ASSESSMENT OF BIOMEDICAL SOLID WASTE GENERATION RATE AND IT'S MANAGEMENT PRACTICE IN BAKO PRIMARY HOSPITAL, BAKO TOWN, WEST SHEWA ZONE, ETHIOPIA

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Approval sheet for submitting final thesis

As a member of board of examining of the final MSc. Thesis open defense , we certify that we have read and evaluated thesis prepared by **TSEHAY FIKIRE** under the title **Assessment of Biomedical solid waste generation rate and its management practice at Bako primary hospital** and recommend that, the thesis be accepted as fulfilling the thesis requirement for the degree of Master of Environmental health science and technology .

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Department Head	signature	Date

Declaration

I declare that this is an original work and has not been submitted, in whole or in part, in any previous application for a degree or professional qualification in any other institution. I confirm that due references have been provided on all supporting literature and contributor to any resources in this work has been appropriately acknowledged.

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This thesis work has been undertaken under our supervision as advisors, I confirm the finalization of his MSc. thesis work.

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ABSTRACT

Background: Biomedical waste is a type of hazardous waste that is produced during the diagnosis, treatment, or immunization of humans. As a result, it requires special attention and management before disposal. Most developing countries, including Ethiopia, have no effective health care waste management practices. There is a lack of research that has gone into greater detail about the main cause of the high proportion of hazardous waste generation in comparison to general waste, as well as the average waste generation per patient flow in the studied health facility.

Objective: The purpose of this study was to assess the biomedical solid waste generation rate and its management practice at Bako Primary Hospital, Bako town, western Oromia, Ethiopia.

Methods: Facility-based cross-sectional study design for quantitative and case study qualitative was used to assess the biomedical solid waste generation rate and management practice in Bako primary hospital from July 12-18/2021.The study was conducted to manage data quality, training, pre-testing, and weighting scale calibration were used. A calibrated weight balance was used to calculate the amount of biomedical solid waste generated. The current practice of biomedical solid waste management was evaluated using an observational checklist and a semi-structured interview guide. The correlation between the total number of patients and the total amount of biomedical waste generated was assessed using Spearman's rank correlation coefficient (r). The collected data was organized and entered into Epi data version 3.1 and it was cleaned to eliminate missing values, outliers, and other inconsistencies. Data was cleaned before being exported to SPSS version 26for analysis and a one-way ANOVA test was performed. Questionaries' was translated to local language Afan Oromo, then back to English to keep its consistency.

Result: The average daily generation rate of biomedical waste was determined to be 0.69kg/bed/day and/ or 0.381kg/patient/day. At the point of generation, there was no segregation of biomedical waste by type. Substandard open plastic bins were used to collect and transport mixed biomedical solid waste.

Conclusion: The average biomedical waste generation rate in Bako primary hospital was (0.69kg/bed/day and/or 0.381kg/patient/day)were above the threshold value of the hazardous biomedical solid waste generation rate in low-income countries, was by reported by WHO, and its management was underprivileged. There was lack of appropriate biomedical waste segregation with different waste categories at point of generation and inadequate waste collection equipment's in most of all in different departments. There is an urgent need to establish standard biomedical solid waste management at all.

Keywords: **biomedical waste, hazardous waste, health care waste, waste generation**

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ACRONOMYS AND ABBREVIATIONS

HCW	Healthcare Waste
BMWM	Biomedical Waste Management
HCFs	Healthcare Facilities
FMHACA	Food, medicine, health Authority and control Agency
SOP	Standard operative procedure
FEPA	Federal Environmental Protection Agency
WHO	World Health Organization
HCWG	Health care waste generation
OPD	Outpatient department
IPD	Inpatient department
HBV	Hepatitis B virus
HCV	Hepatitis C virus
AIDS	Acquired Immune Deficiency Syndrome
BMW	Biomedical Waste
KII	Key Informant interview
IDI	In-depth interview
EPA	Environmental Protection Agency
FEPA	Federal Environmental Protection Agency
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
SPSS	Statistical Package for Social Science
PPE	Personal Protective Equipment
PI	principal investigator
KG	Kilogram

CHAPTER ONE – INTRODUCTION

1. BACK GROUND INFORMATION.

Biomedical waste is "Any solid and liquid waste including its materials and any intermediate product, which is generated during the treatment, immunization of human beings and animals". Most common producers of biomedical waste contain hospitals, clinics, laboratories, offices of physicians, dental, and veterinarians, house health care, and funeral homes. (Harender Singh ,2016)

During the healthcare delivery method, healthcare establishments can certainly generate hazardous biomedical wastes (BMWs) to a human being or the environment. These waste are broadly categorized as general (non- hazardous) and hazardous waste. General waste is constituted 85% of the total waste while the remaining 15% is a hazardous waste (Deress et al**,** 2018**)**.

Biomedical solid waste management, as well as posing technical problems, is strongly influenced by cultural, social, and economic circumstances. Aweil designed waste policy, a legislative framework, and plans for achieving local implementation are essential. Change will be gradual and should be technically and financially sustainable in the long term **(**Emmanuel et al, 2014**).**

In recent years, the global healthcare system has expanded primarily in many developed and developing countries. This enables the delivery of healthcare to a greater number of people across a wider geographical area (Nor Faiza MT Noor Artika HYM ,2019) **.**

This enables the delivery of healthcare to a greater number of people across a wider geographical area unfortunately; advances in healthcare activities can result in an ever-increasing amount of waste that is not properly disposed (Shalini Harsh.2019).Every year an estimated 16 billion injections are administered worldwide, but not all of the needles and syringes are properly disposed of afterwards, creating a risk of injury and infection and opportunities for reuse (WHO 2018)**.**In 2010, the World Health Organization (WHO) estimated that injections with contaminated needles and syringes were still responsible for about 33,800 HIV infections, 1.7 million hepatitis B viral infections and 315,000 hepatitis C viral infections in low-income countries (WHO2015).

Regardless of its influence on the environment and public health in general, proper medical waste handling and management are still severely vulnerable in many developing countries. According to a new WHO/UNICEF Joint Monitoring Program report published in 2019, there is very inadequate safe management of biomedical solid waste in developing countries, with only 27 percent of healthcare facilities having basic biomedical solid waste management services. Medical waste production in Ethiopia, as in many developing countries, has increased sharply in recent years due to rapid population growth, which increases the amount of biomedical solid waste generated in the country (MA.Abebe

2017).However, biomedical solid waste management in health institutions remains inadequate and has received less attention. The nature and quantity of waste generated, as well as institutional Practices for the long-term management of biomedical solid waste have not yet been investigated in the study setting. However, all health care facilities have chosen incineration as a method of disposing of biomedical solid waste management.

However, a survey on the status of hospital incinerators discovered widespread deficiencies in their construction, siting, and operation; the majority of healthcare facilities (HCFs)(80%) use low-temperature technology, which causes air pollution.(Preliminary assessment of the status of hospital incineration facilities as a biomedical waste management practice in Addis Ababa City, Ethiopia (Berihun D. Solomon Y 2017).

To minimize and control the risks associated with improper biomedical solid waste management, it is critical to plan and develop an evidence-based intervention strategy. However, the amount of biomedical solid waste generated, as well as the current waste management system used at Bako Primary Hospital, had not yet been investigated.

1.1 STATEMENT OF THE PROBLEM

The generation and disposal of biomedical solid waste has emerged as a global issue. According to a systematic review of 135 articles published since 2015, at least half of the world's population is threatened by environmental, occupational, and public health risks as a result of poor biomedical waste management (caniato and Tudor 2017)**.**

It is estimated that approximately 16 billion injections are administered worldwide each year, but not all needles and syringes are properly disposed of after use, causing a risk of injury, infection, and opportunities for reuse (WHO 2016).In 2010,the World Health Organization estimated that injection with contaminated needles and syringes in low- and middle-income countries, syringes were still responsible for approximately 33,800 HIV infections, 17 million HBV infections, and 31500 HCV infections (WHO 2015)**.**

Regardless of its negative impact on the environment and public health in general, proper biomedical solid waste handling management is still severely hampered in many developing countries (Emmanuel et al, 2016).According to a WHO assessment, between 20% and 60% of health care facilities in 22 developing countries lack a proper biomedical waste management system.

(WHO 2016)According to a new joint WHO/UNCEF global report published in 2019, there is no or very limited safe management of health care waste in least developed countries. Only 27% of health care facilities provided basic biomedical solid waste management services. However, there is a severe lack of reliable data on factor such as waste generation and waste characterization, making it difficult to find an appropriate and long-term management solution (caniato and Tudor 2017) recent joint WHO/UNCEF reports show that only three of the eight SDG regions have data on biomedical solid waste management services in HCFs (WHO/ UNCEF 2019).

Medical waste production in Ethiopia, as in many developing countries, has increased sharply in recent years because of rapid population growth (M.A.Ababe 2017) and thus increased demand for health services. In 2010, the country implemented the fourth health sector development program, particularly after the global declaration of UN MDGs.To address the society's basic health needs and accomplish the related MDGs, one of the program's pillars was the expansion of health facilities (HSDP IV 2014)which allows an increasing number of people to receive modern medical healthcare (Windfed and Brooks 2015).The prevalence of needle stick injury is a concern in recent times, although its documentation is grossly under-estimated (Akter N 2027) **.**Empirical observation in our study indicated that 13.3 % (4 out of 30) of waste cleaners and 12.5% (5 out of 40) of healthcare workers had injuries for the last 12 months by contaminated needle or sharp objects.

The fact that health care workers are aware of the risk of HIV/AIDS transmission through used needle stick in the present and other study (Yoseph W 2016) .Is a good indication for the practice of

Universal precautions that are required in diseases prevention On the other hand, the absence of continued training and any of operating guidelines on biomedical waste handling and management in health centers require close attention. In-situ absence of operating guideline is consistent with other studies. (Fentahun M Kedir A 2015) Furthered more, in Ethiopia; all health facilities have chosen incineration to treat HCW(Keshaun20014).Following, national HCWM guide line which recommended double –champers incinerators (>8500c) as the optimal method of bio medical waste treatment (MOH, 2008).It is imperative to plan and develop evidence based intervention strategy (Asrat et al, 2018)**.**

In developing countries, including Ethiopia, because researches in the area are few in number, and limited in scope, practical information about hospital biomedical solid waste management is inadequate, especially for the development of management organizations for hospital waste (Abebe F , 2017) .However, the quantity of biomedical solid waste generated as well as existing bio medical waste management system practiced in Bako district hospital was not examined yet. Therefore, this study aimed at filling this gap by providing the information on bio medical solid waste generation rate, current management practices.

Lots of the problem can be surrounded if the biomedical waste management is properly implemented. The activities that are usually performed as part of biomedical solid waste management involve segregation, storage, collection, transportation and disposal of biomedical waste. A system that is managed by negligent and untrained staff, the risks and the importance of their “contribution” is feared. Management of biomedical waste solid needs commitment at all the levels from healthcare providers (Rahila Rehman, 2014).

1.2 SIGNIFICANCE OF THE STUDY

The following are the study's major findings.

To assess bio medical solid waste generation rate and its management practices and then implementing the appropriate intervention to enhance the waste management practice providing vital information on biomedical solid waste generated at the facility level.

This study gives more information and evidence to BMWs managers, health professionals, cleaners, local community, other staff members and policy makers on the actual picture of biomedical waste generation rate, its organization, the status of waste management practice, and its major challenges.

Identify the gaps from the current practices of biomedical solid waste management practices and then forward appropriate intervention.

It would be supporting and enhance HCFs for well-organized institutional-based planning, designing, budgeting, and implementing of BMWM procedures to be economical, effective, and efficient through system improvements as early as in the planning stage. Besides, used as baseline data for future studies in this area.

It also assists policymakers, researchers, and other interested parties in developing an effective biomedical solid waste management practices in Bako Primary Hospital.

This study aimed to investigate the practice of biomedical waste management system and related public health problems in Ethiopia with the view of identifying the gaps in biomedical waste handling that require interventions

The result of this study would serve as a stepping-stone to identify the real gap in the management of biomedical solid waste and could be the basis for the development of feasible, environmentally safe and cost-effective biomedical solid waste management in healthcare facilities nationwide.

There are plenty of studies on bio medical solid waste generation and its management practice in Hospital in Ethiopia but were not well studied in primary Hospital in west Shewa zone.

So, this study was done to identify the status of biomedical solid waste generation and its management practice in Bako primary.

1. 3 LITERATURE REVIEW

A literature search was undertaken based on agreed-upon study topics to analyze the diverse experiences on biomedical solid waste generation rates and management strategies. Computerized literature search engines of scholarly articles were used to find relevant papers. Science Direct, PubMed, and Google Scholar were among them. Furthermore, a hand search was carried out

All healthcare facilities generate Health Care Risk Waste (HCRW) that causing risk to human health as a result of its contented of infectious materials, sharps, hazardous chemicals or radioactivity. (Harhay M, 2015) In the course of their healthcare activities, hospitals are among the complex institutions that generate a wide spectrum of hazardous waste materials (Rao PH, 2018).A substantial portion of biomedical waste (75-90 percent) is non-risk or general healthcare waste, similar to Municipal Solid Waste (MSW) and a lesser portion (10-25 percent) is hazardous waste, which can offer a variety of health concerns. Improper waste management can result in the full mass of the waste becoming potentially contagious if infectious waste is mixed with non-infectious waste (Lars M, Johannessen E, 2017).

Biomedical solid waste, which is defined as any solid waste generated because of patient diagnosis, treatment, immunization of humans or animals, is generated in large quantities in hospitals (Jorge Emmanuel, 2013).According to WHO the waste generated by hospitals has a higher risk of infection and damage than other types of waste. Biomedical waste is a big issue in most developing countries, owing to its ever-increasing generation and poor management (Askarian M, Vakili M, Kabir G, 2014).

Biomedical solid waste management is the process of storing, collecting, transporting, treating, and disposing of waste. (Moradi A, 2017).The goal is to clean up the surrounding environment and recognize that waste does not pose a health risk. Biomedical Waste management has advanced to the point where it is now not only planning proper disposal but also trying to determine whether certain waste materials can be reused and recycled(Davorin Kralj, Stamenković M, 2016).A healthcare practitioner is responsible for the safe and proper disposal of biomedical solid waste. In healthcare settings, there is a pressing need to decrease both the cost and the environmental impact of biomedical solids waste generation and disposal (RCN, 2017).

1.3.1. Hospital biomedical solid waste generation rate

Biomedical solid Waste is produced as a result of healthcare activity. The pace of generation varies depending on the type of hospital. Different generation rates exist, which vary not only from country to country but also within a country (Alagoz AZ, Kocasoy G, 2015) .Based on WHO (2013) report;

Factors affecting biomedical solid waste generation are: established waste management methods, type of healthcare establishment, hospital specializations, proportion of reusable items employed in healthcare, and proportion of patients treated on a day-care basis. (Jorge Emmanuel, 2013) Furthermore, the study

found that the rate of biomedical solid waste generation is affected by a country's level of economic development, national health insurance reimbursement, the location of a healthcare establishment, the proportion of disposable substances used in healthcare activities, and the season of the year; this seasonal variation could be due to the fact that the nature of illness of patients admitted to hospitals changes with the seasons. (Katoch S, Kumar V, 2016)**.**

When comparing the generation rates of middle-income and low-income countries, it is clear that the latter has a lower rate. However, in high-income countries, the range of values for countries with similar income levels is likely to be as wide as in low-income countries (WHO, 2014)**.**

According to the WHO, 80 percent of general healthcare waste,15% pathological and infectious waste, 1% sharps waste, 3% chemical or pharmaceutical waste, and less than 1% special waste, such as radioactive or cytostatic waste, pressurized containers or broken thermometers, and used batteries, generate biomedical waste (Annette Prüss, 2017)

Table 1: Hospital waste generation rate in different Regions of the world, 1999.

Region	Kg/bed/day	Proportion of hazardous waste (%)
North America	7-10	5-20
Latin America	3	5-20
Western Europe	3-6	No data
Eastern Europe	1.4-2	No data
Middle East	1.4-2	No data
East Asia High income	2.4-4	5-10
East Asia Middle Income	1.8-2.2	No data
Western Europe	3-6	No data
Rural sub-Saharan Africans	0.3 -1.5	2-10
Iow - income countries	0.3-3	No data

Source: Pruss A. et al. (1999

Table 2: biomedical waste generation rate in different African countries

	country	BMWGR (kg/Bed/Day)	Country	BMWGR (kg/Bed/Day)
Africa	Algeria	0.96	Mauritius	0.44
	Cameroon	0.55	Morocco	0.53
	Egypt	1.03	Sudan	0.87
	Ethiopia	1.1	Tanzania	0.75

Source, Sustainability 2017

Table 3 : Biomedical waste generation rate in different hospitals.

Source	Source Daily waste generation (kg/bed/day)
University hospital/ Referral hospital	4.1–8.7
General hospital	2.1–4.2
Primary hospital	0.5–1.8
Primary health-care center	0.05–0.2

Sources: Commission of the European Union (1995), Halbwachs (1994), Durand (1995).

According to a research conducted in Sylhet, Bangladesh (2006), the average trash generation rate for hospitals was 0.934 kg/bed/day, with non-hazardous waste accounting for77.08 percent and hazardous waste accounting for 22.92 percent (Shahjahan K, Alam S, Muhammad A, 2016)**.**

A survey done in Irbid, Jordan, showed the generation rates of healthcare waste in three hospitals 6.904kg/pat/day (4.315kg/bed/day)at the Princess Basma Hospital,5.718kg/pat/day (3.212 kg/bed/day) at Princess Bade'ah Hospital, and 4.532 kg/pat/day (2.556 kg/bed/day) at Ibn Al-Nafis Hospital (Al-Shareif M, 2014).

Even among hospitals in the same category, according to a study conducted in Greece (2012), there is a substantial variance in the rate of healthcare waste generation.

The average amount of total biomedical solid waste created per bed per day ranged from 0.012 kg/bed/day in public psychiatric hospitals to 0.72 kg/bed/day in public university hospitals. The average amount of biomedical waste generated in private hospitals ranged from 0.0012 kg/bed/day in psychiatric clinics to 0.49 kg/bed/day in delivery clinics. Biomedical solid waste was statistically similar to birth and general hospitals in both the public and private sectors, according to nonparametric statistics. In comparison to the similar public hospitals, private birth and general hospitals created statistically more waste. Infectious or toxic and toxic medical wastes accounted for

10% of total hazardous medical waste solid generated in the public cancer hospital and 50% in the university hospital (Komilis D, Katsafaros N, Vassilopoulos P, 2016)**.**The biomedical solid waste generation rate in Nigeria (2011) in eight hospitals found in Ibadan Metropolis revealed that the public

hospitals generated waste was between 0.37 to 1.25 kg/patient/day, while private hospitals generated between 0.12 to 0.28 kg/pt./day. Regarding the composition of biomedical solid waste, infectious waste represented 26 to 37%. (Wahab A, 2011)

In Kenya, the amount of infectious waste was higher than the general waste which indicates lack of proper segregation of waste (Global Enviromental Facility, 2009).

A study done in Amana District Hospital, Tanzania showed that the average medical solid waste generation rate was 1.8kg/patient/day. (I. S. Kagonji, S. V. Manyele, 2015).

Nearby, a study conducted in Hawassa City, Southern Nations, Nationalities and Peoples Region (SNNPR) Ethiopia (2011) revealed that 48.73% (range: 41.0-67.7%) was infectious and 6.16% sharps (range: 2.12_9.98%) (Rahman H,2017)/A study conduct in Gondar University Teaching Hospital (2007)) revealed that the average generation rate biomedical solid waste estimated based on the number of inpatient was 0.95 kg/bed /day and 0.142 kg/outpatient/day. There were statistically significant correlation among patient flow and the generation rate of biomedical solid waste with P-value less than 0.002 (Dagnew E, Hameed S, Seyoum L, 2017).

A study conducted in Addis Ababa, Ethiopia (2011) showed that non-hazardous healthcare waste(median: 58.69%, range: 46.89–70.49%) and hazardous biomedical solid waste (median: 41.31%, range: 29.5 –53.12%), the majority of which was infectious (median:13.29%, range:6.12-20.48%) and pathological waste (median:10.99%, range: 4.73-17.25%) and the rest sharps and pharmaceutical were (median: 8.74%, range:6.41-11.07%) and (median:6.14%, range:3.54-8.73%) respectively. The total quantity of biomedical solid waste generated from public hospitals was significantly more ($p<0.05$) But, there was no a statistical significant difference between the amount

of biomedical solid waste generated from public versus private hospitals (Debere MK, Gelaye KA, Alamdo AG, Trifa ZM, 2016).The literature analysis showed that the rate at which hospitals generate biomedical solid waste differs from hospital to hospital, even within the same country. In order to establish the rate of biomedical solid waste creation in hospitals, it is necessary to consider the nature and function of hospitals in Ethiopia, such as private, public, primary, general, referral, and teaching hospitals.

1.3.2 Hospital biomedical solid waste management practice

According to the World Health Organization, biomedical solid waste should be segregated by the person who produces each waste item based on potential hazard characteristics, treatment requirements, and disposal route by the person who produces each waste item (WHP, 2004)

For each kind of biomedical solid waste, separate labelled color code containers (infectious waste yellow, chemical and pharmaceutical waste brown, general waste black) should be supplied in each medical area.

Each medical area should have separate labelled color-coded bins for each category of biomedical waste (infectious waste yellow, chemical and pharmaceutical waste brown, general waste black).In each hospital room, closed color-coded labelled containers for temporary or short-term storage of biomedical solid waste (depending on the type of waste, not more than 12 hours) are stored away from patients indoors. Not more than three-quarters of a waste bag or sharp container should be used (WHO ,2005).

The collection period should be set and acceptable for the amount of waste, but should not exceed one day. To reduce the transit of laden carts into wards and other clean areas, biological waste collection must follow precise routes through hospitals. The useless waste materials should ideally be processed to lessen their potential health or environmental hazard and volume, with the residual residues being delivered for land disposal to a suitable place. After reduction or treatment, all biomedical waste systems will require access to land for final disposal of the leftover biological waste materials. Restricted access to avoid scavenging, daily soil cover to reduce odours, and frequent compaction and isolation of waste to prevent pollution of groundwater and neighboring regions are all desirable qualities of a landfill (WHO,2019)

It should be highlighted that no single solution is suitable for all types of biomedical solid waste or for all operational scales. Incineration, land filling, burning, autoclaving, and chemical treatment are all common technologies. Microwave disinfections, plasma touch technology, detoxification, and advanced wet oxidation are some of the newer technologies. In addition, India has created a new solar treatment method (WHO, 2019)**.** In bio-medical solid waste there are batteries, which come in all sizes and shapes, these substances contain toxic chemicals that should never be incinerated

(Kim EH, p. 2017)**.** Batteries depending upon types may contain mercury, lead, cadmium, and lithium. Some of the solutions related to the problems of battery waste are whenever possible, rechargeable batteries should be employed. When this is not possible, a careful battery rounds up 14 should be implemented to capture and recycle or appropriately dispose of the batteries (Prokopowicz A, p. 2015).In many hospitals mercury from damaged thermometers and blood pressure apparatus disposed without proper precaution could contaminate the environment (Stephen O, 2010),

If a country decided to use incineration as biomedical solid waste treatment choices it should be the national governments might utilize emission restrictions and other requirements to safeguard effective waste treatment, diminish emissions and also decrease exposure and risks to workers and the community (Eker HH, p. 2016).

The spread of blood borne pathogens in bio-medical solid waste motivated the world health organization also issue a policy in 2004 calling for the progress of national policies, guidance, and plans for biomedical solid waste management. The policy paper, however, also recognizes the risks associated

with incineration, which in developing countries can be problematic due to the lack of capacity for emission testing or regulatory enforcement (Global Environmental Facility (GEF), 2018).

A significant amount of Polyhalogenated Aromatic Hydrocarbons (PAHs) are found in the biomedical solid waste and those substances have been of concern over several decades because of their increasing occurrence and persistence in the environment and their biochemical waste and toxic effects(Labib OA, 2010)**.**

In India there have been improvements in the management of biomedical waste in the last decade and developing countries have been drown lessons from India's experience. Since 1995, India was made great progress in managing biomedical solid waste, nevertheless delays caused by weaknesses in the country's legal and institutional framework for biomedical solid waste management (Katoch S, 2007).The National Government has formulated biomedical solid waste Rules, prepared national guidelines, and implemented a national training program. Countries have devised their own biomedical solid waste management strategies and guidelines and provided assistance to government hospitals to implement biomedical solid waste management initiatives. Non-Governmental Organizations (NGOs) have played a major role in bringing the BMWs management agenda to the attention of government officials, creating public awareness of BMWs issues and training healthcare facility personnel (Patil AD, p. 2016).WHO in 2004 prepared a policy paper calling on developing countries and countries in transition to develop national policies, guidance manuals, and implementation plans for15sound management of biomedical solid waste (WHO, p. 2015).the management of biomedical waste in many developing countries has been often poor and it raises concerns about inappropriate BMWs management methods employed in such states. Inappropriate treatment and final disposal of BMWs, leads to an adverse impact on public health, occupational health and safety, and the environment (Chen SJ, p. 2017)**.**

A study done in South Africa showed that incineration was a leading option for treatment technology of biomedical solid waste with most of the incinerators situated on the healthcare facility sites. Similar to numerous first world countries, though, non-incineration technologies are quickly becoming the dominant treatment technologies, mainly due to increased costs associated with raised air emission control standards mandatory for incineration facilities (Kobus O, John C, 2018).In Ethiopia, there is no specific biomedical solid waste management legislation. However, there are policies and regulations with requirements that may offer a legal frame for the management of biomedical waste solid (MOH, 2008).

The Ethiopia Environmental Pollution Control Proclamation, No 300 of 2002, after defining hazardous waste as ―an unwanted material that is believed to be deleterious to human safety or health and the environment‖ pronounces the following prohibitions and restrictions in its management.―No person shall pollute or cause any other person to pollute the environment by violating the relevant environmental

standards (—Article3-subarticle1).Concerning the management of hazardous waste, it states that the generation, keeping, storage, transportation, treatment or disposal of any hazardous waste without a permit from the Environmental Protection Authority or the respective Regional Environmental Agency is prohibited (68), (MOH, 2008).

The Ethiopia 2000 Public Health Proclamation No.200 pronounces the following prohibitions and restrictions about hospital waste —Any solid, liquid and other waste generated from hospitals should be handled with special care and their disposal procedures should meet the standards set by the public health authorities. The proclamation neither provided a clear definition of the various categories of HCW nor did it indicate the legal obligations that biomedical solid waste producers have with regard to segregation, safe handling, treatment and disposal. In addition, it did not indicate specifications for record keeping and reporting, and inspection systems for enforcement of the law (FEPA ,2008).

The16 Environmental Impact Assessment Proclamation no.299/2002 requires proponents to undertake Environmental Impact Assessment (EIA) for those projects considered to have significant environmental impacts and listed as such in directives issued pursuant to this proclamation. According to the EIA guideline issued by the Federal Environmental Protection Authority (FEPA),

large hospitals waste incineration facilities, chemical treatment facilities and landfills for toxic, hazardous and dangerous waste are among the list of projects considered to have adverse and significant environmental impacts and hence require full environmental impact assessment (EPA,2005).A study conducted in Hawassa City showed that most (67%) of the healthcare Facilities (BMWs) had no segregation of waste at their facility. In two (22%) of the BMWs, the waste was segregated into sharps and other waste. Only one (11%) BMWs reported using a complete colour coding system (yellow puncture-proof plastic container for infectious waste, black for general waste and puncture-proof safety box for sharps waste).

However, even at this facility it was observed that general waste was frequently mixed with infectious waste. Six (67%) of the BMWs were did not use safety boxes for sharps, of them were to mix sharps with other waste in simple wastebaskets. The absence of waste segregation at most of those BMWs and the improper segregation in other facilities indicate a low level of awareness of the importance of waste segregation by those who manage the waste at those BMWs. For instance, the study results showed that in most of these BMWs, waste management issues were under the responsibilities of administrators, without health backgrounds, who probably have little knowledge about biomedical solid waste management (Israel Deneke H, Hanibale Atsbeha Z, 2011).

Another study conducted in 2009 on the Evaluation of Injection Safety and biomedical solid waste management in Ethiopia showed absence of segregation practices in 75% of the BMWs and mixing of

hazardous BMWs with other wastes in healthcare facilities in addition observed burning of BMWs in open holes, enclosures and open areas in 65% of the healthcare facilities (Habtetsion T, 2019)**.**

A study done by Crown (2007) in preliminary health center assessment findings from three Regions of Ethiopia in 2007 indicated that in some instances, improper use of incinerators were observed (USAID, 2007) .A study conducted in Addis Ababa (2011) revealed that almost in all of the hospitals there was no segregation of waste into infectious, pathological and pharmaceutical, and had no separate bins for the collection of infectious 17waste. Non-Hazardous biomedical waste was often mixed with infectious waste. Although four of the surveyed hospitals disposed of their waste on-site in their own incinerators and the other were disposed of at both off-site (non-pathological waste) and on-site (pathological waste), though the remaining one hospital disposed of the waste at off-site because the incinerator was not done at the time of data collection). Pre-treatment of highly infectious laboratory waste was also not done in any of the hospitals (Debere MK, 2013).

It is evident that much more can be done in terms of biomedical solid waste management, but in a developing country like Ethiopia, the handling of waste generated in healthcare institutions continues to pose significant health and environmental risks. As a result, developing countries must continue to make significant efforts to decrease the public health and environmental consequences of inefficient biomedical solid waste management systems. As part of promotional and preventive efforts, Ethiopia's health policy prioritizes the development of environmental health, the promotion of occupational health and safety, and the prevention of environmental pollution with hazardous chemical waste. There is no formal biomedical Waste Management Legislation in Ethiopia for the management of biomedical solid waste (Ethiopian Health Police of Transitional Government of Ethiopia ,1993).

In Ethiopia currently there are two national guidelines and one voluntary code of practice formulated independently by the Federal Ministry of Health and the second one were Federal Environmental Protection Authority and Quality Standard Authority of Ethiopia that exclusively deal with biomedical waste solid management (MOH, 2008) ,Because of inadequate, research data on the existing situation of biomedical solid waste management in the country, the national guidelines have been developed by considering the general situation in developing countries and based on the biomedical solid and biomedical solid waste guideline prepared by the United Nations Environment Program(p. Federal Enviromental Protection Authority2004).

1.3.3 Segregation of bio medical waste

Segregation practices across the country. Such waste segregation systems should rely on a consistent color coding system that provides a visual indication of the potential risk posed by waste in that container

and makes it easier to place waste items in the correct container and maintain segregation during transport, storage, treatment, and disposal (Harsh M, 2015).

Segregation should always be the responsibility of the producer and should take place as close to the source of the waste as possible (Rush brook P, 2014).

The bag and container must bear the international symbol and be made of leak-proof plastic bags or receptacles. To safely handle sharps, the container should be rigid and impermeable, retaining not only the sharp but also any residual liquid from the syringe. There is no color marking for radioactive waste containers, but they must be lead boxes labeled with radioactive symbols. The lead box will prevent material emissions (WHO, 2017b).

Health care management studies conducted in Amhara region HFs, Ethiopia, revealed the absence of segregation practice in 75% of HCFs and the mixing of hazardous HCW with other waste in the health care facilities; additionally, waste was scattered on the road surrounding the treatment site due to the use of substandard waste containers during transportation **(Teshiwal Deress, 2019**) According to a study conducted in Addis Abeba(2011), almost all hospitals did not segregate waste into infectious, pathology, and pharmaceutical waste and did not have a separate bin for infectious waste collection. Non-hazardous health care waste was frequently mixed with infectious waste. Another study conducted in Hawassa University's referral hospital (Debere, et, al,, 2017)

Another study conducted in Hawasa town revealed that the majority (67%) of health care facilities had no waste segregation at their facility by using complete color coding (yellow punctured –proof plastic container for infectious waste, black for general waste, and puncture –proof safety box for sharp waste(Asrate al, 2018).Another study conduct in Hawasa town showed that most (67%)of the health care facilities had no segregation of waste at their facility by using complete color coding (Yellow punctured –proof plastic container for infectious, black for general waste and puncture –proof safety box for sharp waste (Alamdo AG, 2017).

1.3.4 Collection of bio medical waste

Bio medical waste must often be stored prior to transport for final treatment and/or disposal site after segregation at the source of generation and collection. To avoid waste accumulation, waste must be collected on a regular basis and transported to the HCF's central storage area before being treated or removed. To reduce the passage of loaded carts through wards and clean areas, the collection must take a specific route through the HCF. The hospital staff should exercise extreme caution when handling BMWs in order to avoid occupational hazards.

The most serious risks are associated with the injuries that sharp can cause. When working with Bio medical waste, sanitary staff and cleaners should always wear protective clothing, which should include an overall or industrial apron, boats, and heavy duty gloves (WHO, 2004)

Collection should begin in the most hygienically sensitive medical areas (e.g. intensive care unit, dialysis, operating rooms) and proceed in a predetermined route around other medical areas and temporary storage locations. The frequency of collection should be refined over time to ensure that no waste containers are overflowing at any time (WHO, 2017b)

Collection time should be fixed and appropriate to the quantity of waste produced in each area of the health care facility .Generally waste should not be collected at the same time, or in the same time rolley, as infectious or other hazardous waste (WHO 2017b). However a study conducted in Addis Ababa city showed that the city administration has a primary and secondary mixed solid waste collection system there is no separate hazardous biomedical waste collection, transportation and disposal system and technologies. The biomedical waste in hospital was stored in black, yellow, and red primary storage containers. The biomedical waste in hospital was conducted in menellik –II referral hospitals indicate that the HCW was collected daily in the morning at 8; 00 AM (Atanafu and kumie, 2017).

1.3.5 on site storage of bio medical waste

Following bio medical waste collection on each ward, different section of the health care facility (HCF), there should be a well-designed temporary storage place in the compound, the size of which should be determined by the volume of waste generated as well as the frequency of collection. Inside the health care facility, a storage location for bio medical waste should be designated. When new construction is undertaken, space for waste storage should be incorporated into the design of the building. The size of these storage areas should be determined by the amount of waste generated and the frequency with which it is collected (WHO 2017b).

The study conducted in Hawasa University's referral hospital discovered that, with the exception of a few wards, the majority of departments (units) did not have temporary storage. As a result, when the buckets in the containers become full, patient attendants simply store or place waste on the floor or ground. There was no storage container outside the hospital for health care waste, patient attendants, or others. The area must be totally enclosed and separate from supply room of food preparation area. Only Authorized staff should be have access to the waste storage areas. Loading docks, space for compactors and balers, staging areas for sharp boxes, recycling containers, and secure storage for hazardous items such as batteries should all be provided (WHO , 2017b) unless a refrigerated storage room is available, the facility should not be located near food stores or food preparation areas, and access should always be

limited to authorized personnel. Cytotoxic waste should be stored separately from other health care waste in a designated secure location (Emmanel et al, 2016)

1.3.6 Transportation of bio medical waste

Biomedical waste should be transported within the hospital or other facility using wheeled trolleys, containers, or carts that are not used for anything else. The cart should be simple to load and unload, with no sharp edges that could damage waste bags or containers, and simple to clean (Emmanuel et al 2014). However, according to a study conducted in public health care facilities in the city of Adama, the majority of the devices used for non-site transportation of HCF were open or unprotected. (Asrat M, 2018).

Another study conducted in Meneilk –II referral hospital found that the majority of devices used for on-site transportation of BMW were closed bins with wheels. The waste on the municipal garbage tank (completely infectious) was stored for a minimum of one week and a maximum of three weeks before being transported to the city municipal disposal site by an outsourced private campaign (Atnafu and kumie, 2017).Furthermore, a study conducted in Addis Abeba city and Hawasa town health care facilities revealed that the majority of solid waste at the HCFs was discovered to be collected primarily in open plastic containers from the point of generation to the treatment area.(Hayleamicheal et al, 2017).

1.3.7 Treatment and Disposal of technology bio medical waste

In the selection of BMWMG technologies, the terms treatment and disposal are frequently used incorrectly interchangeably (Koscasoy,2017) clarify "treatment as an alteration of a waste stream or contaminated site in order to reduce, eliminate, or immobilize hazardous constituents," while "disposal implies disregard for return, and is thus considered to be permanent storage or release. According to the classification of the two terms, examples of treatment technologies include incineration and pyrolysis, microwave and autoclave sterilization, and chemical disinfection. In contrast, disposal technology includes the use of landfills and other similar methods (Kome,20115).According to the literature, the most common methods of disposing of biomedical solid waste, particularly in developing countries, are open dumping, land filling, or incineration (Hossain et al, 2018).Infectious waste health care waste poses a greater risk to health and should be treated before disposal; a variety of options are available, including incineration, chemical treatment, autoclaving, microwaving, and shredding/compacting (WHO, 2014)

1.3.8 Incineration of bio medical waste

In Ethiopia and elsewhere, incinerating medical waste is the most preferred and widely used treatment method. The waste management hierarchy is topped by incineration, which is followed by source reduction, reuse, recycling, and final disposal/landfilling. In the current study, approximately 94 percent of health facilities used burning as their preferred medical waste treatment method; 3 percent used 2-

chamber incinerators, 39 percent used 1-chamber incinerators, and the remaining health facilities, a significant number, used open burning as their medical waste treatment method (WHO, 2019).

Inadequate or inefficient medical waste incineration can result in the release of toxic pollutants into the atmosphere as well as bottom and fly ash, which contains toxic organic and inorganic compounds. Toxic emissions include organic emissions such as polychlorinated dibenzo-dioxins/furnace (PCDD/Fs) and polycyclic aromatic hydrocarbons (PAHs), inorganic emissions, and toxic metal ashes. These products are carcinogenic and have an impact on human development, reproduction, and immune systems. (WHO, 2018)

Incineration is a high-temperature process (8500c to 1100$_o$C).Dry oxidation is a process that converts organic and combustible waste into inorganic, incombustible matter, resulting in a significant reduction in waste volume and weight. Incineration is the most commonly used medical waste treatment method (WHO,2019)When properly designed and operated; the incinerator will destroy all biologically and chemically hazardous materials and reduce the volume of waste that needs to be disposed of to about 10% of its original volume.

The technique also has the significant advantage of rendering hypodermic syringes (" sharp") unusable by melting and/or deforming them and then oxidizing them into ash. Based on the requirements for the final disposition of any waste treatment process and the types of waste that may be classified as infectious, it appears that incineration is an environmentally responsible option for volume reduction, cost and convenience of handling the final product, and assurance of permanent disposal of potentially biologically hazardous materials(Harsh M, 2017).

1.3.9 Autoclave

The autoclave of biomedical waste is regarded as an alternative technology to incineration, but it is regarded as a more precise method than incineration (Jang,et, al,2006).This is due to the fact that autoclaves are a dual treatment option for biomedical solid waste management, and autoclaving waste necessitates another treatment method as a final method. Furthermore, it is incapable of handling large amounts of hazardous waste. Furthermore, autoclaves cannot treat a wide range of chemical and hazardous substances, including chemotherapy waste, mercury, volatile and semi-volatile organic compounds, radioactive waste, and other chemical wastes (UNEP 2012). It is not appropriate for or not suitable for treating large body parts, animal carcasses, or other large items that, due to their mass and characteristics, make heating the entire material to the prescribed temperature difficult or time consuming (.(Emmanuel et, al, 2014))

1.3.10 Open dump and open burning of bio medical waste

In developing countries, the most common method of biomedical waste disposal is open dump. This is most likely less expensive, and no other alternatives are available at this low cost. Although this is the cheapest option, open dumping has long been recognized as a potential source of public and environmental pollution. It is an uncontrolled and insufficient disposal option for biomedical waste because it is accessible to scavengers and animals (WHO, 2019)As a result, BW should not be disposed of on or near an operational dump. This is due to the fact that uncontrolled BM spreads infection pathogenic microorganisms to the environment. This is due to the fact that uncontrolled BM spreads infection pathogenic microorganisms to the environment through direct contact through wounds, inhalation or ingestion, or indirect contact with the or, food chain, or pathogenic host species (Emmanuel et al, 2014)

Each year, it is estimated that more than three million MBW are exposed to the stressful events of a pre-cutaneous injuries with a contaminated sharp object. In 2000, WHO estimated that contaminated syringe injection caused: 2.1 million HBV infections (32percent of all new infections),2 million HCV infections (40 percent of all new infections);and260,000HIVinfections(5percent of all new infections).Epidemiological studies show that a person who receives one needle–stick injury from a needle used on an infected source patient has a 30%,1.8%, and 0.3%& risk of becoming infected with HBV, HCV,and HIV,respectively (Rapiti et al , 2015).

1.3.11 Health impact of bio medical waste

Health-care activities generate waste, which can have a negative impact on one's health. Infectious components in biomedical waste, such as contaminated sharps and syringes, pose the greatest health risk due to the possibility of direct exposure to pathogens in blood and other fluids from patients via pre-cutaneous injuries (PI), abrasion, and a cut in the skin (Rapiti et al,2017).

We know that appropriate biomedical solid waste management can be achieved by: the presence of a responsible waste management team, the preparation of a compressive plan, the waste handlers being equipped with the most up-to-date information, skill, and practices, the allocation of adequate funding, the estimation of the quantities and types of biomedical solid waste, the use of enforced codes of practice and guidelines, and the provision of regular training (MOH 2008) The value of biomedical solid waste information has been highlighted in the literature review when creating a biomedical solid waste management intervention strategy. This inquiry (auditing biomedical waste in public and private institutions in the Region) was planned against this backdrop. The existing state of biomedical waste management in Africa, according to research findings, cannot ensure the safety of healthcare facility workers, patients, and the public. Instead, current mismanagement puts the public's health and the

environment in threat. In Ethiopia, as in many other African countries, the degree of safety in the handling and disposal of biomedical waste is quite low. Biomedical solid waste management is a major concern. The general assumption is that healthcare facilities lack proper biomedical waste management practices.

As a result, developing a biomedical solid waste management intervention strategy that can be implemented consistently in Bako primary hospital is serious. It is difficult to plan and establish an effective intervention strategy for better biomedical solid waste management. As a result, an examination of biomedical solid waste management techniques was required, as well as the determination of generation rate.

1.3.12 Conceptual framework of the study

According to the review literature, the rate of bio medical solid waste generation is directly affected by the number of patients (the number of patients determined by the type of service). Furthermore, the rate of biomedical solid waste generation can be affected by health care facility waste management practices, such as the presence of waste recycle practices and the proportion of disposable substance use in health care activities, which directly affect the amount of waste .generated.

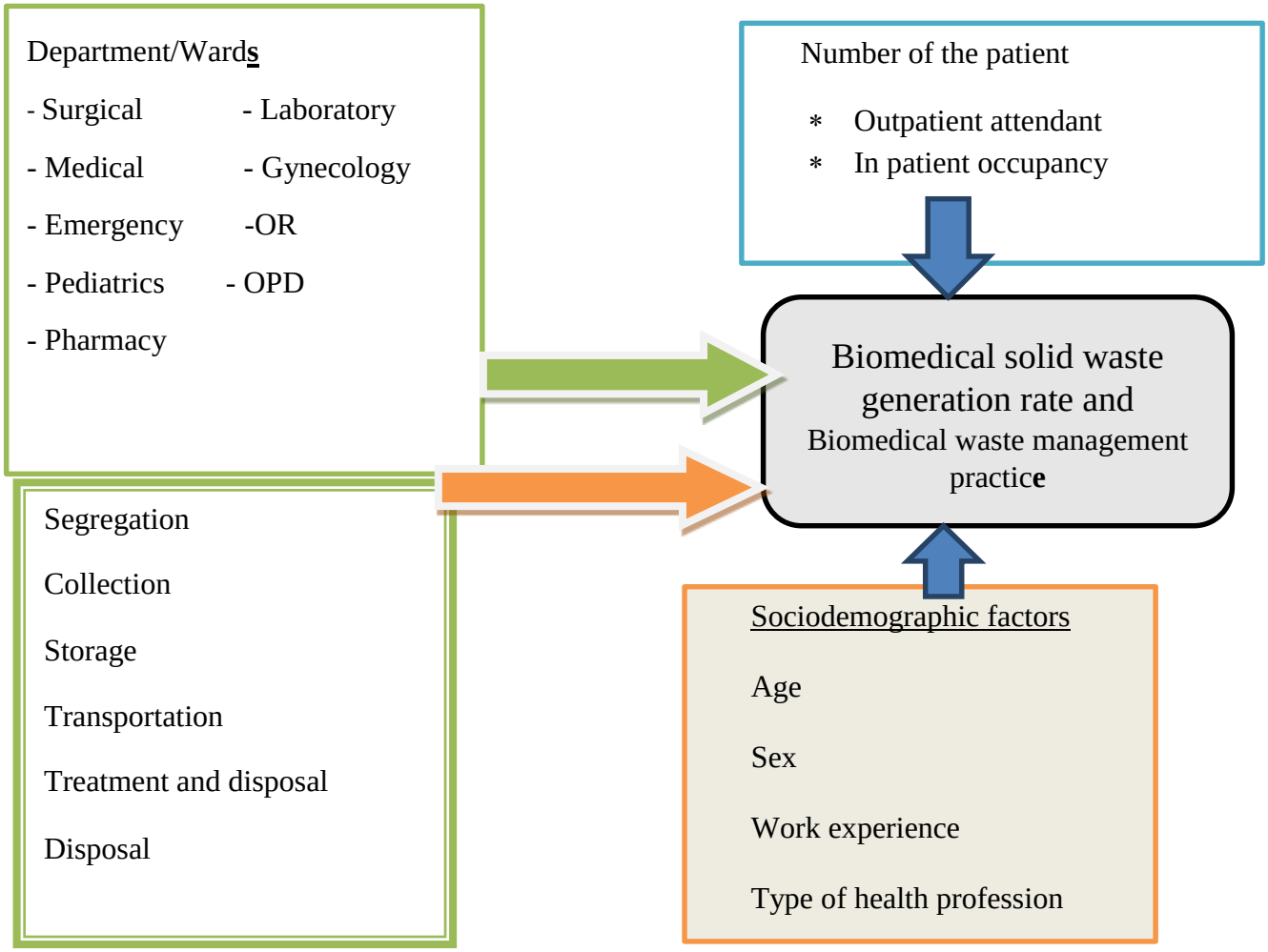

Figure 1: Conceptual framework showing the relation between factors affecting biomedical solid waste generation rate and its management practice, 2021.

3. OBJECTIVE

3.1 General objective

The general objective of this study was to assess the bio medical waste generation rate, and its management practice in Bako primary hospital, Bako town, West Showa Zone, Oromia Region, Ethiopia, 2021.

3.2 Specific objectives

To determine biomedical medical solid waste generation rate in Bako primary hospital.

To assess factors affecting biomedical solid waste management practice in Bako primary hospital.

4. METHODS AND MATERIALS

4.1 Study Area and Period

The study was conducted in different departments of Bako Primary Hospital, Bako town, west Shewa zone, Ethiopia, from July 12 to 18, 2021, which was built to serve providing medical services for the community. It is located approximately 251 km western of Addis Ababa, the capital of Ethiopia. It has an average altitude of 1760 m above sea level, its temperature ranges from a maximum of 18.2°C to 29.5°C and a minimum of 7–20°C and its annual rainfall ranges from 1200–2600 mm. It is currently the only primary hospital in Bako Tibe woreda west Shewa zone, offering services to around 64 beds, 32584 outpatient attendants 2007 inpatients, and for a catchment area of over 267,768 people. It has nine major wards, 124 different health professionals, 23 waste handlers and 40 different supportive employees. There are 5 health centers and 28 health posts in the woreda. The hospital, which was established in 2007 E.C.

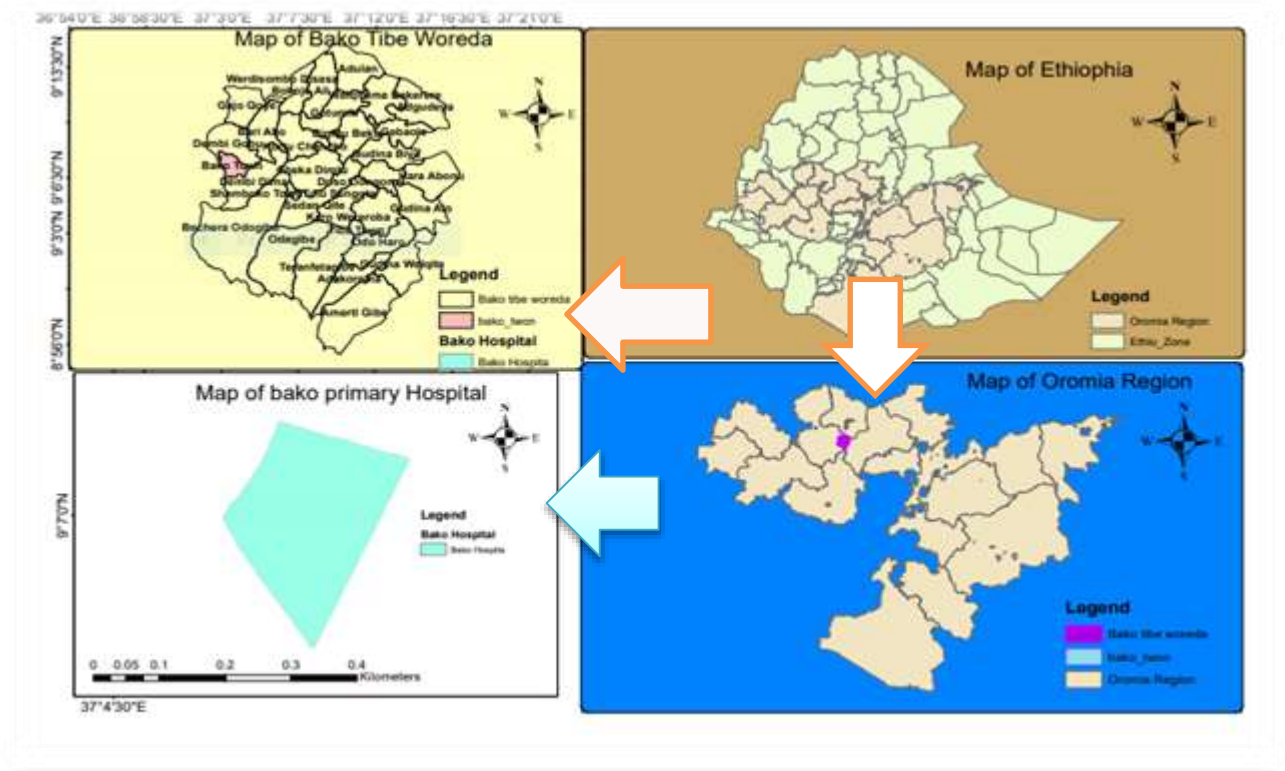

Figure 2: Source of Satellite image, 2021.

4.2 Study Design

An institution -based cross-sectional study design for quantitative and case study qualitative was used to assess the biomedical solid waste generation rate and management practice in Bako primary hospital.

4.3 Population

4.3.1 Source of population

All health workers at Bako primary Hospital for quantitative study and all department leaders and cleaners of Bako primary Hospital for qualitative study

4.3.2 Study population

All health workers working in Bako primary Hospitals for **quantitative** and all purposefully selected department leader's cleaners at Bako primary Hospital for **qualitative** study.

4.3.3. Study unit health workers who worked in the Hospital for quantitative and chief executive officer, Cleaners in the hospital, and all department leaders for qualitative study

4.4 .4 Inclusion criteria

A health professional who worked for more than six months at hospital

4.4.5 Exclusion criteria

Health workers who was not interested to respond questionaries'

4.4 Sample Size and Sampling Techniques.

Five from each department leaders, four cleaners, One Hospital manager (CEO), one medical director (MD) and one environmental health professionals for qualitative study and all health workers in Hospital were for quantitative study.

Table 4: Background information of Key Informant Interview and in depth Interview participants on Bio medical waste management Bako primary Hospital, West Shewa zone, Ethiopia, 2021

Participant characteristics	category	Number
Sex	Male	5
	female	7
Age	20-29	5
	30-29	3
	40- 49	4
Marital status	Single	4
	Married	8
Educational status	Primary	0
	Secondary	3
	Diploma	2
	Degree	6
	masers	1

For quantitative all health professionals (100%) in Bako primary hospital were participated on the study. The researcher was not use sample size calculation. Due to small size source population, the total health workers in Bako primary hospital were 124.

4.5 Data Collection Tools and Procedure

Interviewer administered structured questionnaire for quantitative data and interview guide for qualitative data. Plastic bags of various colors that based on criteria national guidelines and the type of waste generated, furthermore the waste was characterized in accordance with the National Healthcare Waste Management Guideline. (FMOH, 2008)The buckets and plastic bags were labeled to indicate the various categories of biomedical waste, the location of generation, the date and time of collection, and the type of waste.

The amount of biomedical solid waste generated was then measured by collecting and weighting waste generated from all wards for seven consecutive days using a calibrated weight balance. The existing biomedical solid waste management system at Bako Primary Hospital was investigated using -structured questionnaire interviews all health workers at Hospital. key informant interviews hospital CEO, department leaders ,environmental health office and in-depth interview with cleaners and an observational checklist, key interview guide and in depth interview guide line were adapted from the Ethiopian Food Medicine and Healthcare Administration and Control Authority (FMHACA) inspection checklist for BMW management in HCFs and International Committee of Red Cross(ICRC) .

4.6 Data Collection Techniques and Quality Management.

Data on waste generation were gathered using observational checklists and measurement equipment (weighting scale).The observational checklists were created in order to observe and evaluate how the hospital separates (segregate), collects, transports, treats, and disposes of waste. A standard weighing scale was used to calculate the rate of biomedical waste generation.

Biomedical samples were collected and measured on a daily basis for seven days in a row. Empty plastic buckets of standard color coding (**black** for general waste, **brown** for pharmaceutical waste, **yellow** for infectious waste, and **red** for pathological waste) were distributed to various sections of the hospital on a daily basis. Plastic bags of various colors coding were stored inside the appropriate buckets. The buckets and plastic bags were labeled with the various BMW categories, the location of generation, the date of collection, and the sample number. A waste weighing and recording station was set up in a convenient location. The collected waste were then removed in plastic bags every morning, and the weight was measured at (2:00local time) using a weighing scale with capacities ranging from 0.5 kg to 25 kg. The measurement was repeated three times, and the mean of the three measurements was used to calculate the final waste weight. The patient registration office provided data on the number of out patients and inpatient flow for the study period. The daily waste generation depends on the number of beds occupied and patients treated in outpatient departments were recorded daily. The biomedical waste generation rates were estimated because of kg/bed/day, kg/patient/day and kg/outpatient/day, as described by world health

organization pruss et al. (2013), Awad et al. (2004) and Engdaw et al. 2007. For data collection, two B.Sc. nurses, three nurses (data collectors), and one Environmental health (supervisor) were trained. Two-day training was conducted for data collection.

The purpose of the training was for data quality, the type of BMWs, the use and calibration of a weighing scale, infection prevention and control techniques, including proper PPE use, was provided prior to data collection. A data collection guideline was created and used to help with training. Data were entered into a suitable datasheet on a daily basis. Every morning, weight scales were set up and calibrated. In addition, investigators and supervisors were on-site every day. 12 key informant interviews were also conducted with the officer in charge of the facility and selected workers using semi-structured interview guide to understand the biomedical waste management practice.

Additional qualitative data were collected from workers who have direct and major contact with waste management through in-depth interviews to obtain details on the status of the hospital's waste management systems.Waste handlers, Key Informant Interview for medical doctors, hospital managers (CEO), all department leader, Environmental health officer, cleaners. a face-to-face interview was conducted using an interview tool (WHO,2013)guideline. The interview tool directs participants to discuss the hospital's waste segregation practice, how the hospital collects and transports waste, how the hospital finally disposes of waste, and how the waste is managed overall during COVID-19.All interviews were (photographed), and field notes were taken. Meanwhile, an on-site inspection was conducted to assess the status of the hospital's waste management systems.

4.7 Data Quality Assurance

The questionnaire was pre-tested in six respondents with similar characteristics to the study subjects in Gedo town Gedo hospital to identify potential problem areas with any of the questions. To assure the quality of the data, data collectors and supervisors were trained, and the questionnaire was pre-tested. Daily spot checks and reviews of completed questionnaires were conducted by the principal investigator and supervisors to guarantee the accuracy and consistency of the data collected.

All questions and checklists were logically tied to the variables examined and the overall study goals in order to promote validity. Furthermore, the instrument was constructed to measure all components of the variables and to use an existing instrument that had already been validated in other research, as well as calibration and standardization of the measuring equipment, all of which contributed to the study's validity. A peer assessment of the questionnaire is the first step in determining the measuring instrument's validity and reliability.

To ensure reliability during data collection, different strategies were employed. First, the measuring instruments were calibrated. Second, professionals were recruited for supervisors. In addition, two

Follow up sessions were conducted. There was also daily onsite supervision by the investigator during the actual measurements. A content analysis of the data from key informant interviews and observation were analyzed using thematic framework manually by categorizing and organizing according to thematic similarities and differences to understand relationships in the overall setting of the study. During data analysis, EPI info statistical software was used for data entry and cleaning. In addition, selected correct statistics also helped for the validity and reliability of the study

4.8 Study Variables

4.8.1 Dependent Variables

Biomedical solid waste generation rate

Biomedical waste management practice

4.8.2 Independent Variables

Outpatient attendant

In patient occupancy

Department/Wards

Sociodemographic factors

4.9 Operational definitions

A. Biomedical solid waste: All waste generated from different department /units such as medical, pediatrics, gynecology, OPD, surgical, operation room, laboratory, pharmacy and emergency the hospital.

B. Biomedical solid waste generation: The amount of waste generated from the hospital for a period of seven consecutive days from July 12-18/2021.

C.Hazardous waste: Includes sharp, infectious, pharmacological and pathological wastes generated from studied in the hospital.

D. Non-hazardous waste: waste that has not been infected. E.g. general office waste, packaging, or left over food in the hospital.

E.Sharps waste: Used and unused sharps (e.g. needles, syringes, and blades) from studied in the hospital.

F. Pathological waste: Include human body parts, and fetuses in the hospital.

G. Segregation: It's separation of BMW into general, sharps, infectious, Pharmacological and pathological waste from the hospitals.

H. Infectious waste: Waste suspected to contain pathogens (e.g. waste contaminated with Blood & other body fluids; laboratory cultures & microbiological waste) in the hospital.

4.10 Data management and Analysis

The raw quantitative data collected from the field was coded before entered into Epi-Data version 3.1. After the screening and correction of the data entry mistake, then data was exported to SPSS version 25 for analysis. The analysis of biomedical solid waste generation rates among wards was descriptive analyzed and computed by one-way ANOVA and the relation between patient follows and total waste generated confirmed by person correlation further more waste management analyzed by bivariate logistic regression these independent variables<0.2 p-value as candidate and analyzed final result by multi variate logistic regression .Manually analyzing qualitative data from key informant interviews and observation Theme analysis of the data was carried out manually, with material being sorted and organized based on thematic similarities and differences. The data was then categorized and analyzed to determine the linkages between it and/or within the study's larger context. The total amount of garbage created and its type were compared among several case teams using the Kruskal–Wallis test because the data distribution was not homogeneous (with unequal variance) even after Transformation.

To see if there was a bivariate relationship between the total number of patients and the total amount of healthcare waste generated, researchers employed Spearman's rank correlation Coefficient (rs), by dividing the mean healthcare waste creation rate in kg per day by 365 days, the annual healthcare waste generation rate was computed.

4.11 Data Quality management

To ensure data quality, data collectors were trained prior to collection and the weighing scale was calibrated before the actual measurements began. During the actual measurements, the supervisor was on-site every day. To ensure the trustworthiness of the data collection tool, key Informant interview, questionnaires, observation checklists were pretested with a pilot survey of a similar study population at the nearest hospital prior to the actual data collection period.

4.12 Ethical Consideration

A formal letter of permission to conduct the study was obtained from the JU research committee office to communicate with the zonal health office and hospital administrative and Permission letter was obtained from Bako primary hospital administrative to communicate with relevant study population for both quantitative and qualitative data. Finally, verbal consent was obtained from the respondents included in the study immediately before the interview.

4.13 Dissemination Plan of Study Findings

After the analysis and interpretation of the data, the necessary information was disseminated to concerned bodies, the research and publication office, Bako Primary Hospital, Bako Tibe Woreda Health office, Bako Tibe Administration office and Jimma University.

Table 5: Description of Socio-demographic characteristics of the study participants with the response rate =124(100%)

Variables	Category	Frequency (124)	Percentages (%)
Sex	male	58	46.8
	female	66	53.2
Age	20-30	25	20.2
	31- 40	51	41.12
	41-50	18	4.6
	>50	30	24.2
Professional category	nurse	98	79
	pharmacy	7	6
	laboratory	10	8
	medical doctor	9	7.3
work experience	0-3 yrs.	30	24.2
	4-10 yrs.	47	37.9
	11-15yrs	25	20.2
	>15 yrs.	22	17.8

A total of 124 respondents in Bako primary hospital were included with 100% response rate. Around half of, 53.2% of the respondents were female and whereas 46.8% of the respondents were male. About (20.2%) respondents were found age between 20-30 years old. Majority of the respondents age between 31-40yearsold were (41.12%).The majority,79% of the respondents professional category were nurse; whereas 6%, 8% and7.3% were pharmacy, laboratory and medical directors on their occupational status respectively. Below half of the respondents (24.2%) have work experiences around 0-3 years and 37.9%, 20.7% and 17.8 of the respondents have a work experience of 4-10yrs ,11-15yrs and >15 years and above on their work experiences respectively.

CHAPTER FIVE RESULT

5. RESULTS

5 .1 The Waste Generation Rate of the Hospital.

A total of 797 patients have visited Bako primary Hospital during data collection time (within one week) in all health service delivery units. Of these, 442(55.5%) patients were admitted to the (IPD) inpatient department and 355 (45.5%) were seen at OPDs.

The total mean biomedical solid waste generated within one week were 303.99kg/week and from those proportion 216.32 was hazardous waste or risk waste (71.2%) and the remaining 87.67(28.8%) general waste was produced.

The types of hazardous wastes generated in Bako primary Hospital were sharps, infectious, pharmaceutical, and pathological(placenta and blood) waste and also waste generated (**0.381kg**/**pt**./day and **0.69kg**/bed/day was produced by one patient.

The measured daily, monthly and annual total waste generation rate were 0.381kg/pt./day and 0.69kg/bed/day and monthly were 11.43kg/pt./month,20kg/bed/month whereas annual total waste generation rate were 110,956 kg/pt./year or 251.85kg/bed/year and monthly waste generated waste was produced totally (**Table 6)**

Table 6: The types of waste and their generation rate at Bako primary Hospital, Bako town, Ethiopia 2021.

Waste type	Weight of daily generated waste(mean in kg ±SD)	%	Weight of daily generated waste (Kg/patient/day)	Weight of daily generated waste (kg/bed/day	Weight of yearly generated waste (kg/year)
General	87.67± (12.52)	28.839	0.11	0.149	31,999.55
Pathologic	36.7± (5.242)	12.072	0.046	0.062	13,395.50
Infectious	129.35±(18.47)	42.55	0.162	0.219	47,212.75
Pharmaceutical	9.67± (1.38)	3.181	0.012	0.016	3,529.55
Sharp	40.6± (5.8)	13.355	0.050	0.069	14,819.00
Total	303.99±(43.427)	100	0.381	0.69	110,956.35

#797Total patients visited the hospital during the data collection period; ∗∗there were a total of 442 IPD attendants in the hospital during the data collection time.

5 .2 Weekly distribution of Hazardous Waste and General Waste in Different Service Units.

Gynecology and emergence ward waste were highly waste generated weekly and least amount of waste was generated from pharmacy wards. However, the highest share of the pathological waste was from the gynecology unit 59.97kg/week, 46.4kg/week, whereas less amount of hazardous waste generated from pharmacy wards 17.27 kg/week, and respectively **(Figure 4**)

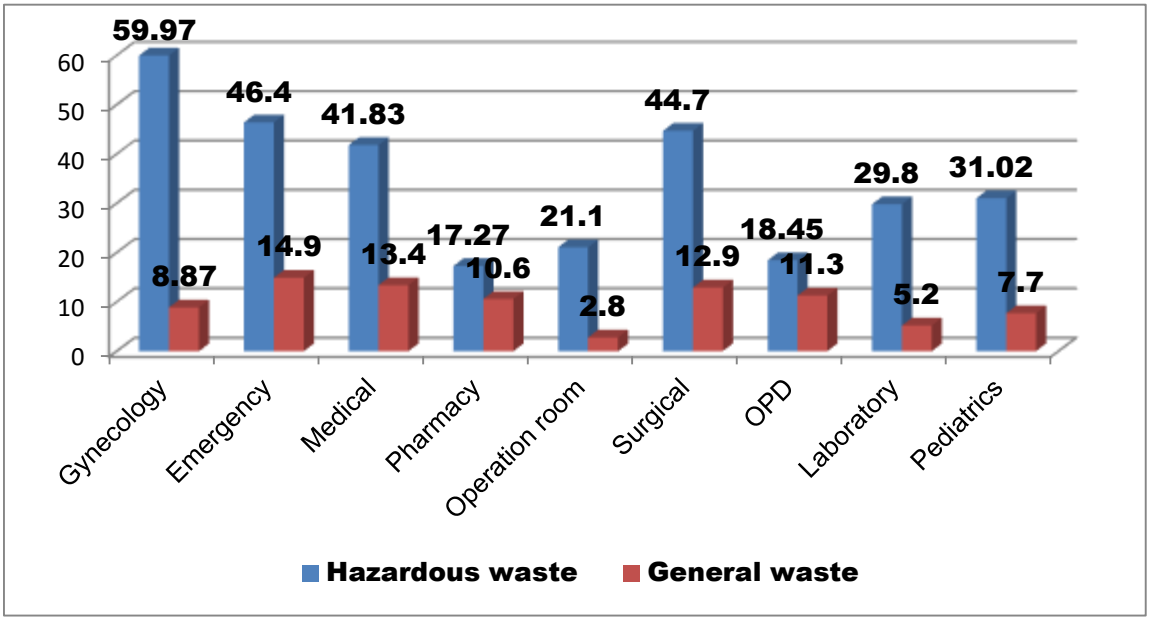

Figure 4**:** Weekly Distribution of types and amount of hazardous and general biomedical solid waste generation rate at each service unit of Bako primary hospital, Ethiopia, July, 2021

5. 3 Comparison of Hospital Waste Generation among Different Service Units.

The Kruskal–Wallis test indicated a statistically significant (X2 42.1, $p < 0.011$) difference in daily biomedical solid waste generation rate among different case teams. This implies that the type or specialty of case teams was a factor for the generation rate of MMWs. Spearman's rank Correlation coefficient (rs) estimation showed a strong positive linear relationship between the amount of hospital waste generation and the total patient flow ($r = 0.7$, $p = 0.001$) (**Table 7**)

Table 7: Comparison of patient flow, total BMW generation, and its type using the Kruskal–Wallis test in each case team in Bako primary Hospital, Ethiopia, 2021.

Types of case teams	Patient flow, n (%)	Total hospital wastes, n (%)	General BMW, n (%)	Hazardous BMW, n (%)	p-value
Gynecology	71(8.90)	56.97(18.74)	8.87(0.10)	48.1(22.35)	0.000
Emergency	156(19.57)	46.4(15.16)	14.9(0.17)	31.5(14.56)	0.000
Medical	67(8.15)	41.83(13.76)	13.4(0.15)	28.43(13.14)	0.000
Pharmacy	102(12.79)	20.27(6.66)	10.6(0.12)	9.67(4.47)	0.002
Operation room	21(2.63)	15.8(5.19)	2.8(0.03)	13.3(6.14)	0.001
Surgical	72(9.03)	44.7(14.7)	12.9(0.14)	31.8(14.70)	0.000
OPD	154(19.32)	16.0(5.26)	11.3(0.13)	5.6(2.588)	0.000
laboratory	101(12.67)	29.8(9.80)	5.2(0.01)	24.6(11.37)	0.000
pediatrics	53(6.64)	31.02(10.20)	7.7(0.08)	23.32(10.796)	0.000

The Pearson correlation coefficient (r) was used for testing the presence of somewhat bivariate correlation between the daily total amount of biomedical solid waste generated and the total number of patients who visited the primary Hospital on a daily basis. Accordingly, there was a strong positive correlation between the amount of biomedical solid waste generated and total patient flow ($r = 22.631^{**}$, $p = 0.001$).

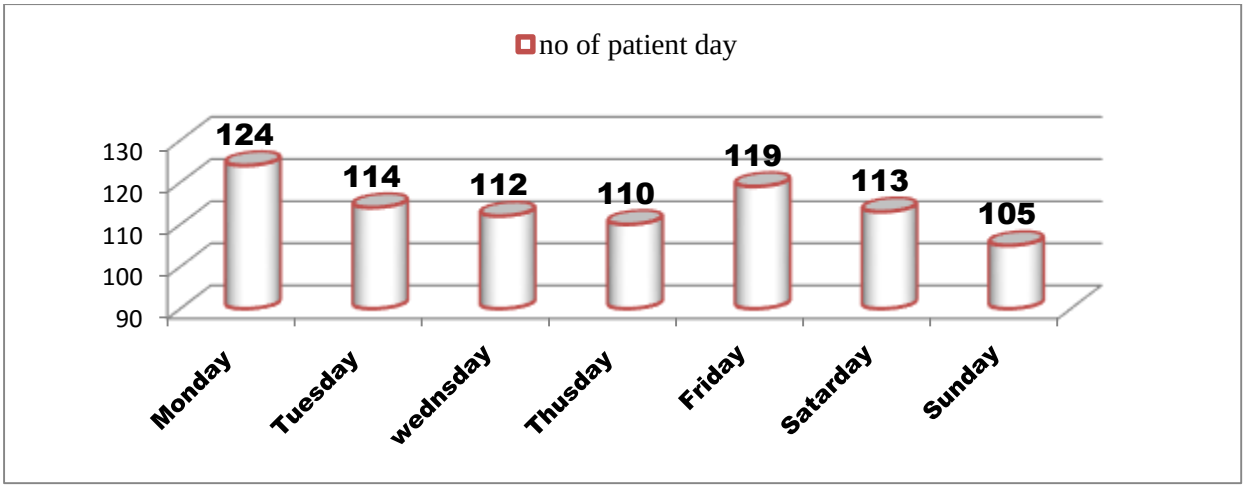

Figure 5: Comparison of Daily Biomedical Solid Waste Generation Rate and Patient Flow in Bako primary hospital, Ethiopia, 2021.

5.4 Biomedical Solid Waste Generation Rate in Different Wards

The daily average biomedical solid waste generated in gynecological and pharmacy wards were of Bako primary hospital was 43.43±18.6kg/day and 17.27±5.467kg/ day, respectively. A great amount of biomedical waste was generated from the gynecology ward (43.43±18.6kg/day. (19.72%), whereas fewer amounts of biomedical waste were generated from the pharmacy wards (17.27±5.467kg/day (5.681%).There was a statistically significant variation in the average biomedical solid waste generation rate in different wards (F =17.287, p = 0.003) (**Table 8**)

Table 8: Total Biomedical Solid Waste Generated in Different Wards by Type of Waste within 7 Days of Data Collection Time in Bako primary Hospital, Bako town, Ethiopia, 2021.

Type of ward /department	Biomedical Waste Generation Rate (kg/Week)								
	Sharps (kg/day)	Infectious (kg/day)	Pharmaceutical (kg/day)	Pathological (kg/day)	General Waste (kg/day)	Total	Mean	SD	% by weight
Gynecology	4.5	23.1	3	20.5	8.87	59.97	23.567	3.91	19.72
Emergency	8	23.5	0	0	14.9	46.4	6.628	4.29	15.26
Medical	6	17.43	0	5	13.4	41.83	5.975	6.25	13.76
Pharmacy	0	0	6.67	0	10.6	17.27	5.467	1.85	5.681
Operation room	2.9	4.2	3	8.2	2.8	21.1	3.014	3.17	6.941
Surgical	9	22.8	0	0	12.9	44.7	6.385	4.25	14.70
OPD	1.35	3	0	2.8	11.3	18.45	2.635	2.05	6.069
Laboratory	4.6	20	0	0	5.2	29.8	4.257	6.29	9.802
Pediatrics	4.3	16.02	0	3	7.7	31.02	4.431	6.24	10.20
Total kg/week	40.6	129.35	9.67	36.7	87.67	303.99	43.427	16.64	100

5.5 Socio demographic characteristics of the respondents (n=124) in Bako primary hospital, Bako town; west Shewa zone, Ethiopia 2021.

A total of 124 respondents in Bako primary hospital were included with 100% response rate. Around half of, 53.2% of the respondents were female and whereas 46.8% of the respondents were male. About (20.2%) respondents were found age between 20-30 years old. Majority of the respondents age between 31-40yearsold were (41.12%).The majority,79% of the respondents professional category were nurse; whereas 6%, 8% and7.3% were pharmacy, laboratory and medical directors on their

occupational status respectively. Below half of the respondents (24.2%) have work experiences around 0-3 years and 37.9%, 20.7% and 17.8 of the respondents have a work experience of 4-10yrs ,11-15yrs and >15 years and above on their work experiences respectively.

'Bivariate analysis of Biomedical Solid Waste Management Practice with sociodemographic and other factors. During bivarte analysis age of respondent, sex, professional category and work experience analyzed from that the only age, sex and work experience of respondent were candidate for multivariate analysis (**Table 9).**

Table 9: Bivariate analysis of factor affecting biomedical Solid Waste Management Practice with sociodemographic factors at Bako primary hospital, west Shewa zone, Ethiopia, 2021.

Variable	Category	Waste Segregation		COR(95%CI)	P-Value
		Yes no (%)	No no (%)		
Age	20-30yrs	12(48)	13(52)	1	0.00
	31-40yrs	21(41.2)	30(58.8)	0.12(0.29-0.502)	**0.004***
	41-50	5(27.8)	13(72.2)	0.159(0.043-0.592)	**0.005***
	>50	3(10)	27(90)	0.289(0.060-1.398)	0.123
Sex	male	32(55.2)	26(44.8)	1	0.00
	female	19(28.8)	47(71.2)	0.328(0.156-0.690)	**0.003***
Profession category	nurse	42(42.9)	56(57.1)	0.667(0.159-2.821)	0.582
	pharmacy	3(42.9)	4(57.1)	0.667(0.87-5.127)	0.697
	Laboratory	3(30)	7(70)	1.167(0.168-8.090)	0.876
	M/Doctors	3(33.3)	6(66.7)	1	0.00
Work experience	0-3yrs	12(40)	18(60)	0.33(0.090-1.231)	**0.099***
	4-10yrs	19(40.4)	28(59.6)	0.327(0.96-1.121)	0.075
	11-15yrs	6(24)	19(76)	0.704(0.170-2.911)	0.628
	>15yrs	4(18.2)	18(81.8)	1	0.00

In above table * indicate, variables which who have p -value less than 0.25 in bivariate analysis and candidate for multivariable logistic regression. The finding from multivariate analysis showed that the Odd of biomedical waste segregation age between 20-30 yrs. 0.153 time more likely than those age of greater than 50 years.[AOR=0.153:95% CI(0.036-0.654). Similarly the odd of biomedical waste

segregation and storage of health workers at age 31-40 yrs. 0.119 times more likely than those at age of greater than 50 years age.[AOR=0.119:95% CI(0.030-0.474).

Furthermore, the odd of biomedical waste Segregation and storage of female health workers2.624 times more likely than males.[A0R=2.624: 95% CI(1.039-6.627)

Table 10 : Multivariate analysis of factors affecting of Biomedical Solid Waste Management Practice with sociodemographic factors Bako primary hospital, west Shewa zone, Ethiopia, 2021.

variable	Category	Waste Segregation		COR(95%CI)	AOR(95%CI)	P-Value
		Yes no (%)	Yes no (%)			
Age	20-30yrs	12(48)	13(52)	0.12(0.29-0.502)	0.153(0.036-654)	**0.011****
	31-40yrs	21(41.2)	30(58.8)	0.159(0.043-0.592)	0.119(0.030-0.474)	**0.003****
	41-50	5(27.8)	13(72.2)	0.289(0.060-1.398)	0.319(0.064-1.578)	0.161
	>50	3(10)	27(90)	1	1	0.00
Sex	Male	32(55.2)	26(44.8)	1	1	0.00
	female	19(28.8)	47(71.2)	0.328(0.156-0.690)	2.624(1.039-6.627)	**0.041****

In above table * indicate, that variables who have p <0.05 in multivariate analysis.

'Bivariate analysis of Biomedical Solid Waste Management Practice with sociodemographic and other factors. During bivarte analysis age of respondent, sex, professional category and work experience analyzed from the age, sex, professional category and work experience of respondent were not candidate for multivariate analysis of Waste collection **(Table 11).**

Table 11: Bivariate analysis of waste collection with age, sex, professional and work experience.

variable	Category	Waste collection		COR(95%CI)	P-Value
		Yes no (%)	No no (%)		
Age	20-30yrs	13(52)	12(48)	3.03(0.957-9.61)	0.059
	31-40yrs	27(52.9)	30(58.8)	2.921(1.065-8.011)	0.037
	41-50	24(47.1)	13(72.2)	3.286(0.939-11.500)	0.063
	>50	9(50)	9(50)	1	**0.00**
Sex	male	34(58.6)	24(41.4)	1	0.00
	female	38(57.6)	28(42.4)	1.044(0.511-2.134)	**0.906**
Profession category	nurse	59(60.2)	39(39.8)	0.529(0.134-2.09)	0.364
	pharmacy	3(42.9	4(57.1)	1.067(0.145-7.822)	0.949
	Laboratory	6(60)	4(40)	0.533(0.086-3.307)	0.500
	M/Doctor	4(44.4)	5(55.6)	1	0.00
Work experience	0-3yrs	23(59)	16(41)	0.835(0.217-3.212)	0.793
	4-10yrs	34(63)	20(37)	0.706(0.191-2.614)	0.602
	11-15yrs	9(45)	11(55)	1.467(0.335-6.430	0.612
	>15yrs	6(54.5)	5(45.5)	1	0.00

Bivariate analysis of Biomedical Solid Waste Management Practice with sociodemographic and other factors. During bivarte analysis age of respondent, sex, professional category and work experience analyzed from the age, sex, professional category and work experience of respondent were not candidate for multivariate analysis of onsite waste handling (**Table 12**)**.**

Table 12: Bivariate analysis of onsite waste handling with age, sex, professional category and work experience.

variable	Category	onsite waste handling		COR(95%CI)	P-Value
		Yes no (%)	No no (%)		
Age	20-30yrs	6.730(36)	6.730(64)	1.778(0.600---5.266)	0.299
	31-40yrs	12(23.5)	39(76.5)	3.250(1.238 --8.529)	**0.017***
	41-50	6(33.3)	12(66.7)	2.000(0.594-- 6.730)	0.263
	>50	15(50)	15(50)	1	**0.00**
Sex	Male	24(36)	42(63.6)	1	**0.00**
	Female	18(31)	40(69)	1.270(0.600- 2.686)	**0.532**
Profession category	Nurse	28(28.6)	70(71.4)	1.778(0.600-5.266)	0.299
	pharmacy	0(0)	7(100)	3.250(1.238-8.529)	**0.017***
	Laboratory	9(90)	1(10)	2.000(0.594-6.730)	0.263
	M/Doctors	5(55.6	4(44.4)	1	**0.00**
Work experience	0-3yrs	14(35.9)	25(64.1)	1.488(0.384--5.770)	0.565
	4-10yrs	18(33.3)	36(67.7)	1.6670(0.448--6.207)	0.446
	11-15yrs	5(25)	15(75)	2.500(0.525--11.894)	0.250
	>15yrs	5(45.5)	6(54.5)	1	0.00

Bivariate analysis of Biomedical Solid Waste Management Practice with sociodemographic and other factors. During bivarte analysis age of respondent, sex, professional category and work experience analyzed from the age, sex, professional category and work experience of respondent were not candidate for multivariate analysis of Waste treatment and disposal (Table 13)**.**

Table 13: Bivariate analysis of waste treatment and disposal with age, sex, professional category and work experience.

Variable	Category	Waste treatment and disposal		COR(95%CI)	P-Value
		Yes no (%)	No no (%)		
Age	20-30yrs	17(68)	8(32)	1.778(0.600--5.266)	0.299
	31-40yrs	32(62.7)	19(37.3)	3.250(1.238--8.529)	0.017
	41-50	9(50)	9(50)	2.000(0.594 --6.730)	0.263
	>50	18(60)	12(40)	1	**0.00**
Sex	male	48(48.3)	18(27.3)	1.270(0.600--2.686)	0.532
	female	28(48.3)	30(51.7)	1	0.00
Profession category	nurse	54(85.7)	44(14.3)	3.125(0.782--12.495)	0.107
	pharmacy	6(85.7)	1(14.3)	2.564(.000—0.12	0.999
	Laboratory	9(90)	1(10)	0.139(.012--1.608)	0.114
	M/Doctors	9(77.8)	1(22.2)	1	0.00
Work experience	0-3yrs	21(53.8)	18(46.2)	3.125(.782--12.495)	0.107
	4-10yrs	32(59.3)	22(40.7)	2.564(.000—0.00)	0.999
	11-15yrs	16(80)	4(20)	0.139(.012--1.608)	0.114
	>15yrs	7(63.6)	4(36.4)	1	0.00

The finding from multivariate analysis showed that the odd of biomedical waste segregation age between 20-30 yrs. 0.153 time more likely than those age of greater than 50 years.[AOR=0.153:95% CI(0.036-0.654). Similarly the odd of biomedical waste segregation and storage of health workers at age 31-40 yrs. 0.119 times more likely than those at age of greater than 50 years age.[AOR=0.119:95% CI(0.030-0.474). Furthermore, the odd of biomedical waste segregation and storage of female health workers 2.624 times more likely than males.[A0R=2.624: 95% CI (1.039-6.627). significantly associated with biomedical waste management practice after adjusting in multivariate analysis.

Table 14: key informant interview participants for describing waste management practices in Bako primary Hospital, Ethiopia, 2021.

Hospital health workers	No
Environmental health expert	1
Department heads	5
Waste handler team leaders	4
Medical doctor	1
Hospital manager	1
Total	12

Notes: Department heads selected from Pharmacy, laboratory, gynecology, OPD and IPD while Waste handler team leaders from twenty-three waste handlers four were purposefully selected depend on their potential waste generated and high patient flows such as gynecology, OPD, IPD, and laboratory.

5.6 Qualitative results at end the following four themes are formed and summarized

1 problem of waste segregation practice

2, problem of waste collection and transportation practice

3, Shortage of supplies materials

4. Waste treatment disposal problem practice

5.6.1 Theme 1: problems of waste segregation practice

In this category participants' reflect on the inappropriate waste segregation at Bako primary hospital most of them complained that there was no culture of waste segregation based on infection prevention guide line among health care workers and fear of being injured with sharp and infectious waste.

IDI -1: 27-yrs-old female participant stated that ''yeah! Nobody could separate waste from this hospital except few female health workers even they mix sharp needles with other waste which is to be injury us during waste disposal''.

IDI- 2: 21-yrs.-old female participant reported that'' Yes! For first time our leaders told to us whether three basket or bag needed for waste collection but it was not in practical in each wards
only one basket available so, any health workers through any kinds of waste to that basket whether it was sharp or not any way we are always in threat ''.

KII –3: 32- yrs.-old male participant stated that ''yeah! Really it was planned to apply infection prevention by giving awareness for health care workers at all wards, however it was not applicable''

KII -3: 27- yrs.-old male participant reported that ''yes! The usage of color-coded and labeled waste containers at the site of generation was not implemented and only the segregation of sharp waste utilizing the safety box was practiced, placentas and blood-stained cotton pads were stored in separate containers''.

5.6.2 Theme 2: problem of waste collection and transportation practice.

Based on researcher observation and the majority participant report the hospital waste were temporarily stored in open dustbins that could attract insects, flies ,cat/dogs and they were also prone to spill over; these could potentially contaminate the environment that can cause disease and injury to those exposed to them. This quoted by the following sentence.

KII-2: 33 yrs. old female participant stated that ‘’yes! As a leader I request the necessary supplies for waste collection based on infection prevention guide line however I couldn’t got from store most of them stock out and waste transportation methods was employed by manually by waste handlers’’.

KII -1: 35 yrs. old male participant reported that ‘’yeah! Most of supplies obtained from donors therefore it had no continuity therefore for future we will have planned to purchase just like others drugs’’

5.6.3 Theme -3: Shortage of supplies materials

The majority of respondents complained on lack of personal protective apparatus such as heavy duty glove thick-soled boots, and leg protectors were identified as a resource related factor for waste segregation, storage and transportation.

IDI-4: 25-yrs-old female participant reported that ‘’yes! There was scarcity of supplies especially on personal protective supplies and disinfectant so this needs urgent solution ‘’

KII-1: 32 yrs. old male participant sated that ‘’yes! On supplies there was shortage but now we will have planned to purchase directly from Pharmaceutical agency’’.

5.6.4 Theme- 4: waste treatment and disposal problem practice

The majority of respondents complained open burning and incinerator was the common methods of disposing of biomedical solid waste in the hospital had incinerator which are made from breaks and these incinerators had poor efficiency due to lack of regular maintenance and the air inlet parts were blocked with ash. Ash disposal pit were not employed because of full of erosion.

KII -7: 27yrs old male participant stated that ‘’Yeah! The fence of the incinerator was not maintained regularly; as a result, goats from a nearby resident simply entered through the opening’’.

KII-8: 27-year-old male participants reported ‘’yes! Adverse health consequences of infectious waste, solid waste on patients, medical staffs, workers, and neighbors during waste transportation' Bad odor, fugitive dust, and pest damage caused by BMW to the environment and the hospital had placenta pit to dispose open placenta (unsafe) for the environment and for all hospital staff’s’.

KII- 12: 23years old male participant stated that ‘’yes! Hospital had an attempt to treat infectious waste before dispose of using either barakina or alcohol while the autoclave was used to treat biohazard waste at their laboratory rooms, operation room and gynecology wards’’.

Figure 6: Photo shows, hospital biomedical solid waste temporal storage at the point of sources in Bako primary hospital, Ethiopia, 2021.

Figure 7: Photo shows, biomedical solid waste collection and transportation in Bako primary hospital, Ethiopia, 2021.

Figure 8: Photo showing incinerator, open pit, open burner container and open placenta pit (unsafe) for hospital respectively, used for waste disposal of all types of biomedical solid waste in Bako primary hospital, Ethiopia, 2021.

CHAPTER SIX DISCUSSION

6. DISCUSSION

The average biomedical solid waste generation rate in Bako primary hospital was determined to be 0.69kg/bed/day and 0.318/patient/day. The result of this study was lower than a study conducted in the USA (2.79 kg/bed/day) and Bahrain (1.177kg/patient/day as mentioned in a WHO report (Al-thukair AA 2017) .

The higher biomedical solid waste generation rate in high income countries may be due to the higher per capita gross domestic product (GDP), that is, the developed nations' due to more services than others, which tends to generate a higher amount of waste in HCFs. But current study results was higher when compared with the study conducted in public healthcare facilities in Bujumbura, Burundi(0.22kg/patient/day), (Besufekad Mekonnen 2020) and Almost similar with study conducted at the municipal hospital of Ghana(0.39kg/patient/day),and lower than the local study conducted in Mizan- Tepi University Specialized Hospital(0.073kg/bed/day (Nahom Solomon 2021)and lower than the Gondar teaching hospital(0.37kg/patient/day (Wondimagegn 2017)The differences in average waste generation rates could be speculated to result from the differences levels of healthcare facilities, types of service offered and, on a country to country basis, on the level of economic development.

The current study lower than the study done in USA 2.79kg/bed/day, Bangladesh 0.934kg/bed/day , primary hospital in Ethiopia at national level 1.1 kg /bed/day, Gonder 0.95kg/bed/day, and greater than the study done at Mizen tape Hospital 0.073kg/bed/day .

Moreover, according to WHO, developed countries generate on average up to 0.5kg of hazardous biomedical solid waste per hospital bed per day, while low-income countries generate on average 0.2kg of hazardous biomedical solid waste per hospital bed per day. However, the results from this study identified about 0.69kg/bed/day of total biomedical (hazardous) waste generated from Bako primary hospital, which was not corresponding with the stated WHO value. The major reason for the high percentage of bi medical solid waste generation may be due to there was no waste segregation practiced in the Bako primary hospital, which probably may increase the biomedical solid waste generation rate.

The results of this quantitative and qualitative study confirmed that there was weak segregation of biomedical solid waste into different categories using color-coded containers and labels. This finding is consistent with study done Somaliland and Kenya (Ali M, 2018) and inconsistent with a study

conducted in different hospital in Mizan primary Hospital Southwest, Ethiopia (Nahom Solomon, 2020).

These indicated that the implementation of biomedical waste segregation strategy varied from hospital to hospital in Ethiopia and also varied from country to country this may be due to lack of training for health care workers on waste segregation. This idea also supported by (WHO, 2005) (Lars M.2014)stated that the first priority among waste management practice is segregation of waste at the point of generation. The current study showed that Bako primary waste mixed waste were collected and transported in a carton or open plastic bins and not labeled at the point of generation. The waste were scattered on the surrounding treatment and disposal sites due to the use of substandard waste containers. This was also contributing to the risk of infections for health care providers, patients, visitors and the neighboring community.

Handlings of biomedical solid waste were dangerous activities in poor segregation practice, because biomedical waste containers were not labeled. The health care workers are obligated to put biomedical waste in wrong bins (Pudussery K, 2016).

The odd of biomedical solidwaste segregation practice health workers at age 31-40 yrs. 0.119 times higher than those at age of greater than 50 years workers. It might be respondents who are in the older age group relative with the other age categories put health care waste in a wrong bin, because there is ignorance and fatigue of health care workers to put health care wastes in appropriate bin. **(**Pudussery K, 2014)

The odd of biomedical solid waste segregation practice age between 20-30yrs. workers 0.119 times higher than those ages of greater than 50 years workers. Those old age health care workers less likely gave attention to segregate waste when compare to young age health care workers .The possible reason for this one was the old age health care workers not rushed on procedure then they were disposed waste at appropriate place. Because there is ignorance and fatigue of health care workers to put health care wastes in appropriate bin. (Pudussery K, 2014)

The odd of waste segregation practice among female health care workers 2.6 times higher than those male health care workers. This idea also supported by qualitative study results.

IDI -1: 27-yrs-old female participant stated that ‘’yeah! Nobody could separate waste from this hospital except few female health workers even they mix sharp needles with other waste which is to be injury us during waste disposal’’

The possible reason for this female health care workers had special gift to give attention for something than male similarly those old age health care workers more less likely gave attention to segregate waste when compare to young age health care workers .The possible reason for this one was the old age health

care workers not rushed on procedure then they were disposed waste at appropriate place. The qualitative study also support the quantitative result it was categorized in to four themes problem of waste segregation, problem of waste collection and transportation, Shortage of supplies and waste disposal. The majority participant complain about waste segregation stated that main problem for that un availability of continuous supplies and negligence of some health care workers and even the temporary storage area was not appropriate it has no lids and attracts flies, rodent and other insect based on current research finding the researcher concluded the following points.

Biomedical solid waste segregation

The segregation consists in separating of different waste based on the hazardous characteristics of waste. Based on the world health organization assessment only about 10-25% of biomedical solid waste are hazardous, the management of biomedical solid waste costs could be greatly reduces if a proper segregation were implemented. Segregation of biomedical waste also decreases the risk of infecting workers handling waste (Pruss, A 2013).The biomedical solid waste should be segregated by using colour containers (Askarian . M ,2014)

The research conducted in different countries revealed that biomedical solid waste segregation practices varies in different countries; such as the study conducted in Libya, Brazil, Nigeria, Iran, Ghana, South Africa, and Ethiopia confirmed that, hazardous biomedical solid waste were stored in the same containers as domestic waste(Debere. M,2016).These creating a great risk to the hospitals staffs, the public, and the environment (C.E. Silva, 2016). Whereas the study conducted in Greece, Mongolia, Portugal, China and India showed biomedical waste were segregated according to the characteristics using colour coding and/or labelling of waste containers (Desalegne, S.2017)

Temporal storage of biomedical solid waste

The place where the biomedical solid waste is kept before transporting to the final disposal site is termed as a temporary waste storage area (Kabi . G, 2013).Intermediate storage takes place in a specially designed storage area in order to avoid biodegradation, odours, and the attraction of insects and rodents (Bdou. A, 2017).The comment practices in Jordan, Nigeria, Libya, South Africa, and Ethiopia were no special storage area/room for biomedical waste, waste store temporary in open containers which creates potential threat (Nemathaga. F, 2015).On the other hand, in Greece, Mongolia, and Portugal the biomedical waste stored in a room equipped with screen for fillies and rodent protection, clearing facilities and well ventilated (Tsakona. M, 2016).

Collection and transportation of biomedical solid waste

Biomedical waste should be collected and transported in a regular base. The collection of biomedical waste must follow specific routes through the hospitals in order to reduce the passage of loaded carts

through wards and other clean area. The carts should be easy to load and unload, free from sharp edges that could damage waste containers, and easy to clean (WHO ,2005).The study conducted in many developing countries showed that biomedical solid waste collected and transported in open plastic containers; this was possibly due to lack of awareness which could lead to direct exposure to hazardous substance for waste handler (Harhay.M,2016).Whereas in developed countries biomedical waste were collected and transported by different closed containers with specific colour codes through pre-established routes, which include specific corridors and elevators on each floor(Hossain. M,2015).

Treatment of biomedical solid waste

The purpose of biomedical solid waste treatment is to decrease the potential hazard posed by waste, while attempting to protect the environment (Pruss. A , 2012).The study conducted in developing countries reviled that the commonest method of biomedical waste solid treatment was done by poor design and construction incinerators have low combustion capacity (Richard .K ,2017).Such types of incinerators have public health risk from incinerator emissions are driven largely dioxin, furan and A high amount of ash are generated because of the incomplete burning of biomedical waste (WHO , 2015). Pre-treatment of highly infectious lab waste was not done in many hospitals found in developing countries like Ethiopia, Ghana, Nigeria, and South Africa (Kummerer. K,2018)

Disposal of biomedical solid waste

Biomedical solid waste disposal is an important problem for public health and the environment (Mostafa.G, 2014).Because biomedical waste contains infectious materials, genotoxic chemicals, heavy metals like mercury, Poly Vinyl Chloride (PVC), and radioactive substance(WHO ,2015).Many researches confirmed that, the problems were higher in developing countries for example, the study conducted in Libya, Ghana, Iran, and Nigeria showed that, hospitals disposed of their waste , along with general domestic waste , in an open dumping site outside of their compounds (Bassey. B,2015).Other countries like Ethiopia, South Africa, Tanzania, and Botswana untreated biomedical waste and the waste from incineration residues openly dumped on-site (Mbongwe. B ,2014).These lead to environmental pollution problems, fires, higher risk of diseases transmission and open access to scavengers and animals (Emmanuel. R, 2017).Whereas, the biomedical solid waste disposal within the countries of the European Union (EU) and China were strictly control by law in order to prevent the negative consequence of hazardous biomedical solid waste on the human health and the environment (Botelho, 2012).

Biomedical solid waste management training

Biomedical solid waste handling is a hazardous activities; workers should be trained before starting work handling waste, and then on a regular basis (Townend. W ,2015) .The training focus on the safe waste handling procedures, nature of the work in the hospital, the hazards and possibility of worker exposure,

and the responsibilities of individual workers (Arash .M ,2015). Best practices in biomedical waste management require that workers received repeated training (WHO ,2014). In some countries like Libya, Nigeria, and Ethiopia there were no regular formal training program on biomedical waste management (Longe. E,2013).While others such as India, Iran and Uganda; have repeated training and instruction about appropriate biomedical waste management to take adequate precautionary measures in handling biomedical waste (Dehghan.i M, 2018)

The waste segregation, collection, transport, treatment, and disposal practices of the Bako primary Hospital were substandard. In this crisis time, all people in the region are recommended to protect themselves from cross contamination by using different PPE. Surprisingly, the waste handlers, the priority groups to use PPE, in Bako primary Hospital were facing the scarcity of the PPE such as safety boots and facemasks.

They were not using their duty gloves, and this might be due to the lack of awareness creation strategies such as training since they were also reporting that they did not take any training which guides them on how to handle wastes during this critical time. Waste were also collected with an open container, and some of the wastes were ended up with open dumping. Furthermore, the absence of standard operating procedures and the biomedical solid waste management committee was an important finding in the hospital.

Waste were also collected with an open container, and some of the wastes were ended up with open dumping. Furthermore, the absence of standard operating procedures and the biomedical solid waste management committee was an important finding in the hospital. This is in contrary to the national and international (WHO) recommendations of proper biomedical solid waste management practice in Bako primary hospital (Powell-Jackson.et al, 2016).

CHAPTEER SEVEN CONCLUSIONS AND RECOMMENDATIONS

7. CONCLUSIONS

The average biomedical solid waste generation rate in Bako primary hospital was (0.69kg/bed/day and/or 0.381kg/patient/day), which was higher than the world health organization (WHO) threshold value for hazardous biomedical solid waste generation rate in low-income countries, and it was poorly managed. There was lack of appropriate biomedical solid waste segregation with different waste categories at point of generation and insufficient waste collection equipment's in most of all in different departments. Age, sex, professional category, work experience, biomedical solid wastes were all factors that influenced biomedical solid waste management practice.

The finding of this study confirmed that standard biomedical waste segregation was lacking in the hospital. Therefore, all biomedical solid waste were mixed with the general waste that leads to the total biomedical solid waste generated to be considered both infectious and hazardous. The waste was collected and transported using a non-standard encoded container and hence both the collection and transportation systems were ineffective to protect the environment from contamination. The use of low combustion single-chamber incinerators for the treatment of biomedical solid waste contributes the release of huge amounts of air pollutants to the environment. Overall, the biomedical solid waste management systems in Ethiopia were almost not yet installed and produce an environmental pollution and potential health risk. Therefore, all biomedical solid waste were mixed with general waste and collect ,transported using substandard open plastic bag. Moreover, the incinerator and placenta pit was operated as in poor management ways. Low level of awareness about the importance of implementing appropriate biomedical solid waste management systems are predominant in many developing countries. For better result we need to increase the level of training and education regarding biomedical solid waste and environment-friendly health care with optimum priority, under rules and regulation. There is an urgent need to be establishing standard biomedical solid waste management at all healthcare facilities in developing nations especially in primary hospital.

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7.1. RECOMMENDATIONS

This research has demonstrated, a lot of gaps regarding proper biomedical solid waste management in the hospital. The following are recommendations regarding the different aspects of biomedical solid waste management that requirement to be communicated to ensure proper handling and disposal in order to protect the environment and the public.

Policy makers (Ministry of Health and Regional Health bureau)

The proper development and implementation of an information-based biomedical solid waste management strategic plan has significant benefits for hospitals. There is a critical need for raising awareness and education on biomedical waste issues. This must be supported by a representative and fully functional biomedical solid waste management structure, which is able to monitor and control all biomedical waste management activities.

Develop rules, regulations and operational guideline for the management of biomedical solid waste in health facilities nationwide.

Hospital administrators (service providers)

Waste generators should play very crucial role to ensure proper handling, transportation, and disposal of the waste they generate. The hospital biomedical solid waste management emphasizes the duty of care as one of the responsibilities of the biomedical solid waste generator. The employer is entrusted with the responsibility of providing a safe working environment, protection of the environment and public health. Proper education and awareness should be implemented in all hospitals. Adequate budgeting allocation, regular training and investment in biomedical solid waste management should be implemented by the hospital administrators.

Record keeping is also the responsibility of the waste generator. It is important for a number of reasons, such as being a management tool, providing a baseline for measuring progress in terms of implementing the biomedical solid waste management plan.

The hospitals must have a waste management plan, drafted after a properly conducted biomedical waste audit. Data on biomedical solid waste collection, segregation, transportation, storage, disposal, protective equipment, education, training and awareness must be included in the waste management plan. The hospital must have a functional and accountable hospital biomedical waste management structure that meets on a regular basis and which is assigned the responsibility of evaluating progress in terms of the implementation of the biomedical waste management plan.

Researchers - Further research

Further studies should consider for the impact of intervention on biomedical solid waste management system were not studied; therefore, study should be conducted on the evaluation of the effectiveness of

measures taken on biomedical solid waste storage, collection, transportation, treatment disposal and other involvement for the improvement of biomedical solid waste management.

7.3. Strength and limitation of the study

7.3.1 Strength of the study

The use of different approaches (semi structured interview and observation) to measure and recognize the problem was one of the study's primary strengths. Checking the weighing scale calibration before starting the data collection.

7.3.2. Limitations of the Study

Because no similar studies were undertaken during COVID-19, the assessment was made with studies conducted prior to the pandemic. Furthermore, because our research was conducted at a single location, it could not be practice to other situations

Liquid waste management was not considered in this systematic study. Furthermore, the biomedical recycling efforts for reusable products were not taken into account.

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Institute of health science, faculty of public health department of environmental health science and technology.

1. **Information on verbal consent sheet**

Greeting!

Introduction and objective; I am _____postgraduate student from jimma university, Institute of health science. I am conducting the study Bio medical solid waste generation rate and its management practice.

Benefit and harms: This study will contributes in interventions to promote safe bio medical solid waste management practice in the medical Centre. So participating in this study means you are playing role of adoption of changes (intervention) to be made) to minimize potential threats to public health and environment. You will receive payment for your participation. It also contributes for intervention to mitigate the impact of different gaseous pollutant that generated from the incinerator which is affecting the nearby community.

Confidentiality: The information you will be kept strictly confidential, your name will not be registered and will never be used in connection with any information you tell us. I would like assure your participation will not have any effect at all on your health or other administrative service that you get from the hospital

Right of the participation : Your participation is voluntary and you are not obligate to answer any question , if you fill discomfort with the interview , please fill free to drop it at any time you want .

Moreover, you can ask any question which not clearly for you concerning this interview.

Responsibility: If you want to be sure the realability, you can contact;

Tesfalem Getahun (PhD, Candidate)

Dessalegn Dadi (PhD, Assistant professor)

Contact address; Tel: (+251)962229523 or E- mail tesfisho@gmail.com

: Tel: (+251) 911784061 or E-mail dessalegndadi@yahoo.com

Jimma University, Department of Environmental health science and technology

Dr.Sable Work mokenen (PhD, Associated professor)

Head, Department of Environmental Health science and Technology, Faculty of public health, Jimma University, Ethiopia.

Contact address; Tel: (+251) 910882128 E-mail seblework2001@yahoo.com

Consent form; Are you willing to participate in this study?) Yes____no _____

I. Annex

Data collection tools

1. Name of data collectors_____
2. Signature _____
3. Type of ward _____
4. No of bed occupied_____
5. Date _____

Time _____

Seven consecutive day biomedical waste generation sheet by Departments (kg/day)

Hospital Name---------- Code---------

Departments	Monday	Tuesday	Wednesday	Thursday	Frida	Saturday	Sunday	Total
OPD								
Pharmacy								
Laboratory								
Pediatrics								
surgical								
medical								
Gynecology.								
Emergency								
Operation room								
TOTAL								

Seven consecutive day healthcare waste generation sheet by hospital & BMW type (kg/day)

Hospital Name---------- Code---------

Waste category	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
General								
Sharp								
Infectious								
Pathological								
Pharmaceutical								
Total								

Seven consecutive day healthcare waste generation sheet by hospital & BMW type (kg/day)

Hospital Name---------- Code---------

Observational check list for assessing for BMSWM practices

I. Waste segregation

1. Is waste separated into at least three clearly labeled bins at the point of generation? a) yes __ b) no___
2. If yes, is a proper waste segregation system in place, based on bin color coding? A) yes__no__
3. Is the hospital use, national standard color coding option) a) yes___ b) no_____ If you don't specify _____
4. Is there a written procedure for segregation? a) yes___ b) no _____
5. Personal protective equipment (PPE) is readily available. a) yes___ b) no____
6. Are there any visible aids or instructions near the waste bins to assist with correct waste separation?? a) yes ___ b) no _____
7. Is waste separated into at least three clearly labeled bins at the point of generation? a) yes __ b) no___
8. If yes, is a proper waste segregation system in place, based on bin color coding? A) yes__no__
9. Is the hospital use, national standard color coding option) a) yes___ b) no_____ If you don't specify _____
10. Is waste separated into at least three clearly labeled bins at the point of generation? a) yes __ b) no___
11. If yes, is a proper waste segregation system in place, based on bin color coding? A) yes__no__
12. Is the hospital use, national standard color coding option) a) yes___ b) no_____ If you don't specify _____
13. Is there a written procedure for segregation? a) yes___ b) no _____
14. Personal protective equipment (PPE) is readily available. a) yes___ b) no____
15. Are there any visible aids or instructions near the waste bins to assist with correct waste separation? a) yes ___ b) no _____
16. Is the hazardous waste containers labeled with the word ‘’ Hazardous waste ‘’? a) yes__b) no _
17. Is the word "hazardous waste" printed on the hazardous waste containers? A) yes b) no ___

II**. Waste collection**

1. Is the waste collection do with time table of frequency of collection? a) yes ___ b) no____

a. Sharps (collected when ¾ yes____no_____

b. Infectious waste (collected daily) yes_____no_____

2. Proper labeling yes_____ no_____-

3. Availability of vehicle (trolley) yes _____ no _____

4. Availability of supply of vehicle? yes_____no_____

5. Availability of PPE Yes _____no _____

18. Is waste separated into at least three clearly labeled bins at the point of generation? a) yes __
b) no___

19. If yes, is a proper waste segregation system in place, based on bin color coding? A) yes__no__

20. Is the hospital use, national standard color coding option) a) yes___ b) no_____
If you don't specify _____

21. Is there a written procedure for segregation? a) yes___ b) no _____

22. Personal protective equipment (PPE) is readily available. a) yes___ b) no____

23. Is the hazardous waste containers labeled with the word ‘’ Hazardous waste ‘’? a) yes__b) no _

24. Is the word "hazardous waste" printed on the hazardous waste containers? A) yes b) no ___

25. Is the hazardous waste containers labeled with the word ‘’ Hazardous waste ‘’? a) yes__b) no _

26. Is the word "hazardous waste" printed on the hazardous waste containers? A) yes b) no ___

27. Is the hazardous waste containers labeled with the word ‘’ Hazardous waste ‘’? a) yes__b) no _

28. Is the word "hazardous waste" printed on the hazardous waste containers? A) yes ___b) no___
Is the hazardous waste containers labeled with the word ‘’ Hazardous waste ‘’? a) yes__b) no _

29. Is the word "hazardous waste" printed on the hazardous waste containers? A) yes b) no ___

II. **Waste collection**

6. Is the waste collection do with time table of frequency of collection? a) yes ___ b) no____

c. Sharps (collected when ¾ yes____no_____

d. Infectious waste (collected daily) yes_____no_____

7. Proper labeling yes_____ no_____-

8. Availability of vehicle (trolley) yes _____ no _____

9. Availability of supply of vehicle? yes_____no_____

10. Availability of PPE Yes _____no _____

III. **Waste storage**

1 Is there enough storage space? a)yes __ b) no ____

1. Place of room
Nearby to treatment unit a) yes _____b) no_____

Easily accessible for transportation a)yes_____b)no_____

Away from food storage for preparation a)yes_____b)no _____

3. The storage area must have sufficient space that is easy to clean and disinfect, as well as an impermeable hard-standing base, suitable water supply, drainage, and ventilation, and be shaded from the sun Lockable /secured storage room and a) yes _____ b) no_____

2. The universal biological hazard symbol shall be posted on the storage area door, yes____no_____
3. Waste containers a) yes_____b) no_____
4. . Is there a labeled and lidded biological solid waste storage container? a) yes___b) no_____
5. Can infectious waste be kept for no more than two days before being handled or disposed of, and can a safety box be kept for up to one week? a)Yes___b)no _____
6. Is it required that cleaning materials, protective clothing, and waste bags or containers be kept close to the storage area? a) yes ____b) no_____

IV. **Waste transportation**

1. Availability of appropriate waste transport wheel/trolley/ cart? a)yes___b)no____
2. Proper handling of waste during transportation a)yes____b)no___
3. A space for cleaning vehicle and linked with sewerage line(drainage) a) yes_____b)no_____
4. Is there availability of cleaning agents and disinfectants ?a)yes ___b)no___
5. Availability of PPE a)yes___b)no____

V. waste treatment

1. Is sharp and infectious waste treatment before disposal a)yes___b)no_____
2. If yes, what type of method used_____?

a) Incineration

b) On site clean sterilization

c) Gas vapor sterilization

d) Thermal inactivation or chemical disinfection

3. Availability of PPE a)yes____b)no_____

VI. Waste disposal

1. What kind of biomedical solid waste disposal system does your health care facility use recently?
   a. Presence of incinerator a)yes___ b)no ___

   If yes, type of container

i. Controlled air double chamber incinerator a)yes__ b)no____
ii. Rotary kiln a)yes_____ b)no_____

iii. Pyrolytic incinerator a)yes____ b)no____

iv. Specify if other type_____

a. Condition of incinerator (functional , distance)

b. Open burning a)yes___b)no_____

c. A availability of placenta pit a) yes___b) no____

d. Land disposal a)yes___ b) no____

If yes, 1-open dumps to municipal disposal site a) yes_____b)no_____

a. Proper disposal of BMSW a) yes__ b)no____

b. A availability of PPE a)yes_____b) no_____

II: Key informant interview questionaries'

Medical director

General information of the organization

1. Name of the organization _____
2. Type of the organization _____
3. How many beds? _____
4. How many average patient/days? _____
5. Is there fulltime assigned staff for BMW management? A) yes____b)no _____
6. Is there any policy and procedure? a)Yes _____b) no _____

A. Its Organizational set up

6.1. Is there full-time management staff allocated to BMW? a) Yes____b)no_____?

A.Envirmental health/ public health professional a)yes _____b)no _____

B. sanitary engineer a) yes____b)no _____

C. waste handlers a) yes_____b)no _____

7. Is there afunctional committee for infection prevention and patient safety/biomedical solid waste management a) yes_____b)no_____?

a) .Availability of Guide line /directives a) yes_____b) no_____

b. SOPs a)yes_____b)no_____

c. Recording and reporting system a)yes ____ b)no____

8. Availability of solid waste management plan? a)yes_____b)no_____

9. What department are responsible for BMWM at your healthcare facility?

a. Health and safety_____

b. Maintenance /facility_____

c. Environmental health _____

d. Nursing _____

e. Other specify _____

Waste management officer

B. Waste minimization

1. Is the waste minimization policy being followed, i.e., reducing the amount of waste generated at the source (reduced packaging, returning containers to the supply)? A)yes___b) no___
2. Is it possible to prevent reusing the needle and syringe? A) yes ___ b) no ____
3. Are purchasing policies in place to reduce hazardous waste, such as PVC-free and mercury-free supplies, the use of less toxic substances, and safe injection equipment? a)yes___ b)no _____
4. Is chemical and drug purchase centralized? Is stock management adequate (has the quantity of unused or expired medications been reduced a)yes____ b)no____

C. WASTE POLICY

1. Is there some national legislative provision on waste management? a)yes ___b) no ___
2. Is there any national waste management plan? a) yes____b) no ____
3. Is there any national waste management plan in the health facility itself? A)yes___ b)no__
4. What is the local practice regarding anatomical waste? a)yes ___b)no _____
5. Is any budget allocated to waste management? a)Yes____ b) no _____

D. TRAINING

1. Has the national developed any training material, or is external training material available? a) yes__ b)no _____
2. Have all staff member been trained? Are course held for new staff member and when never change are made in the waste management plan? a)yes___ b) no ___
3. Is the content of the training adjusted to suit each category off staff? a)yes___ b)no _

E. INFECTION CONTROLL OFFICER

Staff protection measure

1. Are regular checks carried out to ensure that protective measures are taken? a)yes __ b) no ___
2. Is the PPE appropriate for the activity concerned, and is it worn correctly? A)yes___b) no _
3. Do employees wear glove regularly when in contact with waste? A) Yes__ b)no _____
4. Do employees in contact with the waste wash their hands properly and regularly? A) yes__b)no
5. Have all staff member been vaccinated against HBV and COVID -19? A) Yes ___b)No __

6. Is there a system for dealing with accident involving exposure to blood or other body fluids (posters/notice concerning the measure to be taken, post- accident care, and registration?)

a) Yes _____b) no _____

7. Is every staff member aware of the emergency measure to be taken in to the event of an accident, spilling, or splashing / spraying ? a) yes____ b)no _____

Hospitalaa Bakkooti raga halaa kosii jajjaboo madisisuu guyyaa torbaa fi ittifufinsaan Kan sassabamuu ta'aa, kutalee (kg/day)

Maqaa Hospitalaa _____ kodi _____

Observational check list for assessing for Biomedical solid waste management practices

Dawwnaattin halaa ittin kosileen jajjaboon kuni dalgamaa jiruu ilaaluu ta'aa. (Observational check list for assessing for biomedical solid waste management practices)

1.Kosii walitti qabuu (Waste segregation

1. kosiin walitti qabamani kuni adda addaa bahan, mallatooni itti ta'ee bakka burqa isaatti ta'ee jiraa a) Eyyee _____b) Lakkii _____

2. Yoo, eyyee ta'ee, halaa garii ta'een walitti qabame, mallatoo qabaa? a) Eyyee__b) lakkii ___

3. Hospitalii kuni qajjelfamma nationalaa egee mallatto itti godhee ni dalagaa? a) eyyee _b) lakkii ___ Yoo, hin beekinee ibsii _____

4. Halaa tartibaa kosiin walitti qabamuu bareffamma qabduu? a) eyyee __b) lakkii_____

5. Yeroo hundaa ufataa balaa irraa isiin bararuu

6. Qajjelfamma halaa ittin hojjii keessaan dalgidaani itti fayyadamittani ofii biraa qabatanii hojjetuu? a) eyyee___b) lakkii_____

7. Kosiiwaan suma'aa ta'ani mallatoo suma'aa ta'uu isaa Kan ibsuu qabduu? a) eyyee ___b) lakkii _____

8. Jechaa suma'aa jedhuu irratti barreffamee maxxanee jiraa? a) eyyee ___b) lakkii____

I.Kosii waliitti qabuu (waste collection)

1. Kosii walitti qabamuu kuni yeroo jedhamee keessatti ittifufinsaa ta'aa jiraa?

a) eyyee__b) lakkii_____

A.lilimoon yoo ¾ ta'uu walittii qabamaa? a) eyyee ____b) lakkii _____

B.Balfaa cimmoo guyyaa guyyaa walitti qabamuu? a) eyyee ____b) lakkii _____

2. Halaa gariin adda bahe walitti qabamaa? a) _____b) _____

3. Gejjibaa qabduu? a) eyyee _____b) lakkii _____

4. Dheyessiin gejjibaa jiraa? a) eyyee _____b) lakki _____

5. Uffataa balaa irra isiin barraruu? a) eyyee _____b) lakkii _____

I. Kosii walitti kusuu (waste storage)

1. Bakka gahaa ta'ee kusuudhafi qabduu? a) eyyee _____b) _____

2. Dhiyyoottii agama a) eyyee _____ b) lakki _____

Salphatti gejjibisisuudhafi mijjatadhaa a) eyyee _____b) lakkii____

Bakka nyatiin itti qopha'uu irraa fagoodhaa a) eyyee ____b) lakkii _____

3. Bakki kusaa kunii gahaa, halaa salphaan quliqula'uu fi halla offi keessatti dabarsuu hin danadeenyneen, ifaa fi bakka aduun argachuu hin dandeeyneen kufamee jiraa? a) eyyee____b) lakkii_____

4. Bakka kusaa sannaat mallatoleen balla jedhuu irratti maxanffamee jiraa

5. Meshalee kosii a) eyyee _____b) lakkii _____

6. marshaled jajjabboo ta'anii itti cuqqalamee jiraa?a)eyyee _____b) lakkii _____

7. Kosii balaffamma cimmo ta'ani kanaa guyyaa lama dursaa qabamee , moo akkumma sefti boxi torbani tokkof tursituu ? a) eyyee _____-b) lakkii _____

8. Meehalee quliqulinaa, ufataa balla irra isiin barraruufi meeshalee ittin kosii fayyadamitanii nannoo kusaa ta'aa? a) eyyee _____b) lakkii _____

IV.kosii gejjibisisuu (waste transportation)

1. Meeshaleen ittin kosii gejibisifammani, garii, barrella fi konkolata? a) eyyee __b) lakkii__

2. Kosii halaa gariin qabamee gejjibisiffamma jiraa? a) Eyyee_____ b) lakkii ____

3. Bakka gahaa ta'ee qabduu yomuu meeshalee kosii itti gejjibisifatanii yomuu quliquleesitanii bakka sararaa dhanga'alaa waliin akka wali hin qunamineef? a) eyyee___b) lakkii____

4. Meeshalee ittin quliqulessaan fi disinfekishinii qabduu? a_ eyyee _____b) lakkii _____

5. Uffataa balaa irra isiin barraruu qabduu? a) eyyee _____b) lakkii_____

V. kosii yaluu (waste treatment)

1. Lilimoo fi kosii balfaa cimoo ta'ni osoo hin gatiin dursaa yaltuu? a) Eyyee____ b) lakkii____

2. Eyyee, yoo ta'ee tofitaa isaa kamiin fayyadamituu _____

a) Insinerateraa

b) Bakka sannatii steralizii ta'aa

c.hurka arattiin steralizee ta'aa

d) Ifaa anisaa hinqanibee yoo kemikalaan fayyadamituu

3. Uffataa balla iraa isiin bararuu qabduu? a) eyyee ____b) lakkii ____

VI. Kosii gatuu/ dhabamisisuu (waste disposal)

1. Hospital kuni kosii jajjaboo kannaa yaluufi isaa kamiin fayyadamma jirtuu amma kanaa?

a) Inserateeraa qabduu

If yes, type of container

Yoo, eyyee, ta'ee goosaa meeshalee kamiin

I.Hurka lama isaa qabuu dhaa insinerateer keessaan.

ii.rotarii kilin a) eyyee ___b) lakkii _____

iii..Insinerateeraa pyrolitkiidhaa

Iv.kan yoo ta'ee ifaa godhii _____

b.halaa insineereteeraa (fayyidaa kena jiraa, fagoodhaa)

C.bakketti gubbaa jiruu a) eyyee _____ b) lakkii _____

d.bolla obatti qabduu a) eyyee ____b) lakkii _____

e.Bakka itti maqiffamuu jiraa? a) eyyee _____b) lakkii _____

Yoo, eyyee ta'ee bakka mani qophessa qopheesstii bakkee keessaati gatama jiraa ?

a) eyyee_____ b) lakkii ____

a.halaa garii maqiffamaa kosii jajjaboo kuni ? a) eyyee ____b) lakkii_____

b.Uffataa balaa irra isiin bararuu qabduu? a) eyyee ____b) lakkii _____

3. **Gafii qammaa murtessoo hospitalaa fi board**. (Key **informant interview** q**uestionaries**')

Medikalaa direkiteraa (Medical director)

General information of the organization

Oddeffannoo waligall hospitalichaa (General information of the organization)

1. Maqaa dhabatichaa _____

2. Goosa dhabatichaa hospitalaa jalqabaa

3. Siree meeqa qabduu? _____

4. Guyyaatti namaa meeqatu ilaalamaa giduu galessaan _____

5. Yeroo hundaa hojjetaan bakkaa rammadameti argamee hojjetaa? a) eyyee ____b) lakki__

Halaa caasefamma dhabatichaa (Its Organizational set up)

6.1. Yeroo hundaa hojjetaan bakkaa rammadameti argamee hojjetaa? a) eyyee __b) lakki__

a.Ogessaa egumsaa fayyaa naannoo ykn ogessaa fayyaa pablikii qabduu?

b. saniterii injineeri a) eyyee _____b) lakkii _____

C.quliquleesituu kosii qabduu? a) eyyee ____b) lakkii _____

6. Koreen ittisaa balfaa hunda'ee hojjii jiraa, nageenyaa ogessaa ykn manajementi kosi jajjaboo hojjii iraa olee jiraa? a) eyyee ____b) lakkii _____

7. Halaa hojjii irra olummaa polisii tartibaan jira? a) eyyee ___b) lakkii ___

a) Qajjelfaa hojjii iraa olummaa ittin hoganamittanii jira? a) eyyee __b) lakkii _____

b. SOP jiraa? a) eyyee ____b) lakkii _____

c. halii hojjii kanaa galma'ee gabaffammaa a) eyyee ___ b) lakkii _____

8. Karoora hojjii iraa olummaa kosii googaa qabduu? a) eyyee ____b) lakkii ____

9. Gaheen departmeenti balfaa googaa malii akka hospitalaa keessanitti?

a) eyyee _____b) lakki_____

a. Nageenyaa fi fayyaa egamma jiraa? a) eyyee _____b) lakkii _____

b. Halaa suuphaa dhabatichaa _____

c. Ogessaa environmental fayyaa

d. Nursii _____

e. kan biro yoo jiraa ta'ee ibsi

Waste management officer

Biroo qindessaa kosii jajjaboo

Kosii xixiqqessuu (Waste minimization)

1. Haali kosii xixiqqesinuu jalqabamee jiraa, meeqatuu hiriffamma paaki , ta'eetu jiraa bakka kosiin itti kufamuuti ? a) eyyee _____b) lakkii _____

2. Ergaa fayyadaminee booda lilimoo debisanii fayyadamuun dhabatee jiraa? a) eyyee __b) lakki

3. Halii bittaa seeraa hirisuu balfaa suma'aa ta;ee fi isaa bilisaa ta'een fayyadamuudhaaf lilimmo fi meeshlee kemikalaa xiqeesuufi hojjetamma jiraa ? a) eyyee _____b) lakkii _____

4. Bittaa qorichaa fi kemikalaa gidugalessaa? bakka kuusa qorichaa, bayyinna fi kan hin fayyadaminee ykn qorichoota yeroon ire darbee hirisuuf hojjetamma jira?

a) eyyee _____b) lakki____

Seerootaa hojjii iraa olumma koosiwwaani (waste policy)

1. Seera labsiin murta'een egeen hojjetamma jira? a) eyyee ____b) lakkii _____

2. Karoora labsameen hojjii iraa olee jira?

3. Hospital kuni karooraa labsii gidugalessaa egetuu dalgaa jirtuu?

4. Akka halaa qabatama naannoo keessanitti dhobatin gatamma jira ?

5. Bajjeta qabame jiraa balfaa maqisuuf? a) eyyee ____b) lakki _____

Leenjii (training)

1. Leenjii kenuuf qajjelffama giduu gales ykn sana alaa meeshalee leenjii fi qabduu?

a) eyyee _____ b) lakkii _____

2. Hojjetanii hundi leej'ee jira? akkasumasii hojjetani haraaf ni kenema akkasumasi jijjiraminii tokko iyuu hin jiruu karoorii jirate'uu? a) Eyyee b) lakkii

4. Is the content of the training adjusted to suit each category off staff? yes___no ___

3. lenjjin kenamu akkata hojjetan hojjetuu giduu galessa ta'een kenama ?

a) eyyee ____b) lakkii _____

Ta'annoo ittisaa infekishiin (infection controll officer)

Malaa ittisaa to'annoo (Staff protection measure)

1. halaa idileetin ta'annon ittisaa ni fudhatamaa jiraa? a) eyyee ____b) lakki _____

2. Ufataa balaa iraa ittisuu hojjii barabachisaa ta'eef olee jira? , seeran basaan ka'uu?

a) eyyee _____b) lakkii _____

3. Hojjetooni hundi aguugi harka idiletin yeoo hojjetani fayyadamma jiruu?

a) eyyee ___b) lakkii__

4. Hojjetoonii balfa kosii yeroo xuqani harka isaa dhiqatuu ykn idileetin ni fayyadamuu?

a) eyyee _____b) lakki _____

5. hojjetoonii hundinuu tallalii COVID-19 fi HBV fuudhtanii? A) eyyee ____b) lakkii ___

6. Yeroo balaa tasaa saxxilammanii posteraa ykn galmeen akkasummasi ergaa saxxilamani booda ofegannon galma'ee? a) eyyee _____ b) lakkii _____

7. Hojjetanii balaa saxilamee hubannoo tarkanif fuudhachhuf argatee jiraa?