

# Analyzing The Challenges and Opportunities Related to Biomedical Waste Management in District-Level Hospitals

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**Abstract**

**Background:**

Effective biomedical waste management is crucial for safeguarding healthcare personnel, patients, and the environment from the dangers posed by toxic hospital waste. District-level hospitals in Bangladesh continue to have difficulties in establishing efficient waste management systems.

**Objective:**

This study aimed to examine the difficulties and opportunities associated with biomedical waste management practices among healthcare professionals in designated district-level hospitals in Bangladesh.

**Methods:**

A descriptive cross-sectional study was performed from March 2025 to November 2025 in designated district-level hospitals in Bangladesh. A total of 130 healthcare practitioners, encompassing physicians, nurses, custodians, and administrators, engaged in the study. Data were gathered through structured questionnaires and analysed using SPSS version 26. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were employed.

**Results:**

A moderate level of awareness of biomedical waste management among healthcare professionals was observed. Approximately 73.1% were cognizant of BWM regulations, and 60% had undergone training. Nonetheless, fewer than 50% continuously implemented waste segregation at the source. Incineration (26.9%) was the predominant treatment modality. Significant issues comprised insufficient staff awareness or training (26.9%), poor infrastructure (23.1%), and deficient monitoring (19.2%). Participants recommended consistent training, enhanced infrastructure, sufficient PPE provision, and increased oversight to improve biomedical waste management methods in hospitals.

**Conclusion:**

Results from this study suggested enchaining training, infrastructure, and proper supervision is essential to improve biomedical waste management in district levels hospitals to mitigate the health and environmental hazards in Bangladesh.

**Keywords:** Biomedical Waste Management, Healthcare Waste, Hospital Waste, District Hospitals, Healthcare Workers

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**Introduction:**

Biomedical waste management (BWM) is a critical aspect of hospital operations, as healthcare activities invariably produce waste that may be infectious, poisonous, or otherwise detrimental to human health and the environment. Proper handling of these wastes safeguards patients, healthcare personnel, waste handlers, and the

adjacent community from various health hazards, including blood-borne illnesses, chemical exposure, and injury from sharps.<sup>1</sup> Moreover, effective BWM mitigates environmental pollution of air, water, and soil that may arise from hazardous disposal methods such as open burning or unregulated landfilling. Thus, effective BWM underpins the essential goal of health-care



**Figure-1: Biomedical waste management in a hospital**

institutions by mitigating secondary harms linked to health-care delivery.<sup>2</sup>

Bangladesh has experienced a significant rise in biomedical waste due to the proliferation of healthcare facilities. The government established the Medical Waste (Management and Processing) Rules, 2008 to address this issue. The Government of Bangladesh (2008) states that these regulations delineate the legal procedures for the segregation, transportation, treatment, and disposal of medical waste.<sup>3</sup> Despite the existence of these regulations, numerous healthcare facilities, particularly district-level hospitals, continue to encounter issues such as inadequate infrastructure, insufficient staff training, inadequate monitoring, and weak enforcement of rules.<sup>4</sup>

Recent research shows that not properly handling biomedical waste can spread infectious diseases, pollute the environment, and put healthcare workers at risk.<sup>5</sup> The Biomedical Waste Management Rules in India, first put into effect in 1998 and updated in 2016, require healthcare facilities to follow strict rules for separating and treating waste. Studies show that healthcare workers don't always know about or follow the rules.<sup>6</sup> Pakistan, Nepal, and Bhutan are all developing nations that have problems such as not receiving enough money, not having enough treatment facilities, and not educating their staff well enough.<sup>7</sup> Southeast Asian countries including Malaysia, Vietnam, and Thailand have put in place regulations and mechanisms for managing healthcare waste, although problems with inappropriate separation and insufficient monitoring still exist.<sup>8</sup>

In Iran, healthcare waste management has advanced due to national regulations and heightened awareness, issues persist in rural and district hospitals.<sup>9</sup> Biomedical waste management is still a big problem for the environment and public health in many parts of the world, especially in developing countries. To make biomedical waste management systems better, especially in district-level hospitals that serve a lot of people, it is important to improve policy enforcement, infrastructure, and staff training. This study aims to explore the challenges and opportunities related to biomedical waste management in district-level hospitals. To guide this investigation, the following research questions have been formulated.

**Method:**

This descriptive cross-sectional study was conducted in selected district-level hospitals in Bangladesh, focusing on those providing secondary-level healthcare services. These hospitals serve a large population and generate considerable biomedical waste, making them ideal for assessing biomedical waste management systems. The study was conducted over a period of nine months, from March 2025 to November 2025 after the approval of the Institutional Ethics Committee. The study population consisted of 130 healthcare professionals directly or indirectly involved in biomedical waste management, including doctors, nurses, ward attendants, cleaners, and hospital administrative staff. The inclusion criteria were healthcare professionals working in the selected district hospitals, staff with

at least six months of work experience in the current hospital, and respondents who provided informed consent to participate. The exclusion criteria included staff on long-term leave during the study period, recruits with less than six months of experience, and individuals unwilling to participate. Collected data were coded, entered, and analysed using Statistical Package for the Social Sciences (SPSS) software version 26. Descriptive statistics such as frequency, percentage, mean, and standard deviation were used to present the findings. Qualitative data from open-ended responses were analysed thematically.

### Results:

Table-I demonstrated that most respondents were aged 25–34 years (32.3%) and worked in government hospitals (53.8%). Nurses formed the largest group (31.5%), and many had 1–5 years of service (31.5%). Several demographic variables showed significant associations ( $p < 0.05$ ).

Figure-2 illustrated that 38.5% of respondents were very familiar with colour-coded waste segregation techniques, 34.6% were moderately knowledgeable, and 26.9% were unfamiliar, reflecting a reasonable level of general awareness among healthcare professionals.

46.15% of respondents utilized colour-coded bins or bags for biomedical waste segregation, whereas 34.62% employed standard bins or plastic bags, and 19.23% indicated the use of alternative containers (Figure-3).

Figure-4 demonstrated that a majority of respondents (73.1%) were cognizant of biomedical waste management regulations or standards. Furthermore, 60.0% indicated they had undergone training in biomedical waste management, although a significant number remained uninformed or untrained.

Table-II indicated that incineration was the most commonly reported method for infectious waste treatment (26.9%), followed by autoclaving (21.5%) and chemical disinfection (18.5%). Some respondents reported open burning (16.9%), while 16.2% did not know the treatment method.

Table-III illustrated that the biggest problem with biomedical waste management was that staff didn't know enough about it or weren't trained (26.9%). The next biggest problem was that there weren't enough infrastructures (23.1%) and that there wasn't enough monitoring (19.2%). People

didn't talk about money problems and other problems as much.

**Table-I: Demographic information of respondents (N=130)**

Variable	no (%)	p-value
<b>Age (years)</b>		
Below 25	18 (13.8)	0.041
25–34	42 (32.3)	
35–44	36 (27.7)	
45–54	22 (16.9)	
55 and above	12 (9.3)	
<b>Type of hospital</b>		
Government	70 (53.8)	0.032
Private	40 (30.8)	
NGO/Charitable	20 (15.4)	
<b>Gender</b>		
Male	70 (53.8)	0.065
Female	55 (42.3)	
Others	5 (3.9)	
<b>Designation</b>		
Doctor	32 (24.6)	0.027
Nurse	41 (31.5)	
Cleaner/Support Staff	29 (22.3)	
Hospital Administrator/ Manager	18 (13.8)	
Other	10 (7.8)	
<b>Years of service</b>		
6 months -Less than 1 year	22 (16.9)	0.049
1–5 years	41 (31.5)	
6–10 years	28 (21.5)	
More than 10 years	39 (30.0)	
<b>Marital status</b>		
Single	45 (34.6)	0.058
Married	75 (57.7)	
Divorced/Widowed	10 (7.7)	
<b>Education level</b>		
No formal education	10 (7.7)	0.036
Primary	18 (13.8)	
Secondary	22 (16.9)	
Higher Secondary	24 (18.5)	
Graduate	27 (20.8)	
Postgraduate and above	29 (22.3)	
<b>Monthly income (BDT)</b>		
Less than 10,000	18 (13.8)	0.12
10,000–20,000	36 (27.7)	
21,000–30,000	30 (23.1)	
31,000–50,000	26 (20.0)	
Above 50,000	20 (15.4)	

\*Chi-square test was performed

**Table-II: Distribution of study participants based on the methods used for infectious waste treatment before final disposal**

Response option	no (%)
Incineration	35(26.90)
Autoclaving	28(21.50)
Chemical disinfection	24(18.50)
Open burning	22(16.90)
Don't know	21(16.20)
Total	130(100)

**Table-III: Distribution of respondents based on major challenges faced in biomedical waste management**

Challenges	no (%)
Lack of awareness/training among staff	35(26.90)
Insufficient infrastructure (bins, bags, equipment)	30(23.10)
Lack of monitoring and supervision	25(19.20)
Financial constraints	20(15.40)
Irregular collection/disposal services	10(7.70)
Occupational health hazards	8(6.20)
Others	2(1.50)
Total	130(100)

Table-IV showed that the most recommended ways to improve biomedical waste management were regular staff training (19.2%) and installing modern disposal equipment (16.9%). After that, providing enough PPE and properly separating waste at the source were also recommended.

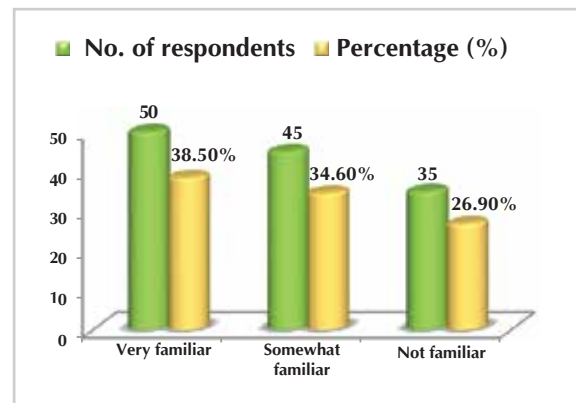
**Table-IV: Distribution of the study population according to measures suggested for improving biomedical waste management (n=130)**

Measures to improve biomedical waste management	no (%)
Regular staff training	25(19.20)
Adequate supply of PPE	20(15.40)
Proper waste segregation at source	18(13.80)
Installation of modern disposal equipment (autoclave/incinerator)	22(16.90)
Stronger monitoring and supervision	15(11.50)
More government support/funding	17(13.10)
Community awareness programs	13(10.00)
Total	130(100.0)

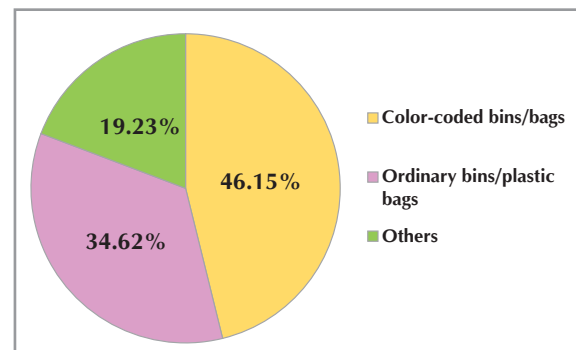
53.8% of respondents perceived biomedical waste to be intermixed with general garbage, 30.8% disagreed, and 15.4% were uncertain, highlighting apprehensions about inadequate waste segregation measures in healthcare settings (Figure-5).

The majority of respondents (53.85%) acknowledged engaging in waste segregation. However, 26.9% indicated inconsistent practices. Furthermore, 30.77% identified deficiencies in waste management techniques, whereas 15.38% conveyed doubt, indicating varied perspectives among respondents.

Table-V clarified that 50% of people who answered the question always separated their trash. People used PPE differently, but many said they used it all the time. Awareness of monitoring and readiness for refresher training were moderate, with several variables demonstrating significant associations ( $p < 0.05$ ).



**Figure-1: Familiarity with color-coded waste segregation practices (N=130)**

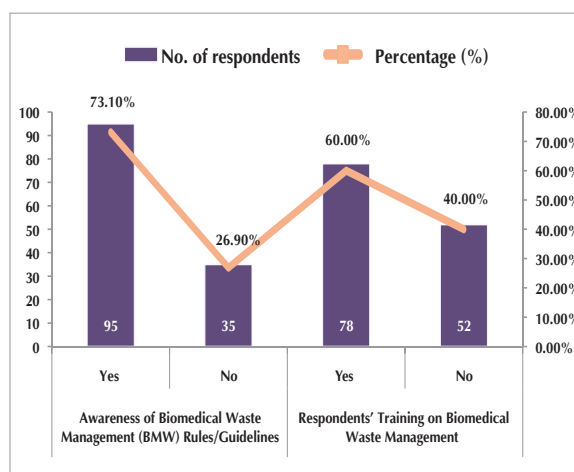


**Figure-2: Types of containers/bags used for biomedical waste segregation (N=130)**

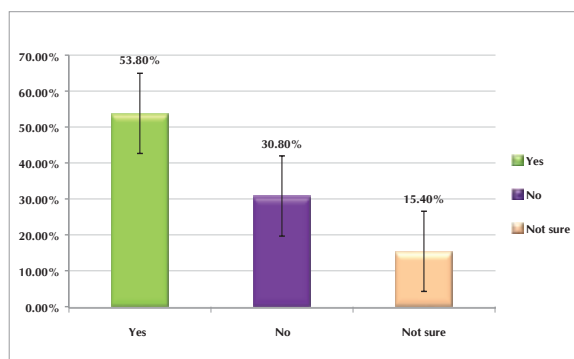
**Table-V: Distribution of respondents according to practices and awareness of biomedical waste management**

Questions	no. (%)	p-value
<b>Respondents' opinions regarding biomedical waste management policy</b>		
Biomedical waste management Policy		
Yes	55(42.30)	0.11
No	43(33.10)	
Don't know	32(24.60)	
Practicing segregation of waste at the point of generation		
Always	65(50.00)	0.03
Sometimes	45(34.60)	
Never	20(15.40)	
Personal protective equipment		
Always	55(42.30)	0.41
Sometimes	45(34.60)	
(PPE) is used while handling biomedical waste		
Rarely	20(15.40)	0,001
Never	10(7.70)	
<b>Responses on biomedical waste management awareness</b>		
Does your hospital conduct regular monitoring or auditing of biomedical waste management practices?		
Yes	55(42.3)	0.03
No	40(30.8)	
Sometimes	35(26.9)	
Would you be willing to participate in refresher training sessions on biomedical waste management?		
Yes	70(53.8)	0.02
No	40(30.8)	-
Maybe	20(15.4)	-
How satisfied are you with the current biomedical waste management system in your hospital?		
Very satisfied	20(15.38)	0.01
Satisfied	40(30.77)	
Neutral	30(23.08)	
Dissatisfied	25(19.23)	
Very dissatisfied	15(11.54)	

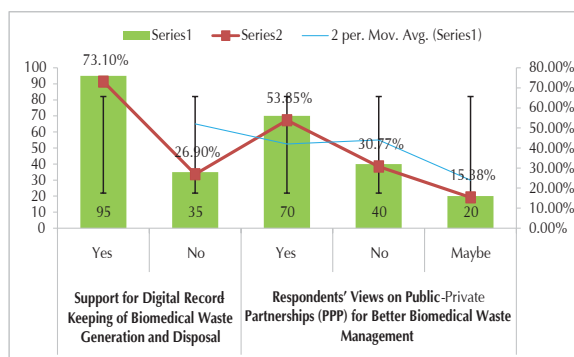
\*Chi-square test was performed



**Figure-3: Awareness and training on biomedical waste (BMW) management among respondents**



**Figure-4: Respondents' views on mixing biomedical waste with general waste (N=130)**



**Figure-5: Responses on waste management practices and perceptions (N=130)**

**Discussion:**

The current study examined the challenges and opportunities associated with biomedical waste management (BWM) in district-level hospitals in Bangladesh. The results show that healthcare workers' awareness and training were only

moderate, which was not enough to make sure that waste was managed properly. In this study, 73.1% of participants were cognizant of biomedical waste management regulations, and 60.0% had undergone training. Deress, Teshiwal et al (2019) reported similar results, finding that about 62% of healthcare workers in Ethiopian hospitals knew about waste segregation guidelines.<sup>10</sup> This shows that healthcare workers have a moderate level of knowledge. The study also found gaps between what people knew and what they did to keep themselves safe, which is similar to this study.

In the current study, 50% of respondents indicated that they consistently practiced waste segregation at the point of generation, whereas 34.6% reported doing so only occasionally. A study conducted by Morteza Dehghani et al (2008) in Iran indicated that 58% of healthcare personnel possessed sufficient knowledge; however, only 45% consistently adhered to proper waste segregation practices, underscoring a divergence between knowledge and practice akin to the results of this research.<sup>11</sup> Tudor et al (2005) found that about 70% of hospitals in developing countries used incineration to get rid of infectious waste.<sup>12</sup> This supports what this study found. The study also found that the main problems with BWM were a lack of staff awareness or training (26.9%), a lack of infrastructure (23.1%), and a lack of monitoring (19.2%).

I think that district-level hospitals need regular training programs, better supervision, better infrastructure, and strict enforcement of national rules to improve how they handle biomedical waste. Dealing with these problems would make safe waste handling much better and lower the risks to health and the environment.

### **Limitation:**

This study was limited by its focus on certain district hospitals, lack of resources, and reliance on self-reported data. Limited access to facilities, policy differences, changing practices, and not including community perspectives may impact generalisability and comprehensiveness.

### **Conclusion:**

The study shows that managing biomedical waste in district-level hospitals is hard because of a lack of training, infrastructure, and monitoring.

Healthcare workers are somewhat aware of the issue but putting it into practice is still hit-or-miss. The study also found gaps between what people knew and what they did to keep themselves safe, which is similar. However, to improve safe biomedical waste management practices, it is important to improve training, infrastructure, the enforcement of rules and augment monitoring.

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