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Research Article

Environmental and Health Risks Associated with Biomedical Waste: A Case of University Teaching Hospital of Butare, Huye, Rwanda

Jean Damascene BUREGEYA ^{1,2*}; Eric SIBOMANA ¹¹ Faculty of Environmental Studies, University of Lay Adventist of Kigali (UNILAK), Rwanda² Microbiology Service; University Teaching Hospital of Butare (CHUB), Rwanda

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*Address for Correspondence:

Jean Damascene Buregeya; Faculty of Environmental Studies, University Lay Adventist of Kigali (UNILAK); Microbiology Service; University Teaching Hospital of Butare (CHUB), Rwanda

Abstract

This study investigated the environmental and health risks associated with biomedical waste in CHUB, Huye District, Rwanda. In the majority of countries across the world, the preservation of the environment and public health depends on the proper biomedical waste collection and disposal. It has been reported that the management of biomedical wastes results in needless deaths of individuals each year. The study had four objectives: (1) To assess the biomedical waste generation and disposal practices across all departments at CHUB; (2) To investigate the implementation and enforcement of biomedical waste management regulations; (3) To assess the risks related to biomedical waste to humans and the environment; and (4) To find out the level of knowledge among healthcare workers on biomedical waste management. With a cross-sectional study design survey and observation methods, data were collected from clinical service of inpatient departments, and the study population was 196 health workers. The WHO rapid assessment tool for waste management and water sanitation was adapted and used. The results of this study showed a great amount of biomedical waste are well segregated (92%), and color coding is respected during biomedical wastes collection and disposal (100%) but a significant part of biomedical liquid wastes are disposed of directly to hand-wash sink water evacuation (14%). Significant cases of needle stick injuries were also observed (21%) and internal regulations and protocols on biomedical waste management are available in most clinical services. The study recommends that regular training of health professionals in biomedical waste management, including transport and disposal essentials, connect remaining clinical departments to the specialized pit dedicated to biomedical liquid wastes to avoid any risk of direct contamination or environmental contamination; and documentation on the type of biomedical waste generated in all clinical services is an important point to be improved.

Keywords: Biomedical wastes, Environmental risk, Waste segregation, Color-coding System, Infection Prevention Control, Environmental risks, University Teaching Hospital of Butare

1. INTRODUCTION

Biomedical waste is a critical aspect of healthcare systems worldwide, as it involves the proper handling, disposal, and treatment of waste generated in healthcare facilities ¹. The World Health Organization (WHO) estimates that each year, about 8 to 16 million new cases are diagnosed with the Hepatitis B virus (HBV), 2, 3-4. 7 million cases diagnosed with Hepatitis C virus (HCV) and 80,000–160,000 diagnosed with Human Immunodeficiency Virus (HIV) due to unsecured injection disposal, and mostly due to very poor waste management systems².

Inadequate management of biomedical waste can be associated with risks to healthcare workers, patients, communities, and their environment. Proper handling of medical waste can minimize the hazards associated with improper waste management ³. Furthermore, medical waste management is an integral part of healthcare service delivery ⁴. Good MWM can be an integral part of effective infection control procedures if properly

implemented ⁵. However, adequate attention has not been paid to MWM practices in many health institutions, especially in Nigeria ³. Biomedical waste (BMW), if not managed properly, will pose significant environmental and health impacts. Healthcare establishments have particular responsibilities concerning the wastes they generate however; the impact of biomedical waste has not been given significant attention.

Biomedical waste management in sub-Saharan Africa is unarguably very poor in its sense of practice, judging from statistics taking in comparison with the stipulated World Health Organization standards. There is an urgent need to address it for public health and effective sanitation ⁶.

In Rwanda, the study that aimed to examine the Hospital Solid Waste management systems and practices at the University Teaching Hospital of Kigali (CHUK) concluded that hospital waste management was not practiced according to WHO's recommended standards ⁷.

Also, the study conducted at Kabgayi Hospital found that about half (49.0%) of healthcare personnel had good knowledge about waste management but the majority of healthcare personnel had poor practices towards bio-medical waste management ⁸.

2. MATERIALS AND METHODS

2.1. General objective

This study was to assess the environmental and health risks associated with biomedical waste in Butare University Teaching Hospital.

2.2. Specific Objectives

The specific objectives of this study were the following:

- (i) To assess the biomedical waste generation and disposal practices across all departments at CHUB.
- (ii) To investigate the implementation and enforcement of biomedical waste management regulations
- (iii) To assess the risks related to biomedical waste to humans and the environment.
- (iv) To find out the level of knowledge among healthcare workers on biomedical waste management.

2.3. Research design

In this study, both survey and observation methods were employed, utilizing a cross-sectional study design as the primary approach. The participants targeted for the survey included heads (in-charges) of inpatient units as well as healthcare providers working within the Clinical Services of the main departments at The University Teaching Hospital of butare. Data collection focused on several key areas, including accidents, incidents, occupational health issues, and activities associated with biomedical waste management within the hospital setting. To ensure comprehensive and structured data collection, both the survey and the observational assessments were conducted using a tool adapted from the World Health Organization's (WHO) rapid assessment checklist for medical waste management and water sanitation. <https://www.who.int/publications/m/item/health-care-waste-management-rapid-assessment-tool>. This adapted checklist provided a standardized framework to evaluate existing practices and identify gaps or challenges related to waste management and occupational safety within the healthcare environment. The methodology aimed to gather relevant insights that would contribute to enhancing biomedical waste management practices in the hospital.

2.4. Data analysis

The data in this study were analyzed through narrative analysis, allowing for a detailed examination of patterns and themes. Findings are presented using tables and charts, accompanied by interpretations that provide meaningful insights. During analysis, comments and corrections were incorporated to refine the results, ensuring accuracy and reliability. Additionally, multivariate analysis was applied to various parameters, offering a deeper understanding of relationships and

trends within the data. This approach enhances the comprehensiveness of the study by integrating multiple perspectives and refining interpretations through iterative review.

2.5. Ethical consideration

Ethical approval for this study was obtained through CHUB administration, ensuring adherence to scientific research standards and regulations. Participation was entirely voluntary, with anonymity strictly maintained for all respondents. To enhance comprehension, interview and survey questions were communicated in a language familiar to participants. These measures upheld ethical integrity, safeguarded participant rights, and reinforced research credibility. By prioritizing transparency and ethical considerations, the study fostered a respectful environment, ensuring reliable data collection while maintaining trustworthiness in its approach.

3. RESULTS

3.1. Identification of respondents

This section shows the identification of respondents of the respondents. This section presents the demographic characteristics of the respondents.

The demographic data collected in this section helps provide a clearer understanding of the respondent profile, which is essential for interpreting the study's findings in the context clinical services across all departments. Such classification is also valuable in evaluating workforce trends and development within the hospital. Identification of health care providers who participated in this study, they are described in more details below:

Table 3.1. Respondent by department distribution

Department	Respondents
Emergency	18
ENT	12
Internal medicine	45
Neonatology	16
Pediatrics	16
Surgery	89
Total	196

Source: Primary data, March 2025

The data presented in Table 4.1 shows the distribution of research respondents across six hospital departments. The Surgery department recorded the highest number of respondents (89), accounting for approximately 45% of

the total sample. This was followed by Internal Medicine with 45 respondents (23%), while Emergency, Neonatology, and Paediatrics had 18, 16, and 16 respondents, respectively, representing a smaller portion of the population. The ENT department had the lowest representation, with only 12 respondents (6%). The distribution indicates a higher engagement of staff in the Surgery and Internal Medicine departments compared to other units.

Table 3.2. Respondent by hospital beds availability

Department/Service	Available bed
Emergency	22
ENT	16
Internal medicine	113
Neonatology	35
Pediatrics	37
Surgery	181
Total	404

Source: Primary data, March 2025

The distribution of hospital beds across departments indicates a strong emphasis on surgical services, which accounts for the highest number of available beds (181), representing approximately 45% of the total. Internal medicine follows with 113 beds (28%), showing significant capacity likely due to its broad patient coverage. Pediatrics and neonatology have 37 and 35 beds, respectively, highlighting attention to child and infant care, while the emergency and ENT departments have the lowest allocations with 22 and 16 beds, respectively. This allocation may reflect either lower demand in these units or a prioritization of more specialized or long-term care services. Overall, the total of 404 beds suggests a moderately equipped facility with a focus on surgical and internal medicine services.

3.2. The effectiveness of biomedical waste generation and disposal practices across all departments at CHUB

The primary objective of this study was to assess the effectiveness of biomedical waste generation and disposal practices across all clinical departments at CHUB. The evaluation involved a set of questions addressing key aspects such as the presence of a designated operational focal point for biomedical waste management, the stage at which waste segregation occurs, the procedures for disposing of and evacuating liquid biomedical waste, and the implementation of a

standardized color-coding system throughout the departments.

3.2.1. Designated operational focal point for biomedical waste management

There is a highly positive trend in biomedical waste management practices, with 100% of respondents affirming that a responsible person has been identified and is actively operational in their respective services.

This unanimous response suggests that all surveyed facilities have taken a crucial step in aligning with recommended waste management protocols by appointing designated personnel. The presence of an identified and functional individual responsible for BMW management ensures accountability, consistent monitoring, and adherence to proper disposal procedures. Such a structure plays a vital role in minimizing health and environmental risks associated with biomedical waste. Moreover, the data reflect an institutional commitment to maintaining hygiene and safety standards, indicating that policies around biomedical waste are not only in place but also being implemented effectively through operational roles.

Table 3.3. The procedures for disposing of liquid biomedical waste

Response	Frequency	Percentage
Specialised pit	168	86
Hand-wash sink	28	14
Total	196	100

Source: Primary data, March 2025

The liquid water disposal system in clinical services is primarily connected to a specialized pit, with 86% of wastewater routed there. This suggests that the majority of liquid waste is managed through a controlled and likely more secure or purpose-built system, which is essential for minimizing environmental contamination and health hazards associated with clinical waste. Conversely, 14% of the wastewater is disposed of through the hand-wash sink evacuation system. This raises potential concerns, as hand-wash sinks are not typically designed to handle hazardous clinical waste, and such a practice could increase the risk of exposure to infectious agents or chemical contaminants among healthcare staff and patients. On the one hand, solid biomedical wastes are well managed, as all respondents (100%) responded that biomedical waste segregation is made at the point of production and transported to a dedicated place for treatment and disposal.

Overall, while most of the system appears to be appropriately managed, the remaining portion indicates a gap in proper waste segregation and disposal protocols that should be addressed to enhance infection control and environmental safety.

3.2.2. Documentation of the gap related to biomedical waste management and guidelines

There are significant gaps in biomedical waste management documentation and guidelines within the

clinical services at CHUB. An overwhelming 92% of respondents acknowledged this gap, pointing to a widespread awareness of the issue.

The Surgery department showed a slightly better perception, with 17% of its staff not noticing any gap, which may suggest either a relatively better structure in that unit or a lower awareness of the existing deficiencies. The specific areas of concern include the development of guidelines for biomedical wastewater management, as highlighted by 69% of respondents. This indicates a strong need for technical and institutional support to create clear, actionable protocols. Additionally, 31% of staff mentioned that while they had received training, they lacked the practical skills or were awaiting administrative support from CHUB's management to operationalize the waste management activities.

These insights point to a critical need for not just capacity-building but also organizational commitment to fully implement biomedical waste management standards and practices.

3.2.3. The figure of the amount of biomedical waste produced by departments

All respondents indicated that they do not have access to, or are not aware of, any specific data or figures regarding the quantity of biomedical waste generated within their respective departments or services. However, they unanimously reported that they do engage in waste segregation at the point of collection. This consistent practice suggests a general awareness and understanding of proper biomedical waste management protocols. Despite the lack of detailed tracking or documentation, their adherence to basic segregation procedures reflects a foundational level of knowledge and compliance, even if the issue is not given high priority in their daily operations.

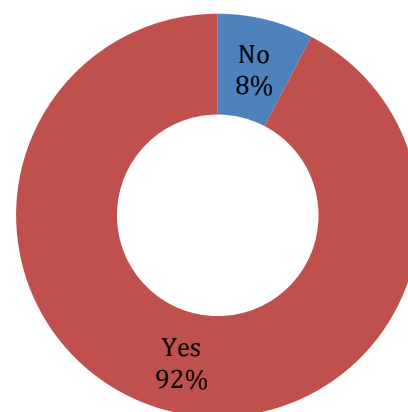
3.3. The implementation and enforcement of biomedical waste management regulations

With the increasing volume of biomedical waste generated by healthcare facilities, effective regulation is critical to safeguarding public health and the environment. By examining compliance levels, regulatory oversight, and institutional practices, the research seeks to contribute to the development of more effective waste management strategies within the hospital.

3.3.1 Implementation of a standardized color-coding system throughout the departments and segregation of solid biomedical waste.

All participants confirmed the implementation of a designated color-coding system for biomedical waste management within their respective departments or services. This standardized system ensures proper identification and handling of various categories of biomedical waste. According to the respondents, both general biomedical waste and solid biomedical waste are consistently segregated at the point of generation, following the established protocols. This practice demonstrates a clear understanding and adherence to

waste management guidelines among the staff. The consistent use of color-coded containers or bags aids in minimizing cross-contamination and supports efficient disposal processes. Such a systematic approach reflects the commitment of the departments to uphold safety, hygiene, and regulatory compliance in waste handling. The unanimous affirmation across all departments also suggests uniformity in training and awareness regarding biomedical waste segregation. Overall, this finding highlights a strong institutional effort toward maintaining proper waste management practices and promoting a safe healthcare environment.



Source: Primary data, March 2025

Figure 3.1. Availability and use of internal guidelines and SOP for biomedical waste management

The data presented in Figure 4.1. highlights a strong adherence to internal protocols concerning biomedical waste management. According to the findings, 92% of respondents confirmed the presence and active use of internal guidelines and Standard Operating Procedures (SOPs) within their departments or services. This high percentage suggests that the majority of healthcare units have recognized the importance of structured waste management processes and have implemented formal measures to ensure compliance with best practices.

The widespread availability and usage of SOPs are a positive indicator of an organization's commitment to health, safety, and environmental standards. It reflects not only regulatory awareness but also the prioritization of minimizing risks associated with biomedical waste. However, the data also implies that 8% of departments may lack such protocols, indicating a potential gap that needs to be addressed to ensure universal compliance and safe handling of biomedical waste across all units.

Table 3.4. Implementation of improvement projects related to biomedical waste management

Response	Frequency	Percentage
Yes	29	15
No	167	85
Total	196	100

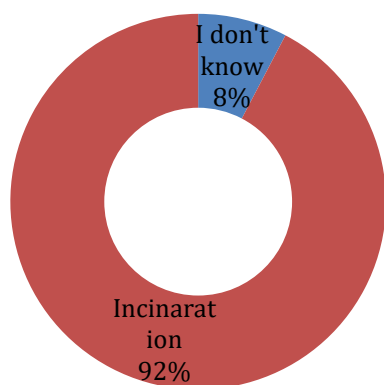
Source: Primary data, March 2025

The data from Table 4.4. reveals a significant gap in the implementation of biomedical waste management initiatives. An overwhelming 85% of respondents reported that no improvement projects have been carried out by their department concerning biomedical waste management. This highlights a critical area of concern, especially given the potential health and environmental risks associated with improper handling and disposal of biomedical waste.

The lack of implemented projects suggests limited prioritization or resource allocation towards effective biomedical waste management practices. It may also reflect gaps in awareness, training, or institutional policies that promote sustainable and safe waste handling. The remaining 15% who acknowledged the existence of projects indicate that a small number of departments may have begun to address the issue, though on a limited scale.

Continuous training, monitoring, and periodic review of these guidelines can help reinforce their effectiveness and close existing gaps.

3.4. Implementation and enforcement of biomedical waste management regulations



Source: Primary data, March 2025

Figure 3.2. Treatment methods used for biomedical waste

The research figure indicating that 92% of respondents affirm the use of an incinerator for biomedical waste treatment at CHUB (Centre Hospitalier Universitaire de Butare), demonstrates a high level of awareness among staff and relevant stakeholders regarding the hospital's waste management practices. This finding suggests that CHUB has established a clear and consistent biomedical waste disposal strategy, primarily through incineration.

However, the 8% of respondents who indicated that they do not know the method used raises important concerns about communication and training within the institution. Given the potential risks associated with improper handling of biomedical waste, all relevant personnel must be fully informed of the hospital's waste management procedures.

This knowledge gap could reflect either limited access to information, insufficient training, or a lack of

involvement in waste management protocols. Addressing this gap would enhance overall compliance, improve safety outcomes, and ensure that all staff can contribute to the hospital's public health and environmental protection goals.

3.5. The risks related to biomedical waste to humans and the environment

Table 4.5. Number of cases of needle stick injuries in service

Responses	Frequency	Percentages
Yes	45	23
No	135	69
No response	16	8
Total	196	100

Source: Primary data, March 2025

The data in Table 4.5. reveal that out of 196 respondents, only 23% (45 individuals) reported experiencing needle stick injuries during service, while a significant majority, 69% (135 individuals), indicated they had not encountered such incidents. Notably, 8% (16 respondents) did not provide any response to the question. This suggests that while needle stick injuries do occur, they are relatively uncommon among the sample population.

However, the presence of non-responses may hint at underreporting, lack of awareness, or discomfort in disclosing such incidents. These findings highlight the importance of reinforcing preventive measures, encouraging incident reporting, and possibly reviewing existing safety protocols to minimize risks in the workplace.

3.6. The knowledge among healthcare workers on biomedical waste management.

Healthcare workers play a crucial role in the management of biomedical waste, and their knowledge and practices significantly influence the overall effectiveness of waste handling procedures. Understanding their awareness and adherence to proper protocols helps identify gaps and inform strategies for training and policy improvements within healthcare settings. Availability of the training plan for staff and its implementation regarding biomedical waste, availability of the post-exposure prophylaxis procedure, known to every staff in the hospital, implementation of improvement projects related to biomedical waste management, and presence of figures related to biomedical waste produced in each clinical department are the questions posed to find out the knowledge among healthcare workers on biomedical waste management

3.6.1. Availability of training plan of staff and its implementation regarding biomedical waste

The findings reveal a significant insight into the state of training on biomedical waste management within the service or department. All respondents (100%) reported that they have received some form of training on

biomedical waste management, indicating a high level of institutional effort to equip staff including clinicians, nurses, allied health professionals, and support staff with essential knowledge and skills in this area. This universal training coverage suggests that the department recognizes the importance of proper biomedical waste handling and is committed to minimizing environmental and health risks. However, despite this widespread training, respondents expressed a clear need for further capacity building, specifically in the area of guideline development for biomedical wastewater management. This points to a gap between general training and the more specialized or practical knowledge required to create and implement effective guidelines. It suggests that while the staff may be aware of biomedical waste management principles, they may lack the technical expertise or confidence to develop or tailor guidelines suited to their specific institutional needs.

3.6.2. The availability of the post-exposure prophylaxis procedure and known to every staff member in the hospital

All respondents (100%) confirmed that the post-exposure prophylaxis (PEP) procedure is both available and known by every staff member within their service. This indicates a high level of awareness and accessibility of the PEP protocol across all departments. Regarding the availability of a formal training plan and documented records for PEP in each service or department, 85% of respondents reported that such resources are in place. However, 15% indicated that their departments do not have a structured training plan or documented records concerning PEP. These findings highlight a generally strong presence of PEP awareness and procedural knowledge among staff, although there remains a gap in comprehensive training and documentation in some areas. Addressing this gap could further enhance preparedness and ensure consistent, effective responses to occupational exposures across all services.

Table 3.6. Multivariate analysis of biomedical waste management in the University Teaching Hospital of Butare to humans (staff) and the environment.

	COR (95% CI)		AOR (95% CI)		P-value
Protocol and SOP documents development					
Yes	0.45	0.45 (0.23-0.97)	0.60	(0.30 - 0.93)	<0.001
No					
Activities or projects implemented so far for biomedical waste management					
Yes	0.21	0.21 (0.06-0.69)	0.24	(0.08 - 0.55)	0.041
No					
Staff protection against biomedical waste contamination					
Yes	0.37	0.37 (0.02 -0.89)	0.33	(0.06 - 0.76)	0.006
No					

Source: Primary data, March 2025

The results in Table 4.6. indicated that regarding the presence and development of protocol and SOP documents, the adjusted odds ratio (AOR) was found to be 0.60 (95% CI: 0.30 - 0.93).

This indicates a significant reduction of 40% in the odds of personnel engagement in biomedical waste management in the hospital compared to those without such facilities ($p < 0.001$).

Furthermore, no activities or projects implemented in the service on biomedical waste management emerged as another significant factor associated with biomedical waste management concerns in CHUB.

Staff in their department don't implement activities or projects related to waste management an AOR of 0.24 (95% CI: 0.08 - 0.55), indicating a substantial 76% reduction in the odds of waste disposal management compared to those without such access ($p = 0.041$).

The staff's protection showed a significant association with waste management. Staffs who reported has got both vaccination are much more secured than the ones who got one vaccine. An AOR of 0.33 (95% CI: 0.06 - 0.76), indicating a notable 67% reduction in the odds of being contaminated ($p = 0.006$).

4. DISCUSSION

The findings of this study underscore a highly commendable trend in biomedical waste management practices, particularly regarding the identification and assignment of responsible personnel. Respondents' unanimous confirmation (100%) that a dedicated individual is actively engaged in managing biomedical waste within their clinical services reflects a critical shift toward accountability and structured oversight. This trend aligns with World Health Organization (WHO) guidelines, which emphasize the importance of appointing trained personnel to oversee biomedical waste management to ensure compliance with safety standards and protocols ⁹.

Effective biomedical waste management is essential not only for maintaining hygiene and preventing disease transmission but also for mitigating environmental hazards. The involvement of a responsible officer serves as a cornerstone in the execution of waste management policies, including segregation, collection, transportation, treatment, and disposal ¹⁰. This proactive approach ensures that healthcare facilities do not become sources of secondary infection or ecological damage, which is often the case in facilities lacking trained personnel or standardized procedures.

The findings related to liquid waste disposal systems further highlight institutional adherence to environmental health practices.

A significant majority (86%) of the clinical services dispose of wastewater via a specialized pit system, indicating an infrastructure that is designed to contain and potentially treat biomedical effluents. This method is preferable as it minimizes the risk of contamination to the general sewage system and local water bodies. Such systems are recommended by health and environmental agencies, as they provide a controlled environment for the breakdown and neutralization of hazardous substances in clinical effluents ¹¹.

However, the finding that 14% of wastewater is disposed of via hand-wash sink evacuation systems raises concerns. This method poses potential risks, especially if the wastewater contains biological contaminants or hazardous chemicals, which can enter municipal sewage untreated. Studies have shown that improper disposal of liquid biomedical waste can lead to antibiotic resistance development, waterborne diseases, and adverse ecological impacts ¹². This highlights the need for targeted interventions to upgrade waste disposal infrastructure and ensure that all clinical departments comply with safe disposal protocols.

The observed trend, while predominantly positive, underscores a dual reality: While awareness and structural implementation are commendable, there remain pockets of suboptimal practice that require attention. Continuous training, infrastructure upgrades, and policy reinforcement are crucial to bridge these gaps. National health policies and international frameworks must support healthcare institutions in achieving 100% safe waste disposal practices, both for solid and liquid waste streams

Based on the findings of this study, several key themes emerge regarding the current state of biomedical waste management in healthcare settings. These include the positive implementation of foundational practices, such as color-coding and internal procedural guidelines, contrasted with notable gaps in continuous improvement and project implementation.

The universal implementation of a designated color-coding system for biomedical waste management among all respondents represents a fundamental and commendable achievement. Color coding is a critical component of biomedical waste management as it facilitates the segregation of waste at the source, reduces cross-contamination, and enhances the safety of healthcare workers and the environment ¹³.

Its presence across all departments suggests a shared understanding of its importance and a baseline compliance with national or institutional biomedical waste management policies. Furthermore, 92% of participants reported the active use of internal guidelines and Standard Operating Procedures (SOPs). This indicates a structured approach to waste management, which is essential for maintaining consistency, ensuring staff accountability, and reducing the risks associated with improper handling of biomedical waste ¹⁴. The presence of SOPs may also reflect institutional commitment to regulatory adherence, staff training, and operational safety.

However, despite these foundational systems being in place, a significant gap remains in the proactive improvement and evolution of biomedical waste management practices. Notably, 85% of respondents indicated that their departments had not undertaken any improvement projects related to biomedical waste management. This lack of innovation or advancement projects highlights a stagnant approach, potentially undermining long-term sustainability and compliance. Without periodic reviews and updates, even well-established systems can become obsolete or ineffective ¹⁵. This stagnation can also be indicative of broader systemic issues, such as insufficient funding, lack of leadership initiative, or limited staff engagement.

The concern over this lack of initiative is further underscored by the 92% of respondents who acknowledged this deficiency. This widespread awareness signifies that the problem is recognized among staff but may not be adequately addressed by institutional leadership. Awareness without action poses a risk, as it could lead to demotivation among staff and the erosion of compliance over time. It also raises questions about organizational priorities and the mechanisms in place for feedback and quality improvement.

To bridge this gap, institutions should prioritize the establishment of continuous quality improvement (CQI) programs that include regular audits, feedback loops, and capacity-building initiatives. Involving frontline staff in designing and implementing these improvement projects could also enhance ownership and compliance¹⁶. Moreover, leadership commitment is

critical in driving a culture of continuous improvement and ensuring resource allocation for biomedical waste management advancements.

The research findings, revealing that 92% of respondents at the University Teaching Hospital of Butare (CHUB) acknowledged the use of incineration for biomedical waste management, underscore the institution's apparent commitment to environmentally sound waste disposal. Incineration remains one of the most widely recommended methods for biomedical waste treatment due to its effectiveness in reducing infectious waste volume and neutralizing pathogens⁹. This high level of awareness among respondents is encouraging and suggests successful implementation of incineration protocols. However, the 8% of respondents who reported being unaware of the waste treatment method employed at the University Teaching Hospital of Butare (CHUB) raise concerns about internal communication and staff training on waste management practices.

Effective biomedical waste management requires not only functional systems but also well-informed personnel¹⁰. This gap in awareness could indicate a need for more inclusive training, particularly targeting auxiliary and newly recruited staff who may not be directly involved in waste disposal but are still impacted by its implications.

The knowledge and awareness of biomedical waste handling procedures are crucial for maintaining safety standards within healthcare facilities. According to the WHO¹⁷, lack of awareness among health workers significantly contributes to improper waste segregation, which can increase the risk of healthcare-associated infections (HAIs) and environmental contamination. Therefore, the University Teaching Hospital of Butare management should consider routine training and continuous professional development sessions focused on biomedical waste handling as part of their institutional safety protocols.

Regarding occupational safety, the finding that only 23% of respondents reported experiencing needle stick injuries during their service is a relatively positive outcome, especially in comparison to global statistics. According to a study, needle stick injuries affect millions of healthcare workers annually and account for significant occupational exposure to blood-borne pathogens such as HIV, hepatitis B, and hepatitis C.¹¹ The 69% who reported never experiencing such injuries suggest the presence of effective preventive measures at the University Teaching Hospital of Butare, such as the use of personal protective equipment (PPE), safe disposal practices, and possibly, training on handling sharps.

However, the 8% of respondents who did not answer the question related to needle stick injuries deserve closer attention. Non-responses in surveys can often signal discomfort, fear of repercussions, or a lack of clarity about what constitutes a needle stick injury.

Previous studies have shown that underreporting of such incidents is common due to fear of stigmatization or administrative consequences¹⁸. CHUB may benefit from

creating a safer reporting culture, where staff are encouraged to report incidents without fear, and are assured of follow-up care and support. The findings of this study reflect a commendable level of awareness and preparedness among healthcare workers in relation to biomedical waste management and post-exposure prophylaxis (PEP), both critical components of occupational health and safety in healthcare settings.

The fact that all respondents (100%) reported receiving training in biomedical waste management signifies a strong institutional commitment toward enforcing best practices in handling hazardous medical waste. Biomedical waste poses serious public health and environmental risks if not managed properly, making regular training imperative for all healthcare personnel, including clinicians, nurses, allied health professionals, and support staff¹⁰. Previous studies have shown that continuous education and training are essential in improving knowledge, attitudes, and practices related to waste segregation, disposal, and minimization¹⁴. These findings align with guidelines from the World Health Organization (WHO), which emphasize training as a cornerstone of effective waste management systems⁹.

Similarly, the universal awareness and availability of PEP procedures among all respondents highlight effective institutional policies regarding occupational exposure to blood borne pathogens, such as HIV and Hepatitis B and C. PEP is a crucial intervention following exposure to potentially infectious materials, and timely initiation can significantly reduce the risk of infection transmission¹⁹. Ensuring that every staff member knows the PEP protocol suggests a robust communication framework and the success of ongoing safety and risk management programs. Preparedness reduces anxiety among healthcare workers and promotes prompt and appropriate responses to occupational exposures²⁰.

However, a notable gap exists: 15% of respondents reported the absence of a structured training plan or documentation concerning PEP in their departments. This shortfall poses risks to the sustainability and consistency of PEP implementation. Without a formalized and traceable training structure, new or rotating staff may lack critical exposure-related knowledge or delay seeking PEP due to confusion or misinformation. Literature underscores the importance of institutionalizing training programs and maintaining comprehensive records as a means to monitor compliance and identify areas for improvement²¹.

This inconsistency may be reflective of variations in departmental leadership, resource allocation, or monitoring frameworks. To bridge this gap, healthcare facilities must ensure not only that PEP protocols are available and known but also that structured training programs are integrated into routine staff orientation and continuing professional development. Furthermore, documentation serves as an accountability mechanism and a source of data for audits and policy refinement.

Conflict of interest

I, BUREGEYA Jean Damascene, declare that there are no conflicts of interest related to the publication of this

research entitled “Environmental and Health Risks Associated with Biomedical Waste: A Case of University Teaching Hospital of Butare, Huye, Rwanda.” This study was carried out independently, and the results, conclusions, and interpretations presented are solely based on the objective analysis of the data collected. At no point during the research process was I influenced by any financial support, professional relationships, or personal interests that could have impacted the integrity or neutrality of the study. All aspects of the research were undertaken with full academic independence, ensuring that the findings remain unbiased and credible. I affirm that no external pressures or incentives could have compromised the scientific rigor or ethical standards upheld throughout the study. This declaration is made in full transparency and per publication ethics.

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