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Comparative Assessment of Medical Waste Management in Multi-System and Selected Teaching Hospitals in Ekiti State, Nigeria

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ABSTRACT

Medical facilities, such as hospitals, clinics, and locations where diagnosis and treatment are administered, create dangerous waste that predisposes individuals to deadly infections. Medical waste management aims to improve health and prevent public health and environmental threats. Questionnaires, interviews, site visitations, and observations were utilized to determine the management strategies implemented in the three hospitals and evaluate the efficacy of waste management. The hospitals under review are Afe Babalola University Multi-system Hospital (AMSH), Ekiti State University Teaching Hospital (EKSUTH), and Federal Teaching Hospital Ido-Ekiti (FETHI). Statistical Package for the Social Sciences (SPSS) was utilized for the statistical analysis of the questionnaires, and the mean assessment was utilized to compute the waste per bed each day. The results revealed that the three hospitals' sharp, infectious, and pharmaceutical waste is the most sorted. All hospitals burn their medical waste in incinerators but dispose of the ashes in dumpsites. The mean evaluation of all hospitals' medical waste was weighed to establish the overall amount generated. The total amount of medical waste created at AMSH, EKSUTH, and FETHI is 31.5 kg, 53.6 kg, and 135.1 kg, respectively. The medical waste generated per bed per day in AMSH, EKSUTH, and FETHI is 0.61 kg, 0.74 kg, and 0.73 kg, respectively. It was determined that the proper management and disposal of waste is a critical obligation of healthcare facilities. There should be a provision for educating personnel about the consequences of inappropriately disposing of medical waste.

INTRODUCTION

There are several ways to ensure health, restore patients' health, and save lives through healthcare activities. However, they also generate waste, 20% hazardous to health, damage, or exposure to synthetic or radioactive materials. Waste management is a serious problem that affects everyone, from healthcare workers to patients and their families, and the general public is no exception. It's also possible that improper treatment or disposal of such waste could result in environmental contamination or desecration. There are several easy and effective ways to limit the dangers associated with hazardous medical waste.

The current method of waste management in our current circumstances has been causing worry in recent years. Litters of solid waste and wastewater pollute diverse ecosystems and the environment. Businesses and industries in our society have a history of dumping waste into rivers and farmlands without first treating it, endangering the natural environment in the process. The possibility of contamination of the water resources of Calabar due to poor waste management and the

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potential human health risk to the residents of the metropolis has been reported (Ogarekpe et al. 2023). The effects of poor waste management are enormous, hence, unacceptable. Hospitals and other medical care facilities are not exempt from this rude protest. Municipal wastes (MW) are distinct from other waste because of their destructive properties. It has received minimal attention compared to managing other forms of solid waste in Nigeria (Agunwamba et al. 2013). The strategic and holistic management of biomedical waste in sub-Saharan Africa cannot be overemphasized. Healthcare Waste Management (HCWM) ensures that medical wastes are handled correctly and disposed of safely. The entire waste management process, from planning to disposal, which is covered by HCWM (Oyebode et al. 2022, Oyebode 2022a). According to (Adu et al. 2010), healthcare workers should get regular in-service training on proper source segregation of MW to aid in the efficient and secure handling, transportation, treatment, and disposal of waste from healthcare Institutions. The transmission of infectious organisms can be greatly reduced by separating hospital waste at the site of its creation. The most important natural resources are land and water since they are essential to all life (Verma et al. 2022, Oyebode 2022b). The lack of water treatment technology has led to severe pollution in developing and growing countries, worsening the water crisis (Abdelfattah et al. 2022). A large amount of solid garbage is produced by human activity (Sharma 2008).

PAST STUDIES

During production and consumption, waste might be anything that is no longer needed. The definition of waste is everything the owner discards pursues, or is forced to discard (EU 2013). Waste is everything that will be disposed of, has been designated for disposal, or must be disposed of by national legislation as specified by the Basel Convention. Unwanted resources are what we mean when we talk about waste. Debris from our homes, offices, schools, and other public institutions (domestic waste), as well as industrial waste (industrial waste from corporations and industries), are all examples of garbage (industrial waste).

Nigeria's waste-generating situation has been a source of global and local concern. Cities in Nigeria, which are among the world's fastest expanding, are confronted with the challenge of SWG. The implications are substantial when a country's population rapidly increases, and waste is not adequately handled (Babayemi & Dauda 2009). SWG and management in cities in developing countries have emerged as important issues. Waste products are created in considerable numbers due to the rapid turnover of things manufactured, sold, and acquired. A wide range of factors, including population expansion, changes in lifestyle, increased use of throwaway materials, excessive packaging of goods, and consumer habits, all contribute to incremental change. Depending on the location, Nigerian municipal trash densities typically range from 250 to 370 $kg.m^{-3}$. About 25 million tons of garbage are produced yearly in impoverished countries at daily rates of 0.44 to 0.6 kilos per capita per day, whereas in wealthy nations, the rate is 0.7 to 1.2 kilograms per hour per day (Olukanni & Mnenga 2015).

Wastes produced from different sources are classified as follows. Fig. 1 shows different sources of waste.

I. Urban or Municipal wastes
II. Industrial wastes
III. Commercial wastes
IV. Agricultural wastes

Medical Waste

When it comes to the waste created during medical or diagnostic treatments, it is known as medical waste (or HCW). MW comes from hospitals, doctors' offices, dentists' offices, blood banks, veterinary hospitals and clinics, and

Source: (Almuneef & Memish 2003)

Fig. 1: Sources of waste.

medical research institutes and labs. Hospitals, physicians' offices, dental offices, blood banks, veterinary hospitals and clinics, and medical research institutes and labs generate medical waste. Medical discharge, or "controlled hospital waste," contains blood, bodily fluids, or other infectious agents (EU 2013).

In Nigeria and throughout the world, MW is a major source of concern since it has the potential to spread disease or cause damage. Care workers and employees who deal with medical waste, patients and their families, and the broader community, are all in danger from improper waste management. In addition, incorrect waste disposal or treatment might lead to environmental pollution or contamination. Among the many types of hazardous waste are sharps (of which infected ones are a subcategory), medical waste, radioactive waste, industrial by-products, and infectious waste. Other types of hazardous waste include pharmaceutical waste and containers under pressure. When it comes to medical waste management (MWM), each organization takes a different approach, but it must be evaluated as a whole.Fig. 2 presents the different types of medical waste.

Medical Waste Management and Treatment

The MWM literature is dense with studies examining and explaining various management techniques and methodologies for achieving effective, responsive, and long-term processes. Managing waste in health facilities is complicated, and everyone involved in the industry, from floor cleaners to senior managers, must understand and address it to be effective.

It's a global challenge when it comes to MWM. If waste is not adequately handled in the healthcare business, it can harm the environment, the local people, and both domestic and wild animals. Waste disposal capacity decreases as the number of HCI grows, and the population increases, putting people and natural resources in danger (Kwikiriza et al. 2019).

Medical Waste Segregation

Everyone on the team is affected by the importance of segregation in waste management. Training, regular information, and frequent checks are all important for maintaining the long-term viability of the system already in place. Disposal and management costs can be reduced by segregating the many types of waste produced simultaneously. Most MWM begins with segregation (Arivarasu et al. 2020).

Sharps

A "sharp" instrument has a point or edge that may pierce or cut through the flesh. Sharps can be used at home, at work, and on the road to treat the medical needs of humans and their pets. Examples of sharps include needles, syringes, lancets, auto injectors, infusion sets, and connection needles/sets.

Around the world, 66,000 cases of hepatitis B, 16,000 cases of hepatitis C, and 200-5,000 cases of HIV infection were linked to sharps injuries reported by the World Health Organization (WHO 2013).

Sharp waste must be carefully handled and disposed of. The goal of sharps waste management is to keep all things safe until they can be disposed of in an environmentally-

Source: (Puška et al. 2021)

Fig. 2: Medical waste.

friendly manner. The autoclave is the last step in the sharps waste disposal process. Only chemotherapeutic sharp waste is normally burned, making it a less prevalent alternative. Safety measures must be adopted to minimize harm from sharps while increasing the amount of waste that can be disposed of. The best and safest way to manage sharps waste is to follow hospital guidelines and government regulations, instructing healthcare providers on properly disposing of the waste.

Pharmaceutical Waste

Examples of pharmaceutical waste include drugs that are outdated or contaminated with other substances. Most pharmaceutical waste comprises expired, unused, spilled, and harmful pharmaceuticals, medications, and immunizations. Discarded bottles, vials, and connecting tubing used in handling pharmaceuticals are also included in this category. Healthcare facilities should only deal with small amounts of pharmaceutical waste.

Pathological Waste

Waste considered pathological comprises organs, tissues, and body parts or fluids such as blood. Pathological waste is made up of identifiable body parts and infected animal corpses. Even though these pathological wastes may include nutritional and physiological components, they must be handled as infectious wastes for safety purposes (Nwachukwu et al. 2013). When performing research at veterinary facilities, researchers must use various animal feces exposed to infectious organisms.

Infectious Waste

According to (NESREA 2020), biomedical research lab waste, pathological waste, and standard disposable tools and equipment contaminated with infectious pathogens are all included in the definition of infectious waste. Infectious waste includes blood, synovial fluid, spermatozoa, cervical mucus, nausea, fecal matter, and urinalysis samples.

Infectious waste infections can put people's health in danger, causing a global disaster and causing problems in health, economics, and other aspects of human activity. To minimize the source of infection, waste management is crucial, and preventing waste from ever becoming infectious would necessitate a difficult and specialized treatment and management system. Waste containment, transportation, treatment, and disposal systems will be strained as infectious MW rises (Ali et al. 2021).

Chemical Waste

To fulfill safety, health, and regulatory standards, chemical waste is typically segregated on-site into designated waste carboys and transported by a professional contractor. It is possible to flush sodium chloride solutions and other watery waste. Some chemicals require a lot of water to be flushed away. An example of a drying agent is an acid or alkaline solution that contains soluble salts, such as soluble inorganic salts or alcohols that include salts. Toxic chemicals are segregated in watery waste. Chlorinated waste and non-chlorinated waste are the two categories of organic solvent waste. To avoid the formation of dioxins, chlorinated solvent waste is frequently incinerated at high temperatures (Shibamoto et al. 2007).

Radioactive Waste

Radioisotopes are commonly used in tertiary care centers for diagnosis and treatment. MWM includes the proper disposal of radioactive waste. One of the primary goals of radioactive waste management is to safeguard the public, medical professionals, and patients from exposure to harmful radiation. Using radioisotopes for diagnostic or therapeutic reasons necessitates keeping radiation levels at tolerable ranges. To evaluate radiation safety, regular hospital and radiation staff monitoring is required. You should keep track of the types and quantities of radioactive waste you produce and how you dispose of it. During waste disposal, a radiation safety officer must be present (Khan et al. 2010).

Medical Waste Disposal and Treatment

In underdeveloped countries, the most prevalent means of disposing of MW are incineration or landfilling on a limited scale. Microwave irradiation, electromagnetic treatment, high-temperature sterilization, chemical hydrolysis, and ionized combustion are some non-thermal treatments that have gained favor recently (Zafar 2022).

Individuals who come into contact with hazardous healthcare waste are in danger of becoming hurt or contaminated. It has been claimed that certain health institutions dispose of syringes in pit latrines. Patients and communities can become infected when syringes are not properly disposed of, such as by burning (destructive incineration) or burying them. Practitioners' understanding of proper disposal techniques for spent syringes is limited, which may be traced back to a lack of curriculum in medical schools (Manyele & Lyasenga 2013).

Incineration of Waste

Human and veterinary healthcare facilities, academic hospitals, and medical research facilities should practice ecologically responsible waste disposal. This category also includes non-infectious household garbage. From 1800 to 2000 degrees Fahrenheit, garbage is combusted in this process (982 to 1093 degrees Celsius). On the other hand, on-site burning has the advantage of being quick and easy, but it has issues with emissions. Incineration minimizes the waste that

must be disposed of, even if landfill cannot be completely substituted. Compressors are commonly integrated inside garbage trucks to limit the amount of waste delivered to the incinerator. Before 1997, infectious medical waste, including body parts and tissues, could only be disposed of by burning. As more information on incineration safety becomes available, certain governments and municipalities will continue promoting it as a treatment option.

In the burning of medical waste, there are three primary types of incinerators. They include;

1. Controlled-Air incinerator
2. Excess-Air incinerator
3. Rotary Kiln incinerator

Autoclaves

Autoclaving, or steam sterilization, is the most commonly used alternative to incineration. It's less expensive and poses no known health risks. This procedure is used to sterilize or disinfect waste before landfilling. Thermal breakdown of waste occurs in a pressure and temperature-controlled chamber. This method will destroy bacteria. Most medical waste, especially microbiological waste, may be autoclaved. As a result, autoclaving is not an option for hazardous chemical wastes like pathology and cytotoxicity. Steam sterilizes bio-hazardous waste. After sterilization, waste can be disposed of in landfills or burnt under less strict conditions. Fig. 3 is a picture of an autoclave.

Microwave

Waste can also be disinfected with the use of microwave technology. Computerized controls guarantee that the minimal conditions for disinfection and appropriate equipment performance are satisfied. Approximately 90% of MW may be handled using this method, similar to autoclaving. According to reports, shredding reduces volume and uses less energy than an incinerator. Due to the size of the autoclave and the amount of material, temperatures can vary from 250 to 325 degrees Fahrenheit, and pressures can range from 40 to 80 PSI. For 20 to 30 minutes, waste is normally held at a high temperature and pressure. When the cycle is over, the steam is removed from the autoclave, the

Source: (Bondtech 1997)

Fig. 3: Autoclave.

Source: (Pascoe et al. 2020)

Fig. 4: Microwave.

pressure is relieved, and the autoclave is ready to be opened. Fig. 4 below shows a microwave used to treat medical waste.

Chemical Disinfection

Chlorine and other chemical disinfectants are employed in this method. When dealing with liquid waste, chemical disinfection is the way to go. Microbes in waste, contamination level, disinfectant concentration and quantity, contact duration, and mixing requirements all play a role in determining the efficacy of disinfection. Alternatively, MW might be ground up and disinfected using a liquid solution. Earth's waste is more evenly dispersed, making it easy to dispose of any remaining debris. Sewage and landfills are used to dispose of liquids and solids. Reactive chemicals can be used to make some chemical waste inert. Most chemical waste is disposed of in this way.

Irradiation

The waste must be sterilized using a cobalt source. Gamma radiation from cobalt destroys all microorganisms in sewage. Cobalt's pricing and operational costs have prevented commercial waste management organizations from adopting this technology. Also, there are concerns about the radiation-based cleaning method. Autoclaving and microwave procedures should still be used to dispose of pathological waste.

Sanitary Landfill

The most ecologically responsible method of disposing of MW is to use a sanitary landfill. Waste is buried in the earth, where microorganisms slowly convert it into harmless molecules. Many toxic chemicals, bacteria, radioactive substances, and other hazardous materials will seep into the soil if anti-seepage measures aren't implemented at the MW dump system. The anti-seepage layer should be made using clay, high-density polyethylene, and other materials to ensure the sanitary landfill is adequately selected. Installation of landfill gas collection and distribution pipelines is also necessary. According to (Oyebode 2019), decomposable waste is created more than non-decomposable waste, particularly in Ado Ekiti. In his research, he designed a sanitary landfill, which included evaluating the landfill's lifespan, locating a suitable site, determining the cost analysis, and shaping the landfill's building timeline.

Best Practice for Medical Waste Handling

Most MW issues may be avoided if healthcare providers follow simple best practices. Employees should be aware of the guidelines and then sort and segregate all waste into the proper, color-coded waste containers based on the kind of waste. It is imperative that all containers of waste be properly labelled and that they are accompanied by the proper paperwork while being transported. A professional MW disposal company may help a hospital achieve these best practices. Table 1 presents the standard color coding system recommended by the International Solid Waste Association (ISWA) for collecting and disposing of medical waste.

Table 1: Standard colour coding recommendations.

Type of waste	Color coding	Type of container
Household refuse	Black	Plastic bag
Waste entails a risk of contamination	Yellow	Plastic bag or container
Anatomical waste	Yellow	Plastic bag or container
Infectious waste	Yellow marked "highly infectious."	Plastic bag or container which can be autoclaved
Sharps	Yellow	Sharps container
Chemical and pharmaceutical waste	Brown, marked with a suitable symbol	Plastic bag, container

Source: (ISWA 2017)

Medical Waste Management Practices in Ekiti State

According to Nigeria's constitution, local governments must deal with waste. In Ekiti State, there is no need for the EKSWMB to act as the sole governmental entity responsible for waste management. As a result of the local government authority's inability to handle the waste management profession, the Ekiti State Waste Management Board was established. When it started, waste management in Ado-Ekiti was also disorganized and embarrassing for most of the city's residents.

Medical Waste Management Practices in Nigeria

Poor countries produce much thicker, wetter, and more harmful types of garbage than wealthy nations, so affluent countries' waste disposal methods don't work there. There are also many unplanned slum areas in underdeveloped nations, making it difficult for collecting vehicles to navigate the densely populated areas. According to Awosusi (2010), underdeveloped countries like Nigeria, where a wide range of health issues compete for limited resources, tend to provide less attention and importance to waste management in the healthcare industry. A lack of practical information and studies on the public health repercussions of poor waste management in the healthcare sector is a problem. A lack of reliable records and effective waste management practices in many poor nations means that hundreds of tons of healthcare waste are thrown in waste dumps and other areas of the environment, frequently with non-hazardous waste. According to other surveys (Offorma 2017), MW disposal systems are almost nonexistent in Nigeria.

MATERIALS AND METHODS

Southern Nigeria's Ekiti State is bordered by four states: Kwara State in the north; Kogi State in the northeast; Ondo State in the south and southeast; and Osun State in the west. Ado-Ekiti is the capital of Ekiti State, which was created in 1996 from a section of Ondo State. Most of the state's population is from the Ekiti tribe, a subset of the Yoruba people. Nigeria's tiniest state, Ekiti, is the country's 30th-largest and 31st-most populous, with an estimated population of 3.3 million in 2016. The state borders Nigeria's lowland forests in the south and Guinea's forest-savanna mosaic in the north. The Ekiti State map is seen in Fig. 5.

Ekiti State's economy is partly built on agriculture, including yams, rice, cocoa, and cassava. Logging and tourism are two important small businesses. Ekiti has the country's joint-thirteenth highest Human Development Index and is considered the core of the Ekiti people's motherland.

Research Methodology

Surveys were used as part of the study's research design. Each hospital was asked to complete a short survey based on best practices for the safe disposal of medical waste. Interviewees included healthcare managers, nurses, nursing assistants, and trash handlers within and outside institutions. There was a questionnaire about MW creation and the key elements of its collection, transportation, treatment, and final disposal. The data collected will be utilized to examine the profile of the MWM program implemented by the hospitals. To gather primary data on MWM procedures, we conducted site visits. MW generation per patient per day was calculated for each facility.

Data Collection and Method of Analysis

The information was gathered throughout March and April in the year 2022. A mix of primary and secondary sources provided the research data, and they include:

I. Weighing scales were used to calculate the daily waste created per bed in each hospital.

II. The same strategy was utilized in the design of the questionnaires to gather data on the management of waste created in the selected hospitals. Also included were questions on possible factors that might affect waste development and management practices (Wafula et al. 2019, Awodele et al. 2016)

III. Literature includes journals, textbooks, conference proceedings, dissertations, and online publications.

RESULTS AND DISCUSSION

Quantity of Medical Waste Generated in the Hospitals

The quantity of waste generated in the three hospitals under study could not be calculated in terms of waste category

Fig. 5: Map of Ekiti State.

because not all the MW in the three hospitals was sorted. Hence, the quantity of the daily waste generated was determined according to the departments/units/wards where the waste was generated. Table 2 presents the quantity of MW generated in FETHI.

Quantity of Waste Generated at Federal Teaching Hospital Ido Ekiti

From Plate 1 (Fig. 7), the total quantity of MW generated at FETHI is 135.1 kg per day. There are 450 beds in this teaching hospital. There is a total of 185 beds in use. The quantity of MW per bed per day is 0.73 kg. Table 2 further presents the Environmental Department generates the highest quantity of waste (42.3 kg). The table shows that the renal department generates the least MW (6.3 kg). Fig. 6 presents the distribution of the MW in percentages.

Fig. 7: Plate 1- Medical waste being weighed in FETHI.

Table 2: Quantity of Medical Waste Generated at FETHI.

S/N	Department/Unit/Ward	Weight [kg]
1.	Male Medical Ward	10
2.	Female Medical Ward	7
3.	Radiology Department	29.5
4.	Theatre Department	6.5
5.	Mortuary Department	18.2
6.	Environmental Department	42.3
7.	Renal Department	6.3
8.	Emergency Department	15.3
	TOTAL	135.1

Source: (Fieldwork 2022)

As shown in Fig. 6, the units with the leading proportion are Environmental Department (31.31%), Radiology Department with (21.84%), Mortuary Department with (13.47%), Emergency Department (11.33%), Male Medical Ward (7.40%), Female Medical Ward with (5.18%), Theatre Department with (4.81%) and Renal Department with (4.66%). Table 3 presents the quantity of MW generated in EKSUTH.

Quantity of Medical Waste Generated at Ekiti State University Teaching Hospital Ado Ekiti

Table 4 gives the total quantity of MW generated at EKSUTH as 53.6kg per day. There are 238 beds in EKSUTH and 72 beds in use, so the quantity of MW per bed per day is 0.74 kg. In this hospital, the unit that generates the highest quantity of waste is the Radiology Department (14 kg), and the unit that generates the least amount of waste is the Emergency Department (3.5 kg). Fig. 8 presents the distribution of MW in percentages.

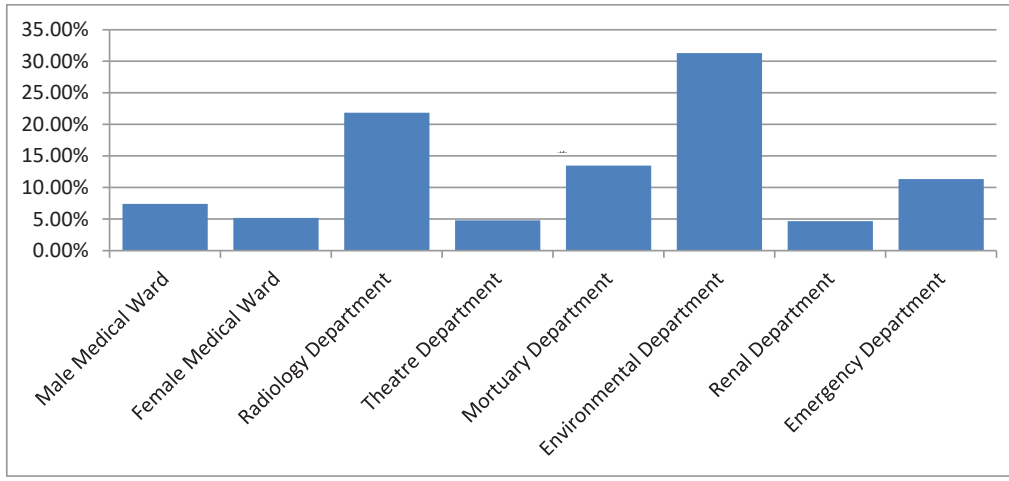

Fig. 6: Proportion of the percentage of medical waste in Federal Teaching Hospital Ido Ekiti.

Table 3: Quantity of medical waste generated at EKSUTH.

S/N	Department/Unit/Ward	Weight [kg]
1.	Male Medical Ward	11
2.	Female Medical Ward	4.9
3.	Radiology Department	14
4.	Theatre Department	10.5
5.	Laboratory Department	3.8
6.	Emergency Department	3.5
7.	GENERAL OUTPATIENT DEPARTMENT	5.9
	TOTAL	53.6

Source: (Fieldwork 2022)

The proportion of MW generated in the different units of the teaching hospital is shown in plate 2 (Fig. 9). The locations with leading proportions are Radiology Department (26.12%), Male Medical Ward (20.52%), Theatre Department (19.59%), General Outpatient Department (11%), Female Medical Ward (9.14%), Laboratory Department (7.09%) and Emergency Department with (6.53%). Table 4 presents the quantity of medical waste generated at AMSH.

Quantity of Medical Waste Generated at Afe Babalola University Multi-System Hospital Ado Ekiti

Table 4 gives the total quantity of waste generated at AMSH is 31.2kg. There are 400 beds in this teaching hospital, and the total number of beds in use is 51.

The quantity of MW generated per bed per day is 0.61kg. Table 4 presents that the male medical ward generates the most waste (7.5kg). The Pediatrics Ward generates the lowest quantity of waste (3.9kg). Fig. 10 presents the distribution of MW in percentages.

The proportion of the MW generated in the different units of the teaching hospital is shown in plate 3 (Fig. 11). The

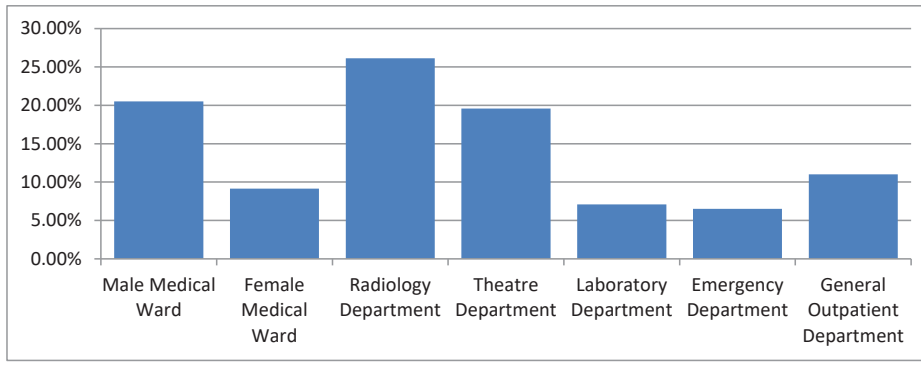

Fig. 8: Proportion of the percentage of medical waste in Ekiti State University teaching hospital.

Fig. 9: Medical waste being measured in EKSUTH.

Table 4: Quantity of medical waste generated at AMSH.

S/N	Department/unit/ward	Weight [kg]
1.	Male Medical Ward	7.5
2.	Female Medical Ward	6
3	Emergency Department	4.3
4	Renal Department	4
5	Pediatrics Ward	3.9
6	Obstetrics and Gynecology Department	5.5
	TOTAL	31.2

Source: (Fieldwork 2022)

units with the highest proportions are the Male Medical Ward (24.04%), Female Medical Ward (19.23%), Obstetrics and Gynecology Department (17.63%), Emergency Department (13.78%), Renal Department (12.82%), and Pediatrics Ward (12.5%).

Medical Waste Sorting in the Hospitals

The questionnaires administered to the health workers were used to determine the frequency of waste generated in the teaching hospitals. There were 54 respondents; 22 from Afe Babalola University Multi-System Hospital, 17 respondents from Federal Teaching Hospital Ido Ekiti, and 15 respondents from Ekiti State University Teaching Hospital. Table 5 presents all respondents' responses to MW sorting.

From Table 5, sharps are the most segregated MW in the hospitals, with 88.9% and 48 respondents segregating sharp waste in the teaching hospitals. This table also presents sharp, infectious, and pharmaceutical waste, which are the most segregated in teaching hospitals. Fig. 11 presents the graphical representations of the waste frequencies of MW sorted out in all the hospitals and Table 6 presents the frequency of medical waste sorted out in AMSH.

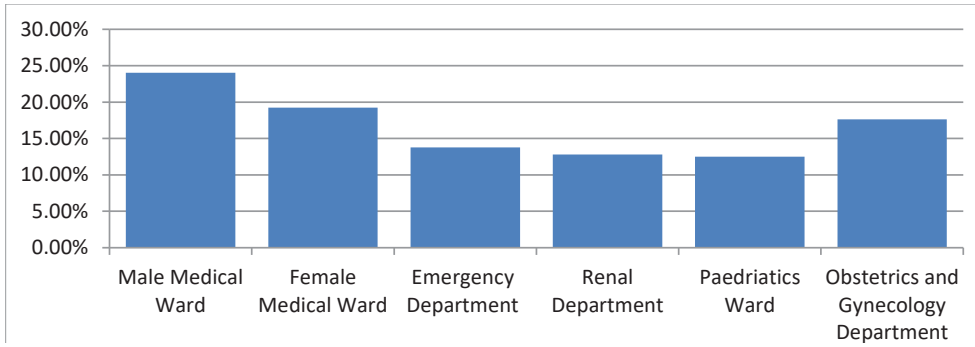

Fig. 10: Proportion of the percentage of medical waste in Afe Babalola University Teaching Hospital Ado Ekiti.

Fig 11: Plate 3 - Medical waste being measured in AMSH.

Table 5: Frequency of medical waste sorted in all the Teaching Hospitals.

		Responses		Percent of Cases
		N	Percent	
The type of waste is sorted out	Sharps	48	22.5%	88.9%
	Infectious waste	44	20.7%	81.5%
	Pathological waste	32	15.0%	59.3%
	Pharmaceutical waste	40	18.8%	74.1%
	Chemical waste	26	12.2%	48.1%
	Radioactive waste	23	10.8%	42.6%
Total		213	100%	394.4%

Source: (Fieldwork 2022)

Medical Waste Sorted Out in Afe Babalola University Multi-System Hospital.

From Table 6, it is clear that in AMSH Sharps, infectious and chemical wastes are the most sorted wastes in teaching hospitals. The least sorted-out waste in AMSH is a pharmaceutical waste. Table 7 presents the frequency of medical waste sorted out in EKSUTH.

Medical Waste Sorted out in Ekiti State University Teaching Hospital

Table 8 presents that sharps, infectious waste, and pharmaceutical waste are the most segregated waste in EKSUTH. The least segregated waste is chemical waste and radioactive waste. Table 8 presents the frequency of medical waste sorted out in FETHI. The tables presented that sharps, infectious waste, and pharmaceuticals are the most segregated waste in FETHI. However, it further says that infectious waste is the most segregated waste in the hospital, and radioactive waste is the least segregated waste in FETHI.

Medical Waste Sorted Out in Federal Teaching Hospital Ido Ekiti

Methods of Medical Waste Management

The questionnaire administered to the health professionals and workers examined MW awareness, collection, treatment, and disposal. Table 9 presents the respondents' awareness of the risk of poor MWM.

Table 10 shows that 94.4% of respondents know the risk of poor MWM, while a few are unaware. All respondents in EKSUTH, FETHI, and about 19 in AMSH know the risk of improper MWM. This indicates that most healthcare professionals and workers in these teaching hospitals know the risks of poor MWM. Table 9 presents the number of respondents that have been to training on MWM.

Table 10 presents that 22 respondents have attended training in MWM, and 31 respondents have not been to any training or offered courses on MWM. Most respondents in AMSH and EKSUTH have not attended any training on MWM. Table 11 presents the waste management methods practiced in the hospital.

Table 6: Frequency of medical waste sorted out in AMSH.

The type of waste is sorted out	Sharps	Count	19
		% within the Hospital of Respondent	86.4%
	Infectious waste	Count	16
		% within the Hospital of Respondent	72.7%
	Pathological waste	Count	14
		% within the Hospital of Respondent	63.6%
	Pharmaceutical waste	Count	13
		% within the Hospital of Respondent	59.1%
	Chemical waste	Count	16
		% within the Hospital of Respondent	72.7%
	Radioactive waste	Count	14
		% within the Hospital of Respondent	63.6%
Total		Count	22

Source: (Fieldwork 2022)

Table 7: Frequency of medical waste sorted out in EKSUTH.

Type of wastes sorted out	Sharps	Count	16
		% within the Hospital of Respondent	94.1%
	Infectious waste	Count	14
		% within the Hospital of Respondent	82.4%
	Pathological waste	Count	9
		% within the Hospital of Respondent	52.9%
	Pharmaceutical waste	Count	14
		% within the Hospital of Respondent	82.4%
	Chemical waste	Count	5
		% within the Hospital of Respondent	29.4%
	Radioactive waste	Count	5
		% within the Hospital of Respondent	29.4%
Total		Count	17

Source: (Fieldwork 2022)

Table 8: Frequency of medical waste sorted out in FETHI.

The type of waste is sorted out	Sharps	Count	13
		% within the Hospital of Respondent	86.7%
	Infectious waste	Count	14
		% within the Hospital of Respondent	93.3%
	Pathological waste	Count	9
		% within the Hospital of Respondent	60.0%
	Pharmaceutical waste	Count	13
		% within the Hospital of Respondent	86.7%
	Chemical waste	Count	5
		% within the Hospital of Respondent	33.3%
	Radioactive waste	Count	4
		% within the Hospital of Respondent	26.7%
Total		Count	15

Source: (Fieldwork 2022)

From plate 4 (Fig. 13), incineration is widely used in hospitals in Ekiti State. 15 respondents from AMSH and FETHI indicated that incineration is the waste management method in their hospitals, while 16 respondents from EKSUTH agreed with this same waste management method. Incineration is one of the best methods for MWM, and these hospitals practice such a method. Fig. 12 presents the graphical representation of this frequency, and Table 12 presents the location of medical waste segregation.

Table 12 presented that 50% of the respondents believe that MW should be segregated at the source of generation. Eight respondents in AMSH and EKSUTH are of the opinion that MW should be sorted at the source of generation, while 11 respondents in FETHI also agree with this. The table further shows that 18 respondents do not know where MW should be segregated; 11 are from AMSH, and 6 are from EKSUTH. Fig. 14 indicates the graphical representation of this frequency. Table 13 presents the frequency of the procedures for collecting and handling waste.

Table 14 presents that the majority of the respondents have procedures for the collection and handling of waste in hospitals. 16 respondents in AMSH, 13 from EKSUTH, and 14 from FETHI have procedures for collecting and handling waste. Table 14 presents the type of containers for sharps.

98% of respondents consent to the safety boxes as the preferred container for sharps. All respondents in EKSUTH, FETHI, and 21 respondents in AMSH are aware of the

Table 9: Are you aware of the risk of poor medical waste management?

	Frequency	Percent	Valid Percent
Yes	51	94.4	94.4
No	1	1.9	1.9
Maybe	2	3.7	3.7
Total	54	100.0	100.0

Source: (Fieldwork 2022)

Table 10: Have you attended any training in medical waste management?

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	22	40.7	40.7	40.7
No	31	57.4	57.4	98.1
Maybe	1	1.9	1.9	100.0
Total	54	100.0	100.0	

Source: (Fieldwork 2022)

Table 11: Which waste management method is practiced in your hospital?

	Frequency	Percent	Valid Percent	Cumulative Percent
Open burning	4	7.4	7.4	7.4
Incineration	46	85.2	85.2	92.6
Landfills	1	1.9	1.9	94.4
Open dumping	3	5.6	5.6	100.0
Total	54	100.0	100.0	

Source: (Fieldwork 2022)

Table 12: Location of medical waste segregation.

	Frequency	Percent	Valid Percent	Cumulative Percent
Source of generation	27	50.0	50.0	50.0
Outside the bin	9	16.7	16.7	66.7
I don't know	18	33.3	33.3	100.0
Total	54	100.0	100.0	

Source: (Fieldwork 2022)

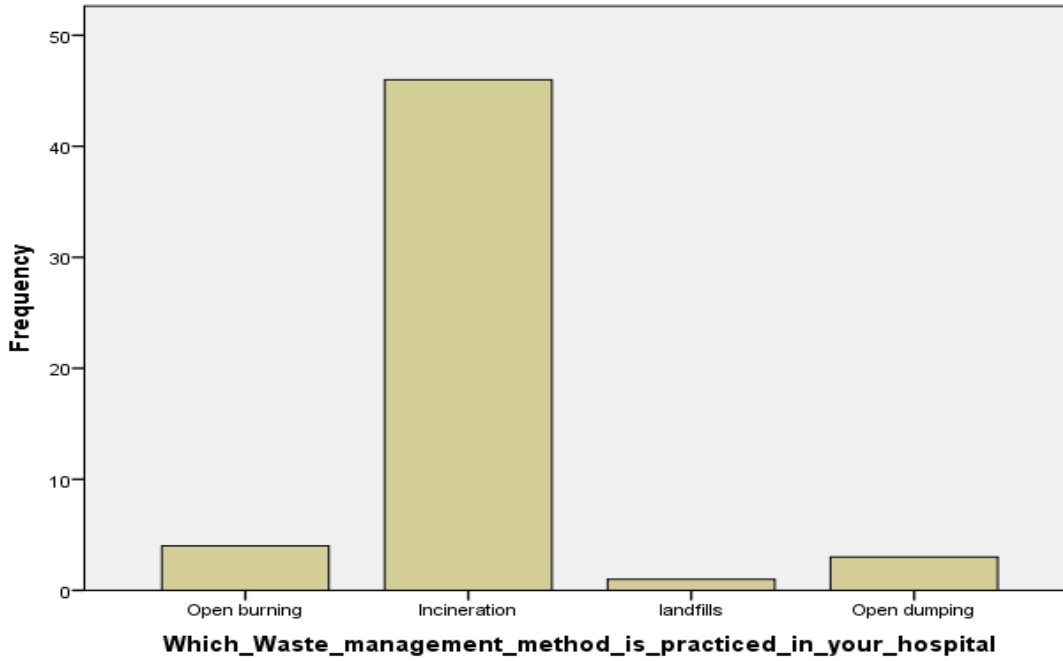

Fig. 12: Graphical representation of waste management methods practiced in hospitals.

Fig. 13: Plate 4: A preceding incinerator in EKSUTH.

presence of safety boxes for sharps in their hospitals. These sharps include needles, syringes with needles, broken glass ampoules, scalpels, blades, infusion sets, etc. Table 15 presents the frequency of color coding for MW disposal.

Table 15 shows that more than 50% of the respondents color codes their waste for disposal, and more than 30% do not color-code their waste. 15 respondents in AMSH, 6 respondents in EKSUTH, and 8 respondents in FETHI

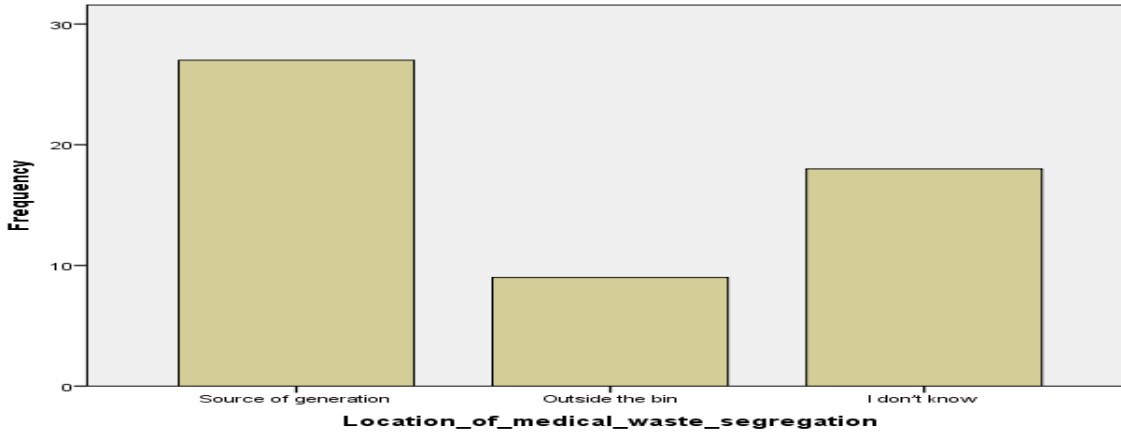

Fig. 14: Graphical representation of the location of medical waste segregation.

believe that they color-code their waste for disposal, but 8 respondents from EKSUTH, 3 respondents from AMSH, and 7 respondents from FETHI do not agree. Fig. 15 below presents the graphical representation of this frequency. Table 16 presents the waste disposal frequency in hospitals. Plate 5 (Fig. 15) presented Colour coded waste for disposal in EKSUTH (Fig. 11).

Table 16 presents 37 respondents who consent to waste disposal daily, and 13 respondents dispose of waste when storage is full. 14 respondents in AMSH, 13 in EKSUTH, and 10 in FETHI dispose of their MW daily, while 5 from AMSH, 4 from EKSUTH, and FETHI disposes of their waste when full.

CONCLUSIONS

MWM is critical in any country to safeguard the general public's health. Healthcare workers need to be aware of the dangers of inappropriate MW disposal. Patients, medical workers, and waste handlers can all die due to improper handling of MW. The government should establish fundamental rules for MWM in the health sector. In the course of our investigation, there have been challenges, problems, and positives. The results of this study, which included AMSH, EKSUTH, and FETHI, led to the following conclusions.

1. The wastes that get the most attention in the three hospitals are sharps. Sharps are stored in red and white boxes by AMSH, EKSUTH, and brown boxes by FETHI. Boxes are located in key locations in each hospital and may only be accessed by healthcare staff.
2. Before the waste was taken away to be thrown away, it was collected at the three hospitals in bins next to

Table 13: Do you have procedures for the collection and handling of waste?

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	43	79.6	79.6	79.6
No	4	7.4	7.4	87.0
Maybe	7	13.0	13.0	100.0
Total	54	100.0	100.0	

Source: (Fieldwork 2022)

Table 14: Types of container for sharps.

	Frequency	Percent	Valid Percent	Cumulative Percent
Nylon bags	1	1.9	1.9	1.9
Safety boxes	53	98.1	98.1	100.0
Total	54	100.0	100.0	

Source: (Fieldwork 2022)

Table 15: Do you color code your medical waste for disposal?

	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	29	53.7	53.7	53.7
No	18	33.3	33.3	87.0
Maybe	7	13.0	13.0	100.0
Total	54	100.0	100.0	

Source: (Fieldwork 2022)

Table 16: Waste disposal frequency.

	Frequency	Percent	Valid Percent	Cumulative Percent
Daily	37	68.5	68.5	68.5
Weekly	4	7.4	7.4	75.9
When storage is full	13	24.1	24.1	100.0
Total	54	100.0	100.0	

Source: (Fieldwork 2022)

Fig. 15: Plate 5 - Colour-coded waste for disposal in EKSUTH.

patients' beds and other places inside and outside of the different units/wards.

3. The most sorted out wastes in the three hospitals are Sharps, Infectious waste, and Pharmaceutical waste, with a percentage frequency of 88.9%, 81.5%, and 74.1%, respectively.
4. The total medical waste generated at AMSH, EKSUTH, and FETHI is 0.61kg, 0.74 kg, and 0.73 kg, respectively.
5. AMSH and EKSUTH use appropriate color codes for their waste, while FETHI use the same color code for all their waste.
6. All hospitals have similar waste management methods.
7. MW treatment is practiced in all hospitals. The sharp wastes are sterilized using an autoclave before final disposal.
8. Incineration is the waste management method used in all hospitals. The type of MWI technology used is the controlled-air incinerator. It is also known as a starved air incinerator or modular combustion. But after being burned, all hospitals dump their MW out in the open with their other general waste.
9. There is no current dumpsite near any of the hospitals or any existing environment in any of the hospitals studied.
10. While most hospital employees know the dangers of improper MW disposal, they get little to no training.
11. FETHI and EKSUTH are secondary care level hospitals, while AMSH is a tertiary care level hospital.

Recommendations

The following are the most important suggestions that came out of the evaluation that was conducted.

1. Educating the public about the dangers of MW and the best methods to follow.
2. Segregation should always take place at the source of generation.
3. As part of the treatment process, contaminated sharps need to be transported in a safe, secure way.
4. Hazardous material waste minimization should be a priority.
5. More MW recycling firms should be put up to use recyclable medical waste.
6. The correct management and disposal of waste is a vital responsibility of healthcare establishments.
7. Educate employees on the dangers of improperly disposing of MW by providing them with educational opportunities.
8. For a Health Care Facilities (HCF) to be registered, it should be required to adhere to correct waste disposal rules and laws.
9. All hospitals utilized the incinerator to dispose of medical waste. The following factors should be taken into account and implemented to ensure the appropriate application of this technique:
   i. They ensure that only the right kinds of waste are burnt through effective waste reduction and segregation measures.

ii. This incinerator must be constructed in a location far away from people. As a result, there will be less exposure and danger.

iii. A qualified person should be in charge of the operation. To achieve the necessary combustion conditions and emission levels, this is essential.

iv. Protective gear should always keep workers safe, and suitable temperatures must be used.

v. Defective components should be replaced or repaired regularly.

10. It is necessary to dispose of MW through incineration properly. The residues are disposed of in a uniquely engineered landfill or used as building aggregate. The following considerations must be made before MW may be disposed of in landfills:

i. The landfill must be built and operated appropriately, with all the necessary environmental regulations.

ii. We must verify that disposal mechanisms are safe to avoid harm to waste operators.

iii. Humans and animals should not come close to MW until it has been disposed of.

iv. Waste personnel should be informed when MW is carried to the site for disposal so that they can take further measures if necessary.

v. The wastes should be unloaded as close as possible to where they will be dumped and then dumped immediately.

vi. When HCW is dumped, it should be covered with soil.

vii. The landfill should be isolated, and a security fence should be placed.

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