Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Healthcare waste management in the Tamale Central Hospital, northern Ghana. An assessment before the emergence of the COVID-19 pandemic in Ghana

Samuel Kojo Abanyie a, Ebenezer Ebo Yahans Amuah b,*, Nang Biyogue Douti c, Casmid Charles Amadu d, Manaf Baybor c

a Department of Environment, Water and Waste Engineering, University for Development Studies, Tamale, Ghana
b Department of Environmental Science, Kwame Nkrumah University of Science and Technology, Kumasi, Ghana
c Department of Environmental Science, C. K. Tedam University of Technology and Applied Sciences, Navrongo, Ghana
d Department of Earth Science, C. K. Tedam University of Technology and Applied Sciences, Navrongo, Ghana

ARTICLE INFO

Keywords: Healthcare, Waste, Sanitation, Value chain, Environmental management, Northern Ghana

ABSTRACT

Healthcare waste (HCW) poses several environmental and public health challenges. However, much attention has not been given to its management. The present study sought to assess the healthcare waste management (HCWM) practices in the Tamale Central Hospital (TCH) by characterizing and measuring the quantities of waste generated and the associated implications. Observation of the value chain of healthcare waste management, waste quantification using a weighing scale (Top-pan-spring balance), and semi-structured interviews were used in the data collection. The study revealed that, except for sharps, there was no segregation of infectious and non-infectious waste, and healthcare waste was not treated before final disposal. The study showed that a daily record of 5.1 kg of sharps, 24.46 kg of infectious waste and 59.45 kg of general waste was generated. The maternity ward produced more general waste (14 kg), whereas the theatre generated the highest infectious waste (5.70 kg) and sharps (0.8 kg) daily. Generally, the maternity ward recorded the highest daily waste generation of 17.9 kg. The waste treatment method available in the hospital was incineration. However, the incinerator was found to be dysfunctional. Thus, an improvised method (dug pit) was used irrespective of the associated health and environmental implications. The study also revealed that the hospital did not quantify the amount of solid waste that was generated. Inadequate finance and lack of supervision were linked to the problem of poor healthcare waste management in the study area. Also, 82% of the workers mentioned that there was poor HCW segregation at the departments whereas 76% of the patients who received healthcare at the facility were unsatisfied with the HCWM practices. A strong linear relationship in the responses made was recorded. The healthcare waste management index showed that the HCWM practice at the facility was unsatisfactory as it was medium-ranked. The study, therefore, recommends that the hospital considers constructing an on-site waste treatment facility, segregate and quantify waste for effective allocation of resources for treating healthcare waste.

1. Introduction

In the quest of reducing health problems and providing patients care services, healthcare facilities generate waste which includes sharps, packing materials, office waste, and waste from patients, papers, tissues, and hazardous materials (WHO, 2014; Hossain et al., 2011; Ranjbari et al., 2022). Healthcare waste (HCW), which is also defined as medical or biomedical waste, is the different types of waste that are generated from health centres and laboratories, health research facilities, emergency relief actions, and healthcare activities undertaken in homes (World Health Organization, 2011; Doylo et al., 2019). The health sector is increasingly generating waste in the process of controlling diseases and treating patients (Kenny and Priyadarshini, 2021). HCW highly affects environmental sustainability, the health of patients and health workers, and public health (Alharbi et al., 2021; Doylo et al., 2019). Following its deleterious impacts, HCW requires proper management, treatment and disposal strategies to reduce its harmful impacts (Alam and Mosharraf, 2020).

According to the Basel Convention (1992), healthcare waste is considered the second most hazardous waste after radioactive waste. This makes it one of the most perilous concerns in many developing countries (Abah and Ohimain, 2011; USAID, 2012) and health facilities
Healthcare waste does not only pose public health risks, it also affects surface and underground water quality when disposed of indiscriminately. Therefore, it requires significant attention because of its hazardous nature and the environmental and public health risks associated with it (Khan et al., 2006; Ranjbari et al., 2022). Diaz et al. (2005) and Doylo et al. (2019) stated that health workers are also at risk of hospital-related infections (Nosocomial Infections) through accidental pricking by contaminated sharps and orally through contaminated foods, fluids, and water (salmonellosis, E. coli infection, hepatitis A, cholera) and airborne diseases (such as Tuberculosis and Measles).

Statistically, a total of about 23 million infections of hepatitis B and C and, HIV is contracted through infested medical materials (WHO/UNAIDS/UNICEF., 2010). Also, the emergence of public health risk is contributed by the type of method(s) used in managing healthcare waste (Ministry of Health, 2009). Therefore, the infectious nature of healthcare waste makes it a prerequisite to ensure proper management, handling, and disposal technologies (Ministry of Health, Government of Ghana (MOH), 2005), which includes safe collection, storage, transport of waste to treatment sites and proper treatment (incineration, microwave, ultra-violate), and disposal of waste. Nevertheless, at the waste generation stage within healthcare centres, waste segregation and internal storage processes are carried out by nurses. This is mostly done improperly since hazardous waste is commonly mixed with other forms of generated waste (Hussein et al., 2014). This is because they do not have the requisite training and skills to manage such waste. However, according to Basel Declaration (1999), it remains the duty of every healthcare institution to treat and dispose its waste (medical) in the safest manner to ensure that no adverse health or environmental effects are realized.

Tulukhonova and Ulanova (2013) and Nie et al. (2014) have respectively shown that approximately 282,447 tons of medical waste are produced yearly in Africa and nearly 5.22 million people die from the effects of healthcare waste. The above claims call for proper medical waste management in areas where health services are provided. However, several studies including Mbongwe et al. (2008), Bendjoudi et al. (2009), Ferreira and Teixeira (2010), Mangaa et al. (2011), Eslami et al. (2017), Oyekale and Oyekale (2017), Govender et al. (2018), Çetinkaya et al. (2020) in Botswana, Algeria, Portugal, Cameroon, Iran, Nigeria, South Africa and Turkey have respectively shown poor conducts by healthcare facilities in managing their waste. A study by the WHO in 2015 indicated that only 58% of the sampled facilities from 24 countries all around the world had proper systems to deal with the safe disposal of HCW (WHO, 2015).

To tackle this, the Ministry of Health (Ghana) (2006) discussed detailed policy guidelines that served as a complement between the law and policy on medical waste management in March 2006. Also, the WHO revealed that national legislation forms the building block for developing countries in improving medical waste management.

Similarly, IMANI (2016) mentioned that the enactment and enforcement of national legislation on healthcare management is a major prerequisite for the effective management of biomedical waste. Though in Ghana national guidelines on safe and proper hospital waste management have been delineated, reports revealed that hospital wastes are still improperly managed (Abor, 2013; Asante et al., 2014). This is because, there are no constitutional legislations that strictly delineate procedures for proper biomedical waste management and legal formalities to discipline violators (IMANI, 2016). According to the Ministry of Health (2009), for healthcare institutions to fully reduce health problems, proper healthcare waste management is essential. Therefore, this research focused on: (1) determining the healthcare waste handling practices alongside the sanitation value-chain from the point of waste generation to the final disposal; (2) quantifying the amount and types of waste generated; and (3) determining the potential hazards posed to residents and hospital staff due to poor waste management practices.

2. Materials and methods

2.1. Study area description

The research was conducted at the Tamale Central Hospital which is located within the Tamale metropolis of Ghana’s Northern Regional capital. The Metropolis lies between longitudes 0° 36 and 0° 57 west and latitude 9° 16 and 9° 34 north (Ghana Statistical Service, 2014). It has a total estimated land size of 646,902 km² with a population of 371,351 (Asante et al., 2018). The Tamale metropolis borders to the north and west with the Sagnarigu district, the Mion district to the east, southwards and south-westwards with the East and Central Gonja districts respectively (GSS, 2014).

2.2. Data collection

A multi-method research approach was adopted in this study. This entailed the integration of qualitative and quantitative research methods since no single method can completely capture the relevant areas of the study (Amofo et al., 2016; Bryman, 2016). In this study, qualitative data collection tools such as observation and interviews were employed while measurement (quantities) of solid healthcare waste was the quantitative tool used. The Ministry of Health-Ghana (2009) and the Environmental Protection Agency (Ghana) (2002) guidelines for managing biomedical waste were incorporated into the research as secondary sources of information to determine the performance of HCW management practices at the facility (Fig. 1).

2.3. Observation

To validate the data obtained from the interviews, observation was done in the study area. This was done by spending an hour every morning in each of the departments, observing and taking notes of the value chain of waste management in the hospital. The observation was done continuously for 8 days.

2.4. Interview

The Head of the Environmental Health Department, four hospital waste collectors and three (3) workers from each of the departments (a total of 33 health workers) were interviewed to identify the type of waste generated in the various departments (male, female, maternity, labour, children’s wards, theatre, diagnostic analysis laboratory, outpatient, and administration). The number of workers to be considered in this study was determined using the permutation formula suggested by Cochran and Cox (1957) and applied by Amuah et al. (2021) which is presented as:

\[ P_n = n! \]

This study considered 11 departments of the TCH. Hence, this is computed as:

\[ P_{11} = 11! \]

\[ a = 39,916,800 \]

In the application of this formula, Tetteh et al. (2004) and Amuah et al. (2021) revealed that the sample size should either be a factor or multiple of the result (\(a\)). Thus, a panel of 33 which is a factor of 39,916,800 and representative sample size was considered adequate for this study. This was subdivided into 3 workers for each department. Coupled with this, patients (outpatients and inpatients) were also interviewed to determine their perception of waste management in the
hospital. Since the number of patients who visit the hospital is irregular, the sample size calculation was done following Cochran (1963) and adopted by Amuah et al. (2021). This is presented in Eq. (3). It is presented as:

$$ n = \frac{\hat{\sigma}^2 \cdot \sigma \cdot \beta}{e^2} $$  \hspace{1cm} (3)

Where \( n \) = sample size, \( \hat{\sigma} \) = value of confidence level (95%), \( \sigma \) = standard deviation (0.2), \( \beta \) = precision level (0.5) and \( e \) = error margin (0.05).

This is computed as:

$$ n = \frac{(1.96)^2 \cdot 0.2 \cdot 0.5}{0.05^2} = 154 \sim 160 \text{ patients} $$  \hspace{1cm} (4)

The sample size (160) was divided into four (4); outpatients (40 males and females each) and inpatients (40 males and females each). Simple random sampling was employed in the selection of the patients. Eliciting information from the patients was done for 10 days; with 4 respondents from each ward per day. To ensure that there was no case of interviewing a patient multiple times, the folder numbers of every patient considered in the study were recorded on their respective interview guides. The pre-condition for a patient’s eligibility to take part in this study was that the person should have visited the hospital more than once or should have been on admission for two (2) days or more. The views of the workers were also assessed using the healthcare waste management index (HCWMI) which is described in Table 1. The health workers were supposed to rate each of the HCWM processes using the weights.

The interview questions focused on the mode of segregating waste, factors militating waste segregation, how healthcare solid waste is collected and stored, the method(s) used in waste treatment and disposal, the state of the treatment facility(ies) and the disposal site, workplace safety measures that are already in place to prevent infections, potential hazards emanating from poor healthcare waste management on public health, patients and health workers and the unit(s) responsible for handling healthcare waste, and rating the status of healthcare waste management from patients’ perspective.

### Table 1

| HCWMI weighting factor and ranking criteria. | Weight | Range | Ranking |
|---------------------------------------------|--------|-------|---------|
| Segregation                                  | 20     | Very poor | 0 – 25 |
| Collection                                   | 15     | Poor | 26 – 50 |
| Transportation                               | 15     | Medium | 51 – 70 |
| Storage                                     | 15     | Good | 71 – 90 |
| Disposal                                    | 20     | Excellent | 91 – 100 |
| Personal hygiene conditions                  | 15     |       |         |

#### 2.5. Measurement of healthcare waste

The quantities of solid healthcare waste generated in each department were measured using waste collection bins, robber bags, and a top-pan spring balance. Wastes from the departments were collected in a 240 L waste collection bin. This was done daily for four weeks. Each day, the waste was sorted into three categories; general waste (plastics, cans, leaves, paper, and packing cases), infectious waste (solid healthcare waste contaminated with blood, bodily fluids, and human excreta), and sharps (syringe, needle, and blade). The sorted waste was put into large polythene bags and weighed (kg) with a top-pan spring balance. The average waste generated daily by each department was obtained by calculating the mean of measurements taken over four days in each department for all the different types of waste (sharps, infectious, general waste). The formula is shown as:

$$ W_{\text{day}} = \frac{1}{N(W_1 + W_2 + \ldots + W_i)^2} $$  \hspace{1cm} (5)

Where \( W_{\text{day}} \) = average waste generated by each department daily, \( W_i \) = waste generated by each department daily, and \( N \) = number of measurements taken.

Some other forms of waste generated were pharmaceutical wastes (expired and surplus drugs and chemicals that were returned from wards were collected, stored in safety boxes with the biohazard labels, and disposed of twice a year) and pathological wastes (human body parts,
tissue, and fluids) (TCH, 2018). These were not assessed in this research since they are not available to the public.

2.6. Healthcare waste collection and processing: recommendations by regulators

The MOH requires that different types of healthcare waste are collected using different colour-coded containers. These were: black for general waste, yellow for infectious waste, and brown for expired drugs, chemicals, and vaccines. However, healthcare waste must not be stored for more than 24 h (MOH, 2009). According to Amfo-Out and Do (2015), by regulation, general waste can be disposed of at a landfill. Radioactive waste is sent to the radiation protection board. The infectious waste is sorted into recyclable and non-recyclable waste. The sorted waste is then transported to a treatment facility for treatment (sterilization, disinfection, incineration, or steam autoclave) and then finally disposed of at a landfill site. The WHO identified steps to ensure proper healthcare waste management. These include identification of waste, segregation, packing, labelling, documentation, internal and external transportation, temporary storage, treatment technique, disposal of treated clinical waste, and landfill dumping (Marinković et al., 2008; Pruss et al., 1999).

2.7. Ethical concern

To achieve the goals of this research, formal approval was granted before this research by the Northern Regional Health Directorate and the hospital considered in the study. Also, verbal consents of the nurses in charge of the various wards and departments, and the patients were sought before the interviews were granted.

2.8. Data analysis

Waste measurement was repeated to ensure accuracy. Data analysis was essentially descriptive. Then, relevant information was retrieved from interviews, measurement, and observation in a standard form using the R software version 3.6.2 and Microsoft Excel 2016.

3. Results and discussion

3.1. Healthcare waste generation, segregation, and storage

This research showed that the departments generated different types, quantities (Table 3), and characteristics of waste. Generated wastes were segregated into different colour-coded bins according to the nature of waste. This was aimed at encouraging the effective separation of waste according to the types and levels of hazardousness. The colours include black - general waste, yellow - infectious waste, and brown - expired drugs, chemicals, and vaccines (MOH, 2009). Though these containers had been provided for HCW separation at the point of generation, this was poorly done and ineffective since only sharps were keenly segregated. This was also observed at the laboratory unit of the hospital. The study revealed that only sharps were put into safety boxes for further treatment at a locally-made incinerator before disposal. However, other forms of solid healthcare wastes were mixed with communal waste without any form of pre-treatment. The study (Fig. 2) showed that considering the segregation of HCW at the point of generation (departments), 13 (40%) respondents respectively indicated that HCW was not segregated at the point of generation. Meanwhile, 14 (42%) and 6 (18%) respondents also mention that HCW was segregated sometimes and always respectively. The high number of (no and sometimes = 27 (82%) workers) suggest poor segregation of HCW at the departments. A strong linear relationship in the responses made was recorded (Fig. 2). This could be attributed to the fact that 72% of the workers interviewed had not received any education on HCWM. This possibly affected the level at which they prioritized HCW, especially segregating HCW at source, their associated environmental and health implications. This was dissimilar with the findings of Oli et al. (2016) in Nigeria where 81.5% and 57.3% of health workers in government and private hospitals respectively had received HCW education/awareness. Also, the respondents reported that there was no direct institutional arrangement regarding oversight, policies, and regulations on how to manage HCW at the department level. Considering the HCWMI presented in Table 2, the HCWMI of the TCH could be described as medium ranked. Coupled with the information obtained from the patients (Fig. 3), this suggests that the HCWMI practised at the facility was generally below standard.

3.2. Types of solid healthcare waste generated

The garnered data showed that all the departments considered in this study generated general waste (Table 3). The study showed that general waste (59.45 kg) was the largest volume of waste produced in the hospital compared to infectious (24.46 kg) and sharps (5.1 kg). Similar to the findings of Santos et al. (2019) in Brazil on HCW showed that more than 55.6% of the generated HCW is general waste, followed by sharps (2.9%) and infectious (39.1%). Excluding the administration and phar-
any treatment. This suggests poor hazardous treatment services. From Fig. 3, 83 (52%), 38 (24%), and 26 (16%) of the patients considered in this study stated that HCWM at the TCH was poor, moderate and good respectively. Thirteen (8%) indicated “I don’t know”. This suggests that people receiving healthcare at the facility were highly unsanitized with the HCWM practices at the TCH. The study further showed that 108 (68%) of the patients stated to have observed littered waste within the premise of the hospital. However, 79 (73%) of these respondents stated that the waste observed were general whereas 29 (27%) mentioned infectious waste.

The research revealed that healthcare waste management falls within the jurisdiction of the environmental health unit, under the supervision of the estate department of the hospital. Meanwhile, the requisite logistics to ensure proper healthcare waste management were lacking. It was identified that healthcare solid waste was collected into a communal container every morning between 6:00 am and 8:00 am. The sharps were sent to the improvised incinerator after the close of work. When the communal waste container got full, usually it was picked up by a waste vehicle and emptied at the Metropolitan landfill. In instances where it got full before it was emptied, the waste materials were burnt inside the waste container as shown in Fig. 3. However, this is unfriendly to public health and the environment (Mato and Kaseva, 1999; Hassan et al., 2008).

Burning healthcare waste releases toxic pollutants into the environment which can pose serious public health and environmental risks. Smoke from the burning waste also caused discomfort and irritation to people. Fig. 5 shows a flow chart of how waste was handled in the study area and Fig. 6 presents the dysfunctional incinerator. Findings from this study showed that people scavenged the landfill for recyclable materials. As a result, such people may be at risk of cuts or infections due to poor management of healthcare solid waste. The study showed that, at some wards, 20 to 240L in capacity were used to store waste. These were emptied every 24 h into a communal waste container situated at a different location within the hospital. To protect public health and environmental quality, Khan et al. (2019) discussed the need for replacing outdated incinerators with advanced systems such as autoclaving, new practices of pyrolysis and steam sterilization to avoid the emission of toxic gases and elements since the Stockholm Convention considers medical waste incinerators as key sources of hypertoxic PCDDs and PCDD/Fs emitters and heavy metals (Zhang et al., 2020; Ranjbari et al., 2022).

The research also showed that the amount of healthcare solid waste generated was not quantified and was also disposed of in their untreated nature. A recent study unveiled that infectious waste was mixed and disposed of with the general waste. There is a need for proper segregation of healthcare waste. This is because, infections such as Hepatitis B and C, and HIV can be contracted from infested medical materials (WHO, 2005). Finally, according to the findings of this research, waste collectors wore no nose masks and hand gloves to protect themselves from infections. Scavenger also had access to improperly disposed healthcare waste around the hospital and at the final disposal site.

3.4. Waste generation and segregation: implications

Based on the data garnered from the research, the different types, quantities, and characteristics of generated waste from the various departments suggested that varied types of waste management procedures are required. Additionally, departments that produce more harmful waste required more attention. Improper segregation of waste is a potent contributor to human and environmental risk (Udofia et al., 2015). Due to the high costs of hazardous waste treatment and disposal, segregation is an important economic option for healthcare facilities (Rau et al., 2000). A study by Mmereki et al. (2017) in Botswana showed that current HCW collection and storage facilities do not operate efficiently. Thus, more focus should be on the segregation of infectious and non-infectious from general waste, pollution prevention, and recovery of valuable materials from healthcare facilities.

### Table 3
Quantities of solid healthcare waste.

| Department         | Average waste generated (kg/day) | Total |     |
|--------------------|----------------------------------|-------|-----|
|                    | Sharps | Infectious waste | General waste |     |
| Out-Patient        | 0.1    | 0.3              | 10.65         | 11.05|
| Administration      | –      | –                | 1.75           | 1.75 |
| Children’s ward     | 0.4    | 1.3              | 5.7            | 7.4  |
| Male ward           | 0.6    | 1.6              | 4.0            | 6.2  |
| Female ward         | 0.66   | 4.0              | 6.35           | 11.01|
| Labour ward         | 0.3    | 2.85             | 0.9            | 4.05 |
| Maternity ward      | 0.43   | 3.5              | 14.0           | 17.93|
| Emergency ward      | 0.8    | 2.21             | 6.0            | 9.01 |
| Laboratory          | 1.01   | 3.5              | 1.8            | 6.31 |
| Pharmacy            | –      | –                | 7.3            | 7.3  |
| Theatre             | 0.8    | 5.7              | 1.0            | 7.5  |
| Total               | 5.1    | 24.46            | 59.45          | 89.01|

Fig. 4. Burning waste in a communal waste container.

macy that generated only general waste, the others produced sharps, blood-soaked/stained cotton, bandages, and plasters. These findings are similar to Oduro-Kwarteng et al. (2021) and Ranjbari et al. (2022) who indicated that general HCW including papers, containers, glass, food residues and plastics are usually generated at the administrative units of healthcare facilities. The children’s, males’, females’ and emergency wards, and the theatre generated intravenous therapy bags (IV bags) whereas the laboratory added toilet papers, vacuum tubes with blood samples, faecal, urine and sputum sample containers to the gross waste. The children’s, labour, emergency wards, and the theatre peculiarly contributed diapers, placenta, pharmaceutical, and pathological waste respectively. Some of these biomedical wastes which are classified in the hazardous fraction of HCW could result in a range of environmental and health risks (Domingo et al., 2020; Ranjbari et al., 2022).

3.3. HCW treatment and disposal

The main healthcare waste treatment method used was incineration. However, the incinerator had not been operational for about three years. Due to this, a three (3) by six (6) feet-deep pit was used for incinerating sharps. Whenever the pit got full, it was excavated and disposed of together with communal waste. All the other forms of waste were observed to be disposed into the environment without any form of treatment or burnt (Figs. 4 and 6). The absence of a proper system to manage HCW in the study hospital was similar to Eslami et al. (2017) who reported that government (24.29%) and private (14.8%) hospitals in Iran lacked treatment devices, and hazardous HCW were discarded without
is recommended that waste materials are properly segregated at the point of generation before treatment and disposal to protect health and reduce cost in waste treatment and disposal (Rushbrook and Zghondi, 2005; Sasu et al., 2012). According to Ngwuuluka et al. (2009), segregating waste, especially healthcare waste results in a clean solid waste stream that could be easily, safely, and effectively managed through recycling, composting, and landfill. Though Asante et al. (2014) suggested that using colour-coded waste collectors is an efficient method of promoting waste segregation, the recent research revealed that only the children’s ward had colour-coded bins, which were not in use. This was consistent with the findings of Acheampong et al. (2015). This could be as a result of lack of funds, hospital employees’ knowledge and reactive attitudes regarding healthcare waste management as stated by Elnour et al. (2013), and ineffective monitoring and management as mentioned by Beyene and Redaie (2011). The need for proper management of HCW as a means to protect the health and safety of health workers cannot be overemphasized (Oyekale and Oyekale, 2017). Therefore, workers in the facilities, especially those who directly come into contact with hazardous waste should be sensitized on why and how to safely dispose of such materials and the importance of segregating waste. To enhance waste segregation, labels (written or pictorial) can also be placed on the containers for easy identification.

3.5. Healthcare waste management, treatment, and disposal: implications

Incineration is one of the most effective final treatment methods for healthcare waste (Kumar et al., 2010). There are immense benefits from incinerating hazardous waste. Some of these are reducing volumes of waste, the unrecognizable end product in the form of ashes, and the destruction of pathogens that cannot be ignored (Lee and Huffman, 1996). However, in this study, this was seldomly used. The lack of a functioning incinerator contributed to the ineffective disposal of hazardous waste at the facility. The study showed that a hand-dug pit was used as an incinerator for burning. In some cases, hazardous waste was burnt with general waste in a communal waste container (Fig. 4). These practices violate the MOH-Ghana and EPA-Ghana guidelines for disposing of medical waste. Health Professions Council of South Africa (2008),
Asante et al. (2014) and Oyekale and Oyekale (2017) mentioned that disposing and burning healthcare waste in an unlined pit could trigger other problems such as adverse health risks (formation of dioxins) and environmental degradation. A study by Ndoye and Massenet (2008) reported that burning healthcare waste releases toxic pollutants and carcinogenic substances into the environment which could pose serious health risks on liver functioning, skin lesions, immune system, nervous system, endocrine, and reproductive systems (Chardon, 2008). Poor management of healthcare waste could also lead to Nosocomial or hospital-acquired infections such as Urinary Tract Infection, Pneumonia, Bloodstream infections (Acheampong et al., 2015). Additionally, Hoenich and Pearce (2002) revealed that irregular incineration leads to harmful effects on health. Though no formal complaints of emerging health risks as a result of improper burning of hazardous waste, no medical examination, screening, or investigation had been done to ascertain if these improper waste management processes had effects on the hospital workers and the inhabitants around the area. Also, the disposal of the improperly treated hazardous at the landfill made scavengers prone to infections.

The disposal of waste generated within 24 h was also studied by Dehghani et al. (2008), where the storage time for healthcare waste was between 12 and 24 h. This makes it more environmentally and health-wise satisfactory as it conforms with EPA (Ghana), MOH, and the World Health Organization standards. The facility’s inability to quantify generated waste was also recorded by Aroga (2012) in a similar study in Dakar. This is contrary to the WHO guidelines as mentioned by Acheampong et al. (2015). This translates that, there may be an imbalance between generated waste and the funds or resources pooled for waste management, which can also contribute to the spread of infectious diseases as mentioned by Ndié and Yongi (2016). This impairment could be a result of the lack of funds, un-sensitized hospital employees’ and reactive attitudes towards healthcare waste management as stated by Elnour et al. (2013), and ineffective monitoring and management as mentioned by Beyene and Reddie (2011).

The absence of personal protective equipment for healthcare waste managers can be detrimental to health. In the recent study, waste collectors did not have such equipment. These people are unexpectedly liable to contract infectious diseases (WHO, 2006; Coker et al., 2009). To prevent such unforeseen occurrences, hospital waste collectors should constantly receive protective gears, vaccinations, and education or sensitization on safe waste collection processes. Besides, even though (MOH, 2005) indicated that healthcare waste requires different, proper, effective management, treatment, and disposal, information from the interviews showed that the incinerator in the study area was dysfunctional due to lack of finance to either maintain or afford a new one. A study by Babatola (2008) reported that only about 30% of the healthcare facilities in Akure were involved in waste segregation and majority were not sterilizing infectious wastes or using incinerators or autoclaves. This was similar in a study by Yelebe et al. (2015) in the Bayelsa State, Nigeria. This can be a breeding factor for many health problems (Hoenich and Pearce, 2002).

Though WHO recommended that hazardous and non-hazardous waste should be transported and disposed of separately (Chartier, 2014; Pruss et al., 1999), this study showed that infectious waste was mixed and disposed of with general waste. This can trigger public health and environmental pollution (Mbojji, 2008). This deficiency could be a result of the lack of waste management education and sensitization given to health workers on how to dispose of waste generated from various sectors of the facility. This is a pointer to inadequate attention being given to the management of HCW by many healthcare facilities in Nigeria as presented by Uzochukwu et al. (2015) and Oyekale and Oyekale (2017). This reflects poor attitude by healthcare service providers to the management of their HCW. This situation may be a perfect reflection of the inadequacy of available funds which is a major problem confronting many healthcare facilities in Nigeria. Proper management systems can be put in place to prevent scavenging around the disposal site. This can be done by ensuring a clean waste stream, embarking on public sensitization, and ensuring proper engineering at the landfill site. This is because, infections can be contracted by people living close and landfill scavengers (Abor, and Bouwer, 2008; Coker et al., 2009). Generally, the waste management systems of the facility did not meet the guidelines provided by the Ministry of Health, World Health Organization, or Environmental Protection Agency. Besides conforming to these, the hospital is required to have bylaws to serve as localized guidelines for handling generated waste. Although Easa et al. (2009) and Hussein (2009) reveal good healthcare waste management practices in Egypt, the current study’s findings are inconsistent. However, the findings of this study are comparable to and provide evidence in support of (Abor, 2013; Williams, 2013; Ofosu and Wiiaye, 2016), who mentioned that medical waste is not properly managed in Ghana. This was consistent with Aozie et al. (2017) where 1.98% of the healthcare facilities sampled in Ebonyi state followed standard procedures in their medical waste management.

4. Conclusion and recommendations

Healthcare waste is an important component of healthcare service delivery. Based on the analysis made, healthcare waste management practices in the hospital do not fully conform to regulatory standards. Besides, improper management of healthcare waste has adverse health implications to the health of workers, patients, and the public at large. The study showed inadequate record on the volume of HCW generated was a challenge at the facility. Also, a majority of the health workers had not received education on how to manage HCW. Without proper disposal, the healthcare system may become a source of environmental pollution, which could degenerate into disease outbreaks. Patients who received healthcare at the facility were highly unsanctified with the HCMF practised. The compliance with healthcare guidelines by the health workers and the internal HCMF workers was generally poor. The study concludes that there was low compliance with standard HCW management. Thus, proper management systems need to be put in place. Hence, this study recommends; (1) a multi-sectorial waste management approach involving the Municipal Assembly, Environmental Protection Agency and the healthcare facilities will be required to effectively address the healthcare waste management problem; (2) educating health workers on occupational and environmental hazards and the need to segregate healthcare waste using colour-coded waste collection container in the various departments; and (3) enactment and enforcement of stringent national regulations and standards to ensure proper healthcare waste management. There is therefore the need for the creation of more awareness to the proper management of HCW among healthcare facilities in Ghana.

Funding

This research did not receive any grant from any funding agency, commercial or profit sectors.

Declaration of Competing Interest

The authors declare that they have no competing interests.

Acknowledgement

Special thanks to all who advised us on how to modify this paper.

References

Abah, S.O., Ohimain, E.I., 2011. Healthcare waste management in Nigeria: a case study. J. Public Health Epidemiol. 3 (3), 99–110.
Abor, A.P., Bouwer, A., 2008. Medical waste management practices in a Southern African hospital. Int. J. Health Care Qual. Assur. 21 (4), 356–364.
Abor, P.A., 2013. Managing healthcare waste in Ghana: a comparative study of public and private hospitals. Int. J. Health Care Qual. Assur. 26 (4), 375–386.
Acheampong, A.T., Drozdzenyoo, M., Godi, A., Carboo, D., Clarke, E., Tarkang, E.E., 2015. Waste management practices of a regional hospital in Ghana: a case study. Central Afr. J. Public Health 1 (3), 28–36.

Alharbi, N., Alhajj, M.A., 2020. A preliminary lifecycle assessment on healthcare waste management in Makkah City, Saudi Arabia. Int. J. Environ. Sci. Technol. 17, 1753–1764.

Alharbi, N.S., Alhajj, M.Y., Qattan, M.Y., 2021. Toward sustainable environmental management of healthcare waste: a holistic perspective. Sustainability 13, 5280. doi:10.3390/su13095280

Amfo-Otu, R., Doo, I.A., 2015. Hospital solid waste management at Tetteh Quarshie Memorial Hospital, Akumapam-Mampang, Ghana. Int. J. Environ. Waste Manag. 16 (2), 305–314.

Amfo, S., Sackey, I., Ampadu, B., 2016. Landscape changes and fragmentation analysis in a Guinea Savannah ecosystem: case study: Talensi and Nabdram Districts of the Upper East Region, Ghana. J. Geogr. Geol. 8, 41–54.

Amouzegar, B., Belozi, M., Ragamorne, W., Dunka, P., Nandomah, S., Doati, N.B., Anbarye, S.K., Okyere, I.K., 2021. Sack water quality and Vendors’ practices in Domongo, northern Ghana during the emergence of SARS-CoV-2 using multivariable statistics, water quality and pollution indices, and panel assessment. Environ. Chal. 100164.

Anozie, O.B., Lawani, L.O., Eze, J.N., Mamah, E.J., Onoh, R.C., Ogah, E.O., Umueziri, D.A., Anozie, R.O., 2017. Knowledge, attitude and practice of healthcare managers to medical waste management and occupational safety prac- tices; findings from Southeast Nigeria. J. Clin. Diagn. Res. 11 (3), IC01-IC04. doi:10.7860/JCDR/2017/24230.9527.

Areg, A.S.Z., 2012. Contribution à l’amélioration de la gestion des déchets biomédicaux solides à l’hôpital principal de Dakar. Centre Africain D’étudespour En Gestion des Déchets Biomédicaux. Inst. Sup. de Management de la Santé, Dakar, Senegal.

Asante, P., Amoako, E.E., Denteh, S.N., 2018. Assessment of hospital solid waste manage- ment in Tamale Metropolitan: a case study of Tamale West and Central Hospitals. Int. J. Environ. Res. 9, 1–8.

Asante, O.B., Yanful, H., Yaokumah, E.B., 2014. Healthcare waste management; its impact: a case study of the Greater Accra region, Ghana. Int. J. Sci. Technol. Res. Volume 3, 106–112.

Barchia, J.O., 2008. A Study of HCW generation and waste management practice in Accra, Ghana. Afr. Res. Rev. 2 (3), 291–305.

Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (1989) and Decisions adopted by the first session (1992), second session (1994), third (1995) and fourth (1998) meetings of the Conference of the Parties to the Basel Convention. E/CONF.1.1, E/CONF.2.1, E/CONF.3.1, E/CONF.4.1, 1–8. Basel, 6–10 December 1999.

Bendjoudj, Z., Taleb, F., Abdelmalek, F., Addou, A., 2009. Healthcare waste management in Algeria and Mopti Region of Mali. Waste Manage. 29 (4), 1383–1387.

Beyene, H., Redaile, G., 2011. Assessment of waste stabilization ponds for the treatment of hospital wastewater: the case of Hawassa University Referral Hospital. Water Air Soil Pollut. Sci. 15 (1), 142–150.

Bryan, A., 2016. Social Research Methods. Oxford University Press.

Çetinkaya, A.Y., Kuzu, S.L., Demir, A., 2020. Medical waste management in a mid-popu- lation Turkish city: current development of medical waste prediction model. Environ. Dev. Sustain. 22, 6233–6244.

Chardon, B., 2008. Déchets Hospitaliers Et Petits Lieux. Centre Pour L’Environnement, le Développement Durable et l’Education à la Santé (CEDDES), France.

Charlier, Y., 2014. Safe Management of Wastes from Health Care Activities. World Health Organization.

Cochran, P., Cox, A., 1957. Principle of Statistics. Longman Group Ltd., New York.

Cristina, A., 2013. Medical Waste Management in Brazil. Waste Manage. 29 (4), 803–811.

Cochran, W.G., 1963. Sampling Techniques, 2nd Ed John Wiley and Sons, Inc, New York.

Coker, A., Sangodiyi, A., Sridhar, M., Booth, C., Olomolaiye, P., Hammond, F., 2009. Medical waste management in Badan, Nigeria: obstacles and prospects. Waste Man- age. (29), 802–811.

Degbahn, M.H., Azam, F., Changani, E., Degbahn, F., 2008. Assessment of medical waste management in educational hospitals of Tehran University of Medical Sciences, Iran. J. Environ. Health Sci. Eng. 5, 131–136.

Diaz, L.F., Savage, G.M., Eggett, I.L., 2005. Alternatives for the treatment and disposal of healthcare wastes in developing countries. Waste Manage. (Oxford) 25 (6), 626–637.

Domingo, J.L., Marué’s, M., Mari, M., Schuhmacher, M., 2020. Adverse health effects for hospital workers living near waste incinerators with special attention to hazardous waste incinerators. A review of the scientific literature. Environ. Res. 187, 109631. doi:10.1016/j.envres.2020.109631.

Doylo, T., Alemayehu, T., Baraki, N., 2019. Knowledge and practice of health workers about healthcare waste management in public health facilities in Eastern Ethiopia. J. Community Health 44 (2), 284–291.

Esa, B.A., Abdou, M.H., Mahmoud, A.H., El-Mesery, M.A., 2009. Environmental Assessment of Alexandria Medical Research Institute. Journal of Meteorology, Environment (4), 110–120.

Elour, A.M., Mahmoud, A.H., El-Borgy, M.D., Fadellla, N.E.E., 2013. Healthcare waste management assessment of White Nile State hospitals. Unv. Bakht Albrud Sci. J. Issue 14, 347–362.

Environmental Protection Agency, 2002. Guidelines for the Management of Health Care and Veterinary Waste in Ghana. Accra, Ghana.

Eslemi, A., Nowrouz, P., Sheikholeslami, S., 2017. Status and challenges of medical waste management in hospitals of Iran. Civ. Eng. J. 3, 741–748.

Ferreira, V., Teixeira, M.B., 2010. Healthcare waste management practices and risk per-
Uzochukwu, B., Ughasoro, M.D., Etiaba, E., Okwuosa, C., Envaladu, E., Onwujeke, O.E., 2015. Health care financing in Nigeria: implications for achieving universal health coverage. Niger J. Clin. Pract. 18, 437–444.

WHO, 2005. Healthcare Waste Management (HCWM). Risks Associated with HCW. Available at <https://www.healthcarewaste.org/en/125-hcw-risks.html> (Accessed April 20, 2021).

WHO, 2006. Wastes from healthcare activities. Fact sheets no 231. World Health Organization, Geneva.

WHO, 2011. Healthcare waste management Key facts. Geneva World Health Organization.

WHO, 2014. Safe Management of Wastes from Health-Care Activities, 2nd Edition.

WHO, 2015. WHO. Water, sanitation and hygiene in health care facilities. Available at https://www.who.int/water_sanitation_health/publications/wash-health-care-facilities/en/ (Accessed September 25, 2021).

WHO/UNAIDS/UNICEF, 2010. Towards universal access: scaling up priority HIV/AIDS interventions in the health sector. Towards Universal Access: Scaling up Priority HIV/AIDS Interventions in the Health Sector (pp. 162-162). WHO. https://apps.who.int/iris/handle/10665/44443.

William, G.L., 2013. Medical waste disposal practices in some hospitals and clinical laboratories in the Accra Metropolis (Ghana). J. Civil Environ. Res. 3, 90–98.

Yelebe, Z.B., Samuel, J.B., Yelebe, B.Z., 2015. Biomedical waste treatment: a case study of some selected hospitals in Bayelsa state, South-South, Nigeria. Am. J. Eng. Res. 4 (6), 160–164.

Zhang, L.H., Gong, Q.C., Duan, F., Chyang, C.S., Huang, C.Y., 2020. Emissions of gaseous pollutants, polychlorinated dibenzo-p-dioxins, and polychlorinated dibenzo-furans from medical waste combustion in a batch fluidized-bed incinerator. J. Energy Inst. 93, 1428–1438.

Pruss, A., Giroult, E., Rushbrook, P., 1999. Safe management of waste from healthcare activities, Geneva, Switzerland, World Health Organisation. World Health Organisation: Geneva, Switzerland.

Ranjbari, M., Estandahadi, Z.S., Shevchenko, T., Chassagnon-Haned, N., Peng, W., Tabatabaei, M., Aghbashlo, M., 2022. Mapping healthcare waste management research: past evolution, current challenges, and future perspectives towards a circular economy transition. J. Hazard. Mater. 422, 126724.

Rau, E.H., Akaimo, R.J., Ashbrook, P.C., Austin, S.M., Borenstein, N., Evans, M.R., French, H.M., Gilpin, R.W., Hughes Jr., J., Hummel, S.J., Jacobsohn, A.P., Lee, C.Y., Merkle, S., Radzinski, T., Sloane, R., Wagner, K.D., Weaner, L.E., 2000. Minimization and management of wastes from biomedical research. Environ. Health Perspect. 108 (6), 953–977.

Rushbrook, P., Zghondi, R., 2005. Better Health Care Waste Management. World Health Organization, Regional Office for the Eastern Mediterranean Regional Center for Environmental Health Activities (CEHA), Jordan, Amman.

Santos, E., de, S., Goncalves, K.M., dos, S., Mol, M.P.G., 2019. Healthcare waste management in a Brazilian university public hospital. Waste Manag. Res. J. a Sustain. Circ. Econ. 37, 278–286.

Sasu, S., Kümmerer, K., Krarert, M., 2012. Assessment of pharmaceutical waste management at selected hospitals and homes in Ghana. Waste Manage. Res. 30 (6), 625–635.

Tetteh, I.K., Aduah, E., Frempong, E., 2004. Development of a weighing system for use in environmental health impact assessment associated with water impoundment projects in Ghana and its application I. J. Ghana Sci. Ass. 6 (2), 2004.

Tulokhonova, A., Ulanova, O., 2013. Assessment of municipal solid waste management scenarios in Irkutsk (Russia) using a life cycle assessment-integrated waste management model. Waste Manage. Res. 31 (5), 475–484.

Udofia, E.A., Fobil, J.N., Gulus, G., 2015. Solid medical waste management in Africa. Afr. J. Environ. Sci. Technol. 9 (3), 244–254.

United States Agency for International Development (USAID), 2012. Health Care Waste Characteristics at Selected Health Facilities in Mbarara District, Uganda.