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Hospital Waste Generation and Management in Tertiary Health Care Facilities: A Comparative Assessment. Fako Division, Cameroon

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ABSTRACT

Wastes generated in hospitals are highly infectious and pose enormous risk to human health and the environment. This study examines the patterns of healthcare waste generation, handling and compliance to legal standards in two tertiary hospitals: public (PU) and private (RT) in Fako Division, Cameroon. Data was collected for a period of two months. Daily waste produced in each hospital was quantified and characterized as hazardous waste (sharps, infectious and pathological or anatomical waste) and non-hazardous or general healthcare waste. Field visits, site observations, interviews and focus group discussions were carried out with selected hospital administrators and workers. A total of 8461kg and 9609kg of waste was generated in PU and RT respecteively. In PU the waste composition was 95.6% and 4.4% for general and hazardous and 42% and 58% respectively in RT. Waste generated per patient was 0.78 and 0.45 kg/patient/day for PU and RT respectively with significant variation (p=0.013) in weekly outputs in RT. Both facilities adopted a four categories waste segregation policy, although no color coding was used. The onsite incinerator in the public hospital was below standard and rarely used whereas that in the private hospital was satisfactory and used regularly. PU engaged the services of a waste provider unlike in RT in which the entire activity was under the hospital administration. Beside the adoption of safer approaches to waste handling and close compliance with regulations in force the study recommends the adoption of sustainable waste strategies contained in the WASH FIT.

Keywords: Health care wastes, Hospital, Generation rate, Regulations, Cameroon

INTRODUCTION

Wastes generated from healthcare facilities are gaining public concern amidst the rise in infectious and zoonotic disease transmission. These wastes are typically produced in hospitals, medical research centers, care homes, mortuaries and laboratories. Waste issuing from healthcare facilities is categorized into two main groups; general and hazardous wastes. WHO (2015) estimates the composition of waste produced in hospitals to vary between 15-20% and 85-80% of hazardous and general waste respectively. Some recent studies however, indicate that the proportion of infectious healthcare waste generated ranges from 20% to 75% from country to country, including Ghana (Caniato et al., 2015). Hazardous waste, is comprised of sharps, non-sharps, blood, body parts, chemicals, pharmaceuticals, medical devices, and radioactive materials (WHO, 2015). These are materials that are toxic, harmful, carcinogenic, and infectious materials can presents serious threat to the healthcare workers, the public and

the environment in general. Of recent interest are multi-drug resistant microbes from hospital waste that have been known to find their way into various water bodies in the environment (Odonkor and Addo, 2018).

The inability to effectively manage health care wastes and reduce the associated risks are made more severe in developing countries, considering the lack of resources, poor management of available resources and lack of transparency in administration (Caniato et al, 2015) technological, economic, social difficulties and inadequate training of staff responsible for the handling and processing of wastes (Alagöz and Kocasoy, 2008). According to an assessment conducted in 22 developing countries by World Health Organization (WHO), it was observed that the proportion of healthcare facilities that do not use proper waste disposal methods ranges from 18% to 64% (Chartier et al, 2015). Doumtsop (2014) observed that in low income regions in sub-Sahara Africa, speedy development in the health care delivery technologies is not commensurate with growth in sustainable technological capacities to handle the wastes and environmental impacts of such activities. The capability of different institutions in developing countries to properly manage health care waste management have been carried out by several authors, many of them focusing on the differences between public and private hospital facilities (Manga et al, 2011; Abor, 2013; and Awodele et al, 2016).

The present study seeks to compare the HCWM practices in the public and private (faith-based) hospital facilities by determining the following; (1) waste generation rates (2) waste segregation and handling practices and (3) the extent of compliance with sustainable practices.

MATERIALS AND METHODS

In Cameroon approximately 55% of health care providers are public while 45% are private (i.e. combining confessional and private for-profit) (World Bank, 2012). In this study, one public and one private health care provider facility were selected. The choice of facility was based on the need for similarities. Both facilities are of equal standing as referral hospitals located in Fako Division in the Southwest Region of Cameroon. A reconnaissance survey was carried out between March 19 to 31 2018 to necessitate familiarity of the study area.

This study adopted both quantitative and descriptive approaches to examine the medical waste management practices. Site visits including transient walk through inspections using checklists were undertaken across the entire facility to identify the number of departments, wastes collection, handling and disposal practices at the facility.

Waste Characterization and Generation Rate

Visits were made to the respective hospitals and data collected from May 14 to July 13, 2018. A weighting scale was used to quantify the amount of hospital waste generated in each hospital. With the aid of the cleaners (research assistants), waste was collected and measured daily for a period of eight weeks to estimate the amount of waste generated in each institution. Daily, in each hospital, waste collected from the respective wards and services was weighed to get the total amount of waste for the day. After which, a ward was chosen randomly and waste from the ward and characterized as hazardous waste (sharps, infectious and pathological or anatomical waste) and non-hazardous or general healthcare waste and deposited into different colored and labeled plastic bags (Table 1). The containers were emptied in the usual place that

the hospital uses for disposal. Waste was weighed and data recorded in data sheets every day at 7:00 am. Hence, waste weighed on a day is waste generated the day before. To get the waste generation rates per patient for the respective hospitals, the total number of patients attended to during the period of the study was taken from the hospital's statistics department. Patients in this work included both inpatients and outpatients. The total waste generation rates and daily rates per patient and bed were calculated according to Kagonji and Manyele (2011).

Focused Group Discussion

After consent for interviewees was sought, a standardized questionnaire adapted from the WHO (2011) for hospital waste was used. Group meetings and discussions were carried out on a selected day by management. Physical observation and interviews were likewise used whereby face to face interviews were conducted with the concession company and hospitals representatives regarding clinical waste management at the hospitals.

Table 1: Waste classification scheme adopted for the study

Waste category	Waste sub-category	Description
Non-Hazardous waste or General healthcare waste	--	It is waste that has not come in contact with infectious agents, and does not pose a sharps hazard and comprises of paper, cardboard and plastics, discarded food, metal, glass, textiles, packaging, plastics and wood
Hazardous waste	Infectious waste	Waste with large amounts of material, substance or culture with the risk of propagating infectious agents e.g. waste from infectious patients in isolation wards) and waste containing blood, secretions, or excreta entailing a risk of contamination
	Sharps	Waste entailing risk of injury. For example, syringes
	Pathological/Anatomical waste	Body parts, tissues entailing a risk of contamination
	Heavy Metals	Waste such as broken thermometers, used or expired battery
	Pharmaceutical	Expired or left-over drugs
	X-Ray Films	Waste from the imaging center (E.g. x-ray films)
	Pressurized containers	Waste such as used or expired aerosol cans

RESULTS

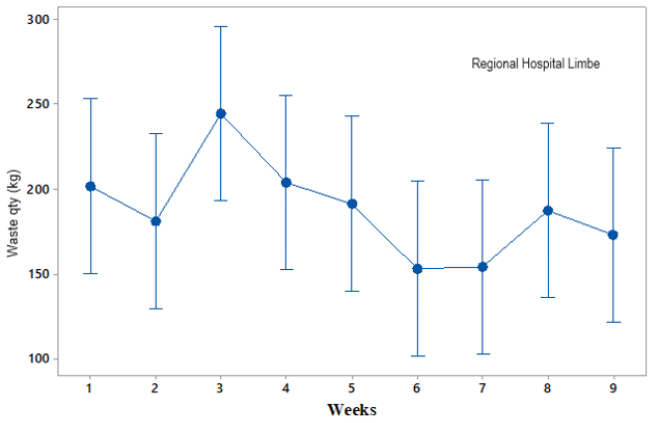
Waste Chracteristics and Generation Rate

The total quantity of waste generated in the PU and RT during the study period was 8461kg and 9609kg respectively (Table 2). The composition of the wastes was 96.6% (8168.5kg) and 41% (4017kg) for general wastes for PU and RT respectively, while hazardous waste was 3.4% (290kg) and 59% (5796kg) respectively for PU and RT. Hazardous wastes included infectious waste (77%) sharps (14%), anatomical waste (0.5%) and radioactive waste (mostly x-ray films) (0.2%) in PU and in RT infectious waste (5207kg i.e. 54.4%), followed by sharps (285kg i.e. 2.7%), anatomical and radioactive (X-ray films) representing 0.7 and 0.2% respectively. Infectious wastes generation were several orders of magnitudes higher in RT compared to PU particularly in the maternity and the theatre/ICU units.

Table 2: Total quantity of waste (kg) and waste generation rates of the PU and RT

Waste Category	PU		RT	
	Kg	%	kg	%
Total Waste	8458.5		9813	
General Waste	8168.5	96.6	4017	41
Hazardous waste	290	3.4	5796	59
Infectious waste	246	77	5500	95
Sharp waste	38	14	261	4.5
Anatomical waste	6	12.7	35	0.6
Average total waste generation daily	188		218	
Total patients during study	10903 per		21292per	
In-patients (Bed occupancy)	1170 per		1189per	
Waste generation rate (kg/patient/day)	0.78		0.46	
Waste generation rate (kg/bed/day)	7.3		8.3	

During the study a total of 10903 and 21292 patients were attended to in PU and RT respectively. The average rate of daily waste generated were 139 and 169 kg/day for PU and RT respectively (Table 2). The waste generated per patient was 0.78 and 0.46 kg/patient/day for PU and RT respectively. While the rate per bed (occupied) was 8.1kg/bed/day in RT, higher than that of PU which was 7.2kg/bedday. The variability of total waste generation per week is shown in Figs 1 and 2.



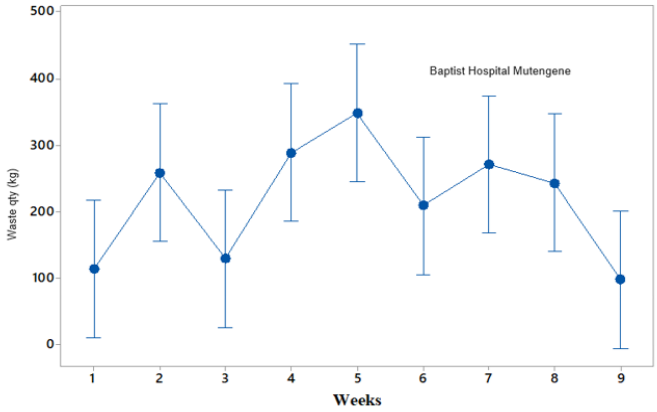
P = 0.316

Weeks	N	Mean	Grouping
1	5	201.7	A
3	5	244.6	A
4	5	204.0	A
5	5	191.4	A
8	5	187.8	A
2	5	181.2	A
9	5	173.2	A
7	5	154.4	A
6	5	153.4	A

No significant different occurs in the waste generation over 9 weeks (p=0.316)
NB: Note, the no significant can be seen with the grouping all having A's

Figure 1: Variation of total waste quantities (in kg) generated weekly in PU

During the study period, no signifant variation (p=0.316) was observed in the quantity of total waste produced weekly in PU, unlike in RT where significant difference was observed (p=0.013).



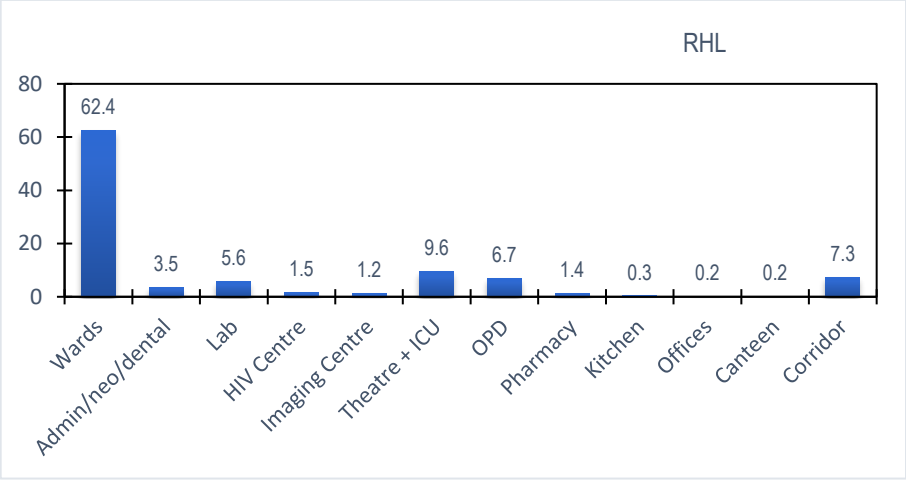
P = 0.013

Weeks	N	Mean	Grouping
1	5	114.1	A
5	5	348.4.	B
4	5	289.0	A
7	5	271.2	A
2	5	258.6	A
8	5	243.3	A
6	5	209.9	A
3	5	129.7	A
9	5	98.4	C

Significant different occurs in the waste generation over 9 weeks (p=0.013)
NB: Note, the significant different occurs as stated in the grouping.

Figure 2: Variation of total waste quantities (in kg) generated weekly in RT

The highest points of generation were the wards, accounting for a total of 62.4% and 68.2% respectively for PU and RT, with the maternity and the female wards being the highest contributors (Fig 3). The theatre and intensive units (ICU) in PU and RT accounted for 9.6% and 12% of the wastes respectively.



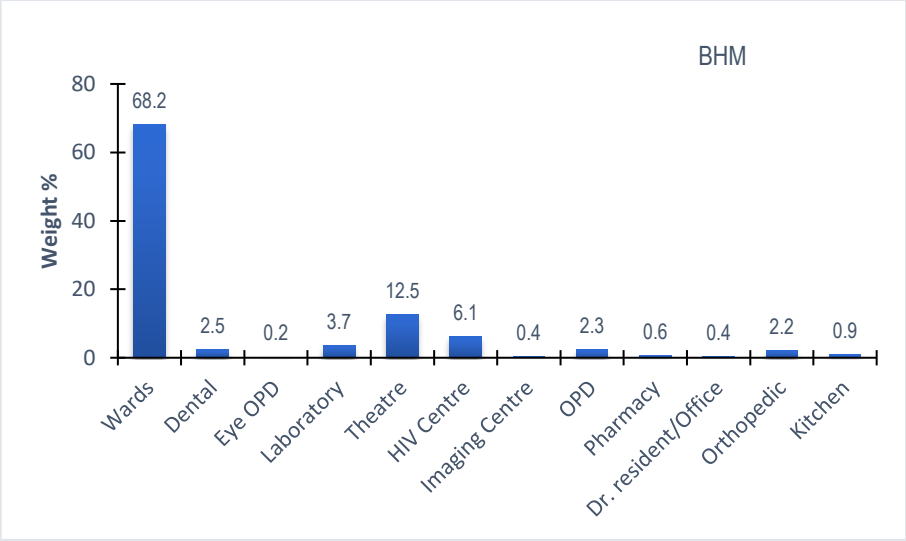


Fig 3: The distribution of the total waste generated from the different departments in PU and RT

Waste Segregation, Collection and Transportation

Waste was separated into four categories namely: general waste, infectious waste, sharps and anatomical waste in different services within the two hospitals. No standard color coding was used, instead to necessitate separation, paper labels were placed on bins and on walls next to where the waste bins were kept. In both cases, waste bins were sometimes lined with plastic and covered. For general waste, where no lining was used, the container was washed after waste discharge and returned to its position. In cases where the bin has a lining, the lining was reused until it could not be used again. Few bins were observed to have been broken. Infectious waste, on the other hand was collected in durable plastic bins, lined with black polythene bags. The plastic lining was disposed along with the waste.

Waste segregation was generally poor, and classification seemed to be different in the two facilities. In PU for example, hazardous wastes represented primarily sharps and blood containing vials and not items that had come into contact with blood and other bodily fluids. Whereas, most materials in RT that had come into contact with blood were handled as infectious waste. The practice of waste segregation also varied from one department to another in both facilities, with more attention in the laboratories and theatres. Sharps were separated at their points of generation and stored in puncture proof safety boxes (plastic or cardboard paper). Some services in PU were found to keep sharps in used plastic water bottles which can easily be punctured. Expired drugs were reportaedly returned to the suppliers in both cases. It was observed in both hospitals that; occasionally infectious waste was often mixed with general waste, by cleaners/janitors with the aim of "facilitating" cleaning.

Waste Treatment and Disposal

Infectious wastes and sharps from the laboratory and theatre were sometimes treated with hypochlorite solution before transportation to the incinerator or disposal site. Meanwhile, in the other units sharps were taken directly to the incinerator. In PU, the designated waste collection site was located within the grounds less than 7 meters from the nearest hospital

building, in an open area, accessible to the public. It was observed that the bins were constantly overflowing. The waste was picked up weekly and disposed of in a dumpsite along with municipal wastes. Still in PU the containers for infectious waste and sharps were collected as soon as they were full and transported to the incinerator within the premises. The incinerator built out of cement blocks that offers less resistant to heat. It was fitted with a chimney measuring about 4 meters in height. The design of the incinerator requires that; the operator enters the incinerator to pack and prepare the material. Petrol and used tires were used to fire the incinerator. The ash and residue generated after incineration disposed into a pit located next to the incinerator. There is no set program for waste incineration, and took place just once during the entire study period.

RT carried out further waste processing at a temporary storage site within the facility where the general waste was manually separated into; dry waste, wet waste and used pressurized cans. The dry waste, comprised of paper and plastic was dumped into a pit within the hospital premises and later burnt. The wet waste, comprising of leftover food (organics) was transported to an open field where it was allowed to decay. Infectious waste and sharps in RT transported to the incinerator within the facility and was fired daily. The incinerator which is constructed out of sun-dried mud bricks has an auto-combustion system that is preheated using dry wood and biogas generated in the hospital. The bottom ash was later disposed of in a pit next to the incinerator. PPE for incinerator operators includes helmet, safety goggles, respiratory mask, heavy-duty, heat resistant gloves, apron, clothes that cover the body and heavy-duty, heat resistant boots. This facility also handles infectious waste from a nearby medical facility.

Co-ordination of Hospital Waste Management

As far as faciility administration was concerned, both facilities managed healthcare wastes in conformity with the existing regulation using a Hygiene Committee. There were no elaborated guidelines on waste management as prescribed by the exisiting regulation. In PU the key personnel are - the Director of the hospital, Service Manager, Sanitation Officer and the Contractor. The Director is at the helm of activities. The Contractor's responsibilities included the recruitment and payment of cleaners, the provision of PPE for the cleaners and supervision of their activities. About 25 persons are employed in the hospital sanitation service department. In RT, the entire waste management process is coordinated by the hospital administration. The Hygiene Committee of RT is comprised of all the unit heads. There are close to 30 workers in the sanitation service functioning on a two-shift system (6am - 3pm; 3pm to 9pm); cleaning is done daily. Recruitment of new cleaners is done through the Hygiene Committee by the Headman. Cleaners are selected after a test-training-test format. The selection process was focused more on the waste management approach of the hospital.

DISCUSSION

The higher total waste output in RT compared to PU could result from several factors such as the number of patients that occupied beds, tests performed daily, examinees available, the type of hospital, specializations, ratio of reusable items, the general condition of the place where the hospital is located, the economic, social and cultural conditions of the patients and visitors (Taghipour and Mosaferi, 2009). In addition, RT as a confessional facility, offers a holistic form of treatment that responds to the needs of the low-income class, for instance, it has a drug

program that is more flexible than that offered by the public hospital for instance. In Cameroon, private (in this case confessional) facilities are considered efficient in the provision of better-quality services as compared to their public counterparts and patients are willing to pay more in the private hospitals if they are confident of receiving quality healthcare treatment (Zeithaml, 1990).

The major categories of wastes were general followed by infectious and sharps wastes. Previous studies have reported that private health facilities generate more hazardous waste than public health facilities (Al-Khatib et al. 2009; Mohee, 2005). This supports the findings of this study, with RT generating 58% hazardous waste compared to 4.4% in PU. The former exceeds the levels predicted by WHO (2015) which ranges between 10% and 25%. Previous studies have reported that the percentage of infectious health care wastes in the total health care waste stream in developing countries can reach 75% compared to 51% in an industrialized country (Diaz et al, 2008; Caniato et al 2015). The average rate of total waste generation was 0.46 and 0.78kg/patient/day for RT and PU respectively. These values are within those estimated by Mato and Kaseva (1999) which range from 0.3 to1.8 kg /patient per day with an average of 0.66 kg/patient per day. The estimated average daily waste generation of 188kg and 218kg in PU and RT respectively yields an annual output of 51 and 62 tonnes. Approximately half of this wastes (~57 tonnes) constitutes general waste, comprising of materials which could potentially be recovered from the health care waste stream as well as large remaining proportion of wastes such as sharps and chemical wastes which are potential hazards and risks to public health and the environment.

Waste segregation at source is an integral component of hospital waste management and it is a major pillar of Cameroon's hospital waste regulation. Four major waste categories (PM Order No. 003/ MINEPDED 2012) are specified along with four color codes in this system. There is no use of the color-coding system as recommended by WHO and the regulations in force. The success of using labelled containers and written posts relies on the literacy, awareness and knowledge of the various waste categories by staff, cleaners, patients and visitors. Hagen et al. (2001) reported on the importance of providing instructive posters as tools to promote effective segregation of HCW in their study of infectious wastes in a Saudi Arabian hospital. Lack of and the inappropriate use of bin liners can be addressed following Longe and Williams (2006) who reported an efficient color-coding system in Nigeria that employed the use of colored buckets for waste segregation.

With respect to waste segregation, the subcategory that receives considerable attention in both facilities was sharps. The increasing use puncture proof safety boxes was attributed to the implementation of the South West Regional Fund for Health Promotion program; a program which provide financial incentives to promote best practice through the Performance-Based Financing (PBF) scheme; sharp boxes are one of its indicators. Collection of these containers are different for the two facilities; while collection occurs daily in RT, in PU pick up is when they were full. This practice conflicts the requirments that sharps are properly secured, do not fall out of the container and should only be three-quarters filled prior to disposal (WHO, 2011). In a study carried out in Cameroon, Mbanya et al (2010) attributes up to 8% exposures from over-filled sharps containers; citing failure to promptly discard over- full containers for sharps. In addition to this, the deliberate mixing of wastes practiced by health workers including

janitors/cleaners points to a lack of knowledge and understanding of what constitutes proper healthcare disposal practice. Some of these inappropriate actions can be curtailed by the production and availability of more elaborated hygiene and safety guidelined and protocols in compliance with the national regulations; a requirement that has not been met by either facility. The storage of general wastes on-site does not conform with the WHO standards as these areas are unhygienic, accessible to the public and serves as habitat for stray verminous animals. Over 60% of the wastes are not contained in bags with sharps and infectious waste highly visible in the waste pile particularly in the case of PU. The very attempt to segregate the waste at the point of generation, only for them to be mixed on-site municipal collection site makes the whole exercise unimportant for those who are supposed to practice it. These actions are in violation of the legal requirement which states that hospital waste can be mixed with household waste provided there has been sorting and the waste is not contaminated with dangerous waste. In addition, such mixing, results in the contamination of general wastes, thereby increasing the quantity of contaminated waste. Outsourcing of medical waste disposal is permitted under the current regulation. However, the waste contractor (municipal waste service provider) who collects waste is by law, required to maintain a waste manifest; and for the treatment of medical and pharmaceutical waste, a permit is required, and certificate of destruction are to be issued. The municipal waste service provider does not have a specialized unit to handle hazardous wastes. This is contrary to the situation reported in Lagos by Awodele et al. (2016) where the State Waste management unit has a specialized unit LAWMA MEDICAL is in charge of medical waste.

The recovery of materials (i.e. pressurized cans) and the composting of wet waste in RT are actions that not only promote sustainable resource use but also reduces the costs of waste disposal. To further these goals however, these activities must be carried out in a safe manner, which includes aspects such as good hygiene practices, clean surroundings, proper and adequate storage of materials. Open burning of dry wastes results in the release of air emissions particularly particulate matter which can be a risk to human health locally. To reduce this risk, other objects (such as plastics, cardboard and paper, metal) could be properly segregated and removed from the waste stream for reuse or sale in secondary markets.

Both facilities identified incineration as the choice of infectious and sharps disposal. It was, however, evident that RT makes full use of its incinerator to the extent that it caters for hazardous wastes disposal for other smaller healthcare facilities. The single chamber brick-walled incinerator in RT, according to Pruss et al (1999) can attain efficiency levels of 80-90% and can result in the destruction of 99% of microorganisms and a dramatic reduction in the volume and weight of waste. This system is not able to destroy many chemical and pharmaceutical residues and can cause massive emission of black smoke, fly ash and potentially toxic gases (Pruss et al (1999). The integration of an onsite biogas system to this incinerator increases the sustainability of the system in terms of materials and energy use. The public hospital has a single-chamber incinerator of below standard which is sparingly used for the treatment of waste. This is of grave concern as it calls into question the actual methods of disposal of infectious wastes and their potential impact on public health and the environment. Table 3 is a comparative assessment of the sustainability of health care waste management in PU and RT. The national regulation does not make it mandatory for facilities to have a quality

Table 3: Comparative assessment of PU and RT on selected aspect of the WASH FIT assessment for health facilities

Aspect	Meets target		Partially meets target		Does not meet target	
	PU	***RT***	***PU***	***RT***	***PU***	***RT***
Waste management unit with well-trained staff	Appointed and contracted but not trained	Appointed with some training				
Functional waste collection containers in close proximity to all waste generation points for: • non-infectious (general) waste • infectious waste • sharps waste			Bins well located; labels posted on walls; sharps collected in boxes and plastic containers	Bins well located; labels posted on walls, sharps collected in boxes and plastic containers		
Waste correctly segregated at all waste generation points			Some sorting of sharps; laboratories, theatres, nursing stations and ICU.	Some sorting of sharps; laboratories, theatres, nusrsing sataions and ICU	Infectious and general wastes are not well segregated	Infectious and general are not well segregated.
Waste register and waste Manifest Traceability					No waste register; No manifest.	No waste register; No manifest.
Functional burial pit/fenced waste dump or municipal pick-up available for disposal of non-infectious (nonhazardous/general waste)		Yes, Pit for bottom ash well secluded;		On site sorted wet waste is open and exposed	Pit is not fenced; Waste at collection point open to public; irregular pickup	
Incinerator or alternative treatment technology for the treatment of infectious and sharp waste is functional and of a sufficient capacity	Yes	Yes		Conforms to medium standard, used often and serves other facilities	Poorly constructed and rarely used.	.
Sufficient energy available for incineration or alternative treatment technologies (mark if not applicable)	N/A	Yes	N/A		Never	
Activities to prevent environmental				Sorting of waste and	Never	

degradation/pollution and enhance resource recovery				recovery of materials; Biogas facility.		
WASH FIT or other quality improvement/ management plan for the facility is in place, implemented and regularly monitored					No plan	No plan

improvement/management plan, in addition to the operational guidelines that are required. A quality improvement management plan would contain a well-defined environmental policy with specific goals and targets. These initiatives could include wastes and energy reduction and also protecting the resources; besides, protecting the resources includes administrating the disposal of harming factors, recycling, reprocessing the reusable items and managing the products protection (Farzianpour et al, 2014). The WASH FIT tool kit is an example of a sustainable management tool that could be exploited. In the context of developing countries, where the concept of sustainability is not well diffused yet and where economic difficulties and constraints result most of the times in underestimation of environmental and social considerations, it is crucial that decision-makers address today sustainability issue, even imperfectly, as ignoring it may only aggravate the problem.

CONCLUSION

The total waste generation rates are higher showing significantly weekly variation in the private facility (RT). Waste distribution was significantly different in the two facilities with hazardous waste comprising 3.4% and 59% of the total waste in PU and RT respectively. Waste segregation practices are generally low (with the exception of sharps), limited by poor methods of identification and guidance. The further sorting of general wastes practiced at the private facility further and the use of biogas in the private facility (RT) is evidence of efficient material use and safe disposal, although the process can be improved to make it safer. In addition, the practice of waste incineration is more effective in the private facility, in contrast to PU (public facility) where incineration is rarely used. Finally, the of HCWM in RT (private facility) is completely under the hospital administration, whereas PU (public facility) has designated some responsibilities to a contractor. In order to meet up with more sustainable practices, the national guidelines could consider requirements aimed at waste minimization which can include reducing the total quantity of waste generated and also reducing cross-contamination of wastes.

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Authors' Contributions

The author undertook the research and writing of this paper.

Competing Interests
The author declares that there is no conflict of interest.

Ethical Issue
Not applicable

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References
1. WHO, UNICEF. Water, sanitation and hygiene (WASH) in health care facilities: Global action plan [Internet]. http://www.who.int/water_sanitation_health/facilities/healthcare/ wash-in-hcf-global-action-plan-2016-03-16.pdf?ua=1. 2015 [cited 2024 Aug 20]. Available from: Water, sanitation and hygiene (WASH) in health care facilities: Global action plan

2. Caniato M, Tudor T, Vaccari M. International governance structures for health-care waste management: A systematic review of scientific literature. Journal of Environmental Management. 2015 Apr;153:93–107.

3. Odonkor ST, Addo KK. Prevalence of Multidrug-Resistant Escherichia coli Isolated from Drinking Water Sources. International Journal of Microbiology [Internet]. 2018 Aug 19;2018:1–7. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6120285/#!po=39.8305

4. Alagöz AZ, Kocasoy G. Determination of the best appropriate management methods for the health-care wastes in İstanbul. Waste Management. 2008 Jan;28(7):1227–35.

5. Chartier Y, Emmanuel J, Pieper U, Pruss A, Rushbrook P, Stinger R, Townend W, Wilburn S,Zghondi R, editors. Safe management of wastes fromhealth-care activities (16) (PDF) Healthcare Waste Generation and Management in Public Healthcare Facilities in Adama, Ethiopia. Available from: https://www.researchgate.net/publication/301298839_Healthcare_Waste_Generation_and_Management_in_Public_Healthcare_Facilities_in_Adama_Ethiopia [accessed Aug 10 2024.

6. Manga VE, Forton OT, Mofor LA, Woodard R. Health care waste management in Cameroon: A case study from the Southwestern Region. Resources, Conservation and Recycling. 2011 Dec;57:108–16.

7. Abor Aseweh P. Managing healthcare waste in Ghana: a comparative study of public and private hospitals. International Journal of Health Care Quality Assurance. 2013 May 3;26(4):375–86.

8. Awodele O, Adewoye AA, Oparah AC. Assessment of medical waste management in seven hospitals in Lagos, Nigeria. BMC Public Health. 2016 Mar 15;16(1).

9. World Bank. Cameroon- Health Results- based Financing 2012 Health Facilty baseline survey. [Internet]. [Updated 2023 Apr] Available from: https://datacatalog.worldbank.org/dataset/cameroon-health-results-based-financing-impact-evaluation-2012-0

10. Kagonji, I.S. and Manyele, S.V. (2011) Analysis of the Measured Medical Waste Generation Rate in Tanzanian District Hospitals Using Statistical Methods. African Journal of Environmental Science and Technology, 5, 815-833. - References - Scientific Research Publishing [Internet]. Scirp.org. 2022 [cited 2024 Aug 10]. Available from: https://www.scirp.org/reference/referencespapers?referenceid=3287235

11. WHO. Safe Management of Waste from Health-care Activities [Internet]. Geneva: World Health Organisation; 2011 [cited 2024 Aug 16]. Available from: http://www.who.int/mediacentre/factsheets/fs253/en/

12. Taghipour H, Mosaferi M. Characterization of medical waste from hospitals in Tabriz, Iran. Science of The Total Environment. 2009 Feb;407(5):1527–35.

13. Zeithaml, Valarie A, A. Parasuraman and Leonard L. Berry. Delivering Quality Service: Balancing Customer Perceptions and Expectations. New York , London, Free Press: 1990.

14. Al-Khatib IA, Sato C. Solid health care waste management status at health care centers in the West Bank – Palestinian Territory. Waste Management. 2009 Aug;29(8):2398–403.

15. Mohee R. Medical wastes characterisation in healthcare institutions in Mauritius. Waste Management. 2005 Jan;25(6):575–81.

16. Diaz LF, Eggerth LL, Enkhtsetseg Sh, Savage GM. Characteristics of healthcare wastes. Waste Management. 2008 Jan;28(7):1219–26.

17. Mato RRAM, Kaseva ME. Critical review of industrial and medical waste practices in Dar es Salaam City. Resources, Conservation and Recycling. 1999 Mar;25(3-4):271–87

18. Hagen DL, Al-Humaidi F, Blake MA. Infectious waste surveys in a Saudi Arabian hospital: An important quality improvement tool. American Journal of Infection Control. 2001 Jun;29(3):198–202.

19. Longe, E.O. Williams A. A Preliminary study of medical waste management in Lagos metropolis, Nigeria. Iranian Journal of Environmental Health Science & Engineering [Internet]. 2006 Apr 1;3(2). Available from: https://www.researchgate.net/publication/26488540_A_Preliminary_study_of_medical_waste_management_in_Lagos_metropolis_Nigeria#fullTextFileContent

20. Mbanya D, Ateudjieu J, Tagny CT, Moudourou S, Lobe MM, Kaptue L. Risk Factors for Transmission of HIV in a Hospital Environment of Yaoundé, Cameroon. International Journal of Environmental Research and Public Health [Internet]. 2010 May 1 [cited 2021 Apr 17];7(5):2085–100. Available from: https://www.mdpi.com/1660-4601/7/5/2085/html

21. Pruss A, Giroult, E, Rushbrook. Safe management of wastes from health-care activities [Internet]. 1999. Available from: http://whqlibdoc.who.int/publications/9241545259.pdf

22. Farzianpour, F., Hosseini, S.H. and Hosseini, S. (2014) Global Change and Human Health. 2nd International Congress on Energy Efficiency and Energy Related Materials Libery Hotels Lykia, Oludeniz, 16-19 October 2014, 365. - References - Scientific Research Publishing [Internet]. Scirp.org. 2014 [cited 2024 Aug 10]. Available from: https://www.scirp.org/reference/referencespapers?referenceid=1334783