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Assessment of Knowledge and Practice in Medical Waste Management among Healthcare Workers in Northern Part of Bangladesh: A Cross-Sectional Study

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Abstract

Background & Objective

Improper medical waste management poses significant risks to health and the environment, especially in resource-limited settings like Bangladesh. Healthcare workers are central to safe waste handling, but their level of knowledge and practice regarding medical waste management is not well established. This study aimed to assess the knowledge and practice of medical waste management among healthcare workers in Bangladesh and to identify factors associated with better performance.

Methods

A cross-sectional study was conducted from April to August 2024 among 350 healthcare workers from five tertiary and secondary healthcare facilities in Rangpur and Dinajpur. Participants were selected using stratified random sampling and included physicians, nurses, and support staff. Data were collected through a structured, pre-tested questionnaire covering socio-demographics, knowledge of waste categories and hazards, and self-reported practices such as waste segregation, use of personal protective equipment, and adherence to color-coded disposal. Knowledge and practice scores were calculated, and associations with training and professional category were analyzed using chi-square and logistic regression tests ($p < 0.05$ deemed significant).

Results

Of the 350 respondents, 52% were nurses, 28% physicians, and 20% support staff. The mean knowledge score was 14.8 ± 3.2 (out of 20), with 63% demonstrating "good" knowledge. Physicians (78%) and nurses (67%) scored higher than support staff (39%) ($p < 0.001$). Regarding practices, 72% reported proper segregation of infectious and non-infectious waste, but only 49% consistently used PPE during waste handling. Color-coded disposal compliance was reported by 55% of participants. Workers who had received formal training in medical waste management were significantly more likely to have good knowledge (OR = 2.9; 95% CI: 1.8–4.6; $p < 0.001$) and better waste-handling practices (OR = 2.4; 95% CI: 1.5–3.8; $p = 0.002$) than those without training.

Conclusion

The study reveals moderate levels of knowledge and mixed compliance with recommended medical waste management practices among healthcare workers in Bangladesh. Training significantly improves both understanding and practice, highlighting the need for regular, structured educational interventions and monitoring systems. Strengthening policy enforcement and continuous capacity building can reduce occupational hazards and environmental contamination.

Keywords: Medical Waste Management, Healthcare Workers, Knowledge, Practice, Cross-Sectional Study, Bangladesh

Introduction

Medical waste generated in healthcare settings includes infectious, sharp, and hazardous materials that pose serious risks to healthcare workers, waste handlers, patients, and communities if not managed properly. Although a majority of healthcare waste is non-hazardous, a significant portion requires safe handling, segregation, and disposal to prevent infection transmission and environmental contamination. In low- and middle-income countries, including Bangladesh, inadequate infrastructure, limited training, and poor adherence to guidelines contribute to suboptimal medical waste management. Healthcare workers play a central role in waste segregation and safe disposal, yet studies indicate gaps in their knowledge and practices, often

exacerbated by insufficient training and weak institutional policies. The COVID-19 pandemic further increased medical waste volumes, stressing already fragile systems and underscoring the need for effective waste management.

In Bangladesh, rapid expansion of healthcare services and insufficient implementation of waste management policies have resulted in inconsistent practices, especially at primary and secondary care levels. There is a lack of comprehensive data on healthcare workers' knowledge and practices related to medical waste management, limiting evidence-based policy development.

This study therefore aimed to assess the level of knowledge and practice of medical waste management among healthcare workers in Northern part of Bangladesh and identify factors associated with better compliance to inform targeted interventions and strengthen infection prevention strategies.

Materials & Methods

A cross-sectional study was conducted from April to August 2024 among healthcare workers in selected public and private healthcare facilities in Rangpur and Dinajpur, Bangladesh. A total of 350 healthcare workers-including physicians, nurses, and support staff involved in clinical care and waste handling -were enrolled. A systematic random sampling method was used to select participants from staff lists provided by each facility.

Data was collected using a self-administered structured questionnaire, adapted from validated medical waste management instruments and guidelines. The questionnaire included sections on socio-demographic characteristics, work experience and training, knowledge of medical waste management (20 items), and self-reported practice patterns (15 items). Knowledge items assessed awareness of waste categories, segregation procedures, and associated health risks; practice items evaluated adherence to segregation protocols, use of personal protective equipment (PPE), and waste disposal behaviors.

Participants completed the questionnaire during work hours with support from trained research assistants. Ethical clearance was obtained from the Institutional Review Board of [Name of Institution], and informed consent was obtained from all participants prior to data collection. Confidentiality and anonymity were maintained throughout the study.

Completed questionnaires were entered into a computer and analyzed using SPSS version 20.1. Descriptive statistics (means, standard deviations, frequencies, and percentages) were calculated for all variables. Knowledge and practice scores were categorized as "good" or "poor" using a 75% cut-off point of the maximum possible score. Associations between participant characteristics (e.g., professional category, training status) and knowledge or practice outcomes were assessed using chi-square tests. Logistic regression analysis was conducted to identify predictors of good knowledge and practice, with $p < 0.05$ considered statistically significant.

Results

Table 1 summarizes the demographic characteristics of the participants and their attitudes and practices related to medical waste management. The mean age of respondents was 37.78 ± 10.15 years, indicating a diverse age range. The gender distribution was nearly equal, with 50.09% female and 49.91% male participants. Most participants were married (89.41%), while 9.34% were single and 1.26% widowed. In terms of religion, the majority identified as Muslim (93.0%), and 7.0% were Hindu.

Regarding professional roles, the largest group was categorized as "Others" (70.56%), followed by nurses (20.83%), doctors (5.39%), and a small proportion of SACMOs, midwives, and paramedics. Participants reported a mean work experience of 13.82 ± 11.64 years, reflecting a wide range of service durations. Most respondents were employed at primary-level healthcare facilities (83.66%), while 16.34% worked in secondary-level institutions.

Education levels varied: 51.71% completed graduation or post-graduation, 25.85% had HSC, 20.47% held a diploma, and 1.97% had SSC qualifications. Only 24.60% of respondents had received Infection Prevention and Control (IPC) training, leaving 75.40% without formal IPC training. A majority (65.71%) reported being vaccinated against Hepatitis B, of whom 66.40% had completed the full three-dose schedule.

When asked about the availability of personal protective equipment (PPE) in their workplace, 65.53% reported a lack of PPE, 12.93% said PPE was sufficiently available, and 21.54% were **uncertain**. Regarding IPC guidelines at their facility, 52.06% indicated that no guidelines were available, 17.24% confirmed availability, and 30.70% were unsure. Sources of IPC information included books or guidelines (30.88%), training (29.26%), and colleagues or friends (22.44%), while 6.46% reported having no source of IPC information.

In relation to medical waste disposal methods, 52.42% of respondents were unaware of the system used at their facility. Among those who knew, 26.57% reported infectious waste incineration, and 17.24% indicated disposal through community garbage systems.

Characteristic	Statistics
Age (years)	38.78 ±10.10
Sex	
Male	279 (50.00)
Female	278 (50.00)
Religion	
Islam	518 (93.0)
Hindu	39 (7.0)
Designation	
Doctor	30 (5.39)
SACMO	6 (1.08)
Nurse	116 (20.83)
Midwife	10 (1.80)
Paramedics	2 (0.36)
Others	393 (70.56)
Years of Experience	13.82 ±11.64
Level of the Hospital	
Primary	466 (83.66)
Secondary	91 (16.34)
Educational Level	
SSC	11 (1.97)
HSC	144 (25.85)
Diploma	114 (20.47)
Graduation/post-graduation	288 (51.71)
Received IPC Training	
Yes	137 (24.60)
No	420 (75.40)
Status of Receiving Hepatitis B Vaccine	
Yes	366 (65.71)
No	191 (34.29)
Number of HBV Doses Received	

Single Dose	32 (8.67)
Two Doses	92 (24.93)
Three Doses	245 (66.40)
Perception on the Availability of PPE in Current Workplace	
Yes	72 (12.93)
No	365 (65.53)
Not Sure	120 (21.54)
Avaliability of IPC Guideline in Current Workplace	
Yes	96 (17.24)
No	290 (52.06)
Not sure	171 (30.70)
Source of Information about IPC	
Training	163 (29.26)
Books/Guidelines	172 (30.88)
Friends/Colleagues	125 (22.44)
Others	61 (10.95)
No Source of Information	36 (6.46)
Perception on the Mode of Waste Disposal at Current Workplace	
Hire Private Company	14 (2.51)
Takes to Another Hospital for Disposal	7 (1.26)
Infectious Incineration	148 (26.57)
Community Garbage	96 (17.24)
Others	292 (52.42)

Table 2 presents the levels of knowledge and practice regarding medical waste management among the study participants. Only 0.40% of respondents demonstrated a low level of knowledge, indicating that the overwhelming majority possessed at least a moderate understanding of medical waste management. A total of 57.45% of participants exhibited a moderate level of knowledge, suggesting familiarity with key concepts but potential gaps in comprehensive awareness. Notably, 43.0% of respondents demonstrated a high level of knowledge, reflecting a substantial proportion of well-informed individuals within the study population.

Figure 2 illustrates the distribution of practice levels related to medical waste management. A small proportion (5%) of participants reported a low level of practice, while 55.0% were categorized at a moderate level, indicating partial adherence to recommended procedures. Encouragingly, a considerable segment (40.0%) demonstrated high-level practices, suggesting consistent and appropriate implementation of medical waste management protocols in their healthcare settings.

Category	Percentage (%)
Knowledge	
Low level	0.40%
Medium level	57.0%
High level	43.0%
Practice	
Low level	5%
Medium level	55.%
High level	40.0%

Table 3 shows how knowledge and practice levels related to medical waste management varied across different demographic and occupational groups. Among female participants, the largest proportions were observed in the medium knowledge (62.37%) and medium practice (59.50%) categories. A significant relationship was found between gender and practice level ($P < 0.001$). In contrast, male participants had a higher percentage in the high practice category (54.32%).

When examined by marital status, single participants were mostly classified under medium knowledge (75.0%) and medium practice (76.92%) levels. There was a statistically significant association between marital status and practice level ($P = 0.003$), notably between single and married respondents.

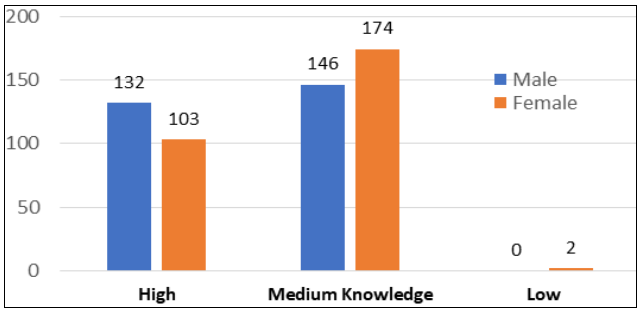
Regarding religious affiliation, both Muslim and Hindu participants showed similar distributions in knowledge, with the majority in each group falling into the medium knowledge category. However, the association between religion and knowledge level was not statistically significant ($P = 0.913$).

Table 3. Characteristics of participants and their association with knowledge and practice levels on medical waste management (n = 557)

Characteristics	Knowledge, N (%)				Practice, N (%)			
	Low	Medium	High	P-value	Low	Medium	High	P-value
Sex								
Female	2 (.72)	174 (62)	103 (36)	0.018*	13 (5)	166 (60)	100(35)	0.000**
Male	0 (0.0)	146 (52)	132 (48)		6 (2)	121 (44)	151(56	
Religion								
Islam	2 (.4)	297 (57)	219 (43)		17 (3)	274 (53)	227(44)	0.061
Hindu	0 (0)	23 (59)	219(41)		2 (5)	13 (33)	24 (65)	
Designation								
Doctor	0 (0)	18 (60)	12 (40)		0 (0)	21 (70)	9 (30)	
SACMO	0 (0)	3 (50)	3 (50)		0 (0)	6 (100)	0 (0)	
Nurse	0 (0)	81 (70)	35 (30)	0.158	0 (0)	95 (82)	21 (18)	0.000
Midwife	0 (0)	3 (30)	7 (70)		0 (0)	8 (80)	2 (20)	
Paramedics	0 (0)	2 (100)	0 (0)		0 (0)	0 (0)	2 (100)	
Others	2 (1)	213 (54)	178 (45)		19 (5)	157 (40)	217(55)	
Level of the Hospital								
Primary	2 (1)	258(55)	206(44)	0.071	19 (4)	213 (46)	234(51)	0.000
Secondary	0 (0)	62 (68)	29 (32)		0 (0)	74 (81)	17 (19)	
Educational Level								
SSC	0 (0)	9 (82)	2 (18)		0 (0)	7 (64)	4 (36)	
HSC	2 (2)	78 (54)	64 (44)	0.008**	4 (3)	61 (42)	79 (55)	0.000
Diploma	0 (0)	79 (69)	35 (31)		0 (0)	100(88)	14 (12)	
Graduation/post-graduation	0 (0)	154(53)	134 (46)		15 (5)	119 (41)	154 (53)	
Received IPC Training								
Yes	0 (0)	93 (68)	44 (32)	0.015	0 (0)	69 (50)	68 (50)	0.29
No	2 (1)	227 (54)	191 (46)		19 (5)	218 (51)	183(43)	

Status of Receiving Hepatitis B Vaccine								
Yes	2 (1)	202 (55)	162 (44)	0.215	10 (3)	182 (50)	174(47)	0.168
No	0 (0)	118 (62)	73 (38)		9 (5)	105 (55)	77 (41)	
Member of HBV doses Received								0.000**
Single Dose	0 (0)	12 (38)	20 (62)	0.207	2 (6)	9 (28)	21 (66)	
Two Doses	0 (0)	52 (57)	40 (48)		2 (2)	31 (33)	59 (65)	
Three Doses	2 (0)	141 (57)	102(43)		6 (3)	143 (58)	96 (39)	
Caption on the availability of Ein Current Workplace								0.000
Yes	0 (0)	42 (59)	30 (41)	0.103	0 (0)	50 (70)	22 (30)	
No	0 (0)	213(58)	152(42)		9 (3)	169 (46)	187(51)	
Not Sure	2 (2)	65 (54)	53 (44)		10 (8)	68 (57)	42 (35)	
availability of C Guideline in Current Workplace								0.010
Yes	0 (0)	45 (47)	51 (53)	0.025	0 (0)	49 (51)	47 (49)	
No	0 (0)	179 (61)	111(39)		13(5)	164 (57)	113(38)	
Not sure	2 (1)	96 (56)	73 (43)		6 (4)	74 (43)	91 (53)	
Source information of IPC								0.000
Training	2 (1)	122 (75)	39 (24)	0.000	0 (0)	71 (43)	92 (57)	
Books/Guideline	0 (0)	88 (51)	84 (49)		0 (0)	108 (62)	64 (38)	
Friends	0 (0)	46 (36)	79 (64)		0 (0)	62 (50)	63 (50)	
Other	0 (0)	30 (95)	2 (5)		14(40)	20 (55)	2 (5)	
Reception on the mode of Waste Disposal at Current Workplace								
Hire private company	0 (0)	6 (42)	8 (58)	0.000	0 (0)	14 (100)	0 (0)	0.000
Takes to another hospital for disposal	2 (28)	5 (71)	0 (0)		0 (0)	5 (71)	2 (29)	
Infectious incineration	0 (0)	78 (52)	70 (48)		2 (2)	98 (66)	48 (32)	
Community garbage	0 (0)	55 (57)	41 (42)		4 (4)	53 (55)	39 (41)	
Don't know	0 (0)	176 (60)	116 (40)		13 (4)	117 (40)	162(56)	

Doctors demonstrated a relatively balanced distribution of knowledge, with 60.0% reporting moderate and 40.0% high knowledge, although most (70.0%) reported moderate practice levels. Nurses similarly showed high proportions of moderate knowledge (69.8%) and moderate practice (81.9%), with the association between professional category and practice level reaching statistical significance ($P < 0.001$). Educational attainment was significantly related to both knowledge ($P = 0.008$) and practice ($P < 0.001$), with diploma and graduate/postgraduate holders showing higher knowledge levels.



Participants who had received Infection Prevention and Control (IPC) training were more likely to have better knowledge and practice scores, and awareness of IPC guidelines at the workplace was also positively associated with both outcomes ($P < 0.05$). Perceived availability of personal protective equipment (PPE) and the source of IPC information were significantly linked with practice levels ($P < 0.001$).

Multivariable logistic regression identified key predictors of good knowledge and practice. Male gender was negatively associated with both good knowledge (AOR = 0.58; $P < 0.001$) and practice (AOR = 0.37; $P < 0.001$) compared to females. Being married was also associated with lower odds of good knowledge and practice ($P < 0.01$). In contrast, working as a nurse or midwife was positively associated with higher knowledge and practice levels ($P < 0.01$). Healthcare workers in secondary-level facilities were more likely to have good knowledge (AOR = 1.34; $P = 0.003$) but less likely to demonstrate good practice (AOR = 0.36; $P = 0.002$) than those in primary-level settings.

Higher educational qualifications (diploma and graduate/postgraduate) increased the likelihood of good knowledge, although only diploma holders showed a significant positive association with practice. Lack of IPC training, PPE availability, and IPC guidelines were all significantly associated with lower odds of good knowledge and practice, highlighting the importance of training and resource availability for effective medical waste management.

Table 4. Factors associated with knowledge and practice level on medical waste management identified by logistic regression (n=557)

Characteristics	Knowledge, N (%)			Practice, N (%)		
	AOR	95%CI	P-Value	AOR	95% CI	P-Value
Sex						
Female						
Male	0.58	0.295, 1.156	<0.001***	0.37	0.21, 0.63	<0.001***
Marital Status						
Single						
Married	0.38	0.24, 0.62	<0.001***	O.49	0.29, 0.83	<0.001***
widowed	0.87	0.47, 1.73	0.66	0.95	0.46, 2.09	0.9
Designation						
Doctor						
SACMO	0.65	0.245, 1.7	0.54	0.45	0.25, 0.80	0.692
Nurse	1.81	0.53, 6.113	<0.001***	1.2	1.15, 1.24	<0.001***
Midwife	1.26	0.73, 2.15	0.004***	1.16	1.13, 1.19	<0.001***
Paramedics	0.6	0.33, 1.09	0.094	0.896	0.525, 1.52	0.687
Others	0.71	0.40, 1.2	0.23	0.939	0.52, 1.6	0.83
Level of the Hospital						
Primary						
Secondary	1.33	0.60, 2.99	0.003***	0.36	0.19, 0.69	0.002***
Educational Level						
SSC						
HSC	0.96	0.902, 1.01	0.138	0.466	0.19, 0.69	0.003***
Diploma	1.37	1.02, 1.82	0.034*	0.55	0.36, 0.82	0.037*
Graduation/Post-graduation	2.23	1.57, 3.20	<0.001***	0.66	0.40, 1.07	0.093
Received IPC Training						
Yes						
No	0.14	0.09, 0.23	<0.001***	0.33	0.20, 0.55	<0.001***
Member of HBV doses Received						
Single Dose						
Two Doses	1.26	0.591, 2.71	O.54	0.38	0.137, 1.05	0.064
Three Doses	1.5	0.90, 2.5	0.114	0.483	0.137, 0.67	0.016*
Perception on the availability of PPE Current Workplace						
Yes						
No	0.16	0.07, 0.25	<0.001***	0.39	0.32, 0.78	<0.001***
Not Sure	0.24	0.16, 0.34	<0.001***	0.27	0.16, 0.45	<0.001***
Availability of IPC Guideline in Current Workplace						
Yes						
No	0.45	0.34, 0.59	<0.001***	0.39	0.32, 0.78	<0.001***
Not sure	0.24	0.16, 0.34	<0.001***	0.27	0.16, 0.45	<0.001***
Source information of IPC						
Training						
Books/Guideline	0.58	0.296, 1.17	<0.001***	0.57	0.22, 1.43	<0.001***
Friends	0.35	0.203, 0.604	<0.001***	0.57	0.22, 1.4	<0.003***
Other	0.9	0.5, 1.6	0.731	0.71	0.40, 1.2	0.23
No source of Information	0.9	0.50, 1.65	0.74	0.43	0.24, 0.75	0.31
Reception on the mode of Waste Disposal at Current Workplace						
Hire private company						
Takes to another hospital for disposal	1.05	0.96	<0.001***	1.9	0.90, 4.3	0.019
Infectious incineration	1.6	0.77, 3.38	<0.001***	3.66	1.3, 9.6	0.008***
Community garbage	0.91	0.69, 1.20	0.494	0.99	0.96, 1.01	0.259
Don't know	0.78	0.56, 1.10	0.145	0.45	0.132, 0.74	0.285

Sources of IPC information were significantly associated with participants' knowledge and practices. Obtaining information from **books or guidelines** and from **friends or colleagues** was linked with higher odds of good knowledge ($P < 0.001$). Learning from friends or colleagues was also significantly associated with better practice ($P = 0.003$).
Additionally, the use of **infectious waste incineration** at the workplace was significantly associated with higher levels of both knowledge ($P < 0.001$) and practice ($P = 0.008$) in medical waste management.

Discussion

This study provides important insights into healthcare workers' knowledge and practices regarding medical waste management (MWM). Age and experience did not significantly affect participants' knowledge or practice, indicating that training and support should target all staff regardless of seniority. Gender differences were observed: males showed higher practice levels, while females tended to have better knowledge, possibly reflecting training differences by role. Marital status was associated with practice, but religion was not, suggesting interventions can be broadly applied.
Nurses demonstrated relatively strong knowledge and practice, highlighting their key role in promoting proper waste management. Importantly, receiving structured Infection Prevention and Control (IPC) training and having access to IPC guidelines were both strongly linked to better

knowledge and practices. Perceived availability of personal protective equipment (PPE) was also associated with improved practice, underscoring the need for both adequate resources and communication about their availability.

While higher education predicted better knowledge, it did not always translate to improved practice, suggesting that theoretical understanding must be complemented by practical training. Additionally, the method of waste disposal (e.g., infectious incineration) was associated with higher knowledge and practice, pointing to the influence of institutional infrastructure on staff behavior. The strongest negative predictor of good outcomes was the lack of IPC training, emphasizing that regular, structured education should be prioritized.

Although this study was conducted in selected healthcare facilities and may have limitations related to self-reporting and participant representation, it offers valuable evidence to guide policy and practice improvements in medical waste management.

Conclusion

Healthcare workers showed moderate to high knowledge and practices related to medical waste management, but significant gaps remain. To improve compliance and safety, key measures should include:

- Expanding structured IPC training for all staff.
- Ensuring consistent access to PPE and clear IPC guidelines.
- Strengthening waste disposal infrastructure and monitoring systems.
- Conducting regular refresher training and workplace audits.

Implementing these strategies can enhance medical waste management, reduce occupational risks, and improve overall healthcare safety.

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