

# Assessment of hospital waste management practices in government and private tertiary hospitals in Dhaka, Bangladesh

Md Anayet Karim Mazumder<sup>1</sup>, Mohammad Tazrian Abid<sup>2</sup>, Ammatul Fardousi<sup>3</sup>, Md Mahmudul Haque<sup>4</sup>, Zulfiquer Ahmed Amin<sup>5</sup>, Md Sayedur Rahman<sup>6</sup>, AKM Shafiqur Rahman<sup>7</sup>, Abu Sayeed<sup>8</sup>

## AFFILIATION

- 1 Armed Forces Medical Institute, Dhaka Cantonment, Dhaka, Bangladesh
- 2 Food Sciences, Department of Life Technologies, University of Turku, Turku, Finland
- 3 Health Systems and Population Studies Division, International Centre for Diarrhoeal Disease Research, Dhaka, Bangladesh
- 4 Department of Community Medicine, Khwaja Yunus Ali Medical College, Sirajgonj, Bangladesh
- 5 President's Office, Bangabhaban, Dhaka, Bangladesh
- 6 Level II+ Hospital, United Nations Multidimensional Integrated Stabilization Mission in Central Africa, Bangui, Central African Republic
- 7 DNCC Dedicated COVID-19 Hospital, Dhaka, Bangladesh
- 8 Department of Post-Harvest Technology and Marketing, Patuakhali Science and Technology University, Patuakhali, Bangladesh

## CORRESPONDENCE TO

Mohammad Tazrian Abid. Food Sciences, Department of Life Technologies, University of Turku, 20014, Turku, Finland. E-mail: [tazrian.abid@gmail.com](mailto:tazrian.abid@gmail.com) ORCID iD: <https://orcid.org/0000-0003-1515-4689>

## KEYWORDS

hospital waste management, healthcare workers, Bangladesh

**Received:** 18 August 2023, **Revised:** 24 December 2023, **Accepted:** 28 December 2023

Public Health Toxicol 2023;3(4):21

<https://doi.org/10.18332/pht/177820>

## ABSTRACT

**INTRODUCTION** Hospitals in Bangladesh grapple with inadequate waste disposal systems and a lack of effective waste management policies, posing substantial health and safety risks to patients and healthcare workers. This study aimed to assess the current state of hospital waste management practices, covering waste generation, segregation, collection, transportation, storage, treatment, and disposal in both tertiary private and government hospitals in Dhaka.

**METHODS** A cross-sectional survey was conducted, in both a government institution, Shaheed Suhrawardy Medical College & Hospital (ShSMCH), and a private tertiary hospital, Bangladesh Medical College and Hospital (BMCH), located in Dhaka, Bangladesh. A total of 217 participants were chosen via convenience sampling. The study utilized a semi-structured questionnaire comprising sections on sociodemographic information, general institutional characteristics, waste management practices, and the implementation of UN-WHO HCWM (United Nations-World Health Organizations Health Care Waste Management) Rapid Assessment Tools.

**RESULTS** Our findings revealed that the majority of

participants (96.4% in ShSMCH and 100% in BMCH) reported practicing waste segregation based on the waste category, with 97.4% mentioning the shredding of plastic syringes after use in both hospitals. Additionally, 82% of respondents in ShSMCH and 51.3% in BMCH indicated the maintenance of hospital waste records at their workplace. Most respondents (87.1%) across both hospitals were vaccinated against tetanus and hepatitis B. Training on Hospital Waste Management (HWM) was reported by 69.8% in ShSMCH and 29.5% in BMCH. The study further assessed the level of practice in waste management, revealing that 58.3% of respondents in ShSMCH and 89.7% in BMCH demonstrated a good level of practice. Significant associations were observed between the level of practice and age group ( $p=0.002$ ) and professional status ( $p<0.001$ ).

**CONCLUSIONS** The study recommends forming trained waste management teams and infection control committees, along with clear guidelines to improve waste management practices. Effective management requires adequate supplies and equipment in all departments. Budgeting for HCWM should be part of both short- and long-term operational plans to ensure compliance and sufficient resources.

## INTRODUCTION

Medical waste refers to all waste generated from healthcare or diagnostic activities, specifically originating from diagnostic, monitoring, therapeutic, preventive, or palliative procedures conducted in human and veterinary medicine settings. It also encompasses any solid or liquid waste produced during treatment or immunization of humans or animals, scientific research related to these procedures, or the production and testing of biological substances<sup>1-3</sup>.

As per WHO guidelines, medical waste is categorized into general medical waste, akin to household waste, and hazardous medical waste, which poses potential health risks<sup>4-6</sup>. Hazardous medical waste includes infectious materials, pathological materials, sharps, pharmaceuticals, chemical substances, waste with heavy metal content, pressurized containers, and radioactive materials<sup>4-6</sup>. Hazardous medical waste includes infectious materials, pathological materials, sharps, pharmaceuticals, chemical substances, waste with heavy metal content, pressurized containers, and radioactive materials<sup>7,8</sup>.

Globally, an estimated 7–10 billion tons of waste are generated annually, with only around 2 billion metric tons constituting municipal solid waste, leaving the majority as medical waste<sup>9</sup>. A WHO assessment in 22 developing countries revealed that 18–64% of healthcare facilities did not adhere to proper waste disposal methods, and nearly 80% of medical waste was combined with other waste types in developing nations<sup>9,10</sup>. Worldwide, approximately 2.2 million individuals succumb to workplace-related diseases and injuries each year, while 170 million suffer serious non-fatal injuries<sup>11</sup>. In Bangladesh, it is estimated that annually, 5.2 million people, including 4 million children, perish due to diseases associated with improper waste management<sup>12,13</sup>.

In Bangladesh, a study conducted in 2012 concluded that many healthcare establishments lacked a standard hospital waste management (HWM) policy or plan, had no formal waste handling procedures, and did not provide pre-treatment of hazardous waste before disposing it in nearby recycling bins<sup>14</sup>. Another study conducted in Bangladesh found that improper oversight by the hospital administrative authority concerned was one of the major factors along with lack of awareness, inadequate supply of equipment such as waste bins, protective gear, unhygienic materials, e.g. non-disposable gloves or contaminated packaging, are responsible for the poor waste disposal systems<sup>15</sup>. Proper and efficient medical waste management is imperative during healthcare services provision, as improper disposal can lead to the transmission of diseases such as hepatitis B, hepatitis C, HIV/AIDS, and other viral infections<sup>16</sup>.

In Dhaka, with its rapid population growth, improper medical waste management poses severe health and environmental threats. Incorrect handling of infectious waste can endanger healthcare workers, patients, waste handlers, and visitors, underscoring the necessity for correct storage, handling, and disposal methods to prevent the spread of

diseases like AIDS and hepatitis<sup>17</sup>. Despite numerous studies in Dhaka, limited research exists in tertiary hospitals. Hence, conducting an extensive investigation to gather baseline data is crucial for the formulation of healthcare waste management rules, regulations, guidelines, and policies in Dhaka.

This study aimed to assess the current state of hospital waste management practices, covering waste generation, segregation, collection, transportation, storage, treatment, and disposal in both tertiary private and government hospitals in Dhaka.

## METHODS

### Study design and settings

A cross-sectional survey was conducted to assess hospital waste management practices in a tertiary private and government hospital in Bangladesh from 1 July to 31 December 2019. Shaheed Suhrawardy Medical College Hospital, Dhaka, with 375 beds, ranks third among government-run hospitals, and at the Bangladesh Medical College and Hospital (BMCH), Dhanmondi, Dhaka, regulated by the Directorate General of Health Services (DGHS), has 300 beds. Eligible participants included doctors, nurses, medical technologists, and sanitation staff (ward boys, Aya, cleaners/sweepers) with a work tenure exceeding six months.

### Study population and sampling

Participants were selected from Shaheed Suhrawardy Medical College Hospital and from the Bangladesh Medical College and Hospital (BMCH), using convenience sampling methods. This approach was chosen for its practicality in enrolling willing participants based on their accessibility. The sample size of 217 individuals was determined based on the existing pool of healthcare workers at the chosen hospitals, with a 10% allowance for potential non-response or incomplete responses.

### Data collection procedure

Data collection was conducted through face-to-face interviews using a semi-structured questionnaire and Rapid Assessment Tool. The questionnaire, adapted from the UN-WHO HCWM Rapid Assessment Tool, consisted of 20 questions that assessed hospital waste management practices. This assessment covered the profile of: 1) healthcare facilities, including services offered, available beds, bed occupancy rates, and outpatient admissions; and 2) medical staff in terms of HCWM training, awareness, vaccination status, and staffing levels. Additionally, the assessment examined HCWM practices as reported by respondents, focusing on waste generation, segregation and handling, storage containers, storage areas, collection and on-site transport, off-site transport, treatment methods, final disposal, regulations, policies and budgets, and management of sanitation and wastewater. Practices were scored, with '1'

denoting a correct answer and '0' for incorrect responses, to categorize overall practice into: Satisfactory ( $\leq 7$ ), Good (8–14), and Excellent ( $\geq 15$ ). The questionnaire was pre-tested on 15 respondents in Bengali, modified accordingly, and used for data collection after finalization. Prior to data collection, participants were briefed about the study's objectives. Hospital waste materials were identified and segregated in different colored containers, as per 'Medical Waste (Management & Handling) Rules-2008'<sup>18</sup>: black, non-hazardous/general waste; yellow, hazardous waste; red, sharp waste; blue, liquid waste; green, reusable/recycled general waste; and silver, radio-active waste. During data collection privacy was maintained, and respondents were assured about the confidentiality of the information provided by them.

### Ethical considerations

Ethical approval of the study was obtained from the ethical committee of AFMI (Armed Forces Medical Institute). Permission for data collection was obtained from the administrative head of Shaheed Suhrawardy Medical College Hospital, Dhaka, and from the Bangladesh Medical College and Hospital (BMCH), Dhanmondi, Dhaka. Written informed consent was taken from each respondent. Information of the participants was kept confidential and was not used for any other purpose except research.

### Data analysis

Data analysis was done using Statistical Package for Social Science (SPSS) V.23 and Excel V.13. Descriptive statistics were calculated using mean and standard deviation (SD) for continuous variables, while frequencies and percentages were calculated for categorical variables. Chi-squared ( $\chi^2$ ) tests were carried out for inferential analysis.

## RESULTS

### Sociodemographic and professional information of respondents

Overall, among the two institutions, BMCH demonstrated a higher level of practice in HWM compared to ShSMCH (89.7% vs 58.3%). Among the 139 distributed surveys in ShSMCH, respondents had a mean age of 32.8 years (SD=9.1). Females comprised 72.7% of respondents in ShSMCH and 48.7% in BMCH. In ShSMCH, nursing was the most common profession at 39.6%, while in BMCH, doctors comprised 34.6% of the study population.

More than half of the respondents had less than five years of service experience, and most of them cited mutilated or shredded syringes following usage as evidence of HW segregation. Almost half of the respondents from ShSMCH (49.6%) reported that hospital waste is stored in color-coded containers. In contrast, 70.5% of respondents from BMCH indicated that hospital waste is stored in plastic dustbins with lids. More than half of respondents (51.3%) at BMCH reported that waste records are not maintained at their workplaces.

**Table 1. Sociodemographic, professional profile, and hospital waste management characteristics of participants in ShSMCH and BMCH, Dhaka, Bangladesh, 2019 (N=217)**

Characteristics	ShSMCH n (%)	BMCH n (%)
<b>Hospital</b>	139 (64.1)	78 (35.9)
<b>Age (years)</b>		
Mean $\pm$ SD	32.84 $\pm$ 9.14	32.27 $\pm$ 7.5
<b>Sex</b>		
Male	38 (27.3)	40 (51.3)
Female	101 (72.7)	38 (48.7)
<b>Religion</b>		
Muslim	99 (71.2)	71 (91.0)
Hindu	34 (24.5)	5 (6.4)
Christian	6 (4.3)	2 (2.6)
<b>Profession</b>		
Doctor	31 (22.3)	27 (34.6)
Nurse	55 (39.6)	15 (19.2)
Medical technician	7 (5.0)	12 (15.4)
Other (ward boy, cleaner, Aya)	46 (33.1)	24 (30.8)
<b>Duration of service (years)</b>		
<5	66 (47.5)	36 (46.2)
5–10	15 (10.8)	26 (33.3)
>10	58 (41.7)	16 (20.5)
<b>HW segregation practice</b>		
Yes	134 (96.4)	78 (100)
Don't know	5 (3.6)	0 (0)
<b>Storage of hospital waste</b>		
Plastic dustbin without lid	3 (2.2)	0 (0)
Plastic dustbin with lid	58 (41.7)	55 (70.5)
Color coded container	69 (49.6)	23 (29.5)
Other	9 (6.5)	0 (0)
<b>HW disposal according to color code</b>		
Yes	139 (100)	78 (100)
<b>Used plastic syringes are mutilate or shred</b>		
Yes	139 (100)	76 (97.4)
No	0 (0)	2 (2.6)
<b>HW collected from the department (daily)</b>		
Once	0 (0)	2 (2.6)
Twice	16 (11.5)	63 (80.8)
Three times	123 (88.5)	13 (16.7)

Continued

Table 1. Continued

Characteristics	ShSMCH n (%)	BMCH n (%)
<b>Transportation of waste</b>		
Wheeled cart/trolley	86 (61.9)	69 (88.5)
Covered bin	33 (23.7)	9 (11.45)
Colored coded bag	20 (14.4)	0 (0)
<b>All kinds of waste are mixed into general garbage</b>		
Yes	10 (7.2)	4 (5.1)
No	129 (92.8)	74 (94.9)
<b>Specific area to store HW</b>		
Yes	136 (97.8)	78 (100)
No	3 (2.2)	0 (0)
<b>Maintenance of HW records</b>		
Yes	114 (82.0)	30 (38.5)
No	19 (13.7)	40 (51.3)
Don't know	6 (4.3)	8 (10.3)
<b>Record available for injuries related to HWM</b>		
Yes	35 (25.2)	14 (17.9)
No	83 (59.7)	51 (65.4)
Don't know	21 (15.1)	13 (16.7)
<b>Disposal of blood contaminated cotton, gauze and other items</b>		
Yellow plastic bag	107 (77.0)	77 (98.7)
Red plastic bag	21 (15.1)	1 (1.3)
Black plastic bag	3 (2.2)	0 (0)
Blue plastic bag	8 (5.8)	0 (0)
<b>Disposal of papers, kitchen waste</b>		
Red plastic bag	23 (16.5)	1 (1.3)
Black plastic bag	74 (53.2)	77 (98.7)
Yellow plastic bag	3 (2.2)	0 (0)
Blue plastic bag	39 (28.1)	0 (0)
<b>Disposal of sharp waste practice</b>		
Red bin	87 (62.6)	77 (98.7)
Black bin	8 (5.8)	0 (0)
Yellow bin	24 (17.3)	1 (1.3)
Blue bin	20 (14.4)	0 (0)
<b>Disposal of hazardous liquid waste</b>		
Drain	20 (14.4)	7 (9.0)
General garbage	0 (0.0)	1 (1.3)
Chemical treatment and discharge into drain	63 (45.3)	64 (82.1)
Don't know	56 (40.3)	6 (7.7)

Continued

Table 1. Continued

Characteristics	ShSMCH n (%)	BMCH n (%)
<b>Use of PPE while handling HW</b>		
Yes	89 (64.0)	76 (97.4)
No	26 (18.7)	1 (1.3)
Irregularly	24 (17.3)	1 (1.3)
<b>Practice of hand wash after handling HW</b>		
Yes	131 (94.2)	78 (100)
No	8 (5.8)	0 (0)
<b>History of needle stick injury</b>		
Yes	51 (36.7)	34 (43.6)
No	84 (60.4)	38 (48.7)
Don't know	4 (2.9)	6 (7.7)
<b>Adequate treatment for needle stick injury</b>		
Received	33 (64.71)	19 (55.88)
Not received	18 (35.29)	15 (44.12)
<b>Vaccinated against tetanus</b>		
Yes	121 (87.1)	78 (100)
No	18 (12.9)	0 (0)
<b>Vaccinated against Hepatitis</b>		
Yes	109 (78.4)	75 (96.2)
No	30 (21.6)	3 (3.8)
<b>Training regarding HWM</b>		
Received	97 (69.8)	23 (29.5)
Not received	42 (30.2)	55 (70.5)

Regarding injuries related to HWM, 25.2% of respondents at ShSMCH indicated that relevant hospital records were unavailable, while this was noted by 17% at BMCH.

**Distribution of hospital workers by level of practice on HWM and characteristics**

Table 2 shows that ShSMCH had an average of 41.7% of health workers demonstrating good hazardous waste management (HWM) practices, while BMCH reported a significantly higher proportion of 89.7% with good HWM practices. Regarding age groups, it was found that none of the groups exhibited a poor level of practice. The majority of health workers aged 29–38 years (79.2%) and those aged ≥39 years (75.8%) had a good level of practice. In terms of professional status, all medical technicians (100%) demonstrated good levels of practice. Nearly all respondents who were doctors or medical technicians had good levels of practice compared to other professional categories.

**Table 2. Distribution of hospital workers by level of practice in hospital waste management (HWM) and characteristics in ShSMCH and BMCH, Dhaka, Bangladesh, 2019 (N=217)**

	Average n (%)	Good n (%)	$\chi^2$ ; df; p
<b>ShSMCH</b>	58 (41.7)	81 (58.3)	
<b>BMCH</b>	8 (10.3)	70 (89.7)	
<b>Age (years)</b>			13.00; 2; 0.002
19–28	34 (45.9)	40 (54.1)	
29–38	16 (20.8)	61 (79.2)	
≥39	16 (24.2)	50 (75.8)	
<b>Sex</b>			1.730; 1; 0.188
Male	28 (35.9)	50 (64.1)	
Female	38 (27.3)	101 (72.7)	
<b>Profession</b>			44.124; 3; <0.001
Doctor	4 (9.8)	37 (90.2)	
Nurse	27 (26.5)	75 (73.5)	
Medical technician	0 (0)	18 (100)	
Other (cleaner, ward boy, Aya)	35 (62.5)	21 (37.5)	
<b>Duration of service (years)</b>			4.959; 2; 0.084
<5	38 (37.3)	64 (62.7)	
5–10	8 (19.5)	33 (80.5)	
>10	20 (27.0)	54 (73.0)	

**Table 3. Assessment of hospital waste management using UN-WHO HCWM rapid assessment tools in ShSMCH and BMCH, Dhaka, Bangladesh, 2019, (N=217)**

Characteristics	Hospital statistics	
	Large and public	Large and private
<b>HCF type</b>		
Bed capacity	850	600
Occupancy	176%	70%
Outpatients per day	250	350
<b>Waste generation (kg/day)</b>		
Domestic waste (general)	1500	600
Sharps	13	7
Infectious (non-sharp) waste	110	53
Recyclable waste	6	5
Waste generation per patient	1.09	1.48
<b>Daily injections performed</b>	5000	3550

### Assessment of HWM using UN-WHO HCWM Rapid Assessment Tool

The results obtained using the Rapid Assessment Tool of WHO are shown in Table 3 for ShSMCH and BMCH. The waste generated by both hospitals were reported for general waste (1500 vs 600 kg/day), recyclable waste (6 vs 5 kg/day), infectious (non-sharp waste) (110 vs 53 kg/day), and

sharp waste (13 vs 7 kg/day). Overall, the study revealed that the amount of waste per patient generated in ShSMCH was 1.09 kg/day and 1.48 kg/day in BMCH. The UN-WHO HCWM Rapid Assessment Tool indicates that the overall state of waste management is good in ShSMCH (weighted result of 63%) and average in BMCH (weighted result of 58%), the details of which are noted in Table 4.

**Table 4. Final result comparison of hospital waste management practices between ShSMCH and BMCH, Dhaka, Bangladesh, 2019 (N=217)**

HWM	ShSMCH		BMCH	
	Weighted result %	Qualitative result	Weighted result %	Qualitative result
Staff and training	86	Excellent	78	Good
HCW segregation and handling	80	Good	60	Satisfactory
HCW waste handling equipment	88	Excellent	90	Excellent
HCW storage area	84	Excellent	65	Good
HCW collection and on-site transport	85	Excellent	92	Excellent
HCWM regulations (code of conduct, management plan, policy)	73	Good	57	Satisfactory
Personal opinion	73	Good	80	Good
<b>Overall</b>	<b>63</b>	<b>Good</b>	<b>58</b>	<b>Satisfactory</b>

## DISCUSSION

This study showed the need for correct waste management, along with clear guidelines to improve waste management practices and the importance of how effective management and budgeting would require adequate supplies and equipment in all departments.

The gender balance of our study was similar to studies of Musa et al.<sup>19</sup>, Nagaraju et al.<sup>20</sup>, and Woromogo et al.<sup>21</sup>, and equal percentage of both males and female were found in the study conducted by Chudasama et al.<sup>22</sup>. This could be attributed to the current study's exclusive focus on two hospitals compared to broader studies conducted across multiple Indian hospitals.

This study is similar to the Chudasama et al.<sup>22</sup> study conducted in India, where 247 people (87%) used proper storage facilities for collecting workplace hospital waste. The WHO Regional Office for South-East Asia, found that during the generation of syringes, disposable needle cutters should be used to damage them after use so that they cannot be reused<sup>23</sup>. A study conducted by Wazir et al.<sup>24</sup>, demonstrated that sweepers in CMH Rawalpindi collect waste twice daily in the morning and in the evening. Dehghani et al.<sup>25</sup> conducted another study in Iran with waste collected three times daily, at the end of each shift. Proper management of waste in hospital wards is crucial for ensuring a safe and hygienic healthcare setting. In order to adhere to infection control protocols, maintain safety standards, address environmental issues, and comply with regulations, it is highly recommended that waste from hospital wards be collected on a daily basis or as often as deemed necessary<sup>26,27</sup>. A higher percentage of respondents in BMCH had been vaccinated against tetanus and hepatitis B than in ShSMCh, and two-thirds of respondents had undergone training regarding hospital waste management. With regard to

adherence to good practices, almost the same outcome was found in a study conducted in Ethiopia by Deress et al.<sup>28</sup> who found that (77.4%) healthcare workers practiced at a good level or adequate level.

Healthcare facilities should implement safe healthcare waste management practices through the prevention of hazardous medical waste generation as one of their overall objectives. Accumulation of medical waste in hospitals, however, indicates that healthcare waste management (HCWM) does exist, but that it is not properly implemented or developed. These differences in practice level on HWM were statistically significant by age and profession, which is similar to a study conducted in Bhutan<sup>29</sup>, potentially because when a health worker ages, he or she will generally gain more experience and improve their knowledge<sup>30</sup>.

Among the main factors that are associated with better quality of medical waste management, the particularly important ones are: the number of beds, the number of hospital days, the number of outpatient services, and the number of trained professionals for HCWM. Providing high-quality services to the community is the main responsibility of healthcare establishments; this cannot be accomplished without a proper waste-handling policy that meets international regulations.

Waste handling equipment, hazardous medical waste collection, and onsite and offsite transport were among BMCH's strongest pursuits, while the rate of waste generation in our study is comparable to that observed in developing countries with a total hazardous waste generation rate per patient of around 0.85 kg/day, lower than other studies in Iran with a rate of 4.45 kg/day<sup>31,32</sup>. This rate is contradicted by some other studies conducted in Taiwan where the estimated daily waste generation rate at NTUH was 4.6 kg/day and in Serbia where the average annual waste

generation per institution at the secondary healthcare level amounted to 29,606.71 kg and at the tertiary healthcare level amounted to 73,419.49 kg<sup>33</sup>.

The decrease in waste generation might be directly related to a more effective waste management system. The amount of medical waste generated by hospitals located in large communities and providing tertiary care is greater than that produced by hospitals in smaller, less populated areas, and so the number of healthcare services users and medical waste produced are directly proportional to the number of inpatient days. Furthermore, previous research has indicated a significant association between the type of hospital and pharmaceutical waste generation<sup>33</sup>. Similarly, according to a study in Botswana's tertiary hospitals, waste management is often poor and staff are rarely involved in making waste handling policies<sup>34</sup>.

Personnel involved in handling healthcare waste should familiarize themselves with the main categories of healthcare waste, as defined in national or local regulations on waste classification, and with safe disposal procedures<sup>35</sup>. Thus, it is important to provide special training within the healthcare waste management sector, including medical waste management topics, to improve HCWM's capacity for safe management.

This study underscores the need for implementing comprehensive waste management policies and educational initiatives to ensure effective waste segregation, storage, and disposal within healthcare settings. Conducting specialized training sessions for healthcare professionals can significantly enhance their understanding and implementation of proper waste management practices. Addressing discrepancies in waste generation rates among different hospitals calls for tailored resource allocation based on each facility's size and type. Collaborative efforts between healthcare institutions, city corporations, and waste management agencies are essential for successful waste management strategies. The research emphasizes successful collaborative areas, offering a model for other hospitals to emulate.

### Strengths and limitations

The study's strength lies in its comprehensive evaluation of waste management practices in both a government and a private tertiary hospital in Bangladesh. With a sample size of 217 participants and employing a cross-sectional design, this research yielded data on waste management practices. Diverse perspectives within the healthcare sector, represented by various professionals such as doctors, nurses, and support staff, enriched the study. The utilization of UN-WHO HCWM Rapid Assessment Tool alongside a semi-structured questionnaire ensured systematic data collection.

However, this study has several limitations. The cross-sectional design restricts establishing causal relationships or assessing temporal changes between variables. Additionally, convenience sampling may introduce selection

bias, potentially affecting the generalizability of findings to broader populations. Reliance on self-reported data might introduce response bias and recall errors among participants. Focusing solely on two hospitals within a specific region might limit the generalizability of these findings to diverse healthcare settings globally. Moreover, calculating sample size based on a single population proportion formula overlooks the heterogeneity among healthcare workers across different contexts.

### CONCLUSIONS

Both hospitals demonstrated satisfactory practices in segregating, collecting, and transporting waste on-site. However, concerns arise regarding the security of temporary storage areas and containers, which lack proper safeguards against unauthorized access. Effective waste management necessitates adequate supplies and equipment across all hospital departments. Additionally, to promote and reinforce Hospital Waste Management (HWM) regulations and procedures, it is essential for government hospitals to prominently display safety reminders, posters, and related policy statements. Budgeting and planning HWM facilities should be integral components of short- and long-term operational plans for both hospitals and local government units. These efforts will facilitate the establishment and maintenance of compliant HWM initiatives, ensuring the availability of necessary personnel, supplies, materials, and equipment.

### REFERENCES

1. Alam MZ, Islam MS, Islam MR. Medical waste management: a case study on Rajshahi city corporation in Bangladesh. *Journal of Environmental Science and Natural Resources*. 2013;6(1):173-178. doi:[10.3329/jesnr.v6i1.22062](https://doi.org/10.3329/jesnr.v6i1.22062)
2. Akter N. Medical waste management: a review. Published online 2000. [https://www.academia.edu/10387429/Medical\\_Waste\\_Management\\_A\\_Review](https://www.academia.edu/10387429/Medical_Waste_Management_A_Review)
3. Akter N, Tränkler J. An analysis of possible scenarios of medical waste management in Bangladesh. *Management of Environmental Quality: An International Journal*. 2003;14(2):242-255. doi:[10.1108/14777830310470459](https://doi.org/10.1108/14777830310470459)
4. Thakur V, Ramesh A. Healthcare waste management research: A structured analysis and review (2005–2014). *Waste Management & Research*. 2015;33(10):855-870. doi:[10.1177/0734242X15594248](https://doi.org/10.1177/0734242X15594248)
5. Narendra M, Kousar H, Puttaiah ET. Enumeration of health care waste management at public and private hospital sector of Mysore, Karnataka, India. *International Journal of Applied Sciences and Engineering Research*. 2013;2:416-419. doi:[10.6088/ijaser.020400003](https://doi.org/10.6088/ijaser.020400003)
6. Alves SB, e Souza ACS, Tipple AF V, et al. The reality of waste management in primary health care units in Brazil. *Waste Management & Research*. 2014;32(9\_suppl):40-47. doi:[10.1177/0734242X14543815](https://doi.org/10.1177/0734242X14543815)
7. Patil G V, Pokhrel K. Biomedical solid waste management

- in an Indian hospital: a case study. Waste management. 2005;25(6):592-599. doi:[10.1016/j.wasman.2004.07.011](https://doi.org/10.1016/j.wasman.2004.07.011)
8. Ghasemi MK, Yusuff RBM. Advantages and Disadvantages of Healthcare Waste Treatment and Disposal Alternatives: Malaysian Scenario. Pol J Environ Stud. 2016;25(1). doi:[10.15244/pjoes/59322](https://doi.org/10.15244/pjoes/59322)
  9. Singh VP, Biswas G, Sharma JJ. Biomedical waste management- an emerging concern in Indian hospitals. Indian J Forensic Med Toxicol. 2007;1(2):6. <https://www.sciepub.com/reference/89780>
  10. WHO 2011. Safe health-care waste management. Published online 2011. <https://www.who.int/news-room/fact-sheets/detail/health-care-waste>
  11. International Labour Organization. Training package on development of a national occupational safety and health program: Module 2: Introduction to the national occupational safety and health system. Published 2013. Accessed August 7, 2023. [https://www.ilo.org/global/topics/safety-and-health-at-work/resources-library/training/WCMS\\_215449/lang-en/index.htm](https://www.ilo.org/global/topics/safety-and-health-at-work/resources-library/training/WCMS_215449/lang-en/index.htm)
  12. Akter N, Chowdhury AMR, Kazi NM. Hospital waste disposal in Bangladesh with special reference to Dhaka City and its environmental evaluation. International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR, B). Published online 1999. doi:[10.1.1.530.8191&rep=rep1&type=pdf](https://doi.org/10.1.1.530.8191&rep=rep1&type=pdf)
  13. Akter N, Hussain Z, Trankler J, Parkpian P. Hospital waste management and it's probable health effect: a lesson learned from Bangladesh. Indian J Environ Health. 2002;44(2):124-137. PMID: 14503385. <https://pubmed.ncbi.nlm.nih.gov/14503385/>
  14. Sarker MAB, Harun-Or-Rashid M, Hiroswawa T, et al. Evaluation of knowledge, practices, and possible barriers among healthcare providers regarding medical waste management in Dhaka, Bangladesh. Med Sci Monit. 2014;20:2590. doi:[10.12659/2FMSM.890904](https://doi.org/10.12659/2FMSM.890904)
  15. Ara L, Billah W, Bashar F, et al. Effectiveness of a multi-modal capacity-building initiative for upgrading biomedical waste management practices at healthcare facilities in Bangladesh: a 21st century challenge for developing countries. Journal of Hospital Infection. 2022;121:49-56. doi:[10.1016/j.jhin.2021.11.009](https://doi.org/10.1016/j.jhin.2021.11.009)
  16. Manyele SV, Tanzania V. Effects of improper hospital-waste management on occupational health and safety. African newsletter on occupational health and safety. 2004;14(2):30-33. <https://www.scirp.org/reference/referencespapers?referenceid=1598901>
  17. Padmanabhan KK, Barik D. Health hazards of medical waste and its disposal. In: Energy from Toxic Organic Waste for Heat and Power Generation. Elsevier; 2019:99-118. doi:[10.1016/B978-0-08-102528-4.00008-0](https://doi.org/10.1016/B978-0-08-102528-4.00008-0)
  18. Uddin Akram. Medical Waste Management and Processing Rules 2008 | PDF | Combustion | Crimes. Published 2008. Accessed August 7, 2023. <https://www.scribd.com/document/589848194/Medical-Waste-Management-and-Processing-Rules-2008>
  19. Musa F, Mohamed A, Selim N. Assessment of nurses' practice and potential barriers regarding the medical waste management at Hamad medical corporation in Qatar: a crosssectional study. Cureus. 2020;12(5). doi:[10.7759/cureus.8281](https://doi.org/10.7759/cureus.8281)
  20. Nagaraju B, Padmavathi G, Puranik D, Shantharaj M, Sampulatha S. A study to assess the knowledge and practice on bio-medical waste management among the health care providers working in PHCs of Bagepalli Taluk with the view to prepare informational booklet. International Journal of Medicine and Biomedical Research. 2013;2(1):28-35. doi:[10.14194/ijmbr.216](https://doi.org/10.14194/ijmbr.216)
  21. Woromogo SH, Djeukang GG, Yagata Moussa FE, Saba Antaon J Saint, Kort KN, Tebeu PM. Assessing Knowledge, Attitudes, and Practices of Healthcare Workers regarding Biomedical Waste Management at Biyem-Assi District Hospital, Yaounde: A Cross-Sectional Analytical Study. Adv Public Health. 2020;2020. doi:[10.1155/2020/2874064](https://doi.org/10.1155/2020/2874064)
  22. Chudasama RK, Rangoonwala M, Sheth A, Misra SKC, Kadri AM, Patel U V. Biomedical Waste Management: A study of knowledge, attitude and practice among health care personnel at tertiary care hospital in Rajkot. J Res Med Dent Sci. 2013;1(1):17-22. <https://www.jrmds.in/articles/biomedical-waste-management-a-study-of-knowledge-attitude-and-practice-among-health-care-personnel-at-tertiary-care-hosp.pdf>
  23. Organization WH. Safe Management of Bio-Medical Sharps Waste in India. WHO Regional Office for South-East Asia; 2005. <https://www.who.int/publications-detail-redirect/9789241548564>
  24. Wazir M, Khan IA, Hussain S, Qureshi AH, Qureshi SM, Chaudhry MA. Hospital waste management in a tertiary care Army hospital. Pakistan Armed Forces Medical Journal. 2005;55(4):349-354. <https://www.pafmj.org/PAFMJ/article/view/1232>
  25. Dehghani MH, Azam K, Changani F, Fard ED. Assessment of medical waste management in educational hospitals of Tehran university medical sciences. J Environ Health Sci Eng. 2008;5(2):131-136. <https://ijehse.tums.ac.ir/index.php/ijehse/article/view/160>
  26. Loveday HP, Wilson JA, Pratt RJ, et al. epic3: national evidence-based guidelines for preventing healthcare-associated infections in NHS hospitals in England. Journal of Hospital Infection. 2014;86:S1-S70. <http://www.bioline.org.br/pdf?se08024>
  27. Organization WH. Practical Guidelines for Infection Control in Health Care Facilities. WHO Regional Office for the Western Pacific; 2004. <https://www.who.int/publications-detail-redirect/practical-guidelines-for-infection-control-in-health-care-facilities>
  28. Deress T, Hassen F, Adane K, Tsegaye A. Assessment of knowledge, attitude, and practice about biomedical waste management and associated factors among the healthcare professionals at Debre Markos town healthcare facilities, Northwest Ethiopia. J Environ Public Health. 2018;2018.



- doi:[10.1155/2018/7672981](https://doi.org/10.1155/2018/7672981)
29. Laabar TD, Siri Wong W, Robson M. Hospital waste management: a study on knowledge, attitude and practice among health staff and waste handlers in Jigme Dorji Wangchuk National Referral Hospital, Thimphu, Bhutan. *J Health Res.* 2012;26(5):271-275. <https://he01.tci-thaijo.org/index.php/jhealthres/article/view/85480>
30. Suchitra JB, Devi NL. Impact of education on knowledge, attitudes and practices among various categories of health care workers on nosocomial infections. *Indian J Med Microbiol.* 2007;25(3):181-187. doi:[10.4103/0255-0857.34757](https://doi.org/10.4103/0255-0857.34757)
31. Eleyan D, Al-Khatib IA, Garfield J. System dynamics model for hospital waste characterization and generation in developing countries. *Waste Management & Research.* 2013;31(10):986-995. doi:[10.1177/0734242X13490981](https://doi.org/10.1177/0734242X13490981)
32. Askarian M, Vakili M, Kabir G. Results of a hospital waste survey in private hospitals in Fars province, Iran. *Waste management.* 2004;24(4):347-352. doi:[10.1016/j.wasman.2003.09.008](https://doi.org/10.1016/j.wasman.2003.09.008)
33. Jovanovic V, Jovanovic D, Matic B, Djonovic N. The influence of healthcare factors on medical waste management in Serbian hospital facilities. *PONS - medicinski casopis.* 2016;13(2):57-63. doi:[10.5937/pomc13-11846](https://doi.org/10.5937/pomc13-11846)
34. Mugabi B, Hattingh S, Chima S. Assessing knowledge, attitudes, and practices of healthcare workers regarding medical waste management at a tertiary hospital in Botswana: A cross-sectional quantitative study. *Niger J Clin Pract.* 2018;21(12):1627-1638. doi:[10.4103/njcp.njcp\\_270\\_17](https://doi.org/10.4103/njcp.njcp_270_17)
35. Jovanović V, Manojlović J, Jovanović D, Matic B, Đonović N. Management of pharmaceutical waste in hospitals in Serbia – Challenges and the potential for improvement. *Indian Journal of Pharmaceutical Education and Research.* 2016;50(4):695-702. doi:[10.5530/ijper.50.4.22](https://doi.org/10.5530/ijper.50.4.22)

#### ACKNOWLEDGMENTS

The authors are grateful to the hospitals' authorities for assisting with the survey process. Also, we would like to thank our study participants who responded to our all questions and gave their valuable time.

#### CONFLICT OF INTEREST

The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

#### FUNDING

There was no source of funding for this research.

#### ETHICAL APPROVAL AND INFORMED CONSENT

Ethical approval was obtained from the Ethics Committee of the Armed Forces Medical Institute (Approval number: 3606/T; Date: 05 October 2019). Permission for data collection was also obtained from the administrative head of Shaheed Suhrawardy Medical College Hospital, Dhaka, and from the Bangladesh Medical College and Hospital (BMCH), Dhanmondi, Dhaka. Participants provided informed consent.

#### DATA AVAILABILITY

The data supporting this research are available from the authors on reasonable request.

#### AUTHOR'S CONTRIBUTIONS

MAKM: conceptualization, research design, methodology, writing of original draft. MTA: research design, writing of original draft, reviewing and editing of the manuscript. AF and MMH: visualization, validation, and writing, reviewing and editing of the manuscript. ZAA: formal analysis, writing of original draft, reviewing and editing of the manuscript. MSR: visualization, validation, writing of original draft. MTA, AKMSR and AS: writing of original draft, editing and critically revising the manuscript for intellectual content. All authors read and approved the final version of the manuscript.

#### PROVENANCE AND PEER REVIEW

Not commissioned; externally peer reviewed.