

RESEARCH ARTICLE

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Assessment of Awareness and Practices of Biomedical Waste Management among Health Care Professionals at a Teaching Hospital in Uttar Pradesh

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Abstract

Improper waste management practices are a serious problem that involves not only the hospital staff but society at large. To improve biomedical waste (BMW) management, it is important to evaluate the current practices in BMW management (BMWM), identify the gaps, and address them. With this backdrop, this research was done to assess the awareness of BMW management practices among the healthcare professionals in a teaching hospital. This is a hospital-based observational study with assessment of 112 doctors, 230 nurses, and 158 waste handlers. The healthcare workers (HCW) were evaluated regarding awareness, and different practices of BMWM with a self-structured questionnaire. An overall score of $\geq 50\%$ in each section was considered satisfactory regarding awareness and practices for BMWM. Data were analyzed statistically using SPSS Ver.21 software. Regarding the awareness on various aspects of BMWM, doctors had maximum level of awareness at 68.6% (60.0% - 77.2%), followed by nurses at 69.3% (63.3%-75.3%) and waste handlers at 55.9% (48.2% - 63.6%). Overall nurses showed maximum awareness of existing practices at 74.0% followed by doctors at 70.2% and waste handlers were at 53.8%. To optimize BMWM, it is important to raise awareness on best practices while evaluating the current practices. Gaps in knowledge and skills need to be identified and closed. Ongoing information, education and communication for health care professionals are pivotal in improving BMWM practices.

Keywords: Biomedical waste (BMW), Biomedical waste management (BMWM), Biomedical waste team, Infection Control, Healthcare workers (HCW)

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INTRODUCTION

Biomedical waste is the waste that is generated during investigation, treatment, or vaccination of humans or animals, or that is produced during manufacture or testing of biologicals.¹ For this study it applied to the above and covers the Biomedical waste (BMW) as described in schedule - 1 of the government of India rules, 1998. About 85% of waste generation in relation to health related activities is non hazardous. The remaining 15% of waste generated out of healthcare activities is considered hazardous. These hazardous material might be infectious, toxic, or radioactive and have potential to cause injury.² Although, the quantity of the infectious waste produced is less as compared to the overall healthcare waste, the poor waste management practices by healthcare workers lead to the mixing of the infectious waste with non-infectious waste and thereby contaminating the whole waste.³ BMW waste production increased manifold during the Covid pandemic which further compounded the situation.⁴

Improper disposal of BMW has many adverse and harmful effects on the environment & human health.⁵ High risk activities like the reuse of syringes and multi-dose vials augments the chances of blood borne diseases manifold.⁶ Needles used by drug abusers lead to further spread of infection.⁷ Repacking of used needles/cotton etc. can be done by unscrupulous elements. Air pollution due to incineration of improperly segregated waste produces toxic gases while water pollution is a problem due to improper liquid waste management.⁸ Increasing antibiotic resistance is a potential threat due to the spread of resistant strains.⁹

Any carelessness in the management of waste generated in a hospital tends to spread infections and contaminate the entire environment. Thus, improper waste management practices are a serious problem that involves not only the hospital staff but society at large. However, in developing countries, biomedical waste management (BMWM) have not received sufficient attention and hence it remains a major biosafety threat.¹⁰

There are numerous myths and misperceptions regarding BMWM among healthcare professionals, health administrators

and the public. Lack of awareness, non-ownership, unstructured training, and lax implementation are the factors largely influencing poor BMWM in India. To improve BMWM, it is important to assess current awareness on proper BMWM. It is imperative to understand and evaluate the current practices in BMWM with gap analysis.¹¹ With this backdrop, this research was done to assess the awareness regarding BMWM practices among the healthcare personnel in a teaching hospital. Further, suitable recommendations to improve BMW practices among healthcare personnel based on study findings were given.

The objectives of this study were to evaluate the level of awareness and existing practices regarding BMWM amongst the HCW. The study compared the level of awareness of BMWM among doctors, nursing staff, and waste handlers. Existing practices of BMWM among doctors, nursing staff, and waste handlers was also compared. Reasons behind inadequate BMWM were evaluated with a thorough assessment of the gaps in knowledge and practices among the HCWs.

MATERIALS AND METHODS

A hospital-based observational study was conducted at Career Institute of Medical Sciences and Hospital, Lucknow from October to December 2019. Ethical clearance was taken from the Institutional Ethical committee to conduct the study. Using the purposive sampling method, 500 Health Care Workers (HCWs) dealing with BMW were included for the study comprising 112 doctors, 230 nurses, and 158 waste handlers. Study groups were based on their designation as faculty, junior/senior residents, medical interns, nurses, and waste handlers. Informed consent was taken from the health care workers after explaining to them the purpose of the study. Confidentiality of the participants and data was maintained.

Our hospital has a BMWM Team that regularly conducts training programs on BMWM. The HCW were evaluated regarding awareness, and practices of biomedical waste management via a self-structured questionnaire. Question set was designed in English and then modified to the local language (Hindi) to make it easily understandable across all the classes of HCP. The questionnaire comprised twenty close-ended questions and

was divided into two sections. The first section consisted of ten questions of one mark each and assessed the awareness regarding BMWM. The second section consisting of 10 questions included questions related to practical implications and practices. An overall score of $\geq 50\%$ in each section was considered as the satisfactory score on awareness and practices for BMWM.

Data were analyzed statistically using SPSS Ver.21 software. Chi-square test was undertaken to find association between the HCP groups regarding their knowledge and practices towards BMWM. The p value was applied on the generated data.

RESULTS

A total of 500 HCWs participated in our study. Out of the 500, 112 (22.4%) were doctors, 230 (46%) were nurses and 158 (31.6%) were

waste handlers. A total of 77.8% of healthcare personnel had received training on BMWM (Table 1).

Analyzing the awareness about various aspects of BMWM, doctors had maximum level of awareness at 68.6% (60.0% - 77.2%), followed by nurses at 69.3% (63.3%-75.3%) and waste handlers at 55.9% (48.2% - 63.6%) (Table 2, Fig. 1).

Table 1. Health care workers who underwent BMWM Training

HCW category (n=500)	HCW those who underwent training
Doctors (112)	89(79.4%)
Nurses (230)	191(83%)
Waste handlers (158)	109(68.9%)
TOTAL	389(77.8%)

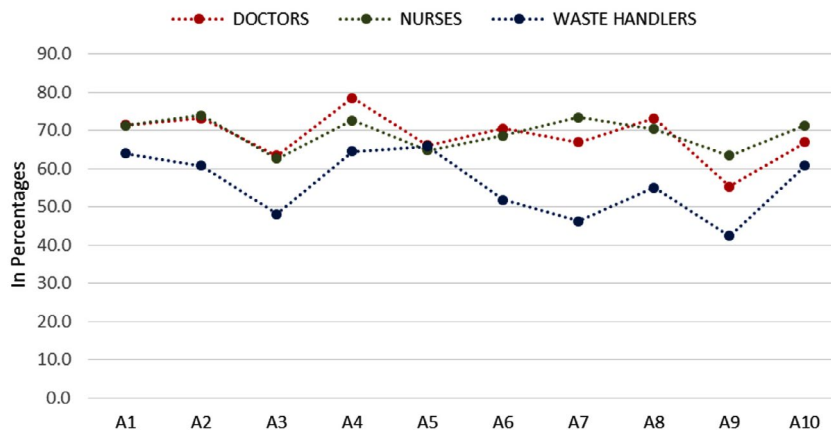


Fig. 1. Level of BMWM awareness among health care personnel.

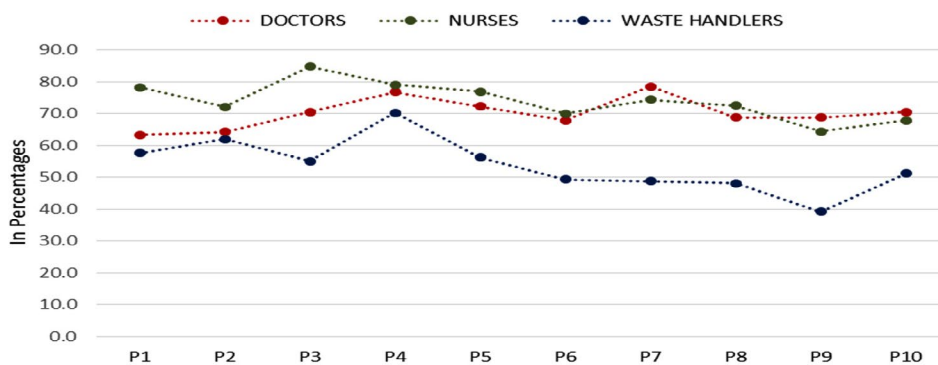


Fig. 2. BMWM adequacy of existing practices among healthcare personnel.

The difference in level awareness among doctors, nurses, and waste handlers about various aspects of BMWM was found statistically significant with a p-value <0.05 (Table 2).

Overall nurses showed maximum adequacy level of existing practices at 74.0%

followed by doctors at 70.2% and waste handlers at 53.8% (Table 3, Fig. 2).

On comparing the existing practices among doctors, nurses, and waste handlers, the significant difference in the level of existing practices was found for all the aspects except

Table 2. BMWM awareness among health care personnel

Awareness of Bio Medical Waste Management as per 2016 guidelines.	SATISFACTORY AWARENESS			chi sq	p-value
	Doctors (N=112)	Nurses (N=230)	Waste Handlers (N=158)		
A1 Salient guidelines of BMWM Rules	80 (71.4%)	164 (71.3%)	101(63.9%)	2.78	0.249
A2 Significance of Biohazard Symbol	82(73.2%)	170 (73.9%)	96(60.8%)	8.55	0.014
A3 Percentage of Infectious waste among total waste in hospital	71(63.4%)	144 (62.6%)	76(48.1%)	9.70	0.008
A4 Hazards associated with improper BMWM	88(78.6%)	167(72.6%)	102(64.6%)	6.61	0.037
A5 Description of PPE while handling BMW	74 (66.1%)	149(64.8%)	104(65.8%)	0.07	0.964
A6 Segregation of BMW at Source	79(70.5%)	158(68.7 %)	82(51.9%)	14.30	0.001
A7 Color coding of BMW as per 2016 guidelines	75 (67.0%)	169(73.5%)	73(46.2%)	30.80	<0.001
A8 Storage of BMW beyond 48 hours	82 (73.2%)	162(70.4%)	87(55.1%)	13.10	0.001
A9 Transportation rules including GPS system in BMW Vehicles	62 (55.4%)	146(63.5%)	67(42.4%)	16.80	<0.001
A10 Proper final disposal of waste	75(67.0%)	164(71.3%)	96(60.8%)	4.71	0.095
Overall awareness	68.6%	69.3%	55.9%		
	(60.0%-77.2%)	(63.3%-75.3%)	(48.2%-63.6%)		

Table 3. BMWM awareness of existing practices among healthcare personnel

Assessment of BMWM Practices as per 2016 guidelines	SATISFACTORY PRACTICES			chi sq	p-value
	Doctors (N=112)	Nurses (N=230)	Waste Handlers (N=158)		
P1 Method for segregating collecting human anatomical waste	71(63.4%)	180 (78.3%)	91 (57.6%)	20.2	<0.001
P2 Method for segregating contaminated linen, casts, cotton gauze	72 (64.3%)	166 (72.2%)	98 (62.0%)	4.93	0.085
P3 Method for segregating infected plastic wastes	79 (70.5%)	195 (84.8%)	87 (55.1%)	41.4	<0.001
P4 Method for segregating general wastes	86 (76.8%)	182 (79.1%)	111 (70.3%)	4.1	0.129
P5 Method for segregating metallic sharp wastes	81 (72.3%)	177 (77.0%)	89 (56.3%)	19.3	<0.001
P6 Method for discarding infectious liquid waste	76 (67.9%)	161 (70.0%)	78 (49.4%)	18.6	<0.001
P7 Method for discarding used disposable needles/ Use of Needle Cutter	88 (78.6%)	171 (74.3%)	77 (48.7%)	36.3	<0.001
P8 How to dispose Intact or broken glassware	77 (68.8%)	167(72.6%)	76 (48.1%)	25.8	<0.001
P9 Practices of reporting of injuries resulting from improperly disposed biomedical waste	77 (68.8%)	148 (64.3%)	62 (39.2%)	31.7	<0.001
P10 Correct management of Spills	79(70.5%)	156 (67.8%)	81 (51.3%)	14.4	0.001
OVERALL(AVERAGE)	70.2%	74%	53.8%		
SATISFACTORY PRACTICES	(61.7%-78.7%)	(68.3%-79.7%)	(46.0%-61.6%)		

Table 4. Level of awareness regarding BMWW among faculty, residents and interns

Questionnaire	Faculty (38)	Senior residents (23)	Junior residents (26)	Interns (25)	Total (112)	chi sq	p-value
A1 Salient guidelines of BMWW Rules	34 (89.5%)	17 (73.9%)	21 (80.8%)	19 (76.0%)	91 (81.3%)	2.96	0.398
A2 Significance of biohazard symbol	35 (92.1%)	18 (78.3%)	17 (65.4%)	12 (48.0%)	82 (73.2%)	16.1	0.001
A3 Percentage of infectious waste among total waste in hospital	30 (78.9%)	17 (73.9%)	14 (53.8%)	10 (40.0%)	71 (63.4%)	12	0.007
A4 Hazards associated with improper BMWW	33 (86.8%)	19 (82.6%)	20 (76.9%)	16 (64.0%)	88 (78.6%)	4.96	0.175
A5 Description of PPE while handling BMW	32 (84.2%)	12 (52.2%)	12 (46.2%)	10 (40.0%)	74 (66.1%)	15.9	0.001
A6 Segregation of BMW at source	34 (89.5%)	15 (65.2%)	16 (61.5%)	14 (56.0%)	79 (70.5%)	10.4	0.015
A7 Color coding of BMW as per 2016 guidelines	29 (76.3%)	17 (73.9%)	15 (57.7%)	14 (56.0%)	75 (67.0%)	4.37	0.224
A8 Storage of BMW beyond 48 hours	34 (89.5%)	18 (73.3%)	17 (65.4%)	13 (52.0%)	82 (73.2%)	12	0.007
A9 Transportation rules including GPS system in BMW Vehicles	28 (73.7%)	14 (60.9%)	12 (46.2%)	8 (32.0%)	62 (55.4%)	11.9	0.008
A10 Proper final disposal of waste	28 (73.7%)	17 (73.9%)	16 (61.5%)	14 (56.0%)	75 (67.0%)	2.98	0.394
Overall awareness (%)	83.4% (71.6%-95.2%)	71.3% (52.8% - 89.8%)	61.5% (42.8% - 80.2%)	52.0% (32.4% - 71.6%)	69.6% (61.1% - 78.1%)		

Table 5. Adequacy of BMWWM practices awareness amongst and among faculty, residents and interns

Assessment of adequacy of BMWWM practices as per 2016 guidelines	Satisfactory practices					Total (112)	chi sq	p-value
	Faculty (38)	Senior residents (23)	Junior residents (26)	Interns (25)				
P1 Method for segregating collecting human anatomical waste	30 (78.9%)	17 (73.9%)	12 (46.2%)	12 (48.0%)	71 (63.4%)	10.9	0.012	
P2 Method for segregating contaminated liner, casts, cotton gauze	29 (76.3%)	19 (82.6%)	13 (50.0%)	11 (44.0%)	72 (64.3%)	12.6	0.006	
P3 Method for segregating infected plastic wastes	32 (84.2%)	19 (82.6%)	15 (57.7%)	13 (52.0%)	79 (70.5%)	11.2	0.011	
P4 Method for segregating general wastes	34 (89.5%)	19 (82.6%)	17 (65.4%)	16 (64.0%)	86 (76.8%)	8.06	0.045	
P5 Method for segregating metallic sharp wastes	29 (76.3%)	18 (78.3%)	15 (57.7%)	19 (76.0%)	81 (72.3%)	3.66	0.301	
P6 Method for discarding infectious liquid waste	30 (78.9%)	17 (73.9%)	17 (65.4%)	12 (48.0%)	76 (67.9%)	7.12	0.068	
P7 Method for discarding used disposable needles/ Use of Needle Cutter	32 (84.2%)	20 (87.0%)	17 (65.4%)	19 (76.0%)	88 (78.6%)	4.46	0.216	
P8 How to dispose intact or broken glassware	27 (71.1%)	16 (69.6%)	17 (65.4%)	17 (68.0%)	77 (68.8%)	0.245	0.97	
P9 Practices of reporting of injuries resulting from improperly disposed BMW	30 (78.9%)	19 (82.6%)	15 (57.7%)	13 (52.0%)	77 (68.8%)	8.64	0.034	
P10 Correct management of Spills	28 (73.7%)	18 (78.3%)	18 (69.2%)	15 (60.0%)	79 (70.5%)	2.2	0.532	
Overall awareness (%)	79.2% (66.3% - 92.1%)	79.1% (62.5% - 95.7%)	60% (41.2% - 78.8%)	58.8% (39.5% - 78.1%)	70.2% (61.7% - 78.7%)			

entities like methods for segregating infective non-plastic waste (p=0.085) and method for segregating general wastes (p=0.129).

Faculties showed the maximum level of awareness at 83.4% and interns showed the minimum level of awareness at 52.0% (Table 4, Fig. 3). On comparing the awareness among faculty, residents, and interns, the significant difference in awareness was found in various aspects.

Overall faculty showed maximum compliance with existing practices with an overall rate of 79.2% while interns' showed an overall 58.8% practice level. (Table 5, Fig. 4)

DISCUSSION

BMWM practices are far from optimal in India. The issues in segregation, transport and disposal are major biosafety threats. Inappropriate disposal techniques have reached alarming levels in respect to environmental safety and public health.

India generates about three million tons of medical waste every year. 10 to 35% of this BMW is potentially hazardous. Inappropriate separationism at point of generation and desultory mingling with non-hazardous waste create a bigger load of hazardous waste.¹²

Various studies in the past have shown that health care workers in our country are still not

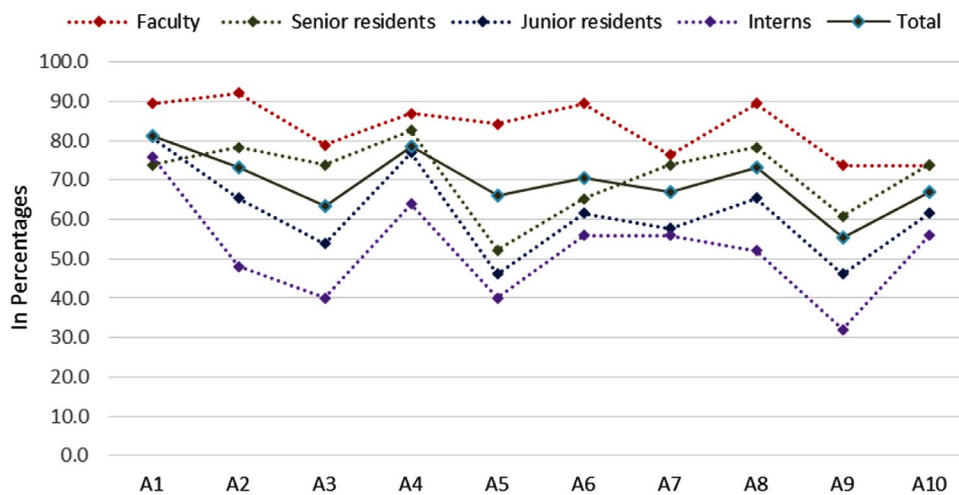


Fig. 3. Level of awareness to BMWM among faculty, residents and interns.

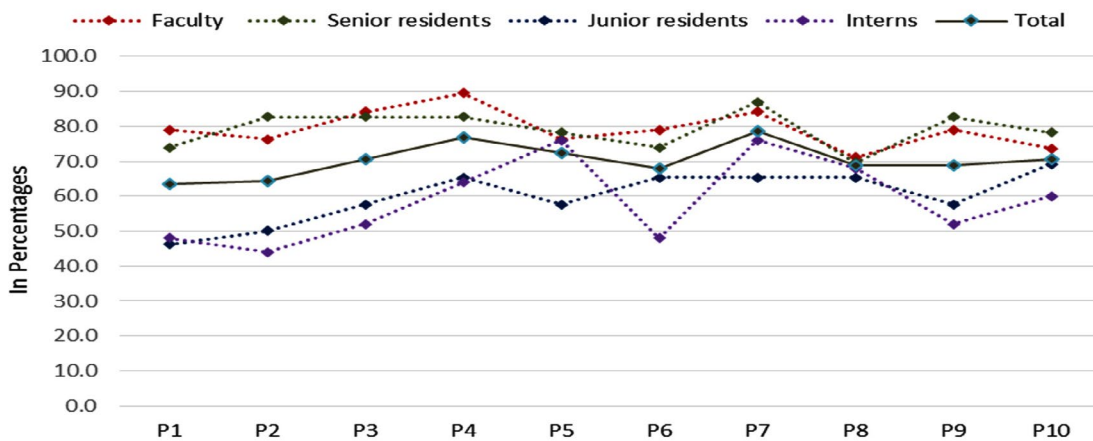


Fig. 4. Level of practices to BMWM among faculty, residents and interns.

fully aware of proper BMW handling and disposal. Although globally there is heightened awareness about proper BMW handling and disposal.¹³ A report by the Indian Institute of Management, Lucknow depicted that about 50 -55% of the BMW generated in India is managed properly at all levels of disposal chain while the remaining mostly ends up mixing with the general waste.¹⁴ Thus heightened awareness, stringent processes, and appropriate skills among health care workers are essential for the adequate management of biomedical waste. Various studies conducted across India revealed gaps in the knowledge, behavioral void, and inconsistent practice which are major roadblocks in proper BMW.¹⁵⁻¹⁶

Overall, most groups of HCP scored fairly on BMW practices awareness. The awareness about BMW among doctors and nurses was relatively better (68.6% and 69.3% respectively), followed by that of waste handlers (59.9%).

The findings are consistent with the study done by a french study, where 62.6% of HCWs were having adequate knowledge regarding BMW.¹⁷ An Indian study found that 64% of nurses had satisfactory knowledge and awareness regarding BMW.¹⁸

The findings in our study could be attributed to the fact that regular BMW training is compulsorily imparted to all doctors, nurses, and waste handlers in the hospital. Additionally, onsite training is giving to all HCWs in the wards by the BMW team. Online and hybrid modes of training were used during the pandemic.

Need to focus on all categories of healthcare workers are of utmost importance. In our study, we found that 79.4% of HCWs have attended the BMW training program of which 79.4% were doctors and 83% were nurses. However, only 68.9% of waste handlers attended the training program. This reflects the low level of awareness and teaching opportunities among the waste handlers.

The gaps in knowledge were seen in BMW aspects regarding segregation, color coding, storage and transport and significance of biohazard symbol and the findings were statistically significant. As these HCWs are regularly engaged in the process of BMW, therefore there is an urgent need to sensitize.¹⁹

Lesser knowledge amongst sanitary staff is mainly attributed to relatively lesser educational qualifications. Kapoor et al in their systematic review concluded that the level of knowledge in the study population regarding BMW was low and continuous training programs were needed to enhance it.²⁰

On comparing the awareness and existing practices among faculty, residents, and interns, the level of awareness was higher among faculties as compared to the other doctors.²¹ This could be due to the greater number of training and onsite programs attended by the faculty and senior residents. As most of the interns and junior residents were recently recruited they had missed some of the training programs. Hence continuous training for all newly recruited doctors needs to be organized periodically. There is also a need for online recurrent training on BMW with short refresher courses.

Though a greater number of doctors and nurses owned BMW practices, nurse's engagement to best practices was noteworthy.²² This could be because of the regular on-site training programs for nursing staff on segregation and transportation. Practices of segregation of plastic waste, metallic waste, and proper use of needle cutters were considerably better in nurses as compared to doctors. Proper discarding of liquid waste and broken glassware was also better known to nurses than doctors. Higher practice compliance scores amongst nursing colleagues could be attributed to better discipline, ownership on BMW process, answerability and the responsibility bestowed upon them. Injury reporting from improperly disposed of BMW were higher among doctors in comparison to nurses.

Sanitation workers were largely ignorant about most of the aspects of BMW practices. Most of these sanitation workers were placed on ad hoc jobs and were less aware about biohazard risk from BMW.

Every step involving biomedical waste generation, segregation, storage, transport and disposal need to be closely monitored. A surveillance system needs to be set for ensuring integrity of the whole process. Information, Education and communication (IEC) activities need to be contextual, ongoing and assessment based.

BMWM training program is essential to sensitize and raise awareness among HCWs. It also emphasizes the importance of the segregation of BMW. The training program also educates about the hazards associated with poor BMWM with special emphasis on sharp injuries.

Training should emphasize on empowering the health professionals on all theoretical and practical aspects of BMWM. Political will, ownership of BMWM, stringent implementation and IEC activities are pivotal in the program. The ramifications of best practices regarding BMWM go beyond realms of biosafety, injury prevention, vaccination, universal precautions. Novel and contextual strategies need to be adapted. Road shows, posters, handouts, stickers, charts and dedicated theme days will raise the awareness.²³ Active surveillance, checklists and regular audits can enhance accountability in BMWM.

CONCLUSION

Improper disposal of BMW has many adverse and harmful effects on the environment & human health. To improve BMWM, it is important to be aware of its proper management and understand and evaluate the current practices in BMWM, to identify the gaps and to address them. Multipronged approach for education and implementation needs to be contextualized utilizing routine and novel tools. Advanced surveillance and checklist based pathways need to be utilized at every level of BMWM.

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None.

DATA AVAILABILITY

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

ETHICS STATEMENT

It is an observational and non-interventional study. Principles of research ethics have been followed. No human or animal experimentation was involved.

INFORMED CONSENT

Informed consent was obtained for experimentation and that it confirms to the standards currently applied in India. The privacy rights of participants were observed.

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