To study the knowledge about the handling of biomedical waste among health-care workers in a COVID-19 hospital setting

Sukhbir Singh, Vrinda Tom¹, Ramesh Verma², Ishwanti Malik¹, Madan Gopal Vashist³, Pushpa Dahiya⁴

Abstract:
BACKGROUND: The unexpected increase in COVID-19-related waste and its inappropriate disposal had blown up the threat of retransmission of this infection and adversely impacted the environment. The aim of this study was to evaluate the existing knowledge about the handling of biomedical waste (BMW) in the COVID-19 Hospital setting among health-care workers (HCWs).

MATERIALS AND METHODS: It was a prospective cross-sectional study done for 3 months, i.e., October 2020–December 2020 among nursing professionals across all seniority posted in COVID hospital. A pretested questionnaire comprised 20 questions was used as a study tool.

RESULTS: The response rate of our study was 94%. The mean age of respondents was 33.97 years, and the mean length of service was 8.32 years. The study revealed that the respondents had a mean knowledge score of 12.21 (Median 12, standard deviation 2.129 and 95% confidence interval of 11.92–12.51).

CONCLUSIONS: There is consensus among the researchers/scholars that COVID-BMW hazards are much more significant than regular BMW. Therefore, its awareness among the HCWs can be a panacea for safer handling of BMW generated in COVID Hospital.

Keywords: Biomedical waste, central pollution control board, COVID-19, health care worker, pandemic, united nations environment program, World Health Organization

Introduction

Biomedical waste (BMW) means any debris generated during the diagnosis, treatment, or immunization of human beings or animals or research on it or in the production or testing thereof.¹ In a developing country like India, approximately 1.5–2 kg/bed/day BMW is generated.² BMW is of different types and may cause different infectious diseases,³ and cause disruptions in the environment and an unfavorable impact on ecological equilibrium.⁴ The recent outbreak of novel coronavirus (COVID-19) Pandemic had considerable public health implications.⁶

Among this Pandemic, BMW management may worsen due to indiscriminate use of personal protective equipment (PPE kits), N95 masks, gloves, etc. Despite Government guidelines regarding rational use, the hospitals face great demand for PPEs, etc., from health-care workers (HCWs) due to fear of contamination with COVID-19.⁷ The unexpected increase in COVID-19-related waste and its inappropriate disposal had blown up the threat of retransmission of this infection and adversely impacted...
the environment. The Central Pollution Control Board (CPCB) had published guidelines for the safe management of this highly infectious waste generated from COVID-19 hospitals and quarantine homes. These guidelines are different from BMW (M and H) Rules, 2016.

With this background in mind, this study was planned to evaluate the existing knowledge about the handling of BMW in COVID-19 hospital setting among HCW of tertiary care, referral, academic and research hospital of Northern India. The study also aimed to find an association between the knowledge differential and selected variables for assessing the future needs of training (if any) and Protecting HCWs from occupational exposure to this highly infectious disease. The permission was obtained from the Institute Ethics Committee before conducting this study.

Materials and Methods

Study design and setting
It was a prospective cross-sectional study carried for 3 months, i.e., October 2020–December 2020 at a tertiary care Hospital in northern India.

Study participants and sampling
All nursing professionals (n = 218) posted in wards, Intensive Care Units, Operation Theatres, sample collection areas dedicated to treating COVID-19 patients were included in the study. They were directly involved in the patient care activities of COVID-19 and the generation of BMW in the COVID-19 hospital setting.

Data collection tool and technique
A self-administered survey questionnaire was prepared after extensive literature reading and used as a study tool. The questionnaire was pilot tested among 20 different experts to check its validity. The questionnaire had two parts. The first part includes questions related to the sociodemographic profile of the participants. The second part contains questions regarding various aspects of BMW management specific to the COVID hospital setting. The questionnaire consisted of 19 closed-ended questions for measuring the existing knowledge about BMW in COVID hospital and one open-ended statement for assessing HCWs perception of their knowledge and training adequacy. The questionnaire was designed on Google form and administered to the study participants through their WhatsApp numbers. All the respondents furnished informed consent through Google forms. The study participants were requested to fill the questionnaire at the earliest and preferably within a week. The participants who failed to submit the filled questionnaires within the prescribed timeline were reminded a maximum of three times at an interval of 1 week for submitting their responses. Participants who failed to respond after repeated reminders were excluded from the study. The nursing staff involved in pilot testing was also not included in the study. All nineteen questions were scored. Each correct response was given a score of one. Wrong answers and unanswered questions were given zero marks. The overall mean score (95% confidence interval [CI]) was calculated for all participants. The descriptive and Chi-square test were used for subgroup analysis.

Ethical considerations
The ethical approval was obtained from Institute Ethics Committee before conducting the study. The informed consent was taken from each participant, and anonymity and confidentiality of the participants are maintained.

Results
A total of 205 nursing professionals responded to our questionnaire and submitted their responses. The sociodemographic analysis revealed that 70% were in the age group of 25–35 years, 84% were female, most were married (80%), and from the urban background (75.6%). The study revealed that 97% of respondents were staff nurses, and 64% of respondents had General Nursing Midwifery qualifications. Forty-four percent of the participants had 0–5 years of service [Table 1].

On the descriptive statistical analysis, the mean age of respondents was 33.97 years (Median 32, standard deviation [SD] 7.131 and 95% CI of 32.98–34.95). Similarly, the mean length of service was 8.32 years (Median 6, SD 6.719 and 95% CI of 7.39–9.24) [Table 2]. The respondents had a mean knowledge score of 12.21 (Median 12, SD 2.129 and 95% CI of 11.92–12.51) with a minimum score of 05 and the maximum score of 16 [Figure 1]. The respondents were categorized as very good (>75% knowledge score), good (50%–75% knowledge score), and
average knowledge group categories (<50% knowledge score). Most of the study participants (72.7%) had good knowledge, followed by very good knowledge (17%). On age group-wise analysis, most of the respondents in all age groups had good knowledge scores (Chi-square = 4.9522, P = 0.2923); similarly, females have slightly higher knowledge than males, and the majority of the study participants of these two groups also had good knowledge score (Chi-square = 0.2384, P = 0.8876). In the same way, on marital status (Chi-square = 1.6214, P = 0.9510), place of residence (Chi-square = 1.6489, P = 0.4385), educational qualification (Chi-square = 12.0545, P = 0.0169), designation (Chi-square = 0.9447, P = 0.6235), and length of service (Chi-square = 11.2156, P = 0.0819) wise analysis, it was found that majority of respondents had good knowledge score [Table 3]. The analysis revealed that most respondents (58%) had perceptions about adequate knowledge, but they need further self-updating [Figure 2].

On individual question-wise analysis, the respondents had very good knowledge about the different color-coded bins used to segregate different BMW categories generated in COVID-19 Hospital. They also had very good knowledge about hazards associated with BMW of COVID hospital, labeling, cleaning/disinfection of waste transport trolley, protective gears of waste handlers, and HCWs dealing with packaging and disposal of COVID-19 patient’s dead bodies. On the other hand, the participants had good knowledge about the correct color-coded category of bags for storage of contaminated glass and medicine vials, appropriate method of transporting and disposal of COVID 19 dead bodies, treatment of red bag waste, and layering of bags used to transport BMW from COVID areas. However, the participants had average knowledge about the date of the latest revision in COVID BMW management introduced by the CPCB, disposal of sharp waste, disposal of noninfected general dry waste, and the maximum time permissible for storage of COVID-19 BMW as per guidelines [Table 4].

Discussion

In our study, the response rate of participants was 94%. In our study, the mean knowledge score was higher among younger nurses, females, unmarried, staff nurses, and beginners in service, i.e., 0–5 years of experience and urban backgrounds. None of these subcategories has a statistically significant difference in mean knowledge score (i.e., P > 0.05). The declining trend in the mean

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**Table 1: Distribution of sample size as per age group, gender, marital status, place of residence, educational qualification, designation, and length of service**

| Parameter                  | n (%)     |
|----------------------------|-----------|
| **Age (years)**            |           |
| 25-35                      | 143 (69.8)|
| 36-45                      | 41 (20.0)|
| >45                        | 21 (10.2)|
| **Gender**                 |           |
| Male                       | 32 (15.6)|
| Female                     | 173 (84.4)|
| **Marital status**         |           |
| Married                    | 164 (80.0)|
| Unmarried                  | 38 (18.5)|
| **Resident**               |           |
| Urban                      | 155 (75.6)|
| Rural                      | 50 (24.4)|
| **Education qualification**|           |
| GNM                        | 132 (64.4)|
| BSc                        | 20 (9.8)|
| MSc                        | 53 (25.9)|
| **Designation**            |           |
| Staff nurse                | 198 (96.6)|
| Nursing officer            | 7 (3.4)|
| **Length of service (years)** |       |
| 0-5                        | 91 (44.4)|
| 6-10                       | 52 (25.4)|
| 11-15                      | 37 (18.0)|
| >15                        | 25 (12.2)|

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**Table 2: Descriptive statistical analysis of sociodemographic variables**

| Parameter                  | Mean | Median | Mode | SD  | Minimum | Maximum | 95% CI of the mean |
|----------------------------|------|--------|------|-----|---------|---------|-------------------|
| Age (years)                | 33.97| 32     | 28   | 7.131| 25      | 54      | 32.9838 – 34.9479  |
| Length of service (years)  | 8.32 | 6      | 3    | 6.719| 2       | 32      | 7.39 – 9.24       |

SD=Standard deviation; CI=Confidence interval

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**Figure 2:** Bar diagram showing perception/opinion regarding knowledge and training adequacy on Biomedical Waste Management in COVID-19 Hospital Setting
knowledge score with an increase in age, seniority, and length of service may be explained by the fact that the COVID-19 Pandemic is novel and is faced first time by all HCWs in early 2019. The CPCB has also issued the guidelines for handling BMW of COVID hospitals in March 2019. Thus, there is no impact of seniority, increase in age, or length of service on HCWs knowledge. However, on the other hand, more knowledge among younger and junior professionals may be attributed to the fact that younger professionals have more learning aptitude and are good learners than their senior colleagues. The knowledge differential due to gender, marital status, etc., can be attributed to the sample size difference. It was also found that respondents with BSc nursing have maximum mean knowledge followed by diploma holders and postgraduate degree holders. This difference in knowledge was found statistically significant ($P = 0.0169$). Better knowledge scores in certain groups compared to others could be because of better exposure to the topic in the former compared to the latter.

In our research, most of the respondents (78%) were not aware of the date of the recent revision in COVID BMW guidelines. Aggarwal,[13] has reported that these guidelines are kept specific for ensuring methodical disposal of COVID waste despite the existence of BMW (M and H) Rules, 2016. However, 66% were aware that COVID BMW is hazardous and needs segregation in the proper color-coded bin and must be separately treated. The correct disposal and treatment of COVID BMW are essential as the World Health Organization report,[14] has suggested that widespread discarding, open burning, and incineration can affect air quality and health consequences due to the exposure to pollutants. Similarly, 90% of respondents were aware of the correct disposal of N 95, triple-layer mask, contaminated gauze, etc. About 79% of the study participants were aware of the proper disposal of infected plastic waste such as nitrile gloves, plastic coverall suit, and face shields. On the contrary, the study carried out by Mehrotra et al.,[15] had found that HCWs poorly understood the disposal of PPE. In our study, 84% of participants were aware of the correct disposal of sharp BMW generated in COVID Hospital. Understanding these aspects of COVID-BMW management is crucial, as United Nations Environment Programme,[16] in its report, has also pointed out that

| Parameter                  | Knowledge score groups | Average knowledge | Good knowledge | Very good knowledge | $\chi^2$, $P$       |
|----------------------------|------------------------|-------------------|----------------|---------------------|--------------------|
| Age (years)                |                        |                   |                |                     |                    |
| 25-35                      | 14                     | 9.8               | 100            | 69.9                | 29                 | 20.3               | 4.9522, 0.2923     |
| 36-45                      | 6                      | 14.6              | 31             | 75.6                | 4                  | 9.8                |                    |
| 46-55                      | 1                      | 4.8               | 18             | 85.7                | 2                  | 9.5                |                    |
| Sex                        |                        |                   |                |                     |                    |
| Male                       | 4                      | 12.5              | 23             | 71.9                | 5                  | 15.6               | 0.2384, 0.8876     |
| Female                     | 17                     | 9.8               | 126            | 72.8                | 30                 | 17.3               |                    |
| Marital status             |                        |                   |                |                     |                    |
| Married                    | 17                     | 10.4              | 120            | 73.2                | 27                 | 16.5               | 1.6214, 0.9510     |
| Unmarried                  | 4                      | 10.5              | 26             | 68.4                | 8                  | 21.1               |                    |
| Divorcee                   | 0                      | 0.0               | 1              | 100.0               | 0                  | 0.0                |                    |
| Widow                      | 0                      | 0.0               | 2              | 100.0               | 0                  | 0.0                |                    |
| Resident                   |                        |                   |                |                     |                    |
| Urban                      | 14                     | 9.0               | 116            | 74.8                | 25                 | 16.1               | 1.6489, 0.4385     |
| Rural                      | 7                      | 14.0              | 33             | 66.0                | 10                 | 20.0               |                    |
| Education qualification    |                        |                   |                |                     |                    |
| GNM                        | 10                     | 7.6               | 96             | 72.7                | 26                 | 19.7               | 12.0545, 0.0169    |
| BSc                        | 1                      | 5.0               | 13             | 65.0                | 6                  | 30.0               |                    |
| MSc                        | 10                     | 18.9              | 40             | 75.5                | 3                  | 5.7                |                    |
| Designation                |                        |                   |                |                     |                    |
| Staff nurse                | 21                     | 10.6              | 143            | 72.2                | 34                 | 17.2               | 0.9447, 0.6235     |
| Nursing sister             | 0                      | 0.0               | 6              | 85.7                | 1                  | 14.3               |                    |
| Length of service (years)  |                        |                   |                |                     |                    |
| 0-5                        | 11                     | 12.1              | 58             | 63.7                | 22                 | 24.2               | 11.2156, 0.0819    |
| 6-10                       | 3                      | 5.8               | 43             | 82.7                | 6                  | 11.5               |                    |
| 11-15                      | 6                      | 16.2              | 26             | 70.3                | 5                  | 13.5               |                    |
| More than 15               | 1                      | 4.0               | 22             | 88.0                | 2                  | 8.0                |                    |
Table 4: Individual question wise analysis of mean knowledge scores

| Knowledge question                                                                 | Count | Sum          | Mean            | SD       |
|-----------------------------------------------------------------------------------|-------|--------------|-----------------|----------|
| Recent revision in BMW guidelines introduced by Government of India               | 205   | 45           | 0.21951         | 0.41493  |
| As per the recent guidelines waste generated in COVID treatment areas are considered? | 205   | 136          | 0.66341         | 0.47370  |
| As per the recent guidelines which among the following statement is true?          | 205   | 183          | 0.89268         | 0.31027  |
| Which among the following statements about BMWM of COVID-19 are true?              | 205   | 181          | 0.88293         | 0.32229  |
| Where do you dispose N 95, triple layer mask, contaminated gauze, cotton and other infected nonplastic items? | 205   | 185          | 0.90244         | 0.29745  |
| Where do you dispose plastic infected waste like nitrile gloves, plastic coverall suit and face shields? | 205   | 162          | 0.79024         | 0.40813  |
| In which color-coded container should the plastic water bottle used by the COVID-19-positive patients in the ward be collected? | 205   | 8            | 0.03902         | 0.19413  |
| How do you dispose the sharps like needle, stillets, and scalpels in COVID-19 areas? | 205   | 172          | 0.83902         | 0.36841  |
| Where do you dispose the contaminated glass and medicine vials and ampoules?      | 205   | 126          | 0.61463         | 0.48787  |
| Which colour-coded bins are used to dispose non-infected general dry waste in the clean donning areas of COVID-19 treatment facilities? | 205   | 30           | 0.14634         | 0.35431  |
| What would be the protective gear for sanitation workers during BMWM duties?       | 205   | 195          | 0.95122         | 0.21594  |
| Which among the following is true about the transport of COVID 19 waste trolley?   | 205   | 161          | 0.78537         | 0.41157  |
| Which all PPE are required for ambulance drivers and helpers managing transporting and disposing COVID-19 dead bodies? | 205   | 191          | 0.93171         | 0.25286  |
| Which among the following is the appropriate method of transporting and disposing COVID 19 dead bodies? | 205   | 116          | 0.56585         | 0.49686  |
| Which among the following technique is used to treat waste collected in the yellow bag? | 205   | 169          | 0.82439         | 0.38142  |
| Which among the following is used for the treatment of red bag waste?             | 205   | 108          | 0.52683         | 0.50050  |
| Which among the following is the correct way of disposing diapers of COVID 19 patients in ICU? | 205   | 182          | 0.88780         | 0.31638  |
| What is the maximum time of storage of COVID-19 bio medical waste as per CPCB guidelines? | 205   | 26           | 0.12683         | 0.33600  |
| How many layered bags are ought to be used to transport BM waste from COVID areas? | 205   | 128          | 0.62439         | 0.48547  |

SD=Standard deviation, COVID-19=Coronavirus disease-2019, BMW=Biomedical waste, BMWM=Bio-medical waste management, PPE=Personal protective equipment, ICU=Intensive care unit, CPCB=Central pollution control board, BM=Biomedical waste

Knowledge about BMW management in COVID-19 hospital settings among HCWs during this critical period of the infectious disease pandemic. Our sample size was representative of nursing professionals across different seniority and age groups working in a COVID hospital setting created in 2050-bedded apex tertiary care hospital. Therefore, it will serve as an essential yardstick regarding awareness about different aspects of BMW management related to COVID hospital. This study also has a substantial social and ecological impact. The proper COVID BMW disposal will prevent secondary transmission of highly infectious disease in hospital staff and the surrounding environment.

Conclusions

There is consensus that COVID-BMW hazards are much more significant than regular BMW. Therefore, its
Singh, et al.: Knowledge about the handling of COVID-19 biomedical waste

awareness among the HCWs can be a panacea for the safer handling of BMW generated in COVID hospital. This explorative analysis has thrown light on the areas where knowledge gaps exist among nursing professionals. Bridging this gap is the need of the hour in combating this Pandemic. Nevertheless, prospective studies on this topic for evaluating the change in understanding among HCWs with the Pandemic’s advancement can be carried in future. The strict implementation of CPCB guidelines and a robust monitoring system will reduce secondary transmission risk within the hospital and the surrounding atmosphere. Besides, the chances of punitive action by the pollution board due to poor waste management will also be prevented.

Informed consent
Yes.

Ethical approval
Yes, Ethical Approval obtained from Institute Ethics Committee.

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Conflicts of interest
There are no conflicts of interest.

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