HOSPITAL SOLID WASTE MANAGEMENT SYSTEMS AND PRACTICES

AT UNIVERSITY TEACHING HOSPITAL OF KIGALI (CHUK), RWANDA

A Thesis

Presented to the School of

Postgraduate Studies and Research

Kampala International University

Kampala, Uganda

In Partial Fulfillment of the Requirements for the Degree

Master of Science in Environmental Management and Development

By:

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September, 2010
DECLARATION A

"This dissertation is my original work and has not been presented for a Degree or any other academic award in any University or Institution of Learning".

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12/10/2010
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DECLARATION B

"I/We confirm that the work reported in this dissertation was carried out by the candidate under my/our supervision".

[Signature of Supervisor]

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APPROVAL SHEET

This dissertation entitled" Hospital Solid Wastes Management Systems and Practices at University Teaching Hospital of Kigali (CHUK)" prepared and submitted by MAHORO Justin in partial fulfillment of the requirements for the degree of Masters in Environmental Management and Development has been examined and approved by the panel on oral examination with a grade of PASSED.

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ACKNOWLEDGEMENTS

The successful completion of this project would be impossible without the assistance and supports from many individuals who have lent me their hands either directly or indirectly. First and foremost, I would like to express my sincere gratitude and appreciation to my supervisor, Dr. SEKABIRA KASSIM for his endless support, invaluable guidance and critics throughout the project. In spite of his busy schedule, he found time for me. With great pleasure, I place on record the support I have received from my teachers, Senior lecturers: Dr. Twaha, Dr. Paul Seggawa, Dr. Patrick Kisangua, Mr. Amon, and Head of department of Environmental science; Ms. Anne. I must express my gratitude to them for their constant inspiration and valuable guidance and suggestions throughout my student career.

My acknowledgement goes to the management and all staff and workers of CHUK, especially the Head of service in charge of Hygiene and HCWM, technical department and HCWM and infection control unit for providing me with the necessary information for this research. My special thanks to my colleagues and classmates: Ms Yvette Ishimo, Mr. Joseph Amandua, Mr. Pierre Dukuziyaturemye, for their immense cooperation and virtues they provided through their actions during my student career. I am fortunate to have friend and well-wishers like them.

I wish to express my deep appreciation and thankfulness to my mother and father and our first born brother. They have taken every care and provided utmost support whenever needed, throughout my student career. With all humiliation and pride, I dedicate this work to my father; BIBUTSA DAMIEN and my mother; NIYITEGEKA GERTRUDE, my brothers; DR. SOSTHÈNE HABUMUREMYI, RUMULI REMY, NGABO SALVI and my sister CYUZUZO MARY GRACE. From the bottom of my heart I say thank you. May the good Lord richly bless you!
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ACRONYMS

CHK: Central Hospital of Kigali

CHUK: University Hospital Centre of Kigali

HCW: Health Care Waste

HCSW: Health Care Solid Waste

HCWM: Health Care Waste Management

IC: Infection Control

IC&HWMC: Infection Control and Hospital Waste Management Committee

GoR: Government of Rwanda

MoH: Ministry of Health

NGO: Non Governmental Organization

POPs: Persistent Organic Pollutants

REMA: Rwanda Environment Management Authority

UNCEP: United Nations Conference on Environment and Development

UNEP: United Nations Environmental Program

USEPA: United States Environmental Protection Agency

WHO: World Health Organization
ABSTRACT

This study investigated hospital solid waste management systems and practices at University Teaching Hospital of Kigali (CHUK) for improving environmental management by promoting the safe and appropriate management of waste from hospitals. A combination of quantitative and qualitative methodologies was used to record necessary information. Data were analyzed with SPSS version 18.0 statistical software. Student t-test and chi-squared tests were mainly applied to assess the data.

The results of this study revealed that CHUK produced two types of waste: Infectious waste (Sharp & Non-Sharp) and Non-Infectious waste, which have been categorized into two classes by considering its bio-characteristics; Biodegradable waste and Non-Biodegradable waste. Results gave an overall average weight of 429 kg/day of Non-Biodegradable waste generated at CHUK. Our study showed that there was no clear policy and plan in place for managing hospital waste at CHUK. Segregation of hospital solid is not conducted according to definite rules and standards. The hospital does not label infectious waste with Biohazard symbol. The questionnaire survey revealed that there are two treatment and disposal options for treated HCW; the incineration was the main method for the on-site treatment of all combustible waste and off-site landfill is the remaining option for treatment of all Biodegradable waste.

Survey had indicated that CHUK provides protective gears and training to all personnel who are engaged in HCW management. Despite of the provision of protective gear, some concerns were reported include injuries from needles stick, sickness and inappropriate bins and improper incineration practice. In the light of the above observations made, a number of recommendations are hereby made with the hope of improving the management of hospital waste in Rwandan hospitals in general and University Teaching Hospital of Kigali in particular.
CHAPTER ONE

INTRODUCTION

1.1 Background Information

The typology of wastes generated in Rwanda from point and non-point sources encompass industrial, agricultural, sewage, domestic, municipal and other wastes including wastes from the medical industry. These wastes are either non-hazardous or hazardous that are potentially harmful to public health and the environment.

Medical waste/hospital waste generated in Rwanda consists of paper waste, textile waste, bio-waste, glass, cardboards, plastics or metal, cans, leftover food, medicine waste, chemical waste and hazardous waste includes infectious waste, anatomic waste, sharps waste, pharmaceutical waste and toxic waste. Waste disposal is generally practiced than waste management and waste is disposed off without consideration for environmental and human health impacts. Co-disposal of non-hazardous and hazardous waste without segregation is common practice (GoR, 2007).

Healthcare Waste (HCW) management has continually been an intractable problem in recent times beyond the capacity of the government, especially Ministry of Health. Waste management in the country suffers from limited technological and economic resources, operational and maintenance procedures, and legal provisions as well as poor funding which collectively result in the prevalent low standards of waste management (MoH, 2008). In developing countries like Rwanda, the legal and institutional/administrative framework for the environmentally sound management of waste is either lacking or inadequate. The Rwandan regulatory system on storing, collecting, transporting, processing and disposing of general waste including hospital waste is still in its initial stages.
The Government of Rwanda has ratified the Multilateral Environmental Agreements on wastes and chemicals. Referring to the STOCKHOLM Convention persistent organic pollutants, signed in STOCKHOLM on 22 May, 2001, and the BASEL Convention on the Control of Tranboundary Movements of Hazardous wastes and their disposal as adopted at BASEL on 22 March 1989, the government of Rwanda has elaborated an organic law n° 04/2005 of 08/04/2005 determining the modalities of protection, conservation and promotion of environment in Rwanda. In its chapter two, articles 32-90, the law addresses the waste disposal, collection, removal and treatment in manner that does not affect the human health and the nature of environment (GoR, 2005).

In 1992, health-care waste management was included in the agenda and discussed at the Earth Summit by the United Nations Conference on Environment and Development (UNCED 1992). Since that time the world has paid more attention to HCW because of its negative impacts on the human health and on the environment (WHO 2001). Poor and Inappropriate management of health care waste exposes the community to health problem (infections, toxic effects, injuries) and environmental risks, especially in poor countries (WHO 1999).

Rwanda is developing guidelines to promote effective HCW management. Health-care waste is the waste generated from healthcare facilities and consists of general waste (GW) and medical waste (MW), which is potentially harmful to human being and the environment. The approximate composition of HCW is typically regarded as 75% GW and 25% MW (WHO 1999). In 2002, the World Health Organization (WHO) conducted a survey to assess ongoing HCW management in 22 developing countries and this showed that the proportion of inappropriate waste disposal methods was between 18% and 64% (WHO 2004).
In Rwanda, the amount of hospital waste is increasing with the improvement in health-care activities after 1994 genocide and with the increasing of population growth (GoR 2008). This rising up of hospital waste should be taking into consideration by setting up the national institution, legislation and regulations on health care waste complied with international regulations established by multilateral environmental and waste agreements or international institutions. The mismanagement of healthcare waste poses risks to people and the environment, for these reasons the hospital waste management should get the priority it deserves.

1.2 The study area

The Central Hospital of Kigali is a principal public institution of the country. It is located at the Center of the Town of Kigali, in the district of Nyarugenge, in Rwanda. Nowadays, it is managed by the Ministry of Health; the National University of Rwanda with the assistance of the Belgian co-operation. Central University Hospital of Kigali (CHUK) is one of national reference hospitals, having a capacity of 509 beds. This hospital has different categories of services: Clinical services, Para clinical services and administrative services.

1.3 Problem statement

It has gradually been recognized that the waste management problems in developing countries are varied and complex with infrastructure, political, technical, social-economic, organizational management, regulatory and legal issues and challenges to be addressed(Prüss et al., 1999, WHO, 1999). Waste management in Rwanda suffers from limited technological and economic resources, operational and maintenance procedures, and legal provisions as well as poor funding which collectively result in the prevalent low standards of waste management (GoR, 2005).
Legislation, policy and regulatory system on storing, collecting, transporting, processing and disposing of hospital waste are not yet clarified; this leads to core environmental problems due to the poor knowledge of health-care waste utilization, regulations and policies awareness of health hazards.

In some Hospitals around Rwanda, untreated HCW including hazardous infectious waste are dumped in uncontrolled sites that are accessible to the general public; therefore it is an issue that needs to be addressed. Although a few studies had attempted to reveal the reality of the medical waste situation, some more systematic research is important to clarify the general picture of healthcare waste management in Rwanda, where the waste management is still poor and inappropriate.

1.4 General and Specific objectives

The General objective of this study was to assess the Hospital solid waste management systems and practices for improving environmental management by promoting the safe and appropriate management of waste from hospitals. In order to realize this objective, the following are the specific objectives:

1. To identify the characterization of Healthcare Solid Waste production at University Teaching Hospital of Kigali;
2. Report on the current status of regulations and procedures regarding hospital waste practices at University Teaching Hospital of Kigali;
3. To identify the current waste management systems and practices that exist at University Teaching Hospital of Kigali;
4. To investigate possible environmental problems associated with the current HCWM at University Teaching Hospital of Kigali.
1.5 Research questions

The following research questions were formulated in order that their answers could address issues raised in research objectives:

1. What is the composition and the amount of HealthCare Solid Waste generated at University Teaching Hospital of Kigali?
2. What are HCWM guidelines, policy and regulatory systems that exist at University Teaching Hospital of Kigali?
3. What are the hospital waste management systems and practices that exist at University Teaching Hospital of Kigali?
4. What are the environmental problems associated with the current HCWM at University Teaching Hospital of Kigali?

1.6 Scope of the study

The work aimed to assess the hospital waste management systems and practices at University Teaching Hospital of Kigali. CHUK is a principal (referral) public institution of Rwanda. It is located at the Center of the Town of Kigali, in the district of Nyarugenge, Rwanda. The study is a preliminary investigation, intend to open the way for further detailed investigations of the same site and other similar sites in the country.

1.7 Significance of the study

Basically the study will contribute to a theoretical enhancement of the current level of knowledge in the existing literature on HCW management and other kind of waste treatment in general. The findings of the study will be used to make specific strategic recommendations on how to set-up an overall HCW management scheme as well as to develop an environmentally sound, affordable and safe treatment/disposal system.
1.8 Clarification of Basic Terms and Concepts

**Medical waste** is waste generated from health institutions. This includes both infectious waste and non-infectious waste materials. Medical waste is also referred to as healthcare waste, hospital waste or clinical waste (Soncuya, Matias and Lapid, 1997; WHO, 1999; WHO, 2005).

**Infectious waste** includes infectious materials that can cause disease to humans (WHO, 2005). Infectious waste means healthcare risk waste which is suspected to contain pathogens and which normally causes, or significantly contributes to the cause of increased morbidity or mortality of human beings, and includes but is not limited to sharps waste and anatomical waste; but excludes baby-nappies and sanitary pads (Godfrey, 2003).

**Hazardous waste** means waste that may, by circumstances of use, quantity, concentration or inherent physical, chemical or infectious characteristics, cause ill health or increase mortality in humans, fauna and flora, or adversely affect the environment when improperly treated, stored, transported or disposed of (Godfrey, 2003).

**Hospital waste management** or healthcare waste management is a process that helps ensure proper hygiene in the health institution and safety of healthcare workers and communities (Sanitation Connection, 2002).

**Waste disposal** refers to the final placement of treated waste (Johannessen, Dijkman, Bartone, Hanrahan, Boyer and Chandra, 2000; WHO, 2005).

**Treatment of wastes** is mainly reducing direct exposure of waste to become less dangerous to humans, at recovering recyclable materials, and at protecting the environment (Johannessen et al, 2000).
CHAPTER TWO

LITERATURE REVIEW

2.1 Waste generated from Hospitals

Hospitals generate mainly solid municipal waste, hazardous waste which is considered as infectious waste and may be toxic or radioactive. Approximately 80% of waste produced from hospitals is solid municipal waste, which is non-contaminated waste and poses no infectious risk to the personal who handles it (MOH, 2004). Healthcare Wastes are wastes arising from diagnosis, monitoring and preventive, curative or palliative activities in field of the veterinary and human medicine. “Very broadly hospital waste is defined as any solid or liquid waste that is generated in the diagnosis, treatment or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biological” (BAN & HCWH, 1999).

Healthcare waste includes all the waste hazardous or not generated during medical activities, there are by-products of healthcare, example sharps, non-sharps, blood, body parts, chemicals, pharmaceuticals, medical devices, and radioactive wastes, paper waste, leftover food (Samuel V. Manyele et al, 2004). These waste if not properly managed can risk of infectious diseases to both workers, patients and the public in general (WHO, 2004. Health-care waste management requires an increased attention and diligence to avoid the substantial disease burden associated with poor practice.

2.2 Hospital waste classification

Different authors introduce different ways of hospital waste classification. These are based on Hospital waste state or form (solid, liquid), character, source and effects. Some of those are described below: Classification of Hospital waste by Eigenheer & Zanon (1991).
They classified hospital waste according to their liquid and solid state:

1. **Liquid Wastes**: Biological waste (Blood, excrement, body fluid etc); Chemical waste (Solutions, inorganic salts etc.); Over-date medicines (Unused drugs, over-date drugs); Radioactive waste (Wastes from radiology).

2. **Solid Wastes**: Perforating and cutting wastes (Needles, syringes, scalpels, blades, broken glass, vials) and Non-perforating and Non-cutting: Wastes from treatment (dressings, stool napkins, plaster cast etc.); Parts of the body (organs, placentas, tissue etc.); Over-date medicines (Expired drugs); Household-type wastes (other wet and dry waste).

Hospital wastes are also classified into different categories based on their sources and potential hazards they may cause:

1. **Clinical Waste**: This is high risk category. This includes body fluid, drainage bags, blood collection tubes, vials, culture dishes, other types of broken/unbroken glassware that were in contact with infectious agents, gauze, bandages or any other materials that were in contact with infectious agents or blood, pathological waste including organs, body parts, tissues.

2. **Laboratory Waste**: This is also high risk category waste. This includes chemicals used in the pathological laboratory, microbial cultures and clinical specimens, slide, culture dish, needle, syringes, as well as radioactive waste such as Iodine-125, iodine -131 etc.

3. **Non-clinical Waste**: This is non-risk category waste. This includes wrapping paper, office paper, food waste, wash and waste water and plastic that has not been in contact with patient body fluid.
Healthcare waste management is a process that helps ensure proper hygiene in the health institution and safety of healthcare workers and communities. Johannessen et al. (2000) opine that proper management of medical waste can minimize the risk both within and outside healthcare facilities. The first priority is to segregate wastes, preferably at the point of generation into reusable and non-reusable, hazardous and non-hazardous components. They identified other important steps as, the institution of a sharps management system, waste reduction, avoidance of hazardous substances wherever possible, ensuring worker safety, providing secure methods of waste collection and transportation, and installing safe treatment and disposal mechanisms.

According to Johannessen et al. (2000), there are generally four key steps to medical waste management: (1) segregation into various components, including reusable and safe storage in appropriate containers; (2) transportation to waste treatment and disposal sites, (3) treatment and (4) final disposal. Acharya and Singh (2000) also identified the medical waste management process to include, handling, segregation, mutilation, disinfection, storage, transportation and final disposal. He suggests that these are vital steps for safe and scientific management of medical waste in any establishment. According to Rao, Ranyal and Sharm (2004), the key to minimization and effective management of medical waste is segregation (separation) and identification of the waste. They recommend that the most appropriate way of identifying the categories of medical waste is by sorting the waste into color-coded plastic bags or containers. Medical waste should be segregated into containers/bags at the point of generation.
The WHO suggests that hospitals should provide plastic bags and strong plastic containers for infectious waste such as empty containers of antiseptics used in the hospital (Prüss, Giroult and Rushbrook, 1999). General waste such as garbage and garden refuse should join the stream of domestic refuse. Sharps should be collected in puncture proof containers. Bags and containers for infectious waste should be marked with Biohazard symbol. Highly infectious waste should be sterilised by autoclaving. Cytotoxic wastes are to be collected in leak proof containers clearly labelled as cytotoxic waste (Acharya, 2000).

Needles and syringes should be destroyed with the help of needle destroyer and syringe cutters provided at the point of generation. Infusion sets, bottles and gloves should be cut with curved scissors. Disinfection of sharps, soiled linen, and plastic and rubber goods is to be achieved at point of generation by usage of sodium hypochlorite with minimum contact of an hour. On site collection requires staff to close the waste bags when they are three quarters full either by tying the neck or by sealing the bag. The storage area needs to be impermeable and hard standing with good drainage. It should provide an easy access to waste collection vehicle (Srivastava, 2000).

According to scientific standards, the infectious wastes in the tropical area can be kept in a temporary storage area for 24 h during the hot season and up to 48 h in cooler seasons (Prüss et al., 1999). Medical waste should be transported within the hospital by means of wheeled trolleys, containers or carts that are not used for any other purpose. Off site transportation vehicle should be marked with the name and address of carrier. Biohazard symbol should be painted and suitable system for securing the load during transport should be ensured. Johannessen et al (2000) recommend that transportation of medical waste on public roads must be carried out by trained staff in a dedicated vehicle with closed containers. Final treatment of medical waste can be done by technologies like incineration, autoclave, hydroclave or microwave (Rao et al, 2004).
2.4 Technology for Hospital Waste Treatment and Disposal

USEPA et al (1990), the choice of technology for waste treatment and disposal should always be driven by the objective of improving current health and environmental impacts. The technology choice should also be functional, safe, economically feasible, and sustainable.

2.4.1 The technology of landfills

Controlled disposal in a sanitary landfill may be an acceptable disposal option for some types of special healthcare waste but other types should be treated before disposal. In any case, final disposal in a landfill will usually be required for the residues from a treatment system. Landfills should be reviewed for appropriate liners and leachate collection systems, and should include ground water monitoring. This technology is mainly used in rural areas with limited options.

2.4.2 The technology of incineration

When done properly is a highly advanced technology that can adequately treat all types of special healthcare waste. The key parameters of controlled incineration are combustion at a sufficiently high temperature (between 1,000°C and 1,200°C in the combustion chamber) for long enough time in a combustion chamber with sufficient turbulence and oxygen for complete combustion to be achieved; and problematic gases to be minimized. Incinerators require skilled operators, extensive flue gas emission controls and, frequently, imported spares and supplies. Properly controlled incineration is relatively expensive. Incineration of wastes generates residues, including air emissions and ash. Environmental controls on incinerators in developed countries have been tightened in recent years, principally because of concerns over air emissions such as dioxins and furans as well as heavy metals.
2.4.3 Autoclaving

This involves the heating of waste material, with steam, in an enclosed container at high pressure. At the appropriate levels of time (> 60 min), temperature (>121°C), and pressure (100 kPa) effective inactivation of all vegetative microorganisms and most bacterial spores can be achieved. Preparation of material for autoclaving requires segregation to remove unsuitable material and shredding to reduce the individual pieces of waste to an acceptable size.

2.4.4 Chemical disinfection

This is used routinely in healthcare to kill microorganisms on medical equipment. It has been lately extended to the treatment of HCW. Chemicals (mostly strong oxidants like chlorine compounds, ammonium salts, aldehydes, and phenolic compounds) are added to the waste to kill or inactivate pathogens. This treatment is most suitable for liquid wastes such as blood, urine stools or hospital sewage.

2.5 Healthcare waste Legislations, guidelines and Regulations aspects

2.5.1 National Regulations

Healthcare facilities and centralized treatment/disposal facilities need to comply with relevant national legislation. Regulations should include clear definitions; precise indications of legal obligations for healthcare facilities, waste managers, and disposal facilities; applicable enforcement and penalty systems; and delegation of legal courts to handle disputes (Lars M. Johannessen et al, 2000).

At national level, The Government of Rwanda has elaborated the environment legislation through the organic law n° 04/2005 of 08/04/2005 determining the modalities of protection, conservation and promotion of environment in Rwanda.
This law defines waste category management and addresses the waste disposal, collection, removal and treatment in manner that does not affect the human health and the nature of environment, prohibition of indecent waste dumping, applicable enforcement and penalty systems (GoR, 2005). There is no specific legislation pertaining directly to the handling, transportation or disposal of Hospital waste in the organic law. However, the waste from hospitals can be classified under this.

2.5.2 International Regulations

The following are the major international regulations:

**Basel Convention**

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was adopted in 1989 and entered into force on 5 May 1992. This environmental treaty strictly regulates the transboundary movements of hazardous wastes and appropriate manner. The Basel Convention is administered at the national and also at the obligates its parties to ensure that such wastes are managed and disposed of in an state level, depending on the contracting party’s legislation; as of 22 July 1997, 113 countries had ratified the convention. The Basel Convention makes specific reference to control of special HCW: sharps, infectious waste, hazardous chemical waste, and pharmaceutical waste (UNEP, 2002).

At international level, Rwanda has ratified the Multilateral Environmental Agreements (MEAs) on wastes and chemicals, in particular BASEL Convention on the Control of Transboundary Movements of Hazardous Waste and their Disposal as adopted on 22 March 1989, the STOCKHOLM Convention on the Persistent Organic Pollutants signed on 22 May 2001 and the ROTTERDAM Convention on commerce transactions of agricultural pesticides and other poisonous products, signed in Rotterdam on 11 September 1998, and in New York from 12 November 1998 to 10 September 1999 (MINITERE, 2006).
2.6 Environmental problems (risks) associated with Hospital waste

2.6.1 Injuries and accidents

There is a risk of injuries related to medical waste handling and carrying by waste hauler and/or cleaner. Akter et al., (1998) reported that, there were several incident (10 cases out of 17) of injury due to exposure to HCW inside or outside of hospital premises. As BAN and HCWH (1999), sharps, which include syringes and needles, have the highest disease transmission potential amongst all categories of medical waste. WHO has estimated the amount of infectious waste and sharp objects in developing countries to be about 15% and 1%, respectively (Prüss et al., 1999). For serious virus infections such as HIV/AIDS and hepatitis B and C, healthcare workers – particularly nurses - are at greatest risk of infection through injuries from contaminated sharps.

2.6.2 Hazardous hospital waste risk

The main health risks hospital wastes are summarized below (WHO, 1999).

- Contamination of drinking water. Possibility of leachate entering an aquifer, surface water or drinking water system.
- Non-biodegradable antibiotics, antineoplastics and disinfectants disposed of into the sewage system may kill bacteria necessary for the treatment of sewage.
- Burning of waste at low temperatures or in open container results in release of toxic pollutants (e.g. dioxin) into the air.
- Carcinogenic waste such as heavy metals, chemical solvents and preservatives pose serious human health risks not only to workers but to the general public. Inefficient and insecure sorting and disposal may allow drugs beyond their expiry date
- Unprotected and insecure landfill may pose health hazard to the scavengers and inhabitants at the vicinity.
2.7 Consequences of Improper Disposal/Non-Disposal of Medical waste

Medical wastes are a source of contamination and pollution to both humans and the natural environment as discussed in this paper. Improper disposal may be hazardous if it leads to contamination of water supplies or local sources used by nearby communities or wildlife. Sometimes exposed waste may become accessible to scavengers and children if a landfill is insecure. Medical wastes are potentially capable of causing disease and illness in man, either through direct contact or indirectly by contamination of soil, groundwater, surface water and air. Windblown dusts from these dumps also have the potential to carry pathogens and hazardous materials. Where domestic animals are allowed to graze in open dumps, there is a risk of reintroducing pathogenic micro-organisms into the food chain. Medical wastes therefore pose a risk to individuals, communities, and the environment if not carefully handled (Akter et al., 1998).

Wastes attract scavenging animals and bats. As it ferments it gives off foul odors, favors fly feeding and contaminates both water and air. Piles of refuse or landfill during its decomposition process generate several gases, the most important among which are methane (CH4), nitrogen (N2) and occasionally hydrogen sulfide (H2S). If burnt, carbon di-oxide (CO2) is released.

CH4 and CO2 are greenhouse gases and have potential greenhouse effects. The soil underlying these wastes is typically contaminated by pathogenic micro-organisms, heavy metals, salts, and chlorinated hydrocarbons. These wastes also cause public nuisance by clogging sewers and open drains, encroaching on roadways, diminishing landscape aesthetics and giving off unpleasant odors and dust (World Bank, 1991). Medical waste incinerations are one of the largest sources of dioxin and mercury pollution in the United States.
According to the United States Environmental Protection Agency (EPA), dioxin from medical waste incineration ends up in dairy foods and meat and both mercury and dioxin are taken up by fish and shellfish. When one eats these foods, one adds to the existing dioxin and mercury body burdens. Other than these, the ash from incinerator consists of both fly ash and bottom ash.

The ash contains high levels of toxic substances such as heavy metals, dioxins and furans. Ironically, as the air pollution equipment becomes more effective in removing particulate matter, the toxicity of the fly ash increases. One of the largest hospitals in Delhi, India was found to have lead in its incinerator ash at levels which would classify the ash as hazardous (BAN & HCWH, 1999). In most cases, disposal of incinerator ash in landfills without a sufficient soil or other impermeable cover may cause leachate to contaminate groundwater.

Incineration has specific health concern since it not only destroys the pathogen but also the material on which the pathogen resides. Thus, those materials go under a process of transformation and dematerialization. In the process they transform solid and liquid toxic waste into gaseous emissions, particulate matters.

The acid gases (e.g. hydrogen chloride, nitrogen oxides and sulphur dioxides), can cause acute effects such as eyes and respiratory irritation, can contribute to acid rain, and may enhance the toxic effects to heavy metals. Particulate matter can cause chronic health effects. Burning of chlorine made material e.g. PVC, creates dioxin, a known animal carcinogen, and considered as human carcinogen.
CHAPTER THREE

METHODOLOGY

Quantitative and qualitative methodologies were used, including four main research tools: ethnographic observations, photographs, personal interviews, a waste sort study, and questionnaires. The quantitative methodologies were used to determine waste generation at site. The qualitative methods enable background explanations of the study to be analyzed. In this study a combination of all these methods were used to complement one another so that a comprehensive search for answers of research questions could be achieved.

3.1 Research design

This study uses the descriptive research design. Cormack (2006) indicates that a descriptive research design was used to develop theory, to identify problems with current practice, to justify current practice, to make judgments or to identify what others in similar situations may be doing. This method was selected because it is easy to administer questionnaires, it saves time. In addition, observation method was also used particularly in the all departments of CHUK to see how HCWM is taking place in the field.

3.2 Sampling and Sampling Procedure

The sampling procedure used in the selection of respondents from the population was stratified random sampling. The sample constituted of the three categories of respondents such as; the Management (Head of hospital, Head of department of HCWM, Research officer, Infection control officer, Incinerator operator/manager), Medical staffs (Paramedical/Nurses), and waste workers/collectors, because the researcher feels that respondents from these groups provide the required information.
The first group of the informants comprised of 5 respondents including the Director of CHUK, Research officer, Infection control officer, Incinerator operators and Head of department of HCWM. The second group comprised of 233 medical staffs in total. The third group constituted the remaining respondents totally 75 HCW workers (cleaners). The method used to select the sample was stratified sampling where calculations were made based on each potion or strata. Totals from each sample were obtained thereafter, combined them to get the required stratified sample. This was obtained by use of Sloven’s formula as illustrated below:

\[
n = \frac{N}{1+(N \times e^2)}
\]

When \(n\) = number of sample population, \(N\) = Total population, \(e\) = error of tolerance.

**Key informants**

\[
n = \frac{5}{1+(5 \times 0.05 \times 0.05)} = 5
\]

**Respondents/employees Medical staffs**

\[
n = \frac{560}{1+(560 \times 0.05 \times 0.05)} = 233
\]

**Respondents/waste workers/collectors/cleaner**

\[
n = \frac{93}{1+(93 \times 0.05 \times 0.05)} = 75
\]

The stratified sample size therefore, was obtained by adding together the three totals as below; \((5 + 233 + 75 = 313)\); the whole sample size.
3.3 Data collection

The primary data was obtained through key informants or other respondent interviews, survey questionnaires, waste generation survey and field observation. In this study a combination of all these methods was used to complement one another so that a comprehensive search.

3.3.1 Questionnaire survey

Questionnaire survey was used to get quantitative information on Healthcare waste management at CHUK. The questionnaires were based on the guidelines for the safe management of waste from CHUK and HCW management. The questionnaires consisted of three main parts: (1) General information (Management Issues e.g., knowledge, guidelines/instructions/policy, training, and equipment); (2) Characterization of the HCW production (e.g., composition of HCW, quantum of waste generated per day); (3) Characterization of the HCWM practices (e.g., segregation, handling, collection, packing, transport, treatment and disposal of HCW); (4) Risks of the current waste management system. The questionnaires were originally developed in English and translated into the Kinyarwanda language by the researcher, whose mother tongue is the Kinyarwanda language. After a pre-test at a hospital, additional modifications were made. A face-to-face interview using the questionnaires was conducted with HCW managers, administrators, medical doctors, nurses and HCW-handling workers.

3.3.2 Interview survey

To understand the overall situation on HCW management and to identify the detailed issues related to current HCW management in CHUK, the researcher undertook face-to-face interviews with Deputy of CHUK, Infection control officer, Incinerator operators, Head of service in charge of Hygiene and HCWM, Person responsible of HCSWM and incineration in Technical service, a truck driver engaged in transporting HCW to the final disposal off-site.
3.3.3 Observation and Photography

This method was used to get information on hospital waste management of CHUK, segregation, measuring and checking the composition of the collected wastes, treatment/disposal methods. Field observations were made at each unit in the hospital using a checklist, focusing on waste type posed by disposal of medical waste. Emphasis was placed on waste generation in the different hospital units and departments, disposal practices and waste treatment technologies used in CHUK, as well as difficulties related with waste management at site. Some photographs were taken to reinforce the findings. Some field notes were taken on site during observation and were analyzed to be used for documentation of this study.

3.4 Measuring health-care waste amount and waste composition

The quantity of HCW generated was calculated by estimating the number of containers (bags, rubbish bins) of segregated HCW taken to be treated and disposed of, and weighed them. The segregated HCW were collected in two categories: (1) Biodegradable waste (BW), (2) Non-Biodegradable waste (N-BW), considered as combustible waste. All bags containing Non-biodegradable waste / combustible waste such as, Infectious and Non-Infectious waste are brought to site incinerator, and weighed them before burning, using weighing machine. The amount of biodegradable waste was calculated by estimating the volumetric capacity of containers, in which they were disposed of. The Biodegradable waste was dumped in the municipal skip container with a volumetric capacity of 10m³, while the ash from Incinerator was set down in the Wheelie container with a volumetric capacity of 6m³. The HCW were weighed in four weeks i.e. 28 consecutive days at CHUK. The weight of the HCW was measured by using a digital scale: UNISCALE with a range of 136 kg (SECA, Germany). Manual separation was done to determine the waste composition. The researcher re-segregated the HCSW brought to be dumped in the skip container and to be incinerated, and manually separated them to determine its composition.
3.5 Data Analysis

The data obtained through key informants were treated as qualitative and were analyzed during data collection period. Data were analyzed with SPSS version 18.0 statistical software (SPSS). Student t-test and chi-squared tests were mainly applied to assess the data.

The outputs are descriptive statistical results such as frequencies, percentiles and correlation tables. Appropriate tests of significance performed to determine the relationship between socio-demographic variables and the variables related to knowledge and health worker awareness, and practice regarding management of Hospital waste.

3.6 Ethical Consideration

The hospital and the respondents were made aware of the fact that the research is purely an academic requirement and as such information gathered will be treated with strict confidentiality.

3.7 Limitations of the Study

The researcher had some constraints, with respect to the information received, in that some relevant information was not provided by respondents due to the sensitive nature of the topic. However, these limitations did not affect the findings of the research.
CHAPTER FOUR

PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

4.1 Repartition of Research respondents

Our research was concerned with 233 medical staff (Nurses, Paramedical staff) and 75 cleaners (waste collectors) working at University Teaching Hospital of Kigali. The figure 1 gives the number of participants of this study and the table 1 shows the reparation of respondents by considering their services or departments. This shows that the sample was mainly composed by medical staff with the proportion of 76% of the whole sample.

Fig 1: Sample repartition
The study revealed that the large number of CHUK Care workers interviewed is from the Internal medicine service. This is means that the most of data collected from this service had greatly influenced the findings of this research, while administrative service is the service less concerned with this study as it can be found in the results below.

**Table 1: Repartition of respondents per department**

<table>
<thead>
<tr>
<th>Departments</th>
<th>Hospital care workers</th>
<th>Medical Staff</th>
<th>Cleaners</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Emergency</td>
<td>20</td>
<td>6</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Anesthesia and Reanimation</td>
<td>4</td>
<td>4</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Private Clinic</td>
<td>10</td>
<td>5</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Internal Medicine</td>
<td>70</td>
<td>17</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>Pediatrics</td>
<td>21</td>
<td>6</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Ophthalmology</td>
<td>10</td>
<td>4</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Stomatology</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>ORL</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Kinesitherapy and Orthopedics</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Dermatology</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Surgery</td>
<td>32</td>
<td>6</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Gynecology-obstetrics</td>
<td>36</td>
<td>8</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Laboratory</td>
<td>13</td>
<td>4</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Radiology</td>
<td>4</td>
<td>2</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Pharmacy</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Administration</td>
<td>3</td>
<td>3</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>233</td>
<td>75</td>
<td>308</td>
<td></td>
</tr>
</tbody>
</table>
4.2 Characterization of the Health Care Solid Waste production at CHUK

4.2.1 Type and the composition of HCSW generated at CHUK

The research findings revealed that CHUK solid waste classification is based on Non-infectious waste and Infectious waste (Sharp and Non-Sharp waste) (figure 2). The great proportion of respondents (91%) reported that Non-infectious waste and Infectious waste are produced at CHUK, 6% of respondents reported infectious waste, while 3% of respondents reported Non-Infectious waste. This indicates that CHUK highly generated two types of HCSW such as Infectious waste and Non-Infectious waste, but some services produced one type of them. The figure 2 also shows that the two types of HCSW were mostly produced in almost all service at CHUK, which indicated the high category of HCSW to be mainly generated by the whole hospital.

Fig 2: Type of HealthCare Solid Waste generated at CHUK
CHUK is a large public referral hospital, in which almost all the ranges of medical activities are practiced (see the figure 3). The figure 3 indicates clearly the distribution of different types of HCSW per service and shows properly the generation of HCSW by type per service at CHUK. On the figure (3) below, we remarked that the Internal Medicine service is the first service generator of both types of HCSW i.e. Infectious waste and Non- infectious waste found at site, while the administrative service is the only service which produces the Non- Infectious waste, means that it is an outpatient service. The distribution of the types of HCSW per service is highly dependent on the type of medical specialty, and the number of service given in each department, but also depends on the number of patients.

Fig 3: HCSW type per department shown by respondents (%) at CHUK
Figure 4 depicts the repartition of Non-Sharp Infectious waste per department. The internal medicine department is the biggest generator of Non-Sharp (Infectious waste) as depicted in the figure (4), while the administrative service didn't produce any Non-Sharp Infectious Waste. The manual separation of HCSW done by researcher revealed that the composition of Non-Sharp Infectious Waste included dressing material, swabs, gauze, pus, bandages, stool napkins, gloves used for medical care or any other materials that were in contact with infectious agents or blood, culture dishes, plaster cast etc.; blood and body fluids waste (placentas, tissue etc.).

Fig 4: Non-Sharp Infectious Waste production per department shown by respondents (%).
Figure 5 indicates the Sharp Infectious waste production per departments. As shown in this chart, the great percentage of respondent (75%) mentioned that the administrative service didn't produce any sharp infectious Waste, while the internal medicine service mainly produces much this type of Sharp waste. The findings of this study shows that the composition of Sharp Infectious waste includes all types of needles, syringes, broken glassware, ampoules, scalpels, blades, lancets, vials.

Fig 5: Sharp Infectious Waste production per department as shown by Respondents (%)
The figure 6 gives the repartition of compostable waste per department. The 33% of respondents reported that the internal medicine highly produced this type of HCSW, while administration, ORL, Kinesitherapy and orthopedics services didn't produce compostable waste i.e. these service are outpatient services. This type of waste comprises for instance, leftover food or garden waste that can be composted.

Fig 6: Compostable waste per department as mentioned by respondents (%)

The figure 7 shows the distribution of the recyclable waste per departments. The percentages of respondents indicate that the all range of activities practiced and service given in CHUK generate this type of HCSW as shown in the chart below. The manual separation of HCSW done by researcher revealed that the composition of Recycle waste included paper, cardboard, non-contaminated plastic, plastic wrapping, cans that can be recycled.
4.2.2 Categories of Health Care Solid Waste generated at CHUK

Among all the types of HCSW produced in CHUK, the large public referral hospital, in which almost all the ranges of activities practiced, the two types of HCSW generated at this Hospital, are also put into two categories by considering its bio-characteristics and for easy collection: Biodegradable waste and Non Biodegradable. Figure 8 shows the percentages of respondents who mentioned the categories of HCSW produced in their respective services, where the 55.8% of respondents reported that they produced the both categories i.e. Biodegradable and Non biodegradable waste, whereas 44.2% reported to have only Non Biodegradable waste. This means that the Non Biodegradable waste was highly produced at CHUK.
4.2.3 Estimation of the HCSW quantities generated at CHUK

Figure 9 presents the average of the quantities of Non-Biodegradable waste incinerated during four weeks i.e. twenty eight days (Cf.Chapter3, Estimation Methodology). Results gave an overall average weight of 429 kg per day of Non-Biodegradable (combustible) waste generated at CHUK. As depicted in the figure 9, a lower weight of combustible waste being generated was 165 kg/day, whereas the maximum weight was 782 kg/day.
Average weight of waste produced by CHUK per day

Fig 9: Average weight of waste produced by CHUK per day

Above daily average weights could help to estimate the total average weight of Non-Biodegradable waste produced per year. The following calculations are the estimation of amounts of Non-Biodegradable waste production in year:

Estimation of amounts of Non-Biodegradable waste production in tones per year

429 kg of Non-Biodegradable waste = 1 day

365 days × 429 kg = 156,585 kg/year

1 kg = 0.001 ton (metric)

156,585 kg = (156,585 × 0.001) ÷ 1 kg = 156.585 tones/year of Non-Biodegradable waste.

Results gave an approximation weight of 157 tones/year of Non-Biodegradable waste.
Estimation of amounts of Biodegradable waste generated at CHUK

The amount of biodegradable waste was calculated by estimating the volumetric capacity of containers, in which they were disposed of. The Biodegradable waste was dumped in the municipal skip container installed by Kigali City Council with a volumetric capacity of 10m³, while the ash from Incinerator was set down in the Wheelie container with a volumetric capacity of 6m³.

The interview with HCW manager and observations revealed that this municipal skip container of Biodegradable waste (Non-Infectious waste) is evacuated by Kigali City Council, four times per month taken to Nyanza landfill for final disposal; this gives the total monthly estimation: 10 m³×4= 40m³. The plate 1 shows the municipal skip container (10m³) used for dumping Biodegradable waste from CHUK.

Plate 1: The municipal skip container used for dumping Biodegradable waste
The container of ash was evacuated also four times a week, this gives the following estimation: The volumetric capacity of wheel container used for ash dump is 6 m³.

Estimation of the volume of ash evacuated per month: \(4 \times 6 \text{ m}^3 = 24 \text{ m}^3\).

The total annual volume of Biodegradable waste taken to be disposed of to Nyanza landfill is \(40 \text{ m}^3 + 24 \text{ m}^3 = 64 \text{ m}^3/\text{month}\), which comes to \(64 \text{ m}^3 \times 12 \text{ months} = 768 \text{ m}^3/\text{year}\).

Plate 2 shows the wheelie container used for the salvage of ash from incinerator. It indicates that the ash dump container was irregularly discharged, as it was overfilled. The interview with the HCW manager and Incinerator operator revealed that the cause of this irregularity was the lack of specific budget for HCWM, along with the lack of off-site transportation payment of HCW. They mentioned that this wheelie container should be usually conveyed once a week, to be discharged to Nyanza dumpsite.

**Plate 2: Wheeled-container used for the salvage of ash from incinerator**
**Waste production**

Hospital waste may be classified into different types according to the source, type and risk factors associated with their handling, storage and ultimate disposal. The European Union has been making a special effort to standardize waste classification through the establishment of the Waste European Catalogue (Alvim-Ferraz and Monso, 2005). This includes both infectious waste and non-infectious waste materials. The research findings revealed that CHUK solid waste classification is based on Non-infectious waste and Infectious waste (Sharp and Non-Sharp) (Figure2).

According to World Health Organization (WHO) (BAN&HCWH, 1999) approximately 85% or hospital wastes are actually non-hazardous, 10% are infectious, and around 5% are non-infectious but hazardous. In the US for example, about 15% of hospital waste are regulated as infectious waste. Given that 91% respondents mentioned that CHUK produced Infectious waste (Sharp & Non-Sharp) and Non-Infectious waste, it is clear that CHUK highly generated two types of HCSW so that the great percentage might be Non-infectious waste concerning WHO study results. The internal medicine and gynecology-obstetrics departments were the largest producers of both healthcare wastes. This might be because most patients visiting those departments are receiving treatment services. As a result, higher generation of waste requires special treatment at all stages, starting from patients and ending at the disposal site (WHO, 1999).

In this study it has been found that the two types of HCSW generated at this Hospital, have been categorized into two classes by considering its bio-characteristics; Biodegradable waste and Non Biodegradable for easy collection for treatments. It was discussed that the landfill was the best treatment used for biodegradable solid waste and slurry disposal (Hamer, 2003).
However, during our interview with waste management staff in the hospital, they could not tell the amount of waste generated in the hospital daily. They could not also provide information with respect to which departments generate the highest and lowest amounts of medical waste in the hospital. Our study showed that there is a high proportion clinical waste at CHUK level, which is compatible with previous studies (Kuroiwa et al. 2004, Da Silva et al. 2005). Results gave an overall average weight of 429 kg per day of Non-Biodegradable (combustible) waste generated at CHUK. This might be because most patients visiting CHUK are receiving treatment rather than consultation. Results gave an approximation weight of 157 tones of Non-Biodegradable waste in a year and the total annual volume of Biodegradable waste of 768 m³.

The amount of waste generated in hospitals depends upon various factors such as number of beds, types of health services provided, economic, social and cultural status of the patients and the general condition of the area where the hospital is situated. For example, in hospitals located in low socioeconomic areas of the cities, most of the waste consists of residues from fruits which are voluminous and abundant, whereas in those located in high socioeconomic areas of the city; most of wastess contain flowers, cans and single use containers for food (Askarian et al., 2004). So far, studies have focused on measurement of HCW amount by `kg/bed per day (Korowai et al. 2004, Da Silva et al. 2005).

4.3 Legislative, policy and regulatory aspects at CHUK

4.3.1 Review of existing HCWM materials at CHUK

There is no clear policy and plan in place for managing medical waste at CHUK. There is no definite policy or plan for purchasing the necessary equipment and for providing the facilities for the correct management of medical waste in the hospital. The hospital has a medical waste management guideline prepared by the head of infection control but this is not strictly followed.
There are still areas where medical wastes are not managed properly at the hospital. The hospital does not have a regular report about how medical waste management is practiced and the process of performing respective studies is also not reported. The hospital provided HCW management training and protective gear to all personnel who were engaged in HCW management, and HCWM procedures were explained to all the workers at CHUK. The cleaning and waste collection activities were in hands of private company (K.G HARVEST), under the supervisor of CHUK.

The findings of this study indicated that HCWM at CHUK, is organized according to specific schemes but there are no explicit rules consigned in a single document providing adequate instructions regarding the management of the HCW within the facility. Nobody is formally nominated to supervise the whole HCWM system or coordinate the efforts between all actors within the hospital. The interview however revealed that CHUK has never carried out a waste management audit. This engenders an obvious lack of efficiency and harmonization in the HCWM procedures.

Our study showed that there was no clear policy and plan in place for managing hospital waste CHUK. There was no definite policy or plan for purchasing the necessary equipment and for providing the facilities for the correct management of medical waste in the hospital. The hospital had a medical waste management guideline prepared by the head of infection control but this is not strictly followed. The hospital did not have a regular report about how medical waste management is practiced and the process of performing respective studies is also not reported. On the contrary, in developed countries, definite rules and regulations exist at the national, regional and hospital levels. For example, in the University Hospital of Freiburg, Germany, there are almost 36 rules at the national level, five rules at the regional level, and 13 rules at hospital level, resulting in a total of 54 rules for the correct hospital waste management (Daschner, 2000).
The 1992 Earth Summit called for action to establish national policy, the development of national guidelines and a training program for HCW management in all countries in the world (UNCED 1992). There is an urgent need to establish such a policy as well as regulation, especially for a country such as Rwanda which has a limited budget to enforce and ensure the introduction of a minimum level of HCW management activities, and incinerator installation at health-care facilities so as to meet the WHO conditions.

### 4.3.2 CURRENT HCWM Policy status at CHUK

#### 4.3.2.1 Training and Knowledge on HCWM

The proportions of respondents who had received training on HCWM were 94% (289/308), whereas 6% (19/308) didn’t at CHUK. Sixty nine percent (212/308) had sufficient knowledge and received training on how to deal with HCW at CHUK, Trained-Medium knowledge were 23% (70/308), Trained-Low Knowledge were 2% (6/308), whereas Not Trained-Medium Knowledge were 2.5% (8/308), and Not Trained-Low Knowledge were 3.5% (11/308) (table 2).

**Table 2: Training and Knowledge on HCWM**

<table>
<thead>
<tr>
<th>Training</th>
<th>Knowledge on HCWM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Good</td>
</tr>
<tr>
<td>Yes</td>
<td>212</td>
</tr>
<tr>
<td>Non</td>
<td>8</td>
</tr>
</tbody>
</table>

In regard to the results above and discussions with CHUK officers revealed that almost all the Hospital care workers only received the training on Infection control and HCWM about one year ago, to minimize risk associated with Hospital care activities.
The results indicated that the great number of respondents who were trained, had also good knowledge on HCWM. This means that the provision of training had increased the knowledge of hospital care workers on how to deal with HCW. These proportions also revealed that there is a significant relation between the knowledge and the fact of being trained ($C = 0.513, p < 0.05$).

**Table 3: Relationship between Knowledge and Training**

<table>
<thead>
<tr>
<th>Nominal by Nominal</th>
<th>Contingency Coefficient</th>
<th>Approx. Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>N of Valid Cases</td>
<td>Value</td>
<td>Approx. Sig.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>.513</td>
</tr>
</tbody>
</table>

The data from the present study revealed that training had increased the knowledge of hospital care workers on how to deal with Hospital waste. The hospital does not provide training for doctors and other personnel about hospital waste management and their potential hazards. Insufficient and irregular training in the hospital with respect to waste management poses serious risks to the personnel as far as the hazards of hospital waste is concerned. To improve knowledge further training by using manuals is also urgently needed. In developed countries, training programs and educational classes are instituted repeatedly for all personnel and the content of these programs are specifically designed for different personnel.

In the USA, part 1910, 1030 are related to Occupational Health and Welfare (29 CFR part 1910, 1030 OSHA) and regulates the training needs for different personnel who are employed in centers where hospital waste production occurs (Department of Environmental Conservation, NY State, 1996).
4.3.2.2 Availability of documents on HCWM at CHUK

According to the results from the survey, only 7% (22/308) of respondents reported that they had seen document or instructive posters on HCWM at work place, while 93% said that they have not seen any (Table 4).

**Table 4: Documents on HCWM and Knowledge on HCWM**

<table>
<thead>
<tr>
<th>Knowledge on HCWM</th>
<th>Documents On HCWM</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>On HCWM Non</td>
<td>286</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>308</td>
</tr>
</tbody>
</table>

The comparison was made to assess whether the absence of documents on HCWM at work place, had affected the knowledge of CHUK care workers. The results indicated that the lack of documents on HCWM had never a significant influence on the knowledge of CHUK Care workers (C=0.069, p=0.479).

**Table 5: Relationship between Documents and Knowledge**

<table>
<thead>
<tr>
<th>N of Valid Cases</th>
<th>Contingency Coefficient</th>
<th>Value</th>
<th>Approx. Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>308</td>
<td>0.069</td>
<td>.479</td>
<td></td>
</tr>
</tbody>
</table>

This study disagrees with the findings of Akter et al. (1999) which indicate that the lack of a HCW management documents seems to affect the low knowledge and awareness on HCW management and Askarian et al., (2004) who reported that it leads to no attempts at segregation.
The results of this study also revealed that there was the significant difference in responding, who is the responsible of HCW segregation \((x^2=6.254, df=1, p=0.012)\).

**Table 6: Responsible of HCSW segregation**

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
<th>Exact Sig. (2-sided)</th>
<th>Exact Sig. (1-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>6.254</td>
<td>1</td>
<td>.012</td>
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<td></td>
</tr>
<tr>
<td>Continuity Correction</td>
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<td>.094</td>
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<td></td>
</tr>
<tr>
<td>Likelihood Ratio</td>
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<td>1</td>
<td>.017</td>
<td></td>
<td>.059</td>
</tr>
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<td>Fisher’s Exact Test</td>
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<td>.059</td>
<td>.059</td>
</tr>
<tr>
<td>Linear-by-Linear Association</td>
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<td>1</td>
<td>.013</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>308</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Computed only for a 2x2 table
b. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .49.

**Provision of Protective equipments**

All interviewees of this study (100%) reported that they have been supplied the protective equipments against potential risks linked with HCWM, including masks and gloves and boots and a uniform or aprons. Figure below (10) indicates that the 84% (195/233) of Medical staff during the study time wore gloves and aprons, and 16% (38/233) wore masks, gloves and aprons. Moreover, 61% (46/75) of waste collectors (cleaners) wore gloves and a uniform, 27% (20/57) wore masks, gloves, a uniform and boots, 11% (8/75) wore a uniform and boots, and only 1% (1/75) wore mask, gloves and a uniform. Survey had indicated that the most CHUK care workers didn’t wear masks during the daily activities; the great percentage was familiar with gloves and uniform or aprons. It was observed that there were no provision of masks and specific shoes (sandals & boots) to medical staff, except in the special service such as from operation theatre and gynecology-obstetrics service. The waste collectors were observed to wear uniform, gloves and boots while cleaning.
It is important to note that the lack of suitable and sufficient protective equipment, the lack of knowledge regarding the correct usage of equipment and the lack of pertinent understanding of the personnel regarding the benefits of using protective equipment exposes personnel to serious potential health effects include infections, respiratory infections, etc. (WHO, 2005).

4.4 Characterization of the HCSWM Practices at CHUK

4.4.1 Segregation, Packaging, color coding and labeling

In the researched Hospital (CHUK), all interviewees (100%) reported that there was an attempt to segregate the HCSW generated at the source (i.e. in the wards themselves) and, in general, the medical staffs are in charge of this duty. The survey revealed that the patients and people who visit the hospital are informed by labels with different color where to throw their trash.
In few wards, improper segregation by nurses had been observed during the survey. This practice should be avoided to minimize the risks with injuries and risks of infection to waste handlers. Figure 11 shows the type of containers used by Medical staff and cleaners/waste collectors for segregation, collection and packing of waste. Results indicate that the all the medical staff used the colored polythene bag onto buckets for HCW segregation (see Plate 3), whereas the cleaners used the colored polythene bag onto plastic container for HCW collection (plate 5).

![Bar chart showing the percentage of response for Medical staff and Cleaners regarding the type of containers used for HCSW segregation and packaging.](image)

**Fig 11: Type of containers used for HCSW segregation and packaging**

The wastes produced within the hospital are generally segregated according to color coding system of CHUK. Table 8 shows that the red polythene bags onto bucket are provided in the hospital for Non-sharp infectious waste segregation, whereas this type of waste was collected in the yellow polythene bag onto plastic container (Wheelie plastic bins) by cleaners (see Plate 5).
Table 7: HCSW Segregation policy at CHUK

<table>
<thead>
<tr>
<th>Hospital Care workers</th>
<th>Non-Sharp Infectious waste</th>
<th>Red polythene Bag</th>
<th>Yellow Polythene bag</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital Medical staff</td>
<td>4</td>
<td>229</td>
<td></td>
<td>233</td>
</tr>
<tr>
<td>Hospital Cleaners</td>
<td>3</td>
<td></td>
<td>72</td>
<td>75</td>
</tr>
<tr>
<td>Total</td>
<td>7</td>
<td>229</td>
<td>72</td>
<td>308</td>
</tr>
</tbody>
</table>

The data analysis revealed that there is a significant difference in using red and yellow bags by Medical Staff and Cleaners (p<0.05).

Table 8: segregation policy and collection policy

<table>
<thead>
<tr>
<th>Chi-Square Tests</th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>298.694</td>
<td>2</td>
<td>.000</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>332.374</td>
<td>2</td>
<td>.000</td>
</tr>
<tr>
<td>Linear-by-Linear Association</td>
<td>234.338</td>
<td>1</td>
<td>.000</td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>308</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The survey found that within the hospital wards and departments the sharp waste was segregated and collected in cardboard sharps boxes. The figure 12 shows that the almost all respondents of this study mentioned that there was an attempt to segregate and collect the Sharp waste in colored cardboard safety boxes. These Sharps boxes are labeled with biohazard sign.
Fig 12: Sharp waste segregation policy at CHUK

The following plate shows the HCW segregation containers used in the different wards and departments at CHUK. It was found that the infectious waste was segregated in the plastic buckets lined with a red polythene bag, not labeled, whereas the all sharp waste are segregated in the well-labeled white cardboard safety box (Plate 3).

Plate 3: HCW containers and cardboard safety box used in different wards
The domestic (Biodegradable) waste are segregated and packaged in the black polythene bag onto plastic wheelie containers, as mentioned by almost all respondents (see table 9 & plate 5).

**Table 9: Domestic waste segregation policy as mentioned by respondents**

<table>
<thead>
<tr>
<th></th>
<th>Domestic Waste (Biodegradable)</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None</td>
<td>Polythene bag</td>
<td>Total</td>
</tr>
<tr>
<td>Hospital Workers</td>
<td>107</td>
<td>126</td>
<td>233</td>
</tr>
<tr>
<td>Medical staff</td>
<td>26</td>
<td>49</td>
<td>75</td>
</tr>
<tr>
<td>Cleaners</td>
<td>133</td>
<td>175</td>
<td>308</td>
</tr>
</tbody>
</table>

Figure 13 shows the number of respondents who mentioned that the transparent polythene bags are suggested for recyclable waste segregation at CHUK.

![Fig 13: Recyclable waste segregation policy at CHUK](image-url)

45
The data analysis and observations of a survey revealed that the recyclable waste (paper, wrappers etc) are segregated in the transparent polythene bag onto plastic bucket. Although plastic bottles are seen to be collected by a private solid waste company (COPED), this recycles plastic materials (Plate 4).

Plate 4: Recycle bins used for recyclable waste in the wards at CHUK

WHO proposed that the segregation must be done at the point of waste generation. To encourage segregation at source, (reusable) containers or baskets with liners of the correct size and thickness must be placed as close to the point of generation as possible (WHO, 2000). The wastes produced within the hospital are generally segregated according to color coding system of CHUK. The survey indicated that the all the medical staff used the colored polythene bag onto buckets for HCW segregation, whereas the cleaners used the colored polythene bag onto plastic container for HCW collection.

According to the proposal by WHO, hospitals have to provide plastic bags and strong plastic containers for infectious waste such as empty containers of antiseptics used in the hospital. Bags and containers for infectious waste should be marked with Biohazard symbol (Prüss et al., 1999). During our interview it was revealed that segregation of medical wastes into infectious medical waste and noninfectious medical waste is not conducted according to definite rules and standards.
4.4.2 Collection, On-Site Transportation and Storage

The interviews with cleaners and observations revealed that HCSW from CHUK are collected by providing the dustbins for Biodegradable and Non-biodegradable. All Non-Biodegradable waste also considered as Combustible waste are to be collected together in the yellow polythene bags onto plastic wheelie bins (see table 8 above), and the Biodegradable waste (i.e. domestic waste) are collected in black polythene bags onto plastic Wheelie bins (see table 10 above) at a fixed point out source. According to the proposal by WHO (2004), In order to avoid both the accumulation and decomposition of the waste, it must be collected on a regular daily basis to the area where the larger containers are kept before removal to the central storage area. The cleaners are responsible of HCSW collection and its on-site transportation. The following plate 5 shows the Plastic wheelie bins used for the collection of HCSW from generation point.

Plate 5: Wheelie bins (15kg) used for collection of HCSW at CHUK
Figure 14 shows the means used by the cleaners to collect and transport the solid waste to the treatment and disposal point. Forty seven percent (47%) of cleaners indicated that the bags containing wastes from different parts of the hospital are brought to the site by wheelbarrow, 1% of cleaners reported that they used wheelie bins for on-site transportation, 52% of cleaners reported that they manually transport the segregated waste from generation point to disposal place, on a daily basis.

Transportation to the central storage area is usually performed by using a wheelie bin or trolley. Wheelie bins or trolley should be easy to load and unload, have no sharp edges that could damage waste bags or containers and they should be easy to clean. Ideally, they should be marked with the corresponding coding color (WHO, 2004).

![Graph showing transportation methods of HCSW at CHUK](image)

**Fig 14: On-site transportation methods of HCSW at CHUK**

We didn’t observe any significant difference of manual collection waste between the group of cleaners who use gloves and the group of cleaners who don’t use gloves ($x^2=0.471$, df=2, p=0.79). We’re expecting a significant proportion of manual collection in the group of cleaners who use gloves.
Table 10: Protective gear and On-site transportation

<table>
<thead>
<tr>
<th>Chi-Square Tests</th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>.471a</td>
<td>2</td>
<td>.790</td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>.577</td>
<td>2</td>
<td>.749</td>
</tr>
<tr>
<td>Linear-by-Linear Association</td>
<td>.198</td>
<td>1</td>
<td>.657</td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>75</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .11.

Biodegradable waste bags (black) are collected in municipal skip waste container (see plate 1) which when overfilled (once a week) is transported to Nyanza landfill, and all Non-Biodegradable waste bags (Yellow) are taken to Incinerator house. The following figures indicate the means used to load the HCSW from the generation point to disposal place at CHUK. The bags are not secured or labeled with the site of generation. The findings and observations revealed that there was no specific HCSW collection point or central storage within CHUK.

Plate 6: Means of collection and on-site transportation of HCSW at CHUK
It was observed that the storage may last up to weeks before the waste is disposed of, which leads to leakages from the skip container and sometimes strong putrefaction odors, and the waste is not protected from the effects of the weather (sun, rain) and scavenging by animals (cats, birds, flies) (see plate 1 & plate 2). This does not match to the proposal by (WHO, 2004), Storage time should not exceed than 24-48 hours especially in countries that have a warm and humid climate (WHO, 2004).

4.4.3 Off-Site Transportation

At CHUK, it was observed that Biodegradable waste was dumped in the municipal skip container, which is removed only when they are full or when the hospital administration requests it be done (once a week) to Nyanza dumpsite. The off-site transportation was organized by a private conveyor jointly mandated by Kigali City Council and CHUK. The interviews with HCW manager and a truck driver engaged in transporting HCW to the final disposal off-site revealed that the truck used for transport of Biodegradable waste was only provided for this purpose. The vehicle didn’t carry a consignment note from the point of collection. The findings of this research agree with Johannessen et al. (2000) who recommend that transportation of medical waste on public roads must be carried out by trained staff in a dedicated vehicle with closed containers.

4.4.4 Options available for Treatment and Disposal of HSCW at CHUK

Pre-treatment

The survey has indicated that 5% (11/233) of medical staff from different service reported that they did pre-treatment (sterilization) of waste in their respective place, 10% (24/233) of medical staff responded that the patient care items are sterilized by autoclaving in Pre-vacuum sterilizers in a sterile supply unit, and 85% (198/233) reported that they didn’t do pre-treatment in their service.
It was found that the pre-treatment system was used in the technical services include surgery, laboratory, and gynecology-obstetrics. All respondents from laboratory and a great proportion of interviewees from surgery, especially operation theatre revealed that they use sterilization and autoclaving as pre-treatment method (Fig. 15).

![Waste pre-treatment](image)

**Figure 15: Pre-treatment practices per service at CHUK**

The majority of the studied health-care facilities adopted dumping and open burning at the facility premises. These disposal methods may jeopardize the health of people living near the facilities, as has been reported (Kuroiwa *et al.* 2004). If the HCW is dumped without preliminary treatment and imperfectly burned then it may still contain potentially harmful microorganisms (Akter *et al.* 2002). This is the case of CHUK where this study indicated that 85% of respondents reported that their service didn’t provide any preliminary treatment to HCW generated. Only 15% of respondents said that HCW were pretreated before being dumped. This means that there are strong possibilities that CHUK people will be at risk of being infected or injured.
Treatment and final disposal

The questionnaire survey revealed that there are two treatment and disposal options for treated HCW (see table 11); the incineration was the main method for the on-site treatment of medical waste especially non-infectious, infectious and sharp wastes, and off-site landfill is the remaining option for treatment of domestic waste.

Table 11: Hospital Care Workers * HCW Treatment

<table>
<thead>
<tr>
<th></th>
<th>On-site</th>
<th>Off-site</th>
<th>Both</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hospital Care Workers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical staff</td>
<td>115</td>
<td>22</td>
<td>96</td>
<td>233</td>
</tr>
<tr>
<td>Cleaners</td>
<td>20</td>
<td>13</td>
<td>42</td>
<td>75</td>
</tr>
<tr>
<td>Total</td>
<td>135</td>
<td>35</td>
<td>138</td>
<td>308</td>
</tr>
</tbody>
</table>

Figure 16 shows that 84.7% of respondents indicated that the medical waste were dispatched to be incinerated, and 15.35% of interviewees reported that incineration and off-site landfill were used for final disposal of HCW at CHUK.

Fig 16: Treatment and final disposal methods of HCSW at CHUK
The interviews with incinerator operators, HCW manager and observations revealed that the incineration have been the on-site treatment technologies chosen in CHUK. A pyrolytic double chamber incinerator fired by light diesel oil has been installed in the CHUK premises; it reaches temperatures of 1200°C or more. Plate 7 shows the type of incinerator within CHUK.

Plate 7: Incinerator at University Teaching Hospital of Kigali (CHUK)

It was observed that there are no pollution control devices and the stack height is low about two meters only. There is a system of recording or weighting the waste bags before being burned. This incinerator has a capacity of burning 4m³ of waste per day.

The findings from one study (Akter et. al., 1999) were as follows: A variety of methods were used by the medical facilities to dispose of waste. These included burning, burial, selling, dumping, reuse and removal by municipal bins. The results showed that 84.7% of respondents indicated that the medical waste were dispatched to be incinerated (burning) i.e. the incineration have been the on-site treatment technologies chosen in CHUK, and 15.35% of interviewees reported that incineration and off-site dumpsite were used for final disposal of HCW at CHUK.
All Non-Biodegradable (combustible) waste was transported to incinerator area, to be burned. Biodegradable waste was transported to off-site area (Nyanza dumpsite) for final disposal. This study agrees with the findings of Diaz et al. (2005) arguing that the most common treatment and disposal methods utilized in the management of infectious hospital wastes in developing countries to include autoclaves; microwave disinfection systems; chemical disinfections; combustion (incineration); and disposal on land.

**Incineration**

According to the study findings, the incineration have been the on-site treatment technologies chosen in CHUK. This reinforce the proposal by WHO (2004) stated that the advantages of providing each health-care establishment with an on-site treatment facility includes convenience and minimization of risks to public health and the environment by confinement of hazardous HCW to the health-care premises.

Diaz et al, 2003 defined the incineration as one of the only technologies that can treat all types of HCW properly and has the advantage of reducing significantly the volume and weight of the waste treated. Incinerators nevertheless require skilled operators, extensive flue gas emission control systems and, frequently, imported spare parts. Incineration generates ash residues and air emissions can contain pollutants such as dioxins and heavy metals. Contrary to Diaz et al, 2003 view, the study findings indicated that incinerator installed in the CHUK had been operated by unskilled workers (see plate 9) and has no strong control of the air-stack emissions (filter) and the stack height is low about two meters only (see plate 8). These installations may nevertheless constitute a serious air pollution hazard to the surrounding area due to the lack of emission control systems (Prüss et al., 1999).
The findings of this study revealed that the incinerator installed at CHUK, was pyrolytic double chamber incinerator fired by light diesel oil; it reaches medium temperature combustion process (800-900°C), producing solid ashes and gases, which has 2 x 80 kg/hour represents a capacity of 800 kg/day if it is used 5 hours a day on average. The incinerator may be operated in batch or continuous modes (Diaz et al, 2003).

4.5 Environmental problems associated with the current HCWM at CHUK

A comparative data analysis revealed that 71% (218/308) reported that they didn't have concerns about the current HCWM, 22% (69/308) of respondents reported the injuries during their daily activity, and it was found that those injuries were accidents, even if they were protected and all of them faced the infectious waste, so that they could be potentially at risk. Many injuries occur because syringe needles or other sharps have not been properly segregated and collected in safety boxes. 1% (3/308) of respondents had declared sickness due to bad odors, but also not wearing masks during work activity. Five percent (14/308) reported the insufficient equipment.

It was observed that the bins used at CHUK were insufficient and inappropriate as also respondents mentioned (1%) (See plate 3 & 4). Bins used to store HCW in CHUK are of not good condition (open buckets); they must have an opening from the front (in addition to the top one) or pedal bins to avoid exposing workers and patients to danger while unloading the bags from the bottom of the bins. The main environmental problems are presented in Table 12.
Table 12: Protective Gears*Types of HCW*Hospital staff*Potential problems

<table>
<thead>
<tr>
<th>Potential problems</th>
<th>Hospital staff</th>
<th>Types of HCW</th>
<th>Non-INF W</th>
<th>INF W</th>
<th>Both</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non potential Problem</td>
<td>Medical staff</td>
<td>Gloves, apron &amp; boots</td>
<td>4</td>
<td>140</td>
<td>16</td>
<td>160</td>
</tr>
<tr>
<td>Cleaners</td>
<td></td>
<td>Masks, gloves &amp; apron</td>
<td>1</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Apron &amp; boots</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>4</td>
<td>8</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Injuries</td>
<td>Medical staff</td>
<td>Gloves, apron &amp; boots</td>
<td>8</td>
<td>16</td>
<td>8</td>
<td>59</td>
</tr>
<tr>
<td>Cleaners</td>
<td></td>
<td>Masks, gloves &amp; apron</td>
<td>8</td>
<td>43</td>
<td>3</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Apron &amp; boots</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Sickness</td>
<td>Cleaners</td>
<td>Gloves, apron &amp; boots</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Insufficient equipments</td>
<td>Medical staff</td>
<td>Apron &amp; boots</td>
<td>1</td>
<td>6</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Others</td>
<td>Cleaners</td>
<td>Gloves, apron &amp; boots</td>
<td>1</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Apron &amp; boots</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>4</td>
</tr>
</tbody>
</table>

The great proportion of respondents who reported injuries were from internal medicine, surgery and gynecology-obstetrics service. Observation revealed that these services had the big number of patients and generated a high category of Infectious sharp waste, which may puncture the bags/containers and expose the workers to injury and infection risk (wrong practices). Laboratory service was observed to have a good condition of HCWM, but also most of interviewees from this service indicated that there were insufficient equipments. Figure 17 shows the main environmental problems facing different services in CHUK.
Almost 85% of sharp injuries are caused between their usage and subsequent disposal. More than 20% of those who handle them encounter 'stick' injuries. During research time, it was observed that the current incineration practices were inappropriate. Observations revealed that CHUK incinerator had no pollution control devices (filters) and the stack height is low (less than 2 meters), and release important quantities of smokes (toxic gases) into atmosphere (see plate 8).
The gases emission and ash from incinerator contain high levels of toxic substances such as heavy metals, dioxins and furans that constitute an environmental health threat. If no proper filtering is done, air can also be polluted causing illnesses to the nearby populations. Incinerator ashes are observed to be poorly disposed of, and were not covered with impermeable cover that may cause leachate to contaminate groundwater (see plate 2).

Plate 8: Toxic gases emission from incinerator at CHUK

One of incinerator’s operators was observed to be improperly protected during incineration that might cause acute effects such as eyes and respiratory irritation or others illness to him. The following plate 9 shows the improper incineration practices observed at CHUK.
Injuries and accidents

Exposure to medical waste can result in disease or injury. According to WHO (1999), all individuals specifically the health care staff (e.g., doctors, nurses, laboratory technicians, and waste handlers), exposed to medical waste, are potentially at risk. The study findings indicated that 22% (69/308) of respondents reported the injuries during their daily activity, and it was found that those injuries were accidents, even if they were protected and all of them faced the infectious waste, so that they could be potentially at risk (Table 8). Almost 85% of sharp injuries are caused between their usage and subsequent segregation; this was encountered to medical staff.
More than 15% of those who handle them encounter ‘stick’ injuries (Cleaners). This is in contention with Akter et al. (1998), who pointed that Medical sharp wastes therefore pose a risk of injuries to nurses and/or cleaners, communities, and the environment if not carefully handled. There is strong epidemiological evidence, that the main concern of infectious hospitals waste is the transmission of AIDS/HIV viruses and, more often, of hepatitis B virus (HBV) through the injuries caused by syringe needles contaminated by human blood, (WHO, 1999). It was found in this study that only one person (nurse) has been infected by stick injuries and had serious sickness due to HIV/AIDS and hepatitis B and C vaccine injection after being injured.

**Inappropriate practices**

According to the study findings five percent reported the insufficient equipment. It was observed that the bins used at CHUK were insufficient and inappropriate as also respondents mentioned (1%) (See plate 3 & plate 4). Bins used to store HCW in CHUK are of not good condition (open buckets); they must have an opening from the front (in addition to the top one) or pedal bins to avoid exposing workers and patients to danger while unloading the bags from the bottom of the bins. This might be evidenced by 1% of respondents who had declared sickness due to bad odors and smell. The findings of one study pointed that the improper waste management will cause environmental pollution; unpleasant smell; and growth and multiplication of insects, rodents and worms, and may lead to transmission of diseases like typhoid, cholera, and hepatitis through injuries from sharps contaminated with human blood. The management of the medical waste is an emerging issue that is magnified by lack of training, awareness, and financial resources to support solutions. The proper collection and disposal of this waste is of great importance as it can directly and indirectly impact the health risks to both public health and the environment (Baraka et al., 2006; Abdulla, et al., 2008).
Risks associated with incineration

Despite the fact that the incineration is one of the only high technologies that can treat all types of HCW properly and has the advantage of reducing significantly the volume and weight of the waste treated. This treatment system can cause much concern. Some studies (Groundwork, 2002), have pointed out that incinerators have been associated with a wide variety of health problems in South Africa, such as disrupting the bodies hormonal, immune and reproductive systems, and even caused cancers.

During research time, it was observed that the current incineration practices were inappropriate. CHUK incinerator had no pollution control devices (filters) and the stack height is low (less than 2 meters), and release important quantities of smokes (toxic gases) or air pollutants (PCI, heavy metals, etc...) that constitute an environmental health threat (see Plate 8). These gases emission and ash from incinerator contain high levels of toxic substances such as heavy metals, dioxins and furans that constitute an environmental health threat. If no proper filtering is done, air can also be polluted causing illnesses to the nearby populations (Diaz et al, 2003).

During the study, incinerator ashes are observed to be poorly disposed of, dumped in wheeled containers which were overfilled and not covered with impermeable cover. According to the United States Environmental Protection Agency (EPA), the ash from incinerator consists of both fly ash and bottom ash (Plate 2). The ash contains high levels of toxic substances such as heavy metals, dioxins and furans.

This incinerator ash are potentially capable of causing disease and illness in human, either through direct contact or indirectly by contamination of soil, groundwater, surface water and air. Windblown ash from these dumps also has the potential to carry pathogens and hazardous materials. Incinerator ash therefore poses a risk to communities, and the environment if not carefully disposed of (Akter et al, 1998).
CHAPTER FIVE

FINDINGS, CONCLUSION AND RECOMMENDATIONS

In this final chapter, the important points emerging from the results of the study are summarized. Conclusions from the study are based on the findings of the study. Valid suggestions and recommendations in line with the objectives of the thesis have been made. This chapter also provides directions for future research in the area.

5.1. FINDINGS

This study examined the Hospital Solid Waste management systems and practices at University Teaching Hospital of Kigali (CHUK). The specific objectives of the study were to: 1) to determine the characterization of HealthCare Solid Waste production at CHUK; 2) To establish the HCWM guidelines, policy and regulatory systems that exist at CHUK; 3) To determine the waste management systems and practices that exist at CHUK; 4) To assess the environmental problems associated with the current HCWM at CHUK.

The researcher made frequent visits to the hospital, taking note of how Hospital Solid waste is managed. Regular visits were made to general medical wards, maternity wards, surgical and critical care wards, operating theatres, and orthopaedic sections. The researcher also made use of both primary and secondary data. Secondary data was obtained from the hospital's documents. Information was also obtained from published and unpublished books, journals, newsletters, periodicals, articles and the Internet. Primary data was collected from questionnaire administration and interviews with authorities of the hospital, health workers and personnel in charge of infection control and waste management at the hospital.
Analyses of data were performed by the use of Statistical Package for Social Science (SPSS) version 18.0 Descriptive statistics such as means and ranges have been computed. Appropriate tests of significance performed to determine the relationship between socio-demographic variables and the variables related to documents, knowledge and health workers training, and practice regarding management of medical waste. The discussions were based on what exist in the hospital in terms of Hospital waste management Vis a Vis recommended practice.

The study revealed that both general and medical wastes are generated in the hospital. Hospital waste is generated from medical practice such as therapeutic procedures like cobalt therapy, chemotherapy, dialysis, surgery, and delivery, resection of gangrenous organs, autopsy, biopsy, para-clinical exams, and injections among others. CHUK Hospital does not regularly quantify Hospital waste, as we could not obtain information on the amount of waste generated in the hospital daily. They could also not tell which departments generate the highest and lowest amounts of medical waste in the hospital, but the results of this study indicated that Internal medicine department generates the high amounts of HCW in the CHUK. Segregation of Hospital wastes into infectious medical waste and non-infectious medical waste is not conducted according to definite rules and standards. The hospital does not label infectious waste with Biohazard symbol. Separation of medical waste and general waste is practiced to a satisfactory extent though. Manual transport method and wheelbarrows are used for on-site transport of waste from the sites of production (different wards) to the treatment area.

The staff employed for handling waste in the hospital use almost incomplete personal protective equipment, such as overall gowns, protective boots and gloves. Survey had indicated that the most CHUK care workers didn’t wear masks during the daily activities; the great percentage was familiar with gloves and uniform or aprons. The waste collectors were observed to wear uniform, gloves and boots while cleaning.
The results of this study indicated that off-site transport of the hospital waste is undertaken by a private waste management company, which transports waste daily. Small pickups are mainly used by the waste management company for transporting the waste to an off-site area for treatment and disposal. The final disposal of the medical waste is thus the responsibility of the private waste management company. The main treatment method used in the final disposal of infectious waste is incineration. Non-infectious waste is disposed of using land disposal method. The hospital does not recycle medical waste materials except plastic bottles are seen to be collected separately, it was informed that these are collected by a private solid waste company (COPED), which recycles plastic materials. The hospital provides training for their personnel about Hospital waste management and their potential hazards. Staff members are not given training on the health and environmental effects of infectious waste annually. CHUK does not provide continued formal training with regards to hospital waste management and Hospital care workers are consequently unaware of the environmental health impacts of medical waste.

The study showed that CHUK does not have any policy and plan in place for managing medical waste. There is no definite policy or plan for purchasing the necessary equipment and for providing the facilities for the correct management of HCW in the hospital. There are also no policies and guidelines regarding the recycling of HCW products. The main problems confronting the hospital with respect to the management of hospital waste include: lack of necessary rules, regulations and instructions on the different aspects of collection and disposal of waste, intermingling of hazardous wastes with domestic waste of the hospital sometimes, failure to quantify and measure the waste generated in reliable records, lack of use of colored bags thereby limiting the bags to only two colors for all waste, the absence of a dedicated waste manager, the absence of a committee responsible for monitoring hospital waste management practices, and the lack of education and training on Hospital waste management.
5.2 Conclusion

Hospital waste must be separated from municipal waste, but in many parts of Rwanda it tends to be collected along with the rest of the waste stream. Poor management of Hospital waste has serious health implication to health workers, patients and the public. Also, due to the toxic nature of medical waste, improper handling may lead to the destruction of natural environment and disturb the balance of the ecosystem. This study examined the Hospital waste management practices in one major hospital in Rwanda, CHUK. From the results of the study, it is obvious that hospital waste management is not practiced according to WHO's recommended standards. There are some areas where hospital wastes are not properly managed. It is imperative for significant investment in the proper management of hospital waste in order to reduce the health risk it poses. The researcher hopes that this study will create the awareness regarding the problem of Healthcare waste management in hospitals and will generate interest for systematic control efforts for effective hospital waste management.

5.3 Recommendations

In the light of the above observations made, a number of recommendations are hereby made with the hope of improving the management of hospital waste in Rwandan hospitals in general and University Teaching Hospital of Kigali in particular. The following recommendations could enhance the operating efficiency of the hospital with regards to medical waste management:

- It is important to measure and quantify the amount of medical waste generated in each unit of the hospital periodically to ascertain which department generates the highest and lowest amount of wastes. This could have implications or resource allocation in managing medical waste.
• There is the need for proper segregation of infectious medical waste and non-infectious medical waste. The provision of plastic bags and strong plastic containers for infectious waste such as empty containers of antiseptics used in the hospital is necessary. Bags and containers for infectious waste should be marked with Biohazard symbol. A standardized system of red color coded bags used for the segregation of risky waste should be used and rigidly followed. Imposition of segregation practices within the hospital will result in a clean waste stream which can be easily, safely and cost-effectively managed.

• The hospital should institute an efficient Sharps Management System, including proper equipment and containers at all sharps generating points, a secure accounting and collection system for transporting the contaminated sharps for treatment and final disposal as well as the proper training of hospital staff on the handling and management of sharps.

• The hospital should institute regular training and education of all workers, from doctors to ward boys, laborers, rag pickers and also workers of the private waste management company. Proper training is necessary to develop awareness of health, safety and environmental issues. It is important for workers to know and understand the potential risks associated with healthcare wastes.

• Hospital waste should be transported in suitable dedicated wheeled leak-proof containers. They should be clearly marked and regularly cleaned. The waste should be carried in a special purpose vehicle or in a special leak-proof, lidded container.

• Environmental health experts must be included in the Infection Control team in the hospital, as well as some waste management experts. This will improve the ability and effectiveness of the Infection Control team to carry out its operations.

• There must be a separate department for dealing with hospital waste and another for domestic waste. This may increase the efficiency of hospital waste management.
- The hospital should develop clear plans and policies for proper management and disposal of medical wastes. It is important to formulate a medical waste management policy separately from the hospital's waste management system. This should be done by a multidisciplinary team including environmental health specialists.

- The hospital must set up a sub-committee to be responsible for medical waste management in the hospital. The sub-committee should be in charge of periodic reviewing and resolving medical waste management issues in the hospital. The sub-committee should also monitor closely the activities of the private waste management company to ensure that they perform their duties as expected.

- There should be an obligation for each Hospital to ensure a safe and hygienic system of medical waste handling, segregation, collection, storage, transportation, treatment and disposal, with minimal risk to handlers, public health and the environment through the coordination between the related persons in the MoH according to their responsibilities.

- There is need for sustained cooperation among all key actors (government, hospitals and waste managers) in implementing a safe and reliable medical waste management strategy, not only in legislation and policy formation but also particularly in its monitoring and enforcement.

5.4 Directions for Future Research

Following from the findings of the study, it would be useful to also consider the following directions for future research:

- The hospital waste management practices of public and private hospitals in Rwanda;

- The health effects of hospital waste disposal and treatment in Rwanda.
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January 30, 2003, at the Techno Centre, Coventry University Technology Park.
And The Way Forward .


APPENDICES

Appendix I: Transmittal Letter

May 121, 2010

The Director,
University Teaching Hospital, Kigali

Dear Sir/Madam,

RE: INTRODUCTION OF JUSTIN MAHORO

This is to inform you that the above named is our registered student (MEM/20001/82/DF) in the School of Post Graduate Studies pursuing a Master of Science in Environmental management and Development (MSc EMD).

He has completed his taught Modules and is left with his Research Project titled: "Hospital Waste Management Systems and Practices: A case study of University Central Hospital of Kigali".

Any assistance rendered to him regarding his Research, will be highly appreciated.

Yours faithfully,

Dr. Tonde Yaro PhD
DEPUTY DIRECTOR-SCHOOL OF POSTGRADUATE STUDIES AND RESEARCH
Appendix II: Informed Consent

CENTRE HOSPITALIER UNIVERSITAIRE
UNIVERSITY TEACHING HOSPITAL

Department of Clinical Research
CHUK

Details of the researcher:

Name: .................................................................
First name: ............................................................
Occupation: ............................................................
Department/Institution: ..............................................
Telephone number: ....................................................
Email: .................................................................

Data Access Form

Please authorize Mr/Mrs/Dr/Prof. .................................................................
conducting a study entitled .................................................................
Systems research in CHUK study of .................................................................

to collect data from CHUK medical staff + cleaners

N.B: You are requested to present your results to Research Department after your study.

Faithfully,

Dr Stephen Rulisa
Head of Department of Clinical Research
Appendix III: Research Instruments

Survey questionnaire for Hospital waste management in CHUK

<table>
<thead>
<tr>
<th>Questionnaire 1</th>
<th>Interview</th>
<th>Person responsible for HCWM: Waste workers/Cleaners</th>
<th>Duration:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reg. No of Interviewee: Q1/CHUK/W1</td>
<td></td>
<td>Department:</td>
<td>Function:</td>
</tr>
<tr>
<td>Assessment made by:</td>
<td></td>
<td>Date:</td>
<td></td>
</tr>
</tbody>
</table>

Instructions: This questionnaire comprises various types of questions. For some, you will respond by circling your choice response. For others, you will provide little explanations on your stand regarding the stated item.

<table>
<thead>
<tr>
<th>N° Topic</th>
<th>Question</th>
<th>Comments / Multiple choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section I: Characteristics of HCWM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Quantity:</td>
<td>Do you provide the system of recording or weighing the waste generated per day?</td>
<td>[1] Yes; [2] No</td>
</tr>
<tr>
<td>Section II: Characterization of HCW production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. HCW segregation &amp; Collection/Color coding &amp; labeling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.5 HCW collection policy:</td>
<td>Which kind of policy is used?</td>
<td></td>
</tr>
<tr>
<td>8. HCW storage area:</td>
<td>Where is HCW stored while awaiting removal or Treatment/Disposal?</td>
<td></td>
</tr>
<tr>
<td>9. HCW collection &amp; on-site transport:</td>
<td>What kind of means do you use?</td>
<td></td>
</tr>
<tr>
<td>9.3 HCW collection for treatment/ final disposal:</td>
<td>Where do you take HCW collected for treatment/disposal?</td>
<td></td>
</tr>
<tr>
<td>10. HCW treatment and disposal:</td>
<td>which kind of system is used?</td>
<td></td>
</tr>
</tbody>
</table>

Explanations

74
**Survey questionnaire for Hospital waste management in CHUK**

<table>
<thead>
<tr>
<th>Questionnaire 2</th>
<th>Interview</th>
<th>Medical staff: Doctor/Paramedical/Nurses</th>
<th>Duration:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reg. code of interviewee: Q2/CHUK/MDD</td>
<td>Department:</td>
<td>Designation:</td>
<td></td>
</tr>
<tr>
<td>Assessment made by:</td>
<td>Date:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Instructions: This questionnaire comprises various types of questions. For some, you will respond by circling your choice response. For others, you will provide little explanations on your stand regarding the stated item.

<table>
<thead>
<tr>
<th>Nº</th>
<th>Topic</th>
<th>Question</th>
<th>Comments / Multiple choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td>HCW segregation &amp; collection/Color coding &amp; labeling</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3</td>
<td>HCW segregation equipment</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3.1</td>
<td>Protective equipments:</td>
<td>What kind of protective equipments do you have?</td>
<td>[1] Masks, Gloves, apron</td>
</tr>
<tr>
<td>6.4</td>
<td>Color coding:</td>
<td>do you have a specific color coding system?</td>
<td>[1] Yes; [2] No</td>
</tr>
<tr>
<td>6.5</td>
<td>HCW segregation policy:</td>
<td>which kind of policy is used?</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>HCW treatment and Disposal:</td>
<td>which kind of system is used?</td>
<td></td>
</tr>
</tbody>
</table>

**Explanations**


THANK YOU!
### Hospital waste management Survey in CHUK

#### Questionnaire 3

<table>
<thead>
<tr>
<th>Name of interviewee:</th>
<th>Function:</th>
<th>Designation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health care facility:</td>
<td>Address:</td>
<td>District:</td>
</tr>
<tr>
<td>Assessment made by:</td>
<td>Date:</td>
<td></td>
</tr>
</tbody>
</table>

**Instructions:** This questionnaire comprises various types of questions. For some, you will respond by circling your choice response. For others, you will provide little explanations on your stand regarding the stated item.

<table>
<thead>
<tr>
<th>Nº</th>
<th>Topic</th>
<th>Question</th>
<th>Comments / Multiple choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Staff</td>
<td>1.1 Medical staff training is training of med. staff available regarding HCWM?</td>
<td>[1] Yes; [2] No</td>
</tr>
<tr>
<td>1.</td>
<td>Staff</td>
<td>1.2 Medical staff training if yes, what kind of training is given?</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Staff</td>
<td>2. HCW off-site transport if HCW is not taken off-site skip the below questions</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Staff</td>
<td>2.1 transport services does the facility provide any off-site transport of HCW?</td>
<td>[1] Yes; [2] No</td>
</tr>
<tr>
<td>1.</td>
<td>Staff</td>
<td>3. HCW treatment and Disposal: ask to be allowed to take photos of the system!</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Staff</td>
<td>3.1 HCW treatment is it treated on-site or off-site?</td>
<td>[1] on-site; [2] off-site; [3] both</td>
</tr>
<tr>
<td>4.</td>
<td>HCF HCWM regulations (code of conduct; management plan, policy...)</td>
<td>do you have any regulations or code of conduct?</td>
<td>[1] Yes; [2] No</td>
</tr>
<tr>
<td>5.</td>
<td>Policy and budget</td>
<td>1.2 Provision of budget: which % of the HCF budget do you allocate?</td>
<td></td>
</tr>
</tbody>
</table>

Personal comments/remarks of the interviewer

Comments

THANK YOU!
Survey questionnaire for Hospital waste management in CHUK

<table>
<thead>
<tr>
<th>Questionnaire 4</th>
<th>Interview</th>
<th>Incinerator Operator or person responsible of incinerator</th>
<th>Duration:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of interviewee:</td>
<td>Department:</td>
<td>Designation:</td>
<td>Assessment made by:</td>
</tr>
<tr>
<td>Instruction: This questionnaire comprises various types of questions. For some, you will respond by circling your choice response. For others, you will provide little explanations on your stand regarding the stated item.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>N° Topic</th>
<th>Question</th>
<th>Comments / Multiple choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Document: Do you have any manual on HCWM or Poster on HCW Treatment</td>
<td>[1] Yes; [2] No</td>
<td></td>
</tr>
<tr>
<td>4. Categories of HCW taken to be incinerated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Categories of HCW containers expected to be taken to incinerator</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. HCW Treatment: Incineration of HCW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2 Capacity of incinerator: what is the capacity of incinerator per hour?</td>
<td>.......... kg/hour</td>
<td></td>
</tr>
<tr>
<td>6.5 Weighing system: Do you have weighing system?</td>
<td>[1] Yes; [2] No, if yes</td>
<td></td>
</tr>
<tr>
<td>7. HCWM Risks: do you have concerns about the current HCW treatment?</td>
<td>[1] Yes; [2] No, if yes</td>
<td></td>
</tr>
<tr>
<td>Explanations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comments</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

THANK YOU!
**Survey questionnaire for Hospital waste management in CHUK**

<table>
<thead>
<tr>
<th>№</th>
<th>Topic</th>
<th>Question</th>
<th>Comments / Multiple choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Staff</td>
<td>how many doctors/nurses are there at your service? Doctors: Nurses: Others:</td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Medical staff</td>
<td>how many doctors/nurses are there at your service? Doctors: Nurses: Others:</td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Medical staff training</td>
<td>is training of med. staff available at your service regarding HCWM?</td>
<td>[1] Yes; [2] No</td>
</tr>
<tr>
<td>2</td>
<td>Document</td>
<td>Do you have any manual on HCWM or Poster on HON segregation at your service?</td>
<td>[1] Yes; [2] No</td>
</tr>
<tr>
<td>3</td>
<td>Awareness</td>
<td>are you aware of HCW management?</td>
<td>[1] Yes; [2] No</td>
</tr>
<tr>
<td>4</td>
<td>Protective equipments</td>
<td>are protective equipments available at your service?</td>
<td>[1] Yes; [2] No; if yes</td>
</tr>
<tr>
<td>4.1</td>
<td>Types of protective gear</td>
<td>what kind of protective equipments do you provide?</td>
<td>Gives them:</td>
</tr>
<tr>
<td>6</td>
<td>HCW segregation policy</td>
<td>are there clearly defined procedures /policy for HCW segregation from your service?</td>
<td>[1] Yes; [2] No</td>
</tr>
<tr>
<td>7</td>
<td>Estimation</td>
<td>do you have any system of recording HON generated at your service? [1] Yes; [2] No</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>HCW treatment and Disposal</td>
<td>which kind of system is used?</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>HCWM Risks</td>
<td>do you have concerns about the current HCW practices? [1] Yes; [2] No</td>
<td></td>
</tr>
</tbody>
</table>

**Explanations**


**Comments**

THANK YOU!
### Data collection sheet of the daily quantity of Health-Care Waste generated (kg/day)

**Assessment made by:**

**Date of assessment (week):**

<table>
<thead>
<tr>
<th>Source</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
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<tbody>
<tr>
<td>S</td>
<td>C N W</td>
<td>C N W</td>
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</tbody>
</table>

#### Estimation of the volume of Biodegradable HCW generated during one week/Skip Container Volume (m²)

<table>
<thead>
<tr>
<th>HCW Skip Container</th>
<th>Total volume</th>
<th>Evacuation per week (Times)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Skip Container for Biodegradable waste:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skip container for ash from Incinerator:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Questionnaire 5

Interview

Head of service in charge of Hygiene and HCWM

Duration:

Name of interviewee:

Department/Service

Designation:

Assessment made by:

Date:

Instructions: This questionnaire comprises various types of questions. For some, you will respond by circling your choice response. For others, you will provide little explanations on your stand regarding the stated item.

I. General information

How many employees are involved in HCWM at this facility? (Number of cleaners/waste collectors)

Indicate the number of persons involved in the collection, handling, and storage of hospital waste, their designation, their training in HCW handling & management, and the number of years of experience of this type of work

II. Health Waste management and Regulations

2. Which departments and staff members at the facility are involved in healthcare waste management?

3. Who is responsible for healthcare waste management at facility?

4. Does the facility conduct any training and public awareness programs on HCW management? Yes ☐ No ☐ If so, what kind of training is given?

5. Do you have any Health waste regulations or code of conduct? Yes ☐ No ☐ If yes, give title of document:

6. What kind of Health care waste treatment/ practices do you provide at facility?

7. Does the management of the healthcare facility have concerns about the facility's current HCW practices? If so, what problems...
GUIDANCE TO CONDUCT A HCWM ASSESSMENT

CHECK LIST OF ACTION

1. Properly quantify the amount of HCW produced in the Health establishment (CHUK);
2. Establish a questionnaire to be distributed in CHUK; Compile and analyze the data;
3. The questionnaire should enable to: Get the state health-care budget and the amount that is currently dedicated to HCWM; Gather information on the collection and treatment / disposal equipments currently in place in CHUK;
4. Design an officer responsible for the identification and the review of the legislation;
5. Compile all the laws and by-laws that have been established at central and local levels;
6. Make an inventory of the rules and regulations which may exist within CHUK related to hygiene of the premises and duties of (non)medical staff concerning HCWM;
7. Analyze the data and extrapolate to estimate the daily production of HCW generated at CHUK;
8. Describe the different types of waste streams found at CHUK;
9. Assess per hospital category the on-site HCWM practices along the HCW stream from segregation, packaging, handling, on-site storage and transportation, off-site transportation, treatment to final disposal;
10. Analyze the public health and environmental risks associated with the practices encountered in the CHUK;
11. Give an indication of the kind of training on HCWM that (no) medical staff gets in CHUK.
12. Assess what training / educational materials are available at all levels and if they are used / distributed properly;
13. Make an inventory of the existing treatment / disposal facilities and their operational status.
14. Analyze the institutions/offices responsible for HCW management, hospital hygiene and infection control, budget allocations and sanitary inspection;
APPENDIX IV: RESEARCHER’S CURRICULUM VITAE

Personal Data
Name: Mahoro Justin
Date of Birth: 22 April 1983
Place of Birth: Rwaza (Rwanda)
Nationality: Rwandese
Marital Status: Single

Address
Private: Musanze
BP 100 Musanze
Phone: (+250)0788577727/+250758577727
E-mail: maokie2001@yahoo.fr

Professional Objectives
Environnemental management,

- Waste Management
- Land use planning & Development
- Environmental Health
- Environment Impact Assessment
- Conservation Planning Practice & Management
- Environmental Pollution and Auditing
- Natural Resources Management
- Population and Environment
- Environment Economics
- Energy and Environment
- Environmental Remote Sensing and GIS
Education for Excellence,

- Strengthening Mathematics & Science
- Geographical Information System

Education:

- **2002-2007**: 5 years of Science with Education, Combination: Mathematics, Geography with Education at Kigali Institute of Education (KIE),
- **2009-2010**: Master of Science in Environmental Management and Development at Kampala International University (KIU).

Degrees and titles:

- 2001: Advanced Certificate of Secondary Education (A 110366)
- 2001: Certificate of language: English
- 2003: Certificate of Helpful Active Listening: As Psychologist Assistant
- 2007: Certificate of Merit: As Journalist
- 2007: Degree of Bachelor of Science with Education (BD 0002912)
- 2008: Certificate of Strengthening Mathematics and Science (In-service Training)
- 2010: Master of Science Degree in Environmental Management and Development.

Experience:

- 2 years in education sector: Acting as science Teacher
- Rwanda: Nyanza landfill: waste management, 2 months (Pracionner), 2009.
- 5 Months: Conservation Education Assistant in Kalisoke Research Center, Disney Worldwide Conservation Fund, Rwanda.
Language Proficiency:

- English: Very good (understanding, reading, written, speaking and teaching)
- French: Very good (understanding, reading, written, speaking and teaching)
- Kinyarwanda: Mother tongue
- Swahili: Good (understanding, reading, speaking and written)

Computer Language Proficiency:

- Basic Software Programmes
- WordStar, WordPerfect and applications (Word, Excel, Power Point, SPSS,...), Internet Browsers

Professionals referees:

Dr. Biryabarema Michael
Dr. Habumuremyi Sosthene (+250783302561)
Dr. Kassim Sekabira (+256772855348)

By Mr. Justin MAHORO, BSCED, MEMD.