# INDIAN JOURNAL OF LEGAL REVIEW

VOLUME 6 AND ISSUE 1 OF 2026

INSTITUTE OF LEGAL EDUCATION

# INDIAN JOURNAL OF LEGAL REVIEW

**APIS – 3920 – 0001 | ISSN - 2583-2344**

**(Open Access Journal)**

**Journal's Home Page – https://ijlr.iledu.in/**

**Journal's Editorial Page - https://ijlr.iledu.in/editorial-board/**

**Volume 6 and Issue 1 of 2026 (Access Full Issue on - https://ijlr.iledu.in/volume-6-and-issue-1-of-2026/)**

**Publisher**

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Chairman of Institute of Legal Education

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Maudhanda Kurichi, Srirangam,

Tiruchirappalli – 620102

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INDIAN JOURNAL OF LEGAL REVIEW [IJLR – IF SCORE – 7.58]

VOLUME 6 AND ISSUE 1 OF 2026

APIS – 3920 - 0001 *(and)* ISSN - 2583-2344

Published by

Institute of Legal Education

https://iledu.in

# BIOMEDICAL WASTE MANAGEMENT IN INDIA: ISSUES, RISKS, AND REGULATORY RESPONSES

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**BEST CITATION** - YOGESH PRASAD KOLEKAR & DR. RAMESH KUMAR, BIOMEDICAL WASTE MANAGEMENT IN INDIA: ISSUES, RISKS, AND REGULATORY RESPONSES, *INDIAN JOURNAL OF LEGAL REVIEW (IJLR)*, 6 (1) OF 2026, PG. 460-465, APIS – 3920 – 0001 & ISSN - 2583-2344. DOI – https://doi.org/10.65393/SETB1568

**Abstract**

India's rapid population growth, expansion of healthcare services, and increasing use of disposable medical products have made biomedical waste management a critical public health and environmental concern. Waste generated during diagnosis, treatment, immunization of humans or animals, or in research activities is known as biomedical waste. Human health, healthcare workers, waste handlers, and the environment are at risk due to improper handling, segregation, treatment, and disposal of such waste. India has enacted specific legal and regulatory frameworks, particularly the Biomedical Waste Management Rules, 2016 (amended from time to time), to address these concerns. Although regulations exist, challenges such as lack of awareness, inadequate infrastructure, poor implementation, and monitoring gaps persist. This article critically examines the issues, risks, and regulatory responses related to biomedical waste management in India. It also analyzes the effectiveness of existing laws and suggests measures to strengthen compliance and sustainable waste management practices.

**Keywords:** Biomedical Waste Management, Public Health, Environmental Risk, Healthcare Facilities, Regulatory Framework, Implementation Challenges, India

## Introduction

Healthcare services are essential for protecting and improving public health. Nevertheless, these services produce a significant amount of waste, some of which is hazardous in nature. Waste generated from hospitals, clinics, laboratories, blood banks, veterinary institutions, research centers, and healthcare facilities is known as biomedical waste. The waste can have infectious materials, toxic chemicals, pharmaceuticals, sharps, and radioactive substances in it.

The rapid growth of hospitals, diagnostic centers, nursing homes, and medical colleges in India has caused an increase in the problem of biomedical waste management. India is estimated to generate thousands of tonnes of biomedical waste every day, and the amount is increasing, especially after the COVID-19 pandemic. Improper disposal of biomedical waste can lead to the spread of infectious diseases such as HIV/AIDS, Hepatitis B and C, and other bacterial and viral infections.

The Government of India has introduced a range of rules and guidelines under the Environment (Protection) Act, 1986, in response to the seriousness of the issue. The Biomedical Waste Management Rules, 2016, replaced earlier rules of 1998 and introduced stricter norms for segregation, storage, transportation, treatment, and disposal of biomedical waste. Despite regulatory efforts, implementation is still not

consistent across states and healthcare institutions.

The objective of this article is to examine the current system of managing biomedical waste in India, identify key issues and risks, evaluate regulatory responses, and assess the effectiveness of legal mechanisms in addressing the issue.

**Research Objectives**

The objectives of the present study are as follows:

To study the concept and management of biomedical waste in India.

To identify key challenges and risks associated with improper biomedical waste management.

To examine the effectiveness of the legal and regulatory framework governing biomedical waste management in India.

**Hypotheses**

Biomedical waste management in India remains inadequate due to weak implementation and enforcement of existing laws, leading to health and environmental risks.

**Analysis of Biomedical Waste Management in India**

**Nature and Classification of Biomedical Waste**

Biomedical waste includes both hazardous and non-hazardous waste. Approximately 10-25% of biomedical waste is hazardous, while the remaining is general waste. Hazardous biomedical waste includes:

Human and animal anatomical waste

Soiled waste (cotton, bandages, dressings)

Sharps (needles, syringes, blades)

Pharmaceutical waste

Chemical waste

Microbiological and laboratory waste

The Biomedical Waste Management Rules, 2016 classify waste into color coded categories such as yellow, red, white, and blue to ensure proper segregation and disposal.

**Issues in Biomedical Waste Management**

Despite regulatory provisions, several issues hinder effective management of biomedical waste in India.

**Poor Segregation Practices**

Safe waste management requires proper segregation of biomedical waste at the point of generation. However, many healthcare facilities fail to strictly follow segregation norms, resulting in the mixing of infectious, hazardous, and general waste. This improper practice increases the risk of infection for healthcare workers, waste handlers, and the public. The process of treating and disposing of mixed waste can become more complex, costly, and environmentally harmful, as it often demands more treatment even when it is not necessary.

**Lack of Awareness and Training**

A significant challenge in biomedical waste management is the lack of awareness and regular training among healthcare workers, sanitation staff, and waste handlers. Many personnel are not fully familiar with biomedical waste rules, color coding systems, labeling requirements, and safe handling procedures. Insufficient training leads to careless handling, improper disposal, and an increase in exposure to health risks. The absence of continuous capacity building programs further weakens compliance with waste management standards.

**Inadequate Infrastructure**

Infrastructure limitations pose a major barrier, particularly in rural areas and small healthcare facilities. Unsafe disposal methods like open dumping, burning, or burial are the result of many facilities not having access to nearby Common Biomedical Waste Treatment Facilities (CBWTFs). The problem is exacerbated by the poor transportation systems, limited storage facilities, and lack of modern treatment

technologies, which contribute to environmental pollution and public health concerns.

**Occupational Hazards**

In the biomedical waste management chain, waste handlers and sanitation workers are some of the most at risk groups. The absence of proper personal protective equipment (PPE) and unsafe working conditions often leads to needle stick injuries, infections, and exposure to toxic and infectious materials. Lack of health insurance, vaccination, and medical check-ups further increases their occupational risk, reflecting serious gaps in worker safety and welfare.

**Weak Monitoring and Enforcement**

Effective biomedical waste management requires strong regulatory oversight; however, monitoring and enforcement remain weak in many regions. Regulatory authorities often suffer from manpower shortages, limited technical capacity, and logistical constraints. Inspections are rare, violations are not reported, and penalties are rarely enforced as a result. This weak enforcement environment reduces accountability and allows non-compliance to persist across healthcare facilities.

**Health and Environmental Risks**

Both public health and the environment are at risk due to the improper management of biomedical waste. When biomedical waste is not handled, segregated, treated, and disposed of according to prescribed standards, it becomes a source of infection, pollution, and long term ecological damage.

**Public Health Risks**

The risk of spreading communicable diseases like hepatitis, HIV/AIDS, and other blood-borne infections is greatly increased by exposure to infectious biomedical waste. Healthcare workers, sanitation staff, patients, and the general public are at risk when waste is not properly separated or disposed of. The reuse of contaminated syringes, needles, and medical equipment, often resulting from poor waste control, is a major public health concern and can lead to outbreaks of preventable diseases. Such practices undermine public trust in healthcare systems and place additional burden on public health infrastructure.

**Environmental Pollution**

Improper disposal methods such as open dumping, uncontrolled incineration, and discharge of untreated liquid waste cause severe environmental pollution. Hazardous chemicals and infectious agents can contaminate soil and groundwater, affecting agricultural productivity and drinking water sources. Incineration without adequate pollution control devices releases toxic substances such as dioxins and furans into the air, which are known to cause cancer, hormonal disorders, and ecological imbalance. These pollutants persist in the environment and pose long term risks to both human health and biodiversity.

**Risk to Informal Waste Pickers**

Informal waste pickers and ragpickers are among the most exposed and unprotected groups in the waste management chain. Illegal dumping and poor supervision often result in biomedical waste reaching open landfills and municipal waste streams, where ragpickers are directly exposed to contaminated materials. The absence of protective equipment, training, or healthcare support exposes them to severe risks of injury, infection, and chronic illness. The social justice dimension of biomedical waste mismanagement is highlighted in this situation and it is imperative to have waste governance that is inclusive and humane.

**Regulatory Responses in India**

**Legal Framework**

**Environment (Protection) Act, 1986**

The Environment (Protection) Act, 1986 acts as the umbrella legislation for environmental governance in India. It empowers the Central Government to take necessary measures to protect and improve environmental quality and to prevent environmental pollution. Under this

Act, the government is authorized to frame specific rules and standards, including those relating to the management and disposal of hazardous and biomedical waste, making it the legal foundation for biomedical waste regulation in India.

**Biomedical Waste Management Rules, 2016 (and Amendments)**

The Biomedical Waste Management Rules, 2016, framed under the Environment (Protection) Act, provide a comprehensive regulatory framework for the safe handling of biomedical waste. These Rules, along with amendments introduced in 2018, 2019, and subsequent years, lay down detailed provisions for segregation, collection, storage, transportation, treatment, and final disposal of biomedical waste. They clearly define the duties and responsibilities of healthcare facilities, Common Biomedical Waste Treatment Facility (CBWTF) operators, and regulatory authorities, thereby fixing accountability at each stage of waste management.

**Guidelines Issued by CPCB**

The Central Pollution Control Board provides detailed technical and operational guidelines on a regular basis to ensure effective implementation of the statutory rules. The guidelines provide rules for treating technologies, emission limits, waste segregation color coding systems, record keeping, and monitoring mechanisms. By providing practical direction and uniform standards, CPCB guidelines play a crucial role in translating legal provisions into operational compliance across healthcare facilities in India.

**Role of Authorities**

**Central Pollution Control Board (CPCB)**

Biomedical waste management at the national level is governed by the Central Pollution Control Board as the apex regulatory authority. It is responsible for establishing technical and operational guidelines, establishing standards for treatment and disposal methods, and setting emission standards for incinerators and other treatment technologies. The CPCB is responsible for monitoring compliance nationwide, coordinating with State Pollution Control Boards, and issuing advisories to ensure that the Biomedical Waste Management Rules are implemented uniformly across India.

**State Pollution Control Boards (SPCBs)**

At the state level, the State Pollution Control Boards act as the primary enforcement agencies. They are responsible for granting authorizations to healthcare establishments and Common Biomedical Waste Treatment Facilities (CBWTFs), conducting inspections, and monitoring compliance with legal obligations. SPCBs are empowered to issue directions, impose penalties, and initiate legal action in cases of violations. They assess the treatment capacity and deal with complaints about the improper handling or disposal of biomedical waste.

**Local Authorities and Municipal Bodies**

The role of local authorities, including municipal corporations and other urban and rural local bodies, is crucial in the management of biomedical waste. They help coordinate waste collection and transportation, prevent illegal dumping, and integrate biomedical waste systems with municipal solid waste management services. By facilitating ground level implementation and local monitoring, these bodies help ensure that regulatory measures translate into effective practice at the grassroots level.

**Suggestions**

**Strengthening Regulatory Enforcement**

Strengthening enforcement of the Bio-Medical Waste Management Rules, 2016 is essential to address persistent compliance gaps. Regulatory authorities must enhance inspection mechanisms, ensure uniform implementation across states, and impose effective penalties for violations, while strengthening the institutional capacity of State Pollution Control Boards.

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**Expansion of Biomedical Waste Treatment Infrastructure**

There is an urgent need to expand and modernize biomedical waste treatment infrastructure, particularly Common Bio-Medical Waste Treatment Facilities in underserved regions. Public private partnerships and the adoption of environmentally sound technologies can help bridge capacity gaps and reduce environmental risks.

**Improving Segregation and Source-Level Management**

Effective segregation of biomedical waste at the source remains a critical challenge. Regular training of healthcare personnel and strict accountability of healthcare institutions are necessary to ensure compliance with prescribed color coding and handling norms, which form the foundation of safe waste management.

**Ensuring Occupational Safety of Waste Handlers**

Occupational safety of biomedical waste handlers requires greater legal and administrative attention. Mandatory use of protective equipment, access to health insurance, vaccination, and periodic medical examinations should be ensured, along with formal recognition and protection of informal waste workers.

**Adoption of Technology-Based Monitoring Systems**

The use of technology driven monitoring systems such as barcoding, GPS tracking, and centralized digital reporting can improve transparency and regulatory oversight. Real time data integration with regulatory authorities would enable timely intervention and strengthen compliance with biomedical waste management norms.

**Conclusion**

In India, biomedical waste management is crucial for safeguarding public health and protecting the environment, especially in light of the growing healthcare sector and the increasing generation of biomedical waste. The Biomedical Waste Management Rules, 2016 in India have established a comprehensive legal framework that clearly defines standards for segregation, collection, treatment, and disposal of biomedical waste. However, despite the presence of these detailed regulations, significant gaps persist at the implementation level. Practical challenges such as improper segregation of waste at the source, inadequate training of healthcare and sanitation personnel, insufficient treatment and disposal infrastructure, and weak monitoring and enforcement mechanisms continue to undermine the effectiveness of the regulatory framework. These deficiencies expose healthcare workers, waste handlers, and the general public to serious health hazards while also contributing to environmental pollution.

Although India has a legally adequate regulatory response to biomedical waste management, the study finds that its success will depend heavily on effective implementation and sustained institutional commitment. Strengthening enforcement mechanisms, conducting continuous capacity building and training programs, enhancing public awareness, adopting technology driven monitoring systems, and ensuring accountability of all stakeholders are essential for achieving sustainable biomedical waste management. A coordinated and collaborative approach involving government authorities, healthcare institutions, common biomedical waste treatment facility operators, and civil society organizations is necessary to bridge existing gaps and ensure compliance with prescribed standards.

Effective management of biomedical waste requires more than just legal compliance. It is a moral, social, and environmental responsibility that is owed to both current and future generations. The safe and environmentally sound disposal of biomedical waste is essential for safeguarding human life, preserving

ecological balance, and promoting sustainable development in India.

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