

Knowledge, Attitude And Practice Regarding Biomedical Waste Management Among Healthcare Workers At Government Healthcare Facilities Of Chargawan Block, Gorakhpur, Uttar Pradesh: A Cross-Sectional Study

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Abstract

Background: Biomedical waste management (BMWM) is an essential component of infection prevention and environmental safety in healthcare settings. Healthcare workers (HCWs) play a pivotal role in ensuring compliance with the Bio-Medical Waste Management Rules, 2016. Inadequate knowledge, unfavourable attitudes, and poor waste handling practices increase the risk of occupational injuries, healthcare-associated infections, and environmental contamination. Evidence regarding BMWM practices at the primary healthcare level in eastern Uttar Pradesh remains limited. This study assessed the knowledge, attitude, and practice (KAP) regarding BMWM among healthcare workers employed at government primary healthcare facilities in Chargawan Block, Gorakhpur.

Methods: A facility-based cross-sectional study was conducted from January to December 2024 among all 104 healthcare workers working in one Community Health Centre, five Primary Health Centres, and thirty Sub-Centres of Chargawan Block, Gorakhpur. A census sampling approach was adopted. Data were collected using a pre-tested, validated questionnaire based on the Bio-Medical Waste Management Rules, 2016. Knowledge, attitude, and practice scores were categorized using predefined criteria. Data were analysed using SPSS version 21. Associations between healthcare worker category and KAP levels were examined using the Chi-square test or Fisher's exact test, with $p < 0.05$ considered statistically significant.

Results: Overall, only 9.6% of participants demonstrated good knowledge, while 75.0% had average knowledge and 15.4% had poor knowledge. Good knowledge was highest among doctors (66.7%) but was absent among paramedics. Most participants (69.2%) exhibited a moderately positive attitude toward BMWM, whereas good practice was observed in only 24.0% of healthcare workers. Formal BMWM training had been received by only 16.3% of participants, and none of the paramedics had undergone any formal training. Significant differences in knowledge, attitude, and practice were observed across healthcare worker categories ($p < 0.001$).

Conclusion: Considerable cadre-specific gaps exist in biomedical waste management at government primary healthcare facilities in Chargawan Block. Paramedics were identified as the most vulnerable group because of the complete absence of formal training and poor knowledge levels. Regular competency-based training, periodic refresher programmes, supportive supervision, and strict adherence to the Bio-Medical Waste Management Rules, 2016 are essential to improve safe biomedical waste handling practices at the primary healthcare level.

Keywords: Biomedical waste management, healthcare workers, knowledge, attitude, practice, healthcare, cross-sectional study, Gorakhpur.

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I. Introduction

Biomedical waste (BMW) comprises all waste generated during the diagnosis, treatment, or immunization of humans and animals, as well as waste produced during related research and healthcare activities.

A substantial proportion of healthcare waste is non-hazardous; however, approximately 10–25% is considered hazardous because of its infectious, toxic, chemical, or radioactive nature. Improper handling and disposal of biomedical waste pose significant risks to healthcare workers, patients, waste handlers, and the surrounding community by facilitating the transmission of infectious diseases, causing occupational injuries, and contributing to environmental pollution.

Healthcare workers (HCWs) are directly involved in the generation, segregation, collection, transportation, storage, and disposal of biomedical waste. Their knowledge, attitude, and day-to-day practices are critical determinants of the effectiveness of biomedical waste management (BMWM). Inadequate awareness of waste segregation protocols, improper use of personal protective equipment, needle-stick injuries, and poor compliance with infection prevention measures may increase the risk of transmission of blood-borne pathogens such as hepatitis B virus, hepatitis C virus, and human immunodeficiency virus. Effective biomedical waste management is therefore an essential component of patient safety, occupational health, and environmental protection.

Recognizing the public health importance of safe biomedical waste disposal, the Government of India introduced the Bio-Medical Waste (Management and Handling) Rules in 1998, which were comprehensively revised as the Bio-Medical Waste Management Rules, 2016. These rules emphasize segregation of biomedical waste at the point of generation using a colour-coded system, safe collection and transportation, scientifically appropriate treatment and disposal, immunization of healthcare workers, and regular training of all personnel involved in biomedical waste handling. Subsequent amendments have further strengthened the regulatory framework by promoting barcoding, pretreatment of laboratory waste, improved monitoring mechanisms, and enhanced accountability of healthcare facilities.

Although the regulatory framework for biomedical waste management in India is well established, its implementation remains inconsistent, particularly at the primary healthcare level. Government primary healthcare facilities often face challenges such as inadequate infrastructure, irregular supply of colour-coded containers, shortage of trained personnel, heavy workload, limited supervisory support, and insufficient opportunities for continuing education. These constraints may adversely affect compliance with recommended biomedical waste management practices and increase occupational as well as environmental hazards.

Assessment of knowledge, attitude, and practice (KAP) among healthcare workers is a widely accepted approach for identifying deficiencies in biomedical waste management. KAP studies provide valuable information regarding existing levels of awareness, behavioural patterns, and practical compliance, thereby enabling health administrators to design evidence-based training programmes and targeted interventions. Several studies conducted in tertiary care hospitals across India have reported variable levels of knowledge and practice among healthcare workers, with doctors generally demonstrating better compliance than nursing and paramedical staff. However, evidence from government primary healthcare facilities, particularly in eastern Uttar Pradesh, remains limited.

Gorakhpur district serves a large population of eastern Uttar Pradesh and neighbouring regions, making its public healthcare system an important component of regional healthcare delivery. Chargawan Block, one of the largest administrative blocks in the district, comprises one Community Health Centre (CHC), five Primary Health Centres (PHCs), and thirty Sub-Centres providing preventive, promotive, and curative healthcare services. Healthcare workers at these facilities routinely generate and handle biomedical waste; however, information regarding their knowledge, attitudes, and practices related to biomedical waste management has not been systematically documented.

The present study was undertaken to assess the knowledge, attitude, and practice regarding biomedical waste management among healthcare workers employed at government primary healthcare facilities in Chargawan Block, Gorakhpur. The study also compared KAP levels among doctors, nursing staff, and paramedical personnel to identify cadre-specific gaps requiring intervention. The findings are expected to provide baseline evidence for strengthening biomedical waste management practices through focused training, supportive supervision, and policy implementation at the primary healthcare level.

II. Materials And Methods

Study Design and Setting

A facility-based cross-sectional study was conducted between January and December 2024 in Chargawan Block of Gorakhpur district, Uttar Pradesh, India. The study was carried out in all government primary healthcare facilities functioning within the block, including one Community Health Centre (CHC), five Primary Health Centres (PHCs), and thirty Sub-Centres (SCs). These facilities provide comprehensive primary healthcare services to the rural population and are responsible for the generation and management of biomedical waste in accordance with the Bio-Medical Waste Management Rules, 2016.

Study Population

The study population comprised healthcare workers directly involved in the generation, segregation, handling, transportation, storage, or disposal of biomedical waste at the selected healthcare facilities. Participants included doctors (MBBS, BDS, and AYUSH medical officers), nursing personnel (Staff Nurses, Auxiliary Nurse Midwives, and Community Health Officers), and paramedical staff (Laboratory Technicians and Ward Attendants).

Healthcare workers who were available during the study period and provided written informed consent were included. Individuals who declined participation or were unavailable despite repeated visits were excluded. However, all eligible healthcare workers consented to participate; therefore, no exclusions occurred.

Sample Size and Sampling Technique

A census sampling technique was adopted. Since the total number of eligible healthcare workers across all selected facilities was manageable, every eligible participant was included in the study. Consequently, all 104 healthcare workers working in the study area were enrolled, comprising 12 doctors, 70 nursing personnel, and 22 paramedical staff. This approach eliminated sampling error and ensured complete representation of the healthcare workforce within the study area.

Study Tool

Data were collected using a pre-designed, pre-tested, and validated structured questionnaire developed with reference to the Bio-Medical Waste Management Rules, 2016, relevant national guidelines, and published literature. Face validity and content validity were assessed by experts from the Department of Community Medicine, Baba Raghav Das Medical College, Gorakhpur. The questionnaire was pilot tested among ten healthcare workers outside the study population to evaluate clarity, comprehensibility, and feasibility. Necessary modifications were incorporated before commencement of the final survey.

The questionnaire consisted of four sections:

- Socio-demographic and professional characteristics of participants.
- Knowledge regarding biomedical waste management.
- Attitude towards biomedical waste management.
- Biomedical waste management practices followed during routine healthcare activities.

Assessment of Knowledge, Attitude and Practice

Knowledge was assessed using 13 objective questions covering biomedical waste categories, colour-coded segregation, biohazard symbols, storage duration, personal protective equipment, sharps management, and statutory provisions under the Bio-Medical Waste Management Rules, 2016. Each correct response was awarded one mark, while incorrect or unanswered responses received zero marks, giving a maximum score of 13.

Knowledge scores were categorized using the study population mean (10.55) and standard deviation (1.79):

- Good knowledge: >12.34
- Average knowledge: $8.76-12.34$
- Poor knowledge: <8.76

Attitude was evaluated using an eleven-item five-point Likert scale ranging from strongly disagree (score 1) to strongly agree (score 5), with a maximum attainable score of 55. Participants were classified as:

- Highly motivated: ≥ 52
- Moderately motivated: $41-51$
- Low motivated: ≤ 40

Practice was assessed using nine questions related to routine biomedical waste handling, including waste segregation at source, disposal of sharps, needle recapping, use of hub cutters, use of personal protective equipment, hand hygiene, mercury spill management, and vaccination status. Each appropriate practice was awarded one mark, resulting in a maximum score of nine.

Practice scores were categorized as:

- Good practice: ≥ 7
- Average practice: $5-6$
- Poor practice: ≤ 4

Data Collection Procedure

Data were collected by the principal investigator through face-to-face interviews conducted at the respective healthcare facilities using the structured questionnaire. Interviews were conducted in either Hindi or English according to participants' preference to ensure accurate understanding of the questions. Confidentiality and anonymity were maintained throughout the study, and no personal identifiers were recorded in the final database.

Ethical Considerations

The study protocol received approval from the Institutional Ethics Committee of Baba Raghav Das Medical College, Gorakhpur, prior to data collection. All collected information was kept confidential and used exclusively for research purposes.

Statistical Analysis

The collected data were entered into Microsoft Excel 2021 and analysed using IBM SPSS Statistics version 21. Categorical variables were summarized as frequencies and percentages. Associations between healthcare worker categories and knowledge, attitude, and practice levels were assessed using the Chi-square test. Fisher's exact test was applied whenever the assumptions of the Chi-square test were not satisfied due to small expected cell frequencies. A two-sided *p* value of less than 0.05 was considered statistically significant.

III. Results

Characteristics of the Study Participants

A total of 104 healthcare workers (HCWs) participated in the study, yielding a response rate of 100%. The study population included 12 doctors (11.5%), 70 nursing personnel (67.3%), and 22 paramedical staff (21.2%). Among the participating healthcare facilities, one Community Health Centre (CHC) contributed 13 participants (12.5%), five Primary Health Centres (PHCs) contributed 31 participants (29.8%), and thirty Sub-Centres (SCs) contributed 60 participants (57.7%). The distribution of participants according to healthcare facility and professional category is presented in **Table 1**.

Table 1. Distribution of healthcare workers according to facility type and professional category

Facility Type	Doctors (n=12)	Nursing Staff (n=70)	Paramedics (n=22)	Total (n=104)
CHC (n=1)	5 (41.7%)	4 (5.7%)	4 (18.2%)	13 (12.5%)
PHCs (n=5)	7 (58.3%)	6 (8.6%)	18 (81.8%)	31 (29.8%)
Sub-Centres (n=30)	0 (0%)	60 (85.7%)	0 (0%)	60 (57.7%)
Total	12 (100%)	70 (100%)	22 (100%)	104 (100%)

Awareness Regarding Biomedical Waste Management

Most participants were aware of the basic principles of biomedical waste management. Overall, 95.2% of healthcare workers recognized the hazards associated with improper biomedical waste management, while 91.3% were aware of the recommended maximum storage period of biomedical waste. Recognition of the colour-coded segregation system was reported by 83.7% of participants, and 86.5% correctly identified the biohazard symbol.

Awareness of the Government of India biomedical waste management guidelines was reported by 77.0% of participants, whereas only 69.2% stated that a biomedical waste management chart was displayed at their workplace. Formal training on biomedical waste management had been received by only 16.3% of healthcare workers. None of the paramedical staff had received any formal training.

Detailed awareness according to professional category is presented in **Table 2**.

Table 2. Awareness regarding biomedical waste management among healthcare workers

Awareness Item	Doctors (n=12)	Nurses (n=70)	Paramedics (n=22)	Total (n=104)
GOI BMWM guidelines aware	11 (91.7%)	55 (78.6%)	14 (63.6%)	80 (77.0%)
BMWM chart displayed at facility	11 (91.7%)	48 (68.6%)	13 (59.1%)	72 (69.2%)
Recognition of biohazard symbol	12 (100%)	61 (87.1%)	17 (77.3%)	90 (86.5%)
Colour-coded bin system (BMW Rules 2016)	12 (100%)	58 (82.9%)	17 (77.3%)	87 (83.7%)
Used sharps segregation protocol	12 (100%)	57 (81.4%)	15 (68.2%)	84 (80.8%)
48-hour BMW storage limit	12 (100%)	64 (91.4%)	19 (86.4%)	95 (91.3%)

Awareness Item	Doctors (n=12)	Nurses (n=70)	Paramedics (n=22)	Total (n=104)
Hazards of poor BMWM	12 (100%)	66 (94.3%)	21 (95.5%)	99 (95.2%)
Formal BMWM training received	2 (16.7%)	15 (21.4%)	0 (0%)	17 (16.3%)

Knowledge Regarding Biomedical Waste Management

Based on the predefined scoring criteria, 10 (9.6%) healthcare workers demonstrated good knowledge regarding biomedical waste management, while 78 (75.0%) had average knowledge and 16 (15.4%) had poor knowledge.

Knowledge levels differed significantly across professional categories. Good knowledge was observed among 66.7% of doctors compared with only 2.9% of nursing personnel, whereas none of the paramedical staff achieved a good knowledge score. Poor knowledge was most frequently observed among paramedical staff (59.1%), followed by nursing personnel (4.3%), while none of the doctors were classified as having poor knowledge.

The association between professional category and knowledge level was highly statistically significant (Chi-square test, $p < 0.001$).

The distribution of knowledge scores is presented in **Table 3**.

Table 3. Knowledge level according to professional category

Knowledge Level	Doctors (n=12)	Nurses (n=70)	Paramedics (n=22)	Total (n=104)
Good (score >12.34)	8 (66.7%)	2 (2.9%)	0 (0%)	10 (9.6%)
Average (score $8.76-12.34$)	4 (33.3%)	65 (92.9%)	9 (40.9%)	78 (75.0%)
Poor (score <8.76)	0 (0%)	3 (4.3%)	13 (59.1%)	16 (15.4%)
p-value (chi-square)				<0.001 ***

Attitude Towards Biomedical Waste Management

Most healthcare workers (69.2%) demonstrated a moderately positive attitude towards biomedical waste management. A highly positive attitude was observed among 15.4% of participants, whereas an equal proportion exhibited a low level of motivation.

Doctors demonstrated the most favourable attitudes, with 83.3% categorized as highly motivated. In contrast, the majority of nursing personnel (82.9%) showed moderate motivation. Among paramedical staff, more than one-third (36.4%) demonstrated low motivation, representing the highest proportion among all professional categories.

The relationship between professional category and attitude level was statistically significant (Chi-square test, $p < 0.001$).

The detailed findings are shown in **Table 4**.

Table 4. Attitude towards biomedical waste management according to professional category

Attitude Level	Doctors (n=12)	Nurses (n=70)	Paramedics (n=22)	Total (n=104)
Highly motivated (score ≥ 52)	10 (83.3%)	4 (5.7%)	2 (9.1%)	16 (15.4%)
Moderately motivated (score $41-51$)	2 (16.7%)	58 (82.9%)	12 (54.5%)	72 (69.2%)
Low motivated (score ≤ 40)	0 (0%)	8 (11.4%)	8 (36.4%)	16 (15.4%)
p-value (chi-square)				<0.001 ***

Biomedical Waste Management Practices

Overall, good biomedical waste management practices were observed among 25 (24.0%) healthcare workers, whereas 69 (66.4%) demonstrated average practice and 10 (9.6%) demonstrated poor practice.

Doctors exhibited the highest level of compliance, with 91.7% demonstrating good practice. In comparison, only 15.7% of nursing personnel and 13.6% of paramedical staff achieved good practice scores. Average practice was the predominant category among both nursing personnel (71.4%) and paramedical staff (81.8%).

Professional category was significantly associated with practice level (Chi-square test, $p < 0.001$).

The distribution of practice scores is summarized in **Table 5**.

Table 5. Practice level according to professional category

Practice Level	Doctors (n=12)	Nurses (n=70)	Paramedics (n=22)	Total (n=104)
Good (score ≥ 7 , i.e., $\geq 75\%$)	11 (91.7%)	11 (15.7%)	3 (13.6%)	25 (24.0%)
Average (score 5–6, i.e., 50–74%)	1 (8.3%)	50 (71.4%)	18 (81.8%)	69 (66.4%)
Poor (score 0–4, i.e., $<50\%$)	0 (0%)	9 (12.9%)	1 (4.5%)	10 (9.6%)
p-value (chi-square)				<0.001 ***

IV. Discussion

The present study evaluated the knowledge, attitude, and practice (KAP) regarding biomedical waste management among healthcare workers employed at government primary healthcare facilities in Chargawan Block, Gorakhpur. By adopting a census approach that included all eligible healthcare workers across one Community Health Centre, five Primary Health Centres, and thirty Sub-Centres, the study provides a comprehensive assessment of biomedical waste management practices at the primary healthcare level. The findings revealed significant differences in knowledge, attitude, and practice among professional categories, with doctors consistently demonstrating better performance than nursing personnel and paramedical staff.

Only a small proportion of healthcare workers demonstrated good knowledge of biomedical waste management, despite high levels of awareness regarding individual components such as the hazards of biomedical waste and the recommended storage duration. This disparity suggests that although many healthcare workers are familiar with basic concepts, comprehensive understanding of biomedical waste management remains inadequate. Similar observations have been reported in studies conducted in different regions of India, where awareness of selected biomedical waste management practices was satisfactory but overall knowledge scores remained suboptimal because of inadequate formal training and limited continuing education. The comparatively better performance of doctors in the present study may be attributed to greater exposure to biomedical waste management during undergraduate and postgraduate medical training, whereas nursing and paramedical personnel often receive limited structured instruction after joining service.

A notable finding of the present study was the remarkably low proportion of healthcare workers who had received formal biomedical waste management training. More importantly, none of the participating paramedical staff reported receiving any formal training. Since these personnel are directly involved in the handling and transportation of biomedical waste, the absence of structured training represents a major occupational health concern. Previous studies have consistently demonstrated that healthcare workers who undergo regular biomedical waste management training achieve significantly higher knowledge and compliance scores than untrained personnel. These observations highlight the importance of periodic competency-based training as an essential component of biomedical waste management programmes.

The attitude of healthcare workers towards biomedical waste management was generally favourable, with most participants demonstrating a moderately positive attitude. Doctors exhibited the highest levels of motivation, whereas low motivation was most frequently observed among paramedical staff. Attitude is an important determinant of behaviour because positive perceptions regarding biomedical waste management are often associated with better compliance with recommended practices. However, favourable attitudes alone cannot ensure safe waste management unless they are supported by adequate knowledge, continuous supervision, and the availability of appropriate infrastructure.

Assessment of biomedical waste management practices showed that only about one-quarter of healthcare workers demonstrated good practice despite the relatively favourable attitude observed among most participants. This finding indicates the presence of a substantial knowledge-practice gap. Although doctors showed excellent compliance, considerably lower practice scores were observed among nursing personnel and paramedical staff. Similar gaps between knowledge and practice have been documented in several Indian studies, suggesting that behavioural change requires not only educational interventions but also regular monitoring, supportive supervision, and adequate availability of colour-coded bins, personal protective equipment, and other essential resources.

The complete absence of formal training among paramedical staff deserves particular attention. This group demonstrated the poorest knowledge scores and the highest proportion of participants with low motivation. Because paramedical personnel frequently perform waste collection, transportation, and preliminary disposal activities, deficiencies within this cadre may substantially compromise the effectiveness of biomedical waste management programmes at primary healthcare facilities. Targeted educational interventions focusing specifically on this group are therefore likely to produce meaningful improvements in overall compliance.

The findings of the present study have important implications for healthcare administration and public health policy. Biomedical waste management should be regarded as a continuous quality improvement process rather than a one-time training activity. Regular in-service training, periodic refresher programmes, supportive

supervision, routine internal audits, and strict implementation of the Bio-Medical Waste Management Rules, 2016 should be institutionalized across all levels of primary healthcare. Display of colour-coded waste segregation charts, uninterrupted availability of biomedical waste containers, and vaccination of healthcare workers against hepatitis B should also be ensured to strengthen occupational safety.

The strengths of the present study include the census-based inclusion of all eligible healthcare workers within the study area, thereby minimizing selection bias and providing a comprehensive representation of government primary healthcare facilities in Chargawan Block. The use of a validated questionnaire and standardized scoring system further enhanced the reliability of the findings.

However, several limitations should be considered while interpreting the results. The cross-sectional design precludes establishing causal relationships between training and biomedical waste management practices. Information on practice was primarily obtained through participant responses and may therefore be influenced by social desirability bias. In addition, the study was conducted within a single administrative block, which may limit the generalizability of the findings to other districts or states. Nevertheless, the study provides valuable baseline evidence regarding biomedical waste management practices in government primary healthcare facilities of eastern Uttar Pradesh and may serve as a reference for future intervention studies.

V. Conclusion

This study demonstrated significant differences in knowledge, attitude, and practice regarding biomedical waste management among healthcare workers employed at government primary healthcare facilities in Chargawan Block, Gorakhpur. Although awareness of selected biomedical waste management principles was generally satisfactory, comprehensive knowledge and appropriate practices remained inadequate, particularly among nursing personnel and paramedical staff.

Doctors consistently exhibited better knowledge, more favourable attitudes, and superior biomedical waste management practices than other healthcare worker categories. In contrast, paramedical staff emerged as the most vulnerable group, characterized by the absence of formal biomedical waste management training, poor knowledge, and comparatively lower motivation. These findings highlight the need for targeted interventions aimed at improving competency among frontline healthcare personnel who are directly involved in biomedical waste handling.

Strengthening biomedical waste management at the primary healthcare level requires regular competency-based training, periodic refresher programmes, supportive supervision, routine monitoring, and strict implementation of the Bio-Medical Waste Management Rules, 2016. Ensuring uninterrupted availability of colour-coded waste containers, appropriate personal protective equipment, and vaccination against occupationally acquired infections should be integral components of institutional biomedical waste management programmes.

The findings of the present study provide baseline evidence for policymakers and health administrators to design cadre-specific interventions that improve biomedical waste management practices and enhance occupational and environmental safety in primary healthcare settings.

VI. Strengths And Limitations

Strengths

The present study included all eligible healthcare workers employed at government primary healthcare facilities within Chargawan Block using a census sampling approach, thereby minimizing selection bias. The use of a validated, structured questionnaire based on the Bio-Medical Waste Management Rules, 2016 ensured systematic assessment of knowledge, attitude, and practice across different professional categories. The findings provide valuable baseline data for primary healthcare facilities in eastern Uttar Pradesh, where published evidence remains limited.

Limitations

The cross-sectional design limits the ability to establish causal relationships between training and biomedical waste management practices. Information regarding practice was primarily self-reported and may therefore be subject to recall and social desirability bias. The study was confined to a single administrative block, which may limit the generalizability of the findings to other regions. Future multicentric studies incorporating direct observational assessments would provide a more comprehensive evaluation of biomedical waste management practices.

VII. Declarations

Ethical Approval

The study protocol was approved by the Institutional Ethics Committee of Baba Raghav Das Medical College, Gorakhpur, Uttar Pradesh, India. Written informed consent was obtained from all participants before enrolment.

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Conflict of Interest

The author declares that there is no conflict of interest.

Author's Contribution

All authors have contributed equally.

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