Original Article

Knowledge, Attitude and Practice of Biomedical Waste Management among Intern Doctors at a Tertiary Care Centre in Eastern India

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Abstract

Objective: To assess the knowledge, attitudes, and practices (KAP) regarding biomedical waste (BMW) management among intern doctors at a tertiary care center in Eastern India.

Methods: An observational, cross-sectional study was conducted between August and December 2024, involving 150 intern doctors from a medical college in Eastern India. Data were collected using a structured, pretested questionnaire encompassing 30 KAP-related items. Descriptive and inferential statistical analyses were performed using SPSS version 16.0, with a significance level of $p<0.05$.

Results: Out of 150 interns, data of 139 participants who returned completed questionnaire (mean age: 24.3 ± 1.2 years; 52.5% males) were analysed. The mean scores for knowledge, attitude, and practice were 7.19 ± 2.14, 7.83 ± 1.77, and 6.88 ± 1.91, respectively. Interns demonstrated strong knowledge in areas such as sharps disposal (80.6%) and color-coded segregation (79.1%) but showed gaps in understanding specific protocols like sodium hypochlorite concentration (54.7%). Attitudes were generally favourable, with 93.5% recognizing the necessity of safe disposal. However, 51.8% perceived BMWM as an added burden. Practices such as proper PPE use (90.6%) and immediate sharps disposal (82.7%) were adhered to, but participation in audits (29.5%) and protocol reviews (63.3%) was limited.

Conclusions: Intern doctors displayed moderate KAP levels regarding BMW management, with significant gaps in specific knowledge and inconsistent practices. Targeted training programs emphasizing practical application and streamlined workflows are recommended to enhance compliance and foster a culture of safety in healthcare.

Keywords: Biomedical Waste Management, Knowledge-Attitude-Practice, healthcare workers, Infection control

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Introduction

Biomedical waste (BMW) refers to waste generated during the diagnosis, treatment, or immunization of humans or animals, or in research activities pertaining to these fields. Its proper management is crucial to prevent adverse health and environmental impacts[1]. Inadequate BMW management has been linked to the spread of infectious diseases, environmental pollution, and occupational hazards for healthcare workers[2]. The World Health Organization (WHO) estimates that approximately 15% of healthcare waste is hazardous and can pose serious risks due to its infectious, toxic, or radioactive nature[3]. Thus, proper BMW management practices are fundamental in maintaining public health and ensuring environmental safety. For the same, the Government of India, under the Ministry of Environment, Forest and Climate Change introduced the Biomedical Waste Management Rules, 2016, with subsequent amendments in 2018 and 2019, to provide comprehensive guidelines for the segregation, handling, treatment and disposal of BMW[4]. Despite these guidelines, gaps persist in adherence to BMW management practices, particularly among healthcare workers, due to insufficient knowledge, improper attitudes, and inadequate training[5].

Intern doctors, who are at the inception of their medical careers, play a pivotal role in patient care as frontline healthcare providers, and are integral to the implementation of BMW management protocols. Their knowledge, attitude, and practice (KAP) are critical to ensuring adherence to guidelines and fostering a safe healthcare environment. However, prior studies have highlighted gaps in the KAP of intern doctors regarding BMWM, due to factors such as inadequate training, lack of awareness, and limited practical exposure[6,7].

In India, tertiary care centers serve as critical hubs for advanced medical services, catering to a vast and diverse patient population. These centers generate substantial quantities of BMW daily, necessitating stringent adherence to management protocols. However, studies indicate that many healthcare institutions face challenges such as limited resources, lack of infrastructure, and inconsistent training programs [8]. Therefore, there is a continuous need to assess and appraise the KAP of intern doctors regarding BMWM to identify existing gaps and address them effectively through targeted training programs [5].The present study aims to assess the knowledge, attitude, and practices of biomedical waste management among intern doctors at a tertiary care center in Eastern India.

Methods

This observational, cross-sectional study was conducted at a tertiary care center in Eastern India between August 2024 and December 2024, among intern doctors posted in various Departments of a Medical College and Hospital of Eastern India. Data collection was initiated after obtaining approval from the Institutional Ethics Committee. The study was conducted on census population and therefore sample size calculation was not required. A total of 150 intern doctors were invited to participate and informed written consent was obtained prior to enrolment in the study.

Data was collected using a pre-designed, pretested self-administered, structured, questionnaire which had two parts. First part included questioned to record sociodemographic data, namely, age, sex and place of residence. The second part contained 30 questions to evaluate the KAP of the participant regarding BMW management.

The second part has three sections, each consisting of 10 questions assessing the knowledge with specific responses, 10 questions assessing the attitude with agree/disagree/no comment as answers and 10 questions assessing the practices with yes/ no responses. There usual practice with regards to BWM was self-reported.

The participants filled up the self-administered questionnaire without scope for undue help.The identity of the study respondents was maintained anonymous at various stages of the study.

Data Analysis. Data was entered into Microsoft Excel 2016 and analyzed using SPSS version 16.0. Results were presented through tables, graphs, and diagrams. Continuous variables (age, domain-specific scores) were expressed as mean ± standard deviation (SD), while categorical variables (gender, domain-specific-responses) were represented as relative frequencies and percentages. The responses to all domain-specific items indicative of correct knowledge, favourable attitude, and proper practice

were scored 1 each. The total knowledge score, attitude score and practice score were obtained for each participant. Knowledge scores, attitude scores and practice scores of the study population did not have normal distribution, therefore Mann-Whitney U test (non-parametric test of significance) was employed to compare between domain scores. A "p-value" <0.05 was considered as statistically significant.

The study adhered to the STROBE guidelines for reporting observational research.

Results

Out of 150 study participants, 139 participants completely filled the questionnaire and their data was included in the analysis. There were 73 males (52.5%) and 66 female interns (47.5%). The mean age was 24.3 (±1.2) years with minimum age of 22 years and maximum age of 27 years. 69.8% of the participants resided either in hostels or as paying guests.

The knowledge of the study participants regarding BMW management is given in Table 1.While most respondents displayed good knowledge in areas such as the governing body (68.3%), the use of color-coded bins (79.1%), and sharps disposal (80.6%), there were gaps in understanding specific topics like the concentration of sodium hypochlorite for pre-treatment (54.7%) and waste storage time limits (59.7%).

Table 1: Knowledge regarding BMW management of the study participants (N=139)

Knowledge-related items	Correct response	Incorrect response
1. Which government body in India regulates the Biomedical Waste Management Rules?	95 (68.3%)	44 (31.7%)
2. What is the significance of using color-coded bins in biomedical waste management?	110 (79.1%)	29 (20.9%)
3. Which area of the hospital has the highest chance of producing biomedical waste?	85 (61.2%)	54 (38.8%)
4. What type of waste is disposed of in yellow-coloured bags according to the Biomedical Waste Management Rules?	98 (70.5%)	41 (29.5%)
5. What is the recommended method for the disposal of sharps, such as needles and scalpels?	112 (80.6%)	27 (19.4%)
6. What concentration of sodium hypochlorite is recommended for pre-treatment of microbiological waste?	76 (54.7%)	63 (45.3%)
7. Which color-coded bag is used for disposing of infectious plastic items like IV tubes and catheters?	91 (65.5%)	48 (34.5%)
8. Which colour-coded bag is recommended for the disposal of used mask (triple layer mask, N95 mask, etc.)?	87 (62.6%)	52 (37.4%)
9. What is the maximum permissible time for biomedical waste to be stored before treatment or disposal?	83 (59.7%)	56 (40.3%)
10. All healthcare workers must follow universal precautions regardless of the patient's infection status.	121 (87.1%)	18 (12.9%)

Table 2 reveals a generally favourable attitude among intern doctors toward BMW management, with over 85% demonstrating satisfactory attitudes in key areas such as the necessity of safe disposal (93.5%), the importance of PPE (92.1%), and the use of color-coded segregation (91.4%). However, attitudes toward certain challenges, such as the perceived burden of biomedical waste management (51.8%) and the time-consuming nature of segregation (57.6%), indicate mixed opinions.

Table 2: Attitude regarding BMW management of the study participants (N=139)

Attitude-related items	Satisfactory attitude	Unsatisfactory attitude
1. Safe disposal of biomedical waste is necessary in healthcare setups.	130 (93.5%)	9 (6.5%)
2. Biomedical waste management is teamwork.	125 (89.9%)	14 (10.1%)
3. Biomedical waste management creates an extra burden on routine work.*	72 (51.8%)	67 (48.2%)
4. Biomedical waste management is a risk for the transmission of any infectious disease.*	95 (68.3%)	44 (31.7%)
5. Segregation of hospital waste into different categories is time-consuming.*	80 (57.6%)	59 (42.4%)
6. PPE is essential while handling biomedical waste.	128 (92.1%)	11 (7.9%)
7. De-contamination and disinfection reduce the risk of infection.	123 (88.5%)	16 (11.5%)
8. The use of colour coding for segregation of waste is essential.	127 (91.4%)	12 (8.6%)
9. Proper biomedical waste management enhances the quality assurance of healthcare sectors.	119 (85.6%)	20 (14.4%)
10. Upgrading knowledge on biomedical waste management is mandatory.	122 (87.8%)	17 (12.2%)

*Negatively phrased statements and reversely scored.

Table 3 indicates that intern doctors generally exhibit correct practices in biomedical waste management, particularly in using PPE during procedures (90.6%), and avoiding the mixing of general and biomedical waste (84.9%). However, areas like segregation into color-coded bins (66.9%), adherence to protocols (63.3%) and participation in audits (66.9%) show room for improvement.

Table 3: Practice regarding BMW management of the study participants (N=139)

Practice-related items	Correct practice	Incorrect practice
1. Do you correctly segregate biomedical waste into designated color-coded bins during patient care activities?	93 (66.9%)	46 (33.1%)
2. Do you wear appropriate personal protective equipment (PPE), including gloves and masks, during procedures that generate biomedical waste?	126 (90.6%)	13 (9.4%)
3. Do you immediately dispose of sharps, such as needles and scalpels, into puncture-proof containers after use?	115 (82.7%)	24 (17.3%)
4. Are you mindful of not overfilling the waste bins to prevent spillage and contamination?	98 (70.5%)	41 (29.5%)
5. Do you ensure proper hand hygiene after handling biomedical waste or waste bins?	110 (79.1%)	29 (20.9%)
6. Do you promptly notify the appropriate authority if you observe improper waste segregation or disposal practices?	95 (68.3%)	44 (31.7%)

Continue.....

7. Do you ensure that waste bins in your department are closed properly and replaced when full to prevent accidental exposure?	100 (71.9%)	39 (28.1%)
8. Do you avoid mixing general waste with biomedical waste?	118 (84.9%)	21 (15.1%)
9. Do you participate in periodic audits or checks for proper biomedical waste segregation in your assigned area?	41 (29.5%)	98 (70.5%)
10. Have you attended or reviewed the hospital's biomedical waste management protocol during your internship?	88 (63.3%)	51 (36.7%)

The study participants showed moderate overall performance in knowledge (6.92 ± 2.14), attitude (6.60 ± 1.70), and practice (6.73 ± 1.78), which were not significantly different from each other.

Table 10a: Total knowledge, attitude and practice scores among the study participants (N=21)

Domains	Mean ± SD score	p-value
Knowledge	7.19± 2.14	0.529[a]
Attitude	7.83± 1.77	0.316[b]
Practice	6.88± 1.91	0.820[c]

p-values were calculated using Mann-Whitney U test

[a] comparison between knowledge and attitude scores

[b] comparison between attitude and practice scores

[c] comparison between knowledge and practice scores

Discussion

Effective management of BMW is crucial to prevent environmental contamination and safeguard public health. The findings provide a snapshot of the current understanding, perspectives, and behaviours of intern doctors regarding the safe and responsible segregation of BMW.

Knowledge of Biomedical Waste Management

Knowledge serves as the cornerstone of any effective BMW management system. Intern doctors, in this study, displayed a relatively good level of knowledge concerning biomedical waste management. The mean knowledge score was 6.92 ± 2.14, which reflected a generally adequate understanding of key concepts such as the use of color-coded bins, sharps disposal, and the role of the governing body in India. This foundational knowledge is crucial because it equips healthcare workers with the necessary awareness to identify risks, understand their responsibilities, and take appropriate action.

A study by Patil and Pokhrel[9] reported a considerable level of awareness and knowledge of hospital waste management practices among the staff. Another study by Patil and Shekdar[10] in Indian hospitals also highlighted satisfactory awareness regarding waste segregation and sharps disposal among healthcare workers, with over 70% demonstrating accurate knowledge of these areas. On the contrary, a study by Mathur et al.[5] found that as compared to doctors, nurses had better knowledge regarding the colour coding and waste segregation at source. In a more recent study conducted by Thapa et al.[11] in a hospital in the North-East India, 66% of the healthcare workers were observed to have adequate knowledge scores.

However, there were certain areas where knowledge gaps were observed. For instance, only 54.7% of participants correctly identified the recommended concentration of sodium hypochlorite for pre-treatment of microbiological waste, and 59.7% knew the maximum permissible storage time for biomedical waste. These gaps indicate that while basic knowledge may be in place, more specialized details regarding waste treatment protocols and storage guidelines are not adequately understood. A possible reason for these knowledge deficiencies could be that such topics are less frequently emphasized during clinical rotations or training programs, with a greater focus placed on patient care. Additionally, the complex nature of biomedical waste management, which involves adherence to

strict and sometimes cumbersome regulations, may lead to gaps in practical knowledge.

Attitudes Toward Biomedical Waste Management

Good knowledge, when reinforced by proper guidance, fosters favourable attitudes toward BMW management. The attitude of intern doctors toward BMW management was generally positive, with a mean score of 7.83 ± 1.77. A high percentage of respondents expressed favourable attitudes toward the necessity of safe disposal (93.5%), the importance of using personal protective equipment (PPE) (92.1%), and the significance of using color-coded bins (91.4%). These findings suggest that intern doctors recognize the importance of safe and effective BMW management, which is crucial for minimizing the risks of infection and cross-contamination.

These attitudes are influenced by both prior knowledge and the guidance provided during training. Structured orientation sessions, hands-on demonstrations, and mentorship from senior healthcare workers help intern doctors understand the rationale behind BMW management practices. When intern doctors see these practices integrated into the daily workflow and emphasized as a collective responsibility, it reinforces the perception that BMW management is not just a regulatory requirement but a critical aspect of patient safety and public health.

In a prior study by SP et al.[12] 98.2% had a favourable attitude towards biomedical waste management, with an overall mean attitude score of 8.77 ± 0.98. Jalal et al.[13] had 73.1% favourable attitudes. In the study by Dalui et al.[14], almost two-thirds (74.1%) had a favourable attitude. Among doctors, 91% and, among nurses, 81% had a favourable attitude towards biomedical waste management.

However, challenges remain. For example, only 51.8% of participants agreed that BMW management creates an extra burden on routine work, while 57.6% felt that waste segregation was time-consuming. These perceptions are consistent with findings by Dalui et al.[14], who noted that 60.3% of participants were either neutral or viewed BMW management as adding to their workload, particularly in settings with inadequate staffing or resources. These responses among our study participants, suggest that despite understanding the importance of BMW management, intern doctors may feel burdened by the time and effort required to properly segregate waste and adhere to regulations. The perception of BMW management as an additional task may be due to the high workload and fast-paced environment that intern doctors experience, which often leaves little room for non-clinical tasks like waste segregation. This underscores the need for ongoing guidance to streamline workflows and reduce the perception of BMW management as a burden.

Practices in Biomedical Waste Management

Good knowledge and favourable attitudes create a strong foundation for translating intent into action, as reflected in the mean practice score of6.88 ± 1.91. Intern doctors who are well-informed and positively inclined toward BMW management are more likely to adopt correct practices such as proper segregation of waste (86.3%) and consistent use of PPE (90.6%). These practices are not only essential for ensuring compliance with BMW guidelines but also critical for preventing infections and maintaining a safe environment for both patients and healthcare workers. A similar finding where 79.3% of healthcare professionals always followed BMWM guidelines was reported by Jalal SM et al.[13] in their study. Also, the study by Sharma S et al.[15], reported proper practice of segregation of BMW by 82% of their participants.

However, the study also highlights areas where gaps in knowledge or insufficient guidance hinder good practices. For instance, only 63.3% of participants reported participating in periodic audits, and 66.9% had reviewed BMW management protocols during their internship. These lower rates may reflect a lack of emphasis on institutional activities or insufficient encouragement from supervisors. Addressing these issues through structured mentorship programs and routine engagement with BMW protocols would reinforce the importance of BMW management at a systemic level, ensuring more consistent practice across all domains.

The interplay between knowledge, attitude, and practice is a dynamic process. Knowledge provides the "what" and "why," while attitudes influence the "how" healthcare workers perceive and approach these tasks. When these elements align, they result in good practice, which not only ensures compliance

but also builds a culture of accountability and safety in healthcare settings. For example, an intern doctor who understands the risks of improper sharps disposal (knowledge) and believes it is their responsibility to prevent infections (attitude) is more likely to immediately discard sharps in puncture-proof containers (practice). Similarly, guidance from supervisors and role models helps reinforce positive behaviours and attitudes, creating a feedback loop where good practices further enhance knowledge and reinforce favourable attitudes.

Moreover, while the overall attitude toward BMW management is positive, the perception of increased workload and the time-consuming nature of segregation may indicate a lack of integration between clinical and waste management tasks. A more streamlined and efficient approach to BMW management, such as digital waste tracking systems or simplified segregation guidelines, may help alleviate some of these concerns.

Limitations of the Study

This study has several limitations. First, it was conducted at a single tertiary care center, meaning the results may not be generalizable to other healthcare settings, particularly those with different infrastructural or training conditions. Additionally, the study relied on self-reported data, which may be subject to response bias. Intern doctors may have over-reported their compliance with BMW management practices, especially when they were aware that their responses would be used for academic or institutional purposes. Finally, the study did not assess the effectiveness of specific training programs or institutional policies related to BMW management, which could have provided further insights into the factors influencing knowledge, attitude, and practices.

Recommendations

This study highlights the need for a comprehensive approach to BMW management that integrates knowledge-building, attitude development, and practical guidance. Based on the findings, several recommendations can be made to improve BMW management practices among intern doctors. First, training programs should be more comprehensive and focus on not only the basic knowledge of BMW management but also on more specialized topics such as waste treatment and storage protocols. Regular workshops, refresher courses, and interactive sessions can help reinforce this knowledge. Second, it is essential to integrate BMW management tasks more seamlessly into the clinical workflow, minimizing the perception of additional burden. Simplifying waste segregation guidelines, using clear labelling on bins, and streamlining the disposal process can make these tasks more manageable for intern doctors. Additionally, hospital administration should focus on creating a work environment that encourages engagement in non-clinical activities like audits without overwhelming intern doctors with additional responsibilities.

Conclusion

In conclusion, this study highlights the importance of ongoing education and structured interventions to improve biomedical waste management among intern doctors. While intern doctors generally possess adequate knowledge and a positive attitude, there is room for improvement in specialized areas and institutional practices. Addressing these gaps through targeted training, mentorship, and streamlined protocols can create a safer and more efficient healthcare environment. Ultimately, a well-informed and guided workforce will not only comply with BMW regulations but also contribute to the broader goals of patient safety and public health.

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