



www.bioinformation.net
Volume 21(10)



Research Article

Received October 1, 2025; Revised October 31, 2025; Accepted October 31, 2025, Published October 31, 2025

DOI: 10.6026/973206300213766

SJIF 2025 (Scientific Journal Impact Factor for 2025) = 8.478

2022 Impact Factor (2023 Clarivate Inc. release) is 1.9

Declaration on Publication Ethics:

The author's state that they adhere with COPE guidelines on publishing ethics as described elsewhere at <https://publicationethics.org/>. The authors also undertake that they are not associated with any other third party (governmental or non-governmental agencies) linking with any form of unethical issues connecting to this publication. The authors also declare that they are not withholding any information that is misleading to the publisher in regard to this article.

Declaration on official E-mail:

The corresponding author declares that lifetime official e-mail from their institution is not available for all authors

License statement:

This is an Open Access article which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly credited. This is distributed under the terms of the Creative Commons Attribution License

Comments from readers:

Articles published in BIOINFORMATION are open for relevant post publication comments and criticisms, which will be published immediately linking to the original article without open access charges. Comments should be concise, coherent and critical in less than 1000 words.

Disclaimer:

Bioinformation provides a platform for scholarly communication of data and information to create knowledge in the Biological/Biomedical domain after adequate peer/editorial reviews and editing entertaining revisions where required. The views and opinions expressed are those of the author(s) and do not reflect the views or opinions of Bioinformation and (or) its publisher Biomedical Informatics. Biomedical Informatics remains neutral and allows authors to specify their address and affiliation details including territory where required.

Edited by Hiroj Bagde

E-mail: hirojbagde8@gmail.com

Citation: Das *et al.* Bioinformation 21(10): 3766-3769 (2025)

Impact of training on waste management practices among healthcare workers

Mayank Das^{1,*}, Sanchit Pradhan¹, Jyoti Adwani², Avnica Agarwal³, Arunendra Singh Chauhan⁴ & Omveer Singh⁵

¹Department of Public Health Dentistry, Subharti Dental College and Hospital, Swami Vivekanand Subharti University, Meerut, Uttar Pradesh, India; ²Department of Endocrine Surgery, King George's Medical University, Lucknow; ³Department of Public Health Dentistry, ITS Dental College & Research Center, Greater Noida, Uttar Pradesh, India; ⁴Department of Public Health Dentistry, Maharishi Markandeshwar College of Dental Sciences and Research, Mullana-Ambala, Haryana, India; ⁵Department of Public Health Dentistry, Career Post Graduate Institute of Dental Sciences and Hospital, Lucknow, India; *Corresponding author

Affiliation URL:

<http://dental.subharti.org/>

<https://www.kgmu.org/>

<https://www.itsdentalcollege.edu.in/>
<https://www.mmumullana.org/institute/dental-sciences>
<https://www.careertrust.in/cpgidsh/>

Author contacts:

Mayank Das - E-mail: dr.mayankdas101@gmail.com
Sanchit Pradhan - E-mail: sanchi1684@gmail.com
Jyoti Adwani - E-mail: jyotiadwani15@gmail.com
Avnica Agarwal - E-mail: avniagarwal37@yahoo.in
Arunendra Singh Chauhan - E-mail: dr.arun00@gmail.com
Omveer Singh - E-mail: omveersingh1679@gmail.com

Abstract:

Improper biomedical waste management poses a major risk to infection control and public health. This quasi-experimental study among 100 healthcare workers from two institutes in Meerut assessed the effectiveness of training on waste management and infection control. Group A received structured lectures, while Group B received educational materials, with assessments at 1, 3 and 6 months. Significant improvements were observed in knowledge, attitude and practice scores over time ($p < 0.05$). The training program effectively enhanced awareness and practices of healthcare workers toward infection control and waste management.

Keywords: Bio-medical waste, health care workers, infection control, quasi-experimental study, waste management practices, effectiveness, training

Background:

Biomedical waste management (BWM) has emerged as a major global public health concern requiring urgent intervention. The term "BWM" is defined as any waste generated during diagnosis, treatment, or immunization of humans or animals, or during research and production/testing of biologicals, as per the Biomedical Waste (Management and Handling) Rules, 1998 by the Government of India [1]. Health care waste is broadly categorized into hazardous and non-hazardous types. Hazardous waste includes infectious materials, sharps, chemicals, pharmaceuticals and radioactive substances; whereas non-hazardous waste comprises items like paper and packaging that pose minimal risk. The World Health Organization reports that 85% of hospital waste is harmless, while 10% is infectious and 5% noninfectious but hazardous [2]. Studies indicate that 15–35% of hospital waste is infectious and demands strict regulation. Although developed nations have improved biomedical waste management (BMW) practices, developing countries continue to face significant gaps, resulting in increased transmission of hepatitis B, hepatitis C and other infections among patients and healthcare workers [3]. In India, hospitals generate approximately 1.3–1.45 kg of waste per patient per day—significantly lower than developed countries (up to 4.5 kg)—but improper segregation and disposal practices make management more challenging [4]. Poor handling of BMW poses health risks to healthcare workers, patients, waste handlers and even the surrounding community [5]. Therefore, effective BMW is a key component of hospital hygiene and infection control. Continuous training and awareness of BMW regulations among healthcare professionals are essential for maintaining safe and sustainable hospital environments [6]. Therefore, it is of interest to evaluate the effectiveness of training sessions in improving knowledge and practices related to biomedical waste management among healthcare professionals.

Materials and Methods:

The quasi-experimental study was carried out in two health care institutes in Meerut city. Ethical clearance was obtained from the institutional ethical committee. Prior to the study, permission was taken from head of institutes. The study procedure was explained to study the subject and informed consent was taken from all participant of the study and confidentiality of the participants was maintained. The study was conducted in two health care institutes between February 2023 and July 2023. All the volunteers were invited for study after explanation of the study procedure and those who accept to participate in the study were included as per inclusion and exclusion criteria including 100 participants of both the institutes. The Exclusion criteria were participants who have already attended the training session and lecture on waste management and infection control and participants not willing to participate in the study. Simple random technique was used and sample size estimation was done by using G Power software (version 3.0). A minimum total sample size of 188 was found to be sufficient for an alpha of 0.05, power of 80% and 0.20 as effect size. Anticipating a dropout rate of 5% in this follow-up study, the total final sample size was decided as 200 (100 per group). A pilot study was conducted on 20 participants to check the validity of the questionnaire and the feasibility of the study. These subjects were not included in the final study. Inter-examiner reliability was calculated which was found to be fair as 0.70. The questionnaire was distributed to participants before and after the intervention process related to infection control and waste management. The components were self-assessment questions, knowledge-based and practice base questions related to infection control and waste management. The intervention consisted of a training sessions including lectures related to infection control and waste management. Educational health material related to biomedical waste management and infection control was distributed among

participants of institutes. Among Group A participants, at the baseline knowledge attitude and practice questionnaire related to waste management and infection control. Reinforcement in form of lectures was given at 1 month, 3 month. Follow up and assessment was done with the questionnaire at 1 month, 3 months and at the end of 6 months. Among Group B participants, at the baseline health educational material related to biomedical waste management and infection control, was

given and again assessment with the questionnaire was done at 1 month, 3 months and at the end of 6 months. Data were analyzed using SPSS software (version 21). Intergroup comparison of increment in mean knowledge, attitude and practices scores was done by independent t-test while the intragroup comparison of mean knowledge, attitude and practices scores from baseline to different follow up points was done.

Table 1: Gender-wise distribution of subjects

Gender-wise distribution			
	Males	Females	Total
Experimental	23(23.0%)	77(77.0 %)	100%
Control	23 (23%)	77 (77.0%)	100.00%
Total	46 (23.0%)	154(77.0%)	200(100%)
P value	1		

Note: Chi-square test.

Table 2: Intergroup and intragroup comparison of knowledge scores at baseline, 1 month, 3 months and 6 months

	Experimental Group		Control Group		P value
		Mean± Std. Deviation		Mean ± Std. Deviation	
At Baseline	100	1.432± 0.55134	100	1.2700 ±0.52905	0.387
1 month	98	7.1939 ± 0.88117	96	1.5208 ± 0.75365	<0.0001
3 months	95	10.38950±.87877	93	1.5376 ± 0.75985	<0.0001
6 month	97	13.32991±.00749	93	5.2043 ± 1.00749	<0.0001
P ^b value of Intragroup comparison	<0.0001				<0.0001

Note: Repeated measures of ANOVA, Independent t-test.

Table 3: Intergroup and intragroup comparison of attitude scores at baseline, 1 month, 3 months and 6 months

Attitude Score	Experimental Gr		Control Group		P value Intergroup comparison
		Mean± Std. Deviation		Mean± Std. Deviation	
Baseline	100	1.3100 ±0.48607	100	1.2600± 0.36845	0.08
1 month	98	3.1800 ±0.78341	96	0.55636± 1.2813	<0.0001
3 months	95	4.7200 ±1.21506	93	1.2903 ±0.56300	<0.0001
6 month	97	5.8200 ±0.67240	93	2.1935 ±0.59450	<0.0001

Note: Repeated measures of ANOVA, Independent t-test

Table 4: Intergroup and intragroup comparison of practices scores at baseline, 1 month, 3 months and 6 months

Practices Score	Experimental Group		Control Group		P value of intergroup comparison
	N	Mean ±Std. Deviation		Mean ±Std. Deviation	
Baseline	100	6.7900 ±1.79952	100	6.1121 ±1.23987	0.055
1 month	98	9.8900 ±1.97916	96	6.1458 ±1.42148	<0.0001
3 months	95	14.6600 ±2.22120	93	6.1290 ±1.43122	<0.0001
6 months	97	15.7800 ±1.94147	93	7.6022 ±1.92884	<0.0001
P value of Intragroup comparison	<0.0001				

Note: Repeated measures of ANOVA, Independent t-test.

Results:

The present study was conducted among 200 study participants among the experimental group and control group (100 in each group). In **Table 1**, the gender-wise distribution of study population among two study groups showed that both the study groups had an equal number of males and females and there were no gender wise differences. In **Table 2**, intragroup comparison of knowledge scores in the experimental group showed that there was a statistically significant increase in knowledge scores from 1 month to 3 months and from 3 months to 6 months. In **Table 3**, the intragroup comparison of attitude scores in the experimental group showed that there was a statistically significant increase in attitude scores from 1 month to 3 months and from 3 months to 6 months. Also, the intragroup comparison of attitude scores in the control group showed that attitude scores did not increase significantly from 1

month to 3 months, but it increased significantly from 3 months to 6 months. In **Table 4**, intragroup comparison of practices scores in the experimental group showed that there was a statistically significant increase in practices scores from 1 month to 3 months and from 3 months to 6 months. Also, intragroup comparison of practices scores in control group showed that practices scores did not show any significant increase from baseline to 1 month and from 1 month to 3 months and then it further increased significantly from 3 months to 6 months. However, intergroup comparison of practices scores between experimental and control group showed that at baseline, there was no statistically significant difference in the practices scores but at every follow up, at every point of time *i.e.* 1 month, 3 months and 6 months, the practices scores among experimental group was significantly higher than that among control group subjects.

Discussion:

The findings from previous studies consistently highlight the critical importance of continuous education and structured training in improving biomedical waste management (BMWM) knowledge, attitude and practices among healthcare personnel. Studies have demonstrated that compliance with waste handling and disposal protocols remains suboptimal in many healthcare settings, particularly in waste transportation practices, which showed the lowest adherence rates [7]. However, the implementation of targeted training programs has been shown to significantly enhance post-test knowledge scores, reaffirming the effectiveness of educational interventions in improving compliance and awareness levels [7]. In the present study, intragroup comparison within the experimental group revealed a statistically significant increase in knowledge scores over successive time intervals, suggesting that sustained training and periodic reinforcement contribute to better knowledge retention and practical application. This aligns with previous evidence indicating that a large proportion of nursing and paramedical staff possess only moderate knowledge and display an unfavorable attitude toward BMWM before formal training [8]. Structured training sessions, therefore, serve as a pivotal component in transforming both cognitive understanding and behavioral attitudes [9]. Furthermore, research has shown that awareness of waste segregation protocols, especially color-coded categorization, remains inconsistent among healthcare workers, with less than three-quarters demonstrating adequate understanding or having undergone formal training [10]. Additional investigations in dental and hospital environments have also found significant associations between knowledge levels and specific factors such as familiarity with waste categories, disposal methods and regulatory oversight mechanisms [11]. These correlations underscore the need for standardized training across all cadres of healthcare professionals. Recent evidence from regional and global studies indicates that inadequate knowledge and poor waste-handling practices persist, especially among sanitary and auxiliary workers [12]. A lack of access to functional incineration facilities and limited staff training further exacerbate improper waste disposal, posing substantial risks to environmental and public health [13]. Generally, educational training plays a crucial role in improving healthcare workers' practices and compliance in healthcare waste management, leading to safer and more efficient handling of medical waste, though continued efforts are needed to sustain and optimize these improvements [14]. Educational interventions are effective in improving healthcare workers' knowledge and practices related to waste management, particularly when delivered as multi-component programs [15]. Collectively, these findings emphasize the necessity of integrating comprehensive BMWM and infection control modules into the curricula of medical, dental, nursing and allied

health institutions. Continuous professional development, supported by regular assessments and refresher programs, is vital to maintaining adherence to regulatory standards and minimizing occupational and ecological hazards. Future research should adopt mixed-method and longitudinal approaches to evaluate the sustained impact of educational interventions on BMWM compliance and institutional safety culture [7-13].

Conclusion:

The training programme was found to be effective in improving the knowledge, attitude and practices regarding infection control and waste management among health care workers.

Acknowledgement:

All authors have made substantive contribution to this study and/or manuscript and all have reviewed the final paper prior to its submission.

Conflict of Interest: NIL**Source of Funding:** NIL**References:**

- [1] Singh S *et al.* *J Educ Health Promot.* 2020 **9**:127 [PMID: 32642483]
- [2] Sahoo MC *et al.* *Cureus.* 2024 **16**:e61823 [PMID: 38975390]
- [3] Narang RS *et al.* *Oral Health Dent Manag.* 2012 **11**:162 [PMID: 23208592]
- [4] Basu M *et al.* *J Nat Sci Biol Med.* 2012 **3**:38 [PMID: 22690049]
- [5] Pandey A *et al.* *J Clin Diagn Res.* 2016 **10**:DC01 [PMID: 28050362]
- [6] Rohilla R *et al.* *J Educ Health Promot.* 2021 **10**:186 [PMID: 34250120]
- [7] Manar MK *et al.* *J Family Med Prim Care.* 2014 **3**:393 [PMID: 25657950]
- [8] Parida A *et al.* *J Lab Physicians.* 2019 **11**:292 [PMID: 31929693]
- [9] Thirunavukkarasu A *et al.* *PeerJ.* 2022 **10**:e13773 [PMID: 35880221]
- [10] Bansod HS *et al.* *Cureus.* 2023 **15**:e34589 [PMID: 36874306]
- [11] Devi A *et al.* *Environ Sci Pollut Res Int.* 2019 **26**:26082 [PMID: 31278642]
- [12] Datta P *et al.* *J Lab Physicians.* 2018 **10**:6 [PMID: 29403196]
- [13] Sharma R *et al.* *Cureus.* 2021 **13**:e14785 [PMID: 34094747]
- [14] Bannour R *et al.* *Antimicrob Resist Infect Control.* 2024 **13**:122. [PMID: 39390611]
- [15] Conti A *et al.* *Sustainability.* 2024 **16**:3513. [DOI: 10.3390/su16093513]