

Hospital Stakeholders' Perception on Environmental Effects Related to Biomedical Waste in Togo's University Hospitals (UHC) in 2021

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Abstract

Introduction: Given its effects, hospital waste is an environmental concern and a threat to health personnel, users of health services and neighboring populations. Our objective was to assess the perception of health care stakeholders on the environmental effects related to biomedical waste produced in Teaching Hospitals (CHU) in Togo in 2021. **Methods:** This was a cross-sectional study held from June 24 to August 28, 2021. It targeted three university hospitals, 340 health care providers and services selected by a probabilistic method with a simple random technique in 25 services, 72 directors, deputy directors, supervisors and heads of services, 27 collection and incineration agents selected by a non-probabilistic method with a reasoned choice technique, 44 patients and attendants and 36 householders of neighboring residents selected by a non-probabilistic method with an accidental choice technique. Variables such as the spreading of disease vectors, soil, air and water contamination, the presence of unpleasant odors and unsightly living conditions were assessed. **Results:** According to the respondents, biomedical waste causes the proliferation of vectors (55.3%), an unsightly environment inside the hospital (47.1%), and unpleasant odors (61.2%). Incineration operations disturb hospital residents (52.8%), according to the householders of the residents. During observation, we note deposits of waste that have not been destroyed and wastewater flowing in some places. **Conclusion:** Biomedical waste

in Togo's university hospitals generates environmental effects and therefore potentially high risks for human health. Improving their management should be a concern for all hospital actors.

Keywords

Environmental Effects, Biomedical Waste, Teaching Hospitals, Environment, Togo

1. Introduction

The primary mission of any health facility is to supply care and services to restore and maintain a healthy population. To achieve this mission, they produce biomedical waste, which should be managed appropriately to minimize the health and environmental effects.

Wastes produced in health facilities include general waste similar to household waste (WSHW) and waste from healthcare activities with infectious risks, also known as biomedical waste (BW). Biomedical waste represents 10% to 25% of the waste in health facilities and constitutes a high infectious risk and its management should be a concern for all actors in the health care system [1] [2] [3]. These are considered the second most hazardous waste in the world after radioactive waste [4] [5]. WSHW includes empty cardboard boxes, empty pharmaceutical packaging, leftover paper from offices, food scraps, wastewater from kitchen sinks, office sinks, showers and excreta from water closets. BW includes bloodstained swabs, pharmaceutical waste, sharps, anatomical waste, chemical waste, wastewater from various health care departments, and mortuary wastewater [2] [3] [6].

Given the large number of departments in university hospitals (UHC), amounts produced are more important and increase from year to year with population growth, especially in developing countries, as well as with the phenomenon of single-use consumables and the context of the COVID-19 health crisis [7] [8]. Wastewater, sewage sludge and septic tank sludge are generated in the various sections of the hospital and have a fairly variable composition depending on the performed activities [9] [10]. The adverse impact in terms of damage to the environment and affecting people's health has been noted due to an often-neglected aspect of liquid health care waste management. In most hospitals, there are neither guidelines and standards nor committees or weaknesses in these guidelines and committees for the management of these liquid health care wastes [10] [11]. In most developing country health facilities, there are no plans or internal regulations governing the management of biomedical, wastewater, and other wastes, nor are there technical guidelines for their collection, transport, storage, and treatment. There is also a lack of reliable data on the quantities produced [12] [13] [14] [15] [16]. In the health facilities, we notice an absence of incinerators or the existence of incinerators that do not meet the standards and cause nuis-

ances during their use. BW is often mixed with WSHW and is stored for several days without being destroyed. In several health facilities, especially in developing countries, poor waste management has been observed at various points in the management chain: poor sorting, overfilling of waste garbage cans, inappropriate transport and storage, and inadequate treatment [17] [18] [19] [20]. This situation was also reported by a joint WHO and UNICEF assessment in 2015 in 24 countries where 42% of ES lacked adequate systems for waste disposal [21]. This leads to a degradation of the living environment [3] [22]. The undestroyed waste ends up in the immediate environment of health facilities making the setting unsightly, sometimes creating unpleasant odors or pollution of soil, air, groundwater and food. Furthermore, chemical and other substances such as aerosols contained in the air of landfills or waste storage or treatment sites due to their toxic, carcinogenic, mutagenic, irritant characteristics are found in the environment. Metal such as mercury, silver and toxic substances such as dioxins are also found in the environment of hospitals. Silver is another toxic element present in hospitals (photographic baths). It is bactericidal and bacteria that develop resistance to silver are also reported to be resistant to antibiotics [3] [17] [23] [24] [25] [26]. Waste is a carrier of pathogens that are found in the hospital environment [9] [23] [27] [28].

Togo is experiencing enormous difficulties in the management of solid and liquid health care waste in its health facilities. The situation seems to be more worrying in the teaching hospitals where the wastes are stored for several days, creating dumps within the health facilities, the discharge of biomedical wastewater into the environment without any treatment, the use of incinerators constituting sources of nuisance during operations, and the discharge of waste related to health care activities into public dumps [29] [30] [31]. A previous study carried out in these university hospitals had shown that solid and liquid waste management was “poor” due to the non-use of waste management guidelines, insufficient training of service providers and collection agents, insufficient user awareness sessions, insufficient coordination of activities, insufficient supervision of service providers and collection agents, insufficient monitoring and evaluation of activities. Sorting was not systematic (74.1%), and the Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) of the effluents were higher than the standards [31].

Thus, it is necessary to assess the perception of the users of these establishments on the effects of improper management of hospital waste on the environment.

2. Methods

2.1. Study Framework

The study took place in Sylvanus Olympio University Hospital (“UHC-SO”) and Campus located in Lomé, and Kara University Hospital located 420 km from the capital. They have the following services: internal medicine, hepato-gastro-en-

terology, pediatrics, neurology, psychiatry and medical psychology, cardiology, gynecology-obstetrics, ENT, stomatology, clinical hematology, allergology, dermatology-venereology, ophthalmology, physiotherapy, radiology, pediatric surgery, traumatology, geriatrics, laboratories, pharmacy, speech therapy, hygiene and sanitation. In addition, UHC-SO has a hemodialysis service. The UHC-SO, Campus and Kara respectively had 1168, 457 and 375 staff in all categories and 833, 179 and 169 beds in 2020 according to the 2020 reports.

Solid BW collection is done by department. Garbage cans are made available to providers. Collection and incineration workers collect them; transport them to the incinerators where they are incinerated. The wastewater is drained into septic tanks which are emptied afterwards if they are full.

2.2. Study Type

This was a cross-sectional, analytic study held from June 24, 2021 to August 28, 2021.

2.3. Targets

The **primary targets** were the environment of the services of the CHU SO, Campus and Kara.

The **secondary targets** were medical and paramedical staff assigned to care and services (doctors, pharmacists, nurses, midwives, senior laboratory technicians, hygiene and sanitation technicians, senior anesthesia technicians, senior radiology technicians, nurses, orderlies), collection and incineration agents, patients and accompanying persons, hospital directors, and other staff, laboratory technicians, nurses, orderlies), collection and incineration agents, patients and accompanying persons, hospital directors and their deputies, heads and supervisors of departments and heads of households in the vicinity of the university hospitals, on the other hand, waste management infrastructures, waste storage and disposal sites.

2.4. Sampling

In each of the three UHCs, departments were selected using a probabilistic method and a simple random technique after identifying the departments involved in waste management. Health care providers and services were selected by a probabilistic method with a simple random technique; directors, heads of services, supervisors of services, waste collection and incineration agents were selected by a non-probabilistic method with a reasoned choice technique; patients and accompanying persons, heads of households of residents by an accidental choice technique.

The total sample size was 519, of which the providers of care and services (319) were calculated by the Schwartz formula ($n = Z^2 apq / i^2$); $p = 0.252$; $q = 1 - 0.252 = 0.748$; the consented risk of error $\alpha = 0.05$; the consented risk reduced variance: $Z\alpha = 1.96$; $i =$ Desired precision for our results = 0.05; the proportion

(25.2%) of hospital center service providers practicing appropriate waste management [32].

2.5. Variables

These variables allow us to measure the effects of waste on the environment and to assess the users' perception of these effects. They include the spreading of disease vectors, the contamination of soil, air and water, the presence of unpleasant odors, and the unsightly environment. These variables were collected by questioning the various hospital actors to have their perception on the effects of waste on the environment, but also by direct observation of the waste storage places, the internal and external environment of the CHUs.

2.6. Inclusion, Non-Inclusion and Exclusion Criteria

The following criteria were used:

- Our study included medical and paramedical, administrative and support staff assigned to care and services in university hospitals;
- Were not included, all persons who are not health personnel, neither sick nor accompanying persons and who were on the premises on the day of the survey;
- Medical and paramedical, administrative and support staff assigned to care and services, heads of households of residents who are not from the university hospitals concerned and who were on the premises on the day of the survey were excluded from our study.

2.7. Data Technique, Tools and Planning Collection

The data collection techniques and tools by study target/source are shown in **Table 1**.

Data collection took place after obtaining authorization from the Minister of Health. Once this authorization was obtained, contact was made with the heads of the three university hospitals to present the authorization and also to explain the purpose of the research. A collection schedule was established at each university hospital. Investigators were trained and supervised by us during the collection.

Table 1. Data collection techniques and tools by study target/source.

Targets/sources	Techniques	Tools
Service providers, maintenance and incineration workers	Survey	Form
Directors, heads and supervisors of services	Interview	Interview Guide
Patients and carers, heads of households	Survey	Form
Infrastructure, service environment, waste storage and incineration site, septic tanks, cesspools, latrines	Observation	Observation grid

2.8. Ethical and Deontological Concerns

Our research protocol was submitted to the Bioethics Committee for Health of the University of Lomé, whose favorable opinion was obtained before the collection began. Authorizations were obtained from the authorities of the Ministry in charge of health and the directors of the three university hospitals. Only subjects who gave free and informed written consent were included in the sample. Data were collected and kept strictly confidential within the study team.

2.9. Data Treatment and Analysis

The collected data were entered using Epi Data 21.0 software. Analysis was performed using SPSS 24.0 software. A description of the data was made by calculating absolute and relative frequencies, as well as means with their standard deviations. Determination of the relationships between waste management and the other variables was performed using Pearson's Chi² statistical test.

3. Results

3.1. Description of Respondents

The targets were health care providers and services, directors, heads and supervisors of services, patients and attendants, collection and incineration agents, and heads of householders in the vicinity of UHC (Table 2). The providers surveyed were physicians (15.9%), State Registered Nurses (SNN) (33.8%), State Midwives (SFE) (13.6%), laboratory technicians (biologist technician and engineer) (10.3%), Medical Assistants (MA) (4.1%), hygiene and sanitation technicians (hygiene assistant, hygiene assistant, senior technician and sanitary engineer) (3.5%), radiology technicians (0.9%), anesthesia and resuscitation technicians (1.8%), physiotherapists (3.2%), auxiliary state midwives (AAE) (0.6%), auxiliary state nurses (IAE) (4.4%), nursing assistants (5.3%), ophthalmology technicians (0.8%), instrument technicians (1.9%), etc.). Their age in completed years of service ranged from 0 to 32 with a median of 7 years. The majority of managers and supervisors, 75% were male and their ages ranged from 32 to 64 years with a median age of 40 years. For collection and incineration agents, the

Table 2. Distribution of respondents by teaching hospitals.

Respondents	UHC			Total
	Kara	Campus	SO	
Providers	75	90	175	340
Directors, Managers and Supervisors	20	21	31	72
Collection and incineration agents	4	3	20	27
Patients and attendants	9	10	25	44
Heads of households	1	10	25	36
Total	109	134	276	519

majority (16/27) were male and their ages ranged from 32 to 62 with a median age of 54. As for the heads of households, 88.9% were men and 13.9% had no schooling; 19.4% had primary education, 38.9% had secondary education and 27.8% had higher education (**Table 3**).

3.2. Effects of Waste on Soil, Water and Air

According to health care providers and services, hospital waste would cause the proliferation of disease vectors (flies, cockroaches, rodents, etc.) (55.3%) and cause an unsightly environment inside the hospital (47.1%) as well as unpleasant odors in and around the hospital (61.2%) (**Table 4**).

Table 3. Distribution of respondents according to targets.

Targets	Headcounts	Percentage (%)
Health care staff (n = 340)		
State-qualified nurse (IDE)	115	33.8
Doctor	54	15.9
State Midwife	46	13.6
Laboratory technician (tech, engineer)	35	10.3
Orderlies	18	5.3
State Registered Nurse (RN)	15	4.4
Medical assistants (AM)	14	4.1
Hygiene and sanitation technician (tech, engineer)	13	3.9
Physiotherapist	11	3.2
Instrumentist	8	2.3
Anesthesia and intensive care technician	6	1.8
Ophthalmology technician	3	0.8
Midwife State auxiliary	2	0.6
Directors, Managers and Supervisors (n = 72)		
Directors, Managers and Supervisors		
Collection and Incineration agents (n = 27)		
Men	16	
Women	11	
Neighboring householders (n = 36)		
No education	5	13.9
Primary	7	19.4
Secondary	14	38.9
Higher education	10	27.8

Table 4. Effects of waste in UHC on soil, water and air according to providers and services (n = 340).

Effects	Headcounts	%
Spreading of disease vectors		
Yes	188	55.3
No	152	44.7
Contamination of well water and other sources		
Yes	33	9.7
No	307	90.3
Soil contamination inside the hospital		
Yes	67	19.7
No	273	80.3
Unsightly environment inside the hospital		
Yes	160	47.1
No	180	52.9
Support for food contamination around the hospital		
Yes	41	12.1
No	299	87.9
Incineration operations constitute a nuisance for local residents		
Yes	74	21.8
No	266	78.2
Waste generated unpleasant odors in and around the hospital		
Yes	208	61.2
No	132	38.8

Directors, supervisors and heads of departments (n = 72), stated that hospital waste caused:

- Proliferation of disease vectors (flies, cockroaches, rodents, etc): 34.7%;
- An unsightly environment and contamination of the ground: 20.8%;
- Contamination of the water table and water: 22.2%;
- Inconvenience for the residents of the hospital during the incineration operations: 20.0%.
- Unpleasant odors: 38.9%.

Collection and incineration officers, reported that hospital waste generated:

- Soil contamination: 13/27;
- An uncomfortable environment: 15/27;
- Inconvenience to hospital residents during incineration operations: 17/27;
- Unpleasant odors: 19/27.

The patients and attendants (n = 44), as well as the heads of households in the vicinity of the UHC (n = 36), declared that hospital waste caused, (respectively):

- Food contamination (9.1% and 5.6%);
- An unsightly environment (45.5% and 27.8%);
- Incineration operations are a nuisance for people living near the hospital (2.3% and 52.8%);
- Unpleasant odors (50% and 33.3% (**Table 5**)).

On observation, waste deposits and sewage flowing in places were observed, creating an unsightly environment in the hospitals (**Figure 1**), and thick smoke during incineration operations could be a nuisance for residents (**Figure 2**).

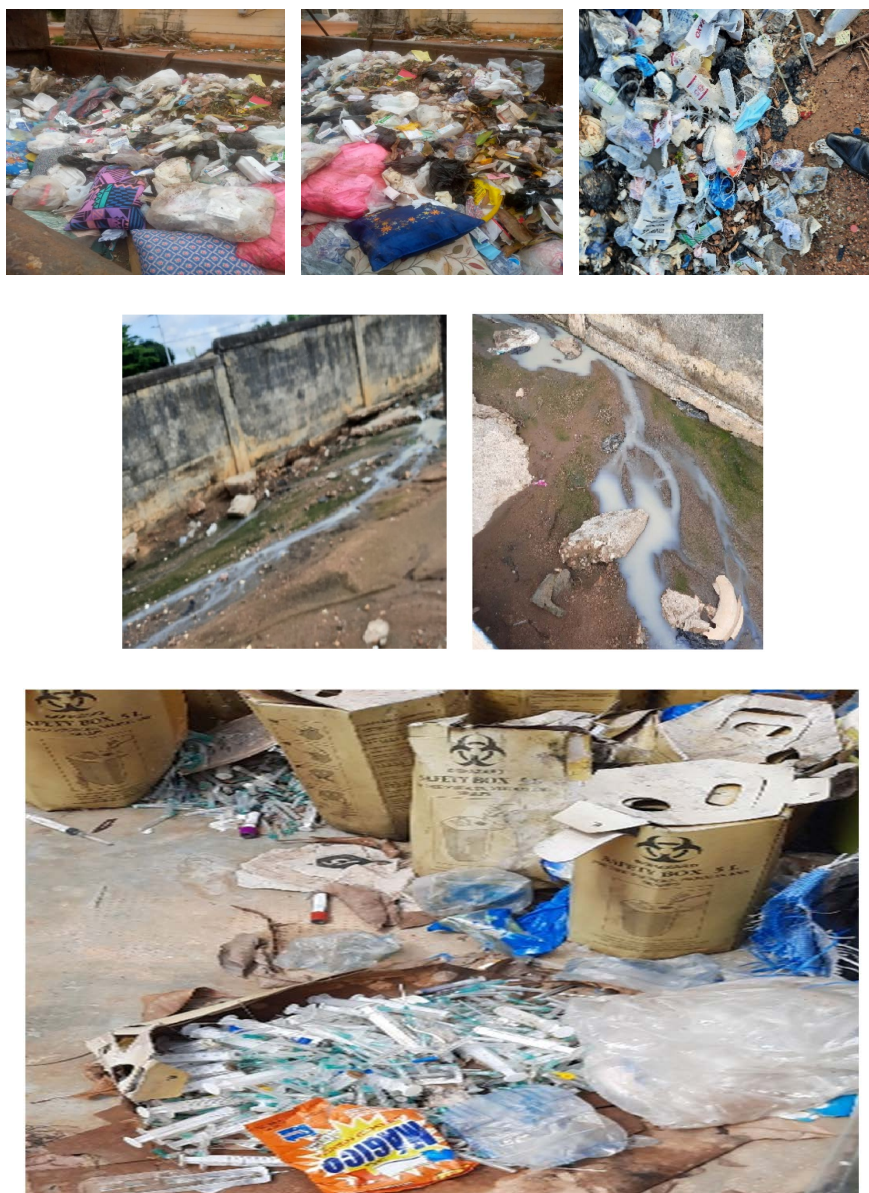


Figure 1. Photos taken during data collection in UHC SO, Campus and Kara in 2021 showing an unsightly setting.

Table 5. Effects of waste in UHC on soil, water and air according to directors, heads and supervisors of departments, collection agents, patients and attendants, and heads of households of residents.

Effects	Headcounts	%
DIRECTORS, MANAGERS, SUPERVISORS		
Spread of disease vectors		
Yes	25	34.7
No	47	65.3
Unsightly environment and soil contamination		
Yes	15	20.8
No	57	79.2
Contamination of water table and water		
Yes	16	22.2
No	56	77.8
Incineration operations constitute a nuisance for local residents		
Yes	14	20.0
No	58	80.0
Waste generated unpleasant odors in and around the hospital		
Yes	28	38.9
No	44	61.1
COLLECTE AND INCINERATION AGENTS (n = 27)		
Ground contamination		
Yes	13	
No	14	
Uncomfortable environment		
Yes	15	
No	12	
Incineration operations constitute a nuisance for residents		
Yes	17	
No	10	
Waste generated unpleasant odors in and around the hospital		
Yes	19	
No	8	
PATIENTS AND ATTENDANTS (n = 44)		
Food contamination		
Yes	4	9.1
No	40	90.9

Continued

Unsightly surroundings			
Yes	20	45.5	
No	24	54.5	
Incineration operations are a nuisance to residents			
Yes	1	2.3	
No	43	97.7	
Waste has caused unpleasant odors in and around the hospital			
Yes	22	50.0	
No	22	50.0	
RESIDENT'S HEAD OF HOUSEHOLD (n = 36)			
Food contamination			
Yes	2	5.6	
No	34	94.4	
Unsightly setting			
Yes	10	27.8	
No	26	72.2	
Incineration operations constitute a nuisance for local residents			
Yes	19	52.8	
No	17	47.2	
Waste generated unpleasant odors in and around the hospital			
Yes	22	33.3	
No	22	66.7	



Figure 2. Photos taken during data collection at the Campus University Hospital in 2021 showing air pollution that may be a nuisance to local residents.

4. Discussions

The objective of our study was to assess the perception of hospital actors on the effects of University Hospitals (UHC) waste in Togo on the environment. At the end of our study, according to the targets surveyed, hospital waste caused the proliferation of disease vectors (55.3%), unpleasant odors inside and around the hospital (61.2%), and intolerable discomfort for the hospital's residents during incineration operations (52.8%) The diversity of the techniques and tools used allowed us to collect data from different targets/sources, which allowed us to triangulate the data and reduce bias.

The limitations of our study lie in the fact that it only shows a snapshot of the effects of waste at a given time and that it was limited to UHC and therefore did not take into account other types of health facilities whose realities are not necessarily the same as UHC.

4.1. About the Effects of Biomedical Waste on Soil, Water and Air

The results of our study showed that hospital waste caused the proliferation of disease vectors such as flies, cockroaches, rodents, etc. inside the hospital (55.3%), an unsightly environment inside the hospital (47.1%). The effects of waste were aggravated by the health crisis at COVID-19 which led to an increase in the quantities produced with the use of PPE such as masks.

Roberts et al, in a study in 2021 in 11 countries in the European, American and Asian continents, found an increase in PPE waste due to the COVID-19 measures and that face masks accounted for over 5% of all waste. This made health facility settings unsightly [33]. Also, PPE and wipes discarded in the environment constitute a potential viral vector of COVID-19 for surrounding people [34]. Heavy metals or materials containing large amounts of lead, mercury or cadmium, due to their incineration, can cause the release of toxic metals into the environment. Waste from health care facilities is responsible for mercury pollution of surface waters [2] [23] [34]. Pathogens of all kinds contained in waste contaminate soil and water [17] [23] [24] [35] [36] [37].

4.2. Effects of Solid Waste on Air

Solid waste management has adverse effects on the air. The results of our study showed that hospital waste caused unpleasant odors inside and outside the hospital (61.2%), proliferation of disease vectors (55.3%). The results of previous studies have shown that the incineration of materials containing chlorine can produce dioxins and furans, and the incineration of heavy metals or materials containing large amounts of lead, mercury or cadmium can result in the release of toxic metals into the environment. Mercury evaporates very easily and can remain in the atmosphere for up to a year [2] [23] [35]. Also, waste management leads to bio-aerosols in the air of landfills or waste storage or treatment sites and incineration leads to the release of persistent organic pollutants (POPs) and greenhouse gases into the air [2] [17] [23] [38] [39]. Another study conducted in

several African countries provided similar results showing that waste management, in this case incineration, potentially creates hazardous effects, such as harmful emissions and residues [40].

4.3. Effects of Liquid Waste on Water, Soil and Air

Liquid wastes such as sewage and excreta are also generated in health facilities. Their proper management should be a concern for hospital administrations and all stakeholders. This will help to minimize the adverse effects on the environment and the health of the population. Effluent and sludge should be disposed of in a manner that meets discharge standards. WHO has developed guidelines for countries to follow [37]. In our study, health care providers and services reported that hospital waste caused unpleasant odors in and around the hospital (61.2%) and these caused the proliferation of disease vectors (55.3%). This means that the discharged wastewater contains organic or inorganic solids as well as microbial contaminants. These discharged wastewaters probably contain excessive amounts of organic carbon, so the polluting capacity of these wastewaters is high [41] [42]. Kasuku and al, in a study in 2016, found the existence of toxic substances in the effluents of the concerned hospital facilities and these could have adverse effects on water and soil. The analysis of the river water into which these effluents were discharged confirmed these findings [23]. EL Mountassir and al, in 2017 in Morocco found that the effluents were highly loaded with pollutants and pose a threat to the environment and health of the people [43]. The discharges of all these wastewaters pollute the receiving environments in this case water and soil [44].

5. Conclusion

Inadequate management of DBM in teaching hospitals results in environmental and community impacts. Users of these facilities are aware of these effects and perceive them as potential health risks to individuals, families and surrounding communities. Proper actions must be taken in resource allocation, organization, and management activities to minimize these effects in order to protect the health of staff, users, and residents.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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