KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY, KUMASI

COLLEGE OF ENGINEERING

DEPARTMENT OF MATERIALS ENGINEERING

ENVIRONMENTAL AUDIT OF SMALL HOSPITALS: A CASE STUDY AT THE ANINWAAH MEDICAL CENTRE, EMENA-KUMASI

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE MASTER OF SCIENCE DEGREE IN ENVIRONMENTAL RESOURCES

MANAGEMENT.

BY

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DECLARATION

I do declare that, except for references to other people‟s work which have been duly cited, this work submitted as a thesis to the Department of Materials Engineering, Kwame Nkrumah University of Science and Technology, Kumasi, for the degree of Master of Science in Environmental Resources Management is the result of my own investigation and has not been presented for any other degree.

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ABSTRACT

The management of medical waste is of importance due to its infectious and hazardous nature that can cause risks on the environment and public health. The study was conducted to evaluate the medical waste management practices, to determine the amount of waste generated and to prepare an Environmental Action Plan (EAP) for the Aninwaah Medical Center, Emena, Kumasi. The survey was conducted at the Aninwaah Medical Center since its waste management practices were not so clear to some staff. To examine the medical waste management practices, the study employed a range of methods including questionnaires survey which targeted 100 randomly selected health care workers and ancillary staff, formal interviews with facility managers, field observations and literature reviews. Compliance with EPA-Ghana guidelines and other recommended used as standards to assess the hospital waste management practices. The waste management practices were analysed for a week to capture the daily management practices. It was observed that medical waste generation rate at the Aninwaah Medical Centre ranged from 0.126-0.157kg/patient/day. About 95% of the waste generated was general/non-infectious waste and sharps. The audit also revealed that segregation procedures the wastes generated were not constantly followed. The hospital workers are not given the proper training and insufficient protection. It was revealed that there are no laws in Ghana on how medical wastes are managed. In view of that, hospitals are not obliged to strictly follow any laws or procedure in the management of medical waste.

DEDICATION

To my father, Mr. Edward Paul Afram, my Siblings (Kofi, Kwadwo, Papa Yaw, Kwame and Ofori) and to my wife Dorcas Owusu Ansah.

ACKNOWLEDGEMENT

I thank God Almighty for His direction and protection throughout my education. I am most grateful to my supervisor Dr. Albert Amartey Adjaottor, for his immense guidance and effort he put into making this research a success.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

1.1 Background Information

Hospitals play a pivotal role in protecting people's health and are a necessary part of our society. As such they must be examples of economic, environmental and social responsibility (Serb C, 2008). The amount of medical waste is increasing constantly throughout the world, raising the issue of its safe and economic disposal as a grave concern (DenBos and Izadpanah, 2002). This is because waste from Healthcare Facilities (HCFs), arising principally from hospitals and clinics, is potentially dangerous since it can spread diseases because of the infectious nature of the wastes, and/or cause injury through the mismanagement of clinical solid/liquid waste (Abd El-Salam, 2010; AlKhatib and Sato, 2009).

Until recently, medical waste management was not generally considered an issue. In the 1980s and 1990s, concerns about exposure to Human Immunodeficiency Virus (HIV) and Hepatitis B Virus (HBV) led to questions about potential risks inherent in medical waste. In 1983, a premier meeting organised by the World Health Organization (WHO) was held at Bergen, Norway to discuss medical waste management issues (Lee et al, 1996).

Medical waste is generally described as any solid/liquid waste that is generated in the course of diagnosis, treatment, or immunization of human beings, or animals, in research pertaining to, or in the production or testing of biological materials (EPA, 2005; OSHA, 1991). Though not all medical wastes are hazardous some waste from healthcare or medical facilities are high risk, hazardous and can affect human health as well as pollute the environment. In a working environment where poor health care waste management

practices are the norm, exposure to infectious wastes due to blood borne pathogens could predispose healthcare workers, patients, and clients to infections (Johannessen *et. al*. 2000; Sawalem *et. al.*, 2009; Pruss *et. al.*, 1999; Akter, 2000).

Although great strides have been made in the field of healthcare system over the years, the health of the public, patients and professionals alike are affected by poor waste management practices (Shinee *et. al*, 2008).

Hospitals undertaking an environmental audit are conducting a type of internal investigation to assess the hospital's compliance with the broad scope of environmental regulations which govern health care entities. An environmental audit provides hospital management with a concentrated opportunity to evaluate whether the facility has a system in place to achieve and maintain compliance while detecting and correcting noncompliance (Riesel, 1986).

The audit forces hospital management to regard the hospital's various units as a whole, which is necessary in several regulatory contexts. For example, whether a hospital is required to hold certain air permits may depend on the level of emissions from facilities such as boilers, generators or backup generators used in the event of power outage.

1.2 Statement of the Problem

A hospital management team's confidence is enhanced when the hospital's balance sheet fairly states the financial position of the hospital after the financial statement has been audited by an independent certified public accountant. The hospital management team should have similar confidence that the hospital is operating in compliance with Environmental Protection Agency (USEPA) and state environmental regulations if the

hospital has undergone a periodic review of the hospital's environmental operations. While independent financial audits are part of a hospital's business cycle, environmental audits are not a regular practice.

Hospital preparedness for the USEPA inspection or inquiry is enhanced where the hospital has in place an audit protocol, a practice of conducting environmental audits. These audits, like financial internal control audits, detect systemic weaknesses in the hospital's procedures which presently may have led to no problems but are at risk to lead to a troubled future. Environmental audits provide the hospital (which shores up internal control weaknesses to guard against fraud) the opportunity to improve procedures, conduct employee training or acquire updated equipment to lessen the risk of an environmental violation.

The Aninwaah Medical Center and some hospitals in Ghana are not exceptions of this problem hence it is prudent for the medical waste problems and situations to be looked at and to find possible remedial measures to them.

1.3 Objectives of the Study

The objectives of the study are to:

- identify the types and quantities of waste generated at the hospital;
- assess the current medical waste management system;
- prescribe suitable treatment options for waste identified;
- integrate the Protocols recommended for managing hospital waste by the EPA, EU, and WHO into their management system; and
- prepare a detailed Environmental Action Plan (EAP) for the hospital.

1.4 Research Questions

- What are the types and quantities of waste generated at the hospital?
- What is the current medical waste management system operated by the hospital?

- Is the hospital operating a suitable treatment options for its wastes?
- Has the hospital integrated the protocols recommended for managing hospital waste by the EPA, EU, and WHO into their management system? and
- Does the hospital have a comprehensive Environmental Action Plan (EAP)?

1.5 Significance of the Study

This study will be a significant endeavour in promoting good work environment in the hospital and motivation of its employees. This study will also be beneficial to management and corporate bodies when they employ effective hospital waste management in their workplace. By understanding the needs of the workers and benefits of quality healthcare delivery, the management and public can be assured of an advantage. Moreover, this research will provide recommendations on how to evaluate the performance of any health institution in accordance to protocols for environment. Moreover, this study will be helpful to the health practitioners in training and informing them in the area of waste management, objectives, and strategies. It will also serve as a future reference for researchers on the subject. And importantly, this research will educate the public in deciding on whether the healthcare facility is really fulfilling its responsibility to the community or it is just showing off to promote its business, hence the need for this environmental audit.

1.6 Scope of the Study

This study will be limited to a general medical hospital type which has a capacity of less than 100 beds. A general environmental evaluation/audit will be conducted. All options of design recommendations and modifications will be limited to environmental and economic evaluation components merely with objective of pollution reduction along with environmental improvement. The study will be conducted at the Aninwaah Medical Center, Emena, Kumasi near KNUST. The study will be concentrated on the waste

generated at the facility (pathological waste, sharps, needles etc).

CHAPTER TWO

LITERATURE REVIEW

2.1 Development of Environmental Audit

In the 1970‟s, some companies in Europe and North America started to systematically evaluate their compliance with environmental legislation. This came up as a result of legislation which made companies responsible for environmental damage they caused. The use of environmental audit spread rapidly in industrialised countries due to stricter environmental legislation and the increasing exposure of a private sector to the risk of being held legally liable for environmental damage. As far as companies were concerned

this trend turned environmental problems into financial risk and therefore needed all the attention it deserves (Lund, T. and Kjorven, 1995). The practice in many ways resembled financial auditing and also became known as Environmental Auditing (EA).

2.1.1 Definition

Efforts to encourage environmental auditing have led to formal definitions of environmental audits by various institutions and individuals of international repute.

Some of these definitions include:

2.1.1a ICC Definition

In 1986, the International Chamber of Commerce issuing a position paper on environmental auditing defined environmental audit as follows:

A management tool comprising a systematic documented, periodic and objective evaluation of how well environmental organization, management and equipment are performing with the aim of helping to safeguard the environment by:

i. Facilitating management control of environmental practices; ii. Assessing compliance with company policies which would include meeting regulatory requirement (ICC, 1986).

2.1.1b EPA Definition

In a policy statement issued in 1986, the EPA defined an environmental audit as "a systematic documented, periodic and objective review by regulated entities of facility operations and practices related to meeting environmental requirement" (US EPA, 1986). The United States Environmental Protection Agency (EPA) however after seventeen (17) years on still defined environmental audit as "a systematic, documented, periodic, and

objective review by regulated entities of facility operations and practices related to meeting environmental requirements" (EPA, 2003 cited in Anthony *et. al.,* 2003).

2.1.1c CBI Definition

The term „environmental audit" was defined by Confederation of British Industry as: the systematic examination of the interactions between any business operation and its surroundings. This includes all emissions to air; land and water; legal constraints; the effects on the neighbouring community; landscape and ecology; the public"s perception of the operating company in the local area. Environmental audit does not stop all compliance with legislation. Nor is it a „green-washing" public relations exercise. Rather it is a total strategic approach to the organisation"s activities (CBI, 1990 cited in Paramasivan 2002).

2.1.1d ISO Definition

The International Standards Organisation (ISO) as part of its standards for environmental management (the ISO 14000 series) in developing a standard for environmental audit proposed a definition for environmental audit as "a systematic, documented, periodic, and objective review of environmental operations, management systems, performance, or practices carried out through a rigorous process of obtaining and evaluating evidence regarding a verifiable objective or assertion about an environmental matter, to ascertain the degree of correspondence with established criteria and then communicating the findings to the appropriate recipient (ISO, 1995).

2.1.1e Others

Many authors have provided a number of definitions on environmental auditing.

Hayes et al., (1999) outlined the following features of environmental auditing:

- Audit is a systematic approach.
- Audit is conducted objectively.
- Auditor obtains and evaluates evidence.
- Evidence obtained and evaluated by the auditor concerns assertions about economic actions and events.
- Auditor ascertains the degree of correspondence between assertions and established criteria.
- Goal, or objective, of the audit is communicating the results to interested users.

McDonagh et al. (1997) defined environmental auditing as a process for checking, on a regular basis, the environmental performance of an existing organisation or activity.

In the context of an environmental management system, Thompson (1995) described environmental auditing as the regular, systematic review of the environmental management system, compliance with laws and regulations, conformance to policies, and the development of an action plan to deal with deficiencies.

Based on the ICC definition, Humphrey and Hadley (2000) highlighted a number of features as follows:

- Audits should be systematic and comprehensive.
- Audits should be fully documented and where possible, substantiated with physical evidence.
- Audits should be periodic rather than “one off” procedure.
- Audits should be objective, providing a true and fair view of the situation at a site or within company.

Millichamp (1996) provided the same meaning as the definition of ICC. However, he made some notes on this definition:

- It is seen as a management tool but might also be used as a tool of regulatory agencies and any contact groups in assessing environmental performance.
- It should be systematic, documented, periodic, and objective.
- It is of performance.
- The objective is to contribute to safeguarding the environment.
- It is part of a management system.
- It is concerned with assessing company policies connected with regulatory requirements but also with appropriate standards as perceived by management.

2.2 Types of Environmental Audit

There are numerous types and purpose of environmental audits. Environmental audits can be classified under two (2) broad categories: Compliance audits and Liability audits (Lund et al, 1995). On the contrary, Humphrey and Hadley (2000) basically divided environmental auditing into three types of corporate audit:

- Compliance audits check whether a company is complying with environmental legislation, industry standards, environmental regulations of the host state under which it operates daily and the company‟s internal policy. e.g. regulatory, Environmental Management System (EMS) and internal standards;
- Single issue audits are the audits typically performed by an independent certified public accountant (CPA) and encompasses both financial and compliance components. e.g. waste minimisation, transport; and
- Liability audits are used to assess the potential environmental liabilities of a property, when a client is seeking to purchase a site or a company or to merge with another. It is a useful tool for reassuring the purchaser that he is not buying

environmental liabilities or problems of potential liabilities.e.g. pre-acquisition, divestment and insurance.

According to Department of Environmental Affairs and Tourism, South Africa, (DEA), 2004, series 14, environmental auditing can be grouped in the following six (6) differing types:

i. Environmental Management Audits ii. Environmental Compliance Audits iii. Environmental Assessment Audits iv. Waste Audits

v. Environmental Due Diligence Audits vi. Supplier Audits

i. Environmental Management Audits

These are audits which are specifically designed to check and evaluate the effectiveness of environmental management systems. Sound environmental management at a site or in an operation depends upon procedures, work instructions, guidelines, specification, training programmes and monitoring systems being implemented by the employees of the organisation operating on the site. If these employees are not given the right instructions, training and procedures within the system, they cannot be expected to carry out their work effectively. Thus, the first stage in auditing an operation is to check the presence, absence and functioning of the environmental management system (which could be formal or informal). This then creates a baseline against which one can check the environmental functioning of an organisation more effectively and objectively.

ii. Environmental Compliance Audits

Environmental compliance (or performance) audits are specifically designed to test compliance (which covers both legal compliance and corporate compliance) to environmental policies, objectives, laws, by-laws, ordinances, regulations and standards. These types of audits will often also include more numerical testing and specific checks on, for example, compliance with requirements in water and air permits and licences.

iii. Environmental Assessment Audits

An environmental assessment audit is an instrument used to check that an Environmental Impact Assessment complies with the minimum legal requirements and also checks to ensure that due legal process has been followed. This particular audit is not common in South Africa but is used elsewhere in the world to assist in EIA quality control and to reduce unnecessary costs and inconvenience should the EIA be appealed against.

iv. Waste Audits

Waste audits are environmental audits which specifically look at the waste management component of an operation or site. In such audits, the various aspects of waste management would be reviewed and the methods, procedures and systems checked and verified. In cases where site management are reluctant to undertake full site environmental audits, it is often easier to motivate for a specialised waste audit because the results of this will often more readily generate data and actions which can save money.

v. Environmental Due Diligence Audits

Environmental due diligence audits are described in different ways but are essentially audits which look at the actual and potential environmental liabilities of a site or operation. They are most commonly carried out as a precursor to the purchase of property which has been or is likely to be used for industrial or commercial purposes. Often, they form a part

of a wider financial due diligence audit which looks at the various business risks associated with the purchase of property. The kind of issues that can emerge from environmental due diligence audits include past dumping or burying of hazardous waste which may result in pollutants contaminating the groundwater. In such circumstances, the owner of the land where the waste was buried could be held liable for the clean-up costs. It is important, when purchasing property, to ensure that the new owner is not taking over someone else‟s hidden environmental liabilities.

vi. Supplier Audits

A supplier audit is an audit carried out by a client to test the environmental compliance of a contractor or supplier. It should be an audit using the environmental conditions included in the contract document. In the absence of any specific conditions, it could be an audit of the supplier‟s environmental management system with special reference to the client‟s business. It is often said that in any organisation, one‟s contractors are the weakest link in the chain of operation. This is not necessarily a reflection on the quality of the contractor‟s service but acknowledgement of the fact that the contractor will not necessarily have the same goals and objectives as the client organisation. The contractor and client will have a contractual relationship which is often based upon the supply of a specific product or service. If the client wishes a contractor to have exactly the same approach to environmental policy and systems as his own, then this needs to be included in the contract. Furthermore, the compliance with such policies and systems need to be regularly audited. Thus a supplier or contractor audit is one where the contractor is audited against the environmental requirements of the contract.

2.3 Key Objectives of Environmental Auditing

Welford (2002) discussed more detailed objectives of an environmental audit, to include:

1. Verifying compliance

   Verify compliance with standards or best available techniques.

2. Identifying problems

   Detect any leakage, spills or other such problems with the operations and processes.

3. Formulating environmental policy

   Formulate the organisation‟s environmental policy if there is no existing policy.

4. Measuring environmental impact

   Measure the environmental impact of each and every process and operation on the air, water, soil, worker health and safety and society at large.

5. Measuring performance

   Measure the environmental performance of an organisation against best practices.

6. Confirming environmental management system effectiveness

   Give an indication of the effectiveness of the system and suggestions for improvement.

7. Providing a database

   Provide a database for corrective action and future plans.

8. Developing the company‟s environmental strategy

   Enable management to develop its environmental strategy for moving towards a greener corporate and performance culture.

9. Communication

   Communicating its environmental performance to its stakeholders though reporting will enhance the image of the company.

2.4 Stages of Environmental Audit

The effective planning and logistics of an audit is critical to ensure a successful audit. Apart from ensuring that the appropriate staff is available to answer audit questions, the logistics of an audit needs to be organised to prevent wasting time. Based on this approach, Humphrey and Hadley (2000) divided the environmental auditing process into three main stages of activity:

i. Pre-Audit Stage ii. On-site Audit Stage iii. Post-Audit Stage

Each of these stages comprises a number of clearly defined objectives, with each objective to be achieved through specific actions. These actions produce results in the form of outputs at the end of each phase.

2.4.1 Pre-Audit Stage

Once a commitment to auditing has been made a number of activities need to be completed before the on-site activities commence. This is done to reduce the amount of time spent in on-site activities which is expensive.

The pre-audit activities usually include the following:

- The sites that are to be audited need to be determined and selected.
- The auditee should be informed of the date of the audit as soon as possible, enabling them to adjust and become used to the concept.
- The audit scope should be identified. The auditee should usually be consulted when establishing the scope.

- The audit plan should be designed in such a way that it can accommodate changes based on information gathered during the audit and effective use of resources.
- Audit team and assignment of responsibility should be established.
- The chosen working papers should be collected. This will facilitate the auditors‟ investigations on the sites.
- The background information on the facility including the facility‟s organisation, layout and processes, and the relevant regulations and standards, should be collected.
- The background information on the site‟s historical uses, and the location of soil and groundwater contamination should be collected.
- The pre-audit questionnaire should be sent to auditee (Humphrey and Hadley, 2000).

2.4.2 On-site Audit Stage

The on-site audit is the most important step of the audit procedure. This is made up of the following steps.

- The opening meeting is the first step between the audit team and auditee. In this meeting the purpose of audit, the procedure and the time schedule are discussed.
- Site inspection is the second step for on-site activity. In this step the audit team may discover matters which are important to the audit but which are not identified at the planning stage.
- The on-site phase requires the audit team to develop a working understanding of how the facility manages the activities that influence the environment and how any EMS, if there is one, works.

- Assessing strengths and weaknesses of the auditee‟s management controls and risks associated with their failure need to be established.
- Gathering audit evidence involves collecting data and information using audit protocol.
- Communicating with the staff of the auditee to obtain most information.
- Evaluating the audit evidence against the objectives established for the audit and an agreed protocol.
- An exit meeting takes place once all of audit findings have been finalized with facility personnel (Humphrey and Hadley, 2000).

2.4.3 Post-Audit Stage

Post-audit activities begin with the preparation of a draft report. The draft report should be reviewed by the facility personnel directly involved in the audit. The final report should be derived from it and it should then be distributed to all interested parties within the organisation. Humphrey and Hadley (2000) confirm that it is important for management to follow-up the report and develop an action plan to implement those audit findings.

The ICC (1991) (cited in Humphrey and Hadley, 2000) identifies five elements of a successful follow-up programme. These include:

1. A standard action plan format;
2. Established procedures for approving the action plan and communicating its contents;
3. Regular reporting of the action plan‟s status;
4. Special reporting and chasing up of overdue action; and
5. Independent auditing of the action plan to verify that all actions sanctioned have been completed.

The formal audit procedure is complete as soon as the action plan has been completed.

2.5 Environmental Audit Methods

There are various ways through which environmental audit can be conducted. Any of the methods can be employed. The methods include;

1. Questionnaires: these are structured to cover prioritized areas of the company in this case the hospital operations and given to relevant personnel to complete. These may include personnel responsible for environmental management, Head of Departments (HOD), nurses and hospital administrator. Questionnaires must be straight forward and unambiguous.
2. Interviews: interviews are conducted with relevant personnel on matters relating to the operations of the company/hospital. This may include issues bordering on the production processes, waste treatment and disposal, occupational health and safety, etc.
3. Checklist: a checklist is prepared to cover issues that are to be considered in the audit. This is to ensure that no issues are overlooked.
4. Inspection of activities / Site visits: auditors, although may be knowledgeable in operations as is being undertaken by the company, there may still be the need to visit to acquaint themselves with what is pertaining on the ground as far as the particular company is concerned. Welford (1996) during the visit there is the need to target segments of the company‟s activity which is perceived as being the most likely to cause environmental problems/damage. Top on the list tends to be the central production process and laboratories. This may involve observing how processes are carried out and may be used to compare with the described methods.

5. Measurement of activities: to be able to quantify the actual adverse impacts of activities on the environment, samples of the components of the environment perceived to be likely affected are taken. Analyses are then performed on these and the results compared with standards for the components considered.
6. Examination of records: pollution records as reported by previous audits (if any) and the environmental performance of the company are examined. This gives an indication to how well the company is performing environmentally in the light of legislation governing its operations as well as its commitment to improvement.

2.6 Limitations to Environmental Auditing

According to the International Organisation of Supreme Audit Institutions, INTOSAI WGEA (2003), 26 percent of the 114 Supreme Audit Institutions (SAIs) did not experience any barriers to conducting environmental audits; however, previous surveys have identified the following barriers:

1. Inadequate SAI mandates;
2. Insufficient established environmental auditing norms and standards;
3. Lack of skills or expertise within the SAI;
4. Insufficient data on the state of the environment;
5. Insufficient national monitoring and reporting systems; and
6. Insufficient formulation of governmental environmental policy (Donald, 2004).

2.7 Environmental Management Systems (EMS)

An Environmental Management System (EMS) is a set of processes and practices that enable an organization to reduce its environmental impacts and increase its operating

efficiency. An Environmental Management System (EMS) is a framework that helps a company to achieve its environmental goals through consistent control of its operations. The assumption is that this increased control will improve the environmental performance of the company. The EMS itself does not dictate a level of environmental performance that must be achieved; each company's EMS is tailored to the company's business and goals (US EPA, www.epa.gov/ems/*).*

2.8 Definition of Hospital

In any community, people become ill and require access to health care facilities and treatment. The problem may be physical, such as diarrhoea, fever or injury, or mental, e.g. psychosis, epilepsy or a learning difficulty.

A hospital (other than psychiatric) means an institution which is primarily engaged in providing, by or under the supervision of physicians, to inpatients, diagnostic and therapeutic services for medical diagnosis, treatment, and care of injured, disabled, or sick persons; or rehabilitation services for the rehabilitation of injured, disabled, or sick persons. Hospitals and healthcare centres are a complex institution which is frequented by people from every walk of life in the society without any difference between age, gender, race and religion (Roa, et. al., 2004). These healthcare delivery centres, established to provide treatment and security of the health of the public on the contrary have become the sources of infections and disease spreading points (Babanyara, et. al., 2013). These health care facilities generate wastes which are universally known as biomedical waste. Biomedical waste is also characterized as health care waste, clinical waste, hospital waste, medical waste etc. which can be used appropriately wherever necessary.

2.9 Classification of Health Care Facilities

One of the health policies of the Government of Ghana is to allow easy access to health facilities at the community level. Health centres and posts are established in deprived areas

in the country to enable people have easy access to health care facilities. Other health care facilities are designed to manage more complex cases, which may be beyond the capability of the community level facility.

Classification of health institution enables management to plan appropriately for health care waste storage, treatment and disposal for each level. This classification is based on daily Out Patient Department (OPD) attendance, daily admissions average occupancy and the degree of ailment or diagnosis. These indicators are used as determinants in the referral system.

Public sector health care facilities in Ghana can be classified into 5 main categories as

1. Tertiary/Teaching/Specialist Hospital.
2. Regional Hospitals.
3. District Hospitals (Level C).
4. Health centres/Clinics (Level B).
5. Community Clinics/Maternal and Child Health Centres (Level A).

Additionally, various private sectors, quasi-governmental and traditional sector facilities provide a wide range of services.

2.9.1 Tertiary /Teaching/ Specialist Hospitals

Tertiary Hospitals provide specialised care and are made up of various departments. They are not limited to the number of beds and are mostly for training purposes.

2.9.2 Regional Hospitals

These are hospitals situated in the Regional capitals. They have between 250 – 300 beds. Included in this category are psychiatric hospitals.

2.9.3 District Hospitals

These provide general health services and are managed by general Medical Officers. They have up to about 120 beds. The district hospitals can be sub-divided into three main levels (A. B and C). The indicators for the categorisation of the 3 levels are as shown in Table 2.1

Table 2.1: Indicators for the categorisation of District Hospitals in Ghana, Ministry of Health, Ghana (2002)

Hospital indicators	LEVELS		
	A	B	C
1. Average bed occupancy	30	50	70+
2. Average OPD attendance	1-30	31-90	91+
3. Average Daily Admissions	1-6	7-12	13+

2.10 Definition of Medical Waste

Medical wastes are produced in all conventional medical units where treatment of (human or animal) patients are provided, such as hospitals, clinics, dental offices, dialysis facilities, as well as analytical laboratories, blood banks, school laboratories. Health care wastes also refer to all materials, biological or non biological, that is discarded in any health care facility and is not intended for any other use (Diaz, 2003). According to World Health Organization (WHO), Healthcare Waste is defined as the total waste stream from a health care establishment, research facilities, laboratories, and emergency relief donations. Any waste which is generated during diagnosis, treatment or immunization of humans or animals, or in research activities pertaining thereto or in the production of testing of biological materials.

2.11 Characteristics and Types of Medical Waste

There are two types of Medical Waste depending on the risks associated with it.

2.11a Non-hazardous or non-risk waste

Approximately 75-90% of the waste generated in healthcare establishment is nonhazardous. This includes food remains, papers, packaging materials etc.

2.11b Hazardous or risk medical waste

The remaining 10-25% of medical waste is hazardous and can be injurious to humans or animals and deleterious to the environment. This includes sharps, pharmaceutical waste, culture specimen, pathological waste, etc (Shinee et. al., 2008).

It must however be noted that if both types are mixed together then the whole waste becomes harmful.

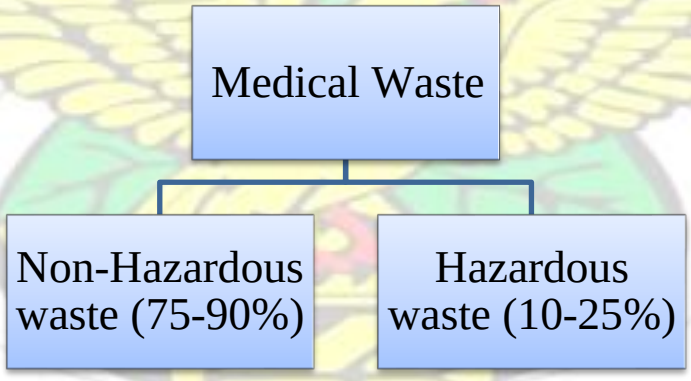


Fig. 2.1 Types of Medical Waste (Shinee et. al., 2008)

2.12 Classification and Categories of Hazardous Waste

Wastes that pose a substantial danger immediately or over a period of time to human, plant, or animal life are classified as hazardous wastes. A waste can therefore be classified hazardous if it exhibits any of the following characteristics: ignitability, corrosivity, reactivity, or toxicity. In the past, hazardous wastes were often grouped into the following

categories: radioactive substances, chemicals, biological wastes, flammable wastes, and explosive. The chemical category includes wastes that are corrosive, reactive, or toxic while the principal sources of hazardous biological wastes are hospital and biological research facilities (Howard et. al., 1985).

According to reports filed by the World Health Organisation, WHO, in 1999 and 2005, hazardous healthcare waste are classified as

- *Sharps:* e.g. hypodermic needles, scalpels, knives, infusion sets, broken glass, etc.
- *Chemical waste:* e.g. reagents, solvents, unwanted disinfectants, film developer, etc.
- *Pathological waste:* e.g. human tissues, body parts, foetus, etc.
- *Infectious waste:* e.g. blood and body fluids, etc.
- *Pressurised containers:* e.g. gas cylinders, aerosols, gas cartridges, etc.
- *Pharmaceutical waste:* e.g. out – dated drugs, etc.
- *Genotoxic waste:* e.g. cytotoxic drugs, gentoxic chemicals, chemotherapy drugs, etc.
- *Waste with heavy metals content:* e.g. batteries, thermometers, etc.
- *Vaccine waste*
- *Radioactive waste:* Some laboratory wastes, wastes associated with radiation therapy. Not likely to be used by small-scale healthcare facilities.

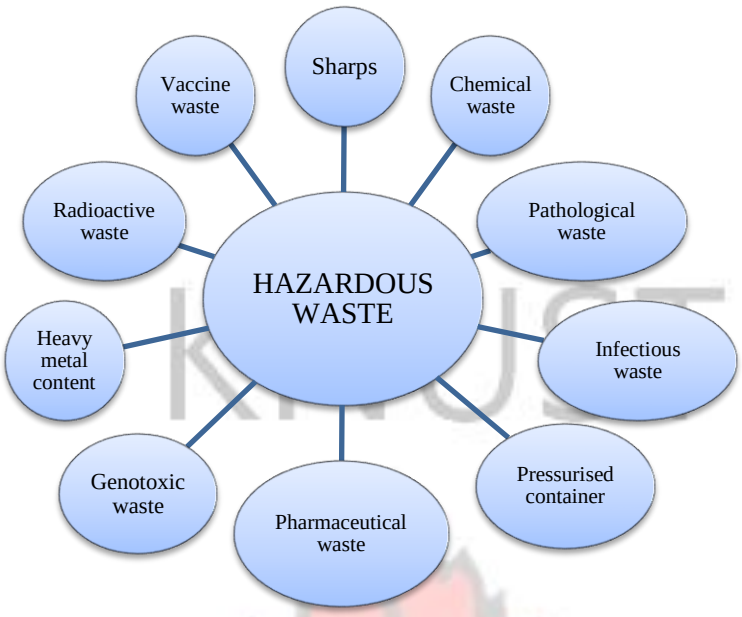


Fig. 2.2 Categories of Hazardous Waste (WHO, 2005)

2.13 Waste Generation

Healthcare waste is generated from various sources. These sources can be classified as major or minor. Teaching/Specialist, Regional hospitals, Mortuaries, and Research centres form the major source while District Hospitals, Polyclinics, Private Laboratories, Health Centres/Post, Dental Clinics, Pharmacies, Veterinary, Maternity Homes, and Alternative Health Care Providers form the minor sources. Health care waste generation depends on numerous factors, such as established waste management methods, type of health-care establishments, the proportion of patients treated on a daily basis and the level of complexity and degree of specialisation of the health facility. Hence, the Teaching Hospitals generate larger quantities of waste per unit than other facilities. In deriving unit generation values, the following hospitals/institutional parameters need to be considered:

i. Number of hospital beds.
ii. Number of in-patients and out-patients (humans or animals). iii. Range of services provided.
iv. Any other activity that leads to the generation of health care waste.

According to Jang (2011), generation of healthcare waste differs not only from country to country but also within the country. Waste generation depends on numerous factors such as established waste management methods, type of healthcare establishment, hospital specialisation, and proportion of reusable or disposables medical devices employed in healthcare, occupancy rate and proportion of patients treated on daily basis and degree of regulation enforcement at national and local levels, definitions of medical waste, training of medical waste management and medical waste treatment and disposal policy type.

Nemathaga *et. al.,* (2008) stated that the quantities of medical waste generated also depends on level of instrumentation at the healthcare facility, number of beds, types of health services provided, economic, social and cultural status of patients and general condition of the area where the hospital is situated. Generation rate in developed countries such as United Kingdom (UK), United States of America (USA), Canada, and Italy among others is greater than the rates found in developing countries such as Thailand, Vietnam, India and Iran (Diaz *et. al.,* 2005). The generation rate of medical waste is also dependent on the regulations and economic status of a country with large variation when expressed as the amount of waste per bed/day or per capita/day. The generation rates for Canada and USA were reported to range from 4.3-5.8 *kg/day* (Nemathaga *et. al.,* 2008). United Kingdom (UK) is the largest producer of healthcare waste in Europe. In 2007/2008, hospitals in UK produced approximately 190000 tonnes of healthcare waste (Tudor *et. al.*, 2009).

Table 2.2 Medical waste generation in selected developed countries (Krisiunas et. al., 2000; Chung and Lo, 2003)

COUNTRY	Kg/patient/day
United Kingdom (UK)	5.5
Ireland	2.6

USA	2.2
France	1.9
Portugal	1.5
Belgium	1.4
Greece	1.4
Italy	1.0
Spain	0.6
Netherlands	0.6
Germany	0.4

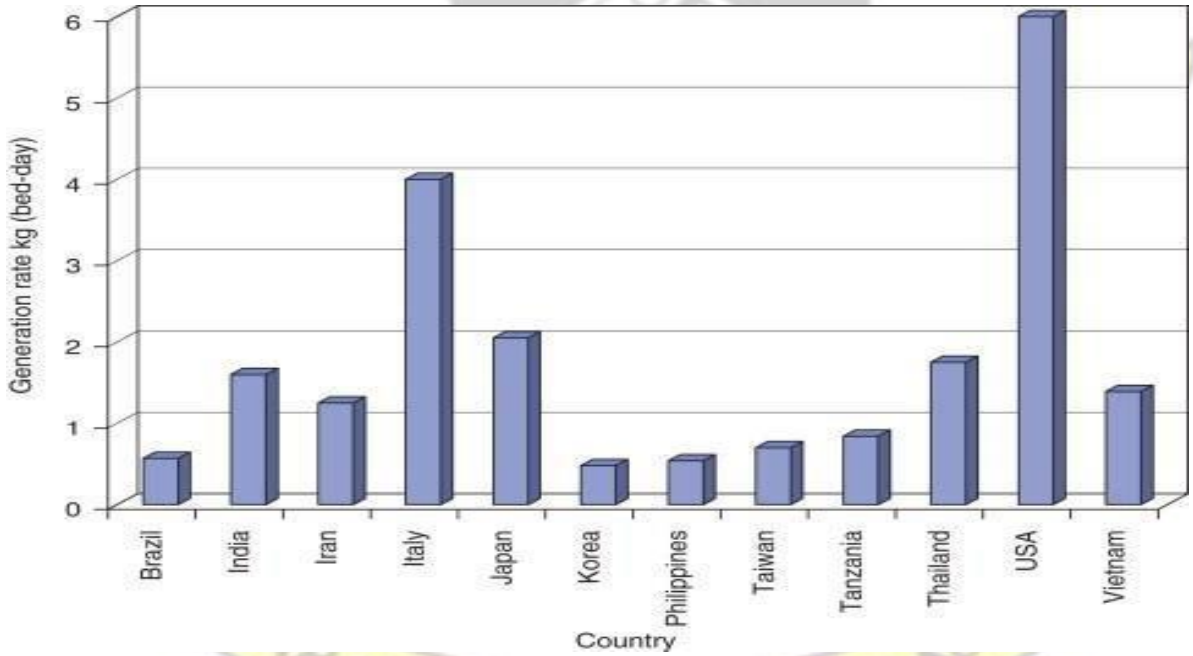


Fig.2.3: Generation rates of Medical Waste in Different Countries (Jang, 2011)

It is evident that developing countries in Africa and Asia continents (Algeria 0.7-1.22 *kg/bed/day*, Libya 1.3 *kg/patient/day,* South Africa 0.60 *kg/patient/day,* and Taiwan 2.41-3.26 *kg/bed/day*) generate the lower amounts of medical waste (Bendjoudi *et. al.*, 2009; Sawalem *et. al.*, 2009; Nemathaga *et. al.*, 2008 and Cheng *et. al.*, 2009).

2.14 Waste Segregation and Packaging

There are differences in management methods of the various waste generated within Healthcare Facilities. There is therefore the need to segregate infectious and hazardous waste from others at the point of generation. The key to minimisation and effective management of health care waste is identification and segregation of the waste. Appropriate handling, treatment and disposal of waste by type reduce costs and do much to protect public health. Cheng *et. al.* (2009), referred to segregation as separation of waste into designated categories. Blenkharn (2008), also defined waste segregation as a process of dividing garbage and waste products in an effort to reuse and recycle materials.

According to the United Nation Environmental Programme (UNEP), (2002), only 10% of the healthcare waste is considered to be potentially infectious. The proportion can be further reduced to 1-5% with proper segregation practiced at the sources of generation of waste.

Segregation should always be the responsibility of the waste producer. It should take place as close as possible to where the waste is generated and maintained in storage areas, and during transport. For successful implementation of waste segregation, personnel of various institutions need to be well educated on the definition and classification of healthcare waste. Staff must also be aware of the rational for segregation as well as colour codes for containers and bags used for different types of wastes.

Colour coding of the waste containers and plastic bags is one of the efficient ways of achieving segregation of waste and for sorting out items such as paper, plastic, glass, and metal for recycling.

The recommended colour coding scheme is as follows:

BLACK – General waste (e.g. kitchen waste, paper, cardboard, sweeping etc.)

YELLOW – Infectious waste (e.g. sharps, patient waste, human/animal tissue and cultures/specimens)

BROWN – Hazardous waste (e.g. expired drugs, vaccines, chemicals etc)

Table 2.3 shows the colour coding for the storage and transportation of healthcare waste. It should always be noted that colour coding for the plastic bags should always correspond or match with the waste containers both at the internal and external storage sites.

Table 2.3: Colour Coding for the Storage and Transportation of Healthcare Waste, Ministry of Health, Ghana (2002)

DESCRIPTION OF WASTE	COLOUR CODE
A. General Waste	Black plastic bag of appropriate size
B. Infectious Waste	
B1. Sharps	Puncture-resistant container and yellow plastic bags
B2. Patient Waste	Yellow plastic bags and containers
B3. Culture Specimen	Yellow plastic bags and containers
C. Pathological/ Organic Human tissues	Yellow plastic bags

D. Hazardous Waste	Brown plastic bags and containers
Pharmaceutical Waste	Brown plastic bags and containers
Photographic chemical waste ❖ Photographic developer ❖ Fixer solution ❖ X-ray photographic film	Brown plastic containers ➢ Brown plastic bags ➢ Brown plastic bags
Radioactive Waste ❖ Solid-combustible/compatible ❖ Non-combustible/noncompatible	Brown containers with radioactive symbol Durable plastic bags which can be sealed
Liquid-Aqueous	Puncture-resistant container (metal) Thick walled polythene bottles or
Spent Sealed sources	organic-glass containers but should have secondary container to prevent them from breaking. Container in which the source was originally received.
Laboratory Waste ❖ Acids ❖ Alkalis ❖ Solvents ❖ Organic substances ❖ Heavy metal(e.g. mercury)	**Brown containers with appropriate labels** Acid label Alkali label Solvent label Organic substance label Heavy metal label

E. Incinerator Ash Sludge	Yellow metal container labelled "Ash" Yellow metal container labelled "sludge"

2.15 Handling

Unless medical waste is properly handled and disposed, it can present risk to healthcare staff, the public and environment (Shinee *et. al.*, 2008; Atkhatib and Sato, 2009). Many developed countries have devised codes of practice and guidelines for the handling and disposal of medical wastes (Bdour *et. al., 2007;* Da Silva *et. al.,* 2005; Lee *et. al.*, 2004). Medical waste is yet to be fully appreciated in the developing countries as they still handle and dispose medical waste together with non-medical waste (Alagoz and Kocasoy, 2008). Handling procedures of medical waste follow after waste has been segregated and placed bags or rigid containers. Rappe and Nyregen (2009), stated that it is through handling of the waste that different groups get into direct contact with it. Medical waste operatives and all other people involved in waste handling are to handle it appropriately with caution bearing in mind the risks that may occur. Protective clothing (overalls, heavy duty or industrial gloves, study shoes, goggles and mask for incineration) are to be worn when handling, transporting or incinerating medical waste (Mato and Kassenga, 1997). Pruss *et. al.* (1999) stated that personnel responsible for health and safety are to ensure that all persons including contracted for handling wastes are suitably protected.

2.16 Transportation

Insa *et al.* (2010) noted that medical waste must be transferred from the place where it is generated to the installations where it will be treated and/or disposed of. Collection and transportation of medical waste must be carried out by trained personnel from authorized

waste collection companies. Transportation of medical waste depends on the category of waste. Abdulla *et al.* (2008) reported that at all times transportation of medical waste should be controlled via a document that shows at least the amount and type of waste, place of origin of waste and waste collection date, and place of destination.

Where waste is transported within the facility, Singh (2001) established that all containers should be covered and labelled as being bio-hazard according to WHO specifications. Kumari *et al.* (2012) also state that transportation routes within a hospital must be specifically designated to avoid passage through patient care areas. Separate times should be dedicated for the transportation of bio-medical waste to minimize chances of it mixing with general waste. Where waste is transported from the healthcare facilities to disposal places by respective local authorities or contractors, there has to be a liaison between waste producers and those responsible for collection and disposal.

Purpose designed vehicles are to be used solely for the transportation of such waste.

2.17 Disposal and Treatment Methods

There are several ways where medical waste can be disposed. The most commonly used methods of medical waste disposal are by incineration, open-air, autoclaving, hydroclave treatment, encapsulation, wet thermal treatment, and microwave irradiation, chemical disinfection, deep – well injection, and sanitary landfill.

2.17a Incinerator:

It is a permanent furnace of masonry / concrete, refractory materials, and metal. The types of incinerators are double – chamber (pyrolitic), single chamber and drum or brick incineration. During incineration, the waste is thermally decomposed at temperatures not less than 200˚C to a maximum of 1200˚C. This method is suitable for infectious wastes,

pathological wastes, sharps, most chemicals and pharmaceutical waste. Dioxins, furans and metals are persistent and bio accumulates in the environment. Materials containing chlorine or metal should therefore not be incinerated (Pruss, et. al., 1999).

2.17b Open – air burning

Burning of wastes in or next to pit where they will be buried. Kerosene or similar fuel may need to be added to maintain combustion. Not recommended as a permanent solution, but better than burying untreated on site (Pruss, et. al., 1999).

2.17c Autoclaving it is a process of steam sterilization under pressure. It is a low heat process in which steam is brought into direct contact with the waste material for duration sufficient to disinfect the material. There are three types: gravity type, pre-vacuum type and retort type. Autoclave treatment is recommended for microbiology and biotechnology waste, waste sharps, soiled and solid waste (Ram, 2007).

2.17d Hydroclave treatment

It is based on innovative equipment named Hydroclave, for steam sterilization process (like autoclave). Hydroclave is a double walled container in which the steam is injected into the outer jacket to heat the inner chamber containing the waste. Moisture contained in the waste evaporates as steam and builds up the requisite steam pressure (Ram, 2007).

2.17e Microwave Treatment

This is a wet thermal disinfection technology but unlike other thermal treatment systems which heat the waste externally, microwave heats the targeted material from inside out, providing a high level of disinfection. Microwave technology has certain benefits, such as, absence of harmful air emissions, no requirement of chemicals, and reduced volume of waste. However, the investment costs are high at present. The microbiology and

biotechnology waste, the soiled and solid wastes are permitted to be microwaved (Dumitrescu, et. al. 2007).

2.17f Chemical Disinfecting it is a treatment recommended for waste sharps, solid and liquid waste as well as chemical wastes. Chemical treatment involves use of at least 1% hypochlorite solution with a minimum contact period of 30 minutes or other equivalent chemical reagents, such as, phenolic compounds, iodine, hexachlorophene, iodine-alcohol or formaldehyde alcohol combination (Diaz, et. al., 2003, Dumitrescu, et. al., 2007).

2.17g Encapsulation

Containers are filled three quarters full with hazardous waste. Materials such as cement mortar, clay, bituminous sand, or plastic foam is used to fill the container. When capping material is dry the container is buried or land filled. This method is effective for sharps waste, small amounts of chemical and pharmaceutical wastes.

2.17h Wet Thermal Treatment

Similar to autoclaving, waste is shredded and exposed to high pressure, hightemperature steam, and so it is therefore recommended for infectious wastes and efficient at disinfecting. The said method has no significant environmental adverse impacts. It cannot be used on pathological, pharmaceutical, and chemical waste and requires qualified operators. Despite its efficiency, it is however not available to most small-scale facilities in Africa.

2.17i Shredding

It is a process by which waste are "deshaped" or cut into smaller pieces so as to make the wastes unrecognizable. It helps in prevention of reuse of bio-medical waste and also acts as identifier that the wastes have been disinfected and are safe to dispose of. A shredder is to be used for shredding in medical waste with minimum requirements

2.17j Sanitary and Secured Land filling

Waste is packaged to minimize exposure, and it placed in a shallow and hollow dug below the land. Waste is then immediately covered with 2 metres of mature waste. Alternatively, packaged waste is placed in a 2m-deep pit in mature waste and covered immediately. Waste-picking by scavengers must be prevented though difficult to do so.

It is suitable for disposing of infectious waste, sharps waste, small amount of chemical and pharmaceutical wastes. Organic materials may eventually be biodegraded. It requires access to sanitary landfill. Transportation to site creates many opportunities for exposure. Improper handling of leachate (liquid that filters through the waste) can cause water pollution and potential public health risks. In all cases where waste is treated, the treated waste should be buried using safe burial methods or disposal in a sanitary landfill. Sanitary and Secured Land fillings are again necessary under certain circumstances: deep burial of human anatomical waste, when the facility of proper incineration is not available, animal waste, under similar conditions; disposal of autoclaved/ hydroclaved /microwaved waste; disposal of incineration ash; disposal of sharps.

There are a number of guidelines for the management of infectious waste materials from medical institutions (Liberti, et. al, 1996). In Bangladesh, proper medical waste management is a new phenomenon and the Government of Bangladesh is trying to develop a new and modern approach to deal with medical waste properly. In view of that, a reputed national NGO in Bangladesh with financial and technical support from Water and

Sanitation Programme (WSP) is working on medical waste management in a project called PRISM (Project in Agriculture, Rural Industry, Science and Medicine) to manage the generated medical waste in different forms. The processes involved are summarized in Fig. 2.4.

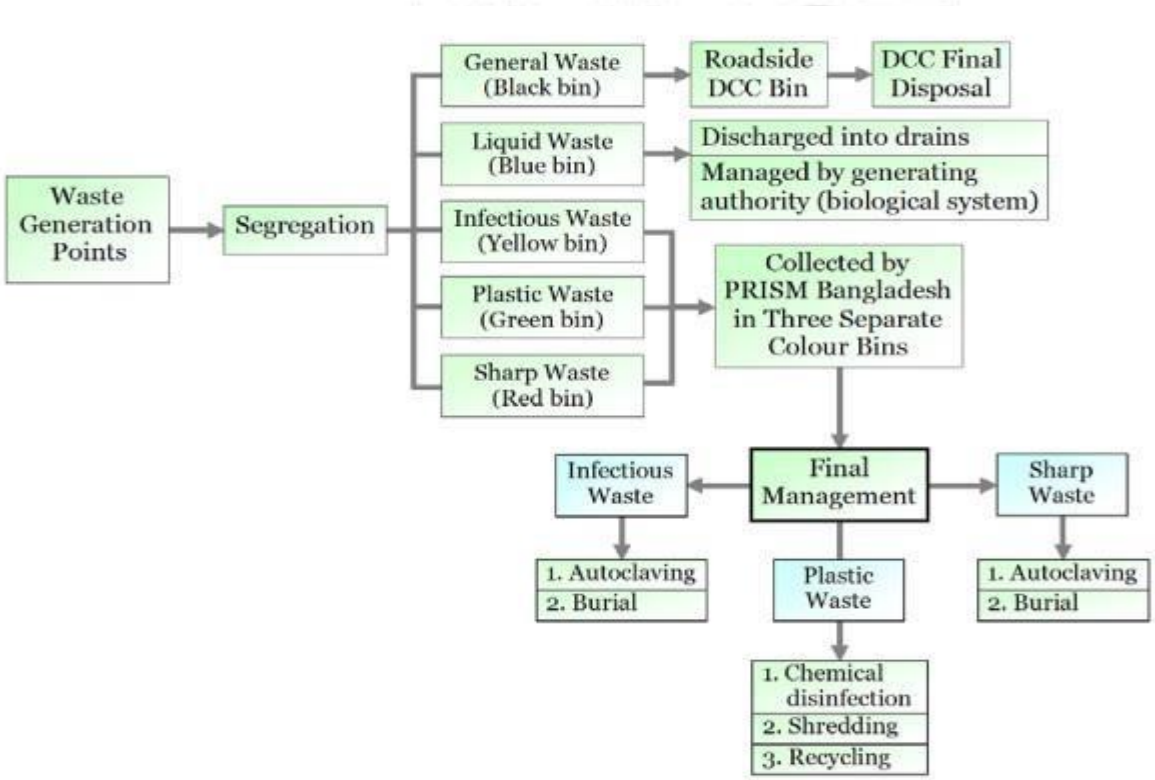


Fig. 2.4 PRISM-Bangladesh method of Medical Waste Management (Liberti, et. al, 1996)

2.18 Storage of Medical Waste

Waste has to be stored before collection and final disposal and should not accumulate in wards, corridors or places that are accessible to the general public. When containers are full to their capacity, the waste must be removed from the collection points on a 24 hour basis of its generation. Waste is not supposed to be stored for more than 48 hours (Hassan *et. al.*, 2008; WHO, 2010).

Pruss *et. al.* (1999) stated that the place where the hospital waste is kept before transported to final disposal sites is termed temporary waste storage. Location and size of any waste storage depends on the quality and type of medical waste produced and frequently collected. Storage areas should kept locked and access to these areas should be limited to personnel responsible for the handling, transportation, incineration and ultimate disposal of the waste. The storage areas should also be securely kept from wild and domestic animals, birds, rodents and insects. All internal and external storage containers are to be kept clean and disinfected. Disinfection should be placed in close proximity of the waste in case a spill occurs.

2.19 Benefits of Proper Medical Waste Management

i. Minimizes the spread of infections and reduces the risk of accidental injury to staff, patients, visitors and the community, ii. Reduces the likelihood of contamination of the soil or ground water with chemicals or micro-organisms, iii. Attracts fewer insects and rodents and does not attract animals, iv. Helps to provide an aesthetically pleasing atmosphere,

v. Helps prevent the spread of epidemic diseases.

2.20 European Union Action on Healthcare Management

European action on environment and health is guided by four documents: The London declaration on health and the environment, the Budapest declaration on health and the Chapter 3-EU environmental policy 23 environments, the European environment and health strategy and the European environment and health action plan 2004-2010. None of these measures constitutes binding legislation, but they identify key areas of action and responses to those.

The first of these documents has been created at the ministerial conference on environment and health of the representatives from member states of the WHO European region in *London in 1999*. It declares the ministers‟ commitment to “action in partnership for improving the environment and health in the twenty-first century” (WHO Europe, 1999) and sets out qualitative goals to achieve this commitment in different areas, such as water, transport and environment in relation to health and the implementation of national environment and health action plans. The follow-up conference on environment and health in *Budapest* has been concluded with a declaration, too, which emphasises the need to research and tackle children‟s environmental health and to improve environmental health in the new member states to reduce inequalities (WHO Europe, 2004).

The *European environment and health strategy* (European Commission, 2003) aims at a reduction in the disease burden attributable to environmental factors by identifying and preventing these factors and by strengthening EU capacities for policy-making in the field of environmental health. The strategy is built on the SCALE elements: being based on Science, focusing on Children, raising Awareness, using Legal instruments, including constant and continuous Evaluation. The implementation of the strategy is done incrementally, thus small steps are taken over a long period of time. The first cycle of this incremental strategy is to build up an integrated monitoring and response system for European environment and health.

Building on the provisions of the environment and health strategy, the Commission has issued the *European environment and health action plan 2004-2010*. This action plan constitutes the first cycle of implementation of the environment and health strategy, aiming at improving knowledge about the links between pollution and health effects by

strengthening research and at a review of policies. Inclusion of all relevant stakeholders in the implementation of the plan is crucial for its success. (European Commission, 2004)

2.21 National Perspective of Healthcare Waste Management

With the increasing number on concerns on health care wastes and their management in the world, the Government of Ghana through the Ministry of Local Government and Rural Development and the Environmental Protection Agency, Ghana (EPA-Ghana) drafted the "Guidance for the Management of Health Care and Veterinary Waste in Ghana", in May 2002. In the preparation of these guidelines the following observations were made:

i. There are no regulations, guidelines or effective means of control for the storage, handling, packaging, and transportation of hospital waste in Ghana.

ii. There is lack of health education and training of staff with regard to the management of medical waste.

iii. All forms of liquid waste are simply drained into sinks, and eventually into the sewerage system. (E.g. acids and alkali are usually not neutralized but occasionally diluted before disposal.) iv. Hospital and laboratory officials are unable to indicate quantities of wastes generated by them.

v. Containers for hazardous/infectious waste are not properly labelled as a caution to handlers.

vi. Most hospitals/clinics visited lacked adequate waste treatment facilities. Amputated parts are therefore being handled by the various Waste Management Departments (WMD) of the Assemblies.

vii. Scavengers visit waste dumps and collect items such as syringes to be sold for use as rollers for the hair.

viii. Animals feed on discarded human tissue from hospitals. ix. Foetal parts found in public drains.

x. In some cases, placentae are sent home for burial because of cultural beliefs.

Therefore these guidelines on health care waste are to enable health care facility administrators, environmental health officers and other Para-medical professionals, as well as District Health Management Teams and Waste Management Units at the District Assemblies, to be aware of the requirements for the proper and safe management of health care waste. The main objectives are:

i. To set out an appropriate institutional and administrative framework and procedures within which to manage and monitor health care waste.

ii. To provide the basis for policy formulation and legislation on health care waste management.

The environmental policies and legal framework in Ghana is in cognisance with global and international principles which include the "Basel convention", which is concerned with trans-boundary movements of hazardous wastes e.g. Medical waste, the "Polluter Pays" Principle, which also implies that all producers of waste are legally and financially responsible for the safe and environmentally sound disposal of the waste they produce, the "Precautionary" Principle, which is concerned with the adoption of measures to protect health and safety when the magnitude of the particular risk is uncertain, and finally the "Proximity" Principle, whereby hazardous wastes including health care waste should be disposed of at the closest possible location to its source in order to minimise the risks involved in its transport. Though the country"s current environmental policies and legal framework are in tune with global and international principles, there is no specific legislation, regulations or bye-laws for the management of health care waste. Ghana is yet

to have a Public Health Act. However there are laws and regulations pertaining to the protection of the environment and health. These include:

1. Local Government Act 462 (1993)
2. Town and Country Planning Ordinances Cap 84 (19440)
3. Ghana Building Regulations LI. 1630 (1997)
4. Vaccination Ordinance Cap 76
5. Quarantine Ordinance Cap 77
6. Mosquito Ordinance Cap 75
7. Infectious Disease Ordinance
8. Food and Drugs law 305b (1992)
9. Environment Protection Act 490 (1994)
10. Environmental Assessment Regulation LI. 1652 (1999)
11. Criminal Code Act 29 (1960)
12. Mortuaries and Funeral Facilities Act 563 (1998)

2.22 Location and Background of Hospital

Aninwaah Medical Centre popularly known as Emena Hospital was founded in the year 1991 with the vision of providing quality basic healthcare for its patrons in the catchment area and beyond. The wholly private health facility is located at Emena near Kwame Nkrumah University of science and Technology (KNUST). Emena is located on a branch road, off the Kumasi-Accra highway, approximately 15 km away from the centre of Kumasi. It is thus a suburb of Kumasi. Aninwaah Medical Centre was established by Dr.

Osei Tuffuor. The hospital currently provides specialist clinical services in Optics, Gynaecology, Surgical, Physiotherapy, Diagnostic Service and Maternity. It records an

average out-patient attendance of about 300, and 70 in-patients and a 300-body capacity mortuary.

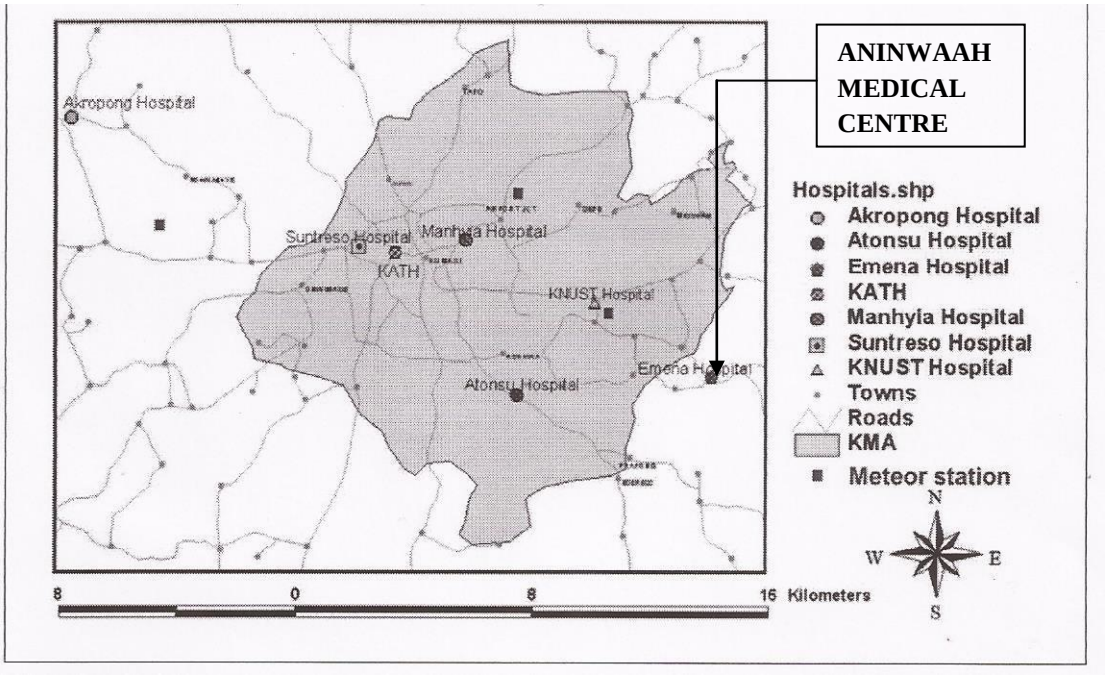


Fig. 2.5 Map showing some Hospitals in the Kumasi Metropolis (Aninwaah Medical Center, 2015)

2.23 Climate

The Ashanti Region falls within the South-western equatorial climate zone where the seasons are primarily regulated by:

- Moist, South-east monsoon winds from the South Atlantic ocean; and
- Dry, dust laden North-east trade winds known as *harmattan*, which blows over the Sahara from the Subtropics high pressure zone.
- Rainfall peaks during two periods, namely April-June and October-November with
- Mean annual rainfall of about 214mm.
- Mean monthly temperatures range of 24-28˚C

The average humidity is about 80 percent at 0900 GMT and 60 percent at 1600 GMT.

The wind direction is usually from the West to the East area of the Kumasi Metropolis.

2.24 Flora and Fauna

The surrounding of Emena is characterized by vegetation made up of shrubs, trees, plants and gardens separating one house from the other. The eastern side of the hospital has a water logged area with sugarcane farms and this is a potential breeding site for mosquitoes. Some reptiles (lizards and snakes) are found in the area

CHAPTER THREE

METHODOLOGY

This chapter describes the methods and procedures that were used for conducting the study. It includes the research design or the general strategy for conducting the study, the research setting, the target population, the sampling technique and sample size. The chapter also

presents criteria for selecting the subjects, data collection instrument, administration of these instruments, data analysis, ethical consideration and limitations of the study. The audit was carried out using the following methods and techniques:

3.1 Choice of Study Area

The Environmental Audit was conducted at the Aninwaah Medical Centre (AMC), Emena, Kumasi for the following reasons;

i. Hospital‟s operations can be taken as a representative of operations of small hospitals; ii. The readiness of management to accept the audit to be conducted of the operations, and iii. Proximity to the University (KNUST).

The audit was conducted between November, 2014 and April, 2015.

3.2 Data Collection

An initial meeting was held with the Administrator, who acted on behalf of the management of the hospital, and some senior staff of the Hospital. The meeting was to introduce the auditor (student) officially to the management of the hospital, and set the terms of reference of the audit, the scope and objectives of the audit.

Procedures for the audit were discussed and a date was set for the commencement of the audit. Information regarding the history and operations, present environmental records, and existing operational policies of the hospital was gathered from the hospital records. Operational standards for the various operations of the hospital were also sought from the appropriate regulatory bodies such as the Environmental Protection Agency (EPA) and Ghana Health Service (GHS).

Other data collection methods consisted of the administration of questionnaires, personal observation, interviews, discussions and review of existing records.

3.3 Organisational Structure of the Hospital

Aninwaah Medical Centre currently has a total of 200 permanent staff with 80 of them being Nurses, 8 Medical Doctors with the remaining being administrative staff, laboratory technicians, cleaners, labourers among others. On top of the organisational structure is the Chief Executive Officer (CEO) to whom all authority of the hospital resides. The CEO has delegated most of his authority to the General Manager (GM). The responsibility of the GM is to see to the general overview of the hospital. The hospital administrator is responsible for the implementation of the medical or clinical duties as well as the administrative and support duties of the hospital. In the Medical services are the doctors, nurses and midwives and ancillary services persons while in the support level are the accountants, maintenance officers, human resource persons, stores and security personnel. The organisational chart is shown in Fig 3.2.

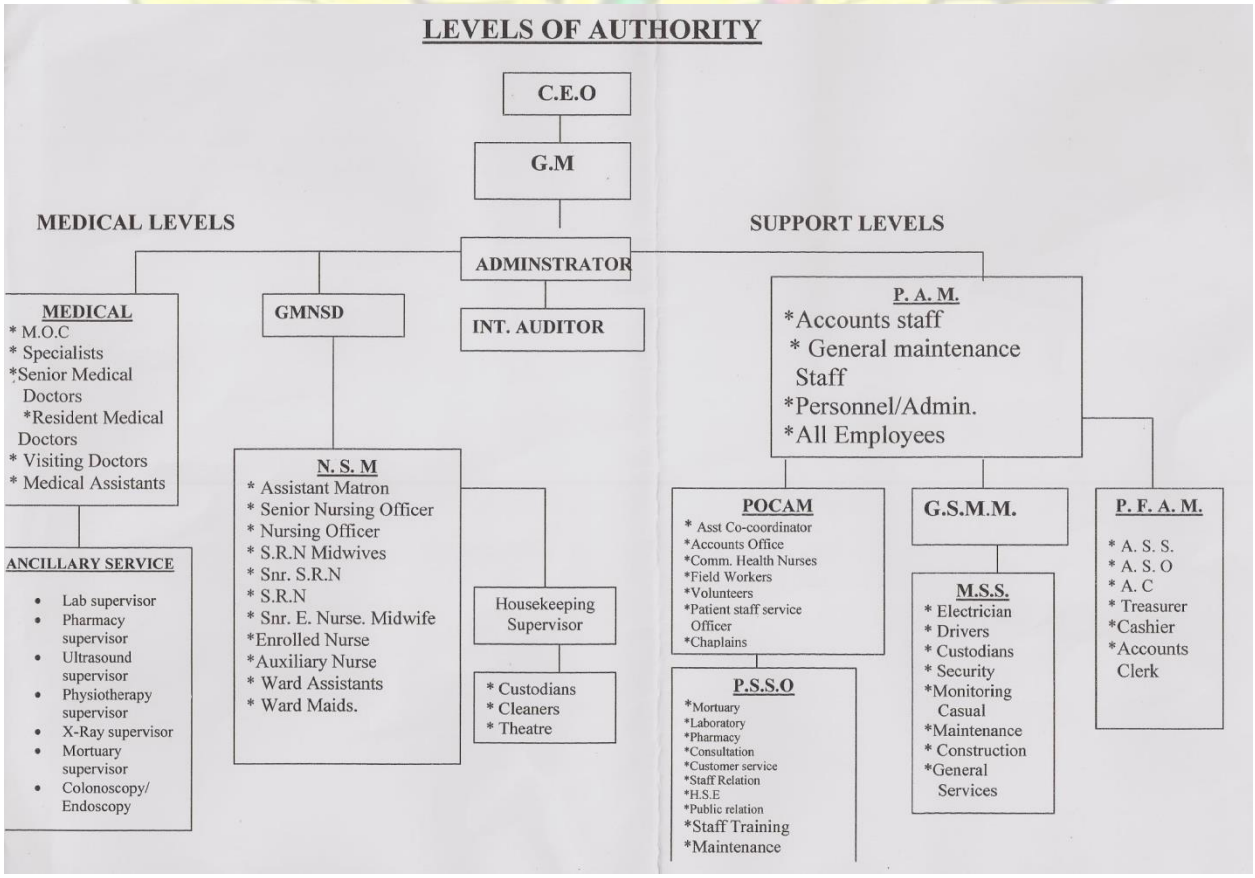


Fig. 3.1 Levels of Authority at the Aninwaah medical Centre

3.4 Research Design

The researcher used a quantitative method with exploratory approach. The quantitative research method is said to be empirical in nature and is also known as scientific research. It is a formal process that includes a method of deductive reasoning by use of measurable tools to collect relevant data and to obtain information. The quantitative method is a traditional method which is used to study phenomena that are exemplified by experiment, surveys or correlation studies of various types (Burns & Groove, 1997). While the exploratory research however is a term used to describe research on a subject that has not yet been clearly defined. It is being used because not much has been done on medical waste management in Ghana.

3.5 Target Population

A study population comprises the entire aggregation of cases that a researcher is interested in (Creswell, 2003). The population was the entire healthcare workers from which a sample may be selected for statistical measurement. The study participants included doctors, nurses, environmental health officer, and waste labourers and management members who are directly concerned in the study.

3.6 Sample and Sampling Techniques

A sample is a subject of the population that is selected for a particular study, and the members of a sample are the subjects. The sample provides the researcher with the needed information to make the research more accurate. Sampling is a representative selection of a population that is examined to gain statistical information about the whole population. The sample size refers to a group from the population on whom information is obtained

and generalized on the population (Polit & Hungler, 1995). A non-probability sampling method specifically Convenience Sampling was used in the study. Convenience Sampling is a non-probability sampling technique where subjects are selected because of their convenient accessibility and proximity to the researcher (Black, 1999). Convenience sampling is very easy to carry out and requires relative little cost and time to carry out. In convenience sampling, subjects are chosen to participate in the study because they are the nearest and most convenient persons to act as respondents and also they happen to be in the right place at the right time. A convenient sample of 100 respondents was recruited to complete the structured questionnaires. Not every element of the population had an opportunity of being included in the sample. The criteria for selection included hospital workers who were willing to participate in the study.

3.7 Instrument for Data Collection

The central, totally indispensable, part of an enquiry is the collection of data. Data collection is about using the selected methods of investigation in a systematic and professional fashion. Data collection is the process of selecting subjects and gathering data from these subjects (Burns & Groove, 1997). The data collection involves selecting subjects, collecting data in a consistent way, maintaining research controls, solving problems that threaten to disrupt the study, administering structured questionnaire, asking subjects to complete data collection forms and recording data gathered. A written questionnaire was used to collect the data and 100 copies were made, sample questionnaire in appendix 1. The questions were arranged systematically and categorized. The researcher administered the questionnaire and guided the respondents in answering the questions after which the researcher waited for the subjects to complete the questionnaire and take it back on completion. Both open and close-ended questions were used. Site visits and key informant interviews regarding knowledge of medical waste management, medical waste

generation, segregation, collection, storage, transportation, and disposal were also data collection instruments that were employed.

3.8 Instrument Validity and Reliability

To ensure the validity and reliability of the research instrument (questionnaire), the researcher submitted it to the supervisor and some other persons who are well knowledgeable in the area of research and the necessary amendment were done. A pilot study was carried out as a trial run to determine as possible whether the instrument is clearly worded and solicits the type of information envisioned (Polit & Hungler, 1997).

3.9 Data Processing and Analysis

The quantitative data from structured questionnaire was coded and a master sheet prepared before the beginning of the data collection to make data ready for entry into the master sheet using SPSS version 16.0 programme. On the other hand, data from the key informant interviews were edited every break of day to get the clear transcriptions of the interviewees‟ accounts. The various emerging themes were identified and classified. Each respondent was allowed to study and fill the questionnaire after brief introduction and explanation of the objectives of study.

3.10 Ethical Consideration

Relevant approval with regards to the ethical consideration was gained prior to data collection. Permission was sort from the management to carry out the study. An information sheet regarding the details of the study was provided to the participants and informed consent was obtained from all willing participants. Anonymity and confidentiality was also assured by not including data on participants name, house number, and telephone number as part of the personal data section of the questionnaire.

3.11 Conceptual Model

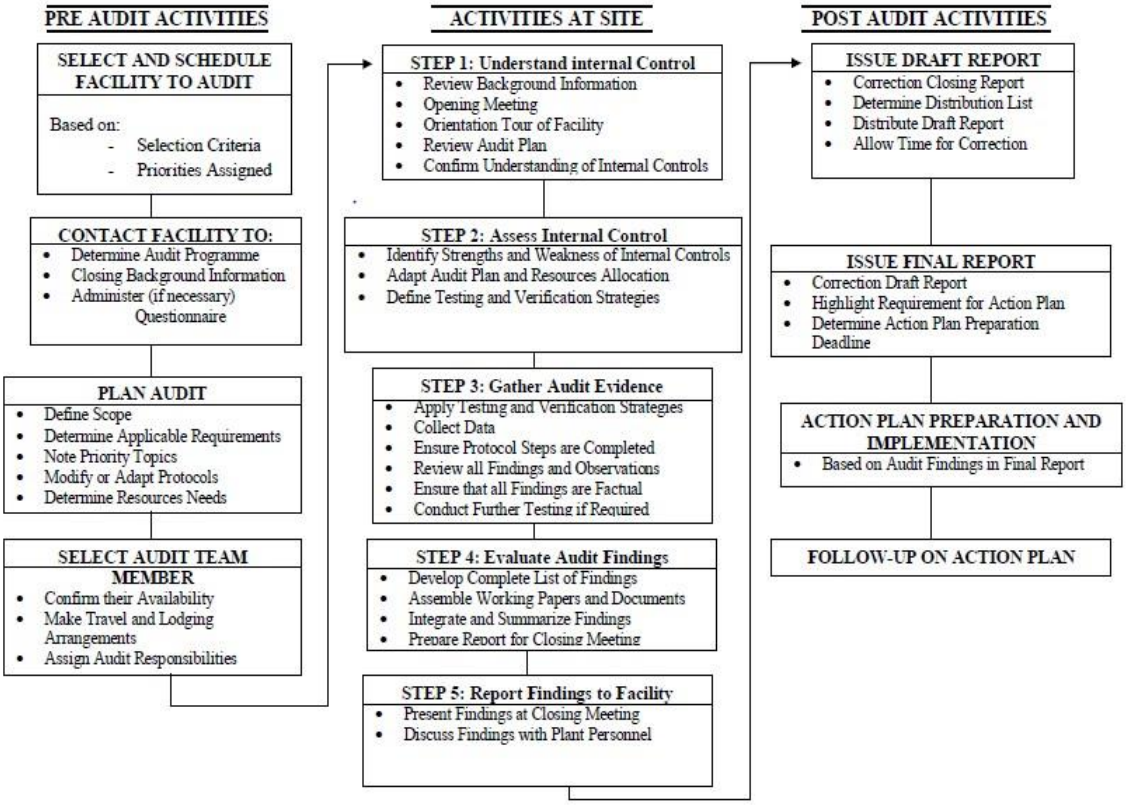


Fig. 3.3 Basic Steps of an Environmental Audit (Humphrey and Hadley, 2000)

CHAPTER FOUR

RESULTS AND DISCUSSIONS

4.0 Introduction

This chapter presents result and discussions from completed questionnaires, individual interviews, field measurements and observations from the study of total of 81 out of 100 questionnaires were completed by the study participants, translating to a response rate of 81%.

4.1 Results

4.1.1 Demographic Information of Respondents.

Results from Table 4.1 indicate that among the respondents who participated in the study, 69% were females while the others 31% were male.

Table 4.1 Respondents distribution and gender at the surveyed health care facility.

Gender	Number of respondents	Percentage (%)
Male	25	31
Female	56	69
Total	**81**	**100**

Table 4.2 shows that the majority of the respondents 61.3% were within the age group 21-40 years while 38.7% were within the age group 41-60 years with 1 percent above age 60. These results depict that there are many young people in the management of medical wastes at various the departments of the health care facility.

Table 4.2 Age distribution or respondents.

Age Group	Frequency	Percentage
21 – 30	23	29.00

31 – 40	26	32.3
41 – 50	16	19.4
51 – 60	15	18.3
Above 60	1	1.00
Total	**81**	**100**

Figure 4.2 shows that most of the respondents were nurses, making up 40.5% and ancillary staff making up 22.7%. Doctors made up 7.0%, Pharmacists 6.0%, Laboratory staff 11.8%, Radiographers 5.6% of the respondents. The category "others" which made up 6.4% included Accounts clerk, Porters, Drivers, Cleaners.

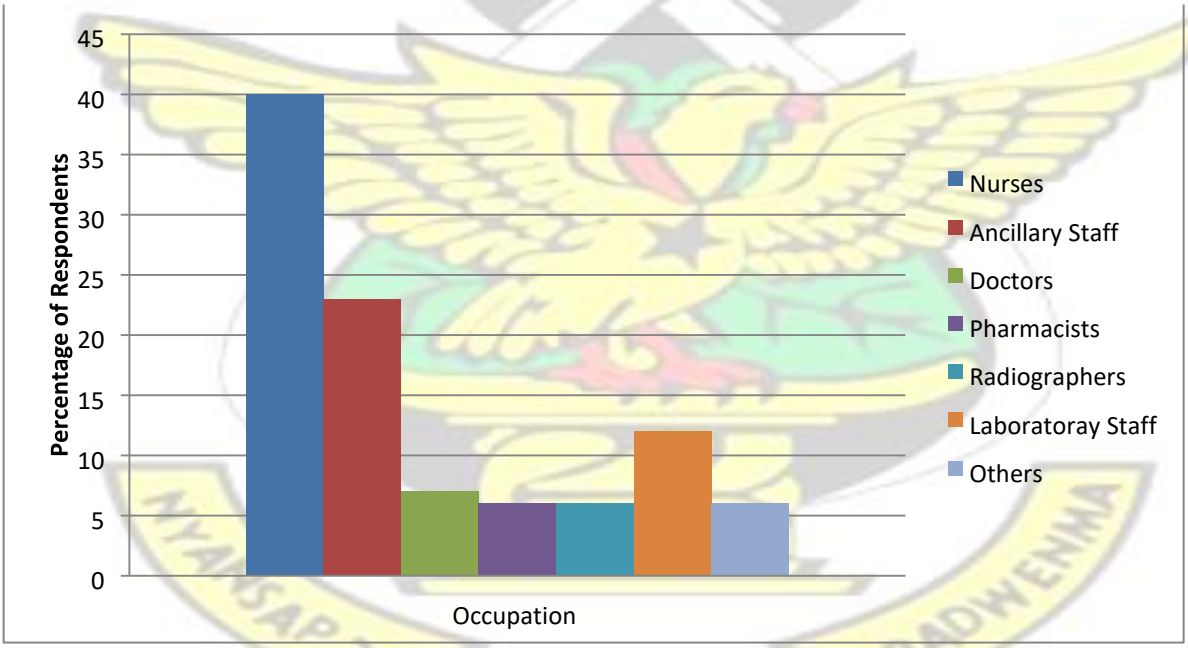


Figure 4.1 Percentage of Respondents by Occupation

Results from Table 4.3 revealed that 32% or respondents have been working at the health care centre for a period of 5 years or less, while 29% have 6-10 years working experience. However, 48% of the respondents had been working at the health care centre for over 10 years.

Table 4.3 Period of Working Experience

Period of working experience	Frequency	Percentage
0 – 5	26	32
6 – 10	16	20
11 – 15	16	20
16 – 20	15	10
Above 21	8	8
Total	**81**	**100%**

4.2 Types of Medical Waste Generated.

The nature and types of medical waste generated in the health care centre are shown on Table 4.4. The common types of medical waste mentioned by respondents were sharps (95%), dressing swabs (86%), human tissue and organs (35.5%) and fluids (25%).

Table 4.4 Types of medical waste generated daily at the health care centre.

Types of Medical waste	Percentage of Respondents (%)
General waste or non-infections	80
Sharps (used annuals, needles, surgical blades, vials, injections, syringes)	9
Pathological Waste	5

Dressing Swabs	2
Fluids	3
Others	1
TOTAL	**100**

Table 4.4 depicts that the majority of the respondents indicated that general waste/noninfectious waste and dressing swabs wastes are the most generated waste at the facility. In a similar study Hassan *et. al*. (2008) confirmed that non-hazardous medical waste, hazardous waste, needles and sharps are the most generated medical waste in surveyed health care establishments in Bangladesh.

4.2.1. Sources of Medical Waste

Interviews, observations and questionnaire revealed the principal sources of medical waste in the surveyed health care facility were from the wards (male and female), maternity and delivery unit, Laboratories, theatres, mortuary, Outpatient Department (dental, eye, surgical, medical), dispensaries and pharmacy, ambulances, blood banks, administration (accounts office, reception), canteen and laundry room.

According to literature, the principal sources of medical wastes are hospitals and clinics; because of the services they offer such as operating theatres, maternity, accident and emergency services, intensive care, pathology, pharmacy, Laboratory and research facilities (Blerkhara, 1995). Other sources of medical wastes reported are immunization/ vaccination clinics, blood banks, nursing homes, practice centres of doctors and dentists (Press *et. al.*, 1999).

4.2.2 Medical Waste Generation Quantities in the Surveyed Healthcare centre

Medical waste generation quantities in the healthcare facility were obtained by actual measurements using appropriate weighing scale. The amount of medical waste generated from the healthcare centre was determined by weighing on a daily basis for a week and the total and average amount of waste generated was determined.

Table 4.5 Summary of the total and average Medical waste generated at Aninwaah Healthcare.

Day	Number of Patients at Aninwaah Healthcare Centre	Average Medical waste generated: kg/day	Generation rate: kg/patient/day
1	150	21.95	0.146
2	198	28.7	0.145
3	205	30.1	0.147
4	175	25.3	0.145
5	187	23.5	0.126
6	234	36.1	0.154
7	169	26.45	0.157
Total = 1,318		192.1	1.02
Average Total = **188**		**27.44**	**0.146**

The study revealed an average of 188 in and out patients is there in Aninwaah Medical Centre daily. The study also revealed that the healthcare facility generates 0.146kg/patient/day of medical waste, (Table 4.5). Cheng *et. al.* (2009) reported that the amount of medical waste generated from medical establishments is associated with the type and size of the institution. According to Pruss *et. al.* (1999), the generation rate of the economic status of a country with large variation expressed as the amount of waste per bed/ day or per capital/ day. Any increase in number of beds and services might change the waste generation rates. This scenario was confirmed by the findings by Abd El- Salam

(2010) in El- Beheira in Egypt, where 2.07kg/ bed/ day was found to be generated from one of the surveyed hospitals which had a large number of bed (590), service (26 departments) and a high occupancy rate (104%).

Abdulla *et. al.* (2008) reported that generation rate of medical waste in Northern Jordan health care facilities was influenced by bed occupancy, size of health care facility and types of service provided. Jang (2011) added the geographic location, the amount of disposable or reliable medical devices and the degree of regulation enforcement at national and local level also influences generation rate of medical waste. Reports from studies indicate that hospitals/ healthcare facilities in developing countries generate lower amounts of medical waste: South Africa 0.6kg/ bed/ day, Algeria 0.7 - 1.22kg/bed/ day, and Libya 1.3kg/bed/ day (Nemathaga *et. al.* 2008, Bendjoudi *et. al.*, 2009 and Sawalem *et. al.*, 2009).

Nemathaga *et. al.* (2008) reported that the studied hospitals in South Africa have low generation rates because they are not situated in highly urbanized environment, bed occupancy rate and services healthcare facilities provide. In the same work, reported that medical waste generation rate for developed countries such as Canada and USA were reported to have high generation rates that range from 4.3 to 5.8 kg per bed/ day. This is because developed countries‟ life style, consumption of high amount of goods and services which tend to generate large amounts of waste (Jang, 2011). Hossain *et. al.* (2011) revealed that medical wastes are yet to be appreciated to the fullest in developing countries and are still handled and disposal together with non-medical waste.

Data collated from the questionnaire respondents indicated that 29% of them (questionnaire respondents) were able to provide information on amount of medical waste generated per day in kilograms. About 5% of the respondents provided data on amount of medical waste generated in forms of plastic bags collected per day while 66% of health

care workers indicated that they did not know the amount of clinical waste generated per day. Result revealed that those who were able to quantify medical waste were waste handlers and cleaners. This was because they are the ones responsible for the collection and management of medical waste to storage places. Interviews results also revealed that the health care facility managers of the health care facility could not provide data on daily generation of medical waste.

4.3 Medical Waste Management Systems and Management

4.3.1 Medical Waste Segregation

According to a draft report "Guidance for the management of Health care and veterinary waste in Ghana", 2002, medical waste must be separated from the other type of waste at the source of generation using colour codes (bags and containers). It was observed during the study that waste segregation is not done at point of generation. Yet about 95% of respondents of the questionnaire said that medical waste generated was segregated at the point of generation while 5% said No. It was however observed that waste segregation was done at the storage point. Medical waste was found to be segregated and collected into bags and containers in the healthcare facility. About 48% of the questionnaire respondents rated segregation as poor, 35% respondents rating as good 15% very good while only 2% rated it excellent. However results from interview with hospital waste managers (Maintenance Officers) revealed that separation of medical waste was not done to satisfactory extent. Poor segregation was also observed that all waste was put in black receptacles which are used to store domestic waste. It was also observed that from the residuals/ash from incinerator showed a mixture of tins for soft drinks and bottles. Results of this study are similar to those of a survey done by Abdulla *et. al.* (2008) in Jordan, who reported that the problem encountered in hospital waste management, was inappropriate segregation. A study in Bangladesh by Hassan et al. (2008) revealed no proper and

systematic segregation of medical waste. He also reported that in Dhaka health care facilities, some cleaners were found salvaging used sharps, saline bags, blood bags and test tubes for resale. Similarly, segregation was not done according to definite rules and standards in three District hospitals studies in Malaysia.

4.3.1.1 Awareness of how Medical Waste is segregated

According to the WHO, 2000, the proper packaging of medical wastes prior to their ultimate distribution or disposal is the most crucial element of any waste management programme to prevent contamination of handlers or the environment. Generally medical wastes are segregated according to the recommended colour coded bags and containers as prescribed in "Guidance for the Management of Healthcare and Veterinary waste in Ghana, 2002." About 65% of respondents from the healthcare centre were able to explain how segregation of medical waste is applied while 35% of them did not know how segregation is done. Results show that among those who were not able to explain the segregation process were nurses, laboratory technicians, drivers, accounts clerks and porters. Results reveal that these healthcare workers have not received training concerning how medical waste is managed.

Most of questionnaire respondents reported that medical waste is put in black plastic bags as well as domestic waste. However sharps were collected in rigid yellow containers which are clearly labelled with the name of the ward and hospital. In similar study conducted in Egypt, Abd El-Salam (2010) reported that WHO in 2000 recommended that bags or sharps containers should be replaced when it is $^{3}/_{4}$ full.

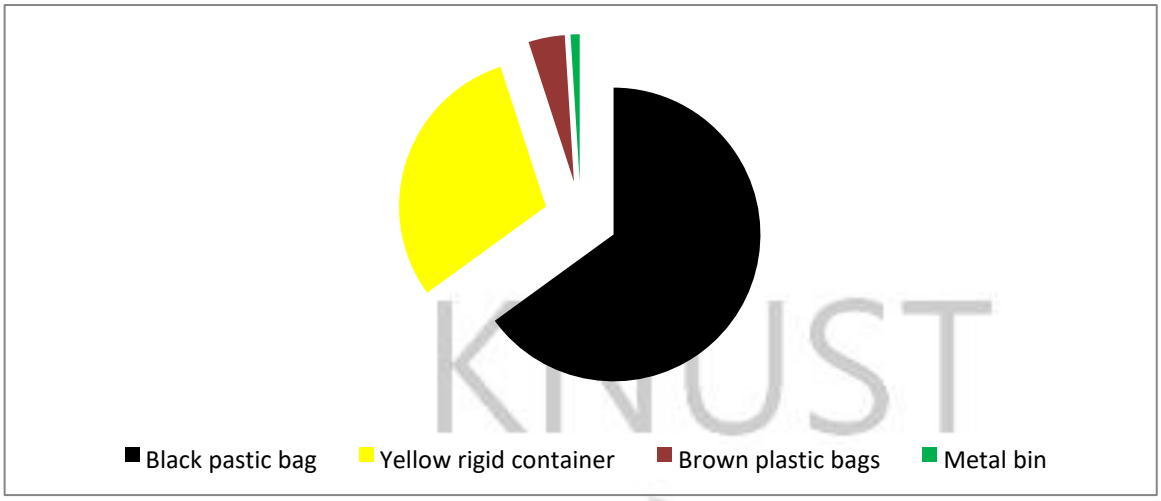


Figure 4.2 Containers where Medical waste is stored.

According to the questionnaire respondents, the common storage receptacles are black plastic bags (65%) and yellow rigid containers (30%) other containers (collectors) included brown plastic bags and metal bins, 4% and 1% respectively. The waste collected from these containers were weighed and segregated. Abdulla et al, 2008 revealed a study in Jordan that all studied hospital used colour coded receptacle to store medical wastes. It further revealed that sharps are segregated in yellow containers and red bags are used to store highly inflections wastes. In the USA, all medical waste are put in red bags while in Canada, medical wastes are put in red, yellow or blue bags according to the MOH‟s classification (Blenkhern, 2011). Some healthcare centres in Nigeria were also reported to use inappropriate receptacles like any plastic bags, paper bags or card board to collect medical wastes (Coker *et. al.,* 2009).

4.3.2 Handling and Storage of Medical Waste

4.3.2.1 Use of Protective clothing.

A total of 95% of the respondents use protective clothing when handling medical wastes while 5% do not use protective clothing.

Table 4.6 Use of protective Clothing when Handling Medical wastes

Respondents‟ Response YES	95
Percentage respondents‟ Response NO	5
Total	**100%**

It was revealed that gloves and nose masks were the common protective clothing mentioned by 93% of questionnaire respondents. Most of the respondents from the healthcare centre indicated that protective clothing like aprons, boots, overall among others were in short supply. In a study conducted in Istanbul, Turkey, medical waste collection personnel in surveyed healthcare facilities wore appropriate uniforms and apparatus. It is also revealed in interviews that there is enough supply of hand gloves and nose masks for cleaners at the centre. However, the gloves used were the surgical kinds which were not appropriate to handle most wastes by waste handlers. Medical waste handlers responsible for collection of medical wastes from the contracted company were observed not all of them wearing complete protective clothing. Muchangong (2010) reported similar to this study that was conducted in the Northwest region of Cameroon, where 77% of medical waste handlers in surveyed healthcare facilities lacked protective equipment. Gloves, overall gowns and masks to protect workers were not provided in studied healthcare facilities.

4.3.2.2 Handling of Medical Waste

According to respondents, they rated handling of medical wastes as follows: 18% poor, 25.3% good and 35.9% very good while 20.8% rated it excellent. It was however later revealed through observation that the handling of medical waste in the healthcare facility

was not systemic. Cleaners were observed carrying medical wastes with their bare hands to storage containers without complete protective clothing (protective boots, industrial gloves, overall gowns and masks).

4.3.3 Storage of medical waste

The place where medical waste is kept before transporting to final disposal site is called a temporary waste storage area. World Health Organization, WHO (2000) proposes central storage rooms in special areas or on the grounds of hospital where larger containers ($1.1m^3$) for wheeled bins should be used to store medical waste until it goes for final disposal either on or off site. This area must be well sanitized and secured in such a way that it should be only accessible to authorized personnel (Pruss *et. al.* 1999). However, it was observed that the waste disposal site (on-site) was not well sanitized and secured as scavengers, rodents and other animals were seen loitering around the waste. It was also observed that medical waste was disposed early in the morning and in the evening at the wards while waste at disposal site was disposed by a contracted company.

According to results from a similar survey in China, Yong *et. al.* (2009) reported that 93% of hospitals had temporary storage locations and in some hospitals, the temporary storage facilities were not satisfactory as they were close to the municipal waste storage area. In some hospitals in China, the storage areas were not sufficiently cleaned after medical waste was transported to disposal facilities (Yong *et al.*, 2009). In a similar report in Istanbul, Turkey, 63% of the hospitals have temporary storage depots and 94% of these satisfy WHO requirements (Birpinar *et. al*., 2009)

The situation at the Aninwaah Medical Centre was that the centre uses external temporary storage containers for medical waste storage. The storage containers are located outside the buildings. It is therefore not under lock and key. Storage containers in the healthcare

centre were not cleaned after medical waste was transported to disposal/treatment places. Storage location of storage containers should be inaccessible to unauthorized people, animals, insects, and birds; they should be placed where there is good lighting, good ventilation and be protected from the sun (Pruss *et. al*., 1999).

4. 3.4 Collection of Medical Waste for Treatment.

Table 4.7 shows that most of medical waste, 51% is collected daily and 9.0% is collected once a week while the 40% is collected twice a day from the wards.

Table 4.7 Respondents response on frequency of medical waste collection services surveyed healthcare facilities.

Daily	Twice per day	Weekly	Two week	Month
51%	40%	9.0	0	0

Kumasi Metropolitan Assembly Sanitation Department is not responsible for collection and transport the medical waste, rather Asadu Waste Management Company. It was observed that the private waste management company did not frequently come for the waste from the external temporary waste container.

Bdour *et. al.* (2007) reported that in Jordan, the collection is done by a private company at the beginning. Coker *et. al.* (2009), reported that in Ibadan, Nigeria, studied healthcare facilities had no definite or regular collection time, medical waste was always over spilling from containers because of not being collected.

4.3.5 Transportation of Medical waste (Onsite)

It can be seen from the study that the healthcare facility has the responsibility of providing onsite transportation of medical waste, while offsite transportation to final disposal/treatment site is handled by disposal company, Asadu Waste Management

Company. There is regular mode of transport to medical waste to an opened storage bin; however the private waste management company has not been coming regularly for the waste from the temporary waste container. Similar onsite transportation practices were also reported in healthcare facilities studied in Malaysia and China, where medical waste is transported to storage room using rickshaw trolleys (Dasimah *et. al*, 2012; Kumari *et. al.*, 2012).

All respondents indicated that the common mode of transporting medical waste to storage containers is by hand. However waste handlers at the healthcare facility use surgical gloves instead of protective gloves. Ad El-Salam (2008) reported that in Bangladesh internal transport to temporary storage areas are carried out manually by waste handlers without protective clothing, increasing the potential risks of accidents, personnel injuries from protruding sharps and strains of the back due to weight. Dehgham *et. al.*, (2008) reported that similar results where 46% of healthcare facilities in Iran transfer medical wastes to temporary stations manually using hands.

4.3.6 Treatment of Medical Waste

The treatment practices for medical waste generated in the healthcare facility were investigated. It was observed that the healthcare facility uses an incinerator, open-air burning, chemical disinfection, and land filling. Abdulla *et. al.* (2008) revealed that the most frequently used treatment practice for solid medical waste was incineration. All respondents were aware that medical wastes are incinerated. Although incineration was the major treatment method applied in this study, WHO (2010) also suggests other treatment methods like microwaves, autoclaving, sterilization, and land filling. Visits to the facility indicated that they use open air burning, chemical disinfection and land filling apart from using incineration. The solid medical wastes are burnt using diesel with temperature of about 600˚C. The incinerator is provided with scrubber to trap toxic air

pollutants emitted. Loading and dishing operations of incinerator are performed manually. It was usually seen that the incinerator was overloaded with medical waste since it was observed to be too small to contain the wastes. Interviews revealed that there was no regular maintenance programme for the incinerator since maintenance was only conducted when there are operational problems.

However, Abd El-Salam (2010) reported that in El-Beheira, the incinerators operate below the recommended temperature. This means that the wastes were not completely destroyed and the ash moves to a collar portion of the incinerators where it hardens into slag. Sawalem *et. al.* (2009) have reported that several studies in developing countries healthcare facilities incinerators are poorly designed and often have operational problems.

4.3.7 Disposal of Medical Waste

It was observed from the frequent visits to the facility that most of the medical wastes are taken to disposal site to be transported to the landfill site while others were incinerated and buried. The ash residues are removed frequently before incineration of a new load. The operator cleans the incinerator and removes ash. The residuals and ash removed are dumped close to the incinerator. Nemathaga *et. al.* (2008) reported that the incineration residues from the surveyed healthcare facilities were openly dumped at sites close to incinerators. These practices are contrary to WHO (2010) recommendation where incinerator residues are to be disposed in a designated place in a landfill.

4.3.8 Training on Medical Waste Management

It is very important for healthcare workers and operatives to be abreast with knowledge on the dangers and hazards that may occur during the discharge of their duties. Therefore, they need to be trained or oriented on the health and safety measures. Proper handling of

different types of waste is of paramount importance for health and safety at the workplace in order to minimize risks (WHO, 1999).

Questionnaire results indicated that 47% of respondents had received training on medical waste management while 53% did not receive any training. It was reported in interviews that there were no scheduled programmes for in-service trainings and workshops on medical waste management. It was reported that the last training was conducted nine (9) years ago. However, it was realized that though there have been little or no formal training programmes in the facility for workers, many of them have a good knowledge of medical waste management due to long service and experience which had given them on-job training opportunities. Birpinar *et. al.* (2009) reported that in Istanbul healthcare in Turkey, 98% of the healthcare facilities organise training courses for the collection personnel and training is carried out twice a year. Kumari *et. al.* (2012) indicated that regular and updated training and awareness programmes were conducted in every department as per requirement in a studied medical hospital in China and certificate of proficient are offered. Coker *et. al.* (2009) reported that in Ibadan, Nigeria healthcare workers were not educated enough in management of medical waste and most of them have not had any special training on management of medical waste. Abdulla *et. al.* (2008) also reported that training programmes on medical waste management for nurses, doctors and technicians were limited in Jordan, as about 92% of the hospital had not provided training to doctors and other personnel on medical waste management.

4.4 Medical Waste Management Documents and Policy

The Aninwaah Healthcare Centre has a well written code of conduct and values which is to guide healthcare workers on managing and handling all sort of wastes generated in the healthcare facility. Results from the respondents indicated that 65% of the healthcare workers are familiar with the code of practice and values with 35% not familiar with this

code of practice and values. Management of the healthcare facility is aware of document which was prepared jointly by the Ministry of Local Government and Rural Development, Ghana and the Environmental Protection Agency, Ghana in May 2002. However since this report is yet to be given a parliamentary approval or sanction, the healthcare facility cannot strictly implement everything in it. The report is captioned "Guidance for the Management of Healthcare and Veterinary in Ghana." The healthcare facility complies with other Laws and Acts enshrined in the constitution of Ghana which includes the Local Government Act 462 (1993), Vaccination Ordinance Cap 76,

Infectious Disease Ordinance, Food and Drugs Law 305b (1992) among others.

Mbongwe *et. al.*(2008) reported that many healthcare workers in Botswana have never seen or used the Botswana Clinical Waste Management Code of Practice, 1996. In a similar study, Abor (2007) reported that in surveyed healthcare facilities in South Africa, there is no clear policy or plan in place for managing medical waste. However, the Kotuba Hospital in South Africa has a medical waste management guideline prepared by the head of infection control, but it is not strictly followed. Abdulla *et. al*. (2008) indicated that 29% of the healthcare facilities studied in Northern Jordan have policies that deal with medical waste, 10% of the hospitals have formal guidelines for medical waste management and 38% indicated that they were verbally informed about the national regulations. Abdulla *et. al.* (2008) highlighted reasons for noncompliance of these policies which include: lack of awareness, shortage of technical assistants to implement them and they are too costly to implement at their facilities.

4.5 Effectiveness of Medical Waste Management Practices

Most of the respondents‟ in the facility rated the medical waste management practices as very good. 17% of the respondents rated the management practice as excellent, 38% of

them rated it as very good while 25% rated the waste management practice of the facility as good with 20% of them rating it as poor. Dasimah *et. al.* (2012) reported the management of medical waste in studied district hospitals in Malaysia was effective; it follows required standards and regulations.

It was revealed in an interview that the facility does not keep or record any medical waste management information. It was realized that records are kept for needles pricks and injuries that occur during treatment of patients. Coker *et. al.* (2009) reported that the present management practices for dealing with medical waste in Ibadan, Nigeria are ineffective.

4.6 Initiatives taken for effective Management of Medical Waste

It was realised in the study that there are no initiatives in the healthcare centre for the effective management of medical waste. Since there has been no training in medical waste management practices for healthcare workers and nobody was willing to take the initiative since medical was not considered a core business of the healthcare facility.

4.7 The problems encountered in the Management of Medical Waste

Response from the questionnaire respondents and interviews identified the following problems in the management of medical waste in the Aninwaah Healthcare Centre.

- Inadequate supply and shortage of complete protective clothing in the handling of medical waste.
- Improper segregation, as empty tins and bottles of drinks are sometimes found in the ash of incinerator.
- It was revealed that there is inadequate supply of waste bins as it was sometimes seen that the available bins were overflowing with waste.

- Storage containers were badly managed and insecure due to lack of fencing and surveillance. Rodents and other animals as well as scavengers are seen loitering around.
- Lack of training for hospital workers especially the medical waste handlers. Jang (2011) indentified common problems in establishing sustainable management of medical waste in developing countries which include: insufficient financial and human resources for proper management of medical waste, ineffective legislative regulations for medical waste, shortage of healthcare workers and lack of public awareness about potential health effect arising from medical waste.

4.8 Potential Risks and Management

Almost all questionnaire respondents reported to have knowledge of the potential risks associated with a medical waste. 97.5% of the questionnaire respondents were aware of the potential risk involved in medical waste with 2.5% having no knowledge of any potential risk the medical waste poses.

4.8.1 Risks of Medical Waste on Human Health

The study revealed that no medical waste related diseases were reported by questionnaire respondents; however, a few cases of injuries to personnel were reported during handling, collection and disposing of medical waste. There have also not been any incidents of outbreaks of diseases related to medical waste in the past 12 months. Reported cases of injuries were at 8% while 92% did not encounter any injury. Needle pricks and blood splashed were the main risks reported during the handling of medical waste. An average of 4 needle pricks per year was reported at the facility. The individuals were tested for HIV and Hepatitis B and C, however they tested negative to the diseases and were given further necessary treatments.

Coker *et. al.* (2009) revealed that incidences of contraction of diseases are prevalent among waste handlers, compared to incidences of other hospital staff in Ibadan healthcare facilities in Nigeria. Waste handlers are exposed to occupational hazards or infections and known to suffer directly from handling medical waste in Ibadan healthcare facilities. Turnberg (1996) revealed that in the USA, waste handlers involved in handling medical waste have a 2.7 to 4 times more chance of getting infected by HIV compared to other staff working inside a healthcare facility.

Coker *et. al.* (2009) indicated that hospital records confirm that incidences of viral blood infection such as HIV, hepatitis B and C, skin infection, cholera, tuberculosis, bronchitis, food poisoning and typhoid fever were the contracted diseases, ailments and health risks indicated by waste handlers which originate from medical waste in healthcare facilities in Ibadan, Nigeria. Mochungong (2010) reported in surveyed healthcare facilities in Cameroon that waste handlers suffer from eye burns, skin related diseases, asthma and pneumonia due to shortage of protective clothing. Jang (2011) reported that in developing countries there was growing concern about the emergence of infectious diseases such as tuberculosis, hepatitis B and C, diphtheria and cholera caused by contact with waste materials.

Inadequate supply of bins also lead to the inappropriate segregation of medical waste which will not only have a serious threat to the general public, operatives and the environment but mostly to refuse collectors and cleaners who are usually not equipped with adequate protective clothing to handle such waste. Improper segregation of medical waste by staff was reported to result in needle pricks and cuts.

4.8.2 Risks of Medical Waste on the Environment

The study revealed that domestic waste, tin, bottles, and papers are disposed together with medical waste. It was also realised that incinerator does not burn at the right temperature (600^oC) therefore causes incomplete combustion to release noxious gases like furans (C_4H_4O) which pollute the air. Medical waste pollutes the soil and makes the environment filthy. Leachates from open storage bins pollute the soil. It was reported that most of the liquid wastes are disposed into the stream nearby which may contaminate water resources and underground water.

Furthermore, medical waste residuals deposited at the landfill have potential to result in the contamination of underground waters.

4.8.3 Risk Management

Questionnaire results show that 96% of respondents have received hepatitis B vaccination with only 4% not vaccinated against hepatitis B. Rouyan *et. al.* (2010) reported that 70.8% of healthcare workers in studied district hospitals in China received hepatitis C vaccination before starting work.

4.9 Solutions for Effective Management of Medical Waste

Questionnaire respondents were asked to give solution for effective management of medical waste. 30% of respondents were of the view that the Ministry of Health, MoH should organise workshops and trainings for all healthcare workers. 15% stated that an effective and efficient segregation system should be developed and implemented. 75% of the respondents suggested that frequent medical trainings must be organised for them and protective clothing must be easy to access. 6% of the respondents suggested that bins and containers must be labelled and disinfected regularly after medical waste is collected. 16% suggested that healthcare workers should know and understand the potential risks

associated with medical waste and importance of consistent use of personal protective equipment. Interviews with management revealed that the draft report for medical waste handling must be given a parliamentary approval and be passed into law.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

The research was carried out to conduct an environmental audit at the Aninwaah Medical Centre, Emena-Kumasi. In this chapter, the conclusions and recommendations are given in relation to the results and the objectives of the study. It provides areas of opportunities for further research.

5.1 Conclusions

This section is to bring to the fore the contributions the study has made to knowledge and indicate the managerial implications of the study. In conclusion, the main findings of the study are identified as follows:

- The medical waste generation ranged from 0.126*kg/patient/day* to 0.157*kg/patient/day* at the Aninwaah Medical Centre with an average of 0.146*kg/patient/day*
- Segregation was not constantly followed. Poor segregation was reported where instances of medical waste was mixed with general waste as it was observed at the incinerator. It was observed that the most common receptacles were black plastic

bags and they were used to collect almost all waste generated in the healthcare centre.

- The handling of medical waste at the Aninwaah Medical Centre was done by healthcare workers. These workers perform all activities without proper training and insufficient protection. Inappropriate protective clothing was observed being used by waste handlers in the healthcare facility.
- It was observed that the facility used external temporary storage containers for medical waste storage. It was however accessible to unauthorized persons and animals. The containers in the facility were not cleaned after medical waste was transported to disposal/treatment sites.
- Collection of medical waste is outsourced to a private company, Asadu Waste Management Company. Collection was not done effectively.
- The Aninwaah Medical Centre is responsible for providing onsite transportation of medical waste. There were regular modes of transport of medical waste to an opened storage bin after which the private waste collection company transported them to the off site for final treatment/disposal.
- The most common treatment method used for medical waste was incineration. Interviews revealed that there were no regular maintenance programmes for the incinerator. Requirements for residual/ash disposal were not adhered to.
- It was observed through interviews that there were no scheduled programmes for in-service trainings and workshops on medical waste management. It was realised that the last training for workers in the facility was conducted 9 years ago.

Healthcare workers‟ knowledge of medical waste management was due to long service and experience which had given them on-job training opportunities.

- About 65% of respondents were familiar with the code of practice and values for managing and handling all sort of wastes generated in the healthcare facility.
- The study revealed that medical waste management at the facility is not properly managed. This was because a number of aspects of managing medical waste are left behind not done.

5.2 Recommendations

The current practices of medical waste management at the Aninwaah Medical Centre were assessed and areas of noncompliance were identified. Based on the findings of this study, there is the need to improve on the medical waste management practices at the facility. To achieve this, some recommendations are presented for different aspects of medical waste management.

5.2.1 Generation, Segregation and Handling

- Hospitals should have weighing facilities and wastes generation rate should be benchmarked using a standard guidance.
- Documents pertaining to quantity of medical waste generated and its management practices in the hospital should be maintained and updated.
- The waste generated in the healthcare facility should be clearly defined.
- It is critical that wastes are segregated at the point of generation prior to treatment and disposal. No matter the final treatment strategy for treatment and disposal of wastes.
- Healthcare facilities should ensure that different types of receptacles with recommended colour coding in adequate quantities are continuously made available in order for medical waste to be segregated.

5.2.3 Storage, Collection and Transportation

- A secured storage facility should be built for the facility. This storage facility must be under lock and key. “No entry” sign should strategically be placed to inform unauthorized persons of dangers of entering controlled area. It should be secured from rodents and flies.
- Storage facility should be cleaned and disinfected to reduce possibility of risks that may occur as a result.
- Medical waste should be transported on-site in suitable wheeled and leak proof/puncture free containers which are clearly marked BIO HAZARD in all hospitals.

5.2.3 Treatment and Disposal

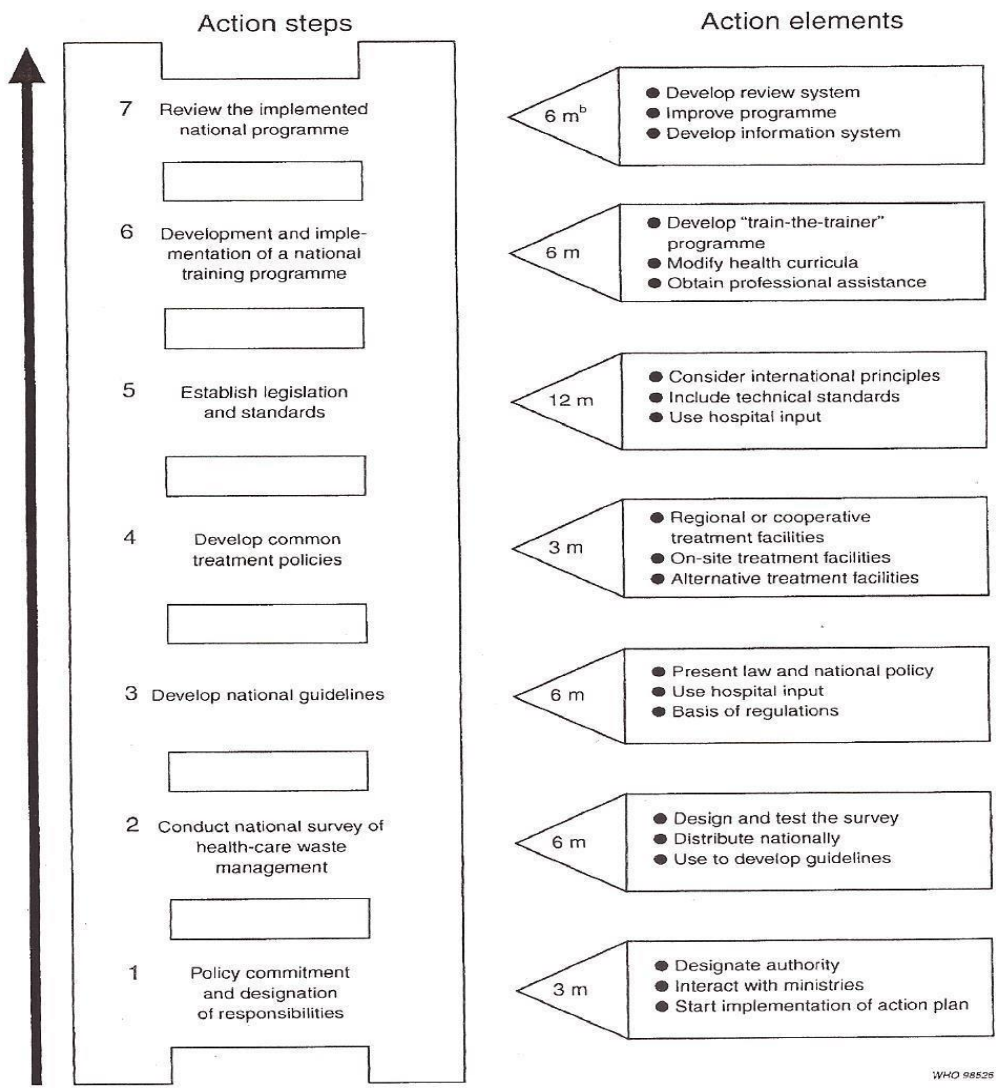
- Waste managers and administrators of healthcare facilities should follow up wastes collected within their facilities and check if the wastes have been appropriately treated and disposed of in order to minimize risks to human health and environment.
- Government should through the Ministry of Health (MoH) give licences to healthcare facilities to own their incinerators.
- Wastes like tins, bottles and plastics should be recycled and not incinerated.
- Hospitals should adopt some effective treatment methods like autoclaving, hydroclaving, microwaving, and encapsulation among others to treat medical waste.

5.2.6 Training and Education

- All staff of healthcare facilities should be progressively trained on medical waste management issues to ensure complete awareness and compliance to standards and guidelines.
- The MoH should periodically evaluate the effectiveness of training and education programmes.
- MoH should develop training modules in English language and local dialect on medical waste management procedures for all health personnel at different levels.
- Information with respect to risks involved in medical waste management practices should be disseminated to the public.
- The MoH should expand capacity building and training of healthcare workers in medical waste management at national level.

5.2.7 Medical Waste Management Aspects

- Hospitals should develop strategic plans for dealing with the management of medical waste issues which include performance indicators in order to address health and environmental risks.
- The draft report should be reviewed and upgraded in order to meet the current international standards and local guidelines on medical waste management.
- Parliament of Ghana should pass the draft report prepared jointly by the Ministry of Local Government and Rural Development and the Environmental Protection Agency, Ghana in May 2002 into law.
- The MoH should develop a National Environmental Action Plan which would help management in a holistic manner.



[a]Source: WHO (1997).
[b]Time (months) to complete action.

Fig. 5.1 Action Plan for National Programme of Healthcare Waste Management

- The MoH should use mass media to sensitize the general public and raise their awareness level on health and environmental risks associated with improper management of medical waste.
- Healthcare facilities should manage risks so as to protect human health and environmental risks associated with inappropriate management of medical waste.

Summary of Healthcare Waste Management

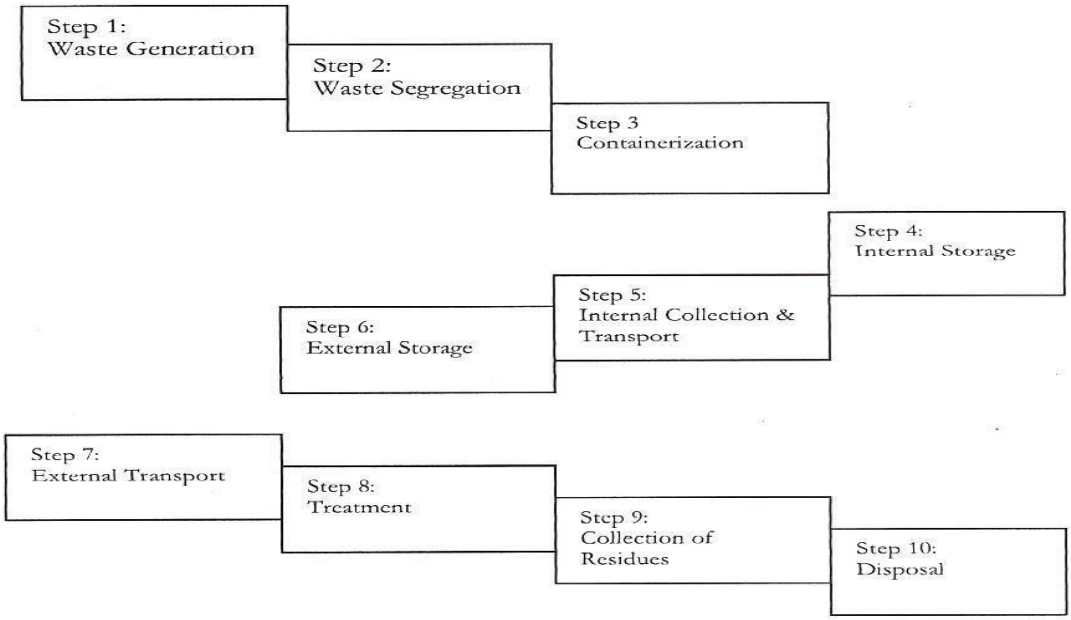


Fig. 5.2 Steps in Healthcare Waste Management

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APPENDICES

APPENDIX 1

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY COLLEGE OF ENGINEERING DEPARTMENT OF MATERIALS ENGINEERING

QUESTIONNAIRE: ENVIRONMENTAL AUDIT OF SMALL HOSPITALS, A STUDY AT THE ANINWAAH MEDICAL CENTRE.

My name is Samuel Akwasi Adarkwa, and I am carrying out a study on the evaluation of medical waste management at the Aninwaah Healthcare Centre. This study is a requirement in partial fulfillment for the completion of a Master Degree in Environmental Resources Management with the Kwame Nkrumah University of Science and Technology (KNUST).

Information collected will be treated confidentially, only the researcher and the college will have access to information provided and the results will be used for academic and research purposes only. Participation in this survey is voluntary and you can withdraw from the study without any obligations, but you are encouraged to take part and answer all questions to the best of your ability.

Section A (Demographic Data)

1. Gender: Male [ ] Female [ ]
2. Age: 21-30 yrs [ ] 31 – 40 yrs[ ] 41 – 50 yrs[ ]
   51 – 60 yrs[ ] Above 60 yrs [ ]
3. Occupation : Doctor[ ] Nurse[ ] Pharmacist [ ]
   Laboratory Staff [ ] Ancillary Staff [ ] Radiographer[ ]
   Other specify_____
4. Work experience in health facility: 0 – 5years [ ] 6 – 10years [ ]

11- 15 years [ ] 16 – 20years [ ] Above 21 years [ ]

Section B (Medical Waste Generation and Management Strategies)

5. What are the types of wastes generated at your healthcare facility?

_____

_____

_____

6. Are infectious waste generated at your healthcare facility? Yes [ ] No [ ]

7. What are the sources of Medical waste generated in your healthcare facility?

_____

_____

_____

_____

8. On the average how much waste is generated per day in your healthcare facility?

_____

9. Is waste generated in your healthcare facility segregated? Yes [ ] No [ ]

10. How do you rate segregation of Medical Waste?

Poor [ ] Good [ ] Very Good [ ] Excellent [ ]

11. Describe how waste is segregated.

_____

_____

_____

_____

12. Where is hazardous clinical waste stored?

Black refuse plastic bag [ ]

Red Clinical waste plastic bag [ ]

Standard metal dustbin [ ]

Pedal [ ]

Yellow sharp container [ ] Others specify_____

13. How is the storage of clinical waste awaiting transportation?

Secure [ ] Insecure [ ]

14. How do you rate the handling of clinical waste?

Poor [ ] Good [ ] Very Good [ ] Excellent [ ]

15. Do you use protective clothing when handling medical waste? Yes[ ] No [ ]

16. If yes, state the protective clothing you use

_____

_____

17. Have you received any training in medical waste management? Yes [ ] No [ ]

18. Which authority collects medical waste in your health care facility?

_____

19. How often is the waste collected by the authority mentioned above?

Daily [ ] Once a week [ ] Once per two weeks[ ] Once per month[ ]

Others specify_____

20. What is the mode of transportation of medical waste within the healthcare facility (onsite)?

_____

21. Is there an incinerator at your healthcare facility? Yes[ ] No [ ]

22. If no, where is medical waste incinerated?

_____

23. How do you rate the effectiveness of Medical Waste Management processes in your health care facility?

Poor [ ] Good [ ] Very Good [ ] Excellent [ ]

24. What are the initiatives that are to be taken for effective management of medical waste?

_____

_____

_____

25. What are the problems you encounter in managing medical waste in your health care facility?

_____

_____

_____

26. Are there any outbreaks of medical waste related diseases reported in your healthcare facility in the past 12 months? Yes [ ] No [ ]
27. If **Yes**, state the diseases

_____

_____

_____

28. Has the Healthcare facility a defined and documented environmental policy (Medical Waste Management Code of Practice)? Yes [ ] No [ ]
29. Have you ever read about the Medical Waste Management Code of Practice? Yes [ ] No [ ]
30. The Medical Waste Management Code of Practice requires any health care worker who comes into contact with medical waste to receive **Hepatitis B** vaccination. Have you received the vaccination? Yes [ ] No [ ]
31. Have you ever sustained any injury during the handling of medical waste in the past 12 month? Yes [ ] No [ ]
32. What are the risks of medical waste to ;

    a) The human health:

    _____

    _____

    _____

33. The environment:

_____

_____

34. What solutions should be employed for effective management of medical waste?

_____

_____

_____

APPENDIX 2

INTERVIEW GUIDES

INTERVIEW GUIDE: For contractor / City Council (KMA) authority responsible for collection and disposal of clinical waste.

1. How often do you collect medical waste in healthcare facilities?

2. How much waste do you collect in (a) Clinics (b) Hospitals (c) Health posts?
3. Is the medical waste that you collect segregated at source?
4. Where is clinical waste stored waiting for collection and disposal?
5. How secure are the clinical waste storage facilities in healthcare facilities where you collect clinical waste?
6. What types of vehicles are used to transport clinical waste?
7. Is the transportation of clinical waste to designated places safe?
8. Where is clinical waste treated?
9. Did clinical waste handlers receive any training in management of clinical waste?
10. Are waste handlers provided with protective clothing when handling clinical waste?
11. Did waste handlers receive any vaccination against hepatitis B?
12. What are the risks associated with clinical waste that have been encountered by in the past 12 months?
13. What are the problems that you encounter in collection and disposal of clinical waste?
14. What recommendations would you give for the improvement of medical waste management?

INTERVIEW GUIDE: Facility waste manager/Health safety officer.

1. How many people visit your healthcare facility per day?
2. How much clinical waste is generated per day?
3. How many injuries related to clinical waste have been reported by healthcare workers and waste handlers in the past 12 months?
4. The Clinical Waste Management Code of Practice requires that all healthcare workers and operatives should be offered hepatitis B vaccination. How many health workers in your institution received the vaccination?
5. How often is clinical waste collected?

6. If clinical waste is not collected as per schedule what do you do with it?
7. Is clinical waste storage accessible to any person or scavengers?
8. Do you record any clinical waste management information?
9. How often is in-service training on clinical waste management for healthcare workers done?
10. Who is responsible for providing a continuous clinical waste training for healthcare workers?
11. How do you manage risks associated with clinical waste?
12. Do you make a follow up of clinical waste collected from your healthcare facility to the landfill to check if it is incinerated properly?
13. What are the problems that you encounter in managing clinical waste?
14. What are the initiatives taken for effective management of clinical waste?
15. What are the risks that inappropriate management of clinical waste poses to?
    a. The environment.
    b. Human health.
16. What solutions can be employed to improve the efficiency of clinical waste management used?

INTERVIEW GUIDE: for Environmental officer from KMA and EPA

1. To what extent do healthcare facilities implement and comply with the following documents:
    a. Ghana Medical Waste Management Code of Practice.
    b. Waste Management Act.
    c. Medical Waste Management Plan.
2. Has the above documents being evaluated to assess if it is addressing all clinical waste issues?
3. Is the Ghana Medical Waste Management Code of Practice commensurable with international standards with on environmental issues?
4. What are the risks that inappropriate clinical waste management poses to the environment and human health?
5. How often does the city council monitor the management of clinical waste in healthcare facilities?
6. Is clinical waste disposed same as domestic waste at landfill?

APPENDIX 3

SAMPLE FORM FOR ASSESSMENT OF WASTE GENERATION

Name of the Health Care Facility .....Month.....Week.....

Town/Village .....District .....Region .....

Waste Collection point	Waste Category (Specify)	Quantity of Waste Generated per Day (Weight and Volume)													
		Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday	
		Kg.	Litre	Kg.	Litre	Kg.	Litre	Kg.	Litre	Litre	Kg.	Litre	Kg.	Litre	Kg.
Sub-Total															
Total															