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Solid waste management in hospitals: A comparative assessment in some selected hospitals in Obuasi Municipality of Ghana

Asare Wilhemina*, Patrick Amedumey, Gameli Boaka Hlordze Raphael

Department of Environment and Sustainability Sciences, Faculty of Natural Resources and Environment, University for Development Studies, Tamale, Ghana

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ABSTRACT

The types of waste generated in hospitals as well as the management practices adopted by the hospitals for the disposal and treatment of the waste have become an issue of great concern to both local authorities and the public. This research aimed at assessing solid waste disposal and management practices of some selected hospitals in the Obuasi Municipality of Ghana. Three hospitals in Obuasi were selected for the study. The names of the hospitals are represented with the letters A, B and C. The objectives of the study were to know the types of waste generated in the hospitals, quantify the waste generated during the study period and compare the solid waste management practices adopted by the hospitals with the Health Care Waste Management guidelines (HCWM) of the Ministry of Health (MoH), Ghana. Relevant data and information were obtained for four weeks in the selected hospitals concurrently. Results from the study showed that hospitals generate plastics, papers, putrescible waste and hazardous waste. In terms of waste quantities, a total of 2260.95 kg of waste were generated in the three hospitals during the study period. Plastic waste was 495 kg (21.89%), papers were 398.7 kg (17.63%) and putrescible wastes were 788.15 kg (34.86%) and 579.1 kg (25.61%) of the waste was hazardous waste.The waste management practices adopted by the hospitals were below standard. Although some proper waste collection was carried out, no waste sorting, processing or treatment was done. Two of the hospitals had contracted Zoomlion Ghana Limited to dispose their waste at the landfill site whiles the other hospital disposes of the solid waste in an open pit and burn the waste as well. Observation made during the study was that most of the waste management staff had low educational backgrounds and therefore have a low understanding of proper waste management practices as well as low remunerations. Comparisons made between the hospitals in terms of their waste management practices and the MoH guidelines on Health Care Waste Management (HCWM) show that the hospitals do not adhere to the guidelines and standards. The study recommend that regulatory authorities enforce strict adherence to standards and effective monitoring of waste management practices in health facilities to safeguard public health and environmental safety.

1. Introduction

Healthcare waste has been a growing concern across the world over the last few years (Hasan and Rahman, 2018). The management and treatment of healthcare waste (HCW) are of great concern owing to its potential hazard to human health and the environment, particularly in developing countries. Healthcare Waste (HCW) constitutes a special category of waste because they contain potentially harmful materials (Mekonnen et al., 2021). Hospital or biomedical waste has distinct features apart from all other types of waste because of its infectious and hazardous properties (Khobragade, 2019).

The relationship between public health and improper collection, handling, and disposal of solid waste in general and hospital wastes is quite clear (Adipah and Kwame, 2019). Some medical establishments play important roles in different activities using modern technology to restore and maintain community health through different departments (Stanhope and Lancaster, 2019). Medical establishments include hospitals, clinics, medical centres, private practices, home health care, blood banks, veterinary offices, clinical facilities, research laboratories, clinical laboratories, and all unlicensed and licensed medical facilities (Buppert, 2020).

The World Health Organization (WHO, 1999) defines hospital solid waste as solid waste that is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or testing of biological, including but not limited to: soiled or blood-soaked bandages, culture dishes and other glassware. It also

* Corresponding author.
E-mail addresses: wilhemina.asare@uds.edu.gh, ewilhemina@yahoocom (A Wilhemina).

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includes discarded surgical gloves and instruments, needles, lancets, cultures, stocks, and swabs used to inoculate cultures and remove body organs. The health-care waste consists primarily of pathological, infectious, chemical, pharmaceutical, and domestic wastes as well as sharps that have been contaminated with blood, infectious agents, tissues, organs and many more (Oduro-Kwarteng et al., 2021).

Globally, about 5.2 million people (including 4 million children) die each year from waste-related diseases (Win et al., 2019). The waste generated from hospitals is now recognized as a serious problem that may have detrimental effects either on the environment or on human beings through direct or indirect contact (Zamparas et al., 2019). As the quantity and complexity of healthcare waste increase, the risk of transmitting disease through inadequate management of waste also increases.

A study done by Kyomba et al. (2021) indicated that poorly managed waste from health care centres can bring about environmental nuisances such as foul odour, flies, cockroaches, rodents, and vermin. To curb this issue, World Health Organization advocated that hospital wastes should be regarded as a class of wastes requiring “special” management (Dieng et al., 2020). This threw much light on the need for studies to be conducted on the wastes generated in healthcare facilities to recommend effective ways of managing the waste to ensure public health and environmental safety.

A lot of research has been done across the globe on healthcare wastes (Govender et al., 2018). However, few research has been conducted on healthcare wastes generation, collection, and disposal in the developing countries in West Africa. In Ghana, very little research has been conducted on waste management in healthcare centres and facilities (Oduro-Kwarteng et al., 2021). According to Adu et al. (2020), waste management in hospitals in Ghana faces a lot of risks such as cross-contamination due to the lack of thorough sorting of the generated waste at the point of disposal of both hazardous and non-hazardous wastes. This has increased the potential for the spread of infections and chemical pollutants. To enhance a proper understanding of the negative impact of improper solid waste management generated by healthcare centres and facilities, this research focused on the identification of the types of solid wastes generated in some selected hospitals in Obuasi, a Municipality in Ghana. Also, the solid waste generated in the hospitals was carefully quantified and the management and disposal procedures of the wastes critically assessed and compared. In addition, this study is one of the few studies that has compared the management of healthcare waste in different health facilities to the Ministry of Health (MoH), Ghana`s guidelines on the management of healthcare waste. This study would in return throw more light on the solid waste management practices by the health care centres. The importance of identifying the variables that might be impeding the development of appropriate healthcare waste management practices is increased by the fact that solid-waste management (SWM) in developing nations has not received enough attention (Da Silva et al., 2005). To give relevance to this study, we evaluated the solid waste disposal and management practices of some chosen hospitals in the Obuasi Municipality of Ghana.

Even though it is obvious how important waste management in hospitals are in developing nations, however, there are not many studies that specifically address the Ghanaian setting. (Ofosu and Wiafe, 2016) undertook studies on solid waste management techniques in a Regional, District, and Private hospital in Ghana in 2016. In five hospitals in Ghana, Adu et al. (2020) conducted research on management and medical sorting procedures. Healthcare waste management in Ghanaian hospitals: associated environmental and public health issues was the main topic of Stephen and Tahiru (2020)'s study. While Abanyie et al. (2021) concentrated on healthcare waste management at the Tamale central hospital, northern Ghana. Pierpaolo et al. (2020) also conducted research on solid waste management and health in Accra, Ghana. The enhancement of solid-waste management is a subject that has drawn interest from several sectors, and it necessitates specialist understanding (Diego et al. 2017). Additionally, studies on the quantification, management, and disposal processes of the solid wastes are particularly relevant, and there is a gap in the literature from this perspective due to the lack of attention and precariousness of these activities in the setting of developing countries. By contrasting the management of healthcare waste at various healthcare institutions with the Ministry of Health (MoH), Ghana's guidelines (2006) on the management of healthcare waste, this paper aims to further the current research.

2. Materials and methods

2.1. Study area

The study was conducted in 3 major hospitals in Obuasi in Ghana, West Africa. The municipality is located between latitudes 5 º35N and 5 º65N, and longitudes 6º35′W and 6º90′W. It covers a total land area of 220.7 square km. The Municipality is bounded on the south by the Upper Denkyira District of the Central Region, East by Adansi South, West by Amansie Central, and North by Adansi North. Obuasi is the Administrative Capital. The Obuasi Municipality experiences semi-equatorial climatic conditions with a double maxima rainfall regime. Mean annual rainfall ranges between 1250 mm and 1750 mm. Temperatures are uniformly high all year with the hottest month being March when a temperature of 30 °C is usually recorded. The mean average annual temperature is 25.5 °C. Relative Humidity is quite high (75–80%) in the wet season. The three major hospitals that were used in the study are represented as health facility A, facility B and facility C Fig. 1.

2.2. Research design

This study is a cross-sectional survey and of explorative nature.

2.3. Sampling and data collection

Primary and secondary data collection methods were used in the study. The primary data collection focused on findings from the field investigations, questionnaires administration and interviews. The field investigation involved daily characterization and quantification of the waste generated in the three hospitals stored in waste bins placed at vantage points. The daily records on waste generated followed WHO, 2017 guide on health care waste records. At health facility **A**, the vantage points were the main entrance, entrances of the male, female and children wards, the eye clinic, out-patient department, pharmacy, RCH centre, and maternity ward. Likewise, the vantage points for facility **B** were the RCH centre, female surgical and female wards, male surgical and male wards, isolation ward, children’s ward, casualty ward, injection room, maternity ward, pharmacy, OPD, Eye clinic and Doctors’ quarters. At facility C, the waste bins were placed in front of the injection room, the male and female wards, pharmacy, dispensary, and toilets.

A questionnaire was developed for data collection covering major areas such as general information on the selected hospitals, personnel involved in the management and disposal of the hospitals’ solid wastes, their segregation, collection, transport, disposal, and the hospitals’ waste management policies. It also covered areas such as the views of waste management personnel about their jobs, motivations, and aspirations. Twenty-five (25) questionnaires were administered to the waste management personnel in the three hospitals: 9 in facility A, 12 in facility B and 4 in facility C. Their responses were then examined for accuracy and completeness to avoid errors.

2.4. Waste quantification, segregation, transport and disposal

To determine the composition of waste by weight/day for the selected hospitals, the selected hospitals were given polyethene bags to

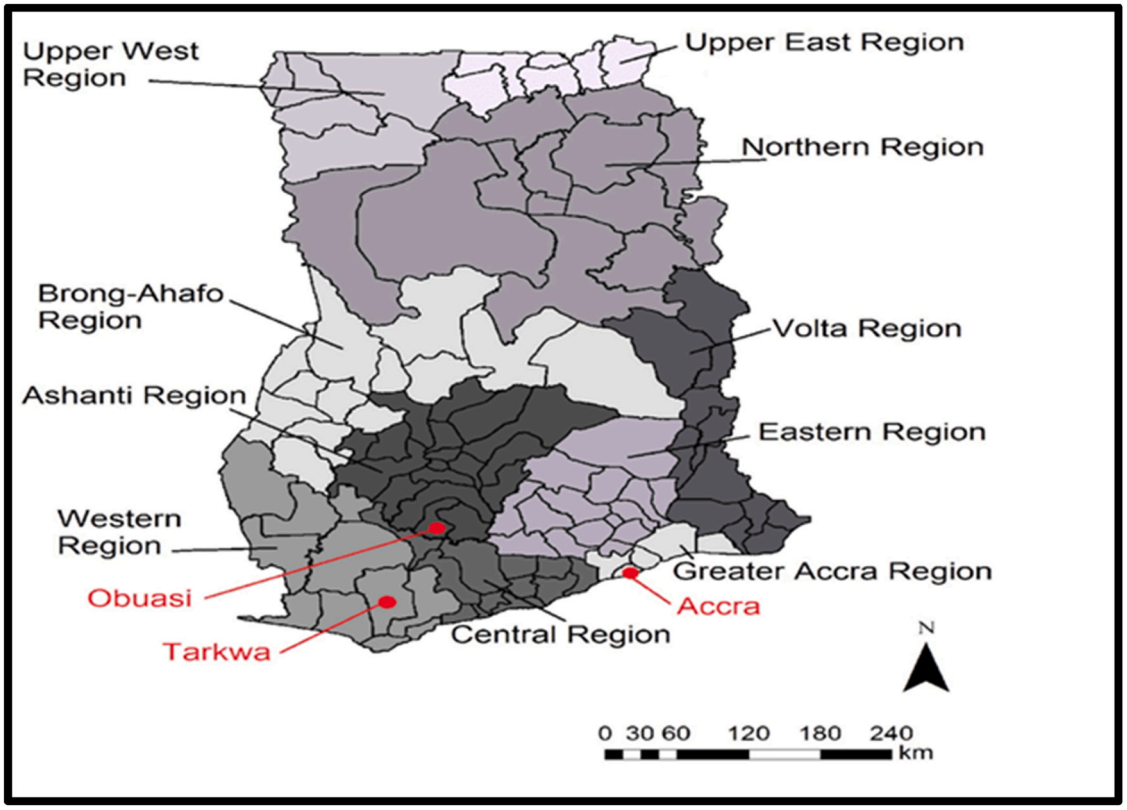

Fig. 1. Map of Ghana showing Obuasi Municipality.

keep their daily waste. The polyethene bags were tagged according to their locations for easy identification. Large polyethene bags were provided and fixed into the waste collection bins at the various hospitals since none of the hospitals had fixed polythene bags (liners) in their collection bins. The polyethene bags were collected at dawn and gathered at a point where they were emptied for segregation and measurement at facility A. At facilities B and C, the same activity was repeated in the afternoon and evening respectively. This activity took about three hours daily for 28 days in each of the hospitals. The waste obtained was then segregated into different classes by hand, protective gear like hand gloves, overall gear, nose mask, safety boots and goggles were used by the researchers during the segregation and weighing of the waste. A spring weighing scale was used to determine the quantities of the various waste components. The total weight of the waste generated for the study period was then obtained by the addition of the weights of the waste types measured.

2.5. Data analysis

Microsoft Excel and SPSS were used to analyze the field data obtained and the results were presented in tables and charts.

3. Results

3.1. Waste types and quantities generated by the three hospitals

A total of 2260.95 kg of waste were generated in the three hospitals. Plastic waste was 495 kg (21.89%), 398.7 kg (17.63%) was papers, putrescible waste was 788.15 kg (34.86%) and 579.1 kg (25.61%) represented hazardous waste. From the results, putrescible was the highest generated waste materials followed by hazardous waste while paper was the least quantity of waste generated. The high percentage of putrescibles (34.865%) in the hospital's waste stream can be attributed to the need for good nutrition for patients during their stay in the hospitals to boast their health and this may have promoted their being served foods from both home and the hospital. The study from Mohee (2005), found that 10% of healthcare waste produced in hospitals had hazardous qualities, and typically consisted of infectious, pathological, and/or chemical wastes, and this conforms to the findings of this study. According to Lee et al. (2004) and Marinkovic et al. (2007), regulated medical waste made up 20.1% of the waste stream from a hospital, and hazardous medical waste, such as infectious waste, sharps, pathological waste, chemical waste, pharmacological waste, and cytostatic, made-up 14% of the waste produced by Croatian healthcare services. Again, general garbage which has characteristics similar to residential waste constituted around 90% of hospital waste. Infectious hazardous waste made up the final 10%. This differs from our findings, where about 25.6% of the waste was hazardous. According to Pruess et al. (1999), 10–25% of medical waste falls under the category of regulated waste, which poses several concerns to human health and the environment. Galtier and Bekaert (2002) also, reported a proportion of infectious waste to be estimated between 15% and 20% of healthcare waste and according to Lee and Hufman (2004), this percentage was approximately 15% in the USA as at (1996). The high percentage of hazardous waste registered in this study raise public health concern and required necessary measures such as adherence to standard waste management practices in the health facilities and effective monitoring by the regulatory agencies to avoid cross-contamination and the spread of infectious diseases in the communities. Also, the high putrescible waste content recorded in the study places the demand for a frequent collection of the waste to avoid decay and odor and again, efficient separation of the waste, should there be a need to include such materials in recycling schemes Fig. 2.

3.2. Composition of solid waste in the hospitals

The major composition of solid waste was categorized into four which included plastics (sachet water, toffee wrappers, polythene bags

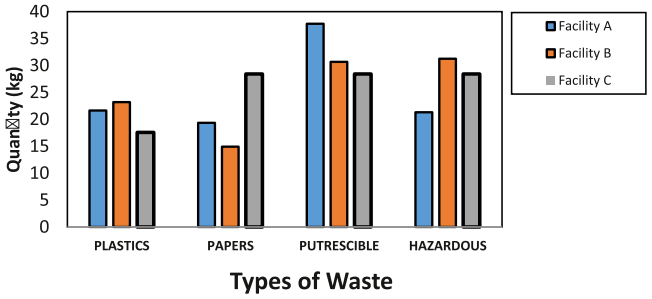

Fig. 2. Composition and Quantity of waste generated in the three Hospitals.

used to wrap consumables, infusion bags), papers (empty boxes, prescription forms, lab forms, empty papers packs for medicines, newspapers, used exercise books), putrescible (leftover cooked food, cassava peels, plantain peels, leftover snacks and all consumables) and hazardous (used gloves, syringes, transfusion needles, blood-stained waste from the generation points). The study lasted for 28 days after which facility A generated 1227.65 kg of waste. Out of the total waste generated in health facility A, 237.5 kg (19.35%) were plastics, 265.35 kg (21.61%) were papers, 463.35 kg (37.74%) were putrescible waste with 261.45 kg (21.3%) as hazardous waste. At health facility A, the solid waste generated increased in order of Dental/Eye Clinic > Administration > Entrance > Parking Garage > RCH Centre > Maternity > Entrance (wards) > Female Ward > OPD > Male Ward in terms of quantity generated during the study period. The male ward generated a high quantity of putrescible waste, this may result from the fact that families are allowed to provide food for relatives admitted to the hospital. During the study, most of the putrescible waste quantified was leftover food from patients after consumption. Aside, the high quantity of putrescible waste, plastics followed and then hazardous waste while papers were the least generated waste in the hospital.

At health facility B, 854.4 kg of waste was generated. 198.25 kg (23.2%) were plastics, 127.45 kg (14.92%) were papers, 261.85 kg (30.65%) were putrescible and 266.85 (31.23%) were hazardous in nature. The solid waste generated increased in the order of Pharmacy > OPD > Doctors' Lodge > Children Ward > Maternity > RCH > Female Ward > Casualty > Male ward in terms of the quantity of waste generated within the stipulated period of the study. Also, the male ward generated the highest amount of waste with putrescible waste being the highest composition. The main components of the putrescible waste were leftover food from the patients and health personnel. The pharmacy recorded no putrescible and hazardous wastes since they only administer drugs and for that reason, the waste generated there were mainly papers and plastic wrappings Tables 1 and 2.

Health facility C recorded 178.9 kg of waste during the study period. Plastics were 31.4 kg (17.55%), papers were 33.75 (18.87%), putrescible were 62.95 kg (35.19%) and hazardous were 50.8 kg (28.4%). The solid waste generated increased in the order of, washroom > Dispensary > Dressing room > Entrance in terms of quantity generated within the study period. More waste was generated at the entrance with the highest composition being putrescible followed by hazardous and then plastics with the least quantity of papers. Observations made during the study were that the waste from the laboratory was added to the waste at the entrance as well as the waste from the consulting rooms. Vermeşan et al., (2019) describe waste composition as the components that make up the waste stream and their relative distribution, usually by per cent weight. A clear understanding of the components of waste can help in the planning and development of effective management systems (Asare et al., 2015). Some generative points in the various hospitals had higher waste quantities recorded than others and this could be linked to the length of stay by patients who visit the hospitals. Relatively, those admitted in the wards are likely to spend more days in the hospitals than those in the OPD and therefore are likely to spend more on consumables as suggested by Hoornweg and Bhada-Tata, (2012) that, the waste composition is influenced by several factors including climate, culture and economic development and hence influences waste collection and disposal. Table 3: below shows the waste generated in facility C.

Analysis of the quantity of waste generated during the study period showed a significant difference between the wastes generated in the selected hospitals. Multiple comparisons of the waste generated by the hospitals showed a significant difference in waste generation rates of the hospitals at a 0.05 significance level and a P-value of 0.00 for the total waste generated for the three hospitals. The comparison of the means of facility B and A was − 13.47 which means that facility A generates more waste than B. Also, the comparison of the means of facility B and C was 24.43 which means that facility B generates more waste than C. Lastly, Facility A had a higher waste generation compared to facility C. The mean difference was 37.90. It was observed from the study that, facility A generated more waste, followed by facility B and the least was facility C. The variations in the quantity of waste generated can be attributed to the size of the hospital, the number of people who visit the hospital, the facilities of the hospital, and the characteristics of patients that visit the hospital.

3.3. Comparison of solid waste management in the hospitals

The study showed that the Environmental Unit of Facility A is responsible for the management and final disposal of solid waste whereas the 'orderlies' in both facility B and facility C are responsible for the management and final disposal of solid waste in the respective hospitals. All the hospitals have constructed drains that channel their liquid and semi-solid waste materials. Facility A has constructed an incinerator that is used for burning infectious waste like used gloves, needles, cotton wool, bandages, infusion bags, IUDs, etc. The incinerator found in facility A was not standard because it was

Table 1
Waste composition and Generation in Facility A.

Waste Types in Kilogram (Kg) and Percentage (%)								
Location	**Plastics**		**Papers**		**Putrescible**		**Hazardous**	
Entrance Parking	24.5	9.24%	23.7	9.98%	41.4	8.93%	0	0%
Garage	23.5	8.87%	21.15	8.91%	45.15	9.74%	0.95	0.36%
Entrance (Ward)	28.05	10.58%	26.95	11.35%	45.2	9.76%	26	9.94%
Administration	27.15	10.24%	18.45	7.77%	27.15	5.86%	3.95	1.51%
OPD	36.9	13.92%	33.2	13.98%	67.2	14.50%	47.95	18.34%
RCH	22.85	8.62%	19.2	8.08%	23.45	5.06%	34.2	13.08%
Dental/Eye Clinic	18.85	7.11%	18.8	7.92%	31.15	6.72%	7.2	2.75%
Maternity	17.25	6.51%	16.1	6.78%	48.2	10.40%	31.25	11.95%
Female Ward	25.45	9.61%	24.8	10.44%	56.75	12.25%	46.4	17.75%
Male Ward	40.85	15.41%	35.15	14.80%	77.7	16.77%	63.55	24.31%
Total	265.05	100%	237.5	100%	463.35	100%	261.45	100%

Table 2
Waste composition Generated in Facility B.

	Waste Types in Kilogram (Kg) and Percentages (%)							
Location	**Plastics**		**Papers**		**Putrescible**		**Hazardous**	
Doctors' Lodge	15.15	7.64%	7.2	5.65%	41.9	16%	0.5	0.19%
OPD	20.15	10.16%	7.65	6%	34.1	13.02%	0.3	0.11%
RCH	21.15	10.67%	16.85	13.22%	16.7	6.38%	50.3	18.85%
Female Ward	27.15	13.69%	17.1	13.42%	34.25	13.08%	43.05	16.13%
Male Ward	43.65	22.02%	17.45	13.70%	70.7	27%	53.3	19.97%
Children Ward	16.35	8.25%	12.3	9.65%	18.85	7.20%	33.3	12.48%
Casualty	26.55	13.39%	15.15	11.895	20.5	7.83%	60.95	22.84%
Maternity	17.6	8.88%	16.3	12.79%	24.85	9.50%	25.15	9.42%
Pharmacy	10.5	5.30%	17.45	13.69%	0		0	
TOTAL	198.25	100%	127.45	100%	261.85	100%	266.85	100%

constructed out of moulded blocks on the ground, and it is not enclosed with a chimney so all the smoke from the burnt waste diffuses into the surrounding air of the hospital's environment.

Observations made during the study were that plastic bins were placed at vantage points to collect waste and some level of source separation was practised in all the hospitals. Facility A has employed the services of Zoomlion Ghana Limited(ZGL), a private waste management company to collect and dispose of most of their waste. Likewise, facility C. However, in facility B, management prefers to collect and dispose of the waste in the facility through their means, thus, by disposing of the waste into a dug-out pit and sometimes burnt the waste. Except for facility B where the orderlies collect and dispose of the waste generated daily, facilities A and C have employed the services of ZGL to collect and dispose of their waste for a fee at specified periods. The "alley system" of waste collection is practised in these hospitals in which the orderlies transport the waste from their generation point to the roadside on the collection day. After that, the wastes are transferred into the waste collection trucks of ZGL and transported to a landfill site.

Findings from the field survey indicated that not all the hospitals have units responsible for waste management except for Facility A which has an Environmental Unit responsible for waste management. Health facility A has an improvised incinerator for the burning of sharps and other hazardous waste but sometimes this type of waste is mixed with the other types meant for disposal at the landfill site. This could pose a health hazard to sanitary workers in the facility and the public as indicated by Kwikiriza et al. (2019), that improper disposal and management of solid wastes in hospitals may be detrimental to the health of patients, health workers and the community at large.

Also, the waste kept in the incinerator is not burnt on time, they wait till it is full and some of the waste is kept on the bare ground which can pose health problems. According to Alam et al. (2019), waste that contains contaminated materials, dangerous chemicals and discarded sharps is hazardous to patients, health workers and visitors in hospitals and communities at large. Also, health facility A has a dug-out made with concrete walls and blocks and it is covered as well. Human tissue waste like the placenta, waste from surgical operations is dumped into the pit. A long PVC pipe is connected to the chamber that serves as the chimney for the odour to diffuse into the atmosphere to reduce its impact on human health. Likewise, wastes generated in facility C are assembled in a cage near the roadside to await the coming of Zoomlion Ghana Limited (ZGL) truck for collection and disposal. The wastes collected are all-inclusive thus, all types of waste are collected for disposal without any managerial activity. The assembled wastes are stored in a cage to reduce human contact with the waste to reduce harm. However, in facility B, the management handles the waste collection and final disposal. They have a piece of land at the back of the hospital building where the dug-out pits are located. The already used ones are covered with clay. When the pit is full the waste is burnt. This practice may expose the community to health risks as indicated by Tope et al. (2018) that a high percentage of workers who handle wastes and individuals who live near disposal sites are infected with gastrointestinal parasites, and other diseases like; cholera, yellow fever, and salmonellosis. Again, inhabitants of such communities are also susceptible to respiratory diseases. According to Munsif et al. (2021), waste burning is detrimental to the environment since harmful gaseous chemicals like carbon dioxide and methane which are major contributors to global warming are released. It is, therefore, necessary for the hospitals to ensure proper waste disposal practices in their facilities.

Although the selected hospitals had put some measures in place to ensure proper waste collection such as providing waste collection bins at vantage points, segregation of the waste is either not effective or not done. Moreover, hospital waste segregation is important for the minimization of its hazards and to ensure its effective management. Solid waste management is a relevant environmental health service and an integral part of basic community service. It was realised that only facility A had a policy document on waste management and a waste management plan for the facility, but the sanitary workers did not have any knowledge of the existence of the policy document and the waste management plan for the hospital. However, a policy and waste management plan are necessary to ensure good practices regarding medical waste Table 4.

3.4. Educational backgrounds of waste management staff and their knowledge on waste management

The educational background of personnel plays a major role in waste management and disposal. The higher educational background of the staff helps bring out their innovativeness and productivity others

Table 3
Waste composition and generation in Facility C.

	Waste Type in Kilogram (Kg) and Percentages (%)							
Location	**Plastics**		**Papers**		**Putrescible**		**Hazardous**	
Entrance (OPD)	15.8	50.32%	13.5	40%	37.5	59.57%	32.7	64.37%
Dressing Room	7.95	25.32%	5.1	15.11%	13.8	21.92%	16	31.50%
Dispensary	4.75	15.13%	5.45	16.15%	10.65	16.92%	1.2	2.36%
Toilet	2.9	9.24%	9.7	28.74%	1	1.59%	0.9	1.77%
TOTAL	31.4	100%	33.75	100%	62.95	100%	50.8	100%

Table 4
Comparison of the Waste Management Practices of the Hospitals.

Solid waste management programme	Facility A	Facility B	Facility C
Waste Generation	Waste is generated at areas like OPD, wards, entrance, etc.	Waste is generated at areas like OPD, Wards, Entrance, etc.	Waste is generated at areas like OPD, Wards, entrances, etc.
On-site Handling, Storage and Processing	Plastic bins are provided in the generation areas to store the waste temporarily.	Plastic bins are provided in the generation areas to store the waste temporarily.	Plastic bins are provided in the generation areas to store the waste temporarily.
Collection	Orderlies	Orderlies	Orderlies
Transfer and Transport	ZGL trucks	Carried by orderlies to the dumpsite.	ZGL trucks
Processing and Recovery	Incineration of hazardous waste	Burning of waste generated	No processing is done
Disposal	Landfill site Burying of human tissue at the hospital	Open pit Burying of human tissue at the hospital	Landfill site Burying of human tissue at the hospital

wise," they do as they are told". At facility C, four personnel are responsible for waste management and disposal. Two (50%) of the staff have completed middle school and the other two (50%) could not complete school. At facility B, thirteen (13) personnel are employed to collect and dispose off the waste in the hospital. Two of the staff completed form four, six completed Junior Secondary School and the remaining five either dropped out of school or could not make it to Junior Secondary School or Middle School. At health facility A, eight people are employed together with the Environmental Officer. The Environmental Officer is the head of the Environmental Unit which is responsible for sanitary activities in the hospital. However, with the exception of the Environmental officer, who had completed tertiary education, six out of the eight workers have no formal education and two dropped out of school.

Most of the personnel involved in waste management and disposal in the three hospitals have not had any formal training in waste management. At health facility A, the orderlies receive instructions from the Environmental officer in terms of waste handling and management. Intermittently, some of the staff are chosen to participate in workshops organized by either the hospital management or the Municipal Assembly mostly on 'hygiene and health'. The staff at facility C act on the orders of their 'foreman' (head). Likewise, the staff at facility B perform their duties based on instructions given by their foreman. Therefore, they have less knowledge of the prescribed waste management practices for the types of waste they handle. Omoyajowo et al. (2021) reported that education helps to enlighten people on various ways to ensure environmental safety and the way humans respond and co-operate on waste management issues is influenced by their level of education. The study revealed that all the hospitals have challenges in terms of adequate protective clothing as well as the availability of sanitary workers. Although the workers use protective clothing in their line of work, frequent usage of personal protective equipment and their availability is a problem. Protective clothing like overall gears, hand gloves, nose masks as well as reagents and tools like rakes, detergents, long brooms, TCP, etc. are required daily for use but are sometimes not available for use. The infrequent usage of protective clothing exposes the staff to health risks as they handle hazardous and infectious waste. According to Manyele (2004), the foundation of healthcare waste management initiatives is training healthcare personnel. Health care worker training initiatives raise employee morale, according to Manyele (2004). The conclusion was in line with the Ministry of Health's 2006 statement that workers may recognize health and safety concerns and prevent additional exposure by receiving education and training. Hospital trash is a known source of health and safety hazards and therefore its proper handling is crucial to ensure environmental protection and public health.

3.5. Challenges of waste management in the hospitals

Observations made from the study in terms of waste management challenges are that all the hospitals or healthcare facilities A, B and C have inadequate number of workers to effectively handle the management of wastes generated. Also, health care facilities B and C lack incinerators that are effective for burning infectious and hazardous wastes except for facility A, where the incinerator is in a poor state and below standard. Effective and efficient waste management requires the progressive usage of protective clothing but because they are not readily available in all the healthcare facilities (A, B and C), waste management becomes a difficult task for the sanitary staff. The lack of exposure of the sanitary workers in the hospitals to a waste management policy or plan makes it unsatisfactory and the workers' dependence on instructions given by their 'foremen' may cause the work to be ineffective because the workers may not work by the instructions given. And where there is no effective monitoring of the staff, the work might not be done effectively with its associated health and environmental consequences. To affirm this, the United States Environmental Protection Agency (USEPA, 2002) posit that, improper disposal of solid waste exposes humans and the environment to harsh conditions through the emission of greenhouse gases and contamination of water sources like groundwater.

Solid waste management is a challenge all over the world, but it is dependent on the level of approach. Solid waste management problems in developed countries are not as high as in developing countries. This is because, the rate of generation of solid waste in developing countries does not correlate with the capacity for its proper management (UNEP, 2007). Solid waste management in hospitals is always the responsibility of the authorities of the hospital and for that matter, they are obliged to ensure proper sanitation in their facilities. Due to this, when the facility is privately owned, it is seen as an economic burden on the management and therefore is handled ineffectively. Enforcement of proper health care waste management standards by regulatory agencies in the country will help to ensure strict adherence to standards regarding proper waste management in health facilities to curb the negative impact it may produce due to lack of adherence to standards procedures and protocols.

3.6. Comparison of solid waste management in the hospitals with ministry of health (MOH), health care guidelines

Health care waste management requires much care and attention due to the hazardous nature of the waste. As such, the Ministry of Health (MoH, 2006) has formulated a policy on health care waste management that serve as guidelines for waste management in hospitals, whether governmental or private. The stages in Health Care Waste Management (HCWM) guidelines are the production of waste, segregation of the waste, internal storage (in the wards and other departments), packaging/labelling and internal transportation to an external storage site i.e., transit storage site e.g., an on-site central storage point. All these stages take place within the facility and are followed by transportation to a treatment plant, (on or off-site) and final disposal. Also, there is a recommended colour coding scheme for storage containers for hospital waste in Ghana (adapted from WHO 1999) which is as follows;.

Table 5
Comparison of waste management practice by the hospitals and with the MoH Guidelines for Health Care Waste Management.

MoH Guidelines steps		Facility A	Facility B	Facility C
Waste Generation	Records should be kept on the quantity of waste generated daily	No records are kept.	No records are kept.	No records are kept.
Segregation and Containerization	Segregation should be at the source. Each waste stream segregated must be placed in an appropriate colour-coded container. Instruction posters regarding the procedure for waste segregation should be pasted in all areas where segregation takes place and other vantage points.	Segregation is not done. Colour-coded containers are not used. Procedures for segregation are not provided in any form. All the types of waste are put together except for hazardous waste which is sometimes segregated.	Segregation is not done. Colour-coded containers are not used. Procedures for segregation are provided in any form. All the types of waste are put together.	Segregation is not done. Colour-coded containers are not used. Procedures for segregation are not provided in any form. All the types of waste are put together.
Internal storage	Storage time shall be reduced as much as practicable. Multiple daily removals of waste are recommended. Every site within the Health Care Facility e.g. ward, theatre, laboratory, pharmacy, kitchen, laundry etc. should be provided with a sufficient number of suitable waste containers. Polythene bags must be placed in rigid containers with the opening folding outward over the rim to minimize contamination of the surrounding. The top of the container should have a wider diameter than the base etc.	Plastic bins are provided at the generation points to temporary store the waste and are removed on daily basis. Polyethene bags are not provided to enhance the waste collection.	Plastic bins are provided at the generation points to temporary store the waste and are removed on daily basis. Polyethene bags are not provided to enhance the waste collection.	Plastic bins are provided at the generation points to temporary store the waste and are removed on daily basis. Polyethene bags are not provided to enhance the waste collection.
External storage	Facilities for external storage should be removed from the kitchen, laundry, ward etc but be within the precincts of the facility and shall be easily accessible to collection vehicles. The facility shall be enclosed and surrounded by an impervious wall of appropriate height and provided with a gate and lock. Health care waste shall not be compressed during collection etc.	There are no external storage facilities.	There are no external storage facilities.	A metallic cage is fixed by the roadside. Waste generated is kept there before they transported to the disposal site
Collection and Transportation	At the institutional level, all health care waste should be sorted on-site before collection and Transportation. The recommended colour coding must be used. This will allow for easy identification of the content of containers thus preventing careless handling and the risk of secondary infection. Wastes from health facilities shall be packaged and transported separately based on the adopted classification. Transporters of waste should be trained in the identification of different waste streams.	Waste is collected and transported by ZGL.	The orderlies collect the waste and dump them in an open pit.	Waste is collected and transported by ZGL.
Treatment Disposal	The treatment option is based on the waste type. Depends on the type of waste.	Incineration of hazardous waste. Disposal of general waste at the landfill site by ZGL Burying of pathological waste.	Burning of the waste generated. Open pit Burying of pathological waste	No treatment is done. Disposal of general waste at the landfill site by ZGL Burying of pathological waste.

Source: Ministry of Health MOH, 2006 and Field Survey, 2016

Color of bins	Waste items to be placed in the bins
Black	General waste (e.g., kitchen waste, paper, cardboard, sweeping etc
Yellow	Infectious waste (e.g., sharps, patient waste, human/animal tissue and cultures/specimens) with the biohazard label, Radioactive waste with the radioactive symbol.
Brown	Hazardous waste (e.g., expired drugs, vaccines, chemicals etc). Where only, small amounts of chemical wastes are generated, these may be added to the infectious waste

Again, storage containers for waste collection should have some characteristics which will make them capable to contain the waste. The following are the requirements for health care waste collection containers according to the guidelines.

- They should be non-transparent.
- They should be impervious to moisture.
- They should be of sufficient strength to prevent damage during handling or use.
- They should be leak-proof.
- They should have close-fitting lids.
- They should be fitted with handles for easy manipulation.
- They should be lightweight and convenient for lifting.
- They should be designed to minimize physical contact.

Based on the requirement in the guidelines, the waste management practices in the hospitals were compared to the guidelines. From the results in Table 5, it could be seen that generally, the hospitals do not adhere to the guidelines, only a few of the procedures are followed by some of the hospitals. This points to the fact that health workers, patients, as well as the public, are at risk from waste-related infections and diseases. The government, Ghana health service and regulatory agencies need to step up and ensure that the guidelines are followed to ensure public safety. There is also a need for regular training of waste management staff and genitors in health facilities for them to practice proper and safe sanitary management for their safety and the safety of the public. The regulatory agencies and hospital authorities must ensure that adequate equipment and materials are provided in the hospitals for proper waste management.

4. Conclusion

The study focused on the assessment of waste management practices of some selected hospitals in Obuasi Municipality. The assessment was based on parameters such as the amount of waste generated during the study period, solid waste management practices adopted by the hospitals and a comparison of the waste management practice adopted by the hospitals and with the MoH Guidelines for Health Care Waste Management. At health facility A, the solid waste generated increased in order as Dental/Eye Clinic > Administration > Entrance > Parking Garage > RCH Centre > Maternity > Entrance (wards) > Female Ward > OPD > Male Ward in terms of quantity within the twenty-eight days' period. At facility B, the solid waste generated increased in order as Pharmacy > OPD > Doctors' Lodge > Children Ward > Maternity > RCH > Female Ward > Casualty > Male ward in terms of the quantity within the stipulated period of study. At facility C, the solid waste generated increased in order as Toilet > Dispensary > Dressing room > Entrance in terms of quantity generated within the study period.

There were significant differences in waste generation across the hospitals studied but the composition was quite similar. It was also realized from the study that a substantial amount of food waste was generated from the wards, therefore segregation of the materials is necessary to avoid contamination of materials that can be included in recycling schemes to reduce the problems associated with waste handling in health facilities. Most of the staff involved in waste handling do not have much training and knowledge on waste management and disposal resulting in poor waste management practices in the hospitals. The study also, observed that most of the protocols in the Health Care Waste Management guidelines were not followed by the hospital's management and therefore, this reflected in improper solid waste management in the facilities. Adequate measures are therefore needed to improve solid waste management practices in the hospitals and in Ghana. The Government of Ghana and regulatory agencies have to ensure effective monitoring in hospitals in Ghana to secure their compliance with the Health Care Waste Management guidelines to ensure public safety. There is also a need to prosecute offenders to serve as a deterrent and promote strict adherence to the safety protocols to promote environmental safety and public health. Effective education of sanitary personnel in health sectors will also help to build their capacity for effective management of health care waste in the various health facilities in the country.

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Ethical statement

This study did not involved any human or animal testing.

CRediT authorship contribution statement

The first author was responsible for the accomplishment of most of the works; writing up of the paper and standardization of the paper. The second and third authors also contributed to the data collection, searching of literature and manuscript preparation. All authors contributed equally to the preparation of the manuscript and approved the final manuscript for publication.

Declaration of Competing Interest

There is no conflict of interest among the authors.

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