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Assessment of knowledge, attitude & practice of biomedical waste management among junior doctors during COVID-19 pandemic in a medical college & hospital of Eastern India

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Abstract: *Purpose:* Bio-medical wastes (BMW) including COVID-19 wastes being important sources of transmission of infections and pollution need scientific handling and disposal. The study group intended to assess the knowledge, attitude and practice of junior doctors in this area. *Methods:* This descriptive, institution based, cross-sectional study was conducted for the period of three months; in a tertiary care hospital of eastern India using predesigned, pretested, semi-structured, two-part questionnaire. Knowledge assessment was done by 'yes-no' questionnaire. Assessment of attitude was accomplished by 'five-point Likert's scale' and that of practice by answers like 'never', 'sometimes' and 'always' against preset questions. The data were analysed using Statistical Package for Social Sciences (SPSS) software. For all cases, p value < 0.05 was considered as statistically significant. *Results:* The majority of 128 participant junior doctors (45.3%) belonged to 26-30 years and nearly half were female. The study population comprised of 88 interns. Rest was post-graduate and post-doctoral trainees. Only 71(55.5%) participants had knowledge level above the mean poorest being in disposal of personal protective equipments. Favorable attitude was found among 73 (57.0%) only. The post graduate/doctoral residents maintained favorable attitude than interns. Adequate practices were found among 50% respondents. Residents observed more adequate practices (60.22%) than interns (31.25%). Only 37 (28.9%) junior doctors attended the training on waste management. Significant association was observed between the level of knowledge and the working category; with residents showing higher knowledge ($\chi 2$ =3.962, df=1, p=0.047). The attitude of residents were statistically better than interns ($\chi 2$=9.057, df=1, p=0.003). The residents and those who spent ≤ 08 hours in duty showed more compliant practices for BMW rules ($\chi 2$=14.626,df=2, p=0.001). *Conclusion:* Significant association between the level of knowledge and working category of the study population was noted in the study. Regular training and follow up is an absolute need for optimizing knowledge, attitude and practices.

Keywords: KAP, BMW, Covid-19, Junior doctor, Institute

Introduction

The term 'Bio-medical waste (BMW) refers to any waste, which is generated during diagnosis, treatment or immunization of human beings or animals or research activities pertaining thereto or in production or testing of biological materials. According to BMW management rules 2016, these rules apply to all who handle biomedical wastes in any form [1].

Not only various types of disease can spread due to improper management of BMW but also it can affect environment adversely [2]. During this pandemic of COVID-19, usage of personal protective equipment (PPE) kits, goggles, face shields, face mask etc. saved millions of lives by preventing disease transmission, but, it also created a huge amount of extra burden of biomedical wastes. As per the Annual Report on BMW management, the total quantum of BMW generation reported in 2020 was 774 tons/day including 656 tons non-COVID wastes, whereas, that during 2019 was about 619 tons/day only [3].

Average monthly generation of COVID-BMW was highest, about 203 tones/day in the month of May 2021[4]. In response to the pandemic, Central Pollution Control Board (CPCB) published guidelines for handling, treatment and disposal of wastes generated during treatment/ diagnosis/ quarantine of COVID-19 patients in addition to BMW management rules 2016 [5]. This study focused on the Knowledge Attitude & Practice (KAP) of the junior doctors of a Medical College Hospital of Eastern India while addressing some degree of deficiency in complying with the guidelines. The study group intends to infuse the practice of highest standards of safety in BMW management and also help the authority to develop the strategy to improve the situation in any such future menace.

Material and Methods

Study Design and area: The study has been conducted in a tertiary care hospital of an eastern state of India among the junior doctors for the period of August to October, 2022. The study was a descriptive, institution based, cross sectional study.

Study Population, Inclusion and Exclusion criteria: All junior doctors who had given informed written consent were included in the study, of the institute. On the contrary, all those declined consent, were excluded.

Study tool: Predesigned, pretested, semi-structured, two- part questionnaire derived from current standard national and international guidelines were used. The first part contained socio-demographic variables and the second part focused on details regarding KAP for BMW management. Questions assessing KAP were objective and close-ended. "Yes *vs* No" type responses were adopted for knowledge assessment, where, correct and wrong responses were awarded '01' and 'zero (0)', respectively.

Attitude assessment was accomplished by adopting "5-point Likert scale" to represent the scores in terms of "strongly agree (5);" "agree (4);" "neutral (3);" "disagree (2);" and "strongly disagree (1)". Negatively phrased statements were reversely coded from 1 to 5 categorically. The questionnaire on practice provided the objective entries of "never", "sometimes" and "always" which were scored as 0, 1, 2 respectively and reversely coded for negatively connoted questions. The overall scores of KAP were calculated by cumulating all scores. The mean was then computed by dividing total scores of each parameter by the number of study participants. Finally, scores below the mean and above or equal to the mean were assigned for inadequate *vs* adequate knowledge; unfavourable *vs* favourable attitude and inadequate *vs* adequate practice, respectively. The overall results were interpreted using frequency distribution table.

Study variables:

Socio-demographic variables:

- Age (in years)
- Sex
- Type of Family (Joint/Nuclear)
- Working Category (Intern, Post graduate and Post doctoral residents)
- Place of Residence (Hostelite/ Day scholar)
- Working hours per day

Main Outcome Variables

- Knowledge about BMW management
- Attitude about BMW management
- Practice of BMW management

Sample size Calculation: Considering *'p'* (percentage of junior doctors with precise knowledge, good practice and a favourable attitude on BMW management) to be 75% (according to other similar study) and d (allowable margin of error) to be 10%; Sample size [6]:

$N = Z\ 2\ (1-p)/d\ 2$; [where Z=1.96 at 95% confidence interval]
N = [(1.96 *X* 1.96)75X25] **/** (7.5X7.5)
N = 128

Data collection: Data sampling was done by Simple random sampling. Following the approval of institutional ethics committee (IEC), the participants were approached and informed about the purpose of the study. Appropriate informed written consents were obtained with the assurance of anonymity and confidentiality. Then they were provided with the preset questionnaires to be filled up.

Data analysis: The data was tabulated in Microsoft Office Excel 2010 (Microsoft Corp, Redmond, WA, USA) and analysis was done using Statistical Package for Social Sciences (SPSS) software, (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY, USA: IBM Corp.). Descriptive and inferential statistical measures were employed to summarize the data. "Pearson's Chi square" analysis was used to test the association between the knowledge, attitude and practice of Junior Doctors on BMW management and their demographic characteristics. For all cases, *p* value < 0.05 was considered as statistically significant.

Results

Demographic characteristics of the study population (Table 1)*:* The majority (45.3% or 58) of the participants belonged to the age group of 26-30 years and nearly half (50.8%) were female. Among the participants 81.3% (104), were from nuclear families. The study population comprised of 88 (68.75%) interns i.e. the junior most category. Lion share of the study population (99) disclosed that they had to work continuously in hospital for more than eight hours at a stretch.

Knowledge level of junior doctors on biomedical waste management (Table 2)*:* The mean score for knowledge was 12.789 ± 2.568 out of total score of 18. Interns had a mean score of 12.325 ± 2.721 whereas Post graduate/ doctoral residents had 13.000 ± 2.482. As a whole, 71(55.5%) participants had knowledge level above the mean. All respondents heard about BMW and its management and 99.2 % knew different categories of it. Segregation of BMW at source, the idea of color coding of bags for disposal, were known to 85.9% and 96.1% of the study population respectively. Only 57 (44.5%) of the study population revealed that used PPEs, goggles and face shield in COVID ward should not be discarded in yellow bag.

Table-1: Demographic characteristics of study population (n=128)

Items		N	%
Age (years)	20-25 YEARS	39	30.5
	26-30 YEARS	58	45.3
	31-35 YEARS	19	14.8
	>35 YEARS	12	9.4
Sex	Female	65	50.8
	Male	63	49.2
Type of Family	Joint	24	18.8
	Nuclear	104	81.3
Working Category	Interns	40	31.25
	Residents	88	68.75
Place of Residence	Day scholar	75	58.6
	Hostelite	53	41.4
Working hours per day	<8 hrs	11	8.6
	>8 hrs	99	77.3
	8 hrs	18	14.1

N-Number, %-Percentage

Table-2: Analysis of Knowledge of Junior doctors about Biomedical Waste

S. No	Knowledge Questions	N	%
1.	Have you heard of Biomedical Waste?	128	100
2.	Have you heard of Biomedical Waste Management?	128	100
3.	Have you heard of Biomedical Waste Rule 1998?	88	68.8
4.	Have you heard of Biomedical Waste Rule 2016?	78	60.9
5.	Do you know Biohazard symbol?	121	94.5
6.	Have you heard about "3Rs" of Waste management hierarchy?	95	74.2
7.	Do you know different categories of Biomedical Waste?	127	99.2
8.	Do you know about segregation at source?	110	85.9
9.	Are you aware of Color-coded bags for disposal of BMW?	123	96.1
10.	Have you heard of CBMWTF?	46	35.9

S. No	Knowledge Questions	N	%
11.	Do you know about various BMW treatment & Disposal methods?	108	84.4
12.	Are chlorinated plastic bags appropriate to use for yellow and red category BMW disposal?	46	35.9
13.	Have you heard of CPCB?	56	43.8
14.	Is red bag appropriate for disposal of discarded N95 masks that were used in COVID-19 ward?	78	60.9
15.	Should PPEs such as goggles, face-shield, that were used in COVID-19 ward be discarded in yellow bag?	57	44.5
16.	Should yellow bag be used for disposal of Liquid wastes like infected secretions, aspirated body fluids, liquid from laboratories and floor washings, cleaning, house-keeping and disinfecting activities etc.?	101	78.9
17.	Is incineration considered the most preferred method of treatment for contaminated recyclable wastes?	75	58.6
18.	Are contaminated gloves discarded in yellow colored bag?	72	56.3

Attitude of junior doctors in Biomedical Waste Management (Table 3*):* Favorable attitude was found among 73 (57.0%) only while the mean attitude score was 40.89 ± 3.246 out of 50. The post graduate/doctoral residents (65.91 %) maintained a more favorable attitude than interns (37.50%). 118 (92.2%) respondents strongly agreed that proper handling of BMW is necessary in healthcare areas. Proper BMW management appeared to be unnecessarily time consuming for only 6 (4.7%) participants. Only 21 (16.4%) strongly disagreed that segregation at source put extra burden on work. The necessity of disinfection of the inner and outer surfaces of containers/bins/trolleys used for storage of COVID-19 wastes with 1% sodium hypochlorite solution on a daily basis was felt logical to only 50 (39.1%) respondents agreeable strongly. Importance of maintaining separate records of COVID 19 waste was agreed upon by 58 (45.8 %) of the participants.

Table-3: Attitude of Junior doctors in Biomedical waste management(n=128)

S No	Attitude questions	Strongly agree		Agree		Neutral		Disagree		Strongly Disagree	
		N	%	N	%	N	%	N	%	N	%
1.	Proper handling of BMW is necessary in health care areas.	118	92.2	10	7.8	0	0	0	0	0	0
2.	Biomedical Waste Management is a team work	102	79.7	22	17.2	4	3.1	0	0	0	0
3.	Proper BMW management is time consuming	21	16.4	59	46.1	29	22.7	13	10.2	6	4.7
4.	Segregation of waste generated at source put extra burden on work	7	5.5	34	26.6	20	15.6	46	35.9	21	16.4
5.	Regular Upgradation of knowledge of BMW management is necessary	83	64.8	34	26.6	5	3.9	6	4.7	0	0
6.	Doctors generally have very low risk of acquiring infections from patient	1	0.8	4	3.1	8	6.3	33	25.8	82	64.1
7.	Proper BMW management enhance the quality assurance of healthcare sectors	83	64.8	34	26.6	4	3.1	6	4.7	1	0.8
8.	Labelling BMW containers does not carry any special significance	6	4.7	9	7.0	6	4.7	32	25.0	75	58.6
9.	It is mandatory to disinfect the (inner and outer) surface of containers/ bins/trolleys (used for storage of COVID-19 waste) with 1% sodium hypochlorite solution daily.	50	39.1	45	35.2	21	16.4	10	7.8	2	1.6
10.	It is mandatory to maintain separate records of COVID 19 waste.	58	45.3	54	42.2	15	11.7	1	0.8	0	0

Practice of junior doctors in handling of biomedical waste (Table 4)*:* We found that 64 out of 128 (50.0%) respondents had adequate practices. PG/PD residents observed more adequate practices (60.22%) than interns (31.25%). The mean score of practice calculated was 26.836 ± 4.889. Sixty five (50.8%) always separated BMW at point of generation. use of separate bags for COVID 19 waste was always followed by 76 (59.4%); while only 44 (34.4%) always and 41 (32.0%) never used double bags for COVID waste. Fifty one (39.8%) of the respondents never cut the mask before disposal and 72 (56.3%) of the participants never mixed BMW with general wastes. Majority, 52 (40.6%) answered that they always labeled the BMW bags or containers as COVID 19 waste. Only 37 (28.9%) junior doctors said that they regularly attended the training on BMW management organized by the institution.

Table-4: Practice of Junior doctors in handling Biomedical Waste (n=128)

S. No	Practice Questions	Never		Sometimes		Always	
		N	%	N	%	N	%
1.	Do you separate BMW at point of generation?	6	4.7	57	44.5	65	50.8
2.	Do you use PPE while handling BMW?	38	29.7	63	49.2	27	21.1
3.	Do you use separate bags for COVID19 waste management?	17	13.3	35	27.3	76	59.4
4.	Do you use double bags for COVID-19 waste?	41	32.0	43	33.6	44	34.4
5.	Do you cut the mask before disposal?	53	41.4	45	35.2	30	23.4
6.	Do you store COVID-19 waste separate from other BMW prior to handling over to CBMWTF?	27	21.1	50	39.1	51	39.8
7.	Do you put non-infectious waste into Black colored bag?	25	19.5	35	27.3	68	53.1
8.	Do you dispose the metallic sharp items into white translucent leak proof, puncture proof, and tamper proof containers?	11	8.6	18	14.1	99	77.3
9.	Do you mix biomedical waste with general waste produced at hospital?	72	56.3	42	32.8	14	10.9
10.	Do you label the BMW bags or containers as COVID-19 waste before transporting to CBMWTF?	28	21.9	48	37.5	52	40.6
11.	Do you report to concerned authority if any accident while handling BMW occurs?	19	14.8	49	38.3	60	46.9
12.	Do you attend the BMW management training organized by your institution regularly?	39	30.5	52	40.6	37	28.9

Association of the KAP of the junior doctors on BMW management with socio-demographic variables (Table 5)*:* It showed that there was significant strength of association between the level of knowledge and the working category i.e., interns or residents; with residents showing higher level of knowledge than interns ($\chi 2$ =3.962, *df* =1, *p*=0.047). PG/PD residents showed better attitude than interns with a significant correlation ($\chi 2$=9.057,df=1, *p*=0.003). The same for hostel dwellers and day-scholars showed that day-scholars observed statistically favorable attitude towards BMW management than their hostelite counterparts ($\chi 2$=6.862, df=1, *p*=0.009). The residents and those who spent eight hours or less than eight hours in hospital on duty showed more compliant practice for BMW rules than those spent more than eight hours ($\chi 2$=14.626,df=2, *p*=0.001).

Table-5: Association of KAP of Biomedical waste Management with Socio-demographic variables					
Socio-demography		**Knowledge**			
		Inadequate (n)	Adequate (n)	Total	Statistics
Working Category	Interns	23	17	40	$\chi 2$=3.962, df=1
	Residents	34	54	88	**p=0.047**
Socio-demography		**Attitude**			
		Unfavorable (n)	Favorable (n)	Total	Statistics
Working Category	Interns	25	15	40	$\chi 2$=9.057, df=1
	Residents	30	58	88	**p=0.003**
Residence	Day- scholar	25	50	75	$\chi 2$=6.862, df=1
	Hostel dwellers	30	23	53	**p=0.009**
Socio-demography		**Practice**			
		Inadequate(n)	Adequate(n)	Total	Statistics
Working Category	Interns	29	11	40	$\chi 2$=12.208, df=2
	Residents	35	53	88	**p=0.002**
Working hours per day	<8 hrs	4	7	11	$\chi 2$=14.626, df=2
	>8 hrs	58	41	99	**p=0.001**
	8 hrs	2	16	18	

Discussion

In this study, more than half of the junior doctors had attained mean knowledge score above the average. This finding was supported by Mitiku et al in a similar study where 62.4 % of study population attained comparable score [7]. However, only 43.2% of the HCW had excellent knowledge as revealed in a recent study done in West Bengal [8]. In Delhi, 33.3% MBBS students scored over 70% in knowledge section in comparison to PG/PD residents attaining 62.2% [9]. In study among operation theatre personnel in Bangalore, 19.3% PG/PD residents and 16.7% interns could secure satisfactory knowledge score (Aanandaswamy et al) [10].

The importance of segregation at source was known to 85.9% of the participants in our study and to 100% of participants in a study conducted in a COVID hospital in Bangalore (Basavaraj et al., 2021) [11]. The level of basic awareness was comparable in other sectors of the country (78.8%, Das et al., 2012, West Bengal) Allahabad city study, this was (81.3%; Mathur et al., 2011, Uttar Pradesh) [12-13]. So, the level of awareness was sufficiently high from long before the advent of Covid-19 pandemic. The study participants had better clarity on the concepts of scientific segregation of potentially soiled and infectious PPE gears including gloves in colour coded bags/bins in comparison to dental residents of New Delhi, who should possess flawless practicing skill in this issue[14].

We have found that PG/PD residents adopt better KAP in BMW management that interns. Probably, experience, exposure and motivation helped them to achieve skills. Association between knowledge score and age groups, nationality, education status and work experience duration were published in a relevant Saudi study (Thirunavukkarasu et al., 2022) [15]. A statistically significant association was found among knowledge level and work experience in a study conducted in West Bengal (Dalui, Anirban et al. 2021) and study in Nigeria (Oluwatosin Makanjuola et al., 2021) [8,16]. Two studies on attitude of HCWs towards BMW management revealed Indian had better professional attitude than their Ethiopian counterparts [7-8].

Participants of our study and similar other study conducted in India strongly disagreed that proper BMW management is time consuming, while in a study in Puducherry (Pradha V. et al., 2021), 91.43% doctors agreed that safe disposal of BMW put an extra burden on them [6, 8, 17]. Only 21 (16.4%) junior doctors of our study strongly disagreed that segregation of BMW at point of generation put extra burden of work. Similarly, in a study in West Bengal (Dalui, Anirban et al. 2021) only 21.6% strongly disagreed with the statement [8].

Regular upgradation of knowledge of BMW is necessary according to 83 (64.8%) of our participants while this number was 50.3% in the study in West Bengal (Dalui, Anirban et al. 2021) & 50% in the Al Ahsa study (Jalal et al., 2021) [6, 8]. Our PG/PD residents showed better attitude than interns with a significant correlation ($\chi2$=9.057,df=1, p=0.003) and also day-scholars showed statistically favorable attitude towards BMW management than their hostelite counterparts ($\chi2$=6.862, df=1, p=0.009) though no significant association was present with knowledge and attitude scores. However, the study conducted by Thirunavukkarasu et al. in 2022 found moderately strong correlation between attitude and practice scores. Statistically significant association between attitude and the age of the participant was present in a study in Saudi Arabia [15, 18].

The practice of BMW management by study subjects were adequate and comparable to the other international studies conducted in Saudi Arabia, Ethiopia [15, 7, 18, 19]. One Indian study from Karnataka, however, concluded poor practice amongst the PG/PD residents and interns as well. The practices of segregation of wastes at source, labeling the BMW bags as COVID-19 wastes were observed by majority of the present study participants as comparable to other similar study participants from India and overseas [6, 8, 16, 20-21]. A study by Basavaraj et al (2021) from Bangalore claims special mention as 100% of participants were stringent to the practice of BMW segregation at source [11].

Reporting needle stick injury (NSI) to the competent authority is an important aspect of HCW health practice. This is adopted by only 46. 9% of the participants in present study in contrast to 95.53% in study by Basavaraj et al and 62.6 % as found by Mathur et al (2011) [11, 13]. A poor awareness about own safety in the setting of a pandemic is definitely a matter of concern for our own residents. As we searched for the reasons we found that only 37 (28.9%) junior doctors regularly attended the training on BMW management and Standard precaution organized by the institution. The similar gloomy scenario was found from the studied from Nigeria (21.5%) [16]. Aanandaswamy et al., (2019) reported that 63.9% of the residents and 61.1% interns received training of BMW management [10].

Present study revealed significant association between practice of BMW management with three socio-demographic variables namely Age, Working category and Working Hours per day. The Saudi study (Thirunavukkarasu et al., 2022) opined significant association between practice and age groups, gender, nationality, marital status and duration of work experience [15]. It is important to note for the administration and management from the study that ceaseless prolonged work as happened during the pandemic failed to extract better performance from the study participants.

Conclusion

The junior doctors participated in present study have suboptimal knowledge about BMW and its management. KAP levels were proportional to the experience and seniority. Only half of the study population had favorable practice of BMW management. Significant association between the level of knowledge and working category of the study population was noted in the study. Strength of our study was all the junior doctors were trained about these fundamental and basic aspects of BMW management during their undergraduate training.

However, the study findings emphasized the necessity of regular training for acquisition of optimal skills and KAP. We have our shares of limitations too like small sample size, short study period, and undefined follow up. The study population included was only junior doctors. In future the study can be designed with a bigger sample size for longer period

with provisions of follow up, including the other category of HCWs like nursing staff, paramedical workers etc. A systematic review and meta-analysis can also be done in this field in upcoming days.

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