

A Cross-Sectional Study of Knowledge and Awareness of Biomedical Waste Handling among Healthcare Professionals in Private Hospitals of Dehradun

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ABSTRACT

Background:

Biomedical waste (BMW) management is an essential component of healthcare systems as it plays a crucial role in preventing infections, protecting the environment, and ensuring compliance with regulatory standards. Inadequate knowledge and improper handling of biomedical waste can pose serious health risks to healthcare workers, patients, and the community. Assessing the level of awareness among healthcare professionals is therefore important for improving waste management practices in healthcare institutions.

Objective:

The present study aimed to assess the knowledge and awareness regarding biomedical waste management among healthcare professionals working in private hospitals in Dehradun, Uttarakhand.

Methods:

A cross-sectional quantitative study was conducted in ten private hospitals in Dehradun, Uttarakhand. A total of 450 healthcare professionals, including doctors, nurses, laboratory technicians, and housekeeping staff, participated in the study. Participants were selected using a multistage sampling technique involving purposive sampling for hospital selection and stratified random sampling for participant selection. Data were collected using a structured questionnaire consisting of 29 knowledge-based items related to the Biomedical Waste Management Rules, 2016. Statistical analysis included descriptive statistics, one-way analysis of variance (ANOVA) to compare knowledge scores among professional groups, and a one-sample t-test to assess whether the mean knowledge score differed from the benchmark level of 80%.

Results:

The overall mean knowledge score among participants was 62.59%, indicating a moderate level of knowledge regarding biomedical waste management. Nurses demonstrated the highest mean knowledge scores, followed by doctors, whereas laboratory technicians and housekeeping staff showed comparatively lower levels of knowledge. The one-sample t-test revealed that the observed knowledge score was significantly lower than the benchmark level of 80% ($t = -6.23, p < 0.001$), indicating a substantial gap in knowledge among healthcare professionals.

Conclusion:

The findings reveal moderate knowledge of biomedical waste management among healthcare professionals, with significant disparities across professional categories. The study highlights the need for regular training programs, targeted educational interventions, and strengthened institutional policies to improve biomedical waste management practices and ensure safe healthcare environments.

Keywords: Biomedical waste management, healthcare professionals, knowledge assessment, hospital waste, infection control, healthcare waste management.

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1.1 Introduction

Biomedical waste management is a critical component of healthcare services as it contributes significantly to infection prevention, environmental safety, and adherence to regulatory standards (Bhattacharya and Sachdev 2025). With the advancement of medical technologies and the continuous increase in patient load, healthcare institutions generate substantial quantities of biomedical waste every day. If this waste is not managed appropriately, it can pose serious threats to public health, environmental sustainability, and the credibility of healthcare facilities.

The rapid expansion of healthcare services has led to an increase in biomedical waste generation, making its proper management an important concern. Improper handling and disposal of biomedical waste can result in severe health hazards, including the spread of infectious diseases among healthcare workers, patients, and visitors within healthcare facilities. Insufficient knowledge and lack of awareness regarding biomedical waste management can negatively affect proper waste segregation and disposal practices.

Studies have shown that inadequate knowledge about biomedical waste handling can pose serious risks to both human health and the environment (Feridoz & Krishnan, 2018). Biomedical waste management is a crucial responsibility of healthcare institutions due to its potential infectious hazards as well as its financial implications. Assessing the knowledge, attitudes, and practices (KAP) of healthcare professionals regarding biomedical waste management provides valuable insights into existing practices and gaps in hospital settings (Mannocci et al., 2020).

Waste produced during healthcare activities has a higher potential for causing infections and injuries compared to general waste. Lack of proper understanding regarding the safe handling and disposal of healthcare waste may result in serious health consequences and environmental damage (Mathur et al., 2011). Healthcare workers play a vital role in managing biomedical waste generated within hospitals. Inadequate knowledge among this workforce can endanger not only their own health

but also that of the wider community (Patil et al., 2013).

Previous research has highlighted gaps in awareness related to specific aspects of biomedical waste management. For example, many healthcare workers lacked adequate knowledge about the correct disposal of pharmaceutical waste and compliance with mask disposal guidelines recommended by the Central Pollution Control Board during the COVID-19 pandemic (Rohatgi et al., 2023). Similarly, most healthcare professionals recognize the importance of preventing hospital-acquired infections as a key responsibility in healthcare settings (Alshahrani et al., 2021).

Studies have also reported variations in knowledge levels among different categories of healthcare workers. Joshi et al. (2020) observed that a large proportion of nurses (89.92%) and doctors (84.25%) understood the importance of disinfecting biomedical waste before disposal, whereas only about half of the laboratory technicians were aware of this practice. Another study by Bansal et al. (2019) reported that only 58% of doctors were familiar with the basic principle of biomedical waste management, which is segregation at the point of generation.

Research conducted among healthcare personnel at Jaipur Dental College revealed inadequate knowledge and awareness regarding biomedical waste hazards, legislation, and management practices. The study found that 36% of nurses had extremely poor knowledge regarding biomedical waste regulations, while only 15% of Class IV employees demonstrated excellent awareness of biomedical waste management practices (Sharma et al., 2013). Similarly, a study conducted in hospitals in Allahabad reported that doctors, nurses, and laboratory technicians had better knowledge of biomedical waste management compared to sanitary staff. Knowledge related to color coding and waste segregation at the source was found to be better among nurses and laboratory technicians than doctors (Mathur et al., 2011). Comparable findings were reported by Manikandan et al. (2023), who noted that nurses and laboratory personnel demonstrated stronger understanding of color

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coding and segregation practices compared to doctors.

In contrast, a study conducted in a tertiary care hospital in Mysore reported satisfactory knowledge regarding biomedical waste management among healthcare professionals. The findings indicated that doctors had the highest level of knowledge, followed by nurses, technicians, postgraduate students, interns, and housekeeping staff (Rao et al., 2018).

Paniyadi et al. (2019) observed that approximately 80% of participants had a moderate level of knowledge about biomedical waste disposal methods, while 20% had limited understanding.

Research conducted in Saudi Arabia reported moderate levels of knowledge regarding biomedical waste management among healthcare professionals, with a notable lack of formal training programs (Alahmari & Alshagrawi, 2024). Similarly, Golandaj et al. (2021) found that only 43% of healthcare personnel were able to correctly identify biomedical waste categories and their appropriate disposal through color-coded containers.

These findings highlight the need for regular training and educational initiatives to improve awareness and practices related to biomedical waste management. Rajpal et al. (2018) emphasized the importance of continuous and intensive training programs for all hospital staff. Mannapur et al. (2014) also suggested that periodic training sessions conducted by experts can significantly enhance awareness and compliance with biomedical waste management guidelines. Factors such as educational level, availability of visual aids, and the presence of color-coded bins within hospital departments also influence effective waste management practices. Therefore, regular training programs should be provided to healthcare professionals to improve their knowledge and practices (Deress, 2018).

Observational studies conducted in Uttarakhand have indicated that many hospitals lack adequate biomedical waste disposal systems, largely due to insufficient awareness among healthcare providers. Therefore, it is essential to reassess and strengthen the knowledge of biomedical waste management among healthcare professionals across the region (Bhatt et al., 2020).

2.1 METHODOLOGY:

Study setting: The study was conducted in ten private hospitals located in Dehradun, Uttarakhand, India. These hospitals were selected to represent private healthcare facilities where biomedical waste

is routinely generated and managed. The selected institutions provide a range of healthcare services and employ diverse categories of healthcare professionals involved in patient care and waste management practices.

Study Approach: A quantitative research approach was adopted to collect and analyze the data for the present study. This method enabled the systematic assessment of healthcare professionals' knowledge and awareness regarding Biomedical Waste (BMW) management through standardized responses obtained from structured instruments. The study followed a cross-sectional design incorporating both descriptive and analytical components.

Study design: The study followed a cross-sectional design incorporating both descriptive and analytical components.

Study Population: The target population consisted of healthcare personnel working in the selected private hospitals in Dehradun. Participants included doctors, nurses, laboratory technicians, and housekeeping staff, all of whom play a role in the generation, segregation, handling, or disposal of biomedical waste within healthcare facilities.

Sample size: A total of 450 healthcare professionals participated in the study. The sample was designed to include representation from different professional categories to allow comparison of knowledge levels across healthcare roles.

Sampling Technique

A multistage sampling strategy was used to select both hospitals and participants.

Stage 1: Hospital Selection

Ten private hospitals in Dehradun were selected using purposive sampling, based on predefined criteria such as availability of biomedical waste management systems and willingness to participate in the study.

Stage 2: Participant Selection

Within each selected hospital, stratified random sampling was employed to ensure representation from different professional groups. The healthcare workforce was divided into four strata:

- Doctors
- Nurses
- Laboratory technicians
- Housekeeping staff

Participants from each stratum were then randomly selected, ensuring balanced representation of the different professional categories and reducing the possibility of selection bias.

Data Collection Tool

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Data were collected using a structured, closed-ended questionnaire developed specifically for the purpose of assessing healthcare professionals' knowledge and awareness of biomedical waste management.

The questionnaire consisted of items related to:

- Awareness of Biomedical Waste Management Rules
- Segregation practices using color-coded containers
- Disposal of sharps, cytotoxic waste, and expired medicines
- Temporary storage and transportation of biomedical waste
- Institutional practices related to waste management and infection control

The structured format of the questionnaire allowed uniform data collection and facilitated quantitative analysis.

Statistical Analysis

The collected data were analysed using appropriate statistical methods.

- A one-sample t-test was conducted to determine whether the mean knowledge score of participants differed significantly from the established benchmark level of 80%, which was considered the acceptable standard of knowledge regarding biomedical waste management.
- A one-way Analysis of Variance (ANOVA) was applied to compare the mean knowledge scores among different categories of healthcare professionals, including doctors, nurses, laboratory technicians, and housekeeping staff.

These statistical tests helped identify significant differences in knowledge levels both in comparison with the benchmark and across professional groups.

Inclusion Criteria

Participants were included in the study if they met the following criteria:

- Healthcare personnel directly or indirectly involved in the generation, segregation, handling, transportation, or supervision of biomedical waste.
- Employees who had been working in the hospital for a minimum duration of six months.
- Individuals who voluntarily consented to participate in the study.

Exclusion Criteria

The following categories of individuals were excluded from participation:

- Interns and staff members on temporary postings.
- Employees who were on leave or unavailable during the data collection period.
- Administrative staff not directly involved in patient care or biomedical waste management activities.

3.1 RESULT:

A total of 450 healthcare professionals participated in the study. Their knowledge regarding Biomedical Waste (BMW) Management was assessed using a structured questionnaire consisting of 29 knowledge-based items aligned with the provisions of the Biomedical Waste Management Rules, 2016 and subsequent amendments.

The analysis revealed that the overall mean knowledge score among the participants was 62.5%, indicating a moderate level of awareness regarding biomedical waste management practices. However, this score remained notably below the expected benchmark level of knowledge for healthcare professionals involved in biomedical waste handling.

Table 3.1 Knowledge Assessment among Professional categories

| Question | Total Participants responded correctly | Doctors responded correctly | Nurses responded correctly | Lab technicians responded correctly | Housekeeping responded correctly |
|----------|--|-----------------------------|----------------------------|-------------------------------------|----------------------------------|
| Q1 | 310 | 115 (37%) | 130 (42%) | 45 (15%) | 20 (6%) |
| Q2 | 310 | 115 (37%) | 130 (42%) | 45 (15%) | 20 (6%) |
| Q3 | 270 | 115 (43%) | 100 (37%) | 50 (19%) | 5 (2%) |
| Q4 | 338 | 120 (36%) | 150 (44%) | 60 (18%) | 8 (2%) |
| Q5 | 248 | 110 (44%) | 120 (49%) | 8 (3%) | 10 (4%) |

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| | | | | | |
|-----|-----|--------------|--------------|-------------|-------------|
| Q6 | 338 | 115 (34%) | 160 (47%) | 25 (8%) | 38 (11%) |
| Q7 | 300 | 115 (39%) | 150 (50%) | 10 (3%) | 25 (8%) |
| Q8 | 280 | 100 (36%) | 100 (36%) | 75 (27%) | 5 (1%) |
| Q9 | 250 | 100 (40%) | 100 (40%) | 25 (10%) | 25 (10%) |
| Q10 | 338 | 115 (34%) | 150 (45%) | 25 (7%) | 48 (14%) |
| Q11 | 220 | 100 (45%) | 100 (45%) | 5 (2%) | 15 (8%) |
| Q12 | 365 | 120 (33%) | 165 (45%) | 55 (15%) | 25 (7%) |
| Q13 | 225 | 100 (45%) | 110 (49%) | 10 (4%) | 5 (2%) |
| Q14 | 280 | 110 (39%) | 110 (39%) | 55 (20%) | 5 (2%) |
| Q15 | 250 | 100 (40%) | 100 (40%) | 5 (2%) | 45 (18%) |
| Q16 | 140 | 80 (57%) | 60 (43%) | 0 | 0 |
| Q17 | 300 | 100 (33%) | 120 (40%) | 75 (25%) | 5 (2%) |
| Q18 | 365 | 115 (32%) | 155 (42%) | 60 (16%) | 35 (10%) |
| Q19 | 300 | 115 (38%) | 140 (47%) | 40 (13%) | 5 (2%) |
| Q20 | 338 | 115 (34%) | 125 (37%) | 60 (18%) | 38 (11%) |
| Q21 | 300 | 110 (36%) | 120 (40%) | 50 (17%) | 20 (7%) |
| Q22 | 300 | 115 (38%) | 150 (50%) | 20 (7%) | 15 (5%) |

| | | | | | |
|-----|-----|--------------|--------------|-------------|-------------|
| Q23 | 56 | 30 (54%) | 26 (46%) | 0 | 0 |
| Q24 | 200 | 80 (40%) | 90 (45%) | 10 (5%) | 20 (10%) |
| Q25 | 300 | 110 (37%) | 130 (43%) | 10 (3%) | 50 (17%) |
| Q26 | 360 | 115 (32%) | 150 (42%) | 60 (16%) | 35 (10%) |
| Q27 | 250 | 110 (44%) | 120 (48%) | 10 (4%) | 10 (4%) |
| Q28 | 300 | 115 (38%) | 150 (50%) | 15 (5%) | 20 (7%) |
| Q29 | 330 | 115 (35%) | 150 (45%) | 25 (8%) | 40 (12%) |

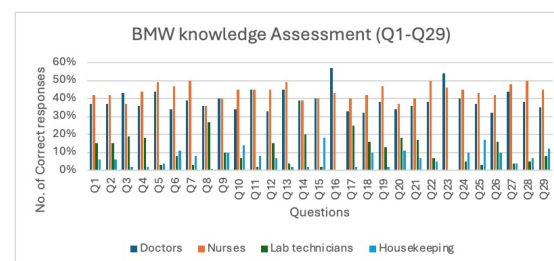


Fig. 3.1 Knowledge Assessment among Professional groups

The distribution of correct responses for each knowledge item across professional categories is presented in **Table 3.1**. The results demonstrate noticeable differences in knowledge levels among doctors, nurses, laboratory technicians, and housekeeping staff.

For Questions 1 and 2, which evaluated awareness regarding biomedical waste management training and knowledge of BMW rules, nurses accounted for the highest proportion of correct responses, followed by doctors. In contrast, laboratory technicians and housekeeping staff showed comparatively lower levels of awareness.

Questions 3 to 5, which assessed knowledge regarding the identification of biomedical waste and treatment methods, revealed a similar trend, with nurses demonstrating relatively better understanding compared to the other professional groups. Housekeeping personnel consistently recorded the lowest number of correct responses in these items.

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Items 6 to 10 focused on color-coded segregation of commonly generated healthcare waste, including materials such as cotton, plastic items, blood bags, glass waste, and biodegradable waste. For these questions, doctors and nurses demonstrated higher levels of correct responses, whereas laboratory technicians exhibited moderate levels of knowledge. Housekeeping staff showed considerably lower accuracy, particularly in items assessing segregation of specific waste categories.

For Questions 11 and 12, which examined knowledge regarding disposal of dry waste and identification of items not classified as biomedical waste, nurses again recorded the highest correct response rates, followed by doctors. These questions highlighted substantial differences in knowledge between professional categories.

Questions 13 to 15, addressing yellow category waste, incineration procedures, and disposal of broken glass items, showed moderate response accuracy across all groups, although nurses continued to perform better than the other categories.

Knowledge items 16 to 18 evaluated participants' understanding of alternative treatment options for yellow category waste, proper disposal of urine bags, and appropriate actions when biomedical waste is found mixed with general waste. In these areas, doctors and nurses demonstrated relatively better awareness, while laboratory technicians and housekeeping staff showed lower response accuracy.

For Questions 19 to 22, which assessed knowledge related to cytotoxic waste disposal, use of sharps containers, management of expired medicines, and barcoding of waste bags, nurses again demonstrated higher proportions of correct responses, suggesting stronger familiarity with procedural aspects of biomedical waste management.

Items 23 and 24, which evaluated knowledge regarding disposal of PPE packaging materials and the permissible duration for temporary storage of biomedical waste, showed low correct response rates across all professional categories, indicating significant knowledge deficiencies in these areas.

Finally, Questions 25 to 29, which addressed disposal of scalpels, the importance of biomedical waste management, the number of color-coded waste bins, waste containment practices, and types of sharps containers, revealed that doctors and nurses consistently demonstrated higher response

accuracy compared to laboratory technicians and housekeeping staff.

Overall, the graphical representation in **Figure 3.1** indicates that nurses achieved the highest number of correct responses across the majority of knowledge items, followed by doctors. In contrast, laboratory technicians and housekeeping staff showed comparatively lower levels of knowledge, suggesting the presence of gaps in awareness among these groups.

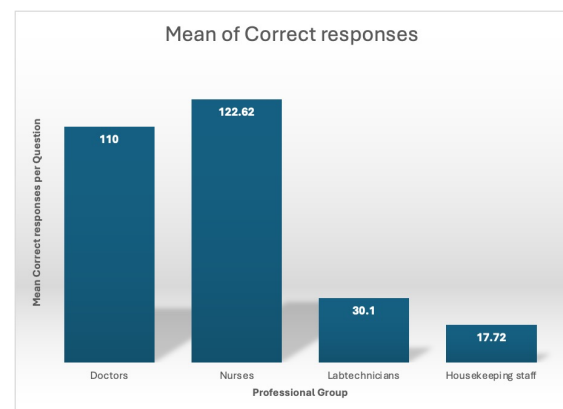


Fig 3.2 Knowledge assessment among professional group

The comparison of mean knowledge scores across professional categories, illustrated in **Figure 3.2**, further confirms these differences. Nurses demonstrated the highest mean knowledge scores, followed by doctors. Conversely, laboratory technicians displayed comparatively lower scores; while housekeeping staff recorded the lowest knowledge levels among the groups studied.

These findings indicate a significant disparity in biomedical waste management knowledge among different categories of healthcare professionals, highlighting the need for targeted training and capacity-building initiatives, particularly for laboratory technicians and housekeeping staff who are actively involved in waste handling and disposal processes.

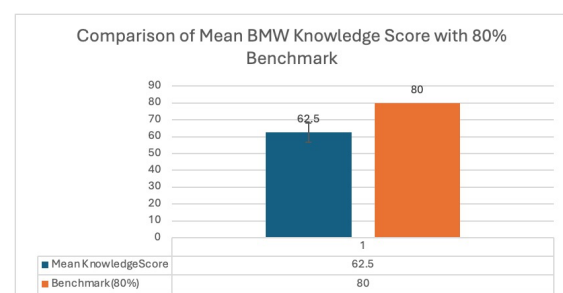


Fig 3.3 One sample T-test result

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To evaluate whether the observed knowledge level met the expected standard, a one-sample t-test was conducted comparing the mean knowledge score of participants with the benchmark value of 80%, as presented in **Figure 3.3**.

The analysis revealed a statistically significant difference between the observed mean score and the benchmark ($t(28) = -6.23, p < 0.001$). The observed mean knowledge score of 62.59% was substantially lower than the expected standard.

Furthermore, the mean difference was -17.41% (95% Confidence Interval: -23.20% to -11.63%), indicating that the participants' knowledge levels were significantly below the recommended benchmark.

These findings provide strong statistical evidence supporting the study hypothesis that a considerable gap exists in the knowledge of biomedical waste management among healthcare professionals.

4.1 DISCUSSION

The present investigation evaluated the level of knowledge related to biomedical waste (BMW) management among healthcare professionals, including doctors, nurses, laboratory technicians, and housekeeping personnel working in selected private hospitals. The findings indicated that the overall mean knowledge score was 62.5%, which falls below the recommended benchmark level of 80%, suggesting that although healthcare workers possess a moderate level of understanding of BMW management, important gaps in knowledge still persist. Comparable findings were reported by **Njiru et al., 2013**, who observed that the overall awareness regarding biomedical waste management among healthcare personnel was approximately 60%, reflecting similar patterns of moderate knowledge in healthcare settings.

When specific components of biomedical waste management were examined, the present study demonstrated relatively improved awareness in certain aspects of waste segregation compared with earlier studies. In particular, knowledge regarding the proper disposal of sharps waste was considerably higher, with 73% of participants correctly identifying puncture-proof containers as the appropriate disposal method for sharps. This level of awareness is notably higher than that reported in the study conducted by **Bhatt et al. (2000)** in Haldwani, where only 41.9% of healthcare providers demonstrated correct knowledge regarding sharps disposal. Similarly, **Patil et al. (2013)** reported that

56.8% of healthcare professionals in Maharashtra were aware of correct sharps disposal practices, which is lower than the level observed in the present study. The improvement in knowledge observed in the current study may be attributed to greater emphasis on occupational safety measures, strengthened regulatory frameworks, and increased implementation of training and awareness programs within healthcare institutions in recent years.

A similar trend was observed with regard to the disposal of expired or discarded medications. In the present study, 67% of participants correctly identified yellow containers as the appropriate disposal category for such waste, which represents a substantial improvement compared to the 37% awareness level reported by **Bhatt et al. (2000)**. This increase in knowledge may reflect better dissemination of biomedical waste management guidelines, increased institutional accountability, and improved compliance with regulatory requirements in healthcare facilities.

The statistical analysis further confirmed the presence of a significant gap between the observed knowledge level and the expected standard. The one-sample t-test demonstrated a statistically significant difference between the participants' mean knowledge score and the benchmark value of 80% ($t = -6.23, p < 0.001$). These findings suggest that despite the enforcement of the Biomedical Waste Management Rules, 2016 and their subsequent amendments, the level of knowledge among healthcare professionals remains below the desired standard, indicating the need for further improvements in awareness and training.

An important observation of this study was the variation in knowledge levels among different categories of healthcare professionals. Nurses demonstrated the highest level of knowledge, followed by doctors, whereas laboratory technicians and housekeeping staff showed comparatively lower knowledge scores. This pattern may be explained by the fact that nurses are frequently involved in direct patient care and routine waste segregation practices, which increases their exposure to biomedical waste management procedures. Conversely, housekeeping personnel often receive limited formal training, even though they play a critical role in the collection, handling, and transportation of biomedical waste within healthcare facilities.

The findings also indicated that healthcare professionals generally possessed adequate knowledge regarding basic elements of biomedical

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waste management, including awareness of training programs, familiarity with BMW regulations, and identification of waste categories. However, deficiencies were evident in more specific operational aspects, such as the disposal of packaging materials associated with personal protective equipment (PPE), permissible duration for temporary storage of biomedical waste, and certain waste segregation practices. These results suggest that while general awareness may exist, detailed procedural understanding remains insufficient in several areas.

Another noteworthy finding was the consistently lower knowledge level observed among housekeeping personnel, particularly in questions related to waste segregation procedures, disposal methods, and regulatory guidelines. Given that housekeeping staff are directly involved in waste collection and transportation, inadequate knowledge within this group could increase the risk of occupational exposure, infection transmission, and environmental contamination. Therefore, targeted training and capacity-building initiatives for support staff are essential to ensure safe and effective biomedical waste management practices.

Similarly, laboratory technicians demonstrated moderate levels of knowledge, which may reflect limited participation in specialized training programs related to biomedical waste management. Considering that laboratory environments generate a substantial volume of infectious and hazardous waste, strengthening awareness and training among laboratory personnel is critical to minimize potential risks associated with improper waste handling.

The findings of this study highlight the importance of continuous education and structured training programs within healthcare institutions. Regular orientation sessions, refresher courses, and practical demonstrations focusing on waste segregation and disposal procedures could significantly improve adherence to biomedical waste management guidelines. In addition, healthcare institutions should implement effective monitoring systems and enforce strict compliance with regulatory requirements to ensure that healthcare workers follow recommended waste management practices.

Overall, the results of this study underscore the presence of significant knowledge gaps in biomedical waste management among healthcare professionals, particularly among laboratory technicians and housekeeping staff. Addressing these deficiencies through targeted training

interventions, strengthened institutional policies, and ongoing educational initiatives is essential for improving biomedical waste management practices and ensuring the protection of public health, occupational safety, and the environment.

CONCLUSION

The present study evaluated the knowledge of biomedical waste (BMW) management among healthcare professionals in selected private hospitals. The findings revealed that the overall average knowledge score among participants was 62.5%, which is considerably lower than the expected benchmark of 80%. The results of the one-sample t-test confirmed a statistically significant gap in knowledge, indicating that healthcare professionals do not possess the desired level of awareness regarding biomedical waste management practices.

The study also identified variations in knowledge levels among different professional categories. Nurses demonstrated the highest level of knowledge, followed by doctors, whereas laboratory technicians and housekeeping staff showed comparatively lower knowledge scores. These findings indicate that although healthcare professionals have some awareness of biomedical waste management, there remain significant gaps in specific areas such as waste segregation, disposal procedures, and regulatory guidelines.

Furthermore, the study highlighted that support staff, particularly housekeeping personnel, exhibited the lowest level of knowledge, despite their crucial role in handling biomedical waste within healthcare facilities. This lack of adequate knowledge may increase the risk of improper waste handling, occupational exposure, environmental contamination, and spread of infections.

Overall, the study concludes that while a moderate level of awareness exists among healthcare professionals, substantial improvements are required to ensure effective implementation of Biomedical Waste Management Rules, 2016. Strengthening training programs, improving awareness, and reinforcing institutional policies are essential to enhance compliance with safe biomedical waste management practices.

Recommendations

Based on the findings of the study, the following recommendations are suggested to improve biomedical waste management practices in healthcare institutions:

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1. Healthcare institutions should conduct regular training and refresher programs on biomedical waste management for all categories of healthcare workers, including doctors, nurses, laboratory technicians, and housekeeping staff.
2. Targeted training programs should be designed specifically for housekeeping staff and laboratory technicians, as these groups demonstrated comparatively lower knowledge levels despite their direct involvement in waste handling.
3. All newly appointed healthcare workers should undergo mandatory orientation sessions on biomedical waste management guidelines before assuming their duties.
4. Hospitals should establish monitoring mechanisms and periodic assessments to evaluate staff knowledge and compliance with biomedical waste management rules.
5. Hospitals should display color-coded charts, posters, and instructional materials related to biomedical waste segregation and disposal in wards, laboratories, and waste collection areas to reinforce correct practices.

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