Evaluation of Knowledge, Practices, and Possible Barriers among Healthcare Providers regarding Medical Waste Management in Dhaka, Bangladesh

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Data Collection B
Statistical Analysis C
Data Interpretation D
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Background: Improper handling of medical wastes, which is common in Bangladesh, could adversely affect the hospital environment and community at large, and poses a serious threat to public health. We aimed to assess the knowledge and practices regarding medical waste management (MWM) among healthcare providers (HCPs) and to identify possible barriers related to it.

Material/Methods: A cross-sectional study was carried out during June to September, 2012 including 1 tertiary, 3 secondary, and 3 primary level hospitals in Dhaka division, Bangladesh through 2-stage cluster sampling. Data were collected from 625 HCPs, including 245 medical doctors, 220 nurses, 44 technologists, and 116 cleaning staff who were directly involved in MWM using a self-administered (researcher-administered for cleaning staff), semi-structured questionnaire.

Results: Nearly one-third of medical doctors and nurses and two-thirds of technologists and cleaning staff had inadequate knowledge, and about half of medical doctors (44.0%) and cleaning staff (56.0%) had poor practices. HCPs without prior training on MWM were more likely to have poor practices compared to those who had training. Lack of personal protective equipment, equipment for final disposal, MWM-related staff, proper policy/guideline, and lack of incinerator were identified as the top 5 barriers.

Conclusions: Strengthening and expansion of ongoing educational programs/training is necessary to improve knowledge and practices regarding MWM. The government should take necessary steps and provide financial support to eliminate the possible barriers related to proper MWM.

MeSH Keywords: **Awareness • Bangladesh • Communication Barriers • Knowledge • Medical Waste • Practice Guideline**

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Background

The wastes generated during the process of diagnosis, treatment, operation, or immunization or in research activities, are termed as medical wastes [1,2]. It is an ongoing problem for many countries and poses a serious public health problem. Due to modernization of medical services and increased number of patients, healthcare institutions generate large amounts of medical wastes. Approximately 75–95% of bio-medical wastes are non-hazardous and the remaining 10–25% are hazardous to humans or animals and detrimental to the environment [3–5]. It is very important to realize that if both of these types are mixed together, then all waste becomes harmful [6]. Reports in the literature shows 80% of all medical wastes are mixed with general wastes [7].The World Health Organization (WHO) estimated that, during 2000, injections with contaminated syringes caused 21 million hepatitis B virus infections, 2 million hepatitis C virus infections, and 260 000 cases of human immunodeficiency virus (HIV) infections [8]. Cases with staphylococcal bacteriemia and endocarditis were reported among cleaning staff after needle injury [9].

Healthcare providers (HCPs) are at risk of occupational dangers as they perform their jobs in hospitals. Serious diseases may develop in HCPs as well as patients and the general public. The highest rates of occupational injury among all workers who may be exposed to healthcare wastes were reported by cleaning personnel and waste handlers; the annual rate in the United States was 180 per 1000 [10].

Based on types of wastes and hospital category, medical waste management (MWM) scenarios at hospitals in Bangladesh are not satisfactory. There are approximately 1300 government hospitals with 43 000 beds, including public specialized hospitals, medical college hospitals (tertiary level), district hospitals (secondary level), and upazila (primary level) health complexes in Bangladesh. Many private hospitals and clinics also provide healthcare. The waste generation rate for infectious waste and sharps waste from government hospitals were 0.11and 0.03 kg/bed/day, respectively [11]. Most health facilities do not have adequate and effective systemic approaches to medical waste disposal. The medical wastes are simply mixed with the municipal wastes in the collecting bins at the road side and some percentage are buried without any precautions or are burned in the open [12]. The pollution of the environment with toxic substances is a serious public health problem in Bangladesh. Public awareness of healthcare wastes has grown recent years, especially with the emergence of acquired immunodeficiency syndrome (AIDS). In the past 10 years, due to increased number and size of healthcare facilities, medical services and use of medical disposable products, the generation of healthcare wastes has increased rapidly. The Ministry of Health and Family Welfare, Bangladesh,

started to address the MWM as a priority program. HCPs has become part of the extensive MWM-related training program and logistics, including different colored bins, were supplied among the healthcare institutions; however, the situation is not yet satisfactory [12,13].

Very few studies had reported on different isolated components of MWM in Bangladesh. One study [14] reported on the health effect of medical practices towards medical wastes. Another study [12] identified the types and amount of medical waste generation. There has been no published study among HCPs regarding awareness of knowledge and practices, and possible barriers to proper MWM in Bangladesh. The WHO recommended raising awareness of medical waste risks and promoting safe and sound practices to improve the situation [15].Therefore, it was necessary to conduct this study with the objective of assessing relevant knowledge and practices, and to identify possible barriers to proper MWM among HCPs. The association of knowledge and practices with background characteristics was also evaluated.

Material and Methods

This cross-sectional study was conducted from June to September, 2012 among different level hospitals in Dhaka division, Bangladesh. A 2-stage cluster sampling method was used to select different levels of hospitals. One tertiary level hospital was selected purposively from Dhaka city. In the first stage, 3 out of 17 district (secondary level) hospitals were selected using a simple random sampling (SRS) method. In the second stage, we also selected 3 upazila (primary level) hospitals, 1 from each of the above-mentioned districts, by applying the SRS.

Subjects

Medical officers, including post-graduate medical students, nurses, technologists, and cleaning staff related to MWM, were recruited from enrolled hospitals. We included those who worked directly with MWM (e.g., involved in clinical activities including pathological/ radiological and cleaning), the permanent employees (except cleaning staff working in tertiary level hospitals, as most of them are on contact basis and postgraduate medical students) of the hospitals and working at least 1 year. A total of 1250 were eligible from all hospitals after excluding those who were not willing to participate. We predetermined that at least 50% of eligible HCPs needed to be included in our study. We selected HCPs at different level hospitals according to their profession and reached our target sample by applying SRS. Finally, we recruited 625 HCPs, including 245 medical doctors, 220 nurses, 44 technologists, and 116 cleaning staff.

Instrument and data collection

A self-administered, semi-structured questionnaire was adapted from other studies [16–18] with little modification to fit the situation in Bangladesh. A researcher-administered questionnaire was used among cleaning staff since most have little education. The questionnaire had 4 parts. The first part consisted of background information. The second and third parts covered the knowledge questions (12 items) and practice questions (8 items) regarding MWM, respectively. The fourth part consisted of possible barriers. The questionnaire was translated into the local language (Bangla) and back-translated to English to reduce the risk of misinterpretation. The questionnaire was pretested with 25 subjects at different hospitals, and necessary amendments were made accordingly. The content validity of the questionnaire was assessed by a panel of experts in the field. Reliability was assessed by using Cronbach's alpha. The values were 0.64 for practice items and 0.86 for barrier items.

Data were collected by 6 staff, 2 in each level of hospital. They were trained extensively in how to collect data and were pretested in the field before actual data collection. Face-to-face interview was conducted for the cleaning staff only, considering their level of education; otherwise, the self-administered approach was used. To maintain harmony and consistency, they were mutually engaged so that everyone could collect data from all level hospitals. The principal investigator led the supervision to ensure high accuracy in data collection.

Statistical analysis

The Statistical Package for Social Science (SPSS) version 20.0 (SPSS Inc., Chicago, IL, USA) was used for all analyses. Chi-square test was used to compare the categorical data, including age and duration of working among groups. Knowledge scores and practice scores were calculated by giving "1" for a correct answer and "0" for an incorrect answer to each item. Total knowledge score and total practice score were computed for each participant. Mean (±standard deviation, SD) scores were computed for knowledge and practices for all groups of HCPs. Inadequate knowledge and poor practice were defined as correctly answering less than 60% of knowledge items (scoring less than 8 out of 12 points) and practice items (scoring less than 5 out of 8 points), respectively [18,19]. A bivariate logistic regression model was used to estimate odds ratios (ORs) of having inadequate knowledge and poor practices regarding MWM. All tests were 2-sided, and statistical significance was considered at P<0.05.

Ethics clearance

The study was approved by the ethical review committee of the National Institute of Preventive and Social Medicine,

Mohakhali, Dhaka. Before data collection, informed written consent was obtained from the respondents. Objectives, procedure, risks, and benefits of participating in the study were explained. They were assured that participation was voluntary and they were free to withdraw at any time without any negative consequences. Moreover, confidentiality of collected data was maintained with highest priority. Privacy of the participants was also maintained during data collection.

Results

Background information

Most of the respondents were female (61.4%). Males were more common among doctors and technologists, whereas females were more common among nurses and cleaning staff. Mean (±SD) age of the respondents was 32.3 (±8.0) years. Nurses were younger than the other HCPs (P<0.001). Approximately one-third of the respondents were college graduates or above. Almost half of the medical doctors and technologists were working in medicine departments (48.3%) and laboratory/blood banks (49.2%), respectively. Medical doctors had more working experience (>18 years) than the others, while cleaning staff had the lowest working experience (P<0.001). Background characteristics are presented in Table 1.

Knowledge regarding MWM

The mean knowledge score (±SD) of the respondents was 7.70 (±1.94). Medical doctors had the highest mean knowledge score (8.22; SD ±1.70), whereas cleaning staff had the lowest (6.14; SD ±1.83) (P<0.001). Figure 1 demonstrates that at least one-third of medical doctors and nurses, and nearly two-thirds of technologists and cleaning staff had inadequate knowledge. The lowest percentage of correct answer for both nurses (43.2%) and cleaning staff (9.5%) was with the item of treatment before disposal, whereas the lowest percentage of correct answers for medical doctors (36.7%) was with disposal of human body parts, and the lowest percentage of correct answer for technologists (38.6%) was with hazardous medical wastes (Table 2).
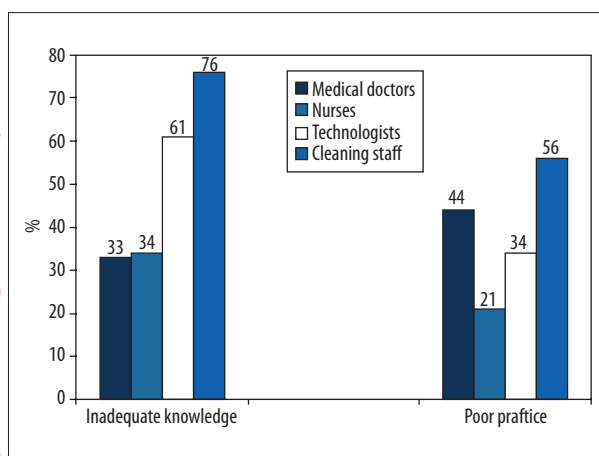
Practices regarding MWM

Mean (±SD) practice score of HCPs was 4.71 (±1.64). Nurses had the highest practice mean score of 5.29 (±1.31) and cleaning staff had the lowest (4.18; SD ±1.54). Figure 1 shows that nearly half of the medical doctors (44.0%) and more than half of the cleaning staff (56.0%) had poor practices. The lowest percentage of correct practice in all 4 groups was with the item of bending/crushing/burning the used needles; percentages were 26.1%, 19.5%, 22.7%, and 21.6% for medical doctors, nurses, technologists, and cleaning staff, respectively (Table 3).

Table 1. Background information of healthcare providers regarding medical waste management.

Variables	Medical Doctors (n=245) N (%)		Nurses (n=220) N (%)		Technologists (n=44) N (%)		Cleaning staff (n=116) N (%)		P-value*
Gender									<0.001
Female (n=384)	97	(39.6)	188	(85.5)	9	(20.5)	90	(77.6)	
Male (n=241)	148	(60.4)	32	(14.5)	35	(79.5)	26	(22.4)	
Age (year)									<0.001
<30	92	(37.6)	111	(50.5)	12	(27.3)	36	(31.0)	
30–40	119	(48.6)	77	(35.0)	25	(56.8)	46	(39.7)	
>40	34	(13.9)	32	(14.5)	7	(15.9)	34	(29.3)	
Duration of working (year)									<0.001
<8	70	(28.6)	57	(25.9)	17	(38.6)	54	(46.6)	
8–18	70	(28.6)	104	(47.3)	17	(38.6)	16	(13.8)	
>18	105	(42.9)	59	(26.8)	10	(22.7)	46	(39.7)	
Training received									<0.001
No	159	(64.9)	50	(22.7)	13	(29.5)	50	(43.1)	
Yes	86	(35.1)	170	(77.3)	31	(70.5)	66	(56.9)	
Hospital level									<0.001
Tertiary	200	(81.6)	161	(73.2)	20	(45.5)	82	(70.7)	
Secondary	21	(8.6)	36	(16.4)	18	(40.9)	26	(22.4)	
Primary	24	(9.8)	23	(10.5)	6	(13.6)	8	(6.9)	

* Chi-squared test.

Figure 1. Distributions of inadequate knowledge and poor practices among healthcare providers regarding medical waste management (n=625). Inadequate knowledge and poor practice were defined as correctly answering less than 60% of knowledge items (scoring less than 8 out of 12 points) and practice items (scoring less than 5 out of 8 points), respectively [18,19].

Associations of inadequate knowledge and poor practices with background characteristics

Table 4 shows the ORs of background characteristics for inadequate knowledge and poor practices. Males, older people (30 years and above), technologists, cleaning staff, and district hospitals were more likely to have inadequate knowledge compared to females, younger age, medical doctors, and tertiary hospitals, respectively after being mutually adjusted for gender, age, profession, length of working, training, and type of hospital. Moreover, nurses (adjusted OR, 0.40; P<0.001) were less likely to have poor practices than to medical doctors. However, after mutual adjustment for gender, age, profession, duration of working, training, and type of hospitals, we found that middle-aged people (30–40 years; adjusted OR, 1.66; P<0.008) and those who did not receive training (adjusted OR, 2.43; P<0.001) were more likely to have poor practices.

Possible barriers to MWM

The barriers are demonstrated in Table 5. Insufficient personal protective equipment (PPE) in the hospitals, lack of equipment

Table 2. Correct answers provided by the healthcare providers on knowledge about medical waste management.

Questions	Medical Doctors (n=245) N (%)		Nurses (n=220) N (%)		Technologists (n=44) N(%)		Cleaning staff (n=116) N(%)		P-value*
Do you know about infectious medical wastes?	233	(95.1)	203	(92.3)	40	(90.9)	93	(80.2)	<0.001
How frequently are wastes removed from source of origin?	195	(79.6)	203	(92.3)	40	(90.9)	93	(80.2)	<0.001
Which one is radioactive medical waste?	213	(86.9)	153	(69.5)	24	(54.5)	76	(65.5)	<0.001
How frequently are wastes removed from central store?	179	(73.1)	151	(68.6)	35	(79.5)	97	(83.6)	0.012
Which one is not transmitted through contaminated syringes?	216	(88.2)	164	(74.5)	30	(68.2)	38	(32.8)	<0.001
Can you define medical wastes?	150	(61.2)	161	(73.2)	28	(63.6)	78	(67.2)	0.053
Do you know about personal protective equipment?	174	(71.0)	137	(62.3)	23	(52.3)	56	(48.3)	<0.001
What is the proper condition to remove the bin?	143	(58.4)	166	(75.5)	18	(40.9)	35	(30.2)	<0.001
Do you know how to treat the infectious waste?	143	(58.4)	118	(53.6)	21	(47.7)	74	(63.8)	0.177
Do you know about hazardous medical wastes?	169	(69.0)	100	(45.5)	17	(38.6)	34	(29.3)	<0.001
Do you know how to dispose of human body parts/IUD**?	90	(36.7)	127	(57.7)	21	(47.7)	27	(23.3)	<0.001
Do you know how to treat waste before final disposal?	107	(43.7)	95	(43.2)	15	(34.1)	11	(9.5)	<0.001

* Chi-squared test; ** IUD – intra-uterine death.

Table 3. Correct answers provided by the healthcare providers about practices on medical waste management.

Items	Medical Doctors (n=245) N (%)		Nurses (n=220) N (%)		Technologists (n=44) N (%)		Cleaning staff (n=116) N (%)		P-value*
Put needle into a special box	186	(75.9)	196	(89.1)	33	(75.0)	90	(77.6)	0.002
Consider as hazardous if accidentally mixed	200	(81.6)	188	(85.5)	19	(43.2)	74	(63.8)	<0.001
Put infectious wastes into a special box	166	(67.8)	195	(88.6)	34	(77.3)	80	(69.0)	<0.001
Sort out medical waste correctly	147	(60.0)	195	(88.6)	39	(88.6)	89	(76.7)	<0.001
Labeling the bin for different types of waste	145	(59.2)	173	(78.6)	27	(61.4)	42	(36.2)	<0.001
Informed higher authority if injured by sharp	100	(40.8)	96	(43.6)	28	(63.6)	52	(44.8)	0.048
Remove as hazardous if not identify correctly	78	(31.8)	76	(34.5)	20	(45.5)	30	(25.9)	0.105
Bending/burning/crushing the used needles	64	(26.1)	43	(19.5)	10	(22.7)	25	(21.6)	0.397

* Chi-squared test.

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Table 4. Associations of inadequate knowledge and poor practices with background characteristics of the respondents.

Variables	Inadequate knowledge		Poor practices	
	Adjusted OR*	P-value	Adjusted OR	P-value**
Gender				
Female	1	Reference	1	Reference
Male	1.24	0.247	1.02	0.906
Age (year)				
<30	1	Reference	1	Reference
30-40	1.50	0.036	1.66	0.008
>40	1.92	0.010	1.62	0.052
Profession				
Medical Doctors	1	Reference	1	Reference
Nurses	1.14	0.564	0.40	<0.001
Technologists	2.96	0.002	0.80	0.539
Cleaning staff	6.60	<0.001	1.62	0.049
Training received				
Yes	1	Reference	1	Reference
No	1.25	0.212	2.43	<0.001
Hospital level				
Tertiary	1	Reference	1	Reference
Secondary	1.92	0.008	0.89	0.659
Primary	0.93	0.805	0.89	0.702

* OR – Odds ratio; adjusted mutually for gender, age, length of working, profession, training received and hospital types; ** P value from Wald statistic. Inadequate knowledge and poor practice were defined as correctly answering less than 60% of knowledge items (scoring less than 8 out of 12 points) and practice items (scoring less than 5 out of 8 points), respectively [18,19].

Table 5. Possible barriers of medical waste management identified by the respondents.

Possible barriers	Medical Doctors (n=245) N (%)		Nurses (n= 220) N (%)		Technologists (n= 44) N (%)		Cleaning Staff (n= 116) N(%)		P-value*
Insufficient PPE** in the hospital	140	(57.1)	153	(69.5)	18	(40.9)	69	(59.5)	<0.001
Lack of instrument for final disposal	128	(52.2)	124	(56.4)	28	(63.6)	58	(50.0)	0.018
Insufficient MWM-related staff	131	(53.5)	121	(55.0)	24	(54.5)	54	(46.6)	<0.001
Lack of guideline/policy	132	(53.9)	112	(50.9)	26	(59.1)	55	(47.4)	0.122
Lack of incinerator	113	(46.1)	116	(52.7)	26	(59.1)	63	(54.3)	0.003
Lack of vaccination program for healthcare providers	79	(32.2)	102	(46.4)	24	(54.5)	61	(52.6)	<0.001
Insufficient recycle bin/container	52	(21.2)	67	(30.5)	9	(20.5)	14	(12.1)	<0.001
Insufficient space in store room	40	(16.3)	41	(18.6)	4	(9.1)	10	(8.6)	<0.001
Lack of cooperation from local authority	21	(8.6)	19	(8.6)	1	(2.3)	17	(14.7)	<0.001
Lack of autoclave	20	(8.2)	23	(10.5)	5	(11.4)	3	(2.6)	0.020

* Chi-squared test; ** PPE – personal protective equipment.

for final disposal, insufficient MWM-related staff, lack of guideline or policy, and lack of an incinerator were identified as the top 5 barriers by the respondents. However, the rank order of the barriers differed among the groups. Insufficient PPE in the hospital was the top barrier among all groups except for technologists, whereas insufficient MWM-related staff was the major barrier (P <0.001). There were significant differences among different groups of HCPs regarding possible barriers, except for lack of policy/guideline (P<0.05).

Discussion

To our knowledge, this is the first study to assess the knowledge, practices, and possible barriers regarding MWM among HCPs in Bangladesh. Our study found inadequate knowledge and poor practices among HCPs regarding MWM. We also identified several possible barriers about MWM – insufficient PPE, lack of equipment for final disposal, insufficient MWM-related staff, and lack of guideline/policy.

Inadequate knowledge was observed more among technologists and cleaning staff than medical doctors and nurses. which is congruent with past studies [9,20]. This inadequate knowledge could be due to low level of general education and, in particular, the basic understanding regarding MWM. Moreover, it was reported in 1994 that improper waste management was attributed more to the negligence of local HCPs [21]. This study also reported that medical doctors had better knowledge than other professional groups, whereas cleaning staff had disquietingly inadequate knowledge. These findings are in line with previous studies [22–24].This might be due to higher technical knowledge among medical doctors than other professional groups. A better knowledge among medical doctors regarding infectious wastes, radioactive wastes, and diseases transmitted through contaminated syringes was observed. However, this study also revealed lack of knowledge among medical doctors regarding MWM in different areas such as proper disposal of human body parts, treatment before disposal, treatment of infectious wastes, and removal of bin/wastes from inside the hospitals. This inadequate knowledge could be due to lack of training during employment, and lack of proper waste management guidelines, as well as lack of discussion on details of harmful effects in general education.

Poor practice was observed among medical doctors, technologists, and cleaning staff, which is in line with a previous study [18]. Deficient practice among cleaning staff might be due to work load, shortage of cleaning staff relative to patients, lack of necessary equipment, and lack of strict supervision and training. Another important reason is that most of the waste handlers are lower socio-economic status with large family size, and lower level of education and knowledge. Most of the time, cleaning staff handle wastes without using necessary

PPE [25]. Since medical wastes are usually mixed with municipal general wastes and are dumped together on vacant land in Bangladesh, the HCPs are sometimes reluctant to properly sort waste. Lack of a proper attitude, due to lack of motivation, could also be an important factor behind these poor practices. Even with adequate knowledge, HCPs may underestimate the importance of safe waste handling. Moreover, the possible reasons for better practices among nurses could be due to the maximum time spent in the clinical ward and closely handling the patients; therefore, risk of acquiring infection was greater than for other staff. However, their role was to protect themselves and at the same time, reduce the exposure risk associated with waste for other HCPs, patients, and attendants [26]. Medical doctors had worse practices than nurses, which could be due to lack of awareness about MWM. There is a tendency among medical doctors to overlook proper waste management in Bangladesh because it is a common perception that dealing the issues of medical wastes is not a doctor's responsibility; therefore, most of the time they neglect this issue.

The top 5 barriers identified by HCPs were insufficient PPE, lack of instruments for final disposal, lack of staff, lack of appropriate guidelines, and lack of incinerators. However, the rank of barriers varied according to profession. Insufficient PPE was identified as the most serious barrier by HCPs except technologists, who identified lack of instruments for final disposal. This could be due to insufficient supply of PPE in the hospital relative to patient turnover, ignorance of this issue, improper hospital management by local administration, and insufficient monitoring and evaluation of the logistics related to MWM by central administration. A study in Bangladesh [25] reported that only 18% of HCPs always use gloves and masks when handling medical wastes; 29% use gloves, masks, and other protective equipment in special cases; and more than half of the providers handle infectious wastes with bare hands. That study also reported there were inadequate instruments for treatment of infectious wastes and sharps in a tertiary hospital and only 11% of hospitals used an incinerator. Moreover, the study findings indicated that no guidelines were strictly followed for proper management of MWM in Bangladesh, which is consistent with the present study.

The selection of all 3 levels of hospitals, recruiting subjects by using SRS procedure, and using pre-tested and validated previously published questionnaire are major strengths of this study. However, measuring responses with a psychometric scale such as the Likert scale and its analysis using ordinal regression model could be the better option to extract more meaningful and useful findings from our study, lack of which is a major limitation of the study. Second, this study was limited to only some hospitals of Dhaka division, which may limit generalizability. Third, we could not include private hospitals and MWM could

be different in those hospitals. Fourth, practice score might be overestimated in our study because it was assessed by self-report. Finally, due to technical jargon, variations in the interpretation of the questionnaire among different level HCPs might be another limiting factor. However, prior training of the data collection staff could resolve this issue significantly. Despite these limitations, our study findings could be used as baseline information for future researchers and policy makers.

Conclusions

Inadequate knowledge and poor practices were observed among HCPs in Bangladesh. Inadequate knowledge and poor practices were more prevalent among technologists and cleaning staff than medical doctors and nurses. Insufficient PPE, lack of instruments for final disposal, lack of staff, lack of appropriate guidelines, and lack of incinerators were identified as the top 5 possible barriers. Practice-based training regarding MWM

is needed among HCPs, especially technologists and cleaning staff, to improve the safe disposal of medical wastes. Moreover, government should take necessary steps to remove the possible barriers of proper MWM.

Conflict of interest

The authors declare no conflict of interest.

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