UNIVERSITY OF EDUCATION, WINNEBA

MEDICAL WASTE MANAGEMENT IN HEALTH FACILITIES IN KUMASI METROPOLIS, GHANA

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DECLARATION

I hereby declare that except references to other authors' works which have been duly acknowledged, this thesis is my own original work towards the award of a Master of Philosophy in Environmental and Occupational Health Education, and that this thesis or part has not been accepted for the award of a degree in this university or elsewhere.

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DEDICATION

I dedicate this work to my wife, Ellen Agyena Nsowaa and Children (Akua Serwaa Benewaa Nsowaa and Afia Adomaa Nsowaa) for their prayers and support.

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I am most thankful to the ALMIGHTY GOD for granting me the grace to complete this work successfully. May all the glory and honour be unto Him.

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LIST OF ABBREVIATION/ACRONYYMS

AIDS	-	Acquired Immuno Deficiency Syndrome
APCDs	-	Air Pollution Control Devices
BMW	-	Bio-Medical Waste
EHSD	-	Environmental Health and Sanitation Directorate
EPA	–	Environmental Protection Agency
GHS	-	Ghana Health Service
HCW	–	Health Care Workers
HIV	-	Human Immuno Virus
KATH	–	Komfo Anokye Teaching Hospital
KMA-WMD	–	Kumasi Metropolitan Assembly Waste Management Department
MOH	-	Ministry of Health
MW	-	Medical Waste
PPE	-	Personal Protective Equipment
SPSS	-	Statistical Package of Social Sciences
SWM	-	Solid Waste Management
WHO	-	World Health Organisation

WM - Waste Management

WMD - Waste Management Department

ABSTRACT

There is a growing concern on how medical wastes are handled in developing countries like Ghana due to their potential source of risks to human health and the environment. A descriptive cross - sectional study was used to assess the current management practices of medical waste at six health facilities in the Kumasi Metropolis. Checklist, observation and questionnaire were used to collect data from the health facilities and 400 healthcare workers. The data was analyzed using the SPSS, version 25. Chi-Square test was used to determine the association between the variables and level of significance was set at $p \leq 0.05$. The results of the study showed that temporary storage holding time for the medical waste was between 12-24hrs and manually transferred to treatment sites in all facilities, except KATH, which used tricycle. Incineration was mostly (66.7 %) used to managed solid medical waste with uncontrolled smokes which could pose threat to the environment. Liquid wastes from some wards were drained into septic tanks while others into the municipal sewage system. Most (74.4 %) healthcare workers had adequate knowledge on medical waste management, although segregation at the point of generation was nearly absent, this was significantly associated with age, profession and years of experience (P-values 0.000; 0.032). There was policy gap on enforcement of medical waste management at the health facilities. The medical waste posed a serious health risk to the health workers, waste collectors and the people in the surrounding communities. Generally, the medical waste management was below the required WHO guidelines. The study recommends sufficient training, effective supervision and resource allocation for waste management.

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Medical waste is all the waste generated from healthcare facilities, medical research centers, and laboratories of which only 10 – 25 % is regarded as infectious whilst about 75 – 90 % usually is non – infectious (Aung et al., 2019; MOH, 2015). Although there have been enormous improvements in medical waste management in recent times; there remains a very complicated problem on human society due to its health and environmental consequences. Medical waste is a special waste as it is deemed more harmful compared to municipal wastes, therefore, collection, storage, transfer and disposal needs more delicate measures (Sharma et al., 2013).

Medical waste includes all untreated solid and liquid wastes (both infectious and non - infectious) generated during the administration of medical care, or the performance of medical research involving humans and animals (Ministry of Health, 2015). Examples of infectious medical waste include pathological waste such as tissues and body fluid, pharmaceuticals such as expired or unused drugs, sharps (syringes, disposable scalpels, blades, etc.), non-sharps (swabs, bandages, disposable medical devices, etc.), chemicals (solvents, disinfectants) and radioactive material, etc., as well as waste water including effluents from mortuaries. These pose health risks due to their infectious, toxic, radioactive or injurious nature (Ministry of Health, 2015). Medical waste may contain dangerous chemicals that can leach into the environment and water bodies with the potential of causing diseases (Deress et al., 2019).

In advanced countries, technologies such as autoclaving and incineration are used for treatment and final disposal of medical waste. Nonetheless, in developing countries,

medical waste has not received the needed attention (Wilujeng et al., 2019) as it is mostly disposed of together with municipal waste (Capoor & Parida, 2021) posing serious health and environmental threats. Medical wastes produced from healthcare services ranges from one country to the other (Ghasemi & Yusuff, 2016). In Ghana, greater part of waste generated by health institutions is not hazardous and can be handled like household waste. However, between 10 % - 25 % of the medical waste poses threat and therefore needs special collection and arrangements by the management of the facility for its safe disposal (Ministry of Health, 2015).

In developing countries like Ghana, infectious medical waste generation and proper segregation for onward treatment and safe disposal is met with challenges. If necessary steps are not taken to ensure adequate treatment of medical waste, this might pose health and environmental risks (Aung et al., 2019). Infectious medical waste may cause diseases amongst waste pickers, waste cleaners, collectors, and recycling waste operators. Furthermore, there are reports that medical waste poses an increasingly health risks to doctors, nurses, technicians, drain cleaners, sweepers, hospital visitors and patients due to its poor management (Wilujeng et al., 2019). Globally, pragmatic steps to minimize the risk of medical waste have become a major concern. Hence, there are some concerted efforts and modalities adopted in creating awareness to management of healthcare facilities and waste management agencies to employ credible and proper waste management system to deal with medical waste which has the potential for the spread of diseases (Deress et al., 2019).

Population is fast growing and this has resulted in a demand for hospitals, pharmacy, private individual practitioners, clinics, diagnostic centers and pathology services. It is obvious that the facilities for waste disposal from healthcare services cannot cope with these growing demands and therefore measures are to be taken to prevent possible diseases outbreaks that may emanate as a result of this in the future.

In healthcare settings, all staffs contribute to the generation, collection, separation and play a role in the waste management in a manner that poses minimal hazard to patients, visitors, staff, and the general public (Deress et al., 2019). Proper handling of medical waste reduces the spread of infections and minimizes the risk of accidental injuries. It helps provide an aesthetically conducive atmosphere and reduces unpleasant odour within the health facilities. It also prevents attraction of insects and other animals to health facilities, reducing the likelihood of contamination of the environment with chemicals and microorganisms (Ministry of Health, 2015).

1.2 Problem Statement

The amount of medical wastes produced from healthcare services and how these are managed is a major public health concern in most developing countries. Reports from previous studies have shown that developed countries have created systems for hospital waste management that is able to ensure proper sorting at the source and disposal (Capoor & Parida, 2021; Wilujeng et al., 2019). However in Ghana, these systems are lacking or not adhered to at most health facilities and therefore infectious and non -

infectious wastes generated are not properly sorted and are most of the times mixed together along the whole chain of waste management from collection to disposal. Liquid wastes generated from some medical facilities and allied institutions are left to pass through the drainage systems into streams and rivers in the neighborhoods where some vegetable farmers use to irrigate their vegetables. The consumption of these vegetables may pose a health hazard to the populace. In addition, improper medical waste management, lack of awareness about the health hazards associated with medical waste, inadequate financial and human resources, and poor control of waste disposal are serious problems connected with medical waste management in the Kumasi Metropolis. Again, there is a policy on hospital waste management in Ghana but it is not properly implemented in the healthcare facilities (Ministry of Health, 2015). There is a lack of enforcement of legislation for handling, treatment and disposal of medical waste. Furthermore, personnel involved in handling medical wastes are largely those with little or no education on waste management and have inadequate knowledge on how to manage the medical waste properly (Deress et al., 2019). This study sought to examine the current management practices of medical waste in the wake of Covid-19 pandemic.

1.3 Objectives of the Study

The main aim of this study is to assess the current management of medical waste in some selected health facilities in the Kumasi Metropolis of the Ashanti Region of Ghana.

1.3.1 Specific Objectives

The specific objectives are to:

i. Examine the current medical wastes management practices at the health facilities.

ii. Assess the knowledge, attitudes and perceptions of health personnel on medical waste management at the health facilities.

iii. Assess the related risks of medical waste generated to the immediate environment of these health facilities.

1.4 Research Questions

The following are some of the research questions which guided the design and approach to the objectives of the study.

i. What are the current management practices and approaches to wastes generated at the health facilities?

ii. How are medical wastes disposal done at the health facilities?

iii. What are the levels of awareness of medical waste management practices at the health facilities?

iv. What are the workers knowledge, attitude and perceptions on medical waste management?

1.5 Justification of the Research

The current practices of medical waste management in Ghana, specifically Kumasi exposes healthcare workers, patients and the general public to health risk. Previous studies have shown that medical waste management may be hindered by improper segregation at source, lack of regular monitoring, lack of formal training, lack of knowledge on medical waste management and inadequate interest from hospital administration (Awodele et al., 2016; Sharma et al., 2013). Additionally, a study

conducted in 24 low – income countries revealed that, on average, only 58 % of health facilities had sufficient systems for safe disposal of medical waste (WHO, 2018). Meanwhile, other studies have reported that, health workers and the general public are at risk of threats from environmental pollution and public health due to unsafe disposal of medical waste (Ghasemi &Yusuff, 2016; Asante et al., 2014). Notwithstanding the several studies that have been done in this field, not many academic studies have focused on the systematic approach to medical waste management in terms of segregation, collection, transportation, condition of waste bins, storage, treatment and final disposal.

This study thus sought to evaluate the current management practices of medical waste in some selected health facilities, which would provide empirical data to health facilities management to put in place sustainable measures that would address the hazards posed by improper management of medical waste in the metropolis. In Ghana, not many people are aware that medical waste contributes immensely to environmental pollution and hazards and therefore creating public awareness regarding the health risk of the medical waste and its impact on the environment and human health cannot be overemphasized. Besides, the research sought to help the Ministry of Health, Environmental Protection Agency in Ghana and institutions concerned to know the situation on the ground as far as management of medical waste is concerned. It also sought to inform decision makers on the needed resources for health facilities to adequately tackle medical waste generated and improved ways to manage them. The document also will contribute to the already existing body of academic knowledge in that it serves as a source of information for subsequent research in this area.

1.6 Organization of the study

Chapter one introduces the study and provides the outline of the study. It captures the background to the study, problem statement, and objective of the study, research questions, and justification of the research. Chapter two also deals with the studies that have been done by other researchers which were related to the subject of study. The review involves in-depth studies related to the problem under study. The third chapter gives a description of how data was collected and analyzed to provide information on medical waste management in the Kumasi metropolis. The sections described under this chapter are the study area, data collection, sampling techniques, data collection procedure and analysis, conceptual framework, validity and reliability and how ethical clearance was obtained. Chapter four captures the interpretation of all the interview responses and content analysis of the data collected on the field of study. The interpretations were presented in the form of tables. Explanations of the data analysis were done by the researcher using some of the responses collected during the field of study and the available secondary data. Chapter five focuses on discussing the findings of this study with regards to the objectives of the study. Chapter six concludes based on the findings analyzed and discussed in chapter four in line with set research objectives. It also gives a summary of the findings to which recommended possible actions are outlined for improved medical waste management within the Metropolis.

CHAPTER TWO

LITERATURE REVIEW

2.1 The Concept of Medical Waste

Medical waste is the unavoidable byproduct of healthcare services, therefore its efficient management is lawful and social responsibility of all healthcare set ups (Shivalli & Sowmyashree, 2015). In developed countries, there are proper mechanisms and processes for management of medical waste. However, the needed attention required by medical waste in most African countries has not been prioritized due to insufficient resources. There is no or limited segregation of infectious medical wastes and usually mixed with non-hazardous waste. In many countries, infectious medical wastes are still handled and disposed together with municipal wastes, posing a great health risk to municipal workers, the public and the environment at large (Capoor & Parida, 2021; Wilujeng et al., 2019). Lack of knowledge or little knowledge and improper management practices among the healthcare workers are major challenges in the management of medical waste. Healthcare workers are not only required to have knowledge concerning proper segregation and disposal of medical waste, but should also have the ability to guide others regarding the same (Gupta et al., 2016). Previous studies show that medical waste management may be hindered by lack of regular monitoring, lack of formal training, lack of knowledge on medical waste management and inadequate interest from hospital administration (Sharma et al., 2013).

Management of waste in Ghana is a combined effort of a team with the Ministry of Local Government leading as a formulator and implementer of law while Environmental Protection Agency playing key role as a regulator. The execution of this responsibility is through the District, Municipal and Metropolitan assemblies which are directly under the

Ministry of Local Government and the Environmental Protection Agency. The person or institution that generates the medical waste is responsible for its disposal and therefore steps are to be taken for the waste segregation, storage, treatment, recycling and safe disposal through the support of the agencies and stakeholder ministries involved (Ministry of Health, 2015).

Previous research conducted by the Waste Management Department of the Accra Metropolitan Assembly in 6 major hospitals in Accra in 1992 showed the average generation of medical waste to be 1.2 kg/bed/day. This is expected to be increased in the years ahead due to an increasing number of hospital beds and improved standards of living (Ministry of Health, 2015). The quantity of waste produced in the out-patient units is usually smaller than that in the in-patient units. However, good segregation at source leads to a reduction in the quantity produced (Abah & Ohimain, 2011).

It is required that managements of health institutions put in place measures to reduce exposure of their staff and the general public to the hazardous components of medical waste. It is anticipated that provision will be made for the supply of all necessary personal protective equipment and their use enforced during the performance of all activities that potentially produce infectious waste as well as those that go into the handling of such waste.

2.2 Classification of Medical Waste

Although awareness regarding medical waste management seems to have improved in recent years, there is a need for a systematic approach to it in terms of effective segregation, safe collection and storage, as well as ultimate treatment and disposal. This is to ensure that medical waste is managed effectively in compliance with existing laws

and regulations. Medical waste must be separated from municipal waste, however, in many health facilities in Ghana, medical wastes are collected together with the rest of the wastes and are dumped into nearby streams (Ministry of Health, 2015). Medical waste composition depends on different parameters, such as the size of the Healthcare facility, type of patient care provided and the waste segregation system available.

Medical waste can be classified as follows:

2.2.1 General or Normal waste

This is likened to domestic waste. It is not harmful. Examples are waste from the hospital kitchen/canteen and sweepings from offices, i.e., paper, cardboard, plastics, etc.

2.2.2 Infectious Waste

This waste is generated by inpatient and outpatient activities that contain highly infectious agents and pathogens (bacteria, viruses, parasites or fungi) that pose a risk of disease transmission. Sources include wastes from surgeries and autopsies on patients with infectious diseases, excreta, aprons, gloves, blood and other body fluids, soiled, dialysis tubes and filters, infected animals, laboratory stocks and cultures.

2.2.3 Sharps

These are sharp-edged waste that can cause risk of injury and infection due to their puncture or cut property. They are considered as one of the most hazardous waste generated in the healthcare. Sources include syringes with attached needles, disposable needles, hypodermic needles, infusion sets, saws, knives, broken glass and pipettes, scalpels and other blades.

2.2.4 Pathological Waste

This type of waste could be a subcategory of infectious waste, but mostly categorized separately when unusual methods of managing, treatment and disposal are used. Sources include body parts, organs, foetuses, human flesh, wastes from surgery and autopsies on patients with infectious diseases.

2.2.5 Pharmaceutical Waste

These are chemical wastes that are normally generated in the provision of pharmaceutical services. It also includes discarded items such as vials and boxes containing pharmaceutical residues, gloves, masks and connecting tubing. Examples are expired drugs, vaccines and leftover drugs.

2.2.6 Electronic Waste

These wastes include X-ray machines, films, computers, ultrasound scanners, etc.

2.2.7 Radioactive Waste

Materials contaminated with radionuclides used in healthcare are in either unsealed or open sources or sealed sources are radioactive wastes. They are produced as a result of procedures like in vitro analysis of body tissue and fluid, in vivo organ imaging and tumor localization, and various investigative and therapeutic practices. Sources include solids, gaseous and liquid wastes contaminated with unnecessary radioactive materials used in diagnosis and therapy of diseases such as toxic goiter, infected glassware, urine and excreta from tested with unsealed radionuclides or patients treated (Ghasemi et al., 2016; MOH, 2015).

2.3 Components of Medical Waste Management

A medical waste management system comprises the following:

i. Segregation

ii. Collection

iii. Storage

iv. Transportation

v. Treatment

vi. Final disposal

Medical Waste Management is discussed below under these headings

2.3.1 Segregation

It is essential to segregate medical waste into various categories to ensure effective disposal (Awodele et al., 2016). Segregation should be done at the point of generation and should always be the duty of the waste producer. The various wastes components are to be placed in their appropriate colour-coded containers as soon as they are generated. Instruction posters concerning the steps for waste segregation should be pasted in all areas where segregation takes place and other vantage points (Ministry of Health, 2015).

Various types of medical wastes demand different way of handling, treatment and disposal. For this reason, it is crucial that medical waste is segregated into the different sub-categories for safety purposes. Segregation of medical waste should be done properly to reduce the risk of waste handlers. Effective segregation of medical waste plays a major role in safe management of medical waste (Awodele et al., 2016). Proper handling, treatment and disposal of medical waste by sub-category helps to decrease costs as the type of waste influences the disposal procedure used, hence disposal costs. Improper or

non-segregation of medical waste makes it infectious and leads to higher management costs (Ministry of Health, 2015). Results from previous study show that medical waste segregation is a necessary step in minimizing the quantity of infectious waste (Awodele et al., 2016). When people have prior knowledge on classification and segregation of medical waste using the recommended colour codes (Fig. 2.1), it is likely that they will handle the waste properly.

Fig. 2.1: Colour-coding of Medical waste containers and their characteristics (Ministry of Health, 2015)

General requirements for waste containers

The characteristics of waste containers below are recommended for collection of waste:

i. They should be opaque

ii. They should be impervious.

iii. They should be leak proof.

iv. They should have close-fitted lids.

v. They should have sufficient strength to prevent easy damage during handling or use (Ministry of Health, 2015)

2.3.2 Collection

When generation of medical waste exceeds collection capacity it may affect its management. Hence, medical waste must be collected frequently and transported to a central storage area within the healthcare facility before being treated to prevent the accumulation of the waste. A timetable of the frequency of collection should be designed. Specific path through the healthcare facility should be followed in the collection of the waste to minimize the movement of loaded carts through wards and other clean areas. The carts for collection of the waste should be easy to load and unload, have no sharp edges that could damage waste bags or containers, easy to clean.

Waste collectors should be equipped with gloves, industrial boots and apron for the collection of the waste. The containers for collection of waste should be placed at vantage points to allow easy access to waste collectors and vehicles. The collection of waste is done in accordance with the frequency of containers becoming full. Waste containers should be sealed appropriately, removed and replaced immediately when they are becoming full. A study conducted in district public hospitals of Tumpat, Batu Pahat and Taiping revealed that both cleaners and nursing assistants were responsible for collecting stored wastes at the wards and transporting them to disposal sites (Omar et al., 2013).

2.3.3 Storage

This refers to the way in which the medical waste is contained during the period between its generation and collection for final disposal. It is categorized into Internal Storage and External Storage. Proper storage of medical waste is one of the major steps in reducing the health hazards it may pose (Ministry of Health, 2015). The type of waste being dealt

with and the potential risk of infection to healthcare workers and waste disposal staff influence the period by which it is kept. Labels on containers should be permanent and legible for the entire storage period (Ministry of Health, 2015).

i. Internal Storage

This is the temporary placement of waste at the source of generation (e.g. ward, OPD) before transfer to external storage points.

The following measures should be taken to ensure safe management of waste at the points of generation:

Reduce storage time as much as practicable, that is, the waste should not be placed beyond 24 hours. Multiple daily removal of the healthcare waste is recommended. The entire sites within the healthcare facility e.g. wards, theatre, laboratory, pharmacy, kitchen, laundry, etc.), must be provided with adequate number of appropriate waste containers. Polythene bags must be placed in rigid containers with the opening folding outward over the container to minimize contamination of the surrounding. The top of the container should have a wider diameter than the base.

Disposable polythene bags should be of suitable size with a minimum of 60 microns and maximum of 100 microns in thickness. Filled bags should be sealed off using a plastic strip which when fastened cannot be re-opened; the bags should be sealed when ¾ full. To serve as a reminder, the bags should have a mark showing the ¾ mark. Sharps should be kept in puncture-resistant containers made of thick cardboard, plywood or strong plastic/metal. Sharps should not be tempered with (e.g. by breaking or bending) before

disposal. Needles should not be recapped before discarding since this is a common cause of puncture injury. Puncture resistant containers should be placed at vantage points; that is areas where sharp items are used. Storage bins should be kept in roofed built-in areas protected from rain, wind, animals and pests such as rodents, cockroaches etc. and scavengers (Ministry of Health, 2015).

Bio-hazard marks and other warning signs should be conspicuously posted on doors leading to storage sites to prevent people from unnecessarily gaining access to the area. Entrance to storage area should be securely locked when unattended. Storage areas should have sufficient space to provide easy access or removal of waste. Medical waste should be collected one way to external storage site without returning to the point of generation: thus the need for sizable receptacles for the transfer.

Transfer of waste bags from internal to external storage should be done with care to prevent rupturing or opening of bags which can contaminate the environment. Vehicles used for transporting waste from internal to external storage sites should be made of a smooth surface material (e.g. plastic) for easy cleansing and disinfection. The containers used for internal storage as well as the storage sites should be cleaned, disinfected and fumigated frequently (Ministry of Health, 2015).

ii. External Storage

This refers to storage at the transit point where waste is stored after removal from internal storage until it is collected and transported for treatment and final disposal. The external storage is usually situated within the healthcare facility, while treatment and/or disposal sites could be on-site or outside the facility. The consistent or regular removal of waste

stored depends on the quantity and nature of waste generated. The following measures should be taken to ensure the safe disposal of the waste:

- External storage facilities should be kept away from kitchen, laundry, ward etc. but be within the facility and should be easily accessible to collection vehicles.
- The facility to which the waste is kept should be enclosed and surrounded by an impervious wall of appropriate height and provided with a gate and lock.
- The walls and floors should be smooth, without cracks, impervious, easy to clean and disinfection must be carried out as frequently as possible.
- The site should be spacious and well ventilated.
- All loading and unloading of waste should take place within the designated collection area around the storage point.
- Greater volume waste bins that can take about 240 litres and above should be available at the external storage facility to receive waste containers from the internal storage points, these bins should be marked for ease of identification of content and the markings must correspond with the colour code used for polythene bags in internal storage.
- Compression of medical waste during collection should be avoided.
- Waste bins should be washed and disinfected more frequently after each collection.
- Waste water from the point of generation and storage area must be drained into septic tanks and soakaways must not be allowed to drain off into storm water drainage or streams; liquid wastes must be appropriately treated (e.g. disinfection, neutralization) prior to final disposal.

- Certain basic standards should be met by external storage facilities for the type of waste stored e.g. refrigerators for storing organic tissues should be considered and provided in facilities as it provides a suitable temperature to prevent extra cellular digestion by microorganisms to cause decay; where refrigeration is not available, these materials should be disposed of without delay.
- Bio-hazard marks and other warning signs should be conspicuously posted on doors to prevent people from unnecessarily gaining entrance to the area.
- Access to the external storage area should be granted to only authorize persons.
- Training of staff should be done frequently to enable them understand the principles of segregation and to follow laid down procedures for colour coding, storage and documentation.
- Waste generated and processed, including the type of waste, volumes and/or weight, and the persons who processed them at the various stages should be recorded and kept (Ministry of Health, 2015).

2.3.4 Transportation

This encompasses the transfer of medical waste from the point of generation to disposal by using machines such as wheel barrow, trolley, cars, etc. The collection and transportation of medical waste from the healthcare facility is done by an accredited Waste Management Contractors who are certified by the District Assembly. Healthcare facilities in the district should work in collaboration with the relevant departments of the District Assemblies. Every necessary step should be taken to prevent odour nuisance to the neighbourhoods and falling off from the car during transportation.

To prevent this, proximity principle, which indicates the need to treat and/or dispose of wastes close to their point of generation could be adopted. This principle, apart from reducing the environmental impact of falling off waste during transportation, it minimizes the cost of waste transport. If there is a mixture of infectious wastes and general waste, it should be considered infectious and managed as such. Likelihood infectious medical waste should be transported directly to the disposal or treatment site within the shortest possible time. Vehicles used for transportation of this waste must be so constructed as to prevent the scattering of packaged wastes, odour nuisance, and must be leak proof. All vehicles used for the transportation of medical waste should carry the bio-hazard mark on all sides. Labels should be firmly attached to containers so that they do not become detached during transportation and handling (Ministry of Health, 2015).

Requirements for the Transportation of Radioactive Waste Containers

Containers for keeping radioactive waste should not be dark (normally yellow), should be marked "Radioactive Waste" and should contain the international radioactive symbol to differentiate it from containers meant to receive other types of waste. Containers for keeping radioactive waste should have labels bearing the radiation symbol on them. The label should be completed and signed by the officer in charge of waste management in the organization.

The labels should be firmly attached to the containers to prevent it from detaching during transportation and handling. The printing on the labels should be permanent and legible for the entire storage and transportation period (Ministry of Health, 2015).

2.3.5 Treatment

Importance must be given to disinfection or sterilization of infectious laboratory and bio-hazardous wastes at the point of generation (Hiremath, 2019). Currently, the untreated infectious wastes are directly sent to common healthcare wastes treatment facility for incineration or final disposal. This increases the chance of infection during transportation, temporary storage and handling (Al Emad, 2011). For this reason, necessary steps should be taken to disinfect or sterilize infectious laboratory and bio-hazardous wastes at the point of generation, to find a better solution or appropriate technology for the proper management (Singh et al., 2019).

Methods of treating medical waste are many and these include incineration, landfilling, autoclaving, microwaving and plasma pyrolysis. However, the best treatment system should be selected carefully based on different factors on which most depends on local conditions, category and quantity of waste produced (Ghasemi & Yusuff, 2016).

The different treatment processes, method and techniques for medical wastes to minimize the hazards and costs are discussed below:

i. Incineration Technology

Incineration of medical waste has been the major technique used worldwide for treating and disposing medical waste such as papers, polyvinylchloride (PVC), plastics and discarded items of equipment (Özkan, 2013). It is also manufactured to treat medical waste that uses thermal decomposition via thermal oxidation at high temperatures between 900 and 1200ºC to destroy the organic fraction of the waste (Ghasemi & Yusuff,

2016). The process of incineration should be done to ensure that its operation provides sufficient safety and reduces the risk to the environment (Berihun & Solomon, 2017).

In Ghana, small scale incineration plants built with cement blocks, metal and lateritic bricks are mostly used by small healthcare facilities for treatment and disposal of medical waste. The most common source of energy for the incineration plant is firewood (Ministry of Health, 2015). This process of medical waste treatment and disposal has been used for so many years. Ghana healthcare policy reviewed in 2020 proposed the use of non-incineration technologies for medical waste treatment in healthcare facilities and the importance to promote the international standards for high temperature incineration (800°C-1200ºC) instead of the current practice with the De Montfort incinerators in healthcare facilities (Ministry of Health, 2020). A research conducted in Malaysia identified numerous constraints in the use of incineration and landfilling in treating medical waste as this can be a major source of dioxin and furan pollution that can cause liver failure and cancer (Ghasemi & Yusuff, 2016).

ii. Autoclaving (Steam Sterilization)

The second most commonly used waste treatment method is Autoclaving or steam sterilization. It is a metal vessel designed to sustain high pressures and temperatures, with a sealable door and an arrangement of pipes and hatches through which steam is introduced to and removed from the vessel. The steam kills pathogens before entombing the wastes (Armstrong & Reinhardt, 2010).

iii. Microwaving

This is the other technology of the incinerator and is a steam-based process and electromagnetic waves with frequencies between radio and infrared waves that use steam to sterilize wastes and damage hazardous agents and disease causing organisms in the waste. It encompasses the use of high-intensity radiation to heat the moisture inside the waste. Categories of waste generally treated in microwave systems are the same as those treated in autoclaves (Ghasemi & Yusuff, 2016).

iv. Landfilling

This is one of the most popular methods of treating and disposing medical waste. The treated waste can be disposed of in a regular municipal waste landfill with most non-incineration technologies. Although, this is simple and cheap waste disposal method but poses health risk and environmental pollution if not handled properly. Also, three waste products, including, liquid-like leachate (that is, water polluted with waste), solid-like degraded waste and gas as landfill gas are produced from landfills that can pollute the environment (Özkan, 2013).

v. Plasma Pyrolysis

This is a new technology for proper disposal of healthcare waste. It changes organic waste into useful products and makes it environmentally friendly. It has two chambers of which the primary chamber operates at a very high temperature whiles the secondary chamber operates at low temperature. It can be used to treat all types of waste due to its high temperature (Vyas et al., 2011).

Table 2.1 Waste Type and Treatment Method

WASTE TYPE	TREATMENT METHOD
1. Human Anatomical Waste	Deep burial
2. Microbiology and Biotechnology waste	Autoclaving/ microwave
3. Sharps	Chemical treatment, autoclaving, microwave
4. Genotoxic waste/ Discarded Medicine and Cytotoxic drugs	Destruction/secured landfill
5. Soiled waste (Items contaminated with blood and body fluids)	Microwave/ autoclaving
6. Soiled waste disposal items, including tubing intravenous sets, Catheters	Chemical treatment/autoclaving/shredding/microwave
7. Liquid Waste (From laboratory and washing, housekeeping, cleaning, and disinfecting activities)	Chemical treatment
8. Chemical waste (From production of biological and disinfection)	Chemical treatment and secured landfill

Source: (Singh et al., 2019)

Fig. 2.2 Microbiological Waste Treatment Device (Singh et al., 2019)

The device above (Fig. 2.2) is a type of device used to treat microbial waste before disposal

2.3.6 Final disposal

Non - infectious and infectious waste should not be left on the premises of healthcare facilities. Non – infectious waste should be picked frequently from the premises by the municipality or transported by the facility to a known and safely managed public disposal

site (MOH, 2015; Özkan, 2013). Infectious medical waste is dangerous for public health and the environment and therefore, careful treatment to eliminate the infectious properties before disposal is an essential task for waste disposal firms.

A study revealed that improper disposal of toxic chemicals from pharmaceutical and other medical wastes find their way into the soil and pollute surface water bodies and the ground water causing health hazard to people who depend on wells for drinking, washing, and agricultural purposes (Sasu et al., 2012). On the other hand, pathological waste disposal may be influenced by religious beliefs, sociocultural, and aesthetic norms and practices. To avoid the contamination of groundwater, the site for pathological waste disposal should be considered. Landfill may be considered as an option for pathological waste disposal in the absence of other treatment method. However, specific area should be selected for the disposal to prevent recyclers or scavengers coming into contact with the waste. Sharp waste may still pose physical risks even after sterilization. Safe sharp pits on the healthcare facility premises can be used for disposal of sterilized sharp waste or encapsulated by mixing waste with immobilizing material like cement before disposal, if the landfill for general waste is unsecured. If access to public disposal site is difficult or unavailable, dumping site can be established at the premises of the healthcare facility for disposal of non – infectious waste. The waste should be covered with a layer of soil when disposed. Healthcare facilities that may not have access to public disposal site or lack adequate space for disposal on the premises can temporarily dispose the waste in a burial area and burned. The ash must be covered with a soil after the burning process is done. The area should be fenced in order to secure it against unauthorized access. If disposal

site is not guarded, scavengers, dogs and hens could carry or spread the waste to the nearby houses. Environmentally friendly option should be planned for permanent disposal of the waste.

There should be a landfill which is purposely designed for the final disposal of treated infectious medical waste (Akum, 2014). In developing countries like Ghana, most of the landfills are open dumps, though it is greatly discouraged by national sanitation policy. The methods for waste disposal in Ghana are: sanitary landfilling, incineration, composting, controlled dumping and uncontrolled dumping (Danso-Manu, 2011).

- **Sanitary landfill**

Open dumping was mostly practiced in Ghana until pressure from the populace enabled most communities to switch to sanitary landfill as an approved method of waste disposal.

- **Septic tank**

Untreated liquid waste can be dumped into septic tank. The waste water is routed out of the health facility into a sewer just like sewage is, but it could instead be used more constructively than just getting flushed down the drain.

The final disposal of waste may be hampered by indiscriminate dumping of waste, deteriorated road network to the landfill site and the size of the landfill.

2.4 Waste Management in Kumasi Metropolis

The KMA-WMD is required to manage the waste in the metropolis and it has the responsibility of keeping the city clean and healthy by the provision and delivery of effective and efficient collection of waste and programmes, and environmentally acceptable disposal. The agencies for the Kumasi metropolis concerning the Solid Waste Management (SWM) are the regional office of Environmental Health and Sanitation Directorate (EHSD), Ashanti, and the office of the Waste Management Department (WMD) of Kumasi Metropolitan Assembly (KMA). In general, solid waste is divided into three (3) categories, namely, domestic, industrial, and medical waste.

With a population of about two million in 2011, an average of 1,500 tonnes of solid waste is generated daily in KMA (Miezah et al., 2015). Out of the 1,500 tonnes/day of waste generation in the city, 1,300 tonnes/day are collected from domestic, commercial and industrial wastes. The remaining 200 tonnes/day left in the gutters, open spaces and communal sites pose a hazard to the people and the environment in the metropolis. The metropolis recorded the highest waste generation rate of 0.75 kg/person/day which was slightly above that of the capital city Accra, 0.74 kg/person/day (Miezah et al., 2015). The composition by weight of waste produced in KMA in 2010 showed that more than 40% is organic and followed by 21% of inert (ashes, debris), 20% of plastics, and 7% of paper and textiles, 2% of wood and metal, and 1 % of glass (Miezah et al., 2015). KMA has the responsibility of collecting, transporting, and disposal of not only the domestic waste but also the industrial and medical wastes generated in the metropolis. The service providers (Zoomlion) collect the hospital containers (12 m^3) thrice a day in KATH, once

a day in KNUST Hospital and once a day in Manhyia Hospital and dispose of the wastes to the Oti Sanitary Landfill Site (Miezah et al., 2015).

The liquid wastes are discharged into the drainage system in the metropolis. In the Development Plan for Kumasi Metropolitan Assembly (2010-2013), the industries known for discharging large quantities of effluent are Guinness Ghana Brewery Limited, Coca Cola Bottling Company and Kumasi Abattoir. The Guinness Ghana Brewery Limited and Coca Cola Bottling Company have installed treatment plants on the site with Environmental Health Officers who ensure that the effluent discharged into the water bodies in the Metropolis are treated to avoid contamination. The abattoir, however, lacks this facility and hence has been discharging its untreated effluents into the water bodies. Insufficient and lack of maintenance of drains and sewage system in the metropolis have resulted to rampant erosion and flooding and therefore steps are to be taken to prevent this.

2.5 Health Personnel Knowledge, Attitudes and Perceptions on Medical Waste Management at Health Facilities

Insufficient knowledge and perceptions, lackadaisical attitude and improper management practices among the healthcare workers are major problems in the management of medical waste (Shivalli et al., 2015; Gupta et al., 2016). Previous studies show that medical waste management may be affected by lack of knowledge on medical waste management and little interest from hospital administration (Thomas & Varghese, 2019). Another study also revealed that medical waste management may be hindered by lack of

regular monitoring and inadequate interest from hospital administration (Sharma et al., 2013). Efficient and effective practice and use of personal protective equipment by the waste collectors and the healthcare workers depend on their level of knowledge and attitude about medical waste and its management (Deress et al., 2019).

A previous study revealed that most medical waste handlers, particularly in the private hospitals/clinics do not have formal training in waste management (Amfo-Otu & Doo, 2015). Medical waste handlers play a pivotal role in efficient management of healthcare waste till its disposal, as they are part of the entire waste management processes and therefore, it is incumbent on their part to be equipped with the knowledge of medical waste management. Good practices and use of personal protective equipment by the healthcare workers depend on their level of knowledge and attitude about medical waste and its management (Shivalli & Sowmyashree, 2015). A previous study revealed that training of healthcare personnel on the use of the personal protective equipment was absent, plausibly due to the lack of resources (Amfo-Otu & Doo, 2015). It is the responsibility of the management of the healthcare facilities to ensure a safe and hygienic ways of healthcare waste handling, segregation, collection, storage, transportation, treatment and final disposal, with reduced or no risk to waste handlers, the environment and the general public using colour coding containers, strong waste bags, adopting ways of internal waste transport and provision of sufficient waste protective tools for waste worker (Akum, 2014). Proper practices of segregation depend on the knowledge of medical waste generator about the various subcategories of healthcare waste management (Olaniyo et al., 2019). Perception on medical waste management and the skill for proper

waste management goes a long way to minimize health risks associated with the improper management of medical waste (Shivalli & Sowmyashree, 2015). Intensification of training has shown to improve practices of health workers regarding how they handle medical waste (Mathur et al., 2011).

Sufficient knowledge on proper way of handling medical waste is crucial as this will go a long way toward safe waste disposal and protection of the community from various adverse effects emanating from infectious waste (Deress et al., 2019). Medical waste handlers are working in an unconducive environment (Al Emad, 2011), and most often are victims of occupational health hazards emanating from poor medical waste management practice. Sufficient knowledge, proper attitude of waste handlers are key factors for having proper infectious medical waste management and to protect the healthcare workers and the community at large from the diseases associated with the improper management of medical waste (Shivalli & Sowmyashree, 2015).

A recent study conducted in India that compared the biomedical waste knowledge, attitude and practices among healthcare personnel concluded that doctors, nurses and laboratory technicians had a better knowledge than the cleaning (sanitary) staff concerning biomedical waste management (Gupta et al., 2016). However, another recent study showed that many doctors had knowledge about waste management but they lacked satisfactory attitude to and practices for the problem (Mathewos et al., 2013).

2.6 Related Risks of Medical Waste Generated to the Immediate Environment of Health Facilities

Medical waste handlers are more exposed to the healthcare waste and therefore at higher risk than healthcare professionals (Deress et al., 2019). Healthcare professionals produce the waste and throw it into the garbage while waste handlers handle the waste more frequently throughout and mostly very less attention is given for their safety. Washing of medical devices is often done by the medical waste handlers and this expose them to the risk of cut with broken glassware and other sharp medical supplies (Shivalli & Sowmyashree, 2015).

Medical wastes can have withering effects on human health if not managed properly (Mathur et al., 2011). Improper management of medical waste can cause numerous health related diseases, occupational health hazards and contamination of food, soil and groundwater (Shivalli & Sowmyashree, 2015). Further to that, improper healthcare wastes management could expose the healthcare workers, patients, workers in support services, visitors to health facilities, waste handlers, scavengers, fetuses in the wombs, and the general public to sharps contaminated with blood containing deadly diseases such as hepatitis B, hepatitis C, HIV/AIDs and other viral diseases (Mathewos et al., 2013). Environmental pollution and foul smell are also caused by improper medical waste management and may lead to the growth and multiplication of infectious vectors like parasites, rodents and worms and likely results in the transmission of diseases (Gupta et al., 2016). Medical wastes spoil aesthetics of the healthcare premises, choke drains and make the place dirty. A previous study revealed that transmission of disease through infectious waste was regarded to be the highest threat from medical waste and if the

pathogens such as bacteria and viruses that cause the diseases were not killed in the treatment process they would be present in the waste (Asante et al., 2014).

2.7 Recycling and Uses of Medical Waste

The word 'waste' means material that is useless and unwanted. However, some of these waste products can be recycled and reused for other purposes. Recycling converts materials that would otherwise become invaluable or waste into useful resources. Recycling of medical waste becomes easier when it is properly segregated at the point of generation. Biodegradable solid medical wastes can be recycled by composting into fertilizer for Agricultural purpose. There are other options for reuse, in particular of items which are not directly used for healthcare (paper, cardboard, glass, metal containers, plastic wrapping, etc.

In developing countries, due to absence of technology, lack of technical know-how as well as improper management procedures, recycling of potentially contaminated materials such as the plastic and metal from syringes or needles is difficult (Abah & Ohimain, 2011). However, the waste water can be treated to remove the hazardous substances before discharging through drains into rivers or streams which can be used by vegetable farmers for irrigation purpose. The most critical issues regarding reclaimed medical waste water is the protection of public health.

2.8 Importance of Effective Medical Waste Management

- It minimizes the incidence of hospital acquired and general infection.
- It leads to cleaner and healthier surroundings.
- It leads to reduction in the cost of infection control within the hospital.
- It reduces the possibility of disease and death due to reuse and repackaging of infectious disposables.
- It results to low incidence of community and occupational health hazards.
- It causes reduction in the cost of waste management and generation of revenue.
- It improves the image of the healthcare establishment and increases the quality of life.

CHAPTER THREE

METHODOLOGY

3.1 The Study Area

3.1.1 Location

This study was conducted in the Kumasi Metropolis in the Ashanti Region, the most populous city in the region. The Metropolis is divided into ten sub metropolitan areas, namely Manhyia, Tafo, Suame, Asokwa, Oforikrom, Asawase, Bantama, Kwadaso, Nhyiaeso and Subin. It is accessible from all corners of the country because of its unique central position. It is the second largest city in the country and the largest of the 30 districts in the Ashanti Region. The Metropolis shares boundaries with Kwabre East and Afigya Kwabre Districts to the north, Atwima Kwanwoma and Atwima Nwabiagya Districts to the west, Asokore Mampong and Ejisu-Juaben Municipality to the east and Bosomtwe District to the south. It is approximately 270 km north of the national capital, Accra (Ghana Statistical Service, 2012).

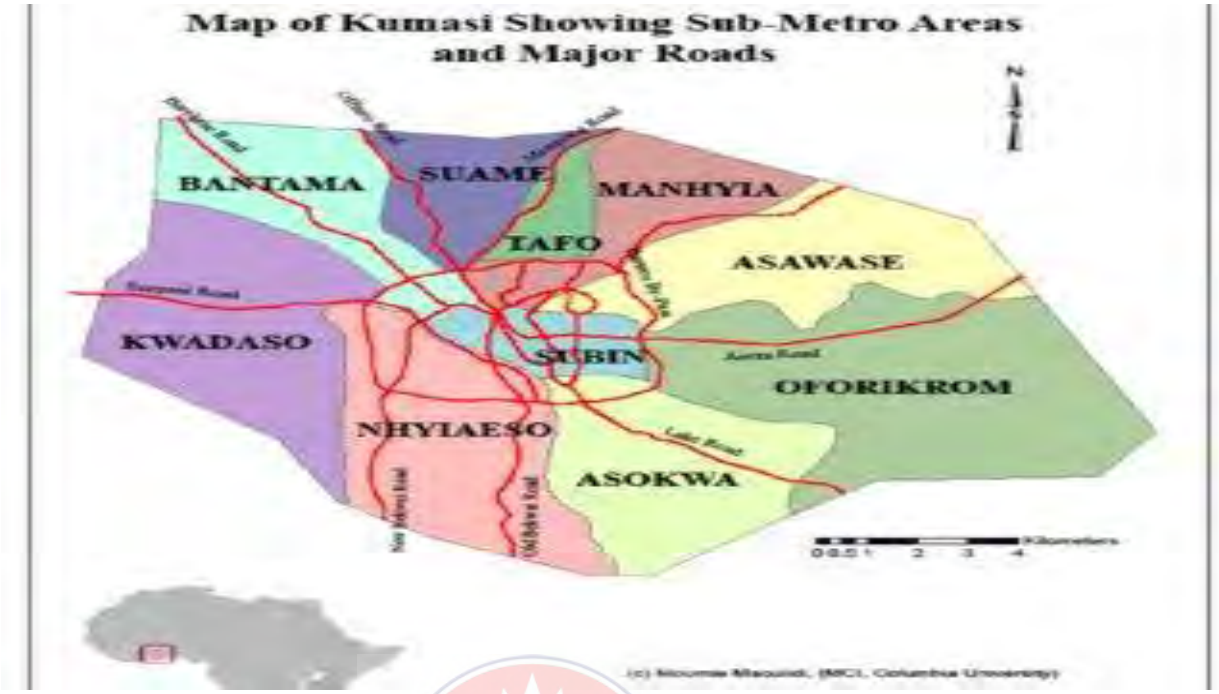


Fig. 3.1: Map showing Kumasi metropolis

(Source: Ghana Statistical Service, 2012)

3.1.2 Vegetation/Climate

The metropolis is about 254 kilometers and located between Latitude 6.35ºN and 6.40ºS and Longitude 1.30ºW and 1.35ºE. It is elevated 250 to 300 meters above sea level. The Kumasi metropolis falls within the wet sub-equatorial type. The average minimum temperature is about 21.5ºC and the maximum average temperature is about 30.7ºC. The average humidity is around 84.16% at sunrise and 60% at sunset. The moderate temperature and humidity and the double maxima rainfall regime (214.3mm in June and 165.2 mm in September) have a direct effect on population growth and the environment as it has precipitated the influx of people from every part of the country and beyond its frontiers to the metropolis (National Population and Housing Census, 2010).

3.1.3 Demography

It is a fast growing Metropolis and accommodates about 36.2 percent of the region's population with an estimated population of 2,063,701 and an annual growth rate of about 5.4%. There are concentrations of economic activities in the city. The first and most important location is the Central Business District (CBD), which include the Kejetia Lorry Park, the Central Market and the Adum Shopping Centre. The other economics nodes include the Suame Magazine (Vehicle repair centre) and Kaase/Asokwa Industrial Area. Most industries which deal in Timber processing, logging, Food processing and Soap making are concentrated at the Kaase/Asokwa Industrial Area. There is also number of satellite markets in the metropolis. These include Asafo Market, Bantama Market, Oforikrom Market and Atonsu Markets. Kumasi is a cosmopolitan city with trading being the main occupation of most of the inhabitants (National Population and Housing Census, 2010).

3.1.4 Health Facilities in the Metropolis

For health administration, the Metropolis is divided into five Sub-metros: Bantama, Subin, Asokwa, Manhyia North and Manhyia South. Komfo Anokye Teaching Hospital (KATH), which is the biggest and modern teaching hospital in the region, situated at Subin Health Sub-metro serves the entire city as well as its immediate peri-urban communities and others from Ghana and overseas. The Kumasi South Hospital (KSH) is located at Chirapatre, within the industrial hub of the metropolis and serves the people of Asokwa, Kaase, Ahensan, Atonsu, Esreso, and Gyenyase. The Manhyia Hospital, situated at Ashanti Newtown near the Manhyia Palace, serves Manhyia, Ashanti Newtown, Krofrom, Aboabo and Asawasi communities. The Suntreso Government

Hospital is located at North Suntreso and serves North and South Suntreso, Adoato, Patasi Estate, Kwadaso, Asuoyeboa, Breman and Suame (Fig. 3.2).

Fig. 3.2 Map Showing some Health Facilities in the Kumasi Metropolis

(Source: Kumasi Metropolitan Assembly, 2010)

3.2 Data Collection

3.2.1 Study Design

The study employed a cross-sectional descriptive study to assess the management of medical waste in some selected health facilities in the Kumasi metropolis of Ashanti region of Ghana. The study focused on medical waste generation, segregation, collection, treatment and disposal. The study also assessed sanitary workers level of knowledge and precautionary measures adopted to protect themselves from the risk posed by medical waste.

3.2.2 Study population and Sample size

The study included all staff of 6 health facilities both (Government and private), including facility management, medical professionals and sanitary personnel at the OPD/emergency, pharmacy, laboratory, canteen and environmental sections of the health facilities. A population of 400 was randomly selected for the study.

3.2.3 Inclusion and Exclusion criteria

The study included all staff of health facilities (both Government and private); including facility management, medical professionals and sanitary staff at the OPD/emergency, labour wards, pharmaceutical, laboratory, canteen and environmental sections of the health facilities that consented to participate in the study. It excluded healthcare workers that did not directly handle cases at OPD/emergency, labour, pharmacy and laboratories, and staff who did not consent to participate in the study as well as staff who have worked less than 5 months since they had no or little experience at the health facilities. In addition, health facilities with staff less than ten (10) and daily average OPD attendance of less than ten (10) were excluded from the study. Patients were also excluded.

3.4 Sampling Techniques

A multistage sampling technique was used in selecting respondents for this study. Purposive and simple random sampling techniques were employed in the study. Purposive sampling technique was used to select six sub-metros which included Bantama, Manhyia, Tafo, Nhyiaeso, Kwadaso and Subin out of the ten sub-metros in the Kumasi metropolis. Eligible health facilities (including public and private) were purposively selected based on their size and status while participants, including nurses, doctors and the waste collectors were selected by simple random technique.

3.4.1 Sampling Procedure

3.4.1.1 Sample Size Estimation

An estimated sample size of 400 healthcare workers was selected from the total population for the study. The sample size was obtained using the Cochran's formula, which is: $n = z^2 (pq)/ e^2$

Where:

n is sample size

z is the z value for confidence level of 95% which is 1.96

p is the (estimated) proportion of the population = 0.5

q = 1- P = 1- 0.5 = 0.5

e is the margin of error = 0.05

Therefore, $n = 1.96^2 (0.5 \times 0.5) / (0.05)^2 = 384.16$

Since it is virtually impossible to get a 100 % response rate when administering questionnaires, an estimated 4% rate was included to make room for any situation of non-responses. Therefore, the 4 % non - respondent rate was 15.4, raising the total sample size to 400.

3.4.1.2 Sampling Frame

Table 3.1 Selected Health Facilities for the Study

Name of facility	Percentages (%)	Estimated Sampling proportions	Status
Komfo Anokye Teaching Hospital	58	232	Public
Manhyia Government Hospital	15	60	Public
Tafo Government Hospital	18	72	Public
Trust Care Service	4	16	Private
Tanoso Community Hospital	3	12	Private
Mikaddo clinic	2	8	Private

Table 3.1 shows the selected health facilities and the estimated sampling proportions based on the bed capacity. KATH was assigned 58 % since it is tertiary hospital with highest bed capacity. Manhyia and Tafo Government hospitals are secondary hospitals and were assigned 15 % and 18 % respectively. Meanwhile, Trust care hospital, Tanoso community hospital and Mikaddo clinic are primary health facilities and were assigned 4 %, 3 % and 2 % respectively.

Table 3.2: Distribution of Professionals in the Departments of the Health Facilities Selected for the Study

Category of Health worker	Percentages (%)	Estimated Sampling proportions
Medical doctor	10	40
Sanitary staff	3	12
Nurse	63	252
Lab technician	8	32
Pharmacist	10	40
Others (Such as administrators)	6	24
Total	**100**	**400**

Table 3.2 shows the different professional groups calculated based on proportion – size.

3.5 Data Collection Procedure

3.5.1 Sources of Data

Sources of data collection consisted of primary and secondary sources. Primary data was collected through field study, questionnaire survey and face-to-face interviews. The responses elicited from healthcare workers and the management of the six selected healthcare facilities provided a primary data for the study. The secondary sources of data included published and unpublished articles, theses, journals, books and news items. The Ghana Public Health Policy, the hospital progress reports and general records were among the documents used. The World Wide Web using the internet provided a broad source for collecting the secondary data.

3.5.2:1 Field Study

Field investigation activities were carried out in the selected health facilities of study to assess the frequency of collection, availability of waste treatment facilities and functionality and whether the waste generated at the departments were dumped into the colour coded dustbins. Pictures were taken in the process to support the investigation.

General information on how medical wastes were managed was collected through questionnaire survey, observation and interview. Data was collected based on the objectives for the study.

i. To examine the current medical wastes management systems and practices at the health facilities, collection of data was based on direct observation. Medical waste segregation, collection, transportation, condition of treatment facilities, disposal method and site of disposal were inspected and observed through several unannounced visits to the study sites within a period of 11 weeks (June, 2020 to August, 2020). Photographs were also taken. Checklist was used to achieve this purpose. Similarly, structured interview was used to assess how the management or administrators managed the waste.

ii. To assess the knowledge, attitudes and perceptions of the health personnel on medical waste management at the health facilities, semi-structured questionnaire was used. Attitudes and perceptions of respondents' practices of medical waste management, techniques and methods of waste disposal in the health facilities were also assessed.

iii. To assess the related risks of healthcare waste generated to the immediate environment at the health facilities, the semi-structured questionnaire was combined with careful observations of the immediate surroundings.

Few of the questionnaires were completed and collected same day of delivery to respondents while others were collected at least a week after delivery. All completed questionnaires were collected within 52 days with 92% response rate, 368 out of 400 questionnaires delivered to respondents.

3.5.2.2: Face-to-face Interviews

To assess the knowledge of health administrators, environmental health officers and waste collectors/orderlies on medical waste management, face-to-face interviews were conducted to collect data from them by using interview guide.

3.6 Data Management and Analysis

The questionnaires were checked for completeness and consistency, coded, and entered into Statistical Package for Social Sciences (SPSS Version 25 IBM Corp, Armonk, NY, USA) for the analysis. Descriptive responses emanating from the interview guide and interactions with the health facilities' management and sanitary staff formed the basis for the qualitative analysis. The data was analyzed and interpreted according to the objectives of the study. Frequency and proportion were used to describe the variables. Pearson's chi-square test was used to establish associations between categorical variables. $P < 0.05$ was considered as statistically significant.

3.7 Conceptual Frame Work

The Fig. 3.3 below shows the general conceptual processes through which the work was followed.

Fig 3.3 Conceptual framework

3.8 Validity and Reliability

After the construction of the questionnaires which was based on the research objectives, suggestions and criticisms were welcomed from my supervisors and colleagues for the necessary corrections. Prior to administering the questionnaire for the main study, they were pilot tested using respondents from Kwadaso S.D.A Hospital to ensure the validity of the items. Response to the questions proved positive and this gave way for the research to take off.

3.9 Ethical Clearance

Ethical clearance for the study was obtained from the Komfo Anokye Teaching Hospital (KATH) Committee on Human Research, Publications and Ethics. In addition, permission was obtained from the Ghana Health Services, Ashanti Regional Health

Directorate and study facilities to conduct the study. Written informed consent was obtained from each participant and heads of health facilities prior to administering the questionnaires. Confidentiality was ensured throughout the study process, including the process of data collection and in reporting. Each participant and health facility was given a unique identification (ID) in coding, instead of the names of the participants, hence protection of their privacy.

CHAPTER FOUR

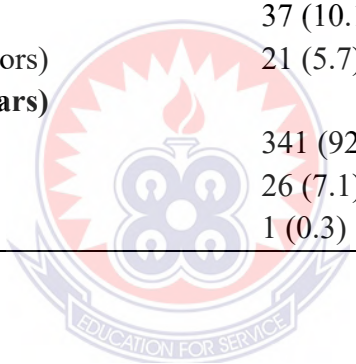
RESULTS

4.1 Socio - demographic Characteristics of Respondents at the Health Facilities

Table 4.1 shows the socio-demographic data of respondents from the health facilities studied included age, gender, job designation and work experience. The age of respondents ranged from 20 to 74 with a mean age of 31.5±7.7 of which 46.2 % of them aged between 20 – 29 years; followed by 30–39 years being (43.5 %) while the least (3.8 %) aged from 55 and above. 67.4 % were female while 32.6 % were male. Nurses formed majority (64.2 %) of the respondents, followed by pharmacist (10.1 %), medical doctors (8.9 %), lab technicians (8.2 %) and sanitary staff (2.9 %). With regards to the duration worked in the health facility, most (92.6 %) had practiced for at least 10 years, 7.1 % had practiced 11-20 years, whereas, 0.3 % had practiced 20 – 30 years at the same facility (Table 4.1).

Table 4.1 Socio - demographic Characteristics of Respondents

Study Variables	Frequency (%)
Age of personnel (in years)	
20-29	170 (46.2)
30-39	160 (43.5)
40-49	24 (6.5)
55+	14 (3.8)
Gender	
Female	248 (67.4)
Male	120 (32.6)
Job designation	
Medical doctor	33 (8.9)
Sanitary staff	11 (2.9)
Nurse	236 (64.2)
Lab technician	30 (8.2)
Pharmacist	37 (10.1)
Others (such as administrators)	21 (5.7)
Worker experience (in years)	
1-10	341 (92.6)
11-20	26 (7.1)
20-30	1 (0.3)



4.2 Medical Waste Management Practices at the Health Facilities

Table 4.2 shows the current management practices of medical waste at the health facilities. Current medical waste management practices at the health facilities involved segregation of medical waste into colour coded waste bins (black, brown, yellow), sharp boxes for sharp objects, transportation of waste from generating sites to treatment and disposal sites (Table 4.2).

Table 4.2 Current Medical Waste Management Practices at the Study Sites

Health facility	Segregation of waste	Record on quantity of waste	Labeling on containers	Condition of waste containers outside the wards	Waste handlers	Type of waste treatment facility available	Condition of treatment facility
WHO/MOH Guidelines	Different components of waste should be placed in designated containers as soon as they are generated	There should be record on quantity of waste generated per day (Weight and Volume)	Visible posters indicating the kind of waste to be disposed should be placed on the containers	Containers must be clean, covered and placed at vantage points	Orderlies, waste collectors, waste company, etc	Incineration, autoclaving, microwaving, plasma pyrolysis, etc	The area must be spacious, clean and fenced
KATH	Improper	Absent, except sharps	Improper	Poor	Orderlies, waste workers and zoomlion	Incinerator	Good
Manhyia Government Hospital	Improper	Absent	Improper	Poor	Orderlies and waste workers	Incinerator	Poor
Tafo Government Hospital	Improper	Absent	Improper	Good	Orderlies	Incinerator	Good
Trust care Hospital	Proper	Absent	Proper	Good	Orderlies	Incinerator	Good
Tanoso Community Hospital	Improper	Absent	Improper	Good	Orderly and any health worker on duty	Absent	-
Mikaddo clinic	Improper	Absent	Improper	Good	Orderly	Absent	-

- Improper/Poor refers to incompliance to WHO & Ghana MOH's standard/guideline for medical waste management.
- Proper/Good refers to compliance to WHO & Ghana MOH's standard/guideline for medical waste management.
- Absent refers to non – availability of facility or activity.

4.2.1 Segregation of Medical Waste into Bins with Appropriate Labels

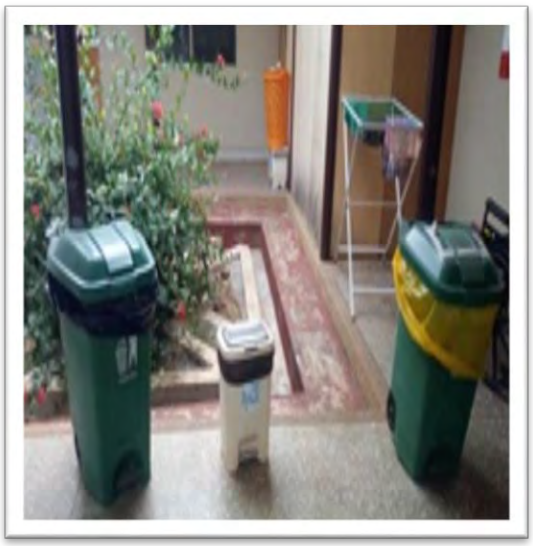
Medical wastes segregation by the healthcare workers observed at the various healthcare facilities (including Manhyia hospital and Mikaddo clinic) was not practiced properly except at Trust care hospital. Segregation of medical wastes into different components was practiced in some departments, particularly the laboratories (soiled cotton, sharps, and other bodily fluid were put into designated boxes and plastic containers. It was observed at Manhyia hospital that a placenta was mixed with general waste in black polythene which was meant for disposal as general waste (Plate 4.1.a). Meanwhile, yellow lining was used for all the types of waste at Mikaddo clinic (Plate 4.1.b). The containers in all the health facilities were of different sizes ranging from 20 to 60 litres.

(a) Manhyia Hospital **(b) Mikaddo clinic**

Plates 4.1 Improper segregation of waste at some of the study sites

4.2.2 Condition of Bins (Containers) at the Study Sites

Tafo Government Hospital had containers in good condition because they were clean, covered and placed at vantage points (Plate 4.2.a). However, at Komfo Anokye Teaching Hospital, the containers were not in good condition (Plate 4.2.b). It was also observed that most wastes bins outside the wards and units of all the health facilities used for the study were not covered. This exposed the waste to the mercy of rain and scavengers. The rain sped up the rate of decomposition of the waste and produced unpleasant odour while the scavengers scattered the waste. This posed a health risks to the health workers, patients and those who passed by these bins, since wind blew bad odour and pathogens from the bins. It was also observed from the health facilities, except Trust Care Hospital that most of the bins (containers) were not labeled and even the labeled ones were not conspicuous. In Manhyia Hospital, most of the bins were not covered and others were not labeled too (Plate 4.2.c). Meanwhile, in Tanoso hospital most of the containers were covered but not labeled (Plate 4.2.d)



(a) Tafo hospital

(b) KATH

(c) Manhyia hospital

(d) Tanoso hospital

Plates 4.2 Condition of bins (containers) at the study sites

4.2.3 Collection and Transportation of Medical Waste

The bins were collected twice a day manually by the waste collectors and orderlies from the wards and various units to the temporary storage sites. It was observed from KATH (Plate 4.3.a) and Manhyia hospital (Plate 4.3.b) that most of the bins became more than ¾

full and were not collected on time. The bins were washed frequently by the waste collectors and orderlies in all the health facilities. In the case of KATH, in addition to the waste collectors and orderlies employed at the health facility, the management of the waste was also contracted to a private company (Zoomlion) for the collection of the waste from the various wards. Most of the waste collectors claimed they disinfected the medical waste before transporting to waste disposal sites, but observations at the study sites however failed to ascertain this. The waste handlers were equipped with personal protective equipment (PPE), including gloves, safety boots, face mask and apron during medical waste collections and transportation but that could not prevent those who even used them from periodic accidental needle prick and cut from sharp. This was linked to inadequate training on proper ways of using the PPE's during collection and transportation of waste.

(a) KATH **(b) Manhyia hospital**

Plate 4.3 Bins from study areas that were more than ¾ full

4.2.4 Storage of Medical Waste

It was observed that all the health facilities had temporary storage sites for keeping the medical waste. These sites consisted of special rooms; open enclosure and metal container. Most of the health facilities had secured their temporary storage areas. The wastes were collected daily and stored temporarily in the waste storage sites before treatment and final disposal. The infectious and non-infectious wastes were mixed up at these temporary storage areas except KATH and Trust care Hospital. Waste collected at the wards and units did not go beyond 24 hours before they were transferred to storage sites. However, it was observed that collected medical waste had piled up in the temporary storage site of Manhyia hospital (Plate 4.4.b) and this was extremely dangerous as it generated bad odour.

4.2.5 External Transportation of Medical Waste

Health facilities including Tanoso Community Hospital (Plate 4.4.a) and Mikaddo clinic with no treatment and disposal sites stored the waste temporarily at a designated place for almost three (3) days before transporting to a nearby facility for treatment and disposal. The transportation was done by tricycle operators. It was subsequently revealed that Tanoso hospital and Mikaddo clinic which claimed they sent their medical waste to bigger facilities for treatment was untrue, and therefore, either the waste ended up on municipal refuse dump untreated or burnt in an open space. The smoke that emanated from the burnt waste posed a serious health risk to the general populace. It was further disclosed that the health facilities paid for the services of the tricycle operators without following up on whether the waste was transported for treatment at the bigger facilities. In addition to this, it emerged during the observation that the tricycle operators transported the medical waste together with domestic waste.

(a) Tanoso hospital

(b) Manhyia hospital

Plate 4.4 Temporary storage areas at the health facilities

4.2.6 Treatment and Final Disposal of Medical Waste

Treatment and safe disposal of medical waste is of utmost importance to prevent infection transmission. Incineration was the final step in the medical waste management in almost all the six (6) health facilities. It was disclosed from the study that 4 (66.7 %) out of the 6 health facilities, comprising Komfo Anokye Teaching Hospital, Manhyia Government Hospital, Tafo Government Hospital and Trust Care services had their incinerators installed in their premises while Tanoso Community Hospital and Mikaddo clinic sent their medical waste to Kwadaso S.D.A Hospital and Komfo Anokye Teaching Hospital for incineration respectively.

4.2.6.1 Treatment of Medical Waste at Komfo Anokye Teaching Hospital

Komfo Anokye Teaching Hospital had two incinerators installed, one for burning anatomic wastes (placenta, tissues, etc.), established on the hospital's premises (Plate 4.5.a) and the other for burning infectious waste (Addfield MP 400, Britain) which was set up recently (Plate 4.5.b). The Addfield MP 400 incinerator had a capacity of one cubic meter and burnt 200 kg to 350 kg of waste within a day depending on the type of waste, thus loading per cycle depended on type of material. For example, plastic required more energy and took longer time to burn than a paper, since plastic had to melt before it burnt into ash while paper burnt straight into ash. The medical wastes were segregated, nicely packed and tied. The distance from the closest departments/wards to the incinerator was about 200 m away from the hospital's premises and was securely sited, thus preventing access by stray animals, children and scavengers and to established early warning system to curb environmental pollution with its resultant consequences. It contained burn chambers, a primary chamber where temperature could rise up to 600 ºC, secondary chamber where temperature could rise up to 1200 ºC. It contained a sensor called thermocouple that detected the temperature within the furnace. The combustion process ran on propane gas, electricity and air. An automated fan system regulated the amount of air (oxygen) that got into the burning chambers. This air flow also had the duty of cooling the grate. When the process started, the unit took about 15 minutes to reach optimum temperature, first in the secondary chamber and then in the primary chamber. The medical waste was fed into the primary chamber by the hydraulic loader and combustion took place on an iron grate. The iron grate allowed ash to collect in a separate compartment situated at the bottom of the incinerator. Gaseous emissions left the

secondary chamber through a chimney. Air pollution control devices were absent in the unit. However, the secondary chamber fulfilled this role by burning the gases at a higher temperature. Again, since it was operated by skilled personnel, it hardly produced harmful smoke. Bottom ash was consistently removed from the unit and disposed of on adjacent fields where food crops such as vegetables were grown. Although the unit was meant to treat segregated infectious medical waste, the bottom ash from the unit contained sharps such as broken bottles. This could cause injury to the vegetable farmers and destroy the soil as well. They had a larger space for the treatment of the medical waste.

At KATH, the health worker on duty was held responsible for any misappropriation of the medical waste in their wards. In this case, the in-charge signed against his/her name when the medical waste was collected. This enabled them trace offenders.

(a) Anatomic waste incinerator at KATH (b) Infectious waste incinerator at KATH

Plate 4.5 Incinerators at Komfo Anokye Teaching Hospital

4.2.6.2 Treatment of Medical Waste at Trust Care and Manhyia Government Hospitals

The incinerators observed at Trust care hospital (Plate 4.6.a & b) and Manhyia hospital (Plate 4.7 a & b) were similar and had chimneys with air pollution control devices (APCDs) mounted but did not function. This caused harmful smoke to be released into the atmosphere and posed risk to the health of the community members. In Menhyia for instance, the community members complained bitterly about the smoke and bad odour emanated from the storage and treatment of medical waste. This was revealed during interview with some members in the communities. They complained the smoke turned their uncovered water and food black and the bad odour caused headache and other diseases. Their incinerators were powered by a propane gas and burnt at a temperature of 1200 ºC. The distances from the closest departments/wards to the incinerators were about 10 m at Trust Care Hospital and 100 m at Manhyia hospital. They were not operated by skilled personnel since their level of understanding on how the incinerators operated was found during the interview to be very low. Both disclosed that they burnt their waste at dawn to prevent the circulation of smoke by strong winds during the day. In Trust Care Hospital, it was found that the medical waste was nicely tied and packed close to the incinerator. However, the space for the treatment of the waste in the hospital was too small. The ash was collected and tied after incineration and given to refuse collectors who used tricycle to collect the waste for final disposal. When asked if they checked where they sent the waste, it was disclosed that they did not follow up after paying for the services of the waste collector to dispose of the waste. This was seen as a dangerous practice, since the ash containing sharps such as broken bottles could end up on the bare soil or refuse dump.

At Manhyia hospital, it was found that the infectious and non-infectious wastes were mixed up and scattered on the floor. They collected the ash and disposed of it into adjacent area, close to the incinerator (Plate 4.8). They also had placenta pit to dispose of placenta (Plate 4.7.c). They had a large space for treatment of medical waste.

(a) Opened incinerator at Trust care hospital (b) Closed incinerator at Trust care

Plate 4.6 Incinerator at Trust Care Hospital

(a) Incinerator at Manhyia hospital

(b) Damaged roofing sheet by the incinerator

(c) Placenta pit at Manhyia hospital

Plate 4.7 Incinerator and Placenta pit at Manhyia Government Hospital

(f) Scattered treated waste at Manhyia hospital

Plate 4.8 Scattered Treated Waste at Manhyia Government Hospital

4.2.6.3 Treatment of Medical Waste at Tafo Government Hospital

In the case of Tafo Government Hospital, the incinerator was locally made of bricks and had a long chimney to conduct smoke into the sky (Plate 4.9.a). It was not properly secured. The distance from the closest department/ward to the incinerator was about 150 m. It was also operated by unskilled personnel and had no air pollution control devices (APCDs) mounted. However, it burned the medical waste effectively. The operators revealed that they did their incineration at dawn to prevent the spread of smoke in the neighborhood. However, during interview with the people in the community around the incinerator, they complained bitterly about the smoke from the incinerator during incineration. Ashes from the incinerator were put into a hand dug pit close to the incinerator (Plate 4.9.b). The placentas were dumped into a pit. Acid was added to the placenta in the pit. It was disclosed that some patients collected their placenta home based on cultural and religious belief.

(a) Incinerator at Tafo hospital (b) A dug pit at Tafo hospital

Plate 4.9 Incinerator and dug pit at Tafo Government Hospital

4.2.6.4 Treatment and Final Disposal of Liquid Waste for all the Healthcare Facilities

Untreated medical waste water was discharged into septic tanks, example Tafo hospital (Plate 4.10.b), soak - aways, and on the bare soil from some departments/wards such as theater. This was viewed as normal practice in the health facilities. However, medical waste water from other departments/wards such as OPD and basins for washing of hands in all the health facilities, except Trust care services were drained directly into the municipal communal sewage system. Examples are drains at Manhyia hospital (Plate 4.10.a) and Tafo hospital (Plate 4.10.c). This was likely to join our water bodies used by vegetable farmers and people close to it. The health implication that may emanate as a result of this could be devastating.

(a) Drain at Manhyia hospital

(b) Septic tank at Tafo hospital

(c) Drain at Tafo hospital

Plate 4.10 Drains from some of the health facilities connected to the municipal sewage

4.3 Knowledge, Attitude and Perception on Medical Waste Management among Health Workers at the Health Facilities

4.3.1 Assessment of Knowledge on Current Practices of Medical Waste Management among the Health Workers

Table 4.3 shows that majority of the respondents (75.5 %) had knowledge on medical waste. Most of the respondents (74.4 %) revealed that they segregated medical waste at the point of generation based on colour coding for medical waste disposal. Meanwhile, majority of the respondents (64.1 %) disclosed that medical waste collected remained at the health facilities for between 12 hrs and 48 hrs and 82.1 % indicated that medical waste collected were transported to the treatment site daily while 86.5 % agreed this would reduce hazards associated with medical waste management (Table 4.3).

Table 4.3 Knowledge on Current Practices on Medical Waste Management among the Health Workers

Variables	Frequency (%)
Knowledge on medical waste	
Yes	278 (75.5)
No	90 (24.5)
Segregation of medical waste	
Yes	274 (74.4)
No	94 (25.6)
Colour coding segregation	
Yes	274(74.4)
No	94(25.6)
Storage duration at sites (hours)	
12	236(64.1)
48	27(7.3)
72	22(6)
96	12(3.3)
More than 96 hours	32(8.7)
Don't know	39(10.6)
Frequency of collection of waste	
Daily	302(82.1)
Weekly	45(12.2)
Monthly	2(0.5)
Other	19(5.2)
Importance of best practice	
Agree	318(86.5)
Disagree	46(12.4)
Undecided	4(1.1)

4.3.2 Assessment of Knowledge, Attitude and Perception on Medical Waste Management among the Health Workers

Table 4.4 shows 62 % of the respondents disagreed that safe management of waste was not important while 78.8 % of the respondents agreed that waste management was a team work. Nearly fifty percent of the respondents (49.2 %) indicated that safe medical waste management would increase the financial burden on health facilities. Meanwhile, more than seventy percent (70.6 %) of the respondents agreed that infectious waste need to be

sterilized prior to disposal. Most of the respondents (89.9 %) agreed that colour code labeling of waste containers prior to filling in medical waste is of clinical significance (Table 4.4).

Table 4.4 Assessment of Knowledge, Attitude and Perception on Medical Waste Management

Variables	Frequency (%)
Safe waste management is not important	
Agree	82(22.2)
Disagree	228(62.0)
Undecided	58(15.8)
Waste Management is a team effort	
Agree	290(78.8)
Disagree	72(19.6)
Undecided	6(1.6)
Safe management increase financial burden	
Agree	181(49.2)
Disagree	176(47.8)
Undecided	9(2.5)
Safe waste management is an extra burden on work	
Agree	136(36.9)
Disagree	214(58.2)
Undecided	18(4.9)
Is necessary to sterilize infectious waste	
Agree	260(70.6)
Disagree	104(28.3)
Undecided	4(1.1)
Is important to label containers	
Agree	331(89.9)
Disagree	34(9.3)
Undecided	3(0.8)

4.3.3 Assessment of Knowledge on Medical Waste Legislation among the Health Workers

Table 4.5 shows that majority (56.3 %) of the respondents were aware of the existence of laws governing medical waste management in the health facilities. Meanwhile, 50.8 % did not know the punishment for the healthcare workers who indiscriminately disposed of

medical waste. Most (80.4 %) of them indicated that such indiscriminate disposal of medical waste should be reported to authorities whilst 83.4 % suggested imposition of more stringent regulation in medical waste management was necessary (Table 4.5).

Table 4.5 Assessment of Knowledge on Medical Waste Legislation among the Health Workers

Variables	Frequency (%)
Availability of laws	
Yes	200(56.3)
No	149(40.5)
Don't know	19(5.2)
How offenders are dealt with	
Sent to the traditional leaders	33(9.0)
Sent to political leaders	27(7.3)
Made to pay fines	84(22.8)
Others	37(10.1)
Don't know	187(50.8)
Necessity to report to authorities	
Yes	296(80.4)
No	52(14.2)
Don't know	20(5.4)
Imposition of more stringent regulation	
Yes	307(83.4)
No	56(15.2)
Don't know	5(1.4)

4.3.4 Knowledge on Medical Waste Management among the Health Workers

Table 4.6 shows that most **(**75.8 %) of the respondents had education on medical waste management whilst 37.5 % disclosed they had it once in a year. The source of education was largely from the environmental officers (41.6 %) and mostly via workshop (42.1 %). Meanwhile, 85.6 % of the respondents agreed that health institutions/centres should organize education program to update them on medical waste management while 87% of them were willing to attend educational programmes on waste management and disposal voluntarily (Table 4.6).

Table 4.6 Knowledge on Medical Waste Management among the Health Workers

Variables	Frequency (%)
Education/Training	
Yes	279(75.8)
No	83(22.6)
Don't know	6 (1.6)
Sources of education	
Environmental officers	153 (41.6)
NGO's	34 (9.2)
Sanitation and water management team	42 (11.4)
Others (including MOH)	47 (12.8)
Don't know	92(25)
Frequency of education	
Weekly	73 (19.8)
Monthly	48 (13)
Once a year	138 (37.5)
Twice a year	33 (9.0)
Other	76 (20.7)
Type/Nature of education	
Workshop	155 (42.1)
Seminar	39 (10.6)
Talk	109 (29.6)
Others	65 (17.7)
Organization of education	
Agree	315 (85.6)
Disagree	51 (13.9)
Undecided	2 (0.5)
Readiness to attend educational program voluntarily	
Yes	320 (87)
No	45 (12.2)
Undecided	3 (0.8)

4.3.5 Assessment of Knowledge on Medical Waste Treatment and Disposal among the Health Workers

Table 4.7 shows most respondents (70.7 %) agreed that infectious waste should be sterilized by autoclaving before shredding and disposal. Meanwhile, 76.3 % of them agreed that an effluent treatment plant should be set up at the health centres to treat infectious waste water. Meanwhile, 36.1 % disclosed that waste collected should be

dumped in an isolated area whereas 66.1 % said there is no waste recycling program at their health facilities. However, 82.3 % disclosed they used incinerator to treat medical waste in the health facilities (Table 4.7).

Table 4.7 Assessment of Knowledge on Medical Waste Treatment and Disposal among the Health Workers

Study variables	Frequency (%)
Necessary to sterilize waste	
Agree	260 (70.7)
Disagree	104 (28.3)
Don't know	4 (1.0)
Setting up effluent treatment plant	
Agree	281 (76.3)
Disagree	59 (16.1)
Don't know	28 (7.6)
Place for disposal of waste	
Dumping in isolated area	133 (36.1)
Waste dump	57 (15.5)
Landfills	105 (28.5)
Other	37 (10.1)
Don't know	36 (9.8)
Availability of waste recycling program	
No	243 (66.1)
Yes	106 (28.7)
Don't know	19 (5.2)
Waste treatment method	
Incineration	303 (82.3)
Composting	16 (4.4)
Biological digestion	7 (1.9)
Chemical digestion	4 (1.1)
Other	38 (10.3)

4.4 Association between Socio-demographic Variables and Segregation of Medical Waste among Health Workers

The results of the chi-square test (Table 4.8) showed that age, profession and years of experience are significantly associated with segregation of medical waste at source (p – value ≤ 0.05). However, gender (p – value > 0.05) is not significantly associated with segregation of medical waste at source. This indicates that young workers, health professionals and experience workers are more likely to segregate medical waste at the source.

Table 4.8 Chi-square Analysis of Socio – demographic Variables and Segregation of Medical Waste

Study variables		Segregation of medical waste		p-value (χ^2)
		Yes	No	
Age range (n = 368)	Up to 39 years	304	26	**0.000 (405.851)**
	More than 39 years	31	7	
Gender (n = 368)	Female	231	17	**0.784 (2.447)**
	Male	96	24	
Profession (n = 368)	Doctor, nurse, lab technician, pharmacist	332	4	**0.000 (111.130)**
	Sanitary staff, others (such as administrators)	21	11	
Years of work experience (n = 368)	Up to 10 years	327	14	**0.032 (122.165)**
	More than 10 years	24	3	

CHAPTER FIVE

DISCUSSION

5.1 Current Management Practices at the Health Facilities

Assessment of the current practices of medical waste is discussed based on generation, segregation, collection, transportation, treatment and disposal at the study sites.

5.1.1 Medical Waste Generation

Results from the study showed that the tertiary hospital (KATH) produced the highest quantity of waste because it was the biggest health facility with the highest bed occupancy, number of workers, health services provided and number of patients that reported to the facility in a day. In addition, in-patient units in all the health facilities used for the study produced higher amount of waste than the out-patient units. This confirmed a study that showed that the quantity of waste produced in the out-patient units is usually smaller than that in the in-patient units (Abah & Ohimain, 2011). However, good segregation at source leads to a reduction in the quantity of infectious waste produced (Abah & Ohimain, 2011). It was observed that there had been an increase in attendance of patients in all the health facilities and this had led to the increased volume of waste produced. This is buttressed by a previous research conducted by the Waste Management Department of the Accra Metropolitan Assembly in 6 major hospitals in Accra in 1992 which showed the average generation of medical waste to be 1.2 kg/bed/day and anticipated its increase in the years ahead due to an increasing number of hospital beds and improved standards of living (Ministry of Health, 2015).

5.1.2 Medical Waste Segregation

Medical wastes segregation at the point of generation was rarely practiced by the health workers, with the exception of a few sharps. Meanwhile, effective segregation should be

done at the point of generation and should always be the duty of the waste producer. This is buttressed by a study conducted in selected hospitals in Lagos, Nigeria which showed that it is essential to segregate medical waste into various categories to ensure effective disposal (Awodele et al., 2016). The study concluded that effective segregation of medical waste plays a major role in its safe management (Awodele et al., 2016). The study revealed that improper segregation at the source was attributed to non-availability of all the required categories of colour- coded containers and unlabeled bins. This is contrary to Ghana Ministry of health's policy which showed that various wastes are to be placed into their appropriate colour-coded container as soon as they are generated. Instruction posters concerning the steps for waste segregation should be pasted in all areas where segregation takes place and other vantage points (Ministry of Health, 2015).

Again, it was revealed from the study that most of the colour codes of the linens did not match with the bins and this affected the waste segregation. According to the Ministry of Health (2015), black is used for general waste such as left-over food, fruits, vegetables, waste paper, empty box. Brown is for pharmaceutical waste such as expired drugs, vaccines and leftover drugs. Yellow for infectious waste such as blood stained cotton, blood, body fluid and placenta. Sharp box is for sharp waste such as needles, blade, and broken glasses.

5.1.3 Collection and Transportation of Medical Waste

The study revealed that the waste bins in the various wards and outside all the health facilities were manually collected by waste collectors and orderlies to the temporary storage sites. This practice was also identified by a study conducted in district public hospitals of Tumpat, Batu Pahat and Taiping which revealed that both cleaners and

nursing assistants were responsible for collecting stored wastes at the wards and transporting them to disposal sites (Omar et al., 2013). The collection was done in accordance with the frequency of containers becoming full. Waste containers were removed and replaced immediately when they were getting full, except a few cases where containers overstayed outside the wards when full.

5.1.4 Storage of Medical Waste

Proper storage of medical waste is one of the major steps in reducing the health hazards it may pose. Meanwhile, with the exception of KATH, Mikaddo clinic and Tanoso community hospital that had special temporary storage sites, all the other health facilities used for the study kept their wastes temporary at the treatment sites. At KATH and Mikaddo clinic, storage bins were kept in roofed built-in areas protected from water, rain, wind, animals and pests such as rodents, cockroaches etc. and scavengers. The temporary storage sites were within the facilities and were easily accessible to collection by vehicles. Entrances to the storage areas were securely locked when unattended and the facilities were kept away from kitchen, laundry, ward etc. These were in compliance with Ghana Ministry of Health's policy. However, Tanoso community hospital used a metal container which was unroofed and therefore did not spare the waste containers from the frequent rainfall.

The study also revealed that some of the medical wastes at Mikaddo clinic and Tanoso community hospital were kept above 24 hours in the temporary storage facilities. This was in contradiction to Ghana Ministry of Health's policy which disclosed that the storage time for medical waste should not exceed 24 hrs (Ministry of Health, 2015).

5.1.5 Treatment and Final Disposal of Medical Waste

Treatment and safe disposal of medical waste is of utmost importance to prevent infection transmission. The study revealed that incineration was the final step in the medical waste management at all the six health facilities. This was buttressed by a similar study by (Özkan, 2013) which disclosed that incineration of medical waste has been the major technique used worldwide for treating and disposing medical waste such as papers, polyvinylchloride (PVC), plastics and discarded items of equipment. The main purpose of the incineration was to minimize the volume of solid waste and to convert it into smoke, heat and ash without posing threat to people and the environment. This was confirmed by (Berihun & Solomon, 2017) which showed that the process of incineration should be done to ensure that its operation provided sufficient safety and reduced the risk to the environment. However, the study revealed that the incineration on-site posed a great challenge as fumes emitted contained toxic chemicals which were harmful to the healthcare workers and the people close to the health facilities. This was buttressed by a research conducted in Malaysia which identified numerous constraints in the use of incineration and landfilling in treating medical waste as this could be a major source of dioxin and furan pollution that could cause liver failure and cancer (Ghasemi & Yusuff, 2016). It was further revealed from the study that the ash was collected and disposed of into adjacent area, close to the incinerator. This was a dangerous practice as it could endanger the lives of the waste handlers and the general public. A recommendation from a study by (Akum, 2014) indicated that there should be a landfill which was purposely designed for the final disposal of treated infectious medical waste.

5.1.6 Treatment and Final Disposal of Liquid Waste

It was observed that all the health facilities used for the study had a septic tank and soak - aways for collection of liquid waste from some of the wards and units. This was in conformity with the Ghana Ministry of Health's policy which proposed that waste water from the point of generation and storage area must be drained into septic tanks and soak ways and must not be allowed to drain off into storm water drainage or streams (Ministry of Health, 2015). However, some of the wastewater in all the health facilities used for the study was discharged directly without treatment from some of the wards and units into the urban drainage system. The health implication that might emanate as a result of this could be devastating. This was buttressed by a study which disclosed that the toxic chemicals from pharmaceutical and other medical waste found their way into the soil and pollute surface water bodies and the ground water causing health hazard to people who depend on wells for drinking, washing, and agricultural purposes (Sasu et al., 2012). It was further revealed that liquid wastes from all the health facilities used for the study were not treated appropriately (e.g. disinfection, neutralization) prior to final disposal.

5.2 Assessment of Healthcare Workers Knowledge, Attitudes and Perception on Medical Waste Management

5.2.1 Knowledge of Healthcare Workers on Waste Segregation, Collection and Treatment

Most healthcare workers (nurses, doctors, pharmacist, and laboratory technicians) demonstrated a good knowledge on colour coding segregation and the need to segregate waste. However, most of the waste collectors and the orderlies showed poor knowledge on medical waste management and this affected the collection, treatment and disposal of

medical waste at the health facilities. This might be attributed to insufficient training and resources. This finding confirmed a study conducted in India that compared the biomedical waste knowledge, attitude and practices among healthcare personnel and revealed that doctors, nurses and laboratory technicians had a better knowledge than the cleaning staff (Gupta et al., 2016). However, another study concluded that many doctors had knowledge about medical waste management but lacked acceptable attitude to and practices for the problem (Mathewos et al., 2013). In this study, most (78.8 %) respondents agreed that management of medical waste was a team work and required all hands on deck to ensure proper management of the medical waste. Meanwhile, less than half of the respondents (49.2 %) disclosed that safe management efforts by the health facilities increase the financial burden on management. However, most of them (58.2 %) disagreed that safe management of medical waste was an extra burden on work. An appreciable number of the respondents had an idea on the availability of incinerator to treat medical waste at the health facilities. From the results of the study, it was obvious that the healthcare workers, including nurses, doctors, pharmacist and laboratory technicians exhibited good knowledge on medical waste management but the practice was not proper. This poor practice was attributed to lack of enforcement of healthcare waste policies by those in authority. However, (Olaniyi et al., 2019) reported that proper practices of segregation depend on the knowledge of medical waste generator about the various subcategories of healthcare waste management. Meanwhile, Shivalli & Sowmyashree, (2015) believed that perception on medical waste management and the skill for proper waste management goes a long way to minimize health risks associated with the improper management of medical waste. Again, it emerged from the interview

with some of the administrators and environmental health officers and observations of the general practices of managing medical waste at the health facilities that, some of the administrators and the environmental officers lacked knowledge or management capacity to successfully manage the medical waste.

5.2.2 Knowledge of Law on Medical Waste Management

Majority of the respondents (56.3 %) knew there were laws governing medical waste management in the health facilities. However, it was revealed that there was inadequate supervision and monitoring of the medical waste management practices and these results pointed to a lack of mechanisms and systems within the health facilities to ensure that good practices were consistently followed. This finding was confirmed by previous study which showed that medical waste management might be hindered by lack of regular monitoring on medical waste management and inadequate interest from hospital administration (Sharma et al., 2013).

5.2.3 Knowledge on Education of Healthcare Workers on Medical Waste Management

In this study, 22.6 % of the healthcare workers had never received any formal training on medical waste management while 37.5 % had training once in a year and this was seen as a hindrance to proper management of the medical waste. This was in conformity with a study in India which revealed that intensification of training improved practices of health workers regarding how they handled medical waste (Mathur et al., 2011). Moreover, interview with some of the waste collectors revealed that most of them had never received any formal training on proper way of managing medical waste. This was in agreement with the findings by (Amfo-Otu & Doo, 2015) in a study conducted at Tetteh Quarshie memorial hospital, Akuapem – Mampong, Ghana, that most medical waste

handlers, particularly in the private hospitals/clinics do not have formal training in waste management. Medical waste handlers play a pivotal role in efficient management of healthcare waste as they are part of the entire waste management processes and therefore they required to be equipped with the knowledge of medical waste management.

5.2.4 Knowledge on Recycling of Medical Waste

The main goal regarding recycling of medical waste is the protection of public health. Recycling converts materials that would otherwise become invaluable or waste into useful resources and it becomes easier when the waste is properly segregated at the point of generation. Unlike domestic waste, reclaimed medical waste is restricted to certain uses due to public health. Recycling of medical waste was absent in all the six health facilities used for the study due to lack of knowledge and absence of technology. This was buttressed by findings of (Abah & Ohimain, 2011) which disclosed that in developing countries, due to absence of technology, lack of technical know-how as well as improper management procedures, recycling of potentially contaminated materials such as the plastic and metal from syringes or needles is difficult.

5.2.5 Knowledge on the use of Personal Protective Equipment by the Waste Collectors

Even though some of the waste handlers complained about lack and delayed supply of logistics, including personal protective equipment by the hospital authorities, however, it was observed that the usage of most of the PPE's provided were very poor as others did not use the PPE's at all. It was disclosed that sometimes the blood from the infectious waste would leak and be spilled on the waste collector and the floor due to improper and irregular use of the PPE's. This was highlighted by findings of (Shivalli & Sowmyashree, 2015) which believed that effective usage of personal protective

equipment by waste collectors in their work depends on their knowledge and perception about medical waste and its management. It was further observed that most of the healthcare workers and the waste handlers lacked knowledge on the importance of PPE's. This was buttressed by a study in Northwest Ethiopia which revealed that efficient and effective practice and use of personal protective equipment by the waste collectors and the healthcare workers depend on their level of knowledge and attitude about medical waste and its management (Deress et al., 2019). Again, it was found that the use of personal protective equipment by the medical waste collectors was low and this was partly due to the lack of irregular supply. This was buttressed by observation by (Amfo-Otu & Doo, 2015) who disclosed that training of healthcare personnel on the use of the personal protective equipment was absent, plausibly due to the lack of resources. The use of long boot, gown, eye protection and face mask even in the midst of covid-19 were mostly overlooked by the waste collectors. However, due importance was mostly given to the use of gloves.

5.3 Hazards Associated with Improper Medical Waste Management

Most of the respondents were aware that medical waste could cause risks and health hazards to the health workers and the general public as well as the environment if not handled properly. However, it was found that foul odour and vectors (mice and rats) were challenges in most of the facilities used for the research. This was buttressed by a study that showed that environmental pollution and foul smell were caused by improper medical waste management and might lead to the growth and multiplication of infectious parasites, rodents and worms and thereby resulting in transmission of diseases (Gupta et al., 2016). Medical waste has a risk profile for those who work in the health facilities,

including nurses, doctors, pharmacists, waste handlers, etc., and the general public if the waste is not managed properly. People who come in direct contact with the waste such as nurses, doctors, patients and cleaners were found to be at the greatest risk to cuts, foul odour, toxic emissions and vector transmission (rat and mice).

In an interview with some of the waste handlers, they disclosed that exposure to the hazardous medical waste had caused HIV/AIDS and hepatitis B viruses through pricks among some of their colleagues and themselves. This was buttressed by a study in Ethiopia that showed that improper healthcare wastes management could expose the healthcare workers, patients, workers in support services, visitors to health facilities, waste handlers, scavengers, fetuses in the wombs, and the general public to sharps contaminated with blood containing deadly diseases such as hepatitis B, hepatitis C, HIV/AIDs and other viral diseases (Mathewos et al., 2013). This was in agreement with a study by (Asante et al., 2014) who disclosed that transmission of disease through infectious waste was regarded to be the highest threat from medical waste and if the pathogens such as bacteria and viruses that cause the diseases were not killed in the treatment process they would be present in the waste. The presence of the microorganisms in the waste could invade the body through cuts in the skin by infected sharps, through a vector transmission and air borne.

Again, children playing in surroundings where health facilities were located were likely to be exposed to discarded syringes, needles, and other sharps. Medical waste handlers were more exposed to the healthcare waste and therefore at higher risk than healthcare professionals (Deress et al., 2019). Healthcare professionals produce the waste and throw it into the garbage while waste handlers handle the waste more frequently with less

attention for their safety. Cleansing of medical devices is often done by the medical waste handlers and this exposes them to the risk of cut from broken glassware and other sharp medical supplies (Shivalli & Sowmyashree, 2015).

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1: Conclusion of the study

- The results of the study revealed that there was improper segregation of medical waste at source due to non – availability of all the required categories of colour-coded bins and liners; this made some of the generators mix infectious waste with non - infectious waste and therefore affected the treatment processes. The medical waste containers and linings which were supposed to be provided by the authorities to all required departments and wards in the health facilities delayed.
- There was absence or inconspicuous labeling on the bins to promote segregation of medical waste into different coloured containers in most of the health facilities studied. The stay-time of the medical waste in temporary storage sites was between 12-24hrs. Transfer of medical wastes to the treatment sites was done manually in all the health facilities, except KATH, which used tricycle.
- The most frequently used treatment practice for solid waste was incineration technology and the incinerated ash was disposed of in dug pits and adjacent areas close to the incinerators. The study also revealed that the incineration used as the waste management technique in the health facilities posed serious environmental implications to the healthcare workers and the surrounding communities.
- The liquid wastes from some of the wards in all the health facilities used for the study were drained into septic tanks while others were discharged into the municipal sewage system.
- The study found that most of the healthcare workers had knowledge on medical waste management but the actual practices at the health facilities were below

standard. There was also a gap in the enforcement of the existing policy of Ministry of Health, Ghana, for the adequate management and treatment of medical waste in the health facilities.

- The study further revealed that there was insufficient training and awareness of healthcare staff, patients and the general public. None of the health facilities used for the study had planned to recycle or reuse medical waste. In addition, some of the administrators and the environmental officers lacked knowledge or management capacity to successfully manage the medical waste.
- The medical waste posed a serious health risk to both the health workers, waste collectors and the people in the surrounding communities.

The study concludes by arguing that the challenges constraining effective management of medical wastes are common to both private and public health facilities and requires concerted efforts not only from the Environmental Protection Agency, Ministry of Health and the Ghana Health Service but also the very management of the various health institutions.

6.2 Recommendations

The following recommendations are made to:

1. Health Facilities
    - There is a need for the healthcare management to put systems in place to ensure compliance among all members of staff. For this reason, when a new staff member is appointed, it is highly recommended that specific rules

regarding the safe management of medical waste be captured in the contract, so as to make him/her fully aware of the importance of this part of his/her work and make them committed to it

- Management of health facilities across the country should regularly educate all health workers irrespective of their age, literacy status and duration of experience on the operation guidelines of medical waste management.
- Waste segregation using colour codes as described in the Ghana Ministry of Health's policy guidelines should be enforced strictly by the health facilities' management. This would greatly reduce risks associated with medical waste to the immediate health workers and the general public at large.
- In order to ensure effective management of medical waste at the health facilities, it is important for the management of the health facilities to establish a medical waste management committee to plan and monitor, on a regular basis, the practices of the staff in compliance with the existing policies and regulations spelt out by the Ministry of Health and Environmental Protection Agency in Ghana.
- The environmental health officers should ensure that needle destroyers be used to destroy needles; used sharps, blade and broken glass should also not be discarded in a plastic container before disposing it off in the bag in order to reduce or prevent sharps injury to waste collectors.
- The environmental health officers should ensure that bins are labeled properly and covered to protect them from rain and scavengers.

2. Ministry of Health

- It should formulate policy, monitor and provide resources for proper medical waste management.
- Personnel with technical know-how should be employed by Ministry of Health as environmental health officers to oversee the management of the medical waste. Nonetheless, proper training should be given to the environmental health officers to put systems in place to effectively manage the medical waste at the health facilities.
- Skilled personnel should be assigned by the Ministry of Health, to health facilities to operate the incinerators to reduce environmental pollution.

3. Ghana Health Service

- It should allocate sufficient budget for all the necessary logistics and personnel for proper management of medical waste in the health facilities.
- It should also ensure that every donor project to be carried out in any of its Divisions/Departments have made financial provisions for medical waste management, especially those that generate waste.
- It should provide training to waste collectors on proper ways of using PPE's for collecting and disposing medical waste since this is necessary to minimize the injuries and infection posed by hazardous medical waste.

4. Local Government

   - It should provide dumping site for proper disposal of solid medical waste.
   - It should conduct periodic inspection on health facilities to ensure compliance to guidelines by the EPA, MOH and other agencies on effective management of medical waste.

5. Health Workers

   - Health workers handling medical waste must wear appropriate personal protective equipment.
   - They must undertake periodic training to acquire knowledge on proper medical waste management.
   - They should adhere to proper disposal methods for each category of medical waste.

6.3 Limitations of the study

The study is limited to only six hospitals due to time constraints, reducing the study's ability to gather more views. Resource constraint was also a major barrier to the study. Again, some health personnel, especially nurses were unwilling to take the questionnaires administered to them for fear of contracting Covid 19. There is the likelihood for partial responses from health facilities employees, for fear of revealing important information about the operation of their health facilities. Yet, these impending hindrances did not significantly affect the validity of the findings of the study

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APPENDIX 1: Questionnaire for the studies

UNIVERSITY OF EDUCATION, WINNEBA

COLLEGE OF AGRICULTURE EDUCATION

MAMPONG-ASHANTI

FACULTY OF SCIENCE AND ENVIRONMENT EDUCATION

DEPARTMENT OF ENVIRONMENTAL HEALTH AND SANITATION EDUCATION

QUESTIONNAIRE FOR HEALTHCARE WORKERS

Dear Respondent,

I am carrying out a study on medical waste management in the Kumasi Metropolitan Districts. The following questionnaire is for healthcare personnel like you. It is against this background that you have been selected to participate in the research by completing the questionnaire. It would thus be very helpful if you assist by answering the questionnaire as per instructions at the beginning of each section. You are required to provide the most appropriate answer in your opinion. Your responses will be kept confidential. In any case the questionnaire is anonymous. Thank you.

Yours faithfully,

…….

Gideon Nsowaa

Researcher

INTERVIEWER: INTRODUCTION AND CONSENT. May I begin the interview now?

NO	QUESTIONS AND FILTERS	CODING CATEGORIES	SKIP
SOCIO-DEMOGRAPHIC CHARACTERISTICS I would like to start by asking you a few questions about yourself.			
Q.1	Health worker's code	…… …1	
Q.2	Name of Department/Organization	……1	
Q.3	Please tell me your date of birth or your age in years.	|__|__|day|__|__|month |__|__||__|__|year |__|__| age (completed years) Don't know 88	
Q.4	What is your position in the hospital/clinic?	Doctor/Dentist…….....1 Cleaner ……..…….....2 Nurse ……..……..…..3 Lab technician ……4 Other, please specify..... …….	
Q.5	Sex	Male ..... ……..1 Female ..... ……..2	
Q.6	How long have you worked in the clinic/hospital?	..... ……..1	

	Level of Awareness of Medical Waste Management Practice **Indicate your extent of agreement or disagreement to the following statements by choosing from the options provided by a tick (√) Or provide the correct answer**		
Q.7	Do you know the category of waste that is called medical waste?	Yes ☐ No ☐	
Q.8	Is it possible for you to tell the difference between the different categories of medical waste?	Yes ☐ No ☐ If yes, explain	
Q.9	Do you segregate your medical waste at the point of generation?	Yes ☐ No ☐	
Q.10	Do you know about colour-coding segregation of medical waste?	Yes ☐ No ☐	
Q.11	Do you follow colour-coding disposal of medical waste?	Yes ☐ No ☐	
Q.12	In your view, is the medical waste disposal practice correct in your hospital/clinic?	Yes ☐ No ☐	
Q.13	In your view, how should objects that may be capable of causing punctures or cuts, that may have been exposed to blood or body fluids including scalpels, needles, glass ampoules, test tubes and slides be disposed of?		
Q.14	The colour code for the medical waste to be autoclaved, disinfected is	Red ……..……1 Black ……..……2 Yellow..……3 Blue/white ……...4 Other, please specify…….... Don't know……88	
Q.15	The colour code for disposal of general waste from the hospital is	Red ……..1 Black ……..2 Yellow……..3 Blue/white ……...4 Other, please specify…… Don't know……88	
Q.16	Which of the following statements about hazardous waste containers is **not** true?	Containers must be closed except when removing or adding waste ……..1 Containers must be clean on the outside……2 Contents must be compatible with the type of waste containers ……...3 Any type of container, including food containers, can be used to contain hazardous waste ……4 Other, please specify……..	

		Don't know……88	
Knowledge, Attitudes and Perception on Medical Waste Management **Indicate your extent of agreement or disagreement to the following statements by choosing from the options provided by a tick (√) 1. Strongly agree, 2. Agree, 3. Disagree, 4. Strongly disagree and Other or supply the answer in the spaces provided**			
Q.17	Safe management of medical waste is **not** important.	1 ▭ 2 ▭ 3 ▭ 4▭ 5 ▭ Other, please specify……	
Q.18	Management of medical waste is a team work/no single class of people is responsible for safe management.	1 ▭ 2 ▭ 3 ▭ 4▭ 5 ▭ Other, please specify……	
Q.19	Safe management efforts by the hospital increase the financial burden on management.	1 ▭ 2 ▭ 3 ▭ 4▭ 5 ▭ Other, please……	
Q.20	Safe management of medical waste is an extra burden on work.	1 ▭ 2 ▭ 3 ▭ 4▭ 5 ▭ Other, please……	
Q.21	Have you got any education on hazards associated with medical waste?	1. Yes ▭ 2. NO ▭	→ **Q.23**
Q.22	If yes, what is/are the source(s) of education?	Environmental officers……...1 NGO's……..2 Water management & Sanitation committee…..……..3 Others (Specify)……..	
Q.23	How often do you have access to such education?	Weekly ……1 Monthly……2 Once a year ……3 Twice a year ……4 Others (Specify)……....	
Q.24	How is the education done?	Workshop ……1 Seminar ……2 Talk ……3 Others (Specify)……....	
Q.25	Do you think that the hospital/clinic should organize education program to upgrade existing knowledge about medical waste management?	Yes ▭ No ▭ Don't know ▭	
Q.26	Will you like to attend voluntarily programs that enhance and upgrade your knowledge about medical waste management?	Yes ▭ No ▭ Don't know ▭	
Q.27	Do you think that infectious waste should be sterilized from infections by autoclaving before shredding and disposal?	1 ▭ 2 ▭ 3 ▭ 4▭ 5 ▭ Other, please specify……	
Q.28	Do you think that an effluent treatment plant for disinfection of infected water should be set up in the clinic/hospital?	1 ▭ 2 ▭ 3 ▭ 4▭ 5 ▭ Other, please specify……	
Q.29	Do you think it is important to report to the authorities about a particular institution if it is not complying with the guidelines for medical	1 ▭ 2 ▭ 3 ▭ 4▭ 5 ▭ Other, please specify……	

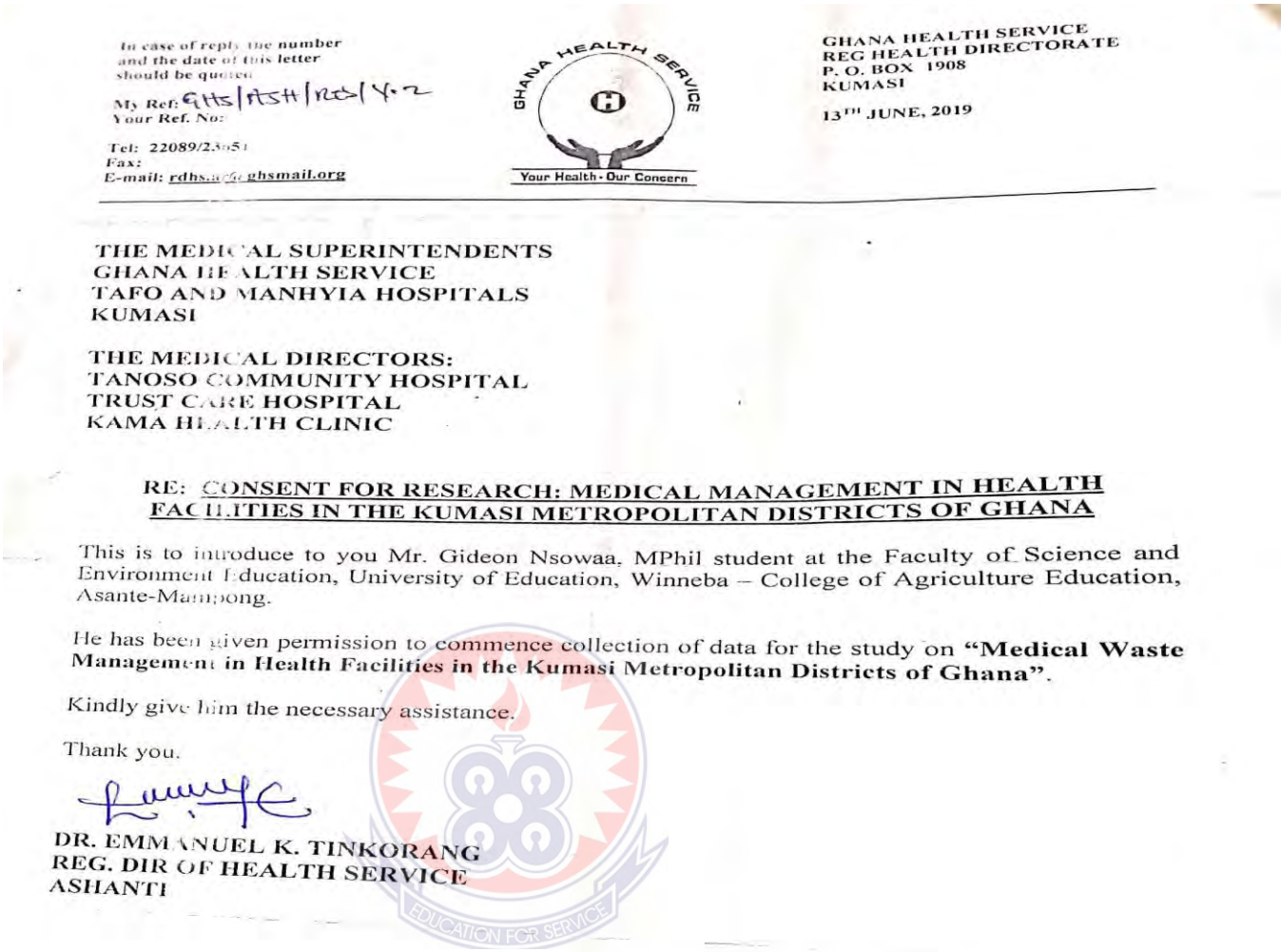
	waste management?		
Q.30	Do you think that labelling the container before filling it with medical waste is of any clinical significance?	1 ☐ 2 ☐ 3 ☐ 4☐ 5 ☐ Other, please specify……	
Q.31	Do you think best practices will go a long way to reduce the health hazards associated with medical waste management?	1 ☐ 2 ☐ 3 ☐ 4☐ 5 ☐ Other, please specify……	

Knowledge of Medical Waste Generation, Hazards and Legislation **Indicate your extent of agreement or disagreement to the following statements by choosing from the options provided by a tick (√)**			
Q.32	Are there any laws governing medical waste disposal in your hospital/clinic?	Yes ☐ No ☐ Don't know ☐	**→ Q.32**
Q.33	How are the people who dispose medical waste any how dealt with?	Sent to the traditional leader ……....1 Sent to the political leaders ……2 Made to pay fines by health officers ……3 Others (Specify)…… Don't know……88	
Q.34	Do you know about medical waste generation and legislation?	Yes ☐ No ☐ Don't know ☐	
Q.35	What agency (ies) regulate(s) medical wastes generated at your health facilities?	State ..... ……..1 Private..... ……..2 Don't know……..88	
Q.36	Do you think it is important to know about medical waste generation, hazards and legislation?	Yes ☐ No ☐ Don't know ☐	
Management Practices and Approaches to Wastes Generated at the Health Facilities			
Q.37	How long do medical wastes remain in your premises?	12 hours ……1 48 hours ……2 72 hours..…….....……3 96 hours ……4 Other, please specify …… Don't know……..88	
Q.38	How often do you expect your waste to be collected?	Daily ……1 Weekly ……2 Monthly ……3 Other, please specify ……	
Q.39	Who regulates the collection and transport of medical waste in your health facility?	Management ……1 Health care waste workers ……2 Securities ……3 Other, please specify …… Don't know……..88	
Q.40	In your view, how should waste collected by your outfit be finally be	Dumping in isolated area ……..1 Waste dump ……2	

	disposed of?	Landfills ……3 Other, please specify …… Don't know……..88	
Q.41	Do you carry out any waste recycling program in your health facility?	Yes ▭ No	→ **Q.41**
Q.42	If you strongly agree, what type of waste processing do you carry out?	Incineration ……1 Composting ……2 Biological digestion ……..3 Chemical digestion ……...4 Other, please specify ……	
Q.43	If there should be a policy that advocate for waste processing prior to final disposal, what processing facilities would you recommend for your hospital/clinic?	Incineration ……1 Composting ……2 Biological digestion ……3 Chemical digestion ……4 Other, please specify ……	
Q.44	Are you aware of any regulation/laws that punish indiscriminate medical waste disposal habit?	Yes ▭ No ▭ Don't know ▭	
Q.45	Would you recommend the imposition of more stringent regulation?	1 ▭ 2 ▭ 3 ▭ 4▭ 5 ▭ Other, please specify……	
Q.46	In your view, what do you suggest should be done to ensure proper management of medical waste?		
	END OF INTERVIEW		
THANK YOU FOR YOUR VALUABLE TIME AND COOPERATION			

Appendix 2

Approval certificates



In case of reply the number and the date of this letter should be quoted

My Ref: GHS/ATSH/RES/Vol.2
Your Ref. No:

Tel: 22089/23051
Fax:
E-mail: rdhs.ar@ghsmail.org

GHANA HEALTH SERVICE
Your Health - Our Concern

GHANA HEALTH SERVICE
REG HEALTH DIRECTORATE
P. O. BOX 1908
KUMASI

13TH JUNE, 2019

THE MEDICAL SUPERINTENDENTS
GHANA HEALTH SERVICE
TAFO AND MANHYIA HOSPITALS
KUMASI

THE MEDICAL DIRECTORS:
TANOSO COMMUNITY HOSPITAL
TRUST CARE HOSPITAL
KAMA HEALTH CLINIC

RE: CONSENT FOR RESEARCH: MEDICAL MANAGEMENT IN HEALTH FACILITIES IN THE KUMASI METROPOLITAN DISTRICTS OF GHANA

This is to introduce to you Mr. Gideon Nsowaa, MPhil student at the Faculty of Science and Environment Education, University of Education, Winneba – College of Agriculture Education, Asante-Mampong.

He has been given permission to commence collection of data for the study on **"Medical Waste Management in Health Facilities in the Kumasi Metropolitan Districts of Ghana"**.

Kindly give him the necessary assistance.

Thank you.

DR. EMMANUEL K. TINKORANG
REG. DIR OF HEALTH SERVICE
ASHANTI

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Our Ref. No.: *KATH IRB/AP/121/20*

Your Ref... No:.....

Komfo Anokye Teaching Hospital Institutional Review Board

15th February 2021

Mr. Gideon Nsowaa
Department of Environmental Health and Sanitation
University of Education
P.O. Box M40
Mampong - Ashanti

Dear Mr. Nsowaa,

Ethics Approval

Protocol title:	Medical Waste Management in Health Facilities in the Kumasi Sub-metropolis, Ghana
Study site:	Komfo Anokye Teaching Hospital, Manhyia Government Hospital, Tafo Government Hospital, Trust Care Hospital, Tanoso Community Hospital, Kama(Mikado Clinic), at the OPD/Emergency, Pharmacy, Laboratories, Canteens and Environmental Sections
Sponsor:	Self-funded

We write in response to the clarifications and revised documents following review by the Komfo Anokye Teaching Hospital Institutional Review Board (KATH IRB) in respect of the research study referenced above.

We are pleased to inform you that KATH IRB, per your correspondence of 12th February 2021, has given approval for the following study documents:

- *Protocol version 1.1 last updated 16th November, 2020*
- *Informed consent form, version 1.1 last updated 16th November, 2020*
- *Case report form for Healthcare Workers, version 1.1 last updated 16th November, 2020*
- *Case report form for Hospital Administrators and Medical Waste Collectors, version 1.1 last updated 16th November, 2020*

Approval for the study is in effect until **14th February 2022** and it is the responsibility of the Principal Investigator to maintain the study in good standing at the Komfo Anokye Teaching Hospital. The Board anticipates to be notified of the actual start date of your project.

Prior to the expiration of the study approval, you must submit to the KATH IRB an "Application for Continuing Review" along with provision of "Annual Report" when the study is ongoing, or a "Termination Report" if the research has been completed.

You must hastily report to the KATH IRB should a modification to the research be proposed, and without delay if an unanticipated development occurs before the next required review. Regulations do not permit you to modify conduct of the study in its present form prior to ethics approval; except where urgent action is required to eliminate an apparent immediate hazard to a study subject or other person. It is of utmost importance data generated from this study must be used for the intended purposes only.

Thank you.

Sincerely,

Dr. Ruth Owusu, BSc, MB ChB, MPH, MGCP
Vice Chairperson, KATH IRB & Head, Public Health, KATH