COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES
SCHOOL OF GRADUATE STUDIES
DEPARTMENT OF BIOLOGY

ASSESSMENTS OF HOSPITAL SOLID WASTE MANAGEMENT: THE CASE OF SAINT PAULS MILLENNIUM MEDICAL COLLEGE'S HOSPITAL AND GIRUM HOSPITAL, ADDIS ABABA, ETHIOPIA

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ASSESSMENTS OF HOSPITAL SOLID WASTE MANAGEMENT: THE CASE OF ST. PAUL MILLENNIUM MEDICAL COLLEGE'S HOSPITAL AND GIRUM HOSPITAL, ADDIS ABABA, ETHIOPIA

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A THESIS SUBMITTED TO THE
DEPARTMENT OF BIOLOGY,
COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES,
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This is to certify that the seminar entitled ***"Assessments of Hospital Solid Waste Management: The Case of St. Paul Millennium Medical College's Hospital and Girum Hospital, Addis Ababa, Ethiopia"*** submitted in partial fulfillment of the requirement for the degree of Master of Science for Specialization in **Ecotoxicology and Environmental Health**, the Graduate Program of the Department of Biology**,** and has been carried out by **Fekede Geleta Hora** ***ID*** **Nº EEHK/07/08**, under my supervision. Therefore, I recommend that the student has fulfilled the requirements and hence here by can submit the Thesis to the Department.

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DEDICATION

I dedicate this work to:

The Almighty of God and for all my family

DECLARATION

I hereby declare that this M Sc thesis is my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis / dissertation have been duly acknowledged.

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This M Sc thesis has been submitted for examination with my approval as Thesis advisor.

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ABBREVIATIONS AND ACRONYMS

AAPDC	Addis Ababa Plan & Development Commission
AIDS	Acquired Immunodeficiency Syndrome
ATSDR	Agency for Toxic Substances and Diseases Register
AU	Africa Union
BMW	Biomedical Waste
ECSA	Ethiopian Central Statistics Agency
EIA	Environmental Impact Assessment
FEPA	Federal Environmental Protection Authority
FMHACA	Food, Medicine and Health-care Administration and Control Authority
FMOH	Federal Ministry of Health
HBV	Hepatitis B Virus
HCFs	Health Care Facilities
HCl	Hydrochloric Acid
HCSWM	Healthcare Solid Waste Management
HCV	Hepatitis C Virus
HCW	Healthcare Waste
HCWM	Healthcare Waste Management
HEHD-FMoH	Hygiene and Environmental Health Directorate of the Federal
HF	Hydrogen Fluoride
HIV	Human Immunodeficiency Virus
HSW	Hospital Solid Waste
HSWM	Hospital Solid Waste Management
ICRC	International Community of Red Crosses
ICU	Intensive Care Unit
GH	Government Hospital
KAP	Knowledge, Attitude, and Practices
MDG	Millennium Development Goals
NSC	National Statistics Censes
OPD	Out Patient Department
PVC	Poly Vinyl Chloride

PH	Private Hospital
St.	Saint
TB	Tuberculosis
UNECA	United Nation Economic Commission for Africa
UNEP	United Nations Environment Program
WH0	World Health Organization

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ABSTRACT

With an emphasis on the potential threats hospital solid waste poses to healthcare personnel, the public, and the environment if improperly managed, the study assessed the solid waste management practices at St. Paul's Millennium Medical College and Girum Hospital in Addis Ababa, Ethiopia. The study's objectives were to characterize the types, determine the generation rates, assess the KAP of the hospitals administrative and health care workers, and investigate the challenges and opportunities in hospital solid waste management's of the study Hospitals. A cross-sectional study was undertaken to assess HCW management methods and generation rate using direct observation, interviews, questionnaire surveys, and weighing scales, with data analyzed using SPSS 22. The Government Hospital (St. Pauli's) generated 882.30±49.54 kg/day of total solid waste, with an average of 1.757 kg/patient/day (1.6 kg bed day–1 and 0.157 kg/outpatient/day) of 61.25% being classified as hazardous waste, and the remaining 38.75% being general waste. The private hospital (Girum) produced 124.81±65.24 kg/day of total solid waste, with an average of 2.12 kg/patient/day (1.8 kg bed–1day-1 and 0.32 kg/outpatient/day) of 57.05% being classified as hazardous waste, while the remainder, 42.795%, was general waste. High hazardous waste generation rates exceed the WHO's 10–25% estimate, primarily due to inadequate waste source segregation. The Kruskal-Wallis test showed significant differences in waste generation rates between hospitals for all the HCW categories (P < 0.05). However, no significant difference was found in the mean generation rate of the HCW within the government hospital wards as well as within the private hospital wards (P> 0.05). Ward chiefs, medical directors, and department heads all have high KAP scores; however, "hospital administrators have a medium, and waste handlers have a low." The KAP scores of the private hospital outperformed that of the government. St. Paul's intermediate storage area converts all forms of waste (excluding sharp waste) into hazardous waste. St. Paul's inadequate placenta disposal, as well as Girum Hospital's feeding all types of produced trash into a low-combustion incinerator, may have endangered both the population and the environment. Inefficient waste management is caused by a lack of legislation and failure to follow guidelines.

Key Words: *General waste; Health care waste: Hazardous waste; Hospital solid waste management's; Government hospital; Private hospital; waste generation rates*

1. INTRODUCTION

1.1. Background of the Study

Healthcare facilities (HCFs) generate healthcare wastes (HCWs) that may be hazardous to healthcare workers, the general public, and the environment (Janik-Karpinska et al., 2023). Healthcare waste is the overall waste stream generated by healthcare establishments: hospitals, clinics, labs, pharmaceutical manufacturing plants, pharmacies, blood banks, veterinary, health-related research facilities, and home healthcare operations (Khajuria et al., 2007; Coker et al., 2009). The amount of healthcare waste produced by various facilities varies depending on a variety of factors, such as the country's income, the patient's income, people's culture and habits, established waste management methods, hospital specialization, the proportion of reusable items employed in the hospital, the proportion of patients treated on a day-care basis, and the number of beds (Elom, 2013).

Healthcare waste is categorized into non-hazardous waste (75–90%), originating from administrative, food preparation, and housekeeping operations, and hazardous waste (10–25%) from pathology, laboratory, body fluid, contaminated sharp items, and chemical or pharmaceutical waste (Chartier et al., 2014). (WHO, 2014) found that healthcare facilities generate 3%, 15%, 1%, and less than 1% of chemical, pathological and infectious, sharps, and special waste includes items like radioactive or cytotoxic wastes, pressurized containers, broken thermometers, and used batteries, respectively, but 80% of waste is general or non-hazardous and manageable by conventional systems like home and urban waste. This proportion is often under control with proper waste stream segregation; otherwise, a general waste stream combined with an infectious component may render the bulk potentially contagious (Gitonga, 2017).

Low- and middle-income countries face insufficient healthcare waste management compared to industrialized and high-income countries (Singh et al., 2022). Factors influencing waste generation include established waste management procedures, healthcare establishment type, hospital specializations, reusable product use, and patient treatment (Prüss et al., 2014). As per the study by Meleko (2018), in the Mizan Tepi University Teaching Hospital, Bench Maji Zone, South West Ethiopia, department-specific variances in waste production contribute to the issue; the office generated the least amount of garbage, at 0.22 kg/day (1.30%), while the gynecological ward contributed the most, at 5.08 kg/day (28.90%).

Mol et al. (2022) found that hospital healthcare waste generation rates were highest in North and South America (4.42 and 1.64 kg/bed/day, respectively), whereas rates in Oceania were almost non-existent (0.19 kg/bed/day) and highest (0.77 kg/bed/day) for hazardous waste. According to Yadav (2001), African rural hospitals are projected to generate between 0.3 and 1.5 kg of medical waste per bed each day, with 5-20% of that waste being hazardous. In contrast, the Middle East, Eastern Europe, and East Asia generate 1.3 kg of garbage per bed every day (WHO, 2011). Whereas Diaz et al. (2008) estimated that rich countries generate 1.2 to 200 times more medical waste than developing countries.

Hospitals generate significant healthcare waste due to advanced medical activities, producing more disposable items, and containing harmful microorganisms that can infect communities and the general public (Annette *et al.,* 2013; Karmakar *et al.,* 2016).Developed countries use good HCWMs for disinfecting infectious waste, but sub-Saharan countries often use on-site disposal, open dumping, burning, and burial methods (Manyale and Anicetus, 2006). Over half of the world's population faces environmental pollution and public health threats due to unsafe healthcare waste disposal (Harhay *et al.,* 2009). Poorly managed waste can cause long-term health risks and re-infection, posing a significant environmental threat (Pachauri *et al.,* 2019). In Ethiopian hospitals, personal protective equipment such as overcoats, boats, masks, and enough buckets was not provided, and improper handling of waste was lacking, leading to potential health risks as some cleaners were found to be engaged in mishandling the generated waste by their type (Sisay *et al.*, 2017).

Waste in healthcare is a particularly serious problem in developing countries. According to a WHO (2004) assessment of 22 developing countries, 18% to 64% of healthcare institutions do not effectively dispose of waste. For instance, in accordance with Ahmed et al. (2014), there were no ongoing processes for the collection, segregation, transportation, or ultimate disposal of pathological and other medical wastes in Khartoum state hospitals' healthcare waste management practices, and Ethiopia has also reported similar findings (Tesfahun et al., 2014).

The study on six hospitals in Addis Ababa found that public hospitals generate 59.22%) more waste than private ones, accounting for 40.48%) of total healthcare waste. However, there was no significant difference in the quantity of hazardous waste produced (Debere et al., 2013).Conversely, private hospitals produced 2.32 kg more garbage per day, while government-run hospitals generated 0.78 kg less total and hazardous waste (kg/bed/day) than commercial

hospitals, according to the study done in the Amhara region (Tesfahun, 2015). Healthcare professionals in Bahir Dar, Ethiopia, reported better healthcare waste management practices (79.2%) in private hospitals, while professionals in public hospitals practiced less (53.5%) (Assamu et al., 2020).

In general hazardous healthcare wastes in Ethiopia had proportions ranging from 21% to 70%, according to studies by various researchers (Debere et al., 2013; Tesfahun et al., 2014; Abebe et al., 2017; Yazie et al., 2019), which show that the value for a certain condition is three to four times higher than the established threshold value (Chartier et al., 2014). The foremost explanation for this high proportion of hazardous HCW may be due to the possibility that segregation of hospital waste streams is weak and there is a there is a lack of enforced public health regulations (Tadesse and Kumie, 2014;Yazie et al., 2019).

The growing healthcare industry is causing a global healthcare crisis due to the increasing demand for sophisticated medical treatments and the increasing waste generated. Rudimentary disposal methods like incineration and land filling negatively impact the environment and public health (Kenny and Priyadarshini, 2021). Improper handling of medical waste can lead to health issues for waste handlers, medical professionals, patients, and the public (Fei-Baffoe, 2020). Living near dumping sites increases the risk of contracting diseases like cholera, yellow fever, and salmonellosis and increases disposal costs (Da Silva et al., 2005;Manyele & Antonietus, 2006). Health-care waste contains potentially harmful microorganisms that can infect hospital patients, health workers, and the general public. Other potential hazards may include drug-resistant microorganisms that spread from health facilities into the environment (WHO, 2018).

Inadequate processing and segregation of medical waste prior to landfill disposal can introduce hazardous chemicals, microorganisms, and medications into the environment (Janik-Karpinska et al., 2023). Mishandling can lead to injuries, infection transmission, environmental pollution, fire threats, and public nuisances (ICRC, 2011; Padmanabhan & Babak, 2019; Mohanty et al., 2019). Inadequate management can result in millions of workers contracting infectious diseases, with around 5.2 million deaths worldwide each year (WHO, 2018).

Hospital waste management in developing countries faces challenges due to financial constraints, lack of knowledge, budgetary limitations, unsuitable laws, infrastructure, and specialized personnel (Ali et al., 2017; Khan et al., 2019; Andeobu, 2022). Improper handling of medical

waste can endanger patients and the environment, negatively impacting healthcare workers' and communities' health and potentially leading to re-infections (Arab et al., 2008; Khan et al., 2019). Healthcare workers' (HCW) management should be prioritized to avoid health risks (Wafula et al., 2019). Monitoring HCWS from generation to disposal is crucial (WHO, 2014). Understanding segregation behaviors is essential for improving the system (Akulume and Kiwanuka, 2016). HCWs should follow WHO guidelines for six processes: segregation, collection, storage, transportation, treatment, and disposal (WHO, 2014). Changing purchasing strategies, using physical disinfection, minimizing waste, and inspecting products upon delivery can also help (Padmanabhan & Barik, 2019).

Health care waste management is crucial for environmental and public health reasons (Lattanzio et al., 2022). It involves building, planning, purchasing, employee education, the use of tools, equipment, and pharmaceuticals, and proper disposal methods (FMOH, 2018). The standard of healthcare facilities (HCFs) services depends on safe waste management procedures for all waste-related tasks, including creation, segregation, collection, transportation, storage, treatment, and disposal (Sahiledengle, 2019). According to Wafula et al. (2019), HCW management should thus receive particular attention and priority. The waste management team, sound administration and organization, meticulous planning, legal frameworks, sufficient founding, and the full involvement of qualified staff in this process are all necessary for the proper management of medical waste in HCFs (Awodele et al., 2016). This study assesses hospital solid waste management practices at St. Paul's Millennium Development Medical College and Girum Hospitals.

1.2. Statement of the Problem

Not recording waste generation data, potentially leading to ambiguity over waste quantity and characteristics, contributed to poor HCWM in developing nations (Khan et al., 2019; Tesfahun *et al.,* 2014). Pachauri *et al.* (2019) emphasize that poor HCWM increases re-infection risk, environmental dangers, and long-term health issues. These factors are also concerning for the hospitals under study. The researcher observed that hazardous medical solid wastes are not properly segregated in wards at St. Paul's Hospital and Girum Hospital, with only black and yellow bucket waste bins available and not uniformly distributed. Paul's Hospital Millennium Development Medical College has a non-functional incinerator, resulting in insufficient on-site

hazardous waste management. Substandard open vehicles transfer waste to outsourced hospitals, which may emit harmful gases. Healthcare trash, such as plastic water bottles, is sold to the needy without being properly treated and waste disposal systems in under investigated hospital facilities are in poor condition. The researcher will assess hospital waste management practices, as mentioned above gaps were identified, and to offer recommendations for improving waste management in healthcare facilities.St. Paul Medical College Hospital, a Federal Ministry of Health referral, offers comprehensive services and a variety of cases, while Girum Hospital (private), located nearby, was chosen due to its proximity. Therefore, comparing and contrasting the waste creation rate is beneficial.

1.3. Objectives of the Study

1.3.1. General Objective

To assess healthcare solid waste management practices at St. Paul Millennium Development Medical College's Hospital and Girum Hospital: characterize the types, determine the generation rates, evaluate the Knowledge, attitude, and the practices of hospital administrative crew as well as waste handlers and different health care professionals, and examine the challenges and opportunities in hospital solid waste management.

1.3.2. Specific Objectives

To characterize (types or nature) the hospital solid wastes in the study hospitals

To determine the generation rates of hospital solid waste,

To evaluate the knowledge, attitude, and practice of healthcare workers, waste management crew, and the hospital administrators, and

To, examine the challenges and opportunities in hospital solid waste management's.

1.4. Research Questions

In line with the above specific objectives, this study will attempt to address the research questions below.

What are the characteristics of hospital solid waste in hospitals?

What are the solid waste generation rates of the hospitals?

What is the knowledge, attitude, and practice status of healthcare workers and waste handlers (janitors) about HSWM?

What is the existing challenges regarding HSWM in both St. Paul's and Girum Hospitals?

1.5. Significance of the Study

Because hospital solid waste is infectious and poisonous, its management is critical for environmental and public safety concerns. Solid medical waste management in Ethiopian hospitals, as well as those under investigation, necessitates significant research.

The purpose of the assessment is to improve the hospitals' solid waste management practices, strengthen coordination among managerial hierarchies, and ensure that international and national policies and regulations on solid healthcare waste management are followed and implemented.

In light of this, the study is believed to have the following contributions:

- It would be an advantage for the health workers to use the findings of the study and improve waste management practices, thereby minimizing the risks associated with the mismanagement of these wastes in general.
- It may assist the health facilities to know their weaknesses and then encourage them to give more attention to improving in solid healthcare waste management practices.
- This study may serve as a jumping-off place for other researchers who want to conduct further research in the area.
- This study also might be published and will scientifically make a significant contribution to the field of research.

1.6. Scope of the Study

The researcher restricts his study to two hospitals in Addis Ababa: St. Paul's Millennium Development Medical College, a government hospital, and Girum Hospitals, a private hospital. The researcher was unable to incorporate additional hospitals or other forms of healthcare waste, such as liquid and gaseous, due to financial limitations. Estimates of the actual amounts created by the institutions under examination may be less accurate due to the one-week data collection interval and the elimination of seasonal variability in waste generation rates.

2. LITERATURE REVIEW

2.1. Definitions of Concepts and Terms

(Based on World Health Organization definitions)

Healthcare waste: Healthcare waste encompasses various waste streams from healthcare establishments, research facilities, laboratories, and emergency relief donations, some of which require more stringent care and disposal.

General waste: solid waste that is not infectious, chemical, or radioactive, including left-over foods, packaging, and office supplies, can be disposed of in shared landfills, with segregation of recyclable materials reducing its impact.

Hazardous waste Healthcare waste, a subset of waste, includes chemically hazardous, infectious, and radioactive materials from multiple sources within a facility.

Chemical waste: healthcare waste, including solid, liquid, and gaseous chemicals from diagnostic, experimental, cleaning, housekeeping, and disinfection activities, can be either dangerous or nonhazardous in terms of health protection.

Heavy metals: consisting of both materials and equipment with heavy metals and derivatives, including batteries, thermometers, and manometers.

Infectious waste Healthcare waste, including items used for diagnosis, treatment, and prevention, can spread infectious pathogens to humans if they come into contact with human blood, tissues, or excreta.

Genotoxic waste: Genotoxic substances, including cytotoxic drugs and chemicals, can be found in vomit, urine, or feces from patients treated with cytostatic drugs, chemicals, and radioactive material.

Pathological waste: Anatomical waste, including tissues, organs, body parts, fetuses, carcasses, blood, and fluids, is a subcategory of infectious waste, potentially including healthy body parts.

Pharmaceutical waste: pharmaceuticals, including expired or no longer needed containers and packaging, as well as items contaminated by or containing pharmaceuticals, can be found in various forms.

Radioactive materials: This includes unused liquids from radiotherapy or laboratory research, contaminated glassware, urine, and excreta from patients treated with unsealed radio nuclides, and sealed sources.

Sharps: Healthcare waste, including needles, blades, knives, infusion sets, saws, broken glass, and nails, can cause cuts or puncture wounds, regardless of infection.

Source: Pruss *et al*. (2014)

2.2. Sources of Solid Healthcare Wastes

HCW is generated during diagnosis, treatment, or research in humans and/or animals" (Nessa *et al.*, 2001). Hospitals, primary health care facilities, medical colleges, research institutes, veterinary hospitals, nursing homes, clinics, laboratories, offices of physicians, dental, home health care, and funeral homes are the common sources of biomedical waste (Chuks *et al*., 2013).

(Based on World Health Organization definitions.)

Major Sources

Healthcare establishments include hospitals, emergency services, outpatient clinics, dialysis centers, first-aid posts, long-term care facilities, transfusion centers, military medical services, related laboratories and research centers, mortuary and autopsy centers, animal research facilities, blood banks, and elderly nursing homes.

Minor Sources

Healthcare establishments include small, specialized, non-health activities like funeral services, ambulance services, and home treatment, as well as non-health activities like cosmetic piercing and tattoo parlor.

Support Service Sources

Out of the many supporting sections, pharmacy, laundry, kitchen, engineering, administration, and patient's attendance units have solid health-care contributions (Nessa *et al*., 2001).

Source: WHO (2018).

2.3. Categories of Healthcare Solid Wastes

2.3.1. General or Non-hazardous Wastes

Seventy-five to ninety percent of the waste generated by medical institutions is classified as general or non-hazardous waste. All waste that has not been contaminated, such as general office waste, packaging, leftover food, or wastes that are not contaminated with blood, bodily fluids, or other infectious agents or materials, such as latex gloves, papers, fabrics, glass, food residues, and containers, is recyclable or biodegradable and is comparable to regular household or municipal waste (Nessa *et al*., 2001, Chartier, 2014).

2.3.2. Hazardous Healthcare Wastes

According to (WHO, 2014) ten to twenty-five percent of hazardous medical waste which is generated from health facilities, and this can cause concerns because of a high likelihood of posing a high risk to community members and staff as these waste encompasses various types of waste, including genotoxic, chemical, radioactive, infectious, pathogenic, and sharp waste, each with unique health hazards like sharps—blades, needles, and syringes—as well as non-sharp items like bandages and swabs, body parts, tissues, organs, and various chemicals and solvents like mercury, disinfectants, radioactive materials, and medications (Chartier, 2014; Oyekale and Oyekale, 2017).

According to Chartier (2014),. Solid health care waste could be categorized below, as indicated in Figure 1:

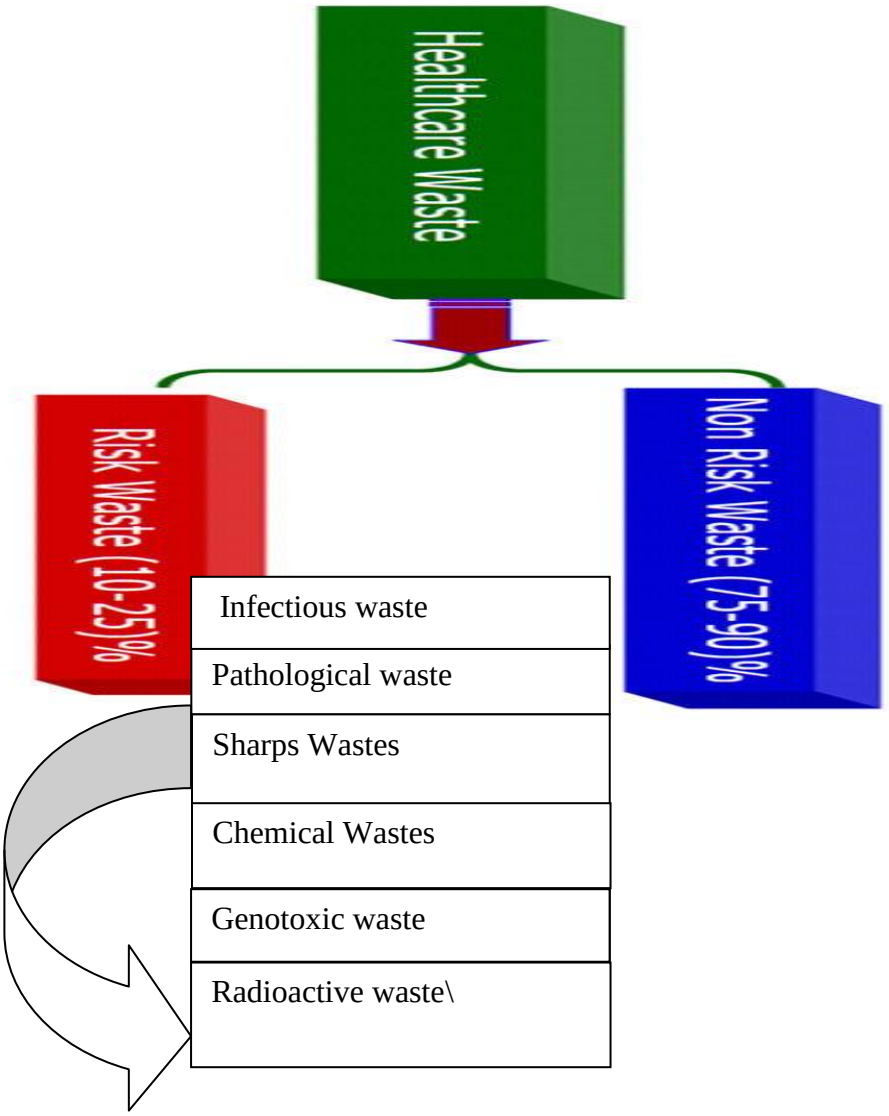

Figure 1: Category of Solid Healthcare Waste

2.4. Composition of Healthcare Solid Wastes

The majority of HCW generators are hospitals, medical centers, laboratories, veterinary clinics, research centers, mortuaries, blood banks, and nursing homes. High-income countries produce up to almost 11 kg of hazardous waste per hospital bed per day (kg/bed/day), while in low-income countries the production rate ranges up to 6 kg. However, in low-income countries, HCW is often not segregated into hazardous and non-hazardous waste, making the actual amount of produced hazardous waste much higher (Chartier, 2014; Taslimi *et al*., 2020). A study reveals that global healthcare waste, generating an average of 2 kg/bed per day, is poorly managed across 78 countries and regions with a range of 0.3 to 8.4 kg/bed. The US and Canada produce the most medical waste, followed by Kazakhstan and Iran in Asia, Spain and Italy in Europe, and Pakistan and Greece in the lowest 0.3 kg/bed/day (Singh *et al*., 2022). and little is known about the generation and distribution of health-care wastes (HCWs) in Africa, according to Udofia and Nriagu (2013). HCW generation rates in African countries vary widely, from 0.15 to 1.3 kg/bed/day).Healthcare waste generation data is not usually recorded in many hospitals in developing countries, but a well-planned management system is highly dependent upon the generation of this data (Khan *et al*., 2019)**.** The unavailability and inadequacy of data about the quantity and composition of healthcare waste is one of the major reasons for improper healthcare waste management in many developing countries (Tesfahun *et al*., 2014).

Generally speaking, emerging and impoverished nations generate less healthcare solid waste than do developed nations (0.38–10.7 kg/bed/day) (Janika-Karpinska *et al*., 2023). Hospital-to-hospital variations exist in HCW quantities due to factors such as seasonal fluctuations, regional economic conditions, the availability of appropriate waste treatment facilities, waste segregation options, training programs, type of healthcare establishment, specializations of the facility, percentage of reusable items used, patient workload, and safety protocols (WHO, 2004;Singh *et al*., 2022).

Taiwan's medical establishments generate 3.8 times more infectious waste annually than regional hospitals. Hospital services and specializations influence waste output, with independent clinics producing less and medical centers and regional hospitals producing the most, primarily from surgical procedures and laboratory services, while internal medicine, pathological laboratory, and dialysis are the main sources of infectious waste in regional hospitals (Cheng *et al*., 2009). A

Greek study found that healthcare waste generation rates vary significantly within hospitals, with average daily waste per bed ranging from 0.012 kg to 0.72 kg between public university hospitals and public mental hospitals, and with private hospitals producing 0.49 kg per bed per day in new-born clinics and 0.0012kg of waste per bed per day in psychiatric clinics (Komilis *et al.,* 2011).

Africa's healthcare facilities generate 0.8 kg of waste per bed per day (Minoglou *et al.,* 2017), while high-income countries can produce up to 10 kg per bed per day (ICRC, 2011). As healthcare services increase to meet the aims of the Millennium Development Goals (MDGs), in underdeveloped nations, waste from these facilities also rises, especially during the last 15 years (Titto *et al*., 2012). Asante *et al*.'s 2014 study on 120 healthcare facilities in Ghana's Greater Accra Region revealed a daily waste generation rate of 1.2 kg/bed. In a similar vein, Tesfahun *et al*.'s (2014) study found that Ethiopian hospitals produce, on average, 1.1 kilograms of medical waste per bed every day. Research conducted in Ethiopian hospitals by Atnafu and Kumie (2017), Meleko, and Adane. (2018), Lemma *et al*. (2021) revealed that the amount of biomedical solid waste generated varies, with values ranging from 0.164–1.94 kg/bed/day and 0.396–0.866 kg/bed/day (0.92 kg/bed/day–0.75 kg/patient/day). Hazardous waste generation in Ethiopian healthcare facilities was unacceptably high, ranging from 21 to 70%, according to Yazie *et al. (*2019).

2.5 .Healthcare solid Waste Management

Healthcare facilities are improving patient care, but advanced procedures and disposable goods contribute to significant healthcare waste (Da Silva *et al.,* 2005; Annette *et al.,* 2013). Healthcare waste is harmful, characterized by infectious agents, genotoxic chemicals, hazardous substances, and used sharps (WHO, 2008; Nwachukwu *et al.,* 2013; Chartier *et al*., 2014). In developing countries, misconceptions and a lack of education about hazardous waste types exacerbate the risk (Babanyara *et al.,* 2020). Proper waste segregation and disposal education is crucial for infection control and healthcare quality (Taskona *et al.,* 2007; Sahiledengle, 2019).

Singh et al.'s (2022) meta-analysis found that only 41% of healthcare workers receive in-service training on medical waste disposal, while only 38.9% of waste is separated and handled properly. Plastic materials, which make up 35% of medical waste, present potential opportunities for sustainable resource recovery and recycling (Lahtela *et al.,* 2019). Transitional economies primarily treat medical waste through incinerators, with over 90% of waste either burned without

abatement devices or disposed of in landfills (Liu *et al.,* 2018). Medical waste treatment incinerators in low- and middle-income countries often use outdated, dangerous technologies, releasing dioxin and heavy metal pollution up to 40,000 times higher than Stockholm Convention emission limits (Ibeanu, 2004;Datta *et al.*, 2018).

Research from most African nation's shows that incinerators aren't working well and waste is disposed of in open dumps without any sort of treatment (Coker *et al.,* 2009; Saad, 2013). A study of 58 articles from 1997 to 2014 in 20 sub-Saharan countries revealed that 53% of waste management workers reported segregation, but the least compliance areas were color code usage (18%) for waste bin labels, "off-site co, off-site conveyance, and periodic training (18%) (Udofia, 2015). However, inadequate waste handling procedures lead to a higher than anticipated 10 to 25% (Fadipe *et al.,* 2011). 89 percent of the medical waste management system in the studied hospitals in Yemen was unsatisfactory, unsuitable, unhygienic, and unacceptable due to a lack of segregation, color-coded containers, rules, storage rooms, infectious waste treatment, personal protective equipment, and safety plans for handling medical waste (Alwabar *et al., 2017*).

Incorrect waste processing can spread diseases and increase the amount of waste sent for burning. Incinerators, often single-chambered, emit hazardous gases (Ferronato and Torretta, 2019). Proper off-site transportation, labeling, and continuous training are necessary (Udofia, 2015). Ethiopian healthcare facilities generate hazardous waste, with unacceptable levels between 21% and 70% because of improper waste segregation due to a lack medical staff awareness and adequate regulatory enforcement (Yazie *et al*., 2019). Berihun and Solomon's. (2017) study revealed that 80% of hospital incinerators in the country use low-temperature technology, which produces air pollutants. A study of 32 Ethiopian governmental healthcare facilities found that 68.5% did not properly separate healthcare waste from hospitals, 81.2% had poor placental disposal pits, 18.7% engaged in secured open pit burning, and 92.8% had small-scale incinerators (Sahiledengle *et al.,* 2017).

Anderson *et al*. (2020) suggest that increasing healthcare sector funding for environmental health services leads to improved service delivery. Rich nations have developed effective policies due to their abundant resources, making them easy to implement (Blenkharn, 2006), whereas developing countries struggle with resource constraints, hindering the implementation of waste management concepts. Insufficient funding in healthcare leads to inadequate waste management

supplies, equipment, and staff training, resulting in insufficient knowledge (Muduli and Barve, 2012). Hazardous waste in developing nations is burned outdoors (Kerdsuwan and Laohalidanond, 2015), mixed with municipal waste(Mahmood *et al., 2011*), illegally recycled, and resold (Mohankumar and Kottaiveeran, 2007), posing significant environmental and health risks. Unhygienic landfill disposal is the primary obstacle to responsible hazardous waste management (Chisholm *et al.,* 2021).

Ineffective waste management in hospitals is linked to the absence of a waste management policy, manual, plan, and standard operating procedures (Salaam *et al.,* 2022).Improper waste handling in healthcare operations poses a significant risk to environmental health and public health (Amsalu *et al.,* 2016). Medical waste handlers manage healthcare waste, including transportation, storage, treatment, and disposal, requiring strict training and adherence to strict regulations (Farzadkia *et al.,* 2009).

Ketema *et al*. (2023) highlight the potential danger posed by inadequate medical waste management procedures to patients, their families, healthcare personnel, and the public. The ICRC. (2011) suggests that standard operating procedures for treating hazardous hospital waste can significantly reduce its presence in unfavorable settings.

The effective management of medical waste in healthcare facilities (HCFs) relies on a competent waste management team, meticulous planning, regulatory frameworks, adequate funding, and qualified staff involvement (Awodele *et al.,* 2016). Healthcare facility managers should ensure medical professionals follow protocols and maintain a proper waste management system, while employees involved in trash collection and segregation receive proper education and training (Anozie *et al.,* 2017).

Separating waste types into color-coded containers with liners at their creation locations is crucial for proper management of hazardous waste (HCW) (Akulume and Kiwanuka, 2016; Datta *et al.,* 2018). WHO (2014) sets waste collection and segregation standards for healthcare, including black general waste containers, yellow labels for sharp, contagious, and pathological containers, and brown containers for chemicals and pharmaceuticals. Wastes are the exceptions to this rule, as they can be collected as needed, and almost all waste types should also be collected as soon as the container is three-quarters full, or at least once a day.

2.5.1 .Healthcare Waste Minimization

The health industry, while crucial for long-term development, is the largest emitter of environmental pollutants. Sustainability is a top concern for healthcare institutions, and scientific research helps clarify the link between environmental sustainability and health effects, directing activities and promoting good practices (Berniak-Woźny and Rataj, 2023). Single-use medical goods, containing 36% plastic, need a circular model to transition to recycling, with designed products, particularly plastics, being reused post-use (Payne *et al.,* 2019).

Reducing waste production can be achieved through revised purchasing policies, stock management, and recycling of non-medical treatment materials, reducing the need for post-treatment disposal (Padmanabhan &Barik, 2019). Proper management of medical supplies in hospital pharmacies is crucial for waste minimization (UNEP/SBC and WHO, 2004). Utilizing source reduction, recycling, waste segregation, and good management practices as outlined in the Ethiopian Healthcare Waste Management Directive No. 16/2013 (FMHACA, 2005) should include the following procedures: Healthcare facility staff adhere to legislation and directives to minimize medical waste. Materials and supplies are obtained with minimal waste, and effective waste reduction and recycling procedures are implemented.

2.5.2 .Healthcare Waste Segregation

Waste segregation is a crucial stage in waste management, and developed nations, due to their abundant resources, have created appropriate policies that are simple to implement (Blenkharn, 2006). The USA, Canada, and the UK strictly practice waste segregation, have standard legislation, and also adhere to the WHO guidelines (Windfeld and Brooks, 2015). Studies in developing nations reveal a lack of appropriate standards implementation and segregation practices, as highlighted by various studies (Abd El-Salam, 2010; Fadipe *et al.,* 2011; Udefia, 2015; Gitonga, 2017; Yazie *et al.,* 2019). As a result, there may be a greater amount of infectious waste, which has the potential to convert regular waste into hazardous waste (Gupta and Boojh, 2006).

Segregation is always the first and most crucial step in HCWM. It entails putting various wastes into separate colored bins with liners or sharps containers in the areas where they are created (Gitonga, 2017). The WHO (2014) text outlines color coding and container types that are "well-designed, strong, and leak-proof "for the proper segregation and collection of HCWs.

Red marked the color of the container for highly infectious waste. Blue container for wastes like anatomical and pathological wastes; Yellow container for "sharp wastes"; Brown-colored containers for chemical and pharmaceutical wastes and Black for General Wastes

2.5.3. Collection

A number of obstacles prevent healthcare facilities in developing nations from effectively managing these wastes (Awodele *et al.*, 2016;Salaam *et al.*, 2022). Few members of the healthcare facility's staff are knowledgeable about the steps necessary for an effective waste management program (Muduli and Barve, 2012; Babanyara *et al.*, 2020). Moreover, waste management is typically assigned to unskilled workers who carry out the majority of tasks without adequate supervision or safety (Diaz *et al*., 2005).

Utilizing HCWs' knowledge, attitude, and practices (KAP) on biomedical waste (BMW) is crucial for designing effective training programs for managing BMW effectively (Olaifa, 2018). (WHO, 2014) recommends using black containers for general wastes, yellow for sharp wastes, blue for anatomical and pathological wastes, red for highly infectious wastes, and brown for chemical and pharmaceutical waste. Nearly all waste categories should be separated and collected at least once a day, or when the container is three-quarters full. Only three types of trash can be collected on demand: radioactive, chemical, and pharmaceutical (Pandey *et al*., 2016; WHO, 2017).

2.5.4. On-Site and Off-Site Transportation of Waste

Healthcare solid wastes should be transported using wheeled trolleys, containers, carts, or vehicles, which should be cleaned and disinfected daily using the appropriate disinfectant (UNEP/SBC and WHO, 2004). Labeling and packing HCW containers is crucial for quick identification and corrective action in accidents. Consignment notes should be carried by every vehicle, transit documentation should be meticulous, and trucks should not be used for other purposes (WHO, 2014).

2.5.5. Treatment

There is a huge gap in knowledge between the developed and developing worlds when it comes to HCW treatment and disposal, primarily due to a lack of adequate resources and non-adherence to guidelines and legislation, many of which cause lasting damage to the environment and consequently to global human health (Kenny *et al., 2021*).

Although autoclaving is the most widely used, successful and safe method of treating medical waste, its high cost and the appearance of the treated waste make it unpopular in many developing countries today (Ferdowsi *et al.*, 2013). Besides this, some use gasification and pyrolysis, which use a co-reactant and a high temperature of up to 1000 degrees Celsius to turn solid waste into a combustible gas that can be incorporated into other energy-related technologies (Ram and Kumar, 2021). In addition, steam augurs operate at atmospheric pressure and require that garbage be shredded prior to the procedure in order to destroy microorganisms through time and heat (Zimmermann, 2017).

In general, hospitals and health facilities produce an increasing amount of waste, including infectious, hazardous, and radioactive materials, with dangerous landfill disposal methods and inadequate incinerators being important concerns in low-income nations (Borowy, 2020). If incineration is deemed to be a viable method for medical waste disposal, low-temperature incinerators should be banned and replaced by more modern incinerators equipped with air pollution control devices. These concerns are widespread in developing countries that lack the financial capacity to purchase ecologically friendly incinerators equipped with cutting-edge technologies. Microwaves and autoclaving are regarded to be preferable methods for dealing with medical waste, although they are often insufficient for pathological, radioactive, laboratory, and chemotherapy wastes (Ghali *et al.*, 2023).

2.5.6. Disposal

Many nations with economies in transition have reported openly disposing of sharps contaminated with dangerous diseases like hepatitis, HIV/AIDS, cholera, typhoid, and respiratory issues (Khan *et al*., 2019; Zafar, 2019). Medically hazardous solid wastes have not gotten enough attention in underdeveloped nations yet (Silva *et al*., 2005). Inadequate handling of medical waste results in stench, growth, and multiplication of insects, rodents, and worms; additionally, injuries from blood-contaminated sharps can spread diseases like cholera, hepatitis, and typhoid (Cocker *et al*., 2009; Yitayel *et al*., 2012). While most hospitals employ outdated incinerators to dispose of medical waste, many hospitals in underdeveloped nations engage in open burning, open dumping, and landfill disposal without any sort of segregation (Janng *et al.*, 2006; Yitayel *et al.*, 2012). Even with the implementation of numerous state-level laws and participation in numerous international treaties, many healthcare facilities, especially those in low- and middle-income nations, still lack safe and efficient medical waste management systems

(Oruonye and Ahmed, 2020). The management of healthcare waste has gained wide attention in recent years. Sustainable assessment of technologies, to this point, revealed that in many cases, autoclave-assisted shredder could be a better alternative for the treatment of hazardous healthcare wastes, while land filling of healthcare waste received the lowest ranking (Hassan and Shareefdeen, 2022).

Ethiopia lacks sufficient facilities for treating hazardous medical waste, resulting in uncontrolled landfills and open fires, and there is no efficient institutional framework or specialized legislation for hazardous waste management, leaving producers partially liable. Used chemical containers in health-care facilities were sorted, collected, and sold to individuals for reuse (Abebe, 2017;Yazie, 2019).

WHO (2005) underlines the significance of using a step-by-step flow process system to manage healthcare waste throughout its life cycle, as shown in Figure 2. Minimization via purchasing methods and inventory control.

Segregation Avoids mixing non-infectious from infectious wastes

Codification is using Color-coding system which defines waste containers

Handling Concerns of waste collection and storing conditions

Transportation Suitable vehicles primarily used for conveying infectious waste should be cleansed routinely.

Treatment Reduce exposure, recover recyclable materials, and safeguard the environment against infectious waste.

Disposal Final placement of treated waste the manner environmentally acceptable method

Figure 2: Hierarchy of Healthcare Waste Management

2.6. Impact of Poor Healthcare Waste Management

Negligent waste management can be a major environmental hazard as well as a source of re-infection and long-term undesired health hazards for the population (Diaz ***et al***., 2005;Salaam ***et al.,*** 2022). As a result, HCW management needs to be given extra consideration and should be given top priority (Wafula *et al*., 2019). The environment and public health can be gravely threatened by improper handling of medical waste (Chisholm ***et al.,*** 2021).Medical waste management is a major concern for all regulators and requires ongoing attention because of the problems caused by poor waste management, which include harm from sharp objects, infectious agent-related diseases in humans, and environmental pollution from toxic and hazardous chemicals (Ghanimeh ***et al***., 2019).

2.6.1. Health Impacts of Improper Healthcare Waste Management

Because of its ability to spread illness and the pathogenic bacteria, heavy metals, and toxic substances that are frequently found in it, solid medical waste has remained a source of worry (Pruss *et al*., 1999). Typhoid, intestinal parasitism, hepatitis, nosocomial infections, and skin conditions are among the illnesses linked to inadequate medical waste management (Udofia, 2015)**.** Damage from infected sharps poses a risk of HIV transmission to a susceptible human host (WHO, 2004). The public, the environment, healthcare professionals, scavengers, family or caregivers, patients, and garbage workers are all impacted by improper treatment and disposal of medical waste (Coker *et al*., 2009).

A South Korean study found various microorganisms in various HCWs, including Pseudomonas spp., Lactobacillus spp., Staphylococcus spp., Micrococcus spp., Kocuria spp., Brevibacillus spp., Microbacterium oxydans, and Propioni bacterium acnes (Park *et al*., 2009). PVC plastics, a significant waste from healthcare facilities, release dioxin into the atmosphere upon low-temperature combustion, a known human carcinogen linked to immunological and endocrine issues (Malkan, 2005; Lahtela *et al.,* 2019). Studies in Japan, Spain, and Germany reveal a link between incinerator emissions and increased levels of dioxins, furans, and hydrocarbons, causing adverse health impacts on workers and residents (Kumagai *et al.,* 2005). Health Care Waste (HCW) poses various risks, including infectious, biological, traumatic, chemical, toxic, and psycho-emotional issues, as per a review by Hossain *et al. (*2011). The health risks associated with HCW are trauma, infection, chemical exposure and poisoning, fire or explosion, exposure to radioactivity, stress, and anxiety. It has been estimated that unsanitary disposal of waste has

placed 50% or more of the population of Africa at occupational, environmental, and public health risks (Harhay *et al.,* 2009).

2.6.2. Environmental Impacts of Inadequate Healthcare Waste Management

If the hazardous and toxic components of healthcare facilities' waste—which include sharps, infectious, medical, and radioactive materials—are not properly handled, disposed of, or allowed to mix with other municipal waste, they pose a serious risk to both human health and the environment (Babanyara *et al*., 2013).

Environmental contamination is caused by toxic emissions from improper medical waste combustion as well as the smell from medical waste disposal (Padmanabhan & Babak, 2019). Medical wastes have a number of harmful consequences for the environment, such as groundwater contamination from untreated medical waste disposed of in landfills, environmental vandalism, and the spread of illness via viruses and germs (Chuks *et al.,* 2013). The improper treatment and disposal of HCWs can lead to environmental impacts such as aesthetic degradation, gas emissions, fire risk, rodent and insect proliferation, soil degradation, water pollution, and atmospheric pollution (Hossain *et al.,* 2011).

2.7. Guidelines/Standards, Rules, Proclamations, and Policies Relevant to Healthcare Solid Waste Management

Guidelines and regulatory body inspections significantly predict appropriate healthcare waste management procedures, attributed to increased awareness and adherence among health workers (Muduli and Barve, 2012). National guidelines for healthcare waste management in developing countries were developed based on the United Nations Environment Program's biomedical and healthcare waste guidelines due to insufficient research data in these countries (FEPA, 2004).

Ethiopia's health policy prioritizes pollution control, occupational safety, and environmental health in handling hazardous chemical waste, despite lacking specific legislation for healthcare waste management (HPTGE, 1993; FEPA, 2004). The management of hazardous biomedical waste in Ethiopia is not subject to specific regulations or regulatory bodies.(Abebe, 2017). Ethiopia lacks specific legislation for managing healthcare waste, despite policies and laws providing a legal foundation for controlling such waste (FMOH, 2008). Ethiopia's Environmental Pollution Control Proclamation No. 300 of 2002 mandates FEPA to manage hazardous waste from large hospitals, incinerator facilities, chemical treatment facilities, and landfills (FEPA,

2000). Nonetheless, drawing on UNEP's biomedical and healthcare waste guidelines, Ethiopia's Federal Ministry of Health, Federal Environmental Protection Authority, and Quality Standard Authority have created voluntary codes of practice, national guidelines, and manuals for healthcare waste management (FEPA, 2004;FMOH, 2008). The existing frameworks mentioned above may provide healthcare waste management (HCWM); however, they are not exhaustive; they are vague when it comes to identifying categories of hazardous HCW, outlining facilities' responsibilities, and dealing with record-keeping and reporting. Furthermore, there is a lack of coordination and overlapping mandates across government agencies, but the Hygiene and Environmental Health Directorate of the Federal Ministry of Health Ethiopia recently published a manual that provides technical knowledge and guidelines for responsible healthcare workers, administrators, and waste management staff to effectively manage healthcare waste at the Woreda, zonal, regional, and national levels (HEHD-FMOH, 2022). Ethiopia has ratified international conventions on hazardous waste management, including the Basel, Stockholm, and Minamata Conventions, which are crucial for its HCWM planning and implementation (HEHD-FMOH, 2022).

3. MATERIALS AND METHODS

3.1. Description of the Study Area

3.1.1. Geographical Location

Addis Ababa is geographically located at the heart of the nation, 9°2′ N latitude to 9°5′ N and 38°45′ E longitude; it covers an area of about 540 km^2 (Teferi and Abraha, 2017; Feyyisa *et al., 2018*). Administratively, the city consisted of eleven sub-cities with an average altitude of 2400 m above mean sea level, with the highest elevation at Entoto Hill to the north reaching 3200 m (Erena *et al.,* 2017). This chartered city is governed by three tiers: The municipal government is at the top, followed by eleven sub-city administrations and 120 woreda administrations at the bottom, according to the Addis Ababa Plan and Development Commission (AAPDC, 2020). As the largest and capital city of Ethiopia, Addis Ababa serves as the nation's administrative and educational hub (AAPDC, 2020). In addition, it serves as the headquarters for a number of continental and international organizations, including the United Nations Economic Commission for Africa (UNECA) and the African Union (AU). Because of its historical, diplomatic, and political significance for the continent, it is frequently referred to as "the political capital of Africa" (Mekonnen *et al.,* 2024). (See figure 3 for the study area's point location map).

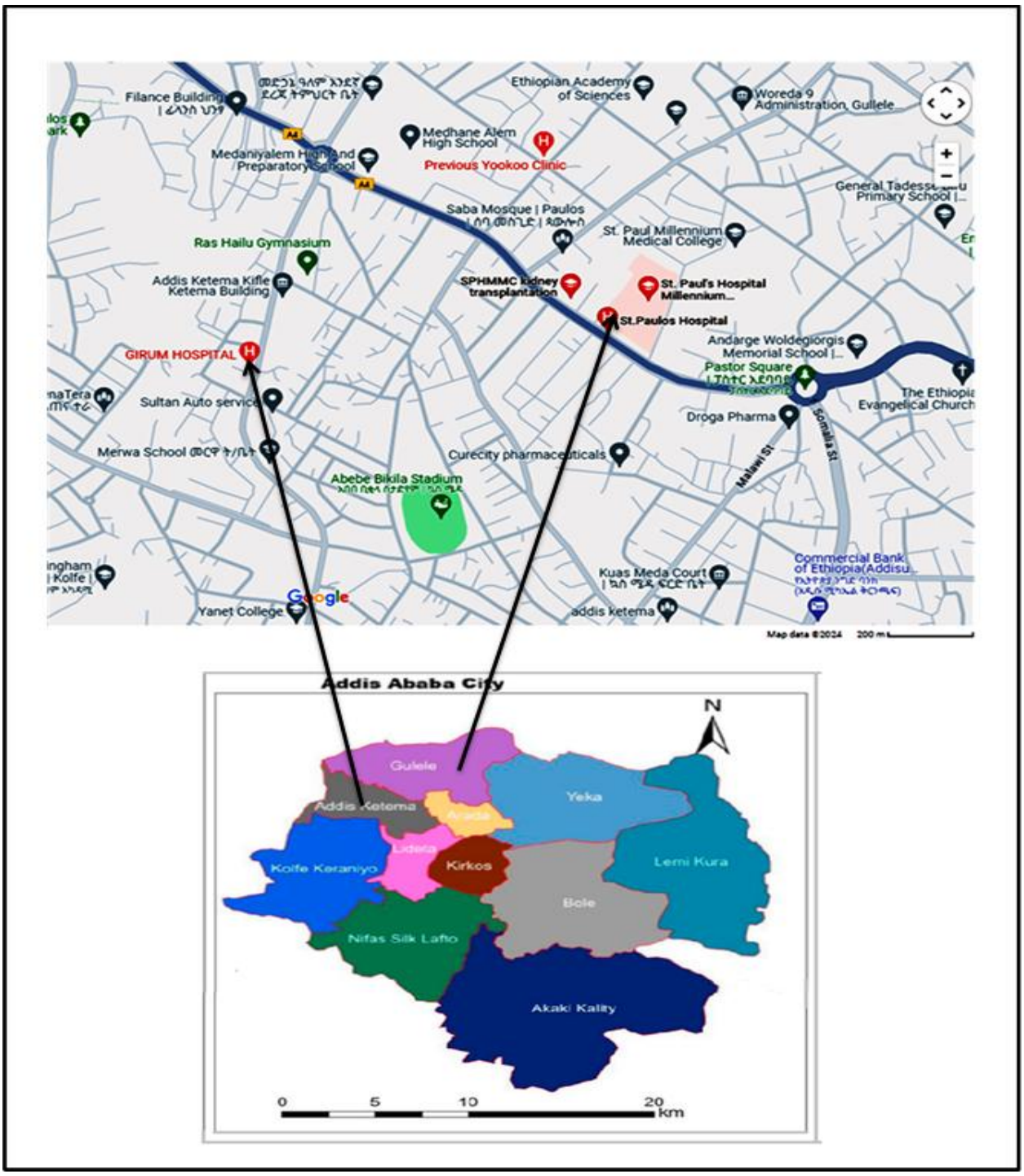

Figure 3: The study area's point location

The study area's point location is depicted in Figure 3, sourced from Google Maps and retrieved on January 21, 2024.

3.1.2. Climate and Topography

Addis Ababa has a subtropical, high-land climate. It falls into the temperate climate with dry winter's category according to Köppen climate classification with dry winters and rainy summers (Koottek ***et al.,*** 2006)**.** The weather and climatic conditions of Addis Ababa are largely influenced by its topography; the altitude ranges between 2100 and 3200 m above sea level (Mekonnen ***et al.,*** 2024). Over the past 60 years, Addis Ababa has experienced an average maximum temperature of 22.9 °C and a minimum temperature of 10.2 °C. The city of Addis Ababa features a complex mix of highland climate zones, with temperature variations of up to 10°C depending on elevation and predominant wind patterns (Feyisa ***et al.,*** 2018).

3.1.3. Geology and Soils

Addis Ababa city is entirely covered with volcanic rocks, basalt, trachyte, ignimbrite, and rhyolite. The construction industry makes use of these rocks extensively and indiscriminately for structural loading, pavements, wall cladding, fencing, cobblestone, and masonry stones (Engidasew and Abay, 2016). The rock and soil outcrops of Addis Ababa are anomalously rich in heavy metals derived from hydrothermal activity. Therefore, heavy metal concentrations in the surrounding rocks and soils are related to gynogenic sources, whereas anthropogenic contribution as a cause of these concentrations is minor (Alemayehu, 2006).

3.1.4. Population and Livelihood

As the last census in Ethiopia was carried out in 2007, the current population of the city is based on estimation. There are several estimates about the population of the city from different sources. However, the national central statistical agency that carries out national census projections is appropriate; in the year 2007, the population was 2,739,551 (CSA, 2007), with 22.77% of the 11.86 million people living in urban areas of the country. In 2015, the population was around 3.3 million, whereas in 2017, the estimated population was around 4 million (Erena *et al*., 2017).

So far, the population is projected to reach about 6 million or more at the end of 2030 (Addis *et al., 2023).* Addis Ababa is facing a massive housing shortage due to rapid migration and high population growth. Informal households are sacrificing quality housing for job access, leading to a trade-off between quality and access to jobs. High traffic congestion, low mobility, and poor public transport contribute to the issue. The city's electricity network is overloaded, and only 21 out of 116 woredas have continuous water supply (Word Bank, 2021).

3.1.5. Education and Health

Addis Abeba University, Addis Ababa Science and Technology University, Ethiopian Civil Service University, Admas University College, St. Mary's University, Unity University, Kotebe Metropolitan University, and Rift Valley University are just a few of the public and private colleges in the city. In addition, the city is home to a large number of public and private schools. There are 75 government and 145 non-government secondary schools. Among this distribution, the female school age population of 14–17 years is about 95,064; the majority of gross enrollment grade 9–12 students are female, with an excess of 106,372. Health facilities in Addis Ababa serve a sizable population in the city's surrounding areas as well as other regional states because the city is the center of the nation in many socioeconomic aspects of people's lives and because people expect better health services in Addis Ababa than in other regional centers (Azagew and Worku, 2020). The basic school water, sanitation, and hygiene services were found to be 65.3%, 31.6%, and 36.7%, respectively. The facility-to-student ratio was 1:48 for the drinking water point, 1:59 for the toilet stance, and 1:147 for the hand washing point. The analysis of facilities access by sex revealed that the toilet-to-student ratio was 1:68 for females and 1:49 for males, whereas the hand washing point-to-student ratio was 1:179 for females and 1:114 for males, indicating disparities in facilities access by sex. The non-functionality rates for drinking water, toilets, and hand washing facilities were 22.5%, 8%, and 19.5%, respectively (Melaku *et al*., 2023). Ethiopia’s health service is structured into a three-tier system: primary, secondary, and tertiary levels of care. The primary level of care includes primary hospitals, health centers, and health posts. The lowest level of primary health care are the health posts staffed with two women each to take care of their communities. They have around 15,000 health posts and about 30,000 women trained to run them. The secondary level of care consists of general hospitals that serve 1 to 1.5 million people. The tertiary level of health care has specialized hospitals and serves 3.5 to 5.0 million people in general. The country's health infrastructure is weak; however, only major cities have hospitals with full-time physicians, most of which are in Addis Ababa (FMOH, 2015).

3.1.6. The Study Hospitals

The St. Paul Millennium Medical College Hospital was established through a decree of the Council of Ministers in 2010, however, the Medical School opened in 2007 and the hospital was founded in 1968 by the late Emperor Haile Selassie I. A board of directors appointed by the Federal Ministry of Health oversees its operations. The College developed Ethiopia's first integrated modular and hybrid problem-based curriculum for undergraduate medical education, and it is now growing into postgraduate programs while widening its undergraduate program offerings. St. Paul Millennium Medical College's Hospital is rapidly expanding its capacity, having grown from 3 to 250 faculty members in the last six years, as well as developing teaching facilities. The institution employs about 2800 clinical, academic, administrative, and support professionals who provide medical specialty services to patients from all over the country, teach medicine and nursing students, and conduct basic and applied research. While the inpatient capacity exceeds 500 beds, the college handles an average of 1200 emergency and outpatient clients and 410 inpatients per day. The hospital of St. Paul Millennium Medical College offers medical care and education to its students through a variety of biomedical and clinical departments, including pathology, anatomy, physiology, biochemistry, pharmacology, public health, emergency medicine, urology, neurology, orthopedics, psychiatry, ophthalmology, dentistry and maxillofacial surgery, radiology, anesthesiology, nursing, intensive care unit (ICU), ART (HIV care), endoscopy, physiotherapy, laboratory, and pharmacy.

Girum Hospital is a private health facility established in 2007 G.C. by an American medical board-certified physician, Dr. Girum Berhane, and his family with the main objective of introducing the art and science of medicine to Ethiopia by instituting an efficient hospital management system, a variety of medical specialties, and investing in the latest medical devices that enable us to offer advanced quality healthcare services in the nation and hold patient referrals abroad. It employs about 200 people in clinical, administrative, and support roles. Pathology, General Surgery, Internal Medicine, Obstetrics, Gynecology, Pediatrics, Radiology, ICU (Intensive Care Unit), Laboratory, and Pharmacy departments. There are more than 50 inpatient beds available, and the hospital treats 34 inpatients as well as 211 emergency and outpatient patients every day on average.

3.2. Research Design

The study design employed both primary and secondary data sources to get information, in accordance with the problem and research objectives outlined in the Introduction Section. Field observation and respondent interviews provided the primary data. Professionals, staff members, and other stakeholders who are concerned participated in semi-structured interviews and a structured questionnaire survey. The books, research papers, academic journals, publications, and document reviews served as the secondary data sources. Both qualitative and quantitative methods are used in the research. In order to combine quantitative and qualitative methods, a cross-sectional survey was ed, and a survey design was implemented. The study was conducted on the assessment of solid healthcare waste management practices and the knowledge, attitude, and practice regarding HCSWM of healthcare experts and waste handlers. To investigate the overall practice of healthcare waste management, the study employed structured and semi-structured questionnaires adapted from the World Health Organization's Healthcare Waste Management Rapid Assessment Tools (WHO, 2004),and the key informants interview. Two (2) hospitals were selected for the exercise using stratified random sampling, where the hospitals were stratified into private and public hospitals based on their ownership, as described in Awodele *et al*. (2016). Conversely, the medical directors, administrators, and heads of the different departments and case teams to be involved in the questionnaire survey of the study will be picked by purposive sampling, while the health professionals from each department or case team and waste handlers that are required for the key informant interview in the study hospitals were selected by way of simple random sampling. To address the problem, the data were acquired from both primary and secondary data from the respondents: direct observation, quantitative (weighing), and qualitative (HCSW characterization) measurements of the HCSW. The study was made to be timely and procedurally manageable up to the final work. The researcher was interviewing the sampling members to gain a deeper understanding of the subject under investigation and to improve the study. The researcher measures the amount of healthcare waste generated on a conventional weighing scale. The frequency of daily new patients and those who had some other health services at the time of the study duration was taken from OPD registers. The researcher proposes using observation instruments for data collection, systematic noting, and real event capture using cameras and other instruments. Hospital waste was collected and weighed daily for seven consecutive days with the help of cleaners.

3.2. 1.Determination of Sample Size

A single population proportion formula was used to calculate the sample size, considering an assumption of proportion, a 95% level of confidence, and a 5% margin of error. Slovin's formula was used to calculate the sample size (n) given the population size (N) and a margin of error (e). It's a random sampling technique that uses a formula to estimate the sample size.

$n_{o=} z^2pq/e^2$

$= (1.96)^2(0.5)\ (0.5)/(0.05)^2$

=385

The target population will be n = no/1+no-1/N.

n = 385/1+ (385)/3000

n_1 = (341) (2800)/3000

=<u>318</u>

n_2 = (341)(200)/3000

Where z = 1.96, p = 0.5, q = 1 - p = 0.5, e = 0.05, and N = 2800 +

n1 = number of samples from St. Paul Millennium Medical College's Hospital

N is the total population of the study hospitals (both hospitals).

e = Error Margin/Margin of Error

n_2 = number of samples from Girum Hospital

The sample size was computed using a single population proportion formula with a 50% proportion assumption, a 95% confidence level, and a 5% margin of error. The total number of healthcare workers present in each healthcare facility was used to decide how many healthcare workers from each hospital should be included in the study. To serve all categories of health professionals, further proportionate allocations were made inside each healthcare facility. At St. Paul Millennium Medical College Hospital, there are currently 521 medical staff members, 1202 nurse staff members, and 1077 other health and supportive staff members. In contrast, Girum Hospital has 22 medical staff members, 108 nurse staff members, and 70 other health and supportive staff members.

Consequently, St. Paul Millennium Medical College's hospital has the following:

1) There are (521) (n1)/2800 = (521) (341)/2800 = 63 medical staff members.

2) Nursing personnel = (1202)(n1)/2800 = (1202)(341)/2800 = 146

3) other health(Pharmacist ;Midwifery ;Lab technical's, and waste handlers) = (1077)(n1)/2800 = (1077)(341)/2800 = 109.Similarly the Girum hospital, there are:

1) Medical staff = (n2) (22)/200 = (22) (23)/ (200)= 3

2) Nurse staff = 108 * n2 = 108 * 23 / 200 = 12.

3) Other health staff (Public Health; Pharmacist; Midwifery; Lab technical's, and waste handlers) = (70) (n2)/200 = (70)(23)/200 = 8

Table 1: Professional Category of the study Hospitals

Professional Category	St,Paul Hospital		Total	Girum Hospital		Total
	Male	Female		Male	Female	
General Medical Practitioner	48	15	63	2	1	3
Nurse	59	87	146	4	8	12
Midwifery	3	7	10	-	1	1
MA/M.sc/MPH	20	8	28	1	-	1
Public Health	19	3	22	1	-	1
Pharmacy	12	4	16	1	-	1
Laboratory	12	3	15	2	-	2
Anesthesia	2	1	3	-	-	-
Radiology	1	-	1	-	-	-
Waste handlers	5	9	14	-	2	2
Total	181	137	318	11	12	23

3.2.2. Instrument of Data Collection

The method adopted for this study, which entailed three data collection instruments, namely a questionnaire survey, direct observation (site visitation), and semi-structured interview (in-depth interview), follows the procedure used by Awodele *et al*. (2016). The researcher using observation systematically noting, and real event capture using cameras and other instruments. Hospital waste was collected and weighed daily for seven consecutive days with the help of cleaners. The waste was sorted into categories and weighed using a weighing balance. The

researcher observed the waste segregation and management system (collection, storage, transportation, treatment, and disposal).

3.2.3. Questionnaire Survey

On the first day, before the data collection was conducted, brief explanations were given to the heads of the medical directors and hospital administrators about the purpose of the study. The respondents that participated in the questionnaire survey were the heads of the selected hospitals (medical directors) and heads of respective departments or case teams (including administration and environmental health/sanitation). A standardized questionnaire adapted from the WHO for HCW (WHO, 2004) was used. Questionnaires, which were employed in the study, include questions about the demographic characteristics of the respondents and attempts to. The questionnaire contained both open-ended and closed-ended items relating to four aspects of medical waste: (1) segregation, (2) collection, (3) transportation, and (4) final disposal.

3.2.4. Key Informants Interview

In order to obtain qualitative information about the healthcare solid waste management of the selected hospitals, a key informant interview was employed. The semi-structured interview questions were structured to generate data from knowledgeable hospital staff from each department or ward, as well as those waste handlers in charge of managing the hospital solid waste system, to learn more about actual solid waste management practices and their perceptions of the overall HCSWM. This instrument was believed to be vital to collecting data that couldn't be obtained using other data collection instruments, like questionnaires. Moreover, it was expected to provide respondents with a chance to express their views. Consequently, the Key Informant Interview (KII) was administered by involving selected staff from each department or section. The main questions during the intended KII were: generation, segregation, collection, transportation, storage, treatment, and disposal; waste recycling and reusing; internal policies and administration; training; and budget for healthcare waste management.

The queries contained a semi-structured interview concerning the KAP about the HCSWM and the results were simply comparing each in percentile and see the high, medium as well as the low KAP of the interviewers. General Information from Respondents Regarding the Study Hospitals;

,Knowledge of Respondents about HCSWM (K), Attitudes of Respondents towards HCSWM (A); and Practice of Respondents in Respect of HCSWM (P).

3.2.5. Direct Observation

An observation was used to assess the management system in terms of segregation, collection, temporary storage, transportation, treatment, and disposal of healthcare waste and how healthcare workers and waste handlers dealt with the healthcare waste in all departments of the hospitals. It was used for assessing the healthcare solid waste management system in each hospital.

3.2.6. Characterization of Healthcare Solid Wastes and Generation Rates

Plastic polyethylene bags and labeled color-coded waste containers were used for the collection of solid waste from the wards, laboratories, and departments of the hospitals. The solid waste was separated (following appropriate safety precautions) into two categories, such as hazardous and non-hazardous, as designated in WHO guidelines (1999). Electronic balances, calculators, and recording forms were used for solid waste measurement. Waste generation per day was determined by dividing the total waste produced over the study duration by the length of the study period (7 days) in kg/day. The solid waste generation was computed by dividing the total weight of waste (in kg) generated per day with the number of beds in the hospital (i.e., the vacant beds were not considered) expressed as kg/bed/day or dividing the total weight of waste (in kg) generated per day with the number of inpatients attended daily in the hospital expressed as kg/patient/day (Kagonji and Manyele, 2011). Likewise, Alagha *et al*. (2018) stated that a universal indicator of medical waste (MW) generation is the weight of healthcare waste generated per bed per day (kg bed per day) for a given medical facility. Accordingly, waste generation per (occupied) bed per day was calculated as given below:

Wbd = [MW weight (kg)]/[(day) × (bed)] where Wbd is defined as the total weight of MW (in kg) generated per occupied bed per day.

3.3. Data Analysis.

The collected data was analyzed by employing different methods. In order to address the stated objectives, both qualitative and quantitative data must be analyzed and interpreted. The required data was analyzed using descriptive statistical techniques used to describe or summarize by using

the Kruskal-Wallis test to clearly state the numbers of patients who got service in hospitals in relation to the amount of solid health care generated. The P-value was employed in order to compare the generation rates of solid waste within wards and between the two hospitals and see whether there was a significant association between responses provided by stakeholders of different age groups and educational backgrounds and their awareness or perception toward accepting and managing waste. The Spearman's Correlation Matrix (rs) was employed to compare hazardous waste (HW) generated, patient flow, and occupied beds in private and government hospitals. Data were analyzed and interpreted under the functions of the Statistical Package for Social Sciences (SPSS-22) software.

3.4. Ethical Issue

An official letter of cooperation was obtained from the Department of Biology, Hawassa University. The IRB obtained ethical letters from the City Government of Addis Ababa Health Bureau and St. Paul's Millennium Medical College Hospital (SPHHMC).The necessary explanation about the purpose of the study and its procedures was done with informed consent from each respondent. Permission for data collection was obtained from hospital administrators. Unwilling participants in the study were not encountered more, and any omission will not be present to ensure confidentiality. An anonymous interviewer was conducted.

4. RESULTS AND DISCUSSION

4.1. Characteristics of the Study Participants

In the course of conducting this study, the researcher distributed survey questionnaires of a total respondent of 341. As all the questionnaires were filled and returned, the response rate, therefore, is 100%. Henceforth, the response rate is fully complete to conduct this study.

Table 2: Demographic characteristics of participants

Socio-Demographic Variable	Variable Category	St. Paul's Hospital	Girum Hospital
Gender	Male	181(56.9%)	11(47.8%)
	Female	137(43.1%)	12(52.2%)
Age	18-25yr	75(23.6%)	4(17.4%)
	26-35yr	201(63.2%)	10(43.5%)
	36-46yr	39(12.3%)	2(8.7%)
	47-55yr	2(0.6%)	7(30.4%)
	>56yr	1(0.3%)	0(0.0%)
Educational status	<grade 10	31(9.7%)	5(21.7%)
	10^{th} complete	1(0.3%)	0(0.0%)
	Diploma	2(0.6%)	1(4.3%)
	Degree	256(80.5%)	16(69.6%)
	MA/MSc/MPH	26(8.2%)	1(4.3%)
	PhD	2(0.6%)	0(0.0%)
Professional Category	Doctor	63(19.8%)	3(13%)
	Nurse	146(45.9%)	10(43.5%)
	Other	109(34.3%)	10(43.5%)
Years of experience	0-5yr	210(66%)	8(34.8%)
	6-10yr	59(18.6%)	6(26.1%)
	11-15yr	31(9.7%)	9(39.1%)
	16-20yr	16(5%)	0(0.0%)
	>20yr	2(0.6%)	0(0.0%)

As can be seen in the above table 2: the vast majority of respondents at St. Pauli's Millennium Medical College Hospital were men (56.9%, n = 181), followed by women (43.1%, n = 137). In contrast, in Gurum Hospital, there are 52.29%, n = 12, more women than men (47.8%, n = 11).
the respondents (23.6%, n = 75) are between the ages of 18 and 25, (63.2%, n = 201) are between the ages of 26 and 35, (12.3%, n = 39) are between the ages of 36 and 46, and the remaining respondents (o.6%, n = 2) and (0.3%, n = 1) are, respectively, between the ages of 47 and 55 and over 56 at St. Pauli's Millennium Medical College Hospital. Comparably, among the respondents at Girum Hospital, 23.2% (n = 4) are between the ages of 18 and 25, 43.5% (n = 10) are between the ages of 26 and 35, 8.7% (n = 2) are between the ages of 36 and 46, and the remaining 30.4% (n = 7) are between the ages of 47 and 55. At St. Paul's Millennium Medical College Hospital, responders who are under age 40 make up the majority (n = 276; 86.8%). Compared to the 76.7% of the same age group in relative comparison at Girum Hospital (n = 14), this age group is more open to change and will likely embrace reform with less opposition, therefore the hospital has a fantastic future opportunity to implement new best practices as of supportive evidence according to (Arora ,2015).
At St. Paul's Millennium Medical College Hospital, 8.2% (n = 26) have an MA or M.Sc., and 0.6% (n = 2) have a PhD. Girum Hospital has 4.3% (n = 1) MA/MSc holders. It is apparent that respondents had a higher educational level at St. Pauli's Millennium Medical College Hospital, particularly at the MA/MSc and PhD levels. The respondents' years of experience at St. Paul's Millennium Medical College Hospital ranged between 11 and 15 (9.7%, n = 31). The majority (39.1%, n = 9) of respondents in the private hospital (Girum) have hired more experienced workers, especially those with 11 to 15 years of expertise. As seen by the respondent's response assessment results, the private hospital (Girum) performs better solid waste management practices than the St. Paul hospital, despite having more educated workers. This could be due to ignorance, as the hospital is government-run, or a lack of sufficient follow-up. Hiring more experienced and female personnel, as well as being run privately, i.e., with ownership, may give the Girum Hospital some opportunity to improve waste management practices in relative terms. This is because private hospitals are clearly business-oriented, resulting in tight follow-up procedures that provide better practices for healthcare professionals as this finding was in do agree with the study finding by Assamu et al. (2020) at Bahir dar,Ethiopia.

4.1.1. General Information from Respondents Regarding the Study Hospitals;

The general information, provided by the respondents about the study hospitals, solid waste storage facilities, the availability of safety supplies and staff training , the existence or absence of hospital solid waste management (guidelines, manuals, directives, plan), and staff delegation as waste management committee members, sanitary engineers, regulatory bodies, and/or other relevant parties functionalities are evaluated in this section.

Table 3: About Study Hospital Facilities

		Response	St.Paul's Hospital	Girum Hospital	Total
1	Availability of Room for storage	Yes	211(66.4%)	17(73.9%)	228(66.9%)
		No	107(33.6%)	6(26.1%)	113(33.1%)
2	Location of the room Easy accessible & away from public	Yes	173(54.4%)	17(73.9%)	190(55.7%)
		No	145(45.6%)	6(26.1%)	151(44.3%)
3	Is the room easily cleanable, properly lighted & Proper ventilation	Yes	149(46.9%)	16(69.6%)	165(48.4%)
		No	169(53.1%)	7(30.4%)	176(51.6%)
4	Lockable/secured storage room	Yes	140(44.0%)	14(60.9%)	154(45.2%)
		No	178(56.0%)	9(39.1%)	187(54.8%)
5	Waste storage room has separate class for hazardous wastes?	Yes	136(42.8%)	13(56.5%)	149(43.7%)
		No	182(57.2%)	10(43.5%)	192(56.3%)
6	Allocation of adequate waste management utilities (PPE kits: boots, gloves, masks, goggles, glasses, and gowns)?	Yes	154(48.4%)	16(69.6%)	170(49.9%)
		No	164(51.6%)	7(30.4%)	171(50.1%)
7	Presence of healthcare waste management Guidelines/directives?	Yes	233(73.3%)	15(65.2%)	248(72.7%)
		No	85(26.7%)	8(34.8%)	93(27.3%)
8	Presence of waste management committee or delegated staffs?	Yes	204(64.2%)	10(43.5%)	214(62.8%)
		No	114(35.8%)	13(56.5%)	127(37.2%)

9	Availability of Health care waste management plan?	Yes	164(51.6%)	19(82.6%)	183(53.7%)
		No	154(48.4%)	4(17.4%)	158(46.3%)
10	Staff training documentation	Yes	171(53.8%)	15(65.2%)	186(54.5%)
		No	147(46.2%)	8(34.8%)	155(45.5%)
11	Are Staffs trained on waste management methods?	Yes	110(34.6%)	18(78.3%)	128(37.5%)
		No	208(65.4%)	5(21.7%)	213(62.5%)
12	Recording and reporting system	Yes	171(53.8%)	17(73.9%)	188(55.1%)
		No	147(46.2%)	6(26.1%)	153(44.9%)
13	Is there fulltime assigned staff for HCW management?	Yes	166(52.2%)	15(65.2%)	181(53.1%)
		No	152(47.8%)	8(34.8%)	160(46.9%)
14	Inspection by the regulatory bodies to the $HSWM_S$?	Yes	173(54.4%)	17(73.9%)	190(55.7%)
		No	145(45.6%)	6(26.1%)	151(44.3%)
15	Budget allocation to the $HSWM_S$?	Yes	109(34.3%)	16(69.6%)	125(36.7%)
		No	209(65.7%)	7(30.4%)	216(63.3%)
16	Sanitary engineer	Yes	105(33.0%)	11(47.8%)	116(34.0%)
		No	213(67.0%)	12(52.2%)	225(66.0%)
	Delegate Waste handlers	Yes	257(80.8%)	21(91.3%)	278(81.5%)
		No	61(19.2%)	2(8.7%)	63(18.5%)

Table 3: displays the participants' responses to questionnaires 1, 2, 3, 4, and 5 concerning the solid hospital waste storage facilities at St. Pauli's Millennium Medical College Hospital; the Yes responses are (50.88%, n = 161.8) and the No answers are (49.22%, n = 156.2), nearly equaling the percentage of Yes or No responses. Unlike at the Girum Hospital, the majority of respondents (66.96%, n = 15.4) gave a yes response, whereas 33.04% of respondents (n = 7.6) gave a no response. This finding shows the solid hospital waste storage facilities are in a better position in Girum Hospital when compared with St. Pauli's Millennium Medical College Hospital.

Table 3: shows that, when asked in questionnaires 6, 10, and 11, if the study hospitals provided safety supplies and staff training, 45.59% (n = 145) of the respondents said "yes," and slightly more than half (54.59%, n = 173) of the respondents at St. Pauli's Millennium Medical College Hospital said "no." In contrast, at Girum Hospital, 42.03% of respondents (n = 9.67) gave a no

response, while over half (57.97%, n = 13.33) gave a yes response. This demonstrates that St. Paul's Millennium Medical College Hospital is not as well equipped for employee safety materials and training provisions as Girum Hospital.

Respondents were asked, in order to examine the functionalities of the study hospitals, if hospital solid waste management (guidelines, manuals, directives, plans, and staff delegation as waste management committee members, sanitary engineers, regulatory bodies, delegated waste handlers, and/or other relevant parties) existed or not. Table (3) questionnaires, 7, 8, 9, 12, 13, 14, 15, 16, and 17 numbers show that, of the respondents, approximately half (52.08 percent, n = 165.625) answered "yes," while 47.92 percent (n = 152.375) at St. Pauli's Millennium Medical College Hospital provided a no response. In contrast, 34.78% of respondents (n = 8) at Girum Hospital said "no," whereas the majority (65.22% of respondents, n = 15) said "yes." The response data indicates that St. Pauli's Millennium Medical College Hospital (the hospital under government administration) is lacking the good services listed in the questions stated above in comparison to Girum Hospital, a private facility.

4.1.2. General Information from Respondents Regarding the Study Hospitals Solid Waste, Segregation, Collection, Transport, and Disposal Practices

The general information provided by the respondents about the study hospitals, solid hospital waste segregation, and collection, transport, and disposal practices is evaluated in this section.

Table 4: the Study Hospitals Solid Waste Segregation practices

		Response	St.Paul's Hospital	Girum Hospital	Total
1	Bins for medical waste are located appropriately in the unit	Never	31(9.7%)	2(8.7%)	33(9.7%)
		Rarely	60(18.9%)	9(39.1%)	69(20.2%)
		Sometimes	107(33.6%)	5(21.7%)	112(32.8%)
		Often	68(21.4%)	5(21.7%)	73(21.4%)
		Always	52(16.4%)	2(8.7%)	54(15.8%)
2	Are all hazardous waste containers kept closed except when filling or adding waste	Never	2(0.6%)	1(4.3%)	3(0.9%)
		Rarely	11(3.5%)	0(0.0%)	11(3.2%)
		Sometimes	82(25.8%)	4(17.4%)	86(25.2%)
		Often	128(40.3%)	4(17.4%)	132(38.7%)

		Always	95(29.9%)	14(60.9%)	109(32.0%)
3	Proper labeling of sources and categories of wastes?	Yes	177(55.7%)	18(78.3%)	195(57.2%)
		No	141(44.3%)	5(21.7%)	146(42.8%)
4	Are visual aids or instructions present near The waste receptacles to help in proper segregation?	Yes	188(59.1%)	11(47.8%)	199(58.4%)
		No	130(40.9%)	12(52.2%)	142(41.6%)
5	3 Bin system in place	Yes	239((75.2%)	18(78.3%)	257(75.4%)
		No	79(24.8%)	5(21.7%)	84(24.6%)
6	Proper labeling of sources and categories of wastes?	Yes	177(55.7%)	18(78.3%)	195(57.2%)
		No	141(44.3%)	5(21.7%)	146(42.8%)

Table 4: presents the answers provided by the participants to questions 1, 2, 3, 4, 5, and 6 about the hospitals' solid waste segregation practices. 5.185%, or 16.5, responded Never, 35.5 (11.17%) respond rarely, 94.5 (29.71%) respond Sometimes, 98 (30.82%) said "often," while 73.5 (23.11%) said "always." When asked a Yes or No question, 195.25 (61.39%) respondents said "yes," and 122.75 (38.60%) said "no." at St. Pauli's Millennium Medical College Hospital. We were at Girum Hospital. 1.5 (6.52%) answered Never, 4.5 (19.5%) answered rarely, 4.5 (19.5%) answered some times, 4.5 (19.5%) answered Often, and 8 (34.8%) answered Always &regarding to Yes or No questions. 16.25 (70.65%) answered yes, and 16.75 %) answered no. By comparing the participants' observations about the solid hospitals' waste segregation practices, the average percentage of "Often + Always" responses is (26.95%) and "61.39%) Yes responses at St. Pauli's Millennium Medical College Hospital, whereas the average percentages of Often + Always are (27.17%) and (70.65%), respectively, in Girum m Hospital. The examination of the Girum hospital's answer indicates that, in comparison to St. Pauli's government hospital, the private Girum hospital has superior waste segregation practices. To acquire their views on solid hospital waste management methods, the key interviewer interviewed 20 key informants from both study hospitals the following were the highlights of the responses to the HSWM in the study facilities; were extremely inadequate, primarily because no one was aware of the extent of the problem caused by this mismanagement; there were passive regulatory bodies that dealt with HSWM practices; the concerned bodies were not committed to

fulfilling their share of the responsibility; and the HSWM practices were resource-poor and relied on outdated technologies.

Table 5: the Study Hospitals Solid Waste Collection practices

		Response	St.Paul's Hospital	Girum Hospital	Total
1	Use of personal protective equipment: gloves, boots, masks &caps all times while handling HCW_s?	Never	25(7.9%)	3(13.0%)	28(8.2%)
		Rarely	8(2.5%)	1(4.3%)	9(2.6%)
		Sometimes	123(38.7%)	4(17.4%)	127(37.2%)
		Often	91(28.6%)	8(34.8%)	29(29.0%)
		Always	71(22.3%)	7(30.4%)	78(22.9%)
2	Health workers are strictly ensuring that waste is collected on time	Never	2(0.6%)	0(0.0%)	2(0.6%)
		Rarely	14(4.4%)	1(4.3%)	15(4.4%)
		Sometimes	59(18.6%)	6(26.1%)	65(19.1%)
		Often	130(40.9%)	4(17.4%)	134(39.3%)
		Always	113(35.5%)	12(52.2%)	125(36.7%)
3	Are the containers marked with the Accumulations start date?	Yes	173(54.4%)	11(47.8%)	184(54.0%)
		No	145(45.6%)	12(52.2%)	157(46.0%)
4	Timely collection of waste containers	Yes	207(65.1%)	20(87.0%)	227(66.6%)
		No	111(34.9%)	3(13.0%)	114(33.4%)
5	Replacement of waste bins before $3/4^{th}$ is Filled?	Yes	173(54.4%)	6(26.1%)	179(52.5%)
		No	167(52.5%)	7(30.4%)	174(51.0%)

Table 5 lists the responses given by the participants to questions 1, 2, 3, 4, and 5.13.5 (4.24%). Never, 12 (3.77%) answered rarely, 91(28.62%) answered some times, 110.5 (34.74%) answered often, and 92 (28.93%) provided always responses. Regarding yes or no questions, 184.33 (57.96%) answered yes, while 141 (44.34%) replied no answers at St. Pauli's Millennium Medical College Hospital. But in Girum Hospital, 3 (13.04%) answered never, 1 (4.34%) answered rarely, and 5 (21.73%) answered some times, 6 (26.08%) answered often, and 9.5 (41.30%) provided always responses. Regarding yes or no questions, 12.33 (53.61%) answered yes, while 7.33 (31.87%) replied no. The average percentage of "Often + Always" responses is

(31.83%) and "57.96% Yes response, respectively, at St. Pauli's Millennium Medical College Hospital, while the average percentage of Often + Always responses is (33.69%) and (53.61%), respectively, at Girum Hospital, given a comparison of the participants' observations about the solid hospitals' waste collection practices. Examining the Girum hospital's response reveals that the private Girum hospital has a little less efficient waste collection system than St. Pauli's government hospital.

At St. Paul's, janitors/waste handlers manually separated water, plastic bottles, office paper, and cartons at interim storage facilities (where hazardous and routine hospital waste were totally mixed), which was taught as an income generator by selling to someone else without treatment. Most hospital wards only had black and yellow trash, so it was unexpected to discover only one red waste can. However, in the institutions under review, 3-bin systems were rarely placed near waste-generating sources; these observations were also consistent with previous research conducted by Abebe (2017) and Yazie (2019), in which used chemical containers in healthcare facilities were sorted, collected, and sold to individuals for reuse.

Table 6: the Study Hospitals Solid Waste Transport practices

		Response	St.Paul's Hospital	Gurum Hospital	Total
1	The filled bags were closed tightly before Transferred?	Yes	173(54.4%)	6(26.1%)	179(52.5%)
		No	51(16.0%)	13(56.5%)	64(18.8%)
		I don't Know	94(29.6%)	4(17.4%)	98(28.7%)
2	Availability of different transporting materials for different waste categories?	Yes	129(40.6%)	16(69.6%)	145(42.5%)
		No	189(59.4%)	7(30.4%)	196(57.5%)
3	Availability of appropriate Trolley/cart/wheel barrow?	Yes	145(45.6%)	18(78.3%)	163(47.8%)
		No	173(54.4%)	5(21.7%)	178(52.2%)
4	Vessel used for the transport of a sharp waste was perforated?	Yes	138(43.4%)	14(60.9%)	152(44.6%)
		No	180(56.6%)	9(39.1%)	189(55.4%)

Table 6 displays the replies supplied by participants to questions 1, 2, 3, and 4. At St. Pauli's Millennium Medical College Hospital, 146.25 (45.99%) said yes, 148.5 (46.62%) said no, and 23.5 (7.39%) said I don't know, whereas at Girum Hospital, 13.5 (58.69%) said yes, 8.5 (56.95%) said no, and 1 (4.34%) said I don't know. According to participant responses, St. Pauli's (a government-run hospital) is not as well-equipped as Girum (a privately owned hospital) for the safe transportation of solid hospital waste. In complete violation of the 3/4th fill limit, sharp waste was discovered loaded in St. Paul's hospital, with needles even placed on the top mouth of the sharp container. Hospitals use similar solid waste collection procedures to the observational analysis conducted by Diaz et al. (2005), which confirmed that most waste management tasks are performed by unskilled workers without proper safety precautions or supervision.

Table 7: the Study Hospitals Solid Waste Disposal Practices

		Response	St. Paul's Hospital	Girum Hospital	Total
1	Are sharps containers reusable?	Yes	136(42.8%)	5(21.7%)	141(41.3%)
		No	182(57.8%)	18(78.3%)	200(58.7%)
2	Properly built incinerator	Yes	151(47.5%)	17(73.9%)	168(49.3%)
		No	167(52.5%)	6(26.1%)	173(50.7%)
3	Are patient kits (bedpans, water jug, etc?) Reusable?	Yes	187(58.8%)	17(73.9%)	204(59.8%)
		No	131(41.2%)	6(26.1%)	137(40.2%)
4	Proper disposal of infectious and non- infectious waste	Yes	239(75.2%)	20(87.0%)	259(76.0%)
		No	79(24.8%)	3(13.0%)	82(24.0%)
5	Availability of placenta pit	Yes	170(53.5%)	17(73.9%)	187(54.8%)
		No	148(46.5%)	6(26.1%)	154(45.2%)
6	Condition of incinerator (functional, distance)	Yes	156(49.1%)	17(73.9%)	173(50.7%)
		No	162(50.9%)	6(26.1%)	168(49.3%)
7	Protected sanitary landfill	Yes	186(58.5%)	8(34.8%)	194(56.9%)
		No	132(41.5%)	15(65.2%)	147(43.1%)

Table 7 shows the responses that participants provided to questions 1, 2, 3, 4, 5, 6, and 7 about the solid waste disposal procedures that hospitals use. When it came to questionnaires 1 and 3 at

St. Pauli's Millennium Medical College Hospital, 161.5 (50.78%) respondents said yes, while 156.5 (49.21%) said no. At the Girum Hospital, however, 12 (52.17%) respondents said no, while 11 (47.82%) answered yes. Girum Hospital's No response (52.17%) is higher than St. Pauli's Hospital's response (49.21%), despite the fact that the No responses from both hospitals are comparable. This suggests that Girum Hospital uses comparatively fewer materials for repurposing the stated materials, which may probably infect one, than does St. Pauli's Millennium Medical College Hospital. With regard to the remaining questionnaires, 2, 4.5.6, and 7 in Table 7 yielded 180.4 (56.73%) yes responses, whereas 138 (43.39%) No responses were obtained at St. Pauli's Millennium Medical College Hospital. At Girum Hospital, on the other hand, 15.8 (68.69%) answered "yes," and the remaining 7.2 (31.30%) said "no." The privately owned Girum Hospital has relatively better solid waste disposal procedures than the government-owned St. Pauli's Millennium Medical College Hospital, according to this participant's response (68.69%), as compared to the latter's (56.73%) Yes answer response.

Hazardous waste was observed being transported by waste workers at the study hospitals by hand or on their shoulders rather than via trolley. The placenta pit wells at St. Paul's Hospital were discovered to be open, unlined, and dug; waste was collected and deposited in the hospital's easily accessible temporary storage facility. All of Girum Hospital's waste was gathered and burned in a faulty incinerator near the wards, where hazardous chimney gas can endanger personnel and patients. Waste mishandling is harmful to both people and the environment. This observational finding is similar to the situation described in the Ethiopian study, in which appropriate waste treatment was inadequate, potentially posing health hazards because certain cleaners were discovered to mishandle waste based on its category (Sisay et al., 2017).

4.1.3. The Knowledge and Practices Parts of the Respondents Information Assessments'

The information provided here to the respondents is aimed at analyzing the participants' own practices and knowledge relating to hospital solid waste management as asked in subsequent questionnaires'. The knowledge and practices of the participants regarding certain questionnaires' posed below in Table 8 are evaluated in this section.

Table 8: Knowledge and Practices of the Study Participants

	Question	Response	St. Paul's Hospital	Girum Hospital	Total
1	Waste management is one of the core standards of health care	Strongly agree	243(76.4%)	11(47.8%)	254(74.5%)
		Agree	63(19.8%)	10(43.5%)	73(21.4%)
		Neutral	3(0.9%)	2(8.7%)	5(1.5%)
		Disagree	4(1.3%)	0(0.0%)	4(1.2%)
		Strongly disagree	5(1.6%)	0(0.0%)	5(1.5%)
2	Medical waste is highly hazardous than municipal waste and therefore requires separate treatment	Strongly agree	211(66.4%)	14(60.9%)	225(66.0%)
		Agree	93(29.2%)	6(26.1%)	99(29.0%)
		Neutral	9(2.8%)	2(8.7%)	11(3.2%)
		Disagree	3(0.9%)	1(4.3%)	4(1.2%)
		Strongly disagree	2(0.6%)	0(0.0%)	2(0.6%)
3	Color-coded bins is part of waste management strategy to separate waste	Strongly agree	225(70.8%)	19(82.6%)	244(71.6%)
		Agree	72(22.6%)	3(13.0%)	75(22.0%)
		Neutral	19(6.0%)	1(4.3%)	20(5.9%)
		Disagree	1(0.3%)	0(0.0%)	1(0.3%)
		Strongly disagree	1(0.3%)	0(0.0%)	1(0.3%)
4	Segregation, collection, transport, treatment and disposal are the key steps in waste management	Strongly agree	186(58.5%)	17(73.9%)	203(59.5%)
		Agree	96(30.2%)	5(21.7%)	101(29.6%)
		Neutral	27(8.5%)	1(4.3%)	28(8.2%)
		Disagree	4(1.3%)	0(0.0%)	4(1.2%)
		Strongly disagree	5(1.6%)	0(0.0%)	5(1.5%)
5	Healthcare waste management guidelines are	Never	57(17.9%)	0(0.0%)	57(16.7%)
		Rarely	42(13.2%)	1(4.3%)	43(12.6%)

	Followed	Sometimes	51(16.0%)	5(21.7%)	56(16.4%)
		Often	127(39.9%)	13(56.5%)	140(41.1%)
		Always	41(12.9%)	4(17.4%)	45(13.2%)
6	Do you treat hazardous HCW differently from General waste?	Yes	131(41.19%)	14(60.86%)	175(42.52%)
		No	84(26.41%)	4(17.4%)	58(25.81%)
		I don't know	103(32.4%)	5(21.74%)	108(31.67%)
7	Do you segregate waste at the point of Generation?	Yes	184(57.9%)	14(60.9%)	198(58.1%)
		No	56(17.6%)	4(17.4%)	60(17.6%)
		Sometimes	78(24.5%)	5(21.7%)	83(24.3%)
8	Use of personal protective equipment at all times while handling wastes?	Yes	228(71.7%)	18(78.3%)	246(72.1%)
		No	90(28.3%)	5(21.7%)	95(27.9%)

Table 8 displays participants' replies to questions 5, 6, 7, and 8 regarding their own hospital solid waste management practices: 57 (17.92%) responded never, 42 (13.21%) rarely, 51 (16.03%) sometimes, 127 (39.93%) often, and 41 (12.89%) always at St. Pauli's Millennium Medical College Hospital. Whereas in Girum Hospital, 0 (0%) never responded, 1 (4.34%) rarely responded, 5 (21.73%) sometimes responded, 13 (56.52%) often responded, and 4 (17.39%) always responded. The responses indicate that Girum Hospital participants adhere more closely to solid waste management guidelines than those at St. Pauli's Millennium Medical College Hospital. Furthermore, according to table 8, questions 6, 7, and 8 analyzed participants' waste management practices: in St. Pauli's Millennium Medical College Hospital, 181 (56.92%) responded yes, 76.66 (23.88%) said no, 24.53 (7.71%) said sometimes and 32.38 (10.8%) said I didn't know. However, in Girum Hospital, 1.66 (7.217%) answered sometimes, 1.25 (5.43%) answered I don't know, 15.33 (66.66%) said yes, and 4.33 (18.82%) said no. Participants at Girum Hospital reported better waste management practices (66.66%) compared to St. Paul's (56.29%), aligning with the study by Assamu et al. (2020), in which healthcare professionals in Bahir Dar, Ethiopia, showed better waste management in private hospitals (79.2%) compared to public hospitals (53.5%).

As an alternative, table 8 presents the participant's responses to questions 1, 2, 3, and 4, which can be utilized to assess the participants' individual knowledge of hospital solid waste

management. 216.25 (68.003%) strongly agreed, 81 (25.47%) agreed, 38.5 (12.07%) disagreed, and 3 (1.02%) strongly disagreed at St. Paul's Millennium Medical College Hospital. While 6 (26.08%) agree, 1.5 (6.52%) are neutral, 0.25 (1.087%) disagree, and 0 (0) strongly disagree, 15.25 (66.304%) of Girum Hospital respondents strongly agree; a comparable knowledge level among the two groups was the response result assessments. These study findings were supported by the study done at Bahirdar, Ethiopia, as expressed by Assamu et al. (2020): ‘‘Hospital ownership and healthcare management systems are linked, with private hospitals employing superior waste management practices than public hospitals. This is because of their business-oriented strategy and stringent follow-up programs, which provide a better experience for healthcare professionals in private hospitals with good KAP’’.

4.2. The Practice of Hospital Healthcare Waste Management Systems

By deducing from the tables, observational analyses, and data presented under the aforementioned sub-sections 4, 1.1, 4.1.2, and 4.1.3 illustrated above, the practice of hospital healthcare waste management systems is explained in this section. Safe waste management practices for all waste-related duties, such as creation, segregation, collection, transportation, storage, treatment, and disposal, are essential to the quality of services provided by healthcare facilities (HCFs) (Sahiledengle, 2019). Segregating solid health care waste at the site of generation is the most important waste management strategy (Akulume and Kiwanuka, 2016). Based on the study participants' response data assessments, the private hospital in Girrum was found to have better performance in all areas of health care waste management practices; this was in addition to the practices directly performed by the study participants at Girrum hospital in relation to the questionnaire than the St. Paul’s Millennium Medical College (the government-run hospital) did. This comparison was made purely for the purpose of observing the impact of ownership on health care waste management practices, even though the researcher was unable to locate any other studies that were based solely on the opinions of study participants (those who completed the questionnaire) regarding the assessment results of waste segregation, collection, transportation, and disposal practices. In other ways, the research findings (from both studied hospitals) suggested that there was no proper healthcare waste segregation practice using color-coded containers. This finding is consistent with research conducted in poor countries, which has revealed a lack of suitable standard implementation and segregation procedures (Abd El-Salam, 2010 ;Fadipe *et al.,* 2011; Udefia, 2015; Gitonga, 2017; Yazie *et al.,* 2019). As a result, there

may be a greater amount of infectious waste, which has the potential to convert regular waste into hazardous waste (Gupta and Boojh, 2006), which explains why the hazardous hospital solid waste generation rates by the studied hospitals were 58.05 percent and 61.25 percent, respectively. Separating waste types into color-coded containers with liners as they are created is crucial for proper management of hazardous waste (HCW) (Akulume and Kiwanuka, 2016; Datta *et al.*, 2018).

4.4.2. General Information Regarding Hospital Solid Waste Management at the Study Hospitals from key informant interviews where 15 participants were from St. Paul's Hospital and 5 were from Girum Hospital.

The instructions are to respond to an interview by saying"Yes"or "No"; but to narrate the issues in response to question number five

1. Is there an appropriate harmony between the incinerator functionality and distance conditions and the safety of hospital workers, patients, adjacent communities, and the environment?
2. The placenta pits were placed and maintained in the appropriate location and conditions?
3. Are hospital solid wastes are separated or segregated based on their waste types at their point of generation?
4. Everyone is taught to use personal protective equipment such as gloves, boots, masks, and caps when handling (health care wastes) HCWs?
5. What are the challenges encountered during healthcare waste management practice in the Healthcarefacility----------

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Regarding HCSWM brought up in an interview, 26.66% of the overall respondents (n = 4) Answered "yes"; while the majority (73.44%, n = 11) at St. Millennium Medical College answered "no". In contrast, 55% of respondents at Girum Hospital (n=2.75) responded (No) unfavorably while 45% of respondents (n=2.25) said yes. The key informant opinions of the Study facilities' HCSWM practices reveal that both hospitals have unsatisfactory HCSWM Practices, with the St. Millennium Medical College facility being more hazardous and worry. Lastly the interviewee was asked to list the challenges the study hospitals face with HCSWM Practices. The following were the highlights of the responses to question number five: 1. The HCSWM practices were extremely inadequate, primarily because no one was aware of the extent

of the problem caused by this mismanagement; 2. There were passive regulatory bodies that dealt with HCSWM practices; 3. The concerned bodies were not committed to fulfilling their Share of the responsibility; and 4. The HCSWM practices were resource-poor and relied on Outdated technologies.

4.4.3. Respondents Knowledge Regarding the Segregation, Collection, Transportation, and Disposals Hospital Solid Waste Management's.

The instructions are to respond to an interview by saying Correct or Incorrect

1. Both infectious/medical waste and general waste cannot be handled and disposed of together.
2 .when collection, the container or bag should be not filled to more than 3/4th capacity with Infectious or medical waste.
3. The containers or bags used for infectious or medical waste should be clearly labeled with the Sources and categories of waste.
4. The transportation of solid hospital waste necessitates a different type vehicle for different waste categories.

4.4.4. Respondents Attitude Regarding the Segregation, Collection, Transportation, and Disposals Hospital Solid Waste Management's.

The instructions are to respond to an interview by saying "Agree", "Undecided" and "Disagree"

1. The allocation of adequate budget for HSWM is considered equally important as other budget Allocations for core activities.
2. Labeling sources and segregating hospital solid wastes into categories is necessary and is more efficient and sufficient for waste management.
3. The issue of Health Care Waste Management (HCWM) is not necessarily all up to healthcare Professionals.
4The presence of visual aids or instructions near waste receptacles is considered necessary for proper segregation.

4.4.5. Respondents Practices Regarding the Segregation, Collection, Transportation, and Disposals Hospital Solid Waste Management's.

The instructions are to respond to an interview by saying "Always," "Sometimes", and "Never"

1. How often you assure allocation of adequate waste management utilities (PPE kits: boots, gloves, masks, goggles, glasses, and gowns) in your hospital
2. How frequently you watch over that waste handlers' are strictly ensuring that waste is collected on time?
3. How much are the events of your involvement in HCWM matters necessitates your participation?
4. How often you are supervising healthcare waste management guidelines and their compliance by waste handlers and health workers within the facility?

According to the results of the knowledge, attitude, and practices tests mentioned above, there were 70% correct answers (high) (n = 10.5) and 30% incorrect respondents (low) (n = 4.5) at St. Paul's Millennium Medical College. In the Girum Hospital, on the other hand, (65%, n=3.5) responded correctly (high), whereas (35%, n=1.5) provided an incorrect response(low).Regarding other aspects, St. Paul's Millennium Medical College respondents (95%, n=14.25) have positive whereas (5%, n=0.5) have negative responses. At Girum Hospital, the same manner that respondents (95%, n=4.75) had a positive outlook and the res (5%, n=0.25) had negative reactions. At the end, participants (65%,n = 9.75) responded good and (35% n = 5.25) poor ,at St. Pauli's Millennium Medical College. Whereas at Girum Hospital, however, (80%, n= 4) responded good, whereas (20%, n = 1) responded poor at Girum hospital. As can be seen from the results the scores for KAP are equivalent for both of the study hospitals with KAP Values. From the assessment results of the key informant respondents response Ward chiefs, medical directors, and department heads all have high KAP scores; however, "hospital administrators have a medium, and waste handlers have a low." The KAP scores of the private hospital outperformed that of the government.

4.3. Waste Generation and Characterization

As illustrated below in Tables 9, 10, 11, and 13, the total weight of hospital solid waste (HSW) produced at St. Pauli's Millennium Medical College Hospital, the Government Hospital (GH),

was 882.30±49.54 kg/day or 1,757(1.6 kgbed–1day–1 &0.157 Kg/out patint/day), of which 61.25% was hazardous waste (HW) and the remaining 38.75% was general waste; this outcome strongly concurs with the Hawassa, Ethiopia study's conclusion that waste generation rates are 1.793 kg/bed/day (Fanta and Fitamo, 2023). At Girum Hospital, the Private Hospital (PH), there were 124.81±65.24 kg/day or 2.12 (1.8 kg bed–1day–1 and 0.32 kg/out patient/day), of which 57.05% were classified as hazardous waste (HW) and the remaining 42.795% as general waste. This study's findings about hospital solid waste generation rates are similar to those of Tesfahun (2015), who found that government-run hospitals generated 0.78 kg less total and hazardous waste (kg/bed/day) than private hospitals, which produced 2.32 kg/bed/daily, and the hazardous waste percentages are predicted to be quite high (61.04%) due to present malpractices in hospital waste management; segregation alone can reduce these percentages by 17%, according to the study done in the Amhara region of Ethiopia. Additionally, this study's findings were consistent with those from Kenya, where a lack of proper waste segregation was seen in the prevalence of infectious waste over general waste (GEF, 2009). Furthermore, research conducted at Amana District Hospital in Tanzania discovered that the average medical waste generation rate was 1.8 kg/patient/day (Kagonji and Manyele), and Eker and Bilgili (2011) conducted a study in Istanbul, Turkey, to estimate the healthcare waste generation rate, which was discovered to be 2.11 to 3.83 kg/bed/day, which was nearly equal to this finding. Healthcare service types and levels, hospital specializations, geographic location (rural vs. urban), present waste management practices, and the proportion of reusable items used in healthcare facilities are all factors that affect variations in waste generation (WHO, 2014; Bdour *et al.,* 2007; Elom *et al.,* 2013). Comparably, the results of the study hospitals' hazardous waste (HW) generation rates of 61.25% and 57.05% are in line with a study conducted by Yazie *et al.* (2019), which noted that inadequate waste segregation, loose regulatory enforcement, and a lack of knowledge among medical personnel are the main reasons why hazardous waste is generated at unacceptable rates in Ethiopian healthcare facilities (21% to 70%). Furthermore, it was observed that the bulk of the solid hospital waste created under study was recyclable plastic. If these hospitals had modern waste treatment technology, the generated plastic debris would have been an opportunity; instead, these hospitals are currently dependent on old systems, which put plastic waste generation at risk.

Table 9: Distribution of healthcare solid waste generation rates by point source and type at St. Paul's Millennium Medical College Hospital

Ward	GW (kg/Week)	HW (Kg/week)			Total HCSW (Kg/week)	Total HCSW %	Total HCSW (Kg/day)
		IW (Kg/Week)	PhW (Kg/Week)	SW* (Kg/Week)			
Emergency	282.1	459.48	122.528	30.63	894.738	14.48	127.8
OPD	593.5	242	153.26	8.06	996.82	16.16	142.4
Laboratory	164	247.179	132.59	34.19	477.959	7.74	68.28
Pediatrics	245.65	381.15	101.64	25.41	753.85	12.21	107.69
Surgical	285.45	452.63	69.63	58.03	865.71	14.01	123.67
Medical	469.4	632.26	164.93	23.73	1290.32	20.89	184.33
Obstetrics/Gyn Total	352.8	462.31	54.39	27.19	896.69	14.52	128.09
Kg/week	2392.97	2877.009	698.968	207.24	6176.187	100	882.26
Mean Kg/day Standard Deviation	341.84±49.54	411.00±49.54	114.14±49.54	29.61±49.54	882.30±49.54		126.04±49.54

GW=General waste; HW=Hazardous Waste; IW = Infectious Waste; PhW: Pharmaceutical Waste; SW*: Sharp Waste; *Includes Needles, Blades, Lancet Needles, Syringes, and Scalpel Blades; Total HCSW=Total Health Care Solid Waste

St. Paul's Millennium Medical College (a government hospital) generated 882.30±49.54±Standard kg/day of solid hospital waste. Of this, 341.84±49.54 mean standard kg/day was general waste (GW), with the majority being 554.75±49.54 average mean standard kg/day. 61.25% was hazardous waste (HW), with 411.00±49.54 mean standard kg/day, 46.58% was infectious waste (IW), 114.14±49.54 mean standard kg/day, 11.32% was pharmaceutical waste (PhW), and 29.61±49.54 average mean standard kg/day, 3.36% was sharp waste (SW*).

Table 10: Distribution and healthcare solid waste generation rates by point source and type

Ward	GW (Kg/Week)	HW (Kg/week)			Total HCSW (Kg/Week)
		IW (Kg/Week)	PhW (Kg/Week)	SW* (Kg/Week)	
Emergency	42	145.04	14.49	21.77	223.3
OPD	196	1.939	9.695	1.295	208.929
Laboratory	21	51.8	3.22	9.709	85.81
Pediatrics	28	54.04	14.42	3.57	100.03
Surgical	14	35.28	2.24	6.65	58.17
Medical	21	78.4	14.7	4.9	119
Obstetrics/Gyn	15.4	53.55	7.56	1.89	78.4
Total Kg/week	337.4	420.049	66.325	49.784	939.88
Mean Kg/day±Standard Deviation	48.20±65.85	60.00±44.15	9.48±5.36	7.11±7.08	124.81±65.24
%Wt .by type	42.95	44.69	7.06	5.3	100

GW=General waste; HW=Hazardous Waste; IW = Infectious Waste; PhW: Pharmaceutical Waste; SW*: Sharp Waste; *Includes Needles, Blades, Lancet Needles, Syringes, and Scalpel Blades; Total HCSW=Total Health Care Solid Waste

According to Table 10, general waste (GW) made up 42.95% of the 124.81±65.24 average mean standard kg/day of solid hospital waste generated at Girum (private hospital), with the majority being 76.591±49.54 average mean standard kg/day. Of the 57.05% that were classified as hazardous waste (HW), 60.00±44.15 mean standard kg/day, 44.69% were classified as infectious waste (IW), 9.48±5.36 mean standard kg/day, 7.06% were classified as pharmaceutical waste (PhW), and 5.3% were classified as sharp waste (SW*).

Table 11: Comparison of healthcare waste generation rates and categories of HCW using the Kruskal-Wallis test

Type of Hospital	Mean Rank		
	Total HCSW*Kg/day	GW**Kg/day	HW***Kg/day
Government	882.3	341.84	554.75
Private	124.81	48.2	76.59
P- Value	0.000	0.000	0.000

From Table 11, when comparing the P-value of healthcare waste generation rates and categories of HCW using the Kruskal-Wallis test among the surveyed hospitals, which is 0.000<0.05, the result shows the waste generation rates within categories of HCW significantly varied between the hospitals.

Table 12:The Mean Generation Rate of Healthcare Solid Waste categories by Departments within the Government and Private Hospitals using the Kruskal-Wallis Test

Ward	Type of Hospital					
	Government			Private		
	GW (Kg/day)	HW (Kg/day)	THCSW (Kg/day)	GW (Kg/day)	HW (Kg/day)	THCsW(Kg/day)
Emergency	282.1	612.64	894.738	42	181.3	223.3
OPD	593.5	403.32	996.82	196	12.93	208.929
Laboratory	164	413.96	477.959	21	64.73	85.81
Pediatrics	245.65	508.2	753.85	28	72.03	100.03
Surgical	285.45	580.29	865.71	14	44.17	58.17
Medical	469.4	820.92	1290.32	21	98	119
Obstetrics/Gyn	352.8	543.89	896.69	15.4	63	78.4
P-Value	0.064	0.064	0.064	0.064	0.064	0.064

GW: General waste; HCSW: Healthcare Solid Waste; HW: Hazardous Waste; Obs/Gyn: Obstetrics/Gynecology; OPD: Outpatient Department

The Kruskal WallisH test yielded a P-Value of 0.064>0.05, indicating no significant difference in the mean generation rate of healthcare solid waste (HCSW) across within the wards of either the government hospital or the private hospital

Table 13: Average daily health care solid waste generation by types of wastes in study hospitals

Types of Waste	Types of Hospitals					
	Government hospital (St. Pauli)			Private hospital (Girum)		
	In Patient/Kg/day	Out Patient/Kg/day	Kg/bed/ day	In Patient/ Kg/day	Out Patient/ Kg/day	Kg/bed/ day
General Waste	215	0.11	0.5	13	0.17	0.4
Infectious Waste	322	0.07	0.8	36	0.11	1.1
Pharmaceutical	75.7	0.03	0.2	6.2	0.02	0.2
Sharp waste	22.8	0.01	0.1	3.2	0.02	0.1
Total HCSW	635			58		

HCSW stands for Health Care Solid Waste.

According to Table 13 on average, Girum, a private hospital, generated 2.12 kg of hospital solid waste per day, consisting of general and hazardous waste, from its inpatients (1.8 kg/bed/day) and outpatients (0.32 kg/day). In contrast, the average daily total hospital solid waste (HSW) created by St. Paul's Millennium Medical College (a government hospital) is 1.757 kg, with 1.6 kg generated per bed per day) and 0.157 kg generated by outpatients. 0.5 kg per bed per day of general waste was generated at St. Paul’s. This is likely because the hospital receives patients from all over the nation, and families and caregivers spend a lot of time in the patient's room during their stay, contributing their fair share to the higher generation rates of this general waste. On the other hand, infectious waste created in Girum (the private hospital) reached a high of 1.1 kg per bed per day.

Table 14:Spearman's Correlation Matrix (rs) between Hazardous Wastes (HW) generated, Patient Inflows, and Occupied Beds in Private and Government Hospitals

Government Hospital		HW	Patient Flow	Occupied Beds
Spearman's rho	HW	1.0	1.000**	1.000**
	Patient Flow		1	1.000**
	Occupied Beds			1
Private Hospital		HW	Patient Flow	Occupied Beds
Spearman's rho	HW	1	1.000**	1.000**
	Patient Flow		1	1.000**
	Occupied Beds			1

** represent $P < 0.01$

A substantial positive linear link ($r = 1.00$, $P<0.000$) was found between the number of patients and the rates of hazardous waste creation in both government and private hospitals, according to Table 11's Spearman's rank correlation coefficient (rs). There was a substantial positive correlation between HW generation rates and occupied beds in both government and private hospitals ($r = 1.00$, $P < 0.000$) (Table 14). And in both hospitals, there was a positive correlation ($r = 1.00$, $P<0.000$) between patient flow and occupied beds. The number of patients had a positive linear correlation, as found by Tadesse and Kumie (2014) and Komilis et al. (2011).

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The study assesses hospital waste management systems and finds that, generally speaking, Private Girum Hospital outperforms the government-run Millennium Medical College Hospital in safe practices for solid waste management, as per the survey responses and evaluation results. The Government Hospital (St. Pauli's) generated 882.30±49.54 kg/day of total solid waste, with an average of 1.757 kg/patient/day (1.6 kg bed day–1 and 0.157 kg/outpatient/day) of 61.25% being classified as hazardous waste, and the remaining 38.75% being general waste. The private hospital (Girum) produced 124.81±65.24 kg/day of total solid waste, with an average of 2.12 kg/patient/day (1.8 kg bed–1day-1 and 0.32 kg/outpatient/day) of 57.05% being classified as hazardous waste, while the remainder, 42.795%, was general waste. High hazardous waste generation rates exceed the WHO's 10–25% estimate, primarily due to inadequate waste source segregation. The assessments revealed that none of the hospitals used proper waste segregation containers, unusual bin arrangements, poor placental disposal, and inefficient incinerators. St. Paul's Millennium Medical College hospital combined regular and hazardous waste, resulting in hazardous waste generation. Girum Hospital's inefficient brick-built incinerator fed both general and hazardous waste, posing health risks. In comparison to previous studies conducted in various parts of the nation, the study hospitals' total HCSW generation rates are high. Examining the KAPs for "waste handlers," department heads ward chefs, medical directors, and hospital administrators. Hospital administrators have a medium KAP, while waste handlers have a low one. Ward chiefs, medical directors, and department heads all have high KAP ratings. When compared to government hospitals, private hospitals had higher KAP scores. There was generally mismanagement in HCSWM practices at the study hospitals, which was frequently made possible by waste handlers' ignorance, inaction waste management guidelines, resource scarcity, passive regulatory bodies, and a failure to adhere to the national health care solid waste management guidelines.

5.2. Recommendations

This study reveals several issues with the medical waste management techniques utilized in the hospitals under review, all of which require immediate attention. Ethiopia's current health policy prioritizes pollution control, worker safety, and environmental health over hazardous chemical waste disposal, despite the lack of specific legislation in this sector at the time. As a result,

managing solid waste in hospitals requires meticulous planning, adherence to legislation, ongoing monitoring, and the creation of a national health care solid waste management strategy with particular tasks. To bring about improvements, cutting-edge medical waste management technologies will be used, along with awareness and education programs involving trash collectors, administrators, and other hospital personnel. This study does not investigate healthcare waste management, particularly liquid and gaseous waste. Additionally, there are just two hospitals in the city of Addis Ababa, one government and one private, that were evaluated, indicating a lack of a comprehensive

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7 APPENDIX

Appendix 1 questioner survey

CONSENT NOTE

Dear/Sir/Madam I would like to request your assistance, as a participant, in this research. This research is being conducted as an objective assessment of hospital solid waste management practices to characterize the composition and waste generation rates of the study hospitals. The purpose of this question is to gather data for the purpose of the study. Your participation is entirely voluntary. I affirm that the data you provide will be kept private and used exclusively for the intended purpose. It might even benefit your organization; I won't have any negative effects on you or it. Kindly provide the most thorough and truthful response you can to the questions in the attached questionnaire. I truly appreciate that, and I know how valuable your time is.

Questionnaire on knowledge and practices of health care workers on solid hospital waste management practices in St. Pauli's Millennium Medical College and Girum Hospitals, Addis Ababa, Ethiopia.

The name of the student is Fekede Geleta Hora.

E-mail address: sifanfekede@gmail.com

Phone number: 0936732408

Institution: Hawassa University

Department: Biology

Study program: (M.sc) in Environmental Health and Ecotoxicology

Research title: Assessment of hospital solid waste management practices: the case of

St.Pauil Millennium Medical College and Girum Hospitals in Addis Abeba.

Date----------

Please answer the following questions by putting a check mark (✓) on the

The appropriate box for your answer is in the space provided below.

Section A: Demographical Information

The information in this section will be used to compare the demographic data with the knowledge and practice of health workers regarding solid hospital waste management practices.

Gender: Male □ Female□

Age 18-25 yr □ 26-35yr□ 36-46 yr □ 46-55yr□ >56yr□

Educational status <grade10 □ 10^{th} complete □ Diploma□ Degree□ MA/M.sc/MPH□ PhD□

Professional Category General Medical Practioner □ Midwifery□ public Health □ Nurse□ Pharmacy □ MPH □ Anesthesia □Laboratory waste handlers□

Years of experience 0-5yr□ 6-10yr □ 11-15yr□ 16-20yr □ >20yr□

Employment statuses Employed □ Part-timer □ contract□

Over all waste Management Practices to be answered by Yes or No & some others accordingly the given directives Put a check mark (✓) in the appropriate box to indicate your choice to the section B questions.

6. Is there 24 hours availability of safe, clean and adequate water supply? (With its reservoir)? Yes □ No □

7. Use of personal protective equipment at all times while handling wastes? Yes □ No □

8. Is there fulltime assigned staff for health care waste management? Yes □ No □

a) Environmental health/ public health professional Yes □ No □

b) Inspection by the regulatory bodies to the hospital solid waste management's? Yes □ No □

c) Budget allocation to the hospital solid waste management's? Yes □ No □

d) Sanitary engineer Yes □ No □

e) Waste handlers yes □ No □

9. Are the following Health care waste management activities practiced during Segregation?

a) 3 Bin system in place Yes □ No □

b) Do you segregate waste at the point of generation? Yes □ No □ sometimes □

c) Posted standardized procedures for segregation process? Yes □ No □

d) Are visual aids or instructions present near the waste receptacles to help in proper segregation? Yes □ No □

e) Are all hazardous waste containers labeled with the word "Hazardous Waste or symbolized"? Yes □ No □

10. Are the following activities practiced during waste collection?

a) Allocation of adequate waste management utilities (PPE kits :boots, gloves, masks, goggles, glasses, and gowns) ? Yes □ No □

b) Timely collection of waste containers Yes □ No □

c) Replacement of waste bins before 3/4th is filled? Yes □ No □

d) The filled bags were closed tightly before transferred? Yes □ No □ I don't know □

e) Are sharps containers reusable? Yes □ No □

f) Are patient kits (bedpans, water jug, etc.) reusable? Yes □ No □

g) Are the containers marked with the accumulation start date? Yes □ No □

11. Are the following activities practiced during waste Storage?

a) Availability of Room for storage Yes □ No □

b) Location of the room Easy accessible & away from public Yes □ No □

c) Is the room easily cleanable, properly lighted & Proper ventilation Yes □ No □

d) Lockable/secured storage room Yes □ No □

e) Waste storage room has separate class for hazardous wastes? Yes □ No □

12. Are the following activities practiced during waste transportation?

a) Availability of different transporting materials for different waste categories? Yes □ No □

b) Availability of appropriate trolley/cart/wheel barrow? Yes □ No □

c) Vessel used for the transport of a sharp waste was perforated? Yes □ No □

d) Proper labeling of sources and categories of wastes? Yes □ No □

13. Are the following activities practiced during waste treatment?

a) Availability of treatment site Yes □ No □

b) Properly built incinerator Yes □ No □

c) Are oil traps cleaned periodically? Yes □ No □

d) Do you treat hazardous health care waste differently from general waste? Yes □ No □ I don't know □

14. Are the following activities practiced during waste Disposal?

a) Proper disposal of infectious and non-infectious waste Yes □ No □

b) Availability of placenta pit yes □ No □

c) Condition of incinerator (functional, distance) Yes □ No □

d) Protected sanitary landfill Yes □ No □

15. Are the following activities practiced on occupational Safety issues?

a) Training and sensitization for staffs yes □ No □

b) Vaccination for staffs (Yes □ No □

c) Recording and reporting of incidents Yes □ No □

16. is there any policies and procedures?

a) Presence of healthcare waste management guidelines/directives? Yes □ No □.

b) Presence of waste management committee or delegated staffs? Yes □ No □

c) Availability of Health care waste management plan? Yes □ No □

d) Staff training documentation Yes □ No □

d) Are Staffs trained on waste management methods? (Technical and administration staffs) Yes □ No □ how often? _____

e) Recording and reporting system yes □ No □

17. What departments are responsible for health care waste management at your health care facility?

a) Health and Safety

b) Maintenance/facility

c) Environmental Health

d) Nursing

Section C. Knowledge

Put a check mark (✓) in the appropriate box to indicate your choice to the section B questions below the following abbreviations will be used in answering the questions SA= strongly agree A= Agree N= Neutral D= Disagree SD= strongly disagree

18. Waste management is one of the core standards of health care.

SA□	A □	N □	D□	S D□

19. Medical waste is highly hazardous than municipal waste and therefore requires separate treatment.

SA□	A □	N □	D□	S D□

20 .Color-coded bins is part of waste management strategy to separate waste.

SA□	A □	N □	D□	S D□

21. Segregation, collection, storage, handling, transport, treatment and disposal are the key steps in waste management.

SA□	A □	N □	D□	S D□

SECTION D.

This Section includes questions that measures and determining the relationship between knowledge and practice of medical waste disposal control measures. Never, Rarely, Sometimes, Often and Always will be used .Put a check mark (✓) in the appropriate box to indicate your choice

22. Use of personal protective equipment: gloves, boots, masks & caps all times while handling health care wastes?

Never □	Rarely □	Sometimes □	Often □	Always □

23. Health workers are strictly ensuring that waste is collected on time

Never □	Rarely □	Sometimes □	Often □	Always □

24. Are all hazardous waste containers kept closed except when filling or adding waste

Never □	Rarely □	Sometimes □	Often □	Always □

25. Color-coded bins are always available in the unit& are allocated (in three bin systems)

Never □	Rarely □	Sometimes □	Often □	Always □

26. Bins for medical waste are located inappropriately in the unit

Never □	Rarely □	Sometimes □	Often □	Always □

27. Patients are consistently advised about the dangers of medical waste in the units

Never □	Rarely □	Sometimes □	Often □	Always □

28. Are healthcare waste management guidelines are followed in your hospital?

Never □	Rarely □	Sometimes □	Often □	Always □

29. Are waste collectors trained on waste management methods?

Never □	Rarely □	Sometimes □	Often □	Always □

30. Challenges encountered during healthcare waste management practice in the healthcare facility----------

Appendix 2: Interview Questionnaires

THE KEY INFORMANTS QUESTIONNAIRES FOR INTERVIEW

Part A: Socio demographic Characteristics of the Respondents

The information in this section will be used to view about the Knowledge, Attitude, and Practices of the key interviewers responses regarding Solid Hospital Waste Management Practices.

1. Gender Male □ Female□

2. Age 18-25 yr □ 26-35yr□ 36-46 yr □ 46-55yr□ >56yr□

3 Educational status <grade10 □ 10th complete □ Diploma□ Degree□ MA/M.sc/MPH□ PhD□

Professional Category Administrative □ Ward chief □ General Medical Practioner □ Midwifery□ public Health □ 4.Nurse□ Pharmacy □ MPH □ Anesthesia □Laboratory waste handlers □

5. Years of experience 0-5yr□ 6-10yr □ 11-15yr□ 16-20yr □ >20yr□

6. Employment statuses Employed □ Part-timer □ contract□

Part B: General Information regarding hospital solid waste management at the study hospitals.

The instructions are to respond to an interview by saying "Yes" or "No" but to narrate the issues in response to question number five

1. Is the incinerator's safety to hospital staff, patients, surrounding communities, and the environment is assessed based on its functional and distance conditions?

2. The placenta pits were placed and maintained in the appropriate location and conditions?

3. Are hospital solid wastes are separated or segregated based on their waste types at their point of generation?

4. Everyone is taught to use personal protective equipment such as gloves, boots, masks, and caps when handling (health care wastes) HCWs?

.

5. What are the challenges encountered during healthcare waste management practice in the healthcare facility----------

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Part C: Respondents Knowledge about regarding the segregation, collection, transportation, and disposals hospital solid waste management's.

The instructions are to respond to an interview by saying "Yes" or "No"

1. Both infectious/medical waste and general waste cannot be handled and disposed of together.

2 .when collection, the container or bag should be not filled to more than 3/4th capacity with infectious or medical waste.

3. The containers or bags used for infectious or medical waste should be clearly labeled with the sources and categories of waste.

4. The transportation of solid hospital waste necessitates a different type vehicle for different waste categories.

Part D: Respondents Attitude about regarding the segregation, collection, transportation, and disposals hospital solid waste management's.

The instructions are to respond to an interview by saying **"Agree", "Undecided" and "Disagree"**

1. The allocation of adequate budget for HSWM is considered equally important as other budget allocations for core activities.

2. Labeling sources and segregating hospital solid wastes into categories is necessary and is more efficient and sufficient for waste management.

3. The issue of Health Care Waste Management (HCWM) is not necessarily all up to healthcare professionals.

4The presence of visual aids or instructions near waste receptacles is considered necessary for proper segregation.

Part E: Respondents Practices about regarding the segregation, collection, transportation, and disposals hospital solid waste management's.

The instructions are to respond to an interview by saying **"Always," "Sometimes", and "Never"**

1. How often you assure allocation of adequate waste management utilities (PPE kits: boots, gloves, masks, goggles, glasses, and gowns) in your hospital

2. How frequently you watch over that waste handlers' are strictly ensuring that waste is collected on time?

3. How much are the events of your involvement in HCWM matters necessitates your participation?

4. How often you are supervising healthcare waste management guidelines and their compliance by waste handlers and health workers within the facility?

<u>የፍቃድ ማስታወሻ</u>

ውድ/ጌታዬ/እመቤት በዚህ ጥናት ላይ እንደ ተሳታፊ፣ እርዳታዎን ልጠይቅህ እፈልጋለሁ። ይህ ጥናት የሚካሄደው በአዲስ አበባ ከተማ ውስጥ በሚገኙት የ ቅዱስ ጳውሎስ ሚሊኒየም ሜዲካል ኮለጅ እና ጉሬም ሆስፒታሎች ላይ የሆስፒታሎቹን የደረቅ ቆሻሻ ስብጥር እና የቆሻሻ ማመንጨት ደረጃን ለመለየት እንዲሁም የደረቅ የቆሻሻ አያያዝ ተግባራት ላይ የጤና አጠባበቅ ሠራተኞች እና ለሎች ጉዳዩ የሚመለከታቸዉ አካላት በሆስፒታል የደረቅ የቆሻሻ አያያዝን በተመለከተ ያላቸዉን የእውቀት፣ የ አመለካከት እና ተግባራዊነት መገምገም ላይ ያተኮረ መጠይቅ ስሆን።የእርስዎ ተሳትፎ ሙሉ በሙሉ በፈቃደኝነት ነው። ያቀረቡት መረጃ በምስጢር እንደሚቀመጥ እና ለተፈለገው ዓላማ ብቻ እንደሚውል አረጋግጣለሁ። የዚህ ጥናት ዉጠት ድርጅትዎን ሊጠቅም ይችላል ነገር ግን በእርሶም ሆነ በድርጅትዎ ላይ ምንም አይነት አሉታዊ ተጽእኖ አይኖረዉም። በተያያዙት መጠይቅ ውስጥ ላሉት ጥያቄዎች የምትችሉትን ትክክለኛ ምላሽ በደግነት ያቅርቡ። በእጅጉ ጠቃሚ ስለሆነዉ ለዉድ ጊዜዎ ክልብ አመሰግናለዉ።

የተማረዉ ስም፡ **<u>ፈቀደ ገለታ ሆራ</u>**

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ስልክ ፡ 0936732408

የትምህርት ተቋሚ ፡ **<u>በሀዋሳ ዩኒቨርሲቲ</u>**

ዲፓርትሜንት፡ **<u>የባዮሎጅ ት/ክፍል</u>**

የትምህርት ፕሮግራም፡ **<u>የሁለተኛ ዲግር</u>(M.SC) በ<u>Environmental health &</u> Ecotoxicology**

የሪሰርች ሪዕስ ፡ **ቅዱስ ጳውሎስ ሚሊኒየም ሜዲካል ኮለጅ እና ጉሬም ሆስፒታሎች የደረቅ ቆሻሻ ስብጥር፡መጠን እና አያያዝ ሁነታ በተመለከተ የሚደረግ ሪሰርች**

መረጃ የሚሰበሰብበት ቀን፡- _____

እባኮትን ከዚህ በታች ባለው ክፍት ቦታ ላይ የመልስዎ ትክክለኛ ሳጥን ላይ(✓) ምልክት በማድረግ የሚከተሉትን ጥያቄዎች ይመልሱ።

ክፍል ሀ- የስነ-ሕዝብ መረጃ

በዚህ ክፍል ያለው መረጃ የስነ-ሕዝብ መረጃን ከጤና ባለሙያዎች እውቀት እና ልምድ ጋር ለማነፃፀር የሆስፒታል ደረቅ ቆሻሻ አያያዝ ተግባራትን ለማገናዘብ ይጠቅማል።

1. **ጾታ ወንድ □ ሴት □**
2. **እድሜ** 18-25 **አመት □** 26-35 **አመት** 36-46 **አመት □** 46-55 **አመት □** >56 **አመት**
3. **የትምህርት ደረጃ** <10**ኛ ክፍል □** 10**ኛ ሙሉ □ ዲፕሎማ□ ዲግሪ□** MA**□ ፒኤችዲ**
3. **የባለሙያ ምድብ ዶክተር □ የህብሬቴሰብ ጤና ሳይንስ □ ፋርማስስት□የጤና መኮኒን□ ነርስ□ አዋላጅ□ድዳት□**
4. **የአመታት ልምድ** 0-5 **አመት □** 6-10 **አመት □** 11-15 **አመት □** 16-20 **አመት □** > 20 **አመት**
5. **የተቀጠሩ የስራ ሁኔታዎች □ ቆሚ □ በትርፍ ሰዓት□ ጊዝያዊ□**

<u>ክፍል- ለ-ጥያቄዎች</u>

በሁሉም የቆሻሻ አወጋገድ አሠራሮች አዎ ወይም አይደለም መልስ የሚያገኙባቸው ልማዶች እና ሌሎችም በዚሁ መሠረት የተሰጡት መመሪያዎች ምርጫዎን ለክፍል- ለ- ጥያቄዎች ለማመልከት በተገቢው ሳጥን ውስጥ ምልክት ያድርጉ(✓) ።

6. **ለ**24 **ሰአታት ደህንነቱ የተጠበቀ፣ ንጹህ እና በቂ የውሃ አቅርቦት አለ ወይ? (ከውኃ ማጠራቀሚያው ጋር)? አዎ □ አይ □**
7. **ቆሻሻዎችን በሚይዙበት ጊዜ ሁል ጊዜ የግል መከላከያ መሳሪያዎችን መጠቀም? አዎ □ አይ □**
8. **ከጤና ተቋመ ለሚመነጩ ቆሻሻዎችን የሚያስተዳደር የሙሉ ጊዜ የተመደበ ሠራተኛ አለ? አዎ □ አይ □**

ሀ) የአካባቢ ጤና/የህዝብ ጤና ባለሙያ በህክምና ተቋመ አለ? አዎ □ አይ □

ለ) በተቆጣጣሪ አካላት የሆስፒታል የደረቅ የቆሻሻ አያያዝን በተመለከተ ክትትል እና ቁጥጥር(ምርመራ) ይደረጋል? አዎ □ አይ □

ሐ) ለሆስፒታል የደረቅ ቆሻሻ አያያዝ ትግበራ የሚሆን በጀት ይመደባል? አዎ □ አይ □

መ) በሆስፒታሉ የንፅህና መሐንዲስ አለ ?አዎ □ አይ □
ሠ) በሆስፒታሉ የደረቅ ቆሻሻ ተቆጣጣሪዎች አሉ?አዎ □ አይ □
9. የሚከተሉትን ለሆስፒታል የደረቅ ቆሻሻ አያያዝ ተግባራት በሴግሬጌሽን ወቅት (ደረቅ ቆሻሻዎችን ከምንጩ በየአይነታቸዉ የመለየት ስራ) ይተገበራሉ?
ሀ) ሆስፒታሉ በሦስት(3) የየራሳቸዉን ምልክት እና የየራሳቸ ቀለማት ባላቸዉ ደረቅ ቆሻሻ ማጠራቀሚያ ፒላስቲክስ ባልድ(ቢን ሲስተም) በሚያዝፈልጉ ቦታዎች ሁሉ ተዘርግቷል? አዎ □ አይ □
ለ) እርሶ ደረቅ ቆሻሻዎችንን በምመነጩቤት ቦታቸዉ ላይ በየአይነታቸዉ ቦታ ላይ ይለያሉ? አዎ □ አይ □ አንዳንድ ጊዜ □
ሐ) የደረቅ ቆሻሻ ማጠራቀሚያ ፒላስቲክስ ባልድዎች ቆሻሻ ለመለያየትለማስቻል ደረጃቸውን የጠበቁ ምልክቶች ተለጥፈዋል? አዎ □ አይ □
መ) ለትክክለኛው ቆሻሻ መለያየት የሚረዱ የእይታ መርጃዎች ወይም መመሪያዎች በቆሻሻ ማጠራቀሚያዎች አጠገብ ይገኛሉ? አዎ □ አይ □
ሠ) ሁሉም አደገኛ የቆሻሻ ማጠራቀሚያዎች "አደገኛ ቆሻሻ ወይም ተምሳሌት" በሚለው ቃል ተለጥፈዋል? አዎ □ አይ □
10. በቆሻሻ አሰባሰብ ወቅት የሚከተሉት ተግባራት ይከናወናሉ?
ሀ) በቂ የቆሻሻ አወጋገድ መገልገያዎች (PPE ኪት፡ ቦት ጫማዎች፣ ጓንቶች፣ ማስኮች፣ መነጽሮች እና ጋውን) ይመደባሉ? አዎ □ አይ □
ለ) የቆሻሻ ማጠራቀሚያዎችን በወቅቱ ይሰበሰባሉ? አዎ □ አይ □
ሐ) 3/4ኛ ከመሙላቱ በፊት የቆሻሻ ማጠራቀሚያዎች ይተካሉ? አዎ □ አይ □
መ) የተሞሉ የቆሻሻ ማጠራቀሚያዎች በጥብቅ ይቀጠራሉ (ይታሰራሉ)? አዎ □ አይ □ አላውቅም □
ሠ) የሾሉ ቆሻሻዎች(ለምሳሌ መረፎዎች) እንደገና ጥቅም ላይ ይዉላሉ? አዎ □ አይ □
ረ) የታካሚ ቁሶች (የአልጋ ቁራጮች፣ የውሃ ማጠራቀሚያ ወዘተ) እንደገና ጥቅም ላይ ይዉላሉ? አዎ □ አይ □
ሰ) የደረቅ ቆሻሻ ማጠራቀሚያ ፒላስቲክስ ባልድዎች በየቆሻሻ ማመንጫ ቦታቸዉ (ስፍራቸዉ) ላይ ስቀመጡ በመጀመሪያ ቀን ምልክት ተደርጎባቸዋል(ወይም የተቀመጡቤት ቀን ይፃፋሉ)? አዎ □ አይ □

11. በቆሻሻ ማጠራቀሚያ ወቅት የሚከተሉት ተግባራት ይከናወናሉ?
ሀ) በሆስፒታሉ የደረቅ ቆሻሻ ማጠራቀሚያ (ማከማቻ) ክፍል አለ? አዎ □ አይ □
ለ) የክፍሉ ቦታ በቀላሉ የሚገኝ እና ከህዝብ የራቀ ነዉ ? አዎ □ አይ □
ሐ) ክፍሉ በቀላሉ ሊጸዳ የሚችል፣ በትክክል መብራት እና ትክክለኛ አየር ማናፈሻ የሚያገኝ ነዉ? አዎ □ አይ □
መ) ክፍሉ ሊቆለፍ የሚችል/የተጠበቀ ማከማቻ ክፍል ነዉ? አዎ □ አይ □
ሠ) የቆሻሻ ማጠራቀሚያ ክፍል ለአደገኛ ቆሻሻዎች የተለየ ክፍል አለው? አዎ □ አይ □
12. በቆሻሻ መጓጓዣ ወቅት የሚከተሉት ተግባራት ይከናወናሉ?
ሀ) ለተለያዩ የቆሻሻ አይነቶች የተለያዩ ማጓጓዣ/መኪና (ለየብቻቸዉ) አሉ? አዎ □ አይ □
ለ) ተስማሚ የሆኑ የቆሻሻ ማጓጓዣ በሆስፒታሉ ግዛዊ ማከማቻ የምወሰድበት (ትሮሊ/ጋሪ/የዊል ባሮው) አለ? አዎ □ አይ □
ሐ) ስለታም ቆሻሻ ለማጓጓዣ የሚያገለግል ምቹ መያዣ አለ? አዎ □ አይ □
መ) የቆሻሻ ምንጮችን እና አይነቶችን በትክክል ለመለየት የሚያስችል ምልክት ይደረጋል ? አዎ □ አይ □
13. በቆሻሻ አያያዝ ወቅት የሚከተሉት ተግባራት ይከናወናሉ?
ሀ) የሕክምና ቦታ መገኘት አዎ □ አይ □
ለ) በትክክል የተሰራ የቆሻሻ ማቃጠያ(በሪነር) አለ? አዎ □ አይ □
ሐ) የዘይት ወጥመዶች በየጊዜው ይጸዳሉ? አዎ □ አይ □
መ) አደገኛ ቆሻሻን ከአጠቃላይ ቆሻሻ በተለየ መልኩ መያዝ እና ማስወገድ ይገባል? አዎ □ አይ □ አላውቅም □
14. በቆሻሻ አወጋገድ ወቅት የሚከተሉት ተግባራት ይከናወናሉ?
ሀ) አደገኛ ቆሻሻን ከአጠቃላይ ቆሻሻ በተለየ መልኩ በትክክል ማስወገድ ያስፈልጋል? አዎ □ አይ □
ለ) የእንግዴ ጉድጓድ መገኘት አዎ □ አይ □
ሐ) የቆሻሻ ማቃጠያ በትክክል የምሰራና አስፈላጊዉን ቦታ ርቀት ላይ የምገኝ ነዉ? አዎ □ አይ □
መ) ደንኑቱ የተጠበቀ ቆሻሻ መጣያ ጉድጓድ ይገኛል? አዎ □ አይ □
15. በሙያ ደህንነት ጉዳዮች ላይ የሚከተሉት ተግባራት ይከናወናሉ?
ሀ) ለሰራተኞች ስልጠና እና ግንዛቤ በቆሻሻ አያያዝ ይደረጋል? አዎ □ አይ □
ለ) ለጤና ሰራተኞች ክትባት በየግዘዉ ይሰጣል? አዎ □ አይ □
ሐ) ክስተቶችን መመዝገብ እና ሪፖርት ማድረግ አሰራር ተዘርግቶል? አዎ □ አይ □
16. ፖሊሲዎች እና መመሪያዎች በተመለከተ እነዝህ ነገሮች አሉ?
ሀ) የጤና አጠባበቅ ቆሻሻ አያያዝ መመሪያዎች/መመሪያዎች አሉ? አዎ □ አይ □

ለ) የቆሻሻ አወጋገድ ኮሚቴ ወይም የተወከሉ ሰራተኞች አሉ? አዎ □ አይ □
ሐ) የጤና አጠባበቅ ቆሻሻ አያያዝ ዕቅድ በሆስፒታሉ አለ? አዎ □ አይ □
መ) የሰራተኞች ስልጠና በሰነድ ተይዞ የሚገኝ ነዉ? አዎ □ አይ □
ሠ) ሰራተኞች በቆሻሻ አያያዝ ዘዴዎች ላይ የሰለጠኑ ናቸው? (የቴክኒክ እና የአስተዳደር ሰራተኞች) አዎ □ አይ □ ምን ያህል ጊዜ? _____
ረ) ክስተቶችን የመመዝገብ እና የሪፖርት ማቅረቢያ ስርዓት አለ? አዎ □ አይ □
17. በጤና እንክብካቤ ተቋም ውስጥ የሆስፒታል የጤና አጠባበቅ ቆሻሻ አያያዝ ኃላፊነት ያለባቸው የትኞቹ ክፍሎች ናቸው? ሀ) ጤና እና ደህንነት ለ) ጥገና/ፋሲሊቲ ሐ) የአካባቢ ጤና መ) ነርሲንግ
ክፍል- ሐ- እውቀት
ለክፍል-ሐ- ምርጫዎትን ለማመልከት በተገቢው ሳጥን ውስጥ ምልክት ያድርጉ (✓) ከሚከተሉት አህጽሮተ ቃላት በታች ያሉ ጥያቄዎች ለጥያቄዎች መልስ ይጠቅማሉ 1= በጣም እስማማለሁ 2= እስማማለሁ 3= ገለልተኛ 4= አልስማማም 5= በጣም አልስማማም
18. የቆሻሻ አያያዝ አንዱ የጤና አጠባበቅ መመዘኛዎች አንዱ ነው።
1□ 2 □ 3 □ 4□ 5□
19. ከህክምና ተቋማት የሚወጡ ቆሻሻ ዎች ከማዘጋጃ ቤት ቆሻሻ በጣም አደገኛ ስለሆነ የተለየ የቆሻሻ አያያዝ ስትራቴጂ ያስፈልገዋል።
1□ 2 □ 3 □ 4□ 5□
20 የተለያዩ ቀለም ኮድ የተሰሩ የቆሻሻ መሰብሰቢያ ወይም ማጠራቀሚያ ፒለስስትክ ባልድዎችን ቆሻሻዎች ለመለየት መጠቀም አንዱ የቆሻሻ አያያዝ ስትራቴጂ አካል ነው።
1□ 2 □ 3 □ 4□ 5□
21. በየተዋረድ ከህክምና ተቋማት የሚወጡ ቆሻሻ ዎችን በየአይነታቸዉ መለያየት፣ መሰባሰብ፣ ማከማቸት ፣ ማጓጓዝ፣ ቆሻሻዎችን በ አግባቡ የማከም እና የማስወጋገድ ስ ራ የቆሻሻ አያያዝ ቁልፍ እርምጃዎች ናቸው።
1□ 2 □ 3 □ 4□ 5 □
ክፍል መ.-ጥያቄዎች
ይህ ክፍል ጥያቄዎች ከህክምና ተቋማት የሚወጡ ቆሻሻ ዎች አያያዝ እና አወጋገድን በተመለከተ ያለዉን ክህሎትና እውቀት ደረጃን ለመገምገም የሚያስችል ጥያቄዎችን ያካትታል። በጭራሽ፣ አልፎ አልፎ፣ አንዳንዴ፣ ብዙ ጊዜ እና ሁልጊዜ ጥቅም ላይ አይውሉም። በማለት ምርጫዎን ለማመልከት በተገቢው ሳጥን ውስጥ ምልክት ያድርጉ (✓)
22. ከህክምና ተቋማት የሚወጡ ቆሻሻ ዎችን አያያዝ ላይ ከቆሻሻዉ ጋር ባላችዉ የስራ ግንኙነት ወቅት/ ጊዜ የግል መከላከያ መሳሪያዎችን፡ ጓንት፣ ቦት ጫማዎች፣ ማስክ እና ኮፍያዎችን ሁልጊዜ ይጠቀማሉ?
በጭራሽ □ አልፎ አልፎ □ አንዳንድ ጊዜ □ ብዙ ጊዜ □ ሁልጊዜ □
23. የጤና ባለሙያዎች ቆሻሻን በወቅቱ መሰብሰብን በጥብቅ እያረጋገጡ ነው።
በጭራሽ □ አልፎ አልፎ □ አንዳንድ ጊዜ □ ብዙ ጊዜ □ ሁልጊዜ □
24. ቆሻሻ በሚሞሉበት ወይም በሚጨመሩበት ጊዜ ካልሆነ በስተቀር ሁሉም አደገኛ የቆሻሻ ማጠራቀሚያዎች ተዘግተዋተዉ ወይም ተከድነዉ ይቀመጣሉ።
በጭራሽ □ አልፎ አልፎ □ አንዳንድ ጊዜ □ ብዙ ጊዜ □ ሁልጊዜ □
25. በሆስፒታሉ በሦስት(3/(በሶስት ቢን ሲስተሞች) የየራሳቸዉን ምልክት እና የየራሳቸ ቀለማት ባላቸዉ ደረቅ ቆሻሻ ማጠራቀሚያ ፒላስቲክስ ባልድ(ቢን ሲስተም) ሁል ጊዜ በሚያዝፈልጉ የስራ ቦታዎች እንዲሁም በየታካሚ አልጋ ክፍሎች ውስጥ ተቀምጠዉ ይገኛሉ ።
በጭራሽ □ አልፎ አልፎ □ አንዳንድ ጊዜ □ ብዙ ጊዜ □ ሁልጊዜ □

26. የህክምና ደረቅ ቆሻሻ ማጠራቀሚያ ፒላስቲክስ ባልድዎች በየታካሚዎች ክፍሎችም ይሁን በለሎች የህክምና የስራ ክፍሎች ውስጥ አግባብ ባልሆነ መንገድ ተቀምጠዋል።
በጭራሽ □ አልፎ አልፎ □ አንዳንድ ጊዜ □ ብዙ ጊዜ □ ሁልጊዜ □
27. ለታካሚዎች ስለ የህክምና ደረቅ ቆሻሻ አደገኛነት እና ስለሚያዝፈልገዉ ጥንቃቄና አያያዝ ያለማቋረጥ ምክር ወይም ግንዛቤ በጠና ተቋሙ ይሰጣል።
በጭራሽ □ አልፎ አልፎ □ አንዳንድ ጊዜ □ ብዙ ጊዜ □ ሁልጊዜ □
28. የህክምና ደረቅ ቆሻሻ አያያዝ መመሪያዎችን ሆስፒታሉ ይከተላል
በጭራሽ □ አልፎ አልፎ □ አንዳንድ ጊዜ □ ብዙ ጊዜ □ ሁልጊዜ □
29. ቆሻሻ አሰባሳቢዎች በቆሻሻ አወጋገድ ዘዴዎች ላይ የሰለጠኑ ናቸው?
በጭራሽ □ አልፎ አልፎ □ አንዳንድ ጊዜ □ ብዙ ጊዜ □ ሁልጊዜ □

30. በጤና እንክብካቤ ተቋሙ ውስጥ የህክምና ደረቅ ቆሻሻ አያያዝ እና አወጋገድ ወቅት ያጋጠሙ ተግዳሮቶች ምንድን ናቸዉ ይግለፁ --- ---------- ---------- ---------- ---------- ---------- ---------- ----------

Appendix 3: St. Paul's hospital IRB ethical letter

Ref. No. PM23/1042
Date: 8/03/2024

Institutional Review Board (IRB) of St. Paul's Hospital Millennium Medical College (SPHHMC)

Ethical Clearance

Research Title: Assessments of hospitals solid waste management: the case of St. Paul's millennium medical college's hospital and Girum hospital Addis Ababa, Ethiopia

Principal Investigator: Fekede Geleta

The IRB of SPHMMC has reviewed the above mentioned research proposal and made the following decision:

- Approved:- _____X_____
- Approved with recommendation:- _____
- Approved on condition :-_____
- Disapproved:- _____

The decision is valid for 12 months and the research should be conducted in compliance with the protocol/proposal approved by the IRB of SPHMMC. Any subsequent revision/amendment of the protocol/proposal needs approval before conduct of the research. The researcher should also submit written summaries of the research status to the IRB every 03 months. Upon the conclusion of the study, manuscripts and thesis work to the final/completed research project needs to be submitted to the IRB.

IRB Chair:
Signature: _____
Date: March /7, 2024

Gadissa Bedada (PhD)
Research Directorate
Director

Federal Ministry of Health
St. Paul's Hospital Millennium Medical College

Cc:

- Vice Provost for Academic and Research
- IRB
- Fekede Geleta
  SPHMMC

ዶ/ር ውለታው ሜኔ
ሜዲካል ሰርቪስ
ም/ፕሮቮስት
03/07/2024

Appendix 1: Girum hospital IRB ethical letter

አዲስ አበባ ከተማ አስተዳደር ጤና ቢሮ
City Government of Addis Ababa Health Bureau

REF.N.O. AAHH/13598/227

DATE 15/06/2016

TO:

- GIRUM HOSPITAL

Subject: Request to access Faciliti es to conduct approved research

This letter is to support Fekede Geleta to conduct research which is entitled as **"Assessments of Hospital Solid Waste Management The Case of St.Pauli's Millennium Medical Collage And Gurum Hospitals, Addis Ababa, Ethiopia"** The study proposal was duly reviewed and approved by Addis Ababa Health Bureau IRB, and the principal investigator is informed with a copy of this letter to report any changes in the study proc edures and submit an activity progress report to the Ethical Committee as required. Therefore we request the Health offices and staffs to provide support to the Principal investigator.

With Regards

Ethical Clearance Committee

Cc

- FEKEDE GELETA
- ETHICAL CLEARANCE COMMITTEE

Appendix 2: a picture displaying the observation of the on-site waste storage area, disposal sites as well as the wards of the study hospitals

Figure A:Girum hospital found burning all types of waste together

Figure B:Girum hospital only Red ducket allocation in its Emergency ward

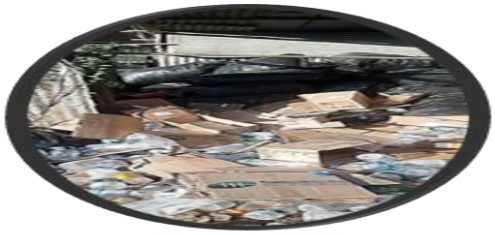

Figure C: plastic water bottles and cartons sorted from Infectious waste for sale at St. Paul's

Figure D: sharp waste found fill to the top level at St .Paul's

Figure E shows waste handlers carrying sharp waste naked.

handed in St. Paul's.

Figure F: Waste is transported, being

carried by hand at Girum hospital

Figure G: Waste is conveyed on shoulder St. Paul’s hospital

Figure H: A substandard incinerator burns all forms of waste and releases hazardous gases in Girum Hospital.

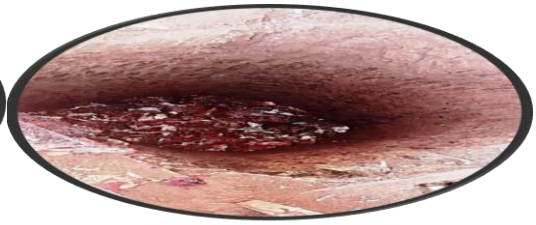

Figure I: St. Paul's all waste types were discovered combined .

Figure J shows St. Paul's poor placenta pit Condition.

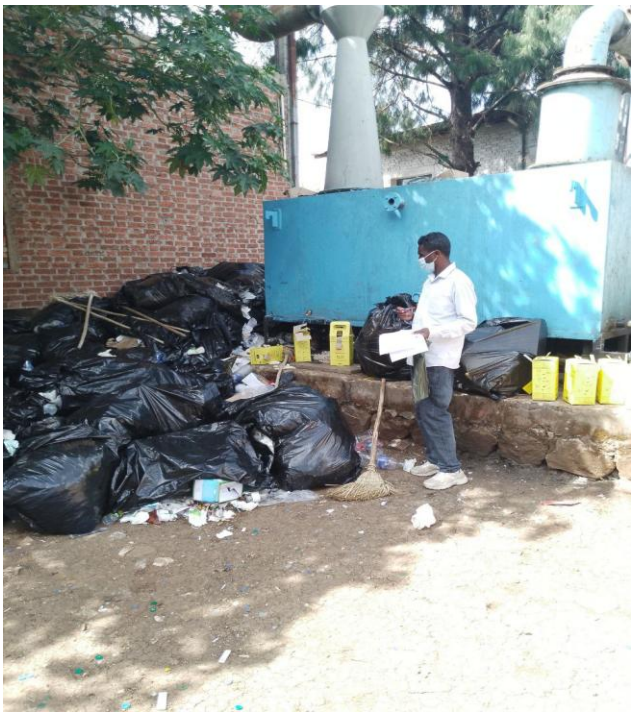

Figure K shows an interim waste storage facility in St. Paul's