

Keeping in Pace with New Biomedical Waste Management Rules: Assessing the Knowledge, Attitude, and Practices of Health-Care Workers of a Tertiary care Hospital in North India

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Submission: 09-10-2020,
Decision: 11-10-2020,
Acceptance: 14-12-2020,
Web Publication: 12-02-2021.

INTRODUCTION

By definition, biomedical waste management (BMW) is any waste, which is generated during the diagnosis, treatment, or vaccination of human beings or animals or in research or the use of biological or in health camps.^[1] It involves all persons and institutes which generate, collect, receive, store, transport, treat, dispose, or handle any form of BMW. On average, the waste generation rate ranges from 0.5 to 2.0 kg/bed/day.^[2] Of the total BMW, 10%–25% is regarded as hazardous and can spread diseases such as Hepatitis B, human immunodeficiency virus acquired immunodeficiency syndrome, and Hepatitis C. It is also a threat to the environment.^[3,4]

Around 8% annual growth of BMW is expected,^[5] since improper handling and unregulated BMW management

ABSTRACT

Background: Due to changes in biomedical waste management rules in 2016 and further amendments frequently thereafter, there is a need to constantly update oneself on this subject, especially the health-care workers (HCWs). **Methods:** A descriptive cross-sectional survey was conducted among the HCWs in a tertiary care hospital. A total of 500 pretested questionnaire were distributed with 427 feedbacks received. Data were analyzed using SPSS version 20 and Epi Info software. **Results:** A total of 427 participants responded with an overall response rate of 85.4%, which included 57 doctors (faculty), 124 resident doctors, 116 nurses, 110 paramedical staff, and 20 housekeeping staff. The mean age of the overall study group was found to be 30.06 ± 8.30 years with 242 male (56.67%) and 185 (42.33%) female participants in the study. The overall percentage of satisfactory response ($\geq 60\%$) for the domains of knowledge, attitudes, and practices shows a declining trend as per occupation with best response among the faculty and worst among the supporting staff with a significant association ($P < 0.001$) for previous training and higher correct response among the participants. **Conclusions:** Overall awareness of this subject is unsatisfactory across various levels of health-care facilities, especially among the grassroot level workers. Thus, widespread publicity, continuous training programs, and audits are must for awareness and uniformity in practices through all echelons.

KEYWORDS: Attitude, biomedical waste management rules, health-care workers, knowledge, practice

is a public health problem, it becomes imperative for all health-care workers (HCWs) to be aware of the proper handling and management of BMW. Reliable and safe and methods for handling BMW are of paramount importance. Proper and effective BMW management is a legal necessity and a social responsibility.^[1]

Past studies have reported that HCWs in our nation are not entirely aware of proper BMW segregation and further disposal. Although there is an increasing

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How to cite this article: Bhalla GS, Bandyopadhyay K, Pandey C, Anand N, Gupta S. Keeping in pace with new biomedical waste management rules: Assessing the knowledge, attitude, and practices of health-care workers of a tertiary care hospital in North India. Med J DY Patil Vidyapeeth 2021;14:662-7.

Access this article online

Quick Response Code:



Website:
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DOI:
10.4103/mjdrdydpv.mjdrdydpv_335_20

awareness about BMW handling and disposal globally,^[5] studies from various parts of our nation suggest gaps in knowledge and lacunae in attitudes and practices are still prevalent to a worrying extent among the various categories of HCWs.^[6-10] BMW management guidelines have been frequently amended^[1,11] and added with a lack of self-update has contributed to the increase in the knowledge gap. Hence, studies are warranted to assess the knowledge, attitudes, and practices concerning biomedical waste.

The Ministry of Environment Forests and Climate Change, Government of India, notified the BMW Management rules, 2016, on March 28, 2016, under the provisions of EPA, 1986.^[12] Further to these, amendments were issued on March 16, 2018, and February 20, 2019. HCWs are not well-versed with these rules even 3 years after their implementation. They either confuse specific categories with those in the old rules or are not aware of the schedule I of the BMW Management rules, 2016.^[12] Hence, this study was undertaken to elucidate the levels of and lacunae in knowledge, attitude, and practice among the various HCWs in a tertiary care hospital and the distribution of gaps and disconnects in and between theory and practice.

MATERIALS AND METHODS

Institutional Ethical Committee of the principal investigator's institution processed the protocol and provided the clearance. (Institutional Ethics Committee, Department of Academics, Army Hospital [R and R], Delhi cantt, IEC Regn number-47/2020 dated June 25, 2020).

The present study was conducted as a descriptive cross-sectional study in a tertiary care hospital in an urban locality in Northern India over a period of 1 year from January 2019 to December 2019. The sample size was calculated by assuming a prevalence of 50% correct knowledge in the environment, keeping a margin of error at 5% and alpha-error at 5% with 95% confidence interval. The calculated sample size came out to be 385. To cater for loss of information due to incomplete forms or no response due to nonsubmission, an additional 30% (115) was added to the sample size making the final sample size to be 500. Inclusion criteria for the study participants were any HCWs (doctors, residents, nurses, paramedics, and housekeeping staff), who was involved in direct patient care and had worked in the hospital under study, for at least 6 months. All administrative staff not involved in direct patient care and those HCWs who had spent <6 months in the hospital under study were excluded.

All those who fulfilled the inclusion criteria were listed, and a sampling frame was made. The study participants

were thereafter selected using simple random sampling method. A total of 500 questionnaires were distributed to all the HCWs who matched the inclusion criteria and 427 feedbacks were received, who were enrolled as study respondents. The questionnaire included a total of thirty questions encompassing all domains (Ten question on baseline characteristics of the participants, ten for knowledge, five on attitude, and five on practices) and was finalized after pilot-testing on a subgroup of sixty individuals from the same population. The study was explained to all the participants, and an initial verbal consent was taken from them. Thereafter, the submission of the form was taken as a final consent from the participant.

The overall scores for knowledge, attitude, and practice were transformed into percentage score. Percentage knowledge, attitude, and practice scores were analyzed on the basis of "satisfactory/acceptable" and "unsatisfactory/unacceptable" scores using "cut-off point" tools. Responses to questions were scored as one (for correct/yes answers) and zero (for incorrect/no answers, respectively). These scores were added to a single value out of a possible total score of ten for knowledge, five for attitude, and five for practices items. Participants who scored $\geq 60\%$ were considered as "satisfactory" for knowledge, attitude, and practices while scoring $<60\%$ measured as "unsatisfactory" for each variable. The data collected were compiled, collated, and analyzed using software such as IBM SPSS version 20 and Epi info 7. The results were tabulated, and appropriate statistics were used.

RESULTS

A total of 427 participants responded out of 500 questionnaires distributed with an 85.4% response rate, which included 57 doctors (faculty), 124 resident doctors, 116 nurses, 110 paramedical staff, and 20 housekeeping staff. There was a total of 242 male (56.67%) and 185 (42.33%) female participants in the study and the mean age of the overall study group was found to be 30.06 ± 8.30 years, with minimum being 17 years and maximum being 54 years. The overall baseline characteristics with variables such as age, gender, experience as HCW, and previous training on the subject is compared for each subgroup [Table 1].

On analysis of the response to the various questions in the knowledge component, a mixed pattern was observed [Table 2]. The percentage of correct responses was found to be the best among the faculty ($>80\%$) for most of the questions and was below average ($<40\%$) for most of the questions among the supporting staff, with an exception for identification of universal symbol for

Table 1: Baseline characteristics of the study participants (n=427)

Study participants (n=427), n (%)	Mean age (years)	Gender, n (%)		Duration as HCW (years), n (%)				Previous training, n (%)	
		Male	Female	<1	1-2	3-5	>5	No	Yes
Faculty 57 (13.35)	42.93±6.02	36 (63.16)	21 (36.84)	-	-	-	57 (100)	10 (17.54)	47 (82.46)
Residents 124 (29.04)	31.43±8.02	80 (64.52)	44 (35.48)	-	2 (1.61)	63 (50.81)	59 (47.58)	34 (27.42)	90 (72.58)
Nurses 116 (27.17)	25.59±5.02	-	116 (100)	58 (50.0)	12 (10.34)	8 (6.90)	38 (32.76)	53 (45.69)	63 (54.31)
Paramedics 110 (25.76)	31.67±6.75	110 (100)	-	10 (9.09)	12 (10.91)	48 (43.64)	40 (36.36)	61 (55.45)	49 (44.55)
Supporting staff 20 (4.68)	34.63±4.63	16 (80)	4 (20)	2 (10.0)	3 (15.0)	6 (30.0)	9 (45.0)	14 (70.0)	6 (30.0)

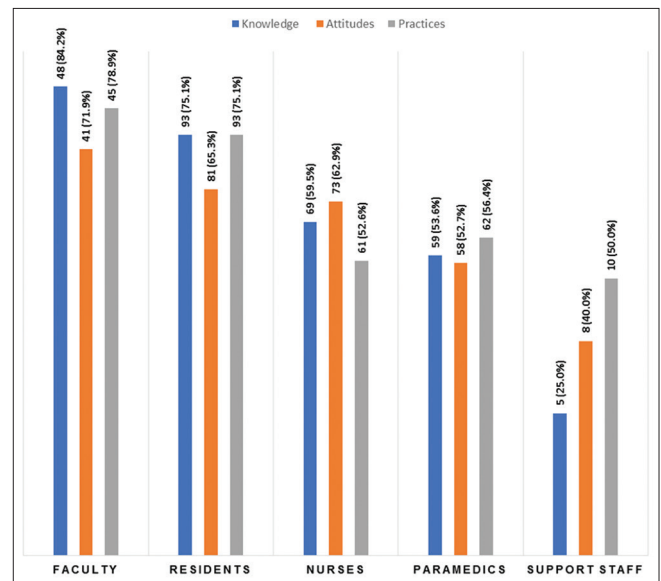
Table 2: Knowledge of study participants in each subgroup (n=427)

Selected questions (correct answer)	Correct response percentage				
	Faculty (n=57), n (%)	Residents (n=124), n (%)	Nurses (n=116), n (%)	Paramedics (n=110), n (%)	Support staff (n=20), n (%)
The maximum time limit for which biomedical waste can be stored (48 h)	47 (82.45)	80 (64.51)	50 (43.10)	42 (38.18)	1 (5.0)
Total colour coding categories for biomedical waste disposal (four)	53 (92.98)	110 (88.70)	90 (77.58)	68 (61.81)	8 (40.0)
Disposal of expired and discarded medicines including cytotoxic drugs (yellow)	49 (85.96)	96 (77.41)	68 (58.62)	54 (49.09)	2 (10.0)
Disposal of chemical liquid waste (discarded formalin, housekeeping and disinfectants) (yellow)	43 (75.43)	80 (64.51)	62 (53.44)	48 (43.63)	3 (15.0)
Disposal of blood bags, lab cultures, vaccines and cell cultures (yellow)	51 (89.47)	76 (61.29)	59 (50.86)	46 (41.81)	4 (20.0)
Disposal of waste sharps (needles, syringes with fixed needles) including metals (scalpels, blades) (white)	48 (84.21)	112 (90.32)	80 (68.96)	79 (71.81)	2 (10.0)
Disposal of broken glass including medicine vials and ampoules (blue)	40 (70.17)	80 (64.51)	50 (43.10)	52 (47.27)	4 (20.0)
The universally accepted symbol for biohazard	53 (92.98)	116 (93.54)	98 (84.48)	87 (79.09)	16 (80.0)

biohazard, where the correct response was 80% in that subgroup. The residents and nurses subgroups had mixed correct response varying from 60% for few questions to more than 90% among the residents and ranging from 43% to 84% for few questions among the nurses. The overall correct response among the paramedics was also not very good, ranging from as low as 38% to as high as 87%.

On analysis of the attitudes and practices components [Table 3], it was found that majority had agreed (strongly agree + agree) to the fact that training is a must for proper BMW management (60.65%), while the aspect of considering BMW duties as a responsibility/burden evoked equivocal responses. Similarly, the majority were following the correct practices of segregation of waste before disposal as per color coding (68.85%) and correct disposal of sharps (61.12%), while recording/reporting of injuries or accidents had equivocal responses.

The overall percentage of satisfactory response ($\geq 60\%$) for the domains of knowledge, attitudes, and practices is depicted for each subgroup [Figure 1] and shows a declining trend as per occupation with best response among the faculty and worst among the supporting staff. The association of variables such as age, duration

**Figure 1:** Distribution of percentage satisfactory response ($\geq 60\%$) for KAP domains in each subgroup (N = 427)

as HCW, and any previous training on the subject with overall percentage satisfactory response for the knowledge domain [Table 4] revealed a significant association ($P < 0.001$) for previous training and higher correct response amongst the participants.

Table 3: Attitudes and practices of study participants (n=427)

Selected questions	Attitudes				
	Strongly agree, n (%)	Agree, n (%)	Neither agree nor disagree, n (%)	Disagree, n (%)	Strongly disagree, n (%)
Safe management of health care waste is an extra burden of work	101 (23.65)	114 (26.70)	50 (11.71)	97 (22.71)	65 (15.22)
Waste management is a part of our responsibility and is a team work	62 (14.52)	107 (25.06)	86 (20.14)	70 (16.39)	102 (23.89)
Training on BMW management is necessary	163 (38.17)	96 (22.48)	43 (10.07)	60 (14.05)	65 (15.22)
Selected questions	Practices				
	Always, n (%)	Mostly, n (%)	Sometime, n (%)	Rarely, n (%)	Never, n (%)
Do you segregate the BM waste according to different categories	122 (28.57)	172 (40.28)	46 (10.77)	54 (12.64)	33 (7.73)
Do you follow the system of recording and reporting injuries/accidents	60 (14.05)	101 (23.65)	89 (20.85)	76 (17.80)	101 (23.65)
Do you dispose sharps in puncture proof container only	154 (36.07)	107 (25.06)	56 (13.11)	54 (12.65)	56 (13.11)
BMW: Biomedical waste management					

Table 4: Association of selected variables with knowledge component (n=427)

Variables	Percentage satisfactory knowledge		Total n	χ^2	P	OR (95% CI)
	Unsatisfactory (<60%), n	Satisfactory (≥60%), n				
Age (years)						
<35	105	206	311	51.2	0.688	0.55 (0.495-0.691)
≥35	38	78	116			
Work experience as HCW (years)						
≤5	102	122	224	0.053	0.818	0.944 (0.579-1.53)
>5	98	105	203			
Any previous training						
No	112	60	172	5.57	<0.001	1.89 (1.11-3.23)
Yes	73	182	255			

HCW: Health care workers, OR: Odds ratio, CI: Confidence interval

DISCUSSION

The present study was aimed at assessing knowledge, attitudes, and practices of the HCWs in a tertiary care hospital toward an inescapable requirement. The study recorded an overall response rate of 85.4% amongst the participants, which is high as compared to a study done by Ajai and Nath where they found an overall response rate of 50.2%.^[13] However, another study done on similar lines by Al Balushi *et al.* found the overall response rate as high as 60.3%.^[14] The high response rate in our study could be attributed to a responsible attitude of the HCWs toward scientific research along with a good understanding of the purpose of the study. The ratio of males and females was almost similar in the study among the various groups of HCW, adding no significance to the outcome with knowledge, attitude, and practice. The mean age of the participants was found to be 30.06 ± 8.30 years in our study which is comparable to the findings of another study by Al Balushi *et al.*, in which the mean age of the study participants was found to be 36.14 ± 8.90 years.^[14]

Discussing the knowledge component, a mixed pattern was observed. While faculty doctors and residents gave the maximum correct responses, most incorrect answers were given by the paramedics and the housekeeping staff. However, biohazard symbol was correctly identified by almost everyone. Our findings were consistent with those reported by Malini and Eshwar where almost 100% of the study population identified the Biohazard symbol correctly.^[15] Similar observations were reported by Madhukumar and Ramesh and Basu *et al.*^[16,17] Possible explanation for this finding could be that the symbol for biohazard remains unchanged since it was first developed by Charles L. Baldwin in 1966; and any HCW who has seen it once, remembers it. This is in contrast with the questions based on Schedule-I of BMW Management rules, 2016, which deals with various categories of BMW and their disposal. These have been changed frequently, are too complicated for less educated staff, and have many grey areas, i.e., articles which are not mentioned in Schedule I of BMW

Management rules, 2016.^[11,12] As shown in results, response to majority of the questions pertaining to BMW categories was unsatisfactory, barring the faculty and residents. This can be explained by a lack of awareness to the new rules. Similarly, unsatisfactory response was seen for the questions pertaining to disposal of glass vials and ampules where most of the HCW marked the answer as white container for sharps (as per the 1998 rules), but as per the BMW Management rules, 2016, they are to be discarded in blue cardboard box. Mathur *et al.*, Basu *et al.*, and Anand *et al.* have reported more than 70% knowledge in their study population regarding BMW categories in their studies.^[5,17,18] Whereas our findings are consistent with those of Madhukumar and Ramesh and Sharma who also found a lack a knowledge among HCWs.^[16,19] A possible explanation is that the abovementioned studies were carried out as per the old rules, whereas, the present study was based on the new rules, and not all HCWs are aware of these rules.

Analysis of the attitudes and practices components revealed that majority had agreed to the fact that training is must for proper BMW management, while the aspect of considering BMW duties as a responsibility/burden evoked equivocal responses. This is comparable with previous studies done, where it was reported that majority of the staff was of the opinion that BMW management is a team work and it did not create extra burden on their work and that regular training of the BMW handlers is required.^[15,16,18] Similarly, majority were following the correct practices of segregation of waste before disposal as per color coding and correct disposal of sharps, while recording/reporting of injuries or accidents had equivocal responses, which is similar to the study by Malini and Eshwar which reported that majority of qualified health-care professionals followed appropriate BMW management practices.^[15]

The association of variables such as age, duration as HCW, and any previous training on the subject with overall percentage satisfactory response for the knowledge domain revealed a significant association ($P < 0.001$) for previous training and higher correct response among the participants. The overall percentage of satisfactory response for the domains of knowledge, attitudes, and practices shows a declining trend as per occupation with best response among the faculty and worst among the supporting staff. Poor knowledge among the housekeeping/class IV employees has also been reported in earlier studies.^[5,6,15,18] Lack of training and/or callus attitude lead to poor knowledge and these factors hold true for the present study too.

There are a few limitations of the study such as the inherent issue of limited information due to the limited

set of questions per domain. Moreover, despite the use of objective scales and efforts to accurately collect the data, the presence of bias inherent to the study design, such as recall bias cannot be ruled out. However, efforts were made to include maximum information on the subject and all categories of HCWs for the study, and despite the above limitations, the study delivers meaningful insights into the knowledge, attitudes, and practices of HCWs on a very relevant subject.

CONCLUSIONS

This study brings out the lack of adequate knowledge among the supporting and the paramedic staff regarding storage, color coding, and disposal of biomedical waste into appropriate colored bin. This shows that overall awareness and good practices regarding BMW management in our country is unsatisfactory across various levels of health-care facilities, especially among the grassroot level workers. The results of this study also highlight the importance of continuous training, as most of the supporting and paramedical staff expressed a lack of recent training on the subject. With the latest BMW management policy coming in vogue in 2016, after a long hiatus and with continuous updates with the amendments in 2018 and 2019 coming very frequently from the authorities, added with a perpetual dearth of outreach activities at the ground level, there seems to be an ever-increasing knowledge deficit of various rules which is evident by the lack of awareness about the present BMW Management rules, 2016 among HCWs.

Hence, frequent training activities regarding BMW management must be made mandatory in the curriculum for all HCWs (with special attention to the paramedics and the supporting staff). All HCW must be made aware of the potential hazards of poorly handled BMW along with compulsory vaccination against Hepatitis B. Once the knowledge is imparted, it is the moral responsibility of each and every HCW at all echelons to practice the correct methods so as to ensure safety to not only the community but also to themselves.

Acknowledgment

We would like to thank Mrs. Jasmeen Kaur for her contribution to the study

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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