

## Efficient Biomedical Waste Management- Need of the Time: A Lesson Learnt From COVID-19 Pandemic

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### ABSTRACT

**Background:** Medical waste management (MWM) is of concern to the medical and general community. Adequate knowledge regarding the management of healthcare waste is an important precursor to the synthesis of appropriate attitudes and practices of proper handling and disposal of medical waste by healthcare workers (HCWs). This study aimed to investigate the knowledge, attitudes, and practices of doctors, nurses, laboratory technicians, and housekeeping staff, regarding BMW management at a tertiary hospital in Telangana.

**Subjects and Method:** This was a cross-sectional study carried out at a tertiary health care center in Mahbubnagar district, Telangana, India. A stratified sampling technique was used to select the different cadre of healthcare providers from the hospital. A self-administered questionnaire assessing the knowledge, attitude, and practices of 300 study participants was prepared. Data were analyzed using SPSS software version 26. Descriptive statistics were used to summarize the data.

**Results:** The majority of respondents were nursing staff 43% (143/300) followed by doctors, interns, sanitation workers, and lab technicians. About 3/4th of the HCWs had experience of more than 3 years. Only 65% of the doctors have correct knowledge of the colour coding of bags. About only 20% of the nursing staff practiced segregation of the waste on-site. The practice of hand washing was significantly higher among female HCWs ( $p = 0.010$ ).

**Conclusion:** This study showed that there is a clear lack of BMW management among the HCW especially class IV staff who handle a large. Thus ongoing training should be provided to HCWs on MWM, with more attention to knowledge of regulatory requirements, and involvement of HCWs in the development of MWM policies to enhance compliance.

**Keywords:** Biomedical waste management, health care workers, COVID-19.

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## BACKGROUND

The term “Bio-Medical Waste” (BMW) includes all the waste generated from any medical procedure in healthcare facilities, research centers, and laboratories during diagnosis, treatment, immunization of human beings and animals, and production or testing of biological materials. About 85% of waste which is generated from the hospital constitutes non-harmful waste, which is equivalent to domestic waste the remaining 15% of this waste is infectious or can contain chemical and radioactive constituents (WHO, 2018; WHO, 2017).

The severe acute respiratory syndrome coronavirus 2 (SARS-COV-2) virus causes COVID-19, a contagious respiratory ailment. The first incidence was recorded in China in December 2019. And in March 2020, the WHO declared it a pandemic due to its quick spread. Up until September 2022, there have been reported about 614,385,693 cases (WHO, 2020). Globally the COVID-19 pandemic resulted in the generation of 8700 tonnes of PPE, 5900 tonnes of masks, 36000 tonnes of gloves, and 140 million test kits by November 2021. As of 7 December, vaccination would have generated over 1,44,000 tonnes of additional waste comprising 88,000 tonnes of glass vials, 48,000 tonnes of syringes plus needles, and 8,000 tonnes of safety boxes (WHO, 2022) Evaluation of COVID-19 data in five Asian cities by the United Nations Development Program (UNDP) found that hazardous healthcare waste has increased by 3.4 kg/bed/day. This amounts to almost 10 times more hazardous healthcare waste than is typically generated, which is between 0.2 and 0.5 kg/bed/day (UNEP, 2020).

According to CPCB data, the amount of BMW produced in the states/UTs of Haryana, Uttar Pradesh, Rajasthan, and Delhi surged from 94 tonnes in May 2020 to 761 tonnes in July. Keen monitoring of the

BMW disposal is necessary not only from a COVID-19 point of view but also as a routine part of hospital waste management across the country. Barcoding needs to be done to each bag and container with biomedical waste. This will allow state boards/CPCB to track all waste generated and its management (EPCA, 2020). A total of 56,898.14 Tonnes of COVID-19-infected waste were produced between June 2020 and June 2021. By 2023, it is anticipated that BMW will produce 975.5 metric tonnes daily (Das et al., 2020).

Appropriate management of Biomedical waste is crucial during these pandemic periods, failure of which can lead to a surge in the number of COVID cases. Central Pollution Control Board under the Ministry of Environment, Forest and Climate Change, India has issued guidelines on the segregation of waste and BMW from different quarantine centres /homes-care & healthcare facilities managing COVID-19 patients and on disposal of PPEs, implementation of which is crucial for, thus preventing the wastes of “the sick” contaminate the “the healthy” (CPCB New Delhi, 2020).

To assess the current status of Biomedical waste management in the current field practice area we carried out the present study. Also, no such study has been carried out in the past as far as this district is concerned. This study aimed to assess the levels of knowledge and attitude towards BMW management among HCWs during the COVID-19 pandemic and to assess the levels of current practice about BMW management among HCW's.

## SUBJECTS AND METHOD

### 1. Study Design

Institutional-based descriptive cross-sectional study carried out at a tertiary health care center in Mahbubnagar district, Telangana, India.

## 2. Population and Sample

Staff working in the different departments of the hospital who are directly involved and play key roles in COVID-19 BMW management. i.e. Doctors, Interns, Nurses, Laboratory Technicians, and Sanitation workers were part of the study. A stratified sampling technique was used to select the different cadre of healthcare providers from the hospital. The inclusion criteria in this study were Health Care Workers (HCW's) giving consent to the study, HCW's with a minimum of 6 months of professional experience, and HCW's who cared for COVID patients. The exclusion criteria in this study were HCWs (mostly Sanitation Workers) who are illiterate with hearing impairment, HCW's below 20 years of age.

Sample size calculation based on the other similar study (Dalui et.al, 2021) 75% will be considered as a percentage of HCWs with precise knowledge, good practice and a favourable attitude toward BMW management. The minimum sample size came to be 297 (approximately 300). We proportionately divided the above sample size among the different healthcare workers. Thus we had 50 Doctors, 50 Interns, 130 Lab technicians, and 50 Sanitary Workers (Total:300).

## 3. Study Variables

The variables in this study were sociodemographic factors pertaining to the study subjects were studied. The knowledge, attitude, and practice related to biomedical waste management were studied among the study subjects.

## 4. Operational Definition of Variables

**Knowledge of BMW management:** is counted from 75% to 100% (15 to 20) as excellent knowledge, from 50% to 74% (10 to 14) as good knowledge; and below 50% (less than 10) as poor knowledge

**Attitude towards BMW management:** is an overall score of attitude that was calculated by adding all scores of the Likert scale

of HCWs and the mean was computed by dividing the overall attitude score by the number of study participants. Finally, unfavorable and favorable attitudes were assigned to attitude scores below the mean and above or equal to the mean score respectively.

**Practice of BMW management:** a practice of BMW by HCW will be categorized into Always, sometimes, never, and ultimate scoring will be given.

## 5. Study Instruments

The data was collected using a self-administered questionnaire after obtaining informed consent from individuals. The privacy of respondents was assured by not asking for their identity information such as name, or employee identity number. The questionnaire consisted of four sections. It will take around 10-30 minutes to complete the questionnaire. Four Sections include the following: (i) Section 1, demographic information; (ii) Section 2, knowledge questionnaire.

There were 20 multiple-choice questions, with 4 options for each question, and one correct answer to be opted. The score interpretations will be graded as excellent, good, and poor (i.e.>75%, 50 to 74%, and <50%). (Dauli et.al 2021); (iii) Section 3, the practice questionnaire contained ten questions with the options "always", "sometimes", and "never". A questionnaire will be filled out directly by observing the practice of HCWs (Dauli et al., 2021); (iv) Section 4, the attitude questionnaire had ten questions on attitude towards BMW management. A five-point Likert scale of measurement was used to represent the scores (Dauli et al., 2021). The validity of the questionnaire prepared in the local language was tested by Cronbach  $\alpha$  which came out to be ( $\alpha= 0.878$ ) which shows good strength.

## 6. Data Analysis

Statistical Package for Social Sciences (SPSS), (IBM Corp. Released 2012. IBM

SPSS Statistics for Windows, Version 28.0. Armonk, NY, USA: IBM Corp.

**7. Research Ethics**

Ethical approval has been obtained from the Institutional Ethics Committee for Biomedical and Health Research, Government Medical College, Mahabubnagar. Letter Rc No: GMCMBNR/IECMR/AP/1/11/2022.

**RESULTS**

**1. Univariate Analysis**

A total of 300 healthcare workers participated in the study after applying the inclu-

sion and exclusion criteria. Nearly half of the participants belonged to the 21 to 30 age group followed by the 31 to 40 age group accounting for 40% of study participants. About 70% of the HCW's were females, the majority were graduates (65%) with either a degree or diploma. The study participants included 43% of nursing staff followed by doctors, interns, sanitation workers, and lab technicians. Experience-wise the HCW's were better with 75% of them having more than 3 years of experience.

**Table 1. Socio-demographic characteristics of the healthcare workers (HCWs) (N= 300)**

Characteristics	Category	Frequency (N)	Percentage (%)
<b>Age</b>	21–30 years	142	47.3%
	31–40 years	122	40.6%
	41–50 years	31	10.3%
	> 50 years	5	1.66%
<b>Cadre</b>	Doctors	50	16.6%
	Interns	50	16.6%
	Staff Nurses	130	43.3%
	Lab tech	20	6.6%
	Sanitation Workers	50	16.6%
<b>Gender</b>	Male	90	30.0%
	Female	210	70.0%
<b>Education</b>	Below Graduate	48	16.0%
	Graduate	195	65.0%
	Post Graduate	57	19.0%
<b>Experience</b>	< 3 yrs	76	25.3%
	> 3 yrs	224	74.6%
<b>Working</b>	Wards	218	72.6%
	ICU	82	27.3%

As in Table 2, this study assessed the status of knowledge regarding Biomedical Waste. Here the study analyzed the HCW's who had correct knowledge of BMW management as per BMW management rules 2019. Overall doctors were showing better scoring performance (65%). Knowledge among Sanitation

workers seems to be poor amongst all (11%). Knowledge regarding the pretreatment of BMW before disposal was found to be poor among all the cadres i.e. 38% among doctors and 16% among sanitation workers. There is a definite need for training esp. among Class IV workers.

**Table 2. Healthcare personnel having correct knowledge of biomedical waste management (N = 300)**

HCWs	Colour Coding of Bags for PPE disposal		BMW as a source of Infection		Max time of storage		Pre-treatment	
	N	%	N	%	N	%	N	%
<b>Doctors (n= 50)</b>	32	65%	50	100%	30	60%	19	38%
<b>Interns (n=50)</b>	23	46%	49	98%	28	56%	15	30%
<b>Staff nurses (n=130)</b>	33	25%	111	85%	78	60%	36	27%
<b>Laboratory workers (n=20)</b>	9	46%	18	90%	10	50%	2	10%
<b>Sanitation workers (n=50)</b>	16	32%	11	22%	9	18%	8	16%

Cronbach's  $\alpha=0.878$

Assessment of the attitude component was done by classifying the score as favorable and unfavorable. Among the HCW's Doctors showed the highest favorable attitude (Mean score= 94%). Also, it was nice to see that

sanitation workers scored well (Mean score= 89%) compared to staff nurses (Mean= 77%) as a period of contact for handling BMW is considerably more among sanitation workers.

**Table 3. Healthcare personnel showing favorable attitude\* regarding biomedical waste management\* (N = 300)**

HCWs	Regarding segregation at site		Need of Training for BMW management		Teamwork		Feeling it is extra Burden \$	
	N	%	N	%	N	%	N	%
<b>Doctors (n= 50)</b>	48	96%	50	100%	49	98%	17	34%
<b>Interns (n=50)</b>	46	92%	50	100%	47	94%	13	26%
<b>Staff nurses (n=130)</b>	114	88%	123	95%	120	92%	42	32%
<b>Laboratory workers (n=20)</b>	16	80%	17	85%	17	85%	8	40%
<b>Sanitation workers (n=50)</b>	47	94%	48	96%	45	90%	38	76%

Cronbach's  $\alpha - 0.8788$

\* Here options ticked for Strongly Agree and Agree were screened

\$ Here reverse coding was done while collecting data hence selected Strongly agree and Agree

In Table 4 and Figure 1 regarding to the practice of handling Biomedical waste we have categorized the practice component as Always, Sometimes, and Never. This study analyzed HCW's who always indulge in BMW management. The practice of hand washing ,Immunization with Covishield

and use of PPE was done by almost all the health care workers i.e >90%. Practice of segregation of waste at the site was poor among all the HCW's with 62% among doctors and 6% among sanitation workers. This highlights improper logistic management that occurred during COVID time.

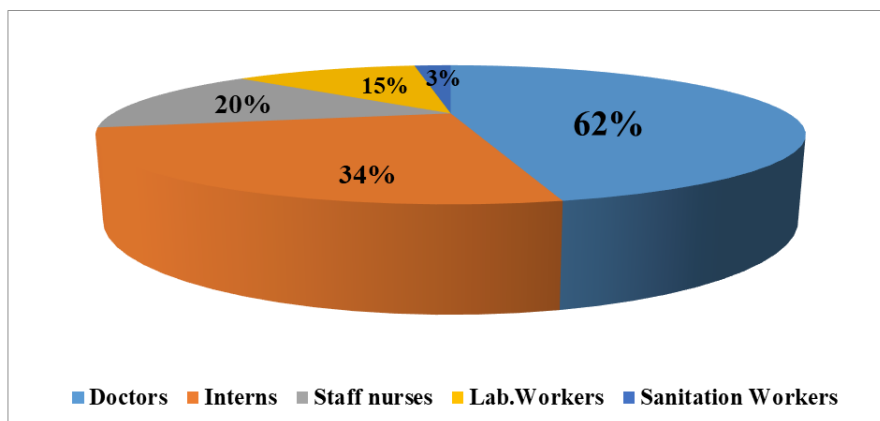
**Table 4. Healthcare personnel who Always practicing biomedical waste management (N = 300)**

HCWs	Hand hygiene		Use PPE while Handling biomedical wastes		Immunization		Segregation of BMW at site	
	N	%	N	%	N	%	N	%
<b>Doctors (n= 50)</b>	50	100%	48	99%	47	94%	31	62%
<b>Interns (n=50)</b>	50	100%	45	90%	47	94%	17	34%
<b>Staff nurses (n=130)</b>	118	91%	118	91%	111	85%	102	78%

HCWs	Hand hygiene		Use PPE while Handling biomedical wastes		Immunization		Segregation of BMW at site	
	N	%	N	%	N	%	N	%
<b>Laboratory workers (n=20)</b>	20	100%	18	90%	16	80%	3	15%
<b>Sanitation workers (n=50)</b>	48	96%	31	62%	45	90%	3	6%

Cronbach's  $\alpha$  – 0.8788

\* Out of Always, Sometimes, and Never options regarding the practice of BMW management



**Figure 1. Segregation of BMW at site by HCW's**

**2. Bivariate Analysis**

As in Table 5, The Social and Biological characteristics of study participants are studied, a total of 300 healthcare workers participated in the study after applying the inclusion and exclusion criteria. A bivariate analysis of

the association of knowledge of the HCW's and socio-biological parameters was assessed. Variables like age, educational qualification, and occupation showed statistically significant association with knowledge of BMW management ( $p < 0.050$ ).

**Table 5. Association of the knowledge of HCPs with demographic variables**

Variables	Category	Excellent		Good		Poor		P
		N	%	N	%	N	%	
<b>Age Group</b>	21–30 years	22	15%	41	28%	79	55%	0.006
	31–40 years	14	11%	53	43%	55	45%	
	41–50 years	0	0%	9	29%	22	71%	
	> 50 years	0	0%	1	20%	4	80%	
<b>Gender</b>	Male	19	21%	23	25%	48	53%	0.626
	Female	17	8%	81	38%	112	53%	
<b>Educational Qualification</b>	Below Graduate	24	50%	10	20%	36	75%	0.003*
	Graduate	43	22%	88	45%	64	32%	
	Post Graduate	41	71%	12	21%	4	7%	
<b>Occupation</b>	Doctor	17	34%	18	36%	15	30%	0.001
	Intern	13	26%	14	28%	23	46%	
	Nursing Staff	3	2%	65	50%	62	47%	
	Lab tech	5	25%	6	30%	9	45%	
<b>Experience</b>	Sanitation Worker	0	0%	1	2%	49	98%	0.145
	< 3 years	9	16%	23	42%	22	40%	
	>3 years	5	4%	40	38%	59	56%	
<b>Working Station</b>	Ward	52	23%	79	36%	87	39%	0.369
	ICU	54	65%	22	26%	6	7%	

\* Somers d value for Ordinal by Ordinal crosstab

Table 6 shows the current study revealed that the HCW who had good knowledge also had good practice of BMW which was found to be statistically significant. But on the

other hand, having better knowledge did not significantly change the attitude of the HCW's.

**Table 6. Relation between Knowledge -Practice and Knowledge -Attitude of BMW management among HCW's**

Knowledge of BMW Management	The practice of BMW among HCW's						Attitude of BMW among HCW's					
	Good		Poor		OR	p	Good		Poor		RR	p
	N	%	N	%			N	%	N	%		
<b>Good</b>	150	50%	12	4%	2.37	0.020	160	53%	1	3%	1.01	0.1531*
<b>Poor</b>	116	39%	22	7%			134	45%	5	6%		

§ Chi square test; \* Fisher Exact test

### DISCUSSION

Biomedical Waste has a high potential for disease transmission directly or indirectly. During COVID-19 especially during the second wave a sudden hike in a number of cases and deaths was noted. That amount of Biomedical waste generated was also high. Many of the government agencies have drafted guidelines for corona prevention one of them was guidelines for Biomedical waste management. In the current study, we have tried to do a situational analysis regarding BMW management among healthcare workers in our tertiary healthcare center.

A knowledge-related question like color coding of the bag, Maximum time of storage of waste, and Pretreatment of the waste were asked which showed 90% of the Doctors and 80% of Interns had excellent knowledge of case sanitation workers 64% of them had excellent knowledge. A study conducted by Hiremath et al. (2017) showed overall awareness regarding colour coding of bags to be 97%. A study by Basavaraj et al. (2021) in a dedicated COVID Hospital showed that about 30% of Doctors had poor knowledge of BMW management. In contrast to this study, Parida et al. (2019) from New Delhi noticed that nurses had comparatively better knowledge than doctors.e 75% vs 74% (Table 2).

This Study seasoned the attitude of the HCW's towards segregation of waste on-site, whether BMW management is a teamwork, and regarding the need for training of HCW's. Regarding those questions, the HCW's showed favorable attitudes ranging from 80% to 100%. Also, the belief that BMW management is an extra burden was seen to be highest among Sanitation workers which tells the increase in the workload and scarcity of manpower felt among them. Teshiwal Deress from northern Ethiopia found favorable attitudes among the HCW's ranging from 65-90%. But here only 28% of the HCW's express BMW management as an extra burden (Deress et al., 2018). Similar results were obtained from the work done by Dalui et al. (2021) where favorable attitude was seen among healthcare workers ranging from 70% to 90%. But when asked about BMW management as an extra burden we got mixed results (Table 3).

Some of the practices of BMW management like maintaining hand hygiene, using PPE while handling BMW, Immunization against hepatitis, and COVID-19 vaccination were observed among the HCW's. Hand Hygiene was practiced by almost all the HCWs ranging from 100% among Doctors, Interns, and Laboratory workers to 91% among staff nurses. Immunization coverage was seen among 94% of Doctors

and Interns, 85% of nursing staff, and 90% among sanitation workers. Only 62% of the doctors practiced segregation of waste on-site in the case of nurses it was high i.e. about 78%. A study conducted by Day and Das (2020) from the Central Institute of Psychiatry, Ranchi, Jharkhand showed much better results as segregation of waste on site was practiced by 98% of nurses vs 76% of Doctors. A study by Lavanya et al. (2018) from Andhra Pradesh found that Hand washing practices were 90% among nurses and 40% among sanitation workers. The use of PPE was only 60% among sanitation workers.

This study assessed the knowledge of the HCW's against the socio-demographic factors. This study found a statistically significant relation with independent variables like Age, Education, and Occupation of the HCW's ( $p= 0.006$ ;  $0.003$ ;  $0.001$ ) respectively. A study by Jalal et al. (2021) from Al-Ahsa found the statistical significance of Gender, education, and work experience ( $p < 0.050$ ). Imchen et al. (2017) assessed the practice against sociodemographic factors which showed a statistically significant association for age, gender, and Occupation ( $p < 0.005$ ) (Table 5).

Female HCW's practiced handwashing with an odds of 3 as compared to Male HCW's. and Doctors showed higher odds by 3.23 compared to other sanitation workers which was statistically significant ( $p < 0.050$ ). A study conducted by Mitiku et al. (2021) from Ethiopia showed that females educated HCW's MSc and above 4 times good practice of BMW as compared to diploma and below education. Another study by Amaan et.al (2022) from Dhaka Bangladesh found statistically significant hygiene practices of doctors compared to nurses.

Thus, COVID-19 has proven that there may be a sudden surge in the need for medical health care, particularly in areas

closer to major cities. In our investigation, we saw a sudden increase in the hospital's caseload. The current investigation also revealed a lack of understanding, a negative attitude, and poor practices regarding Biomedical Waste Management. Training of HCWs is required, particularly for Class IV workers who handle biomedical waste the most and are therefore most at risk of consequences. Workers' capacity for uncertain circumstances will be strengthened through training.

#### **AUTHOR CONTRIBUTION**

Dr. Munnaji Mavatkar: Conceived and Designed Analysis, Performed the Analysis, and Wrote the Paper and Correspondance for the reviewer's feedback on the manuscript; Dr. Kiran Prakash K and Dr. Deepti Vemu: Made framework of the Study and Wrote paper; Dr. Syeda Fahada: Contributed to Analysis tool; Sravani Gavi Reddy (Student 2018 batch): Data collection.

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Nil.

#### **CONFLICT OF INTEREST**

There is no conflict of interest in this study.

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