



Safe Hands, Safe Earth: Prioritizing Security and Sustainability in Medical Waste Management

Twinkle ^{a*}, Manju Mehta ^a and Jatesh Kathpalia Jatesh ^b

^a Department of Family Resource Management, CCS Haryana Agricultural University, Hisar, Haryana, India.

^b Department of Sociology, CCS Haryana Agricultural University, Hisar, Haryana, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: <https://doi.org/10.9734/air/2024/v25i41090>

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/114846>

Review Article

Received: 05/02/2024

Accepted: 09/04/2024

Published: 13/06/2024

ABSTRACT

Proper management of biomedical waste reflects the ethical responsibility of healthcare providers and institutions to protect public health, the environment, and the well-being of their communities. Overall, the effective management of biomedical waste is crucial for safeguarding public health, protecting the environment, ensuring occupational safety, complying with regulations, and fulfilling social responsibilities. Healthcare workers who handle biomedical waste are at risk of needle stick injuries, exposure to infectious agents, and other hazards. Addressing the challenges requires a multi-faceted approach involving government initiatives, regulatory enforcement, public awareness campaigns, investment in infrastructure and technology, training programs for healthcare workers, and collaboration with stakeholders across sectors. By addressing these issues, India can improve its capacity for biomedical waste management.

*Corresponding author: E-mail: twisangwan@gmail.com;

Cite as: Twinkle, Manju Mehta, and Jatesh Kathpalia Jatesh. 2024. "Safe Hands, Safe Earth: Prioritizing Security and Sustainability in Medical Waste Management". *Advances in Research* 25 (4):132-39. <https://doi.org/10.9734/air/2024/v25i41090>.

Keywords: Biomedical waste; healthcare workers; public health; radioactive materials.

1. INTRODUCTION

Biomedical waste refers to any waste generated during medical procedures, diagnosis, or treatment of humans or animals. This waste can include sharps (needles, syringes), laboratory waste (culture dishes, glassware), blood and bodily fluids, pharmaceuticals, medical devices, and radioactive materials. Proper disposal of biomedical waste is crucial to prevent the spread of infections and protect public health and the environment. Bathma et al. [1] reported that “approximately 10-25% of biomedical waste was hazardous and injurious to humans and animals and deleterious environment. It is estimated that annually about 0.33 million tonnes of this hospital waste were generated in India”. “India is lagging behind in large-scale sorting, collection, careful storage, transfer and disposal of biomedical waste. Waste disposal companies are exposed to a variety of health risks and are not safe for waste due to lack of waste management training. Total amount of waste generated in a hospital in Karnataka was found to be 9.43 kg/day, which included 2.75 kg of non-infectious waste, 5.71 kg of infectious waste and 0.87 kg of sharp waste” [2].

2. WHY BIOMEDICAL WASTE MANAGEMENT IS ESSENTIAL?

The management of biomedical waste is essential for several reasons:

1. **Public Health Protection:** Biomedical waste may contain pathogens such as bacteria, viruses, or parasites that can cause diseases in humans. Proper management prevents the spread of infections and protects public health.
2. **Environmental Protection:** Improper disposal of biomedical waste can contaminate soil, water, and air, leading to environmental pollution. Managing biomedical waste ensures that hazardous materials are handled and disposed of safely, minimizing environmental impact.
3. **Occupational Safety:** Healthcare workers who handle biomedical waste are at risk of needle stick injuries, exposure to infectious agents, and other hazards. Effective management practices, including proper segregation, handling, and disposal; help protect the safety and health of workers.

4. **Legal Compliance:** Many countries have regulations and guidelines for the management of biomedical waste to ensure public health and environmental safety. Compliance with these regulations is necessary to avoid legal penalties and maintain accreditation for healthcare facilities.
5. **Social Responsibility:** Proper management of biomedical waste reflects the ethical responsibility of healthcare providers and institutions to protect public health, the environment, and the well-being of their communities. Overall, the effective management of biomedical waste is crucial for safeguarding public health, protecting the environment, ensuring occupational safety, complying with regulations, and fulfilling social responsibilities.

Bhagawati et al. [3] reported “the current status of awareness and practices regarding Bio-Medical Waste Management (BMWM) and areas of deficit amongst the health care workers in a tertiary care teaching hospital in New Delhi, India. Some major areas of deficit found were about knowledge regarding number of BMW categories (17%), mercury waste disposal (37.56%) and definition of BMW (47%). Eshwar et al. [4] depicted that in a study of biomedical waste management was conducted in tertiary care hospital among health care personnel in Puducherry 95% of the doctors had knowledge regarding biomedical waste management. However, the nursing staff (50%) and MPW's (80%) had poor knowledge regarding the colour coding for the segregation of waste. This study also stated that about 35% of nurses and 43% of Multipurpose Healthcare Workers were not vaccinated against Hepatitis B”

3. HAZARDS OF BIOMEDICAL WASTES

“There was a poor level of knowledge and awareness of biomedical waste generation hazards legislation and management among health care personnel” [5]. It was surprising that 36% of the nurses had an extremely poor knowledge of biomedical waste generation and legislation and just 15% of sweepers had an excellent awareness of biomedical waste management practice. Singh et al. [6] revealed that “the knowledge concerning the importance of biomedical waste, its relationship with the ecosystem, the environmental toxins used in

hospitals and the impact of cruelty on public health, remain very minimal. For better result we need to increase the level of education and training regarding biomedical waste and environment-friendly hospitals with optimum priority, under rules and legislation”.

Biomedical waste can have several harmful effects:

1. **Public Health Risks:** Biomedical waste may contain infectious agents such as bacteria, viruses, and parasites, posing a risk of disease transmission to healthcare workers, waste handlers, patients, and the general public if not properly managed.
2. **Environmental Pollution:** Improper disposal of biomedical waste can contaminate soil, water bodies, and the air, leading to environmental pollution. Chemicals and pharmaceuticals present in biomedical waste can leach into the environment, affecting ecosystems and potentially entering the food chain.
3. **Occupational Hazards:** Healthcare workers and waste handlers who come into contact with biomedical waste are at risk of needle stick injuries, exposure to hazardous chemicals, and other occupational hazards. These risks can lead to infections, injuries, and long-term health consequences.
4. **Community Impact:** Improper management of biomedical waste can negatively impact communities living near healthcare facilities or waste disposal sites. Foul odors, visual pollution, and the spread of diseases can decrease the quality of life for residents and damage the reputation of the healthcare facility.
5. **Spread of Drug Resistance:** Improper disposal of pharmaceuticals in biomedical waste can contribute to the development of antimicrobial resistance. Residues of antibiotics and other medications can enter the environment, promoting the growth of drug-resistant bacteria and making infections harder to treat. Overall, the harmful effects of biomedical waste underscore the importance of proper management practices to mitigate risks to public health, the environment, and occupational safety.

According to the World Health Organization (WHO), healthcare activities generate a significant amount of waste, with approximately

85% being general, non-hazardous waste and the remaining 15% being hazardous, including biomedical waste. This proportion may vary by region and healthcare setting. Some studies and reports provide estimates of biomedical waste generation in specific countries or regions. For example, a study published in the Journal of Environmental Management estimated that hospitals in India generate around 0.5 to 2.0 kg of biomedical waste per bed per day, highlighting the considerable volume of waste generated in healthcare facilities. Overall, while precise global figures may be challenging to determine, it's evident that biomedical waste generation is a significant issue worldwide, underscoring the importance of effective waste management practices to protect public health and the environment.

Biomedical waste generation in any region depends on factors such as population size, healthcare infrastructure, the prevalence of medical facilities, and waste management practices. Haryana, being a populous state with a significant healthcare sector, likely generates a substantial amount of biomedical waste. The state government, along with local authorities and healthcare facilities, would implement measures to manage and dispose of biomedical waste safely and in compliance with regulations to mitigate potential health and environmental risks.

4. TYPES OF BIOMEDICAL WASTE MANAGEMENT

Biomedical waste management involves several key steps and methods to ensure safe handling, transportation, treatment, and disposal of biomedical waste.

Some common types of biomedical waste management include:

1. **Segregation:** Proper segregation of biomedical waste at the point of generation is essential. This involves separating different types of waste (e.g., sharps, infectious waste and pharmaceutical waste) into designated containers or bins to prevent cross-contamination and facilitate safe handling. Sengodan [7] reported that “the biomedical waste generated in the year 2010 was 15,875 kg with in-patient strength of 376,660 patients. In the year 2011, 26,103 kg of biomedical waste was generated with in-patient

occupancy of 380,486 patients. In the year 2012, 402,208 patients generated 24,678 kg of biomedical waste. The result showed reduction in biomedical waste generated from 2011 to 2012, which was achieved due to effective waste segregation practices”.

2. **Collection and Storage:** Biomedical waste should be collected and stored in leak-proof, puncture-resistant containers that are colour-coded and labelled according to waste categories. Storage areas should be secure, well-ventilated, and equipped with safety measures to prevent unauthorized access and minimize odour and pest infestation.
3. **Transportation:** Biomedical waste must be transported from healthcare facilities to treatment and disposal facilities using specialized vehicles that comply with safety and regulatory requirements. Transport containers should be durable, leak-proof, and properly labelled to prevent spillage and contamination during transit.
4. **Treatment:** Biomedical waste undergoes treatment processes to reduce its volume and mitigate potential health and environmental risks. Common treatment methods include autoclaving (steam sterilization), incineration, chemical disinfection, and mechanical shredding. Treatment facilities must adhere to regulatory standards and environmental guidelines to ensure safe and effective waste treatment.
5. **Disposal:** Once treated, biomedical waste may be disposed of through various methods, including land filling, deep burial, or recycling (e.g., metal sharps). Disposal methods should comply with local regulations and environmental standards to prevent pollution and protect public health.
6. **Training and Education:** Healthcare workers and waste handlers require training and education on proper biomedical waste management practices, including segregation, handling, and disposal. Training programs help ensure compliance with regulations, reduce occupational hazards, and promote environmental sustainability.
7. **Monitoring and Compliance:** Regular monitoring and compliance audits are essential to assess the effectiveness of biomedical waste management practices and identify areas for improvement.

Compliance with regulatory requirements helps mitigate risks and maintain public health and environmental safety. By implementing these types of biomedical waste management practices, healthcare facilities can effectively mitigate the risks associated with biomedical waste and protect the health and safety of individuals and communities.

5. AWARENESS ABOUT THE LEGISLATIONS REGARDING BIO-MEDICAL WASTE MANAGEMENT

Arora et al. [8] stated that “majority of the respondents had unsatisfactory knowledge, attitude and inadequate practices related to bio-medical waste management. There is a need to improve knowledge about bio-medical waste management to protect the environment from its negative effect. Need based training programmes for health care professionals at college and hospital, was recommended”. Mathur et al. [9] reported that “doctors, nurses and lab technicians had better knowledge than sanitary staff regarding biomedical waste management. Knowledge regarding the colour coding and waste segregation at source was found to be better among nurses and laboratory staff s compared to doctors”. Gupta et al. [10] analyzed that “the health care professionals reported that the hospital waste should be segregated and needs to be disposed properly. Total 47.5 % professionals knew about the categories and the treatment of health care waste properly, of which 81.9% were nurses, 76.8% were doctors, 38.5% were interns, 27.3% were technicians and 19.3% were keeping staff. Majority of the study subjects i.e., 95.8% had knowledge about various health care problems caused by health care workers, of which 38.8% were nurses. Majority of the workers i.e., 96.1% were aware of the colour coding for waste segregation but they did not have any clear idea of what should be disposed in which bin. Overall, it was observed that the knowledge and practices adopted for biomedical waste by the doctors and the nursing staffs was good”. Bansal et al. [11] in “research carried out in a hospital to collect information on knowledge possessed by the staff regarding biomedical waste management practices. Out of these 44.30% were medical, 29.74% were para-medical and 25.95% were non-medical staff. The knowledge of medical staff was higher than para-medical staff and while it was least among non-medical workers”.

Chudasama et al. [12] observed that “majority of (79.6%) sanitary staff had heard about biomedical waste, only (3.7%) were actually aware about the Biomedical Waste Management and Handling Rules, 1998. Very few (28.5%) resident and intern doctors and (25.9%) sanitary staff received training for biomedical waste. Awareness related to various disease transmitted by biomedical waste among the staff was poor. Majority of health care personnel were aware about the availability of different coloured bags used for collection of waste but for identification of coloured bags used as per biomedical waste act, except doctors (98.4%) awareness among other health care personnel was very poor”. Ismail et al. [13] reported that “the knowledge regarding biomedical waste management was poor among all the four groups of hospital staff i.e., doctors, nurses, lab-technicians and sweepers. Most of the doctors (98%) and nurses (70%) were aware that the segregation of biomedical waste has to be done at the point of generation. There was adequate knowledge regarding the risk of disease transmission through biomedical waste in all the groups except the sweepers”. Patil et al. [14] concluded that “the biomedical waste has been a growing concern due to increased awareness in public regarding infectious diseases. Good biomedical waste disposal practices lead to reduction in medical expenditure, unsightly scenes at various disposal bins and dumping sites. Improper biomedical waste management practices and indiscriminate disposal of hospital waste causes spread of illness leading to financial burden to society. Therefore, it is necessary to educate the staff, patients and community about the management of infectious biomedical waste”. Rathod et al. [15] stated that “inadequate knowledge about management of biomedical waste can be associated with the risks to healthcare workers, communities and patients at large. Hospital infection control committee and team are responsible for monitoring of proper implementation of biomedical waste management rules. It is not only related to quality waste management but also to safety of health care workers that is universal precautions and immunization”.

Selvaraj et al. [16] conducted a study among the medical practitioners using questionnaire and reported that 70% of the practitioners have not undergone any training in biomedical waste management. Though most 98% felt that biomedical waste should be segregated, 30.2% of them were still dumping it with general waste.

31% of the practitioners didn't know what ultimately happens to the biomedical waste. The study highlighted the need for programs that not only impart knowledge to the doctors but also motivate them to actively practice proper biomedical waste management—Malini et al. [17] stated that most of the paramedical staff and Class IV worker had poor knowledge regarding colour coding of the containers as compared to medical officers. This might be due to the fact that the medical officers had previously received the training of biomedical waste management. However, more than 90% of the health care personnel were aware about the biomedical waste management expects Class IV. Though, the major concern was inadequate knowledge about universal precautions. Gupta et al. [18] reported that only one fourth of the Class IV workers had knowledge regarding the biomedical waste management legislations and generation. While (93.3%) of the doctors had knowledge regarding the same. Knowledge about segregation and colour coding of biomedical waste was much lower in Class IV workers. Only one out of twenty-two Class IV workers could currently identify the biohazard symbols. Ranjan et al. [19] stated that a higher percentage of participants (61%) were completely unaware about recycling and reusing of biomedical waste. Similarly, 44% of the dental students didn't have any awareness about the management of biomedical waste, 22% were moderately aware, 21% slightly aware, 7% very aware, and 5% fell in extremely aware category. Kumar [20] reported that cross sectional study was conducted among 250 medical students in two professionals. They were sub grouped as 1st and 2nd professionals. 1st professional students were less knowledgeable and aware as compared to 2nd professional regarding segregation, colour coding about biomedical waste management. So, intensive training and orientation classes can be provided for new medical students to improve the attitude and knowledge about disposal for future practical application.

Kumar et al. [21] reported that there is a significant association between “Attended in Service Education Program” and “Level of Knowledge”. The result of the study concluded that 75% of staff nurses were having insufficient knowledge, 25% of the staff nurses were having moderate knowledge and none of the staff nurses were having adequate knowledge on biomedical waste management.

6. REASON FOR POOR DISPOSAL OF BIOMEDICAL WASTE IN INDIA

India faces several challenges in effectively managing biomedical waste on a large scale:

1. **Infrastructure and Resources:** Many healthcare facilities in India, especially in rural areas, lack adequate infrastructure and resources for proper biomedical waste management. This includes the availability of appropriate waste segregation bins, storage facilities, transportation vehicles, and treatment plants.
2. **Awareness and Training:** There may be a lack of awareness and training among healthcare workers and waste handlers regarding proper biomedical waste management practices. Without sufficient education and training, there is a higher risk of improper segregation, handling, and disposal of biomedical waste.
3. **Regulatory Compliance:** While India has regulations in place for biomedical waste management (such as the Biomedical Waste Management Rules), enforcement and compliance monitoring may be lacking, particularly in remote or underserved areas. Inconsistent enforcement of regulations can lead to non-compliance and improper waste management practices.
4. **Financial Constraints:** Many healthcare facilities, especially smaller ones and those in the public sector, may face financial constraints that limit their ability to invest in proper biomedical waste management infrastructure and services. Lack of funding can hinder the establishment of treatment facilities and the procurement of necessary equipment.
5. **Population Density and Urbanization:** India's high population density and rapid urbanization exacerbate the challenges of biomedical waste management. The concentration of healthcare facilities in urban areas, coupled with inadequate waste management infrastructure, can lead to increased generation and improper disposal of biomedical waste.
6. **Informal Sector Involvement:** In some cases, the informal sector, including waste pickers and recyclers, may be involved in the collection and handling of biomedical waste, leading to unsafe practices and

health risks for workers and the community. Addressing these challenges requires a multi-faceted approach involving government initiatives, regulatory enforcement, public awareness campaigns, investment in infrastructure and technology, training programs for healthcare workers, and collaboration with stakeholders across sectors. By addressing these issues, India can improve its capacity for biomedical waste management.

7. CONCLUSION

Addressing the challenges requires a multi-faceted approach involving government initiatives, regulatory enforcement, public awareness campaigns, investment in infrastructure and technology, training programs for healthcare workers, and collaboration with stakeholders across sectors. By addressing these issues, India can improve its capacity for biomedical waste management.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bathma V, Likhari K, Mishra M, Athavale A, Agarwal S. Knowledge assessment of hospital staff regarding biomedical waste management in a Tertiary Care Hospital. *National Journal of Community Medicine*. 2012;3(2):197-201.
2. Thirumala S. Study of Bio-Medical Waste Generation and Management in Various Hospitals in Davangere City of Karnataka. *Indian Journal of Health Science*. 2013;3(3). ISSN 2249-7110.
3. Bhagawati G, Nandwani S, Singhal S. Awareness and practices regarding bio-medical waste management among health care workers in a tertiary care

- hospital in Delhi. *Indian J Med Microbiol.* 2015;33(4):580-2.
4. Eshwar B. Knowledge, Attitude and Practice of Biomedical waste management among health care personnel in a tertiary care hospital in Puducherry. *Int J Biomed Research.* 2015;6(3):172.
 5. Sharma A, Sharma V, Sharma S, Singh P. Awareness of biomedical waste management among health care personnel in Jaipur, India. 2013;12(1):32-40.
 6. Singh A, Singh J, Singh AP, Singh R. Biomedical waste management and their possible health risks with controlling measures In Bareilly City, Up, India. *Journal of Environmental Research.* 2014; 2(4):296-302.
 7. Sengodan CV. Segregation of biomedical waste in a South Indian tertiary care hospital. *Journal of Nature Science, Biology and Medicine.* 2014;5(2):378–382.
 8. Arora L, Agarwal S. Knowledge, attitude and practices regarding waste management in selected hospital students of university of Rajasthan, Jaipur. *International Journal of Chemical, Environmental and Pharmaceutical Research.* 2011;2(1):40-43.
 9. Mathur V, Dwivedi S, Hasson MA, Mishra RP. Knowledge attitudes and practices about biomedical waste management among health care personnel: Across sectional study. *Indian Journal Community Medicine.* 2011;36:5-143.
 10. Gupta S, Boojh R, Mishra A, Chandra H. Rules and management of biomedical Waste at Vivekananda Polyclinic: A Case Study. *Waste Management.* 2012;29:812–819.
 11. Bansal M, Mishra A, Gautam P, Changulani R, Srivastava DK, Singh N. Knowledge and awareness regarding biomedical waste management among employees of a Tertiary Care Hospital. *Indian Journal of Community Health.* 2013; 25(1):86-88.
 12. Chudasama R, Sheth A, Rangoonwala M, Joshi N, Zalayadiya D, Bhola C. Awareness and practice of biomedical waste management among different health care personnel at Tertiary Care Centre, Rajkot, India. *Online Journal of Health and Allied Sciences.* 2013;13(1).
 13. Ismail MI, Kulkarni GA, Kamble SV, Borker SA, Rai R, Amruth M. Knowledge, attitude and practice about bio-medical waste management among personnel of a tertiary health care institute in Dakshina Kannada, Karnataka. *Journal of Medical Science.* 2013;6(4):376-80.
 14. Patil P, Tambe MP, Patil, PJ, Bhagwat VR. Awareness of healthcare workers regarding biomedical waste management: At Tertiary Care Government Hospital in Dhule (Maharashtra). *National Journal of Integrated Research in Medicine.* 2013;4(4):74-79.
 15. Rathod D, Jadav J, Vaghela S. Evaluation of awareness programme on practices of biomedical waste management at Teaching Hospital, Ahmadabad. *International Journal of Medicine and Biomedical Research.* 2013;2(1):28-35.
 16. Selvaraj K, Sivaprakasam P, Nelson SB, Kumar M, Pandiyan KR. Knowledge and practice of Biomedical Waste (BMW) Management among the medical practitioners of Kanchipuram Town, India. *Int. J. Curr. Microbiol. App. Sci.* 2013;10:262-67.
 17. Malini A, Eshwar B. Knowledge, attitude and practice of biomedical waste management among health care personnel in a Tertiary Care Hospital in Puducherry. *International Journal of Biomedical Research.* 2015;6(03):172-176.
 18. Gupta KS, Shukla M, Tyagi S. Knowledge, attitude and practices of biomedical waste management among health care personnel in selected primary health care centres in Lucknow. *International Journal of Community Medicine and Public Health.* 2016;3(1):309-311.
 19. Ranjan R, Pathak R, Singh DK, Jallaludin MD, Kore SA, Kore AR. Awareness about biomedical waste management and knowledge of effective recycling of dental materials among dental students. *J Int Soc Prev Community Dent.* 2016;6(5): 474-479.
 20. Kumar M. Knowledge, awareness, attitude regarding biomedical waste management among medical students in a tertiary care centre:A cross sectional study. *Indian Journal of Research.* 2017;6(4). ISSN 2250-1991.

21. Kumar R, Abinaya N, Vankatesan A, Natrajan M. Bio-medical waste disposal in India: From paper to practice, what has been effected. Indian Journal of Health Sciences and Biomedical Research. 2019;12(3):202.

© Copyright (2024): Author(s). The licensee is the journal publisher. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:

<https://www.sdiarticle5.com/review-history/114846>