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Research Article

Evaluation of the Healthcare Waste Management at 34 Military Hospital, Sierra Leone

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Abstract

The rapid growth of the world population and corresponding rapid global development in medicine have caused an increase in the amount of healthcare waste generated in health facilities, hence causing many problems for the public health and environment of many communities. Healthcare waste management is an integral part of the hygiene and infection control within a healthcare facility because its mismanagement leads to nosocomial infections. The specific objectives of this research were to identify types of healthcare waste segregation, to evaluate the degree of safety of healthcare handlers, to know the quantity of healthcare waste, and to know methods of treatment and disposal. Results from the study showed that the calculated volumes of the non-infectious (general), infectious (including pathological waste), and highly infectious (sharps) are 20,000 m^3, 35,000m^3 and 13,125m^3 respectively, and a total volume of 68,125 m^3 of healthcare waste is generated per week. These wastes were not segregated properly and were treated together in an enclosed incinerator with no proper measures. Statistical tests done showed that the quantity of wastes and the safety practices of service providers are associated with a high risk of infection. This showed that the public health and the environment can be negatively impacted. Furthermore, the government and its partners are making some effort to see an improvement in healthcare waste management at 34 Military Hospital; however, healthcare waste is still a major problem for healthcare providers, patients, public health, and the environment. Notwithstanding, various measures are needed to be considered in order to minimize these problems, including proper education and training for healthcare providers, provision of standard waste management equipment, consulting foreign expertise, adhering to color-coding according to INWMP, and public education.

Keywords

Waste Segregation, Healthcare Waste, Management of Hazardous Healthcare Waste, Disposal, Treatment, Healthcare, Waste Handlers

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1. Introduction

Healthcare waste (HCW) refers to materials generated during the diagnosis, treatment, or immunization of humans, including both hazardous and non-hazardous substances [18]. Common examples include used needles, bandages, pharmaceuticals, and contaminated gloves, all of which pose significant risks to health and the environment if not properly managed [18]. Improper waste management can lead to the spread of infectious diseases such as HIV, hepatitis, and tuberculosis, and contribute to environmental contamination through soil, water, and air pollution [18, 7]. Approximately 15% of HCW is hazardous, underscoring the importance of proper management to mitigate health and environmental risks [18]. Healthcare workers, especially those involved in procedures like injections, are particularly vulnerable [18]. Effective HCW management requires a comprehensive approach, involving segregation, collection, transportation, treatment, and disposal [24]. However, in many developing countries, poor management is linked to insufficient documentation, budgeting, and training [24]. Given the hazardous nature of some waste, treatment requires strict safety protocols [34]. Therefore, proper HCW management is crucial to reducing health risks and preventing environmental harm [18, 17]. Improper disposal of HCW can have long-term detrimental effects on ecosystems. For example, hazardous substances leaching into groundwater or the burning of waste can release toxic fumes into the atmosphere, contributing to air and water pollution [7]. As healthcare systems expand globally, particularly during crises such as the COVID-19 pandemic, managing healthcare waste effectively has become more urgent [32]. Furthermore, healthcare facilities in low- and middle-income countries face compounded challenges due to limited infrastructure, lack of trained personnel, and financial constraints, which exacerbate HCW management problems [24]. Addressing these gaps and ensuring the development of robust management systems is critical to safeguarding public health and the environment.

Globally, healthcare waste generation varies, with 80-85% being non-hazardous, while the remaining 15-20% is hazardous, posing substantial risks if not properly managed [18, 24]. Improper disposal of hazardous materials, such as sharps, can transmit diseases like HIV, hepatitis, and tuberculosis [18]. Additionally, poor waste management can contaminate natural resources, including soil, groundwater, and air, contributing to long-term environmental degradation [17]. The COVID-19 pandemic worsened this issue by increasing medical waste, especially in developing countries that already struggle with inadequate waste management systems [32, 9]. Improper disposal of personal protective equipment (PPE), such as gloves and masks, along with other biomedical waste, has further strained waste management systems, increasing risks of infectious disease transmission and environmental pollution [12]. Proper waste segregation, storage, and disposal are critical to mitigating these risks [12]. However, many low-resource countries face significant barriers, including insufficient infrastructure, lack of training, and limited resources [24]. These challenges are compounded by weak regulatory enforcement and a lack of public awareness about the dangers of improper HCW disposal [13]. Inadequate waste treatment technologies, such as the absence of modern incinerators, contribute to unsafe practices like open burning or illegal dumping, worsening both public health risks and environmental harm [25, 24] Additionally, inadequate documentation and reporting systems in many healthcare settings hinder the ability to track and manage waste effectively [28]. These systemic issues highlight the urgent need for comprehensive HCW management strategies, particularly in developing countries, to address growing risks associated with improper disposal and the increasing volume of medical waste. Effective management requires a multifaceted approach, including safe treatment technologies, improved infrastructure, capacity-building for healthcare workers, and stronger enforcement of waste management regulations.

In low-income countries, HCW management challenges are often worsened by inadequate infrastructure and outdated waste treatment technologies. Many healthcare facilities lack modern incinerators and alternative treatment technologies, which are essential for safely disposing of hazardous medical waste [13]. Furthermore, many healthcare workers in these regions have not received adequate training, contributing to poor waste segregation and disposal practices, thus increasing the risk of disease transmission and environmental contamination [25, 24]. For example, studies in Sierra Leone have highlighted deficiencies in waste management infrastructure, including insufficient storage facilities and unreliable transportation systems, complicating the safe handling of healthcare waste [14, 23]. There are also significant knowledge gaps among waste handlers, resulting in improper waste segregation and hazardous materials being mixed with general waste. Similar issues have been observed in Ghana, where only about half of healthcare workers were familiar with hospital waste management policies, and consistent waste segregation practices were lacking [2] These findings underscore the need for comprehensive strategies to address HCW management challenges, including targeted training programs for healthcare workers, robust waste management policies, and advanced waste disposal technologies. Moreover, effective regulatory frameworks and enforcement mechanisms are essential to ensuring that waste management practices comply with health and safety standards [28, 26]. Addressing these challenges is essential to reducing the health and environmental risks associated with improper HCW management in low-resource settings.

The existing literature highlights the urgency of addressing HCW management, especially in developing countries, where improper disposal can lead to significant public health and environmental risks [18, 17]. The COVID-19 pandemic has

exacerbated these issues by increasing medical waste, which is particularly concerning in resource-limited settings [32]. Studies from countries such as Tanzania and Morocco have identified poor waste segregation practices and emphasized the need for better training and regulation enforcement [25, 3]. These findings highlight the need for immediate action to improve HCW management, particularly in low-resource settings, to protect public health and the environment. The growing challenges in waste management are further compounded by inadequate infrastructure, insufficient resources, and lack of modern treatment technologies in many developing nations [24, 13]. Additionally, weak regulatory enforcement and the absence of robust policy frameworks contribute to unsafe disposal practices, such as open burning, dumping, and improper storage, which increase the risk of disease transmission and environmental contamination [30]. In response, there is increasing recognition of the need for integrated, context-specific solutions that address both technical and organizational barriers to effective waste management. Investments in HCW infrastructure, capacity-building programs, and the adoption of alternative treatment technologies like autoclaving and microwaving, which have shown promise in low-resource settings, are critical steps toward mitigating the adverse effects of HCW [28, 6]. Improving HCW management practices is essential for safeguarding human health and reducing environmental degradation in vulnerable communities.

HCW management in Sierra Leone and other low-income countries faces numerous challenges, including inadequate infrastructure, weak regulatory oversight, and insufficient training for healthcare workers [14, 23]. Many healthcare workers lack awareness of the risks of improper waste disposal, and resource limitations exacerbate these issues [26]. The absence of modern waste treatment technologies, along with weak regulatory enforcement, leads to unsafe disposal practices such as open burning and uncontrolled dumping [30]. Furthermore, the limited financial investment in waste management systems hinders healthcare facilities from acquiring the necessary equipment and methods to handle hazardous waste. Additionally, there is a significant gap in public awareness regarding the health and environmental risks of improper waste disposal, which contributes to poor waste segregation and inadequate handling at all stages of waste management. Effective HCW management is critical to safeguarding public health, occupational safety, and the environment, particularly in low- and middle-income countries [33, 27]. Key challenges include insufficient waste collection services and a lack of awareness [27], with risks such as open burning, improper incineration, and mismanagement of sharps [10]. Addressing these challenges requires a comprehensive approach that includes government initiatives, stricter regulation, public awareness campaigns, infrastructure investments, and extensive training programs [33, 21]. Successful HCW management relies on effective operational management, targeted training, raising awareness, and environmental assessments, contributing to the development of a sustainable healthcare environment that reduces health risks and enhances long-term waste management practices [21, 27].

Therefore, this study aims to evaluate healthcare waste management practices at the 34 Military Hospital in Sierra Leone, focusing on assessing the effectiveness of waste segregation, collection, transportation, treatment, and disposal. The study will identify challenges and gaps in the existing system, particularly regarding infrastructure, personnel training, and compliance with safety protocols. Additionally, the study will examine the health and environmental risks associated with improper waste management and provide recommendations to enhance the hospital's practices, improving public health and environmental sustainability.

2. Research Hypothesis

The general objective of this research work is to predict the health care waste Effect on the environment and public health (EaPH) at 34MH; therefore, the study is carried out to prove a precise research hypothesis stated by the researcher that can be in favor or not (null or alternative) indicating that the rate of infection in 34MH is on an increase and alternatively is not, based on the overall observed and expected values.

3. Data and Method

3.1. Study Area

The study area for this research determined the capital city of Sierra Leone known as Freetown. It is a major port city on the Atlantic Ocean and is located in the Western Area of the country. Freetown is Sierra Leone's major urban, economic, financial, cultural, educational and political Centre, as it is the seat of the Government of Sierra Leone. At the 2015 census' the population of Freetown was 1,055,964 [29]. The population of Freetown is ethnically, culturally, and religiously diverse. The city is home to a significant population of all of Sierra Leone's ethnic groups, with no single ethnic group forming more than 29% of the city's population. As in virtually all parts of Sierra Leone, the Krio language is Freetown's primary language of communication and is by far the most widely spoken language in the city. The city's economy revolves largely around its harbour, which occupies a part of the estuary of the Sierra Leone River in one of the world's largest natural deepwater harbour.

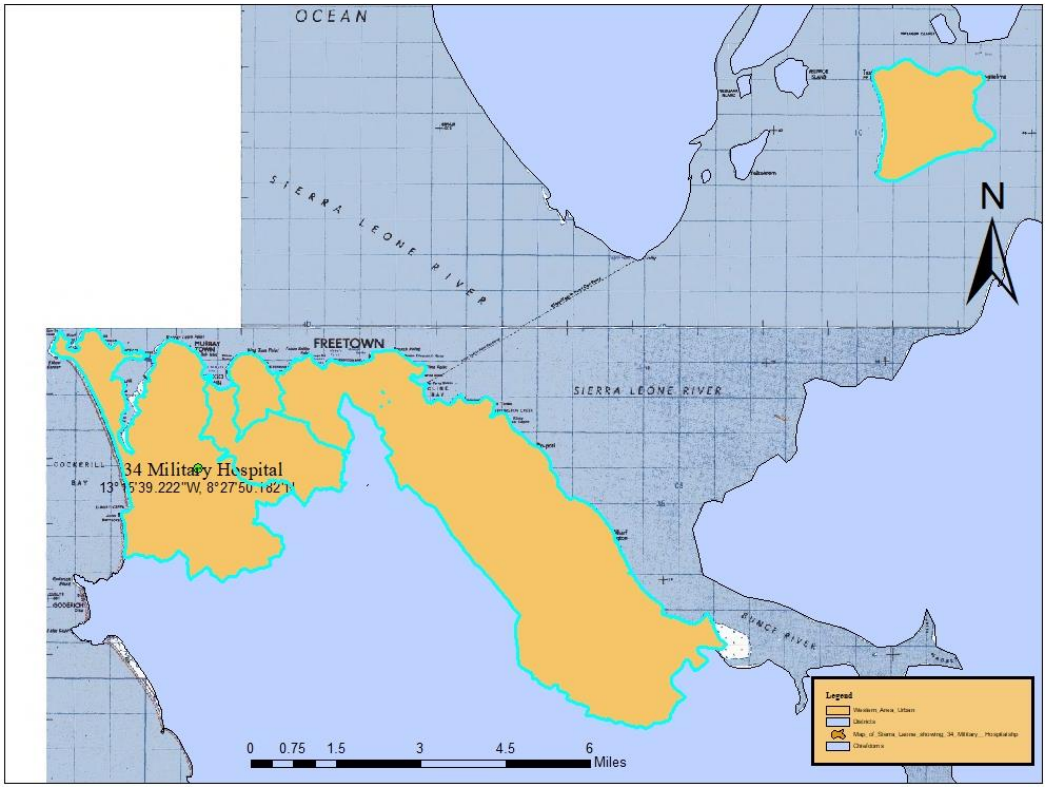

Figure 1. *Sierra Leone showing western area (Author source; 2025).*

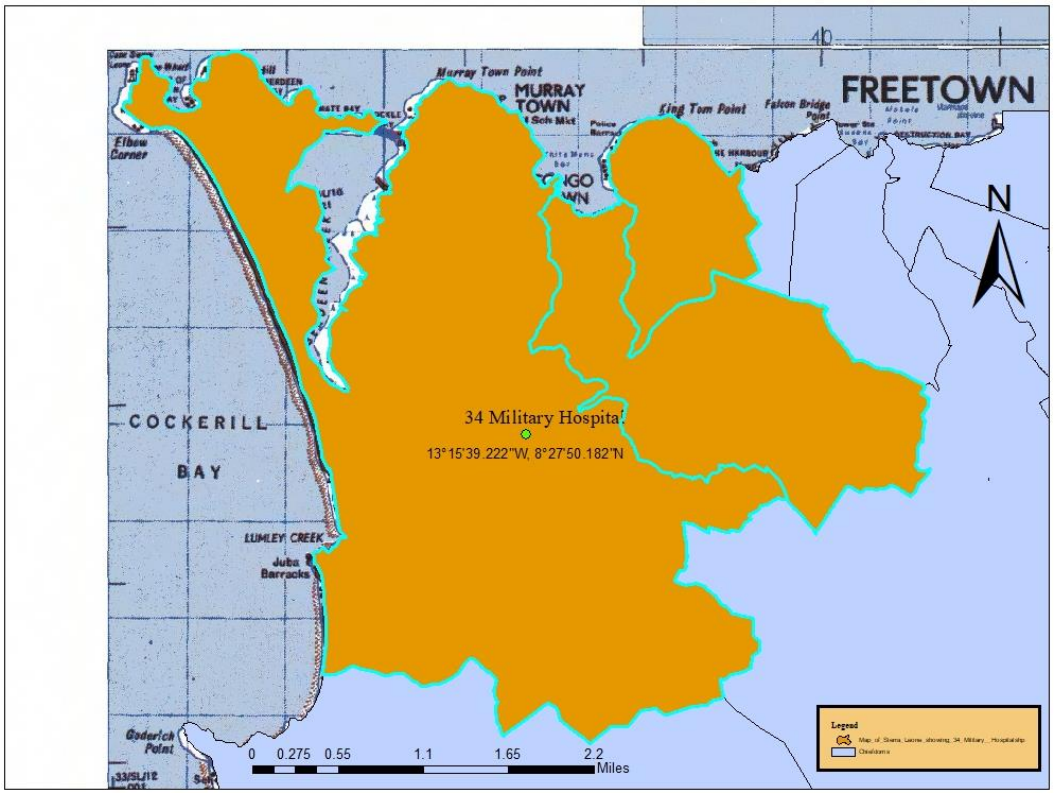

Figure 2. *Study area (Author source; 2025).*

The study site is 34 military hospital which is located at Wilberforce adjacent to Main Regent Road. Wilberforce is found on the west end of the capital city, Freetown, and it is approximately four miles from the centre of the city. 34MH is

a military hospital initially intended for treatment of troops only but presently both civilians and military personnel are allowed to obtain treatment there. The hospital is headed by a commanding officer who is a medical consultant and a colonel in the military, and also by a matron of the same rank. The hospital is populated with approximately 100 nurses, 21 doctors, 20 laboratory personnel and 12 Pharmacists. It consists of a general medical ward (both male and female in different apartments), a female surgical ward, male surgical ward, paediatric ward, maternity ward and an under-five's clinic. A well-equipped lab is situated close to the administrative department whereas the pharmacy is situated at its extreme far right. The theatre is situated at the back of the male surgical ward. The hospital is fenced all around the compound but have large settlements around it.

3.2. Research Instruments

Essential instruments provided in commending the set objective help to gain the final goal of the study within the strategy of the intended survey. Administering of questionnaire was necessary to meet the aim of getting information from the health care providers who are the prone subjects to health care waste hazards and supposed to be acquainted with their safety procedures. Volume of waste to correspond with what results were derived from the respondents to the questionnaire was determined. By estimating the total volume of medical waste (all categories) collected during one day. Technological innovation allowed the use of camera shots to depict visually of the intended research survey. The primary data came directly from individual health care representatives from the various departments through questionnaire administration, personal oral interviews and self-observation, weight for volume measurement and camera for photographic information. Secondary data were collected from the record of the Infection Prevention and Control (IPC) and Research Unit. The Internet, certain policy documents were also used to scout for information.

3.3. Data Collection

Different approaches are adapted in going about collecting data depending on the research objectives. The nature of this research urged to design an eight (8) page questionnaire that targeted the sample population of 34 Military hospital. Respondents within various departments which were randomly selected to represent either the division or subdivision. The researcher introduced himself and explained his mission before administering a questionnaire. Confidentiality was ensured through a participant consent form. Short on-site interviews were conducted during lunch or tea breaks, regardless of qualifications and also collection of data from the physical waste (weight for volume) involved preparation of a chart to record weight of the waste measured at the generation point including the day collected, time, department, and total ensuring easy data processing.

3.4. Analysis

The analysis of data involved using much of descriptive statistical approach with a little of quantitative statistical analysis as the research is both qualitative and quantitative in nature. Coding was done by assigning numbers to options in the individual questions in order to organize the variable to easily differentiate specific data for easy analysis. Special Package for Social Science (SPSS 18) a vital mathematical tool was used during analysis to help produce tables, bar charts and pie charts. Inferential statistics such as chi- square were also used. Soft wares and excel was also used to format tables in which chi-squire test are done and camera simulation for precise comprehension.

4. Results and Discussions

4.1. The Percentage Types of Wastes Generated and Segregated per Week at 34MH

At the point of generation, these were the different types of HCWs identified in the study. The following are the non-infectious (General), Infectious (including pathological waste), and highly infectious (Sharps) at a calculated volume of 20,000 m^3, 35,000 m^3 and 13,125 m^3 respectively. Chemical wastes are not exposed to waste handlers; therefore, recognized container was not observed to keep such. In oral interview some respondents especially those in the laboratory and pharmacy responded that the expired drugs and reagents are kept by staff in the respective departments to wait for the head officer who regulate them for disposal and also that radioactive chemicals are minimally used. The 34 Military Hospital, although use labeled containers, do not adhere to color-coding.

Meanwhile, at various points of generation these wastes were measured by for which the total weight are shown in pie chart below. The result of this work is similar to a result of certain hospital mention in the Namibia Integrated Healthcare waste management plan page 5, supported by USAID and Healthcare Improvement project Namibia.

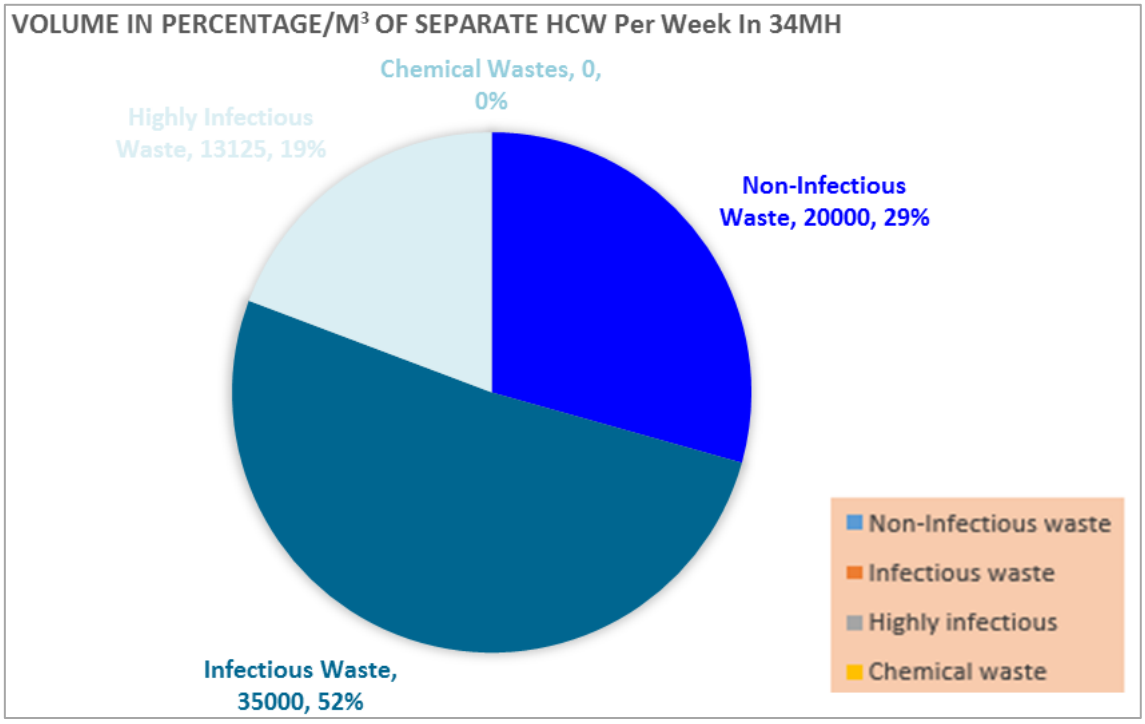

Figure 3. *Volume in percentage/m^3 of separate HCW (Authors source, 2025).*

4.2. Knowledge and Opinion on Segregation and Collection of Healthcare Wastes

From Table 1, the result proved that majority of the respondents are aware and have knowledge on the procedure of segregation and collection of healthcare wastes but slightly have a wrong interpretation of labeled container in the study unit. Table 1 shows that 90.0% of the respondents admitted that wastes are collected in labeled container and 86.0% who acknowledged wastes segregations. However, it was noted from oral interviews and observation that colour- coding was not practiced. There is some misconception on the respondents answer with respect to waste segregation based on color-coding; The 34MH although uses labeled containers, uses no specific colour container for a specific type of waste and hence does not adhere to the October 2012 integrated waste management policy MoHs Sierra Leone which states that black represent Non-infectious (general) waste, yellow for infectious waste, Red for highly infectious (pathological and anatomical) waste. Through oral interview, upon request, the anatomical wastes such as placental and body part are given to patient's relatives for burial or to dump in to pit latrine. Results of this study is similar to those of a survey done by Abdulla et al. [1] in Jordan, who reported that the main problem encountered in hospital waste management was inappropriate segregation.

The author also points out that healthcare personnel and those who handle medical waste are at a significant risk of catching infectious infections, which could affect their overall performance. Research from other nations also indicates that managing medical waste involves a great deal of responsibility when staff members are not properly trained. [11, 19]. Similar trends were observed over the years, where healthcare management practices and inadequate training has led to failures in healthcare institutions [22].

Table 1. *Respondents knowledge and opinion on waste segregation and collection in 34MH (author source, 2019).*

			Do you collect waste in containers labelled BLACK, YELLOW or RED?			Total
			Yes	No	No Idea	
Do you segregate healthcare waste?	Yes	Count	80	2	4	86
		% of Total	80.0%	2.0%	4.0%	86.0%
	No	Count	7	2	1	10

			Do you collect waste in containers labelled BLACK, YELLOW or RED?			Total
			Yes	No	No Idea	
	No Idea	% of Total	7.0%	2.0%	1.0%	10.0%
		Count	3	0	1	4
		% of Total	3.0%	0.0%	1.0%	4.0%
Total		Count	90	4	6	100
		% of Total	90.0%	4.0%	6.0%	100.0%

4.3. Quantity/Categories of HCWs from Different Healthcare Waste Generated at Various Departments in m^3/Week

An important aspect of healthcare waste management is to be able to determine the quantity of waste produced in the healthcare facility. The table below shows the amount of different HCWs generated at various departments at 34MH per week. There are different numbers of containers positioned at each department. The volume of a filled container is 250 m^3. This value is used to estimate the volume of different type of waste collected at the various departments every day per week.

During the provision of healthcare services, healthcare workers utilize substantial quantities of water, electricity, and non-biodegradable carcinogenic polymers [8]. Because a large portion of medical waste contains hazardous elements like blood or bodily fluids, mercury, and other poisonous compounds, disposing of it can be expensive and pose a risk of contaminating both people and the environment. Healthcare professionals' ignorance of appropriate HCWM disposal classification has led to hospitals becoming epicenters of spreading disease rather than working toward eradicating them, particularly in underdeveloped nations worldwide.

Table 2. *Categories/Quantity of HCWs from different departments (author source: 2025).*

Department	No of labeled Containers	Non-infectious waste (m^3)	Infectious Waste (m^3)	Highly Infectious (m^3)	Chemical Waste (m^3)	Total Volume (m^3)
Medical ward	7	1750	2625	875	0	5250
Paediatric ward	5	875	1750	875	0	3500
Maternity ward	8	875	4375	1750	0	7000
Male Surgical Ward	5	875	2625	1750	0	5250
Female Surgical ward	5	875	2625	1750	0	5250
Under 5s	3	875	1750	875	0	3500
Admin	7	3500	0	0	0	3500
Laboratory	11	1750	5250	2625	0	9625
Pharmacy	4	1750	0	0	0	1750
Accident & Emergency	6	875	3500	875	0	5250
Triage	7	1750	3500	875	0	6125
Mortuary	4	0	2625	875	0	3500
Research	2	875	0	0	0	875
Cycosocial	1	125	0	0	0	125
Physiotherapy	3	250	0	0	0	250

Department	No of labeled Containers	Non-infectious waste (m^3)	Infectious Waste (m^3)	Highly Infectious (m^3)	Chemical Waste (m^3)	Total Volume (m^3)
Dental	2	125	875	0	0	1000
Ophthalmology	1	875	0	0	0	875
Chest Clinic	2	250	1750	0	0	2000
HIV	1	875	0	0	0	875
IDPC	7	875	1750	3500	0	6125
TOTAL	91	20,000	35,000	13,125	0	68,125

4.4. Methods of Waste Transportation

Considering proper waste disposal, the means of transportation should be easy and safe. hence it was revealed that hand lifting is still practiced in the methods of transportation as 10 (10.45%) of the respondent admitted and also wheelbarrow which has 8 (7.46%). However, the use of wheel container is on increase as 82 (82.09%) of the respondents replied. This could be as the result of IPC training carried out at the hospital and this is shown below:

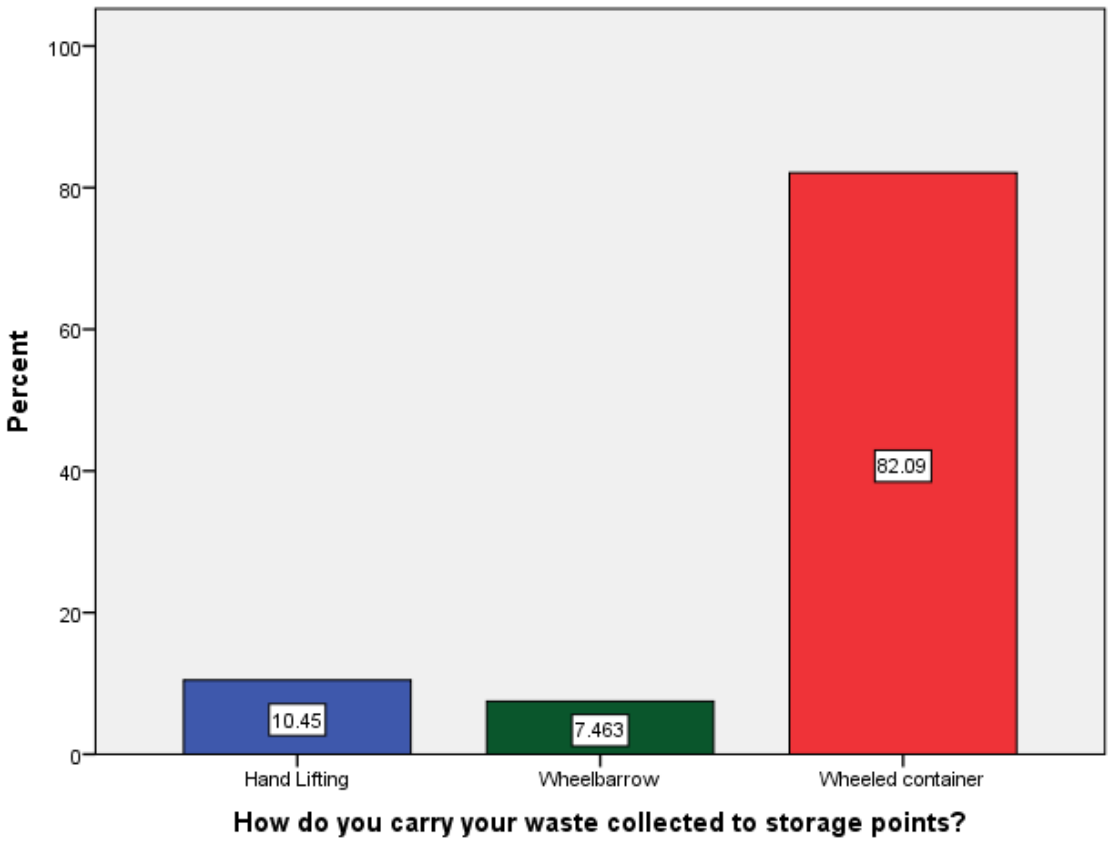

Figure 4. Methods of transportation (Authors source, 2025).

4.5. Knowledge on Waste Disposability by Incineration

One of the methods of healthcare wastes disposability is incineration. Through this research, majority of the respondents pretended to know improved incinerator and the use. For instance, 62 (77.5%) declared available improved incinerator and it use, but it was proved to be negative because many about 53 (66.2%) of the same respondents claimed to have no

idea on the temperature amount for combustion efficiency stated in the INWMP 2012 document, which means their knowledge are not up to date, and that implies the unavailability of improved incinerator and its use in the 34MH. Table 3a and Table 3b below give details of the respondent's ideas on HCWs disposing method by incinerator. However, inappropriate incineration or disposal of healthcare waste (HCW) poses both direct and indirect threats to the environment by contaminating groundwater and soil, which can lead to associated illnesses in nearby communities [35].

Table 3. Waste disposal method (author source: 2025).

Waste disposal methods	Yes		No		No Idea		Total	
	Freq	%	Freq	%	Freq	%	Freq	%
Have improved incinerator	74	74.0%	15	15.0%	11	11.0%	100	100.0%
Incineration practice	71	71.0%	15	15.0%	14	14.0%	100	100.0%

Table 4. Temperature for combustion efficiency (author source: 2025).

Temperature for combustion efficiency		< 95%	> 95%	No Idea	Total
Response	Yes	Freq	9	33	58	100
		%	9.0%	33.0%	58.0%	100%

4.6. The Safety Level of Healthcare Providers on Healthcare Waste Management

The majority of researchers looking into healthcare waste management practices concentrated on the risks that healthcare workers, the environment, and the local population faced because improper use of protective equipment and disposal of waste could lead to the spread of dangerous diseases and other negative health effects. It is vital for an effective healthcare management system to prioritize the safety of healthcare providers by putting certain procedures in place. Personal Protective Equipment (PPEs) are recommended to keep healthcare providers at least 90% away from contacting infection from HCWs. The use of proper (totally) PPEs on duty is highly considered in this research. The result from Table 5 shows that 85 (85.0%) of the respondents agreed to using PPEs on duty, therefore there is some awareness on PPEs use on duty. From the results, 61 (61.0%) responded positively to the total use of PPEs while 25 (25.0%) were negative.

Table 5. Use and proper use of PPEs (author source: 2025).

The safety knowledge of PPEs	Yes		No		No Idea		Total	
	Freq	Percentage	Freq	Percentage	Freq	Percentage	Freq	Percentage
Use of PPEs on duty	85	85.0%	6	6.0%	9	9.0%	100	100.0%
Total use of PPEs	61	61.0%	25	25.0%	14	14.0%	100	100.0%

According to numerous academic studies, hospitals' inappropriate treatment of healthcare workers is inconsistent with their main goal of promoting health and treating illnesses [15, 31]. Environmentally sustainable waste management practices (ESWMP) reduce occupational exposure to healthcare workers [16, 20, 31], prevent the spread of disease [4, 5, 8], and promote and protect population health [15, 31]. Kumar et al. [20] observed that healthcare waste handlers were the most susceptible among healthcare personnel to get infected by infectious waste due to poor management procedures and inappropriate safeguards taken by waste handlers during waste collection, segregation, and disposal.

4.7. The Hypothetical Test of Infection Rate on Healthcare Wastes and the Safety Level of Healthcare Providers Using Chi-squire

The study attempts to find the frequencies expected under the hypothesis that the number of respondents' opinion on the use of PPEs, and quantity of healthcare wastes generated can associate with increase rate of infection at 34MH and the environment due to the quantity of healthcare wastes generated and the safety level of the use of PPEs on duty.

Test is done at 5% level to show whether the differences in the observed and expected data are significant.

4.7.1. The Chi-squire Statistical Test on the Use of PPEs on Duty Regard with Increase Rate of Infection

Table 6. *Observed values on use of PPEs (author source: 2025).*

	Yes	No	No Idea	Total
Do you use PPEs totally?	61	25	14	100
Would you use personal protective equipment on duty?	85	6	9	100
Total	146	31	23	200

H_0: The use of PPEs on duty can associate with increase rate of infection df=2

H_a: The use of PPE on duty can associate with increase rate of infection

From the above table, Chi-squire calculated X= 16.66

Chi-squire critical from the table X_α = 5.991

Hence Chi-sq.cal.> Chi-sq.tab

Because of the Chi-sq. Cal (16.66) > Chi-sq.tab (5.991)

Therefore, we fail to reject H_0

i.e H_0 = the use of PPEs on duty can associate with increase rate of infection

4.7.2. The Chi-quire Statistical Test on the Quantity of Healthcare Wastes Generated Regard with Increase Rate

Table 7. *Observed values on HCWs quantities (author source: 2025).*

Department	No of labeled Containers	Non-infectious waste (m^3)	Infectious Waste (m^3)	Highly Infectious (m^3)	Chemical Waste (m^3)	Total Volume (m^3)
Medical ward	7	1750	2625	875	0	5250
Pediatric ward	5	875	1750	875	0	3500
Maternity ward	8	875	4375	1750	0	7000
Others	71	16500	26,250	9625	0	52375
Total	91	20,000	35,000	13,125	0	68,125

H_0: The quantity of healthcare wastes generated is associated with increase rate of infection

H_a: The quantity of healthcare wastes generated is not associated with increase rate of infection

Df = 9 and test at 5% level

Hence Chi-squire.cal > Chi-sq. tab

Therefore, we fail to reject H_0

i.e. H_0 = the quantity of healthcare wastes generated is associated with increase rate of infection. Since the results shown above that the use of PPEs and the quantity of healthcare waste are associated with increase of infection at 34MH, it is true that the rate of infection will be on the increase in the mere future as per population if proper mitigating measures are not put in place.

4.8. Discussion

This study considered the sociodemography of the respondents, including the differences in sex, age, marital status, their designation, and length of service. It enables the researcher to understand the respondent's character in relation to their response. Moreover, an inferential statistical test was done to know in advance the trend of infection from the total healthcare waste generated and the use of protective gear at 34MH.

It was observed that service providers have less knowledge of healthcare waste processes on a standard basis within the streamline from point of generation to the disposal point. Often, the waste handlers (cleaners) have no or low level of formal education and are widely used in the HCWs management process. The waste disposal method in 34MH can provoke new research on the surrounding environment. Contaminated health care waste is disposed of through drainage, and there is no septic tank present. Effluent tests on liquid waste before it is discharged are not carried out. However, waste handlers at 34MH handled clinical waste with appropriate health and safety measures, using appropriate protective gear.

Notwithstanding, the incinerator used at 34MH does not adhere to certain emission standards; no air pollution control device is attached to the incinerator, chlorinated plastics are not removed before combustion, no method was used to limit toxic metal in the incinerator and no disinfection is noted to be carried out before incineration.

5. Conclusions

The current practices of healthcare waste management in 34MH were identified, and it is noted that the government and its partners are making some effort to see better performance; however, areas of non-compliance were identified. Healthcare waste is still a problem for the service providers, public health, and the environment, and based on the findings of this study, there is a need to improve the healthcare waste management in the local context. Most of the pronouncements made in the Integrated Nation Waste Management Policy document are missing. The process of waste generation, segregation, and transportation to its final disposal point cannot be satisfied and done properly unless the majority of the healthcare providers have a clear understanding of how to manage them in standard procedure. Standard procedures must include comprehensive training programs that educate healthcare providers on the importance of proper waste management practices. Additionally, regular audits and feedback mechanisms should be established to ensure compliance and continuous improvement in waste handling processes. The safety measure of using protective gear, proper separation of waste, and technical measures of waste treatment such as standard incineration and autoclaving are still problems to be considered. Addressing these issues requires comprehensive training programs and regular workshops for healthcare staff to ensure adherence to established protocols. Additionally, developing a robust monitoring system will help identify gaps in compliance and facilitate continuous improvement in waste management practices. This will not only enhance the effectiveness of waste management systems but also promote a culture of safety and responsibility among healthcare personnel. By fostering an environment of accountability, facilities can better mitigate risks associated with hazardous waste and improve overall public health outcomes. Improving overall public health outcomes requires a collaborative effort among all stakeholders involved in waste management. By prioritizing education and ongoing training, healthcare facilities can empower their staff to take proactive measures in handling waste, ultimately leading to a safer environment for both workers and patients alike. The condition of the waste management system at 34MH may be an indication as to how waste is being managed in the other healthcare facilities around the country.

The author recommends that there should be workshops, seminars for waste handlers to educate them on how to manage, segregate, transport and disposal of waste using the standard procedures, also, focus on collaborative decision-making. This approach will not only enhance their skills and knowledge but also foster a sense of responsibility and teamwork among waste handlers. By involving them in the decision-making process, we can ensure that waste management practices are more effective and sustainable.

Government and partners in light of containment and regulating the quantity of healthcare waste and its related problems, need to embark on providing standard waste management equipment that capacitate better performance to meet the objective of INWMP Sierra Leone. Moreover, open-air burning practiced at 34MH should be regulated, and residuals/ash should be regularly tested for harmful substances that could affect human health and the environment and disposed of appropriately, and finally, the MoHS should periodically evaluate the effectiveness of training and education programs. In addition, the Ministry of Health should strictly enforce penalties on the offenders of HCWM rules.

Abbreviation

34MH	34 Military Hospital
AIDS	Acquired Immune Deficiency Syndrome
EaPH	Environment and Public Health
HBV	Hepatitis B Virus
HCV	Hepatitis C Virus
HCW	Health Care Workers
HCW	Healthcare Waste
HCWMS	Healthcare Waste Management Systems
HIV	Human Immunodeficiency Virus
INWMP	Integrated National Waste Management Policy
IPC	Infection Prevention and Control
MoHS-SL	Ministry of Health and Sanitation
PPEs	Personal Protective Equipment
SPSS	Special Package for Social Science
UNCED	United Nations Conference on Environment and Development
US EPA	United State Environmental Protection Agency
US MWTA	United State Medical Waste Tracking Acts
USAID	United States Agency for International Development
WHO	World Health Organization

Author Contributions

Sahr Emmanuel Lebbie: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Project administration, Resources, Software, Writing – original draft

Martina Yeama Williams: Methodology, Resources, Visualization, Writing – review & editing

David Sesay: Software, Writing – original draft, Writing – review & editing

James Koroma: Resources, Writing – original draft, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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Biography

Sahr Emmanuel Lebbie is a renowned Sierra Leonean environmentalist, an articulate and creative person with good organizational and industrial managerial skills, competent in chemical analysis, quality control, human resource development, and administrative and research work at Njala University, Department of Chemistry. He completed his master's in environmental chemistry from Njala University in 2021 and his bachelor's degree in environmental chemistry from the same university in 2019. In addition, he holds a French Certificate from IMATT College, Freetown, in 2023, and a Generic Research Competency License Supervising Certificate for the Postgraduate Supervision Course, Editorial Assistant and Technical Editing, APA Referencing, and Canons of Research from Njala University in 2024. Recognized for his exceptional skills and academic excellence, he was employed as a lecturer at Njala University and also as an associate lecturer in the Health Sciences Department, Central University, Sierra Leone. He has participated in multiple international research collaboration projects recently. Lebbie is dedicated to advancing environmental issues and research in Sierra Leone.

Martina Yeama Williams was born on October 23, 1999, in Sierra Leone, West Africa. Her interest in science started at a young age and became intensify as she grew. Her interest was focused on health sciences, and so she pursued that field of study. Martina holds a bachelor's in biological sciences from Njala University (2022), and she is currently pursuing a Bachelor of Medicine Bachelor of Surgery at the College of Medicine and Allied Health Sciences (COMAHS), University of Sierra Leone. At COMAHS, she is part of the Standing Committee on Research Exchange (SCORE), where she has participated in several medical-related research activities and public health campcampaigns. Her research interest is not only limited to clinicals but also include epidemiology, infectious diseases, mental health, and more. Martina is passionate about promoting health and well-being, rendering public health services to ensure a safe and healthy society. Back at her home town in Bo, she was involved in community mobilization and sensitization during the Ebola and Covid outbreaks. She is also concerned about maternal and child health, advocating for services that foster the well-being of mother and child.

David Sesay is one of the most outstanding Sierra Leonean Renewable Energy Engineers, an articulate and developmental oriented person with good organizational and industrial managerial skills, competent in working with renewable energy sources in providing electricity for rural areas, homes and businesses, electrical and electronics work like troubleshooting of different electrical components and correcting faults, installation of ATS and UPS (ie Automatic Transfer Switch and Uninterruptible Power Supply respectively) and doing field supervision for TARA ENERGY LIMITED, SL, human resource development, administrative and research works at Central University, Department of Technical Sciences in the Renewable Energy program and also part of the Health Science department. He completed his Master of Science degree in Renewable Energy and the Environment from Njala University in 2020 and his Bachelor of Engineering degree in Electrical/Electronic Engineering from Fourah Bay College, University of Sierra Leone, in 2012. In addition, he holds a Diploma in Education Certificate from United Methodist University, Freetown, in 2023. He was employed as a lecturer at Central University and also as a supervising field engineer for TARA ENERGY LIMITED SL. He was once employed at 2E Systems Engineers and Contractors Ltd. SL as an engineer before joining Central University and also has imparted knowledge to many from different schools like Sierra Leone International Mission School, Fatibu Secondary School, and College of Business and Maritime Studies. David is willing and ready to advance renewable energy, environmental issues, and research in Sierra Leone.

James Koroma is a dedicated Electrical Engineer with nine (9) years of experience in the power sector, currently serving at the Electricity Distribution and Supply Authority (EDSA). James plays a key role in ensuring a reliable and efficient power supply to residential, commercial, and industrial consumers. James Koroma earned a Bachelor of Engineering (BEng) in Electrical and Electronics Engineering from Fourah Bay College, University of Sierra Leone, in 2010, where his passion for power systems and infrastructure development first took root and he later completed a Master of Science (MCS) in Renewable Energy and the Environment from Njala University in 2022.