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# Descriptive Analysis of Biomedical Waste Management in Health Care Facilities in the City of Kisangani, Democratic Republic of Congo

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## Abstract

***Introduction:*** Biomedical waste from healthcare facilities poses a serious threat to humans and the environment. Thus, this study aims to assess the level of knowledge, attitudes and practices of healthcare providers in Kisangani regarding the management of this waste.

***Materials and methods:*** A descriptive cross-sectional study conducted among 422 professionals and managers of secondary and tertiary health care establishments in Kisangani, from June 15 to August 15, 2024. Data were collected through structured interviews and observations. Categorical variables are expressed as percentages, and quantitative variables according to their distribution (mean ± standard deviation or median and interquartile range).

***Results:*** The study shows that 64.5% of providers have never been trained in biomedical waste management or on infection prevention and control, and 68.7% of those trained were trained more than 36 months ago.

In addition, 93.6% of providers had little knowledge of the definition of biomedical waste management, 82.7% had little understanding of its steps, and 55.2% recognized its importance. In practice, 69.7% did not sort waste, 78.2% did not use coded garbage bags, and 66.8% lacked containers for sharp objects. Furthermore, 65.2% of establishments did not have a storage area and 74.6% considered waste management unsatisfactory. In addition, 71.8% reported a lack of

functional incinerators, and 77% the lack of suitable means of transport. Finally, 68.7% reported a lack of water tanks, and 79.6% the lack of a dedicated budget.

***Conclusion:*** The study reveals insufficient management of biomedical waste in health care facilities in Kisangani. There is a need to strengthen staff capacities and invest in infrastructure to ensure health safety and protect the environment.

***Keywords:*** Management; biomedical waste; health care establishments; knowledge; attitudes; practices; City of Kisangani

## Introduction

Any human activity that generates waste, and healthcare establishments are no exception to this rule [1]. Dand the current global context of population explosion as well as the multiplication of the number of hospitals [2], we observe a proportional increase in the production of different types of waste, which constitutes a serious threat to man and his environment [3]. According to the World Health Organization (WHO), improper waste management due to the increase in their production and their Improper management is an environmental and health problem throughout the world.

It is reported that 70% of hospital waste is infectious and can cause serious, sometimes incurable, communicable diseases [4]. The dispersion of this type of waste in the environment can harm the biosecurity of human or animal populations living in this environment [5]. Therefore, biomedical waste generated by healthcare facilities (HCF) represents a major challenge on a global scale [6]. Their proper management is essential to prevent healthcare-associated infections, ensure staff safety and protect the environment [3].

Furthermore, the production of poorly managed infectious health care waste (sharp, cutting and sharp objects) is responsible for approximately 8 to 16 million cases of viral hepatitis B infections, 2.3 to 4.7 million cases of hepatitis C infections and 800,000 to 1.6 million cases of HIV/AIDS infections according to the WHO [7].

Furthermore, According to new global data published by WHO and UNICEF in 2019, the safe management of medical waste is non-existent or very limited in a large part of EHS, especially in resource-limited settings (References). The data, representing more than 560,000 EHS from 125 countries, indicates that 40% of EHEs do not separate their waste [6]. As a result, the mismanagement of waste generated at the EHS level exposes staff, patients and society to various risks. For example, in 2002, the results of a WHO assessment of 22 developing countries showed that the proportion of health-care facilities that do not apply appropriate waste disposal methods ranges from 18 to 64 per cent [8].

In sub-Saharan Africa, biomedical waste management in health care facilities remains a concern. 60% of hospitals and 38% of other EHS had basic waste management services. Of these establishments, 71% of public establishments and 55% of private establishments sorted their waste in a secure manner [9].

A study conducted by Odonkor and Mahami in Ghana in 2020 found that less than half of healthcare providers (47.5%) practiced waste separation at the source of production [10]. In 2021, a similar observation was made in Côte d'Ivoire where it was shown that 71.1% of the staff of a regional hospital did not sort waste [2]. In addition, another study in Cameroon in 2022 found that 44.45% of healthcare workers had knowledge about high-risk infectious waste [11].

In the Democratic Republic of Congo, GDBM represents a major public health and environmental issue because this waste, like household or other waste, is constantly being produced in all countries and the risk it entails increases in proportion to the quantity produced [4]. Healthcare waste is a reservoir of potentially dangerous microorganisms that can infect hospital patients, health workers and the general public. Today, the question of its management in hospitals is becoming more and more acute given the various potential risks [12], and its production, the result of human activities, is constantly increasing in all countries, whose dangerousness is increasing in proportion to their harmfulness to human health and the environment [13].

Several studies conducted in the DRC have revealed shortcomings management system for the DBMs at all stages of the management cycle: sorting, collection, storage, transport, treatment and disposal [14, 1 and 15]. This is the case of the survey carried out in Bukavu in 2020 which showed that 91% of healthcare providers had insufficient knowledge about GDBM [14]. While another conducted in Kinshasa in 2023, revealed that healthcare establishments were poorly implementing the national hospital waste management plan, due to insufficient material and financial resources [1].

In Kisangani, a study conducted in 2018 indicated that 61% of providers considered their knowledge of GDBM to be insufficient, while 84.7% were aware of the health risks associated with poor GDBM [15].

By evidence available to date, the reflection of this study focuses on the management of biomedical waste in health care establishments in the city of Kisanganiin order to assess the level of knowledge, attitudes and practices of health care providers in the city of Kisangani on the management of biomedical waste.

## Materials and Methods

### *Study framework*

This study was conducted in health care facilities in the city of Kisangani, Tshopo Province, in the north-east of the Democratic Republic of Congo. This city has 5 Health Zones including 4 General Reference Hospitals, 7 Reference Health Centers, 88 Health Centers, 1st University Clinics of Kisangani, as well as two provincial hospitals, namely the Makiso-Kisangani Provincial Hospital and the Cinquantenaire Provincial Hospital.

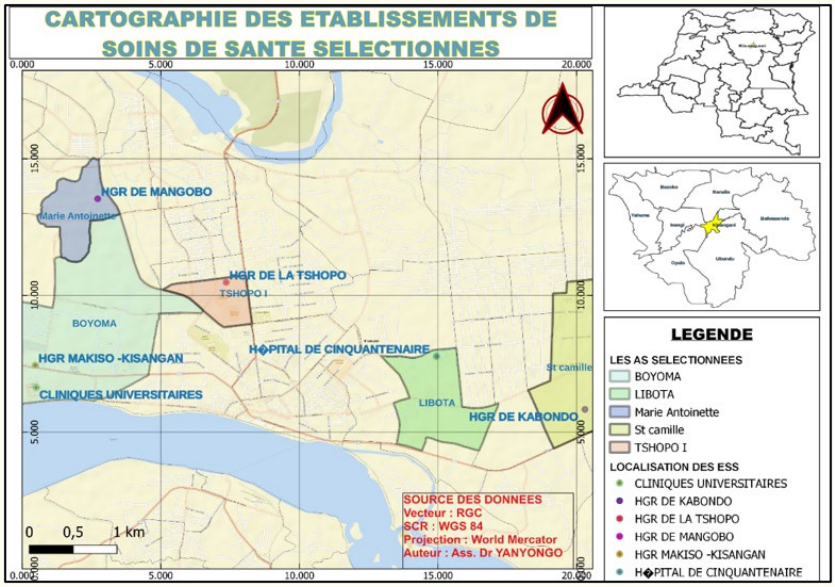


***Figure 1:*** Study setting. This figure shows the health care facilities, including university clinics, HGR Tshopo, HGR Kabondo, HGR Mangobo, HGR Makiso-Kisangani and Hôpital du Cinquantenaire that are identified as priority study sites. These health care facilities are located in the Democratic Republic of Congo (DRC), in the Tshopo province, more precisely in the city of Kisangani.

***Population under study***

The population of this study consists of all health personnel and managers of health care establishments involved in the GDBM, selected proportionally from health care institutions offering patient-specific specialized treatments (secondary level) and those with a highly specialized level (tertiary).

***Type and period of study***

This is a cross-sectional study with a descriptive aim carried out over a period of two months, from June 15 to August 15, 2024.

***Sampling***

Our sample size was calculated using the following SCHWARTZ formula:

$$n = \frac{Z^2 (p)(q)}{d^2}$$

The proportion of providers and managers involved in GDBM was estimated at 50% given that this proportion remains unknown in our study environment, with a margin of error of 5%. The sample size was 384 subjects. By increasing the 10% non-response rate, the size was reduced to 422 subjects.

To determine the sampling for our study, 4Health zones (ZS) were selected from the 5 in the city of Kisangani, and seven (7) secondary and tertiary health care facilities in the city of Kisangani were drawn in a reasoned manner.

Providers were distributed proportionally across the seven (7) secondary and tertiary health care facilities in the city of Kisangani.

Included in this study were any health personnel and managers of health care facilities participating in the biomedical waste management cycle, present at the time of data collection, available to answer our questionnaire and to have given their consent.

***Variables of interest***

The dependent variable in this study is biomedical waste management in health care settings (good or poor). On the other hand, the independent variables are made up of socio-professional descriptions of the respondents (age, sex, marital status, level of education, professional category and seniority, GDBM/ICP training and post-training duration), knowledge of GDBM (knowledge on the definition, importance, and stages related to GDBM), attitudes and practices on GDBM (Application of sorting of biomedical waste, use of codified garbage bags recommended by the WHO in the departments, use of objects containers, sharps, and sharps in all clinical and care areas, storage area of DBMs, use of means of transport of DBMs, presence of a functional incinerator, existence of a placenta pit, ash pit and grinder of functional and GDBM glasses in health care facilities) and resources useful to GDBM in health care facilities (Existence of functional Hand Hygiene stations in the SSE, Water storage capacity for at least 48 hours in the HSS and Existence of a budget for the GDBM).

***Collect and analyze data***

The method used in our study was the direct survey, and the data collection technique consisted of structured interviews conducted by the interviewers using a survey form established on Kobo toolbox and uploaded to the ODK Collect application to describe the socio-professional characteristics of the providers, assess the level of reinforcement and knowledge of the providers on GDBM.

We also used the direct observation technique based on an observation guide with health care personnel and managers of health care facilities to assess the practices and the presence of the necessary infrastructure for GDBM during the period of our study.

To conduct this study, we recruited 14 investigators (researchers and students). They were trained for seven days and followed by close supervision by the author. The questionnaire was pre-tested before its use.

Data were collected using the ODK collect tool and were subsequently exported to Excel for cleaning and then imported into STATA 13 for analysis. The socio-professional descriptions of the surveys, knowledge and attitudes regarding GDBM, GDBM practices, as well as the resources available for this management in health care facilities, were presented in the form of proportions.

For quantitative variables with symmetric distribution, means with standard deviations were presented, while for quantitative variables with asymmetric distribution they were presented as medians with interquartile ranges.

Assessment of the level of knowledge of service providers on GDBM within reach the content of each stage of the GDBM cycle (sorting, collection, storage, transport, treatment and disposal). The level of knowledge was classified as "poor" when the score was between 0 and 1, and "good" when the score was 2.

### *Ethical considerations*

Permissions were obtained from the Ethics Committee of the Faculty of Medicine and Pharmacy of the University of Kisangani, the Head of the Provincial Health Division of Tshopo, the Chief Physicians of the 4 Health Zones of the city of Kisangani, as well as the heads of all the ESS included in our study. Verbal informed consent was obtained from participants before their inclusion in the study, and anonymity and confidentiality of information were rigorously guaranteed.

## Results

### *Socio-professional description of the surveys*

| *Features* | *Frequency* | *%* |
|---|---|---|
| Age of respondents (years) | n = 422 | |
| Mean (SD) | 40 (9) | |
| 29 to 41 | 295 | 69.9 |
| 42 to 54 | 111 | 26.3 |
| 55 years and over | 16 | 3.8 |
| Gender of respondents | n = 422 | |
| Male | 220 | 52.1 |
| Female | 202 | 47.9 |
| Civil status of investigations | n = 422 | |
| Bachelor | 147 | 34.8 |
| Divorced) | 5 | 1.2 |
| Bride) | 239 | 56.6 |
| Free union | 16 | 3.8 |
| Widower | 15 | 3.6 |
| Level of study of the surveys | n = 422 | |
| None | 8 | 1.9 |
| Primary | 3 | 0.7 |
| Secondary | 44 | 10.4 |
| Higher/university | 349 | 82.7 |
| Specialist | 18 | 4.3 |
| Professional category | n = 422 | |
| Doctors | 86 | 20.4 |
| Paramedical | 212 | 50.2 |

| | | |
|---|---|---|
| Medical-Technical | 40 | 9.5 |
| Administrative | 52 | 12.3 |
| Public health | 32 | 7.6 |
| Seniority (years) | n = 422 | |
| Median (p75 – p25) | 7 (11 – 5) | |
| ≤ 24 | 393 | 93.1 |
| > 24 | 29 | 6.9 |
| Trained in Biomedical Waste Management/PCI | n = 422 | |
| No | 272 | 64.5 |
| Yes | 150 | 35.5 |
| Post training duration | n = 150 | |
| < 36 months | 47 | 31.3 |
| ≥ 36 months | 103 | 68.7 |

***Table 1:*** Distribution of surveys according to their socio-professional description.

The results of this table 1 show that the majority of respondents were between 29 and 41 years old, with an average age of 40±9 years, male, married, higher education level/university and paramedical professional category, with a median age of 7 years. The majority had not been trained in biomedical waste management/PCI. Among those trained, the majority had a post-training duration of more than 36 months.

***Knowledge on biomedical waste management***

| ***Variables*** | ***Frequency (n=422)*** | ***%*** |
|---|---|---|
| ***Knowledge about the definition of GDBM*** | | |
| No | 395 | 93.6 |
| Yes | 27 | 6.4 |
| ***Knowledge about the importance of good GDBM*** | | |
| No | 189 | 44.8 |
| Yes | 233 | 55.2 |
| ***Knowledge on the steps related to GDBM*** | | |
| No | 349 | 82.7 |
| Yes | 73 | 17.3 |

***Table 2:*** Distribution of providers according to their knowledge of the GDBM.

The results of this Table 2 had indicated that the majority of providers did not have knowledge on the definition of biomedical waste management (BMWM) and did not master the stages of this management. However, most recognized the importance of good biomedical waste management.

***Attitudes and practices on GDBM***

| ***Variables*** | ***Frequency (n=422)*** | ***%*** |
|---|---|---|
| ***Application for sorting biomedical waste in services*** | | |
| No | 294 | 69.7 |
| Yes | 128 | 30.3 |
| ***Use of WHO-recommended coded waste bags in services*** | | |
| No | 330 | 78.2 |
| Yes | 92 | 21.8 |
| ***Use of OCPT containers in clinical and care areas*** | | |
| No | 282 | 66.8 |
| Yes | 140 | 33.2 |
| ***DBM storage area*** | | |
| No | 275 | 65.2 |
| Yes | 147 | 34.8 |
| ***Use of DBM means of transport (trolley, wheelbarrows and wheeled containers)*** | | |
| No | 325 | 77 |
| Yes | 97 | 23 |
| ***Presence of a Functional Incinerator for the destruction of DBM*** | | |
| No | 303 | 71.8 |
| Yes | 119 | 28.2 |
| ***Existence of a functional placenta pit, ash pit and glass crusher*** | | |
| No | 301 | 71.3 |
| Yes | 121 | 28.7 |
| ***GDBM in ESS*** | | |
| Bad | 314 | 74.6 |
| Good | 108 | 25.6 |

***Table 3:*** Distribution of providers according to their attitudes and practices on GDBM in health care establishments.

The results of this Table 3 showed that the majority of providers did not sort waste, did not use coded garbage bags, and did not have containers for sharp objects (OCPT). In addition, most providers highlighted that health care facilities lacked appropriate storage areas, suitable transport, incinerators and a functional placenta pit, ash pit and glass crusher. This situation leads to insufficient waste management, considered "bad" by the majority of providers, highlighting high risks for health and environmental safety.

***Useful resources for GDBM in healthcare settings***

| *Variables* | *Frequency (n=422)* | *%* |
|---|---|---|
| ***Presence of functional hand hygiene stations in the ESS*** | | |
| No | 291 | 69 |
| Yes | 131 | 31 |
| ***Water storage capacity for at least 48 hours in ESS*** | | |
| No | 290 | 68,7 |
| Yes | 132 | 31,3 |
| ***Existence of a budget on the GDBM*** | | |
| Not | 336 | 79,6 |
| Yes | 86 | 20,4 |

***Table 4:*** Distribution of providers according to their perception of the availability of resources useful for GDBM in their health care establishments.

The results in Table 4 indicated that the majority of claimants reported the lack of functional hand hygiene stations in the HSS. In addition, most had indicated that EHS did not have the capacity to store water for at least 48 hours, as well as the lack of a dedicated budget for biomedical waste management (GDBM).

## Discussion

***Socio-professional description of the surveys.***

The results of our study meant that only 35.5% of providers had received training in biomedical waste management (GDBM), and that for most of them, it had been a long time since their last training (68.7%). A major reason that could explain this high proportion of people not trained in the GDBM, as Lakbala and Lakbala pointed out in 2013, health workers could be burdened with a heavy workload, making it difficult for them to devote the time needed to integrate training into their daily routines [16]. This lack of knowledge illustrates a trend observed in other studies conducted in resource-limited countries, where lack of training continues to impact biomedical waste management. A comparison with research in Ghana and Côte d'Ivoire reveals similar levels of knowledge, despite different contexts [2, 17-20]. According to the WHO, health and cleaning professionals need to be trained and made aware of the health and environmental risks associated with waste, in order to acquire real expertise in biomedical waste management [21].

***Knowledge of Biomedical Waste Management (GDBM)***

The results of our care study showed that the majority of health care providers in health facilities in the city of Kisangani had insufficient knowledge regarding the definition of biomedical waste management, with a rate of 93.6%. This situation highlights a worrying reality, where a significant part of the health workforce does not have the skills required to ensure the safe management of biomedical waste. This finding aligns with studies in other developing countries, such as India and Bangladesh, which have also reported similar levels of insufficient knowledge among health workers [22].

Second, the results of our study indicated that most providers recognized the importance of good biomedical waste management (55.2%). These results are consistent with those of Stephen T. Odonkor and Tahiru Mahami, who noted that 97.8% of respondents considered waste management by health care workers to be a priority [10].

In addition, 82.7% of healthcare providers showed insufficient knowledge of the steps involved in biomedical waste management. This lack of understanding indicates a partial awareness of the risks associated with poor waste management, but it is insufficient to bring about meaningful behavioural change. These results differ from those of Stephen T. Odonkor and Tahiru Mahami, who found that

47.5% of service providers separated waste at the source. In addition, 25.4% of registrants reported segregating sharps, while 18.1% applied colour coding for waste management [23].

***Attitudes and practices on GDBM***

The results of our study highlighted that while some providers recognized the importance of good biomedical waste management, 69.7% felt that biomedical waste was not sorted in departments. This attitude, marked by indifference or insufficient commitment, shows that waste management is not strictly supervised or respected, even in the presence of guidelines.

These results corroborate the conclusions of Ndiaye et al., who found that waste was not identified and sorted during the collection phase [24]. This tendency not to sort waste was also recorded in other hospitals, as indicated by the work of Stephen T. Odonkor and Tahiru Mahami [23], as well as those of Koffi N. et al. and Adon [25], who reported that 71.1% of the staff of the Regional Hospital Centre did not sort the waste collected, and that 60% of the staff of Cocody did not sort it as soon as it was produced. According to WHO, it is crucial that waste separation practices are standardized in all health care facilities and that national regulations and legislation strictly promote biomedical waste management [26].

In addition, it should be noted that 78.2% of providers did not use the coded garbage bags recommended by the WHO, nor the sharps containers in the clinics and clinics according to 66.8% of providers. Indeed, the WHO recommends that all health care facilities have a dedicated space for the storage of sharp, sharp and sharp biomedical waste, identifiable by the biohazard symbol.

In contrast, 65.2% of providers reported the lack of a storage area for biomedical waste, while WHO insists on the need to designate such a space in every health care facility [27].

Furthermore, the results of our study revealed that the majority (77%) of service providers did not use appropriate means of transport for biomedical waste. However, the transport of this waste must be carried out safely, from the storage location to the disposal site, using honeycomb trolleys [28]. A study on biomedical waste management at the regional hospital of Ziguinchor, in southern Senegal, also highlighted risky transport conditions, including the use of rolling tables and bins carried on the back or head [9].

However, 71.8% of providers reported the absence of functional incinerators as well as placenta pits, ash pits and glass crushers in their health care facilities according to 71.3%. However, incineration and the use of functional placenta pits, ash pits and glass crushers are practices recommended by international biomedical waste management standards due to their efficiency. Our results corroborate those of Koffi et al., who concluded that in the absence of functional incinerators and appropriate pits, sharps, pharmaceutical, non-sharps and household waste were burned in the open air, while anatomical waste was buried in pits [25].

Furthermore, the majority of providers (74.6%) acknowledged poor biomedical waste management in health care facilities, clearly demonstrating that biomedical waste management was not properly implemented. These findings corroborate those of Ndiaye et al., who also found biomedical waste management problems at all levels in their studies [24].

***Useful resources for GDBM in healthcare settings***

The results of this study indicated that 69% of providers reported the presence of non-functional hand hygiene stations in healthcare facilities.

These observations clearly indicate that these establishments are not implementing the necessary measures to prevent the spread of micro-organisms, in particular multi-resistant bacteria, responsible for healthcare-associated infections, while the main ones constitute the main vector of contamination.

In addition, 68.7% of providers felt that health care facilities did not have sufficient water storage capacity. This situation could be explained by frequent interruptions in the water supply service, which can last from a few hours to several weeks or even months, or by failures of the water distribution authority, in particular due to the lack of recovery over the entire city. Thus, our results were in

agreement with those of a study conducted in Kenya on the evaluation of service delivery indicators, where it was observed that, in the last three months prior to the survey, water interruptions had occurred. Pendant took place 45 days or less [9].

In addition, 79.6% of providers reported that there was no budget allocated to biomedical waste management. However, Ndiaye et al. Had shown in their study that the biomedical waste management (GDBM) program requires a budget divided between training (22%), equipment (40%), and pit construction and follow-up (38%) [24]. This situation requires strategies to ensure minimum funding for GDBM operations in health care institutions.

## Conclusion

This study highlighted the significant gaps in biomedical waste management in health care facilities in the city of Kisangani, highlighting the need for a comprehensive and multi-sectoral approach to address the challenges related to biomedical waste management in resource-limited areas.

There is an urgent need to build the capacity of staff through regular training and to improve infrastructure for biomedical waste management.

Structured interventions, based on WHO recommendations, are essential to ensure more effective management of biomedical waste, thus involving risks to public health and the environment.

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