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Biomedical Waste Beyond Hospitals: Challenges and Suggestions for Household Biomedical Waste Management in India

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Abstract

Healthcare is undoubtedly an inevitable facet of human existence. As medical science progressed, diseases also increased manifold. Due to growing urban population handling and disposal of wastes has become a big concern. The management of household biomedical waste (BMW) in India is an emerging regulatory concern that has gained increasing attention in the wake of recent public health crises. 'Bio-medical waste' includes any waste generated during diagnosis, treatment or immunization of human beings or animals and household biomedical waste means waste generated at home—such as used syringes, expired medicines, insulin pens, blood-stained or pus-stained cotton, adult/baby diapers, soiled sanitary napkins, pregnancy strips, used condoms and contaminated personal protective equipment. The Bio-medical Waste Management Rules, 2016 (and subsequent amendments) formally include household biomedical waste generated during home healthcare activities (such as for chronic illness, home dialysis, home-based testing) and expect this waste to be segregated and handed separately to municipal authorities. However, implementation is mostly advisory and not mandatory for local authorities, leading to systemic neglect in practice. Doorstep collection and dedicated treatment of household BMW exist primarily during public health crises (e.g., COVID-19 home quarantine), but routine, institutionalized coverage is absent outside select urban areas. In most localities, household BMW is routinely mixed with general municipal waste due to lack of awareness, systems, and resources. Urban Local Bodies (ULBs) are responsible for household BMW, but capacity, funding, and monitoring remain limited, especially in rural/peri-urban areas. There are Common BMW Treatment Facilities (CBMWTFs) in India, primarily serving healthcare institutions rather than households. India lags behind best practices in household biomedical waste management, with significant gaps in collection, infrastructure, and enforcement compared to leading developed countries. This situation exposes significant gaps in segregation practices, infrastructure, public awareness, monitoring, and regulatory oversight. The overall objective of this study is to critically examine present status of household coverage under biomedical waste regulations in India, identify systemic gaps and operational challenges, and propose policy recommendations for scalable and sustainable management approaches. This paper will address the key challenges- technical, financial, regulatory, and social, faced by the household sector and explore why, despite legal acknowledgement, there is still little practical implementation. This study adopts a doctrinal research methodology to systematically analyse statutory provisions, judicial decisions, relevant government reports, and policy commentary to assess legal frameworks in context.

Keywords: biomedical waste, biomedical waste regulations, household medical waste, urban local bodies

1. Introduction

The Bio-medical Waste Management Rules, 2016 were framed under the Environment (Protection) Act, 1986 to regulate the collection, segregation, treatment, and disposal of biomedical waste in an environmentally sound manner. Despite the implementation of biomedical waste management rules, household biomedical waste has been and still overlooked. Due to non-communicable diseases like diabetes, shorter hospital stays to avoid hospital-acquired infections, the onset of epidemics or pandemics and management of chronic diseases at home following hospital discharge, the amount of biomedical waste produced at home is gradually increasing. The prolonged treatment at home results in household biological waste. Given India's ageing population and reliance on doorstep healthcare services, the problem can worsen. As per The Environmental Research and Education Foundation (EREF) report,2018 on Household Needles in Municipal Solid Waste, the number of used needles disposed of in household garbage tripled over the decade from 2001 to 2011 and these needles present a serious risk of needlestick injuries, especially for workers at Material Recovery Facilities (MRFs) handling residential waste and recycling.[1] This paper addresses the challenges associated with household biomedical waste management and thereby suggested the comprehensive approach Strict laws, efficient waste segregation, appropriate collection, transportation, treatment, and disposal techniques.

2. Theoretical framework

This study examines the legal and governance issues related to household biomedical waste management in India using specific environmental law and public policy theories. These frameworks offer a critical perspective through which to examine why domestic biomedical waste is still mainly unsegregated, poorly regulated, and inappropriately handled despite formal recognition under the Bio-medical Waste Management Rules, 2016. The theories aid in the explanation of the institutional behaviour of regulatory bodies, the gap between legislative standards and practical actions, and the ensuing threats to public health and the environment.

2.1 Environmental Governance Theory

Environmental Governance Theory perceives environmental protection as a result of interactions among legal institutions, administrative entities, social actors, and policy instruments, rather than solely the presence of statutory regulations.[2] It underscores multi-tiered governance, coordination among entities, institutional capability, accountability frameworks, and stakeholder engagement. Effective governance in waste management necessitates collaboration among central regulators, state pollution control boards, urban local bodies (ULBs), waste treatment facilities, and the public. This theory elucidates why the legal incorporation of houses into the Bio-medical Waste Management Rules, 2016 in India has not resulted in successful implementation of household biomedical waste management. The statutory framework assigns responsibility for collection and disposal to ULBs; however, insufficient funding, inadequate infrastructure, limited coordination with Common Biomedical Waste Treatment Facilities (CBWTFs), and ineffective monitoring procedures compromise governance outcomes. The transient efficacy of household

[1]Environmental Research & Education Foundation, *Household Needles in Municipal Solid Waste: Policy, Controls and Material Recovery Facility (MRF) Safety* (North Carolina, 2018) 12.

[2] Maria Carmen Lemos and Arun Agrawal, School of Natural Resources and Environment, University of Michigan, Ann Arbor, Michigan 48109, doi: 10.1146/annurev.energy.31.042605.135621

biomedical waste collection during the COVID-19 pandemic illustrates that enhanced governance, explicit responsibility, and emergency-driven cooperation can yield compliance, while standard governance remains fragmented and ineffective. Consequently, environmental governance theory establishes a basis for examining systemic institutional deficiencies and the necessity for enhanced regulatory frameworks.

2.2 Implementation Gap Theory

The difference between formal legal provisions (also known as "law on the books") and their actual application (also known as "law in action") is highlighted by the Implementation Gap Theory.[3] Despite explicit statutory demands, environmental and public health rules frequently suffer from lax enforcement, administrative discretion, and insufficient resources, leading to noncompliance. This theory is especially pertinent to the management of domestic biomedical waste in India, where segregation and handover procedures are outlined in the Bio-medical Waste Management Rules, 2016. These clauses, however, are still mostly advisory and do not impose obligations, sanctions, or oversight procedures on local governments. Because of this, most areas still combine household biomedical waste with municipal solid waste. The implementation gap becomes clear in the contrast between pandemic-specific BMW enforcement during COVID-19 and the usual neglect of household biomedical waste management thereafter. Using this approach, the paper critically assesses why regulatory acknowledgement by itself has not been able to guarantee compliance and emphasises the necessity of required duties, more defined institutional functions, and accountability mechanisms.

2.3 Public Health Risk Theory

According to public health risk theory by Ulrich Beck, poor waste management is a major cause of avoidable health risks, especially for vulnerable groups like garbage handlers and sanitation workers. garbage mismanagement becomes a more widespread public health issue when people are exposed to infectious materials, sharp objects, and polluted garbage, which raises the risk of disease transmission, workplace accidents, and environmental contamination.[4] This idea allows the study to position inappropriate segregation and disposal of domestic biomedical waste as a systemic public health issue rather than just an environmental or municipal failing. Waste handlers and communities are exposed to infections including cholera, hepatitis, and other infectious diseases when domestic biomedical waste is mixed with regular municipal waste. These hazards are increased by the lack of individualised collection systems, training, and protective equipment. Thus, the need for more stringent regulations, capacity building, and preventive measures in household biomedical waste management is strengthened by public health risk theory.

This study creates a thorough framework for assessing household biomedical waste management in India by combining various theoretical viewpoints. Public health risk theory emphasises the health effects of inappropriate disposal, implementation gap theory describes the gap between legal recognition and actual practice, and environmental governance theory stresses institutional capacity and coordination shortcomings. Together, these frameworks explain how regulatory design, enforcement mechanisms, and public health considerations interact to determine household biomedical waste management and underscore the need for effective and sustainable policy reforms.

[3] Pressman, J. L., & Wildavsky, A. (1984). *Implementation: How great expectations in Washington are dashed in Oakland: Or, why it's amazing that federal programs work at all, this being a saga of the economic development administration as told by two sympathetic observers who seek to build morals on a foundation of ruined hopes* (3rd ed.). Berkeley, CA: University of California Press.

[4] Beck, U. (1986). *Risk Society: Towards a New Modernity*. London: Sage. (English translation 1992)

3. Methodology

The regulatory framework controlling domestic biomedical waste disposal in India is examined in this paper using a doctrinal legal research technique. In order to evaluate the efficacy of the Bio-medical Waste Management Rules, 2016 in addressing household biomedical waste, the study methodically examines current legal instruments, court rulings, policy documents, and regulatory guidelines rather than conducting empirical fieldwork or primary data collection.

4. Conceptual and Legal Framework of Biomedical Waste in India

"Medical waste" is any kind of waste that contains infectious material (or material that's potentially infectious). That means waste generated by healthcare facilities like physician's offices, hospitals, dental practices, laboratories, medical research facilities, and veterinary clinics all falls under the category of medical waste.[5] "Bio-medical waste" means any waste, which is generated during the diagnosis, treatment or immunisation of human beings or animals or in research activities pertaining thereto or in the production or testing of biologicals, and including categories mentioned in Schedule I.[6] Initially, Bio-medical Waste (Management & Handling) Rules, 1998 were notified by the Ministry of Environment & Forests (MoEF) under the Environment (Protection) Act, 1986. In exercise of the powers conferred by Section 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), and in supersession of the Bio-Medical Waste (Management and Handling) Rules, 1998 and further amendments made thereof, the Central Government vide G.S.R. 343(E) dated 28th March, 2016 published the Bio-medical Waste Management Rules, 2016. These rules apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle bio medical waste in any form including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories, blood banks, Ayush hospitals, clinical establishments, research or educational institutions, health camps, medical or surgical camps, vaccination camps, blood donation camps, first aid rooms of schools, forensic laboratories and research labs.[7]

5. Current Status of Household Biomedical Waste Management in India

Biomedical waste includes the waste created during healthcare activities in the households such as syringes and needles, insulin pens, blood-stained or pus-stained cotton and gauze bandages, expired or unused medicines, adult/baby diapers, soiled sanitary napkins, used X-ray films, band-aids, blood sugar, pregnancy strips and used condoms, mercury from the broken thermometer and sphygmomanometer.[8] According to the most recent biomedical waste management regulations of 2016, certain of these wastes are classified as hazardous domestic biomedical waste and must be separated at the source using designated colour-coded bags or containers. Such segregated household biomedical waste should be handed over separately, in specified bags or containers, to municipal waste collectors or Urban Local Bodies (ULBs). Sanitary pads, condoms, and other absorbent products used during menstruation, however, have not been classified as biomedical waste. These guidelines are phrased in such a manner that it's not a mandate for the authorities to be followed. This allows officials to overlook the problem, which

[5] Ben Brenner, *What is medical waste*, Med pro Disposal (July 13, 2020), https://www.medprodisposal.com/what-is-medical-waste-medical-waste-definition-types-examples-and-more.
[6] Bio-Medical Waste (Management and Handling) Rules, 1998, cl. 5, Section 3.
[7] Central Pollution Control Board, *Bio-Medical Waste management*, (Sept, 14, 2017), https://cpcb.nic.in/bio-medical-waste-rules.
[8] Narayan P, Jacob AM, et al., "*A Comparative Study on the Knowledge, Attitude, and Perception Toward Hazardous Medical Waste Produced at Home in a Coastal City of Karnataka, India*" (2022) 12 *J Health Allied Sci NU* 126–133.

ultimately results in the hazardous waste being combined with regular solid waste from the city. And when mixed with the general solid waste, it can render the entire waste as infectious waste. Domestic hazardous healthcare wastes contribute to approximately 0.5% of the entire biomedical waste.[9] Household biomedical waste must be segregated at the point of generation, i.e., separated from other domestic (municipal) waste immediately when produced as per the biomedical waste rules. Separate and color-coded bags or containers must be used by the households in accordance with Schedule I of the BMW Rules. It is required that yellow bag should contain contaminated and infectious items (like dressings, swabs, used masks), red bag for non-chlorinated recyclable items (like IV tubes, catheters if generated), white, puncture-proof box for sharps (needles, lancets) and blue bag for glassware and metallic body implants.[10] As the Households are not allowed nor expected to treat biomedical waste on their premises, they must hand over segregated biomedical waste in separate bags/containers to municipal waste collectors. In order to minimize the risk to public health and environment, Urban Local Bodies (ULBs) should tie up with the nearest Common Biomedical Waste Treatment and Disposal Facility (CBWTF) to collect this waste, either from the Material Recovery Facility (MRF) or directly from households if practical. According to the CPCB annual report 2022[11], Domestic biomedical waste is not collected separately from the households by the Urban Local Bodies as required under BMWM Rules, 2016. It can be inferred that despite of legal requirement of separate collection and segregation of household medical waste, there is still gap in the implementation of the requirement. During the COVID-19 pandemic, India implemented several temporary biomedical waste management (BMW) initiatives directed by the Central Pollution Control Board (CPCB), municipal bodies, and healthcare institutions. Other government authorities have also released rules for the treatment of COVID-19 waste, even though the CPCB is the primary agency for any recommendations relevant to BMW in India. These measures have left a notable legacy for waste governance and preparedness. All COVID-19 biomedical waste (from hospitals, quarantine centres, homes, etc.) had to be segregated at source using color-coded and labelled containers—often double-bagged or marked specifically as "COVID-19 waste" for easy identification and safer handling. Additional personal protective equipment (PPE) was mandated for sanitation.[12] Daily digital reporting and tracking systems (mobile applications, web portals) were put in place to monitor quantities, sources, and routes of COVID-19 BMW, enabling better regulatory oversight and timely response. All stakeholders—including hospitals, local bodies, waste treatment operators—were instructed through regular CPCB guidelines and public advisories to adapt to evolving safety and compliance standards. Authorities can learn from the experience of BMW management in this worldwide catastrophe to create a comprehensive system for safe disposal in the post-COVID-19 scenario and to offer ideas for future disaster preparedness.

[9] S. S. and D. Hk, *Knowledge, Perceptions and Practices Regarding Household Biomedical Waste in an Urban Area of Metropolitan City,* RGUHS National Journal of Public Health (2023) available at https://doi.org/10.26463/rnjph.8_2_5

[10]Central Pollution Control Board, *Guidelines for Management of Healthcare Waste as per Biomedical Waste Management Rules, 2016* (June 2018), Ministry of Environment, Forest & Climate Change, Government of India, available at https://cpcb.nic.in/uploads/projects/bio-medical waste/guidelines_healthcare_june_2018.pdf (last visited Aug. 16, 2025)

[11]Central Pollution Control Board, Annual Report on Biomedical Waste Management for the year 2022 as per Biomedical Waste Management Rules, 2016 (July 2023), Ministry of Environment, Forest & Climate Change, Government of India, available at https://cpcb.nic.in/uploads/Projects/Bio-Medical-Waste/AR_BMWM_2022.pdf (last visited Aug. 16, 2025).

[12]Central Pollution Control Board, Guidelines for Handling, Treatment, and Disposal of Waste Generated during Treatment/Diagnosis/Quarantine of COVID-19 Patients – Rev. 4 (17 July 2020), Ministry of Environment, Forest & Climate Change, Government of India, available at https://cpcb.nic.in/uploads/Projects/Bio-Medical-waste/BMW-GUIDELINES-COVID_1.pdf (last visited Aug. 16, 2025).

6. Challenges in Household Biomedical Waste Management

It is commendable that Central Pollution Control Board (CPCB) and the concerned authorities has taken the lead in developing timely guidelines and amendments to the rules. However, household biomedical waste management faces significant challenges in India and globally, owing to gaps in awareness, infrastructure, regulatory enforcement, and social practices. This paper addresses the following challenges faced by the stakeholders:

6.1 Lack of systematic segregation and public awareness: Many households dispose of biomedical waste such as used masks, syringes, and medicines together with municipal solid waste due to poor awareness and absence of dedicated color-coded bins according to the color coding system in Appendix I (Schedule I) of the 1998 BMW Regulations or the 2016 Amended Regulations.[13] According to the CPCB annual report, Domestic biomedical waste is not collected separately from the households by the Urban Local Bodies as required under BMWM Rules, 2016[14]. The entire mass becomes potentially infectious if the infectious and non-infectious wastes are combined. Value of segregation isn't understood among workers and hence is a major threat to them and the environment. Awareness about these practices and the adverse effects of not following them should be spread among all workers and hospital officials.[15]

6.2 Infrastructure and capacity limitations of ULBs and treatment facilities: The main stakeholder urban local bodies do not have dedicated systems or separate arrangements for collecting non-segregated biomedical waste (BMW) directly from households. This leads to the mixing of household medical waste with the general waste which present serious public health and environmental risks.

6.3 Financial constraints and funding gaps: In one study it concluded that ULBs often allocate much less than the recommended proportion of their development funds to waste management—sometimes as little as 0.5–1.7% compared to the prescribed 10–15%. This underfunding directly impacts the ability to upgrade infrastructure and expand capacity.[16] Moreover, Funds from state and federal governments sometimes pass through numerous bureaucratic layers before reaching ULBs, resulting in procedural delays and causing pauses in project implementation and daily operations.[17] The insufficient funding leads to waste accumulation at processing plants, delayed treatment, and increased risk of unauthorized disposal methods like open burning or dumping.

6.4 Regulatory ambiguities and weak enforcement mechanisms: The Bio-Medical Waste Management (BMWM) Rules, 2016 apply broadly to all generators of biomedical waste including household waste but household biomedical waste has not been explicitly addressed in the rules. This leads to uncertainty at the local implementation level regarding roles, segregation practices, and appropriate disposal channels. Additionally, the system isn't perfect since the organisations in charge of enforcing the laws lack authority

[13]S. S. Manekar, R. L. Bakal, R. D. Jawarkar & M. S. Charde, "Challenges and measures during management of mounting biomedical waste in COVID-19 pandemic: an Indian approach", Bulletin of the National Research Centre, Vol. 46, No. 1, 2022, p.159, available at https://doi.org/10.1186/s42269-022-00847-4.

[14] CENTRAL POLLUTION CONTROL BOARD, *Annual Report on Biomedical Waste Management for the Year 2022* (New Delhi: CPCB, 2023) at 25.

[15]G. Khandelwal, "Biomedical Waste Management", International Journal for Research in Applied Science and Engineering Technology, 2021, available at https://doi.org/10.22214/ijraset.2021.36936.

[16] Comptroller and Auditor General of India, Full Report – Waste Management in Urban Local Bodies (2022), available at https://cag.gov.in/webroot/uploads/download_audit_report/2022/Full-Report---Waste-Management-in-Urban-Local-Bodies---English-06502eef24d3134.31315455.pdf (last visited Aug. 18, 2025).

[17] S. S. Manekar, R. L. Bakal, et al., "Challenges and measures during management of mounting biomedical waste in COVID-19 pandemic: an Indian approach", Bulletin of the National Research Centre, Vol. 46, No. 1, 2022, p.159, available at https://doi.org/10.1186/s42269-022-00847-4

and dedication. Because of this, many medical facilities, including hospitals, disregard these regulations and continue to disregard them even after they have been amended. It is the responsibility of the regulatory bodies to take adequate action to ensure that the regulations are followed. There is no coordination between authorities of pollution control and Department of health. Furthermore, not all waste collection and disposal requirements have received significant publicity, so smaller facilities may not be completely aware of the regulations.[18]

6.5 Occupational health and safety risks for waste handlers: It poses a significant challenge in the management of household medical waste in India. These risks stem from both direct exposure to hazardous materials and systemic issues like inadequate training, lack of protective equipment, and poor working conditions. This not only endanger the immediate health of waste handlers but also contribute to broader public health threats and undermine community trust in waste management systems. Waste handlers are at risk of contracting infections such as hepatitis B, hepatitis A, cholera, typhoid, polio, and other communicable diseases due to handling improperly segregated household medical waste mixed with general waste. Sharps (needles, blades), contaminated items, and unsealed medical waste increase the likelihood of injury and infection.[19] Many handlers operate without adequate personal protective equipment (PPE), such as gloves, masks, boots, or uniforms, and receive limited formal training on safe waste handling. This lack increases their susceptibility to accidents and long-term health effects.

6.6 Geographic disparities: Urban vs. rural/peri-urban challenges: In India, household medical waste management is severely hampered by geographic disparities which differ significantly across urban, rural, and peri-urban areas. Households in urban locations generally demonstrate higher awareness and better knowledge of hazardous healthcare waste and its safe disposal compared to rural households. In one comparative study, 37.3% of urban households recognized potential hazards in home medical waste, while only 9.3% of rural households did.[20] The study also advocates that residents in rural areas are usually less knowledgeable about these concerns as compared to metropolitan regions. Rural residents have little or no facilities for gathering and getting rid of hazardous trash when compared to those in metropolitan areas. Through this study, it can be inferred that focus must be on the community segments that will enable to identify, educate, and enhance public health as well as avert unnecessary outcomes brought on by the risks associated with the production of household biomedical waste.

7. Suggestions

This paper presents a series of focused recommendations to tackle the challenges identified. The proposed measures are designed to improve the management of biomedical waste at the household level. These suggestions emphasize fairness and inclusivity in waste handling practices. The goal is to enhance the overall effectiveness of biomedical waste disposal. Ultimately, the recommendations seek to support sustainable and responsible waste management for all stakeholders.

[18] Gaurav Khandelwal, Sanyukta Shinde, et al., "Biomedical Waste Management", International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol. 9, Issue VII, July 2021, ISSN 2321-9653.

[19] J. Gutberlet & S. M. N. Uddin, "Household waste and health risks affecting waste pickers and the environment in low- and middle-income countries", International Journal of Occupational and Environmental Health, Vol. 23, No. 4, 2017, pp. 299–310, available at https://doi.org/10.1080/10773525.2018.1484996 (last visited Aug. 18, 2025).

[20] Prajna Narayan, Ankeeta Menona Jacob, et al., "A Comparative Study on the Knowledge, Attitude, and Perception toward Hazardous Medical Waste Produced at Home in a Coastal City of Karnataka, India", 2582-4287 (2025), available at https://doi.org/10.1055/s-0041-1736273 (last visited Aug. 18, 2025).

Strengthening legal mandates for household BMW handling and collection: The biomedical waste management current rules have the provision for segregation of household waste at home, but it is not mandatory for ULBs to enforce, leading to implementation gaps. The biomedical waste rules must be amended to include explicitly the provision for household medical waste covering segregation, packaging, labelling, and handover to municipal or authorized agencies. Hospitals should be subject to periodic inspections and rigorous, thorough checks using the authority of the Central Pollution Control Board and the State Pollution Control Board. Policy frameworks should actively promote to set up more regional Common Biomedical Waste Treatment Facilities (CBWTFs).

Institutionalizing segregation and collection systems: Color-coded waste segregation (yellow, red, blue, black bins) at source points must be implemented and door-to-door collection of household waste to be promoted. Training should be given to healthcare workers and cleaning staff on waste classification and smart bins with sensors must be used to ensure accurate segregation of waste. This would improve traceability and prevent illegal dumping of waste.

Capacity building programs: Regular and standardized training programs must be organised for frontline workers, municipal staff and waste handlers.

Penalty structure for non-compliance: Strict penalties for non-compliance across all waste generators, large and small healthcare facilities, as well as households must be established to deter the waste handlers from illegal dumping. There should be a mandate for the monthly monitoring and periodic status reports to address the concern of persistent compliance gaps.

Public education and awareness campaigns: public campaigns and sanitation education to build awareness at the household level concerning segregation, risks, and proper disposal of biomedical waste must be institutionalized.

Higher budget allocation to ULBs: More budget allocation must be prioritized for urban local bodies for effective waste management in the society.

8. Conclusion

Through this study it can be concluded that despite the existence of comprehensive policies for biomedical waste management, significant gaps remain in its implementation. The foremost thing to be considered that household medical waste needs to be segregated from the general waste. This study can assist various policymakers and regulatory bodies to design an efficient process for household BMW waste management with a robust implementation strategy. Awareness of mannerly control of household biomedical waste should be spread among the health workers, waste handlers and the general public too. This paper issues a clarion call to urgently address household biomedical waste within India's environmental and public health framework. It emphasizes the need for clear policies, strengthened enforcement, and increased financial support for urban local bodies.