +254 720944804
Email: salamsatawa@yahoo.com: adansatawa@gmail.com
Or

The Director
Institute of Tropical Medicine and Infectious Diseases
Jomo Kenyatta University of Agriculture and Technology
Po Box 62200 00-200 Nairobi
Tel 067-52711
Email: itromid@kemri.org

In case you have a question concerning your rights of participation, you should contact;

The Chairman,
Kenyatta National Hospital/University of Nairobi Research and Ethics Committee,
Prof. A.N Guantai
Tel 2726300 ext. 44355/44102

Consent

I have read the above information and understood that this survey is voluntary and I may stop at any time. I consent to participate in the study.

.....

.....

Signature of participant

Date

.....

.....

Signature of researcher / research assistant

Date

Appendix 2. Questionnaires

QUESTIONNAIRE FOR ALL CADRES

Types of biomedical waste generated and factors Associated with Biomedical Waste Management Practices among Healthcare Personnel at Mbagathi Hospital, Nairobi County

Questionnaire Number.....

The research is being conducted in partial fulfillment of the degree of Master of Science in Public Health at Jomo Kenyatta University of Agriculture and Technology. The information is intended for learning purpose only. The information shall be handled with high confidentiality.

Demography Data

1) Gender of participant

1) Male [] 2) Female []

2) Age in Years

1) 20 -29 [] 2) 30 - 39 [] 3) Above 40 []

3) What is your level of Education.....

4) What is your profession?

1) Doctors [] 2) Clinician [] 3) Nursing []

4) Laboratory Technician [] 5) Sanitary Staff []

5) For how long were you in service.....

6) How did you get employed?

1) Through internal advertisement [] 2) Through internal advertisement []

3) Through friends [] 4) Others (Specify).....

Types of biomedical waste generated

7) Which of the following waste categories do you generate?

Waste Category	Yes	No
Pathological waste		
Sharps waste		
Pharmaceuticals waste		
Radioactive waste		
Kitchen waste from hospital		
Incineration Ash		

Assessment of Knowledge on Biomedical waste management

8) When is the biomedical waste disposal bin sealed?

- 1) Once it is ½ full []
- 2) Once it is ¾ full []
- 3) Once it is completely full []
- 4) I don't know []

9) Which categories do the following these biomedical waste belong to?

Constituent	Radioactive	Infectious	Non infectious	Highly infectious	Chemical
Chemicals					
Radioactive materials					
Pathology materials					
Pharmaceutical					
Kitchen wastes from the hospital					

10) How hazardous do you think these biomedical waste are?

Constituent	Highly Hazardous	Hazardous	Neutral	Not hazardous
Paper, cartons, boxes				
Dressings cotton, plasters				
Chemicals				
Radioactive materials				
Pathology materials				
Pharmaceutical				
Body fluids				
Pressurized containers				
Kitchen wastes from the hospital				
Unused medicines				

Assessment of Attitude on Biomedical waste management

11) Biomedical waste management is concerned

1) Strongly agree [] 2) Agree [] 3) Disagree [] 4) Strongly disagree []

12) It is necessary to segregate waste into different categories at the source

1) Strongly agree [] 2) Agree [] 3) Disagree [] 4) Strongly disagree []

13) Segregation of waste at source increases the risk of injury to waste handlers

1) Strongly agree [] 2) Agree [] 3) Disagree [] 4) Strongly disagree []

14) Containment of sharps not helpful in safe management of biomedical waste

1) Strongly agree [] 2) Agree [] 3) Disagree [] 4) Strongly disagree []

15) Decontamination of biomedical waste reduce chances of infection at source

1) Strongly agree [] 2) Agree [] 3) Disagree [] 4) Strongly disagree []

16) Spillage of biomedical waste during transportation is normally properly managed

1) Strongly agree [] 2) Agree [] 3) Disagree [] 4) Strongly disagree []

17) It is not necessary for waste handlers to take vaccination against hepatitis B?

1) Strongly agree [] 2) Agree [] 3) Disagree [] 4) Strongly disagree []

18) Hepatitis B immunization prevent transmission of hospital acquired infection

1) Strongly agree [] 2) Agree [] 3) Disagree [] 4) Strongly disagree []

19) Proper training is important for biomedical waste management

1) Strongly agree [] 2) Agree [] 3) Disagree [] 4) Strongly disagree []

20) Occupation safety should not be mandatory for waste handlers

1) Strongly agree [] 2) Agree [] 3) Disagree [] 4) Strongly disagree []

21) Incineration is the best way for biomedical waste disposal

1) Strongly agree [] 2) Agree [] 3) Disagree [] 4) Strongly disagree []

22) Management of biomedical waste is satisfactory

1) Strongly agree [] 2) Agree [] 3) Disagree [] 4) Strongly disagree []

Assessment of practices on biomedical waste management

23) How easy for you to use colour coding system for biomedical waste bins?

1) Very easy [] 2) Slightly easy []

3) Easy [] 4) Not easy []

24) How often do you think you place biomedical waste in a wrong bin?

- 1) Frequently [] 2) Quite often [] 3) Not at all []

25) How risky is placing of biomedical waste into a wrong bin?

- 1) Highly risky [] 2) Moderately risky [] 3) Not risky []

- 4) Don't know []

26) If you place biomedical wastes in a wrong bin, do you inform the waste collectors?

- 1) Yes [] 2) No []

27) Do you store your biomedical waste?

- 1) Yes [] 2) No []

28) Do you have any behaviour change communication?

- 1) Yes [] 2) No []

29) Are you being provided with safety gadget in biomedical waste handling?

- 1) Yes [] 2) No []

30) Do you minimize generation of biomedical waste?

- 1) Yes [] 2) No []

31) Do you dispose Pathological waste?

- 1) Yes [] 2) No []

32) Do you dispose Sharps waste?

- 1) Yes [] 2) No []

33) Do you dispose Pharmaceuticals waste?

- 1) Yes [] 2) No []

34) Do you dispose Radioactive waste?

- 1) Yes [] 2) No []

35) Do you dispose Kitchen waste from hospital?

1) Yes [] 2) No []

36) Do you dispose Incineration Ash?

1) Yes [] 2) No []

Thank you

Appendix 3. Focus group discussion guide

Types of biomedical waste generated and actors associated with biomedical waste management practices among healthcare personnel at Mbagathi hospital, Nairobi county

General Introduction to the interview

My name is Mohamed Adan from Jomo Kenyatta University of Agriculture and Technology (JKUAT). I would like to welcome you to this interview and thank you for coming. We shall discuss about the knowledge, attitude and practices of biomedical waste management among medical care workers. I encourage you to share out your ideas freely, because all information collected may help us in the biomedical waste management.

With me here iswho will help me record the points as you air them. We also have a tape recorder to record the discussion in case any point misses our ears. This will help in the analysis and writing of the report.

Q1: Types of biomedical waste generated

Probe

- Biomedical waste categories generated

Explore: Highly infectious, Infectious, Non- infectious, chemical and radioactive and their example

- People who generate biomedical waste

Explore: Doctors, clinician, Nurses, Laboratory technologist, sanitary staff.

Q2: Individual level factors associated with biomedical waste management

Knowledge on biomedical waste management

Probe

- Biomedical waste management

Explore: understanding, Key steps biomedical waste management and how hazardous biomedical waste

- Sealing of biomedical waste disposal bin

Explore: half full, three quarter full, completely full,

- Legal requirement for proper waste management

Explore: Waste management regulation, Public health Act, Environmental regulation and Implementation

Q3: Attitude on biomedical waste management

Probe

- Segregation of waste at source

Explore: General waste, infectious waste, highly infectious, chemical

- Decontamination of biomedical waste

Explore: Who, Availability of disinfectant, use of disinfectant,

- Occupation safety of waste handlers

Explore: Provision of PPE, Vaccination and compensation

- Training on biomedical waste management

Explore: Courses, On Job training, seminars

Q4: Biomedical waste management practices

Probe

- Roles of each cadre in biomedical waste management

Explore: Generation, segregation, collection, transportation, Storage, disposal and handling

- Biomedical waste in a wrong bin

Explore: Bins being full, inappropriate allocation of waste bin, lack of knowledge regarding the constituent of biomedical waste, symbol of waste bins

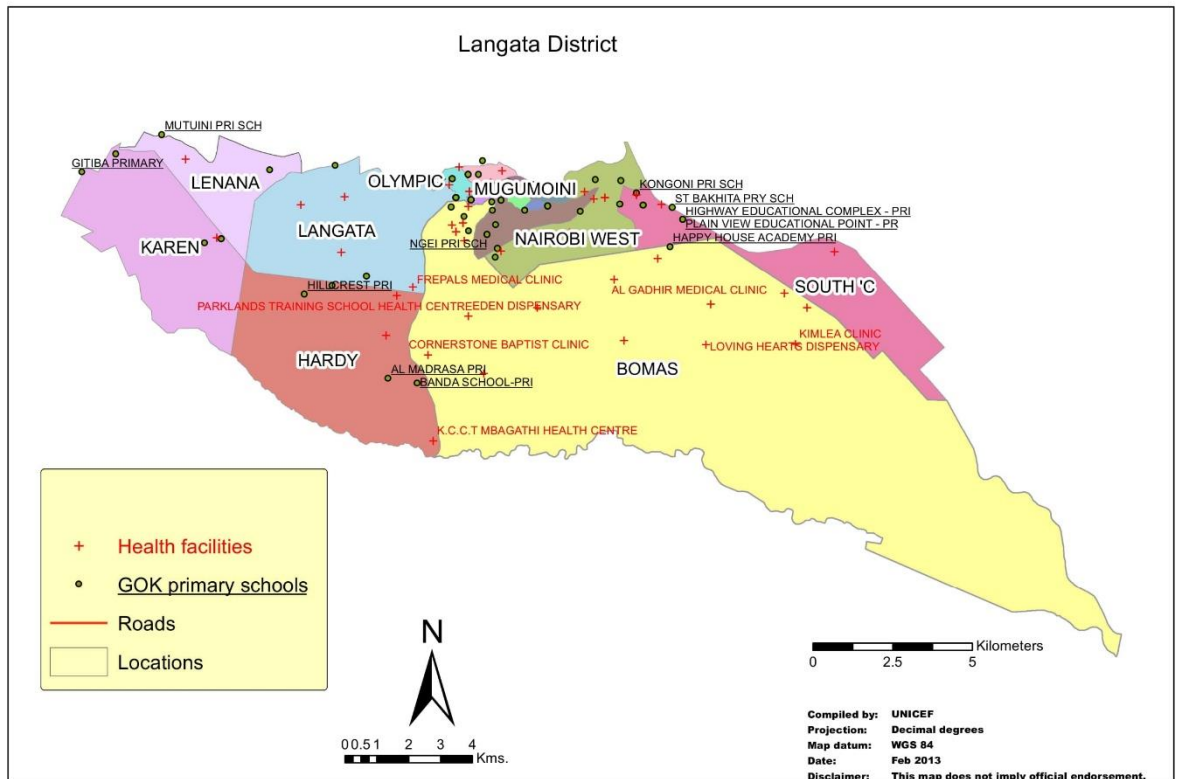
- Transportation of biomedical waste

Explore: Who, containers, bags and transport trolley and handling

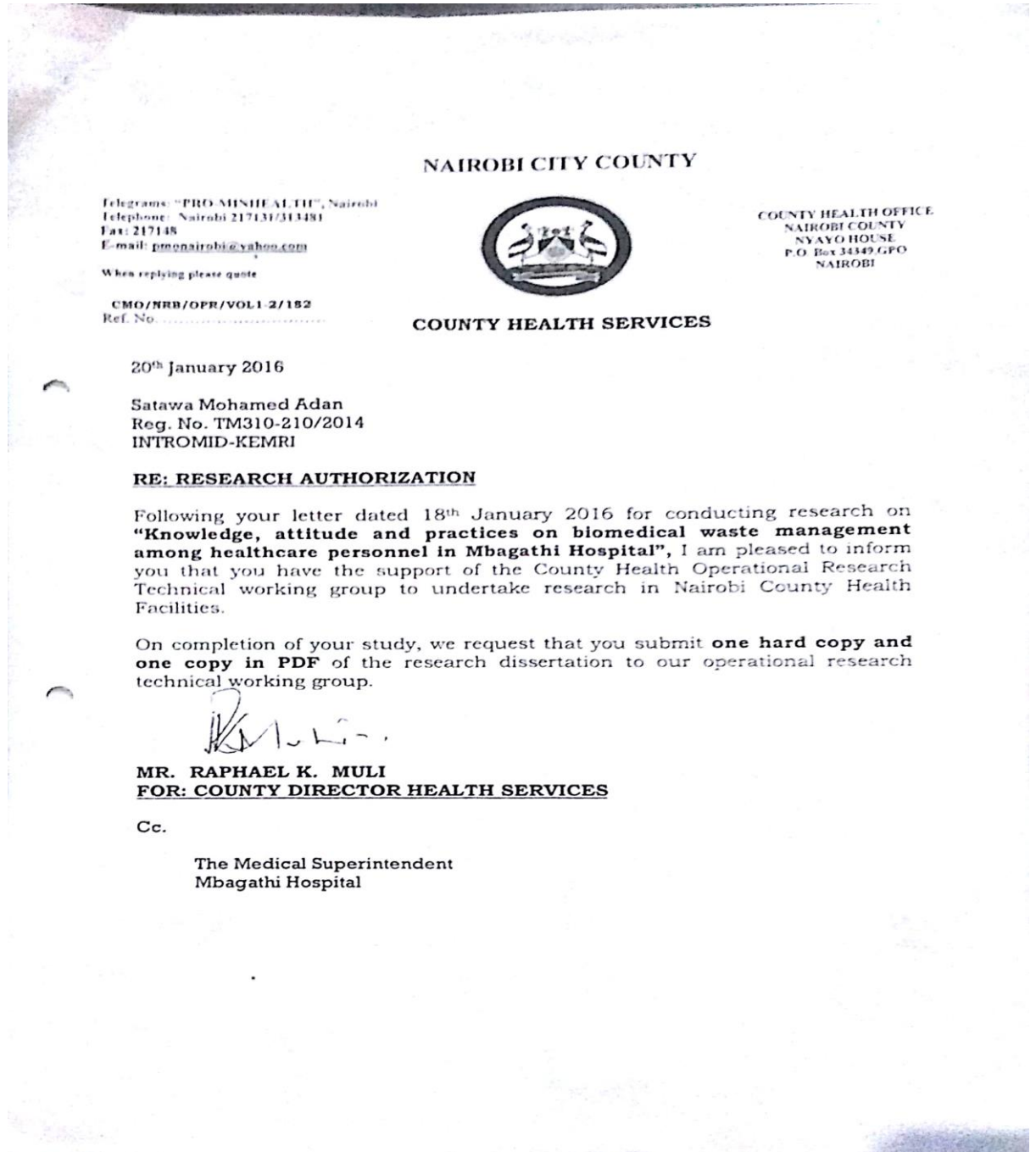
- Storage of biomedical waste
 - Explore:** Who, Closed covered area, Away from normal passage, easily accessible for transportation and handling
- Behaviour change communication
 - Explore** – To whom, poster, leaflets, standard operating procedure at all stages of biomedical waste management.
- Disposal of biomedical waste
 - Explore** – Incineration, Autoclaving and shredding
- Strategies in protection of health workers
 - Explore:** Implementing standard precaution, immunization, PPE, managing exposure in a timely manner and Eliminating unnecessary sharps and injections.
- Management of biomedical waste spillages
Procedures
 - Explore:** PPE, use of disinfectant
- **Improvement of current biomedical waste management practices.**
Perception and preparedness
 - Explore:** Training, Education, Policy related, Use of mass media, Poster, Banner, Culture discharge.

Thank you for your contributions.

Appendix 4. Map of Langata District



Appendix 5. Approval Letter by the County Health Office, Nairobi County



**Appendix 6. Approval Letter by the Medical Superintendent Mbagathi
Hospital**

NAIROBI CITY COUNTY

Tel: 2724712, 2725791, 0721 311 808
Email: ncdhnairobi@yahoo.co.uk



Mbagathi Hospital
P.O. Box 20725- 00202
Nairobi

Our Ref: MS/VOL.1/2015

COUNTY HEALTH SERVICES

28th January 2016

Satawa Mohamed Adan
JKUAT

RE: RESEARCH AUTHORIZATION

This is in reference to your application for authority to carry out a research on *"Knowledge, attitude and practices on biomedical waste management among health care personnel in Mbagathi Hospital"*

I am pleased to inform you that your request to undertake the research in the hospital has been granted.

On completion of the research you are expected to submit one hard copy and one soft copy of the research report / thesis to this office.

Asuleh
28 JAN 2016

Dr. A. J. Suleh
Medical Superintendent
Mbagathi Hospital

Appendix 7. Approval Letter by Ethics & Research Committee –KNH/UON



UNIVERSITY OF NAIROBI
COLLEGE OF HEALTH SCIENCES
P O BOX 19676 Code 00202
Telegrams: varsity
(254-020) 2726300 Ext 44855

KNH-UON ERC

Email: uonknh_erc@uonbi.ac.ke
Website: <http://www.erc.uonbi.ac.ke>
Facebook: <https://www.facebook.com/uonknh.erc>
Twitter: @UONKNH_ERC https://twitter.com/UONKNH_ERC



KENYATTA NATIONAL HOSPITAL
P O BOX 20723 Code 00202
Tel: 726300-9
Fax: 725272
Telegrams: MEDSUP, Nairobi

Ref: KNH-ERC/A/451

Satawa Mohamed Adan
TM310-2100-2014
JKUAT

9th November 2015

Dear Mr. Satawa

Research proposal: Knowledge, attitude and practices on biomedical waste management among healthcare personnel in Mbagathi District Hospital, Nairobi(P610/09/2015)

This is to inform you that the KNH- UoN Ethics & Research Committee (KNH-UoN ERC) has reviewed and **approved** your above proposal. The approval periods are 9th November 2015 – 8th November 2016

This approval is subject to compliance with the following requirements:

- a) Only approved documents (informed consents, study instruments, advertising materials etc) will be used.
- b) All changes (amendments, deviations, violations etc) are submitted for review and approval by KNH-UoN ERC before implementation.
- c) Death and life threatening problems and serious adverse events (SAEs) or unexpected adverse events whether related or unrelated to the study must be reported to the KNH-UoN ERC within 72 hours of notification.
- d) Any changes, anticipated or otherwise that may increase the risks or affect safety or welfare of study participants and others or affect the integrity of the research must be reported to KNH/UoN ERC within 72 hours.
- e) Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. (Attach a comprehensive progress report to support the renewal).
- f) Clearance for export of biological specimens must be obtained from KNH/UoN-Ethics & Research Committee for each batch of shipment.
- g) Submission of an executive summary report within 90 days upon completion of the study. This information will form part of the data base that will be consulted in future when processing related research studies so as to minimize chances of study duplication and/or plagiarism.

Protect to Discover

Appendix 8. Manuscript Publication

11/30/2018

Factors associated with biomedical waste management practices among healthcare personnel at Mbagathi county hospital, Nairobi Kenya



International Knowledge Sharing Platform
Journals & Books Hosting - Conferences & Workshops Solutions

[Home](#) [Journals](#) [Conferences](#) [Books](#) [About us](#)

Journal of Health, Medicine and Nursing

[Home](#)

[Search](#)

[Current Issue](#)

[Back Issues](#)

[Announcements](#)

[Full List of Journals](#)

[Migrate a Journal](#)

[Special Issue Service](#)

[Conference Publishing](#)

[Editorial Board](#)

[Home](#) > [Vol 55 \(2018\)](#) > [Adan](#)

Factors associated with biomedical waste management practices among healthcare personnel at Mbagathi county hospital, Nairobi Kenya

Satawa Mohamed Adan, Gideon Kikuvu, Joseph Mutai

Abstract

Medical care is vital for life and health, but the waste generated from medical activities presents a problem to human health. Mbagathi county hospital generate 210-341kg infectious and highly infectious waste per day. Lack of work place guideline in many hospitals in developing countries, the implementation of biomedical waste regulations is still below the recommended threshold. This study determined factors associated with biomedical waste management practices among healthcare personnel in Mbagathi county hospital, in Nairobi Kenya. This descriptive cross sectional study used quantitative technique to gather relevant data. Purposive sampling was used to have 195 healthcare personnel as a study subject. Quantitative data were collected using structured questionnaires and analysed using Statistical Package for Social Scientists version 20. A descriptive analysis was used to summary the data and association between variable were tested using chi-square, multivariate and bivariate statistical test. P-values were considered significant at < 0.05 . Among the surveyed healthcare personnel, the mean age (\pm SD) was 31.9 (7.5) years, (86.2%) had tertiary level education and (48.7%) were nurses. A significant voluminous of waste are generated: (96.9%) sharps, (91.3%) pharmaceutical, (90.3%) pathological, (81%) kitchen, (68.7%) incineration ash while the least produced waste reported (64.6%) radioactive wastes. Significant number of study participants (22.6%) had inadequate knowledge on biomedical waste management, with score of $\leq 50\%$. The nurses scored significantly more with regards to the knowledge on biomedical waste management compared to other healthcare personnel ($P = 0.001$). 31% of study participant did not know when to seal safety bins. 28.2 %, 3.1% of the study participants disagreed and strongly disagreed respectively on management of the biomedical waste at the facility ($P = 0.005$). Out of 195 of study participants, 6.7% had not agreed on recommended practices related to biomedical waste management at the hospital ($P = 0.001$). Waste generated at various departments are source of infection that healthcare personnel and patient are exposed to and variation of knowledge among healthcare personnel is an indication of inadequacy as far as biomedical waste management is concerned. Periodic sensitization of staff using existing friendly channel to convey messages, environmental and occupation health unit to be incorporated in all curriculum for early exposure so as to address concern arising from biomedical waste management in health facility.

Keywords: Biomedical waste management, Knowledge, attitude and practice, County Hospital, Capital City of Kenya.

Full Text: [PDE](#)

Download journal article submission guidelines

SPONSORED SEARCHES

[Patient Care Management](#)

[Health Care](#)

[Management Practices](#)

[Convert JPG to PDF](#)



Grand Beyazid Hotel

KSh 10,616 Reserveer nu

Booking.com ★★★★★

[To list your conference here. Please contact the administrator of this platform.](#)

Paper submission email: JHMN@iiste.org

ISSN 2422-8419

<https://iiste.org/Journals/index.php/JHMN/article/view/44890>