

# Biodegradable Waste Management in India during COVID-19: Challenges, Sustainable Solutions and Guidelines

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**Abstract:-** The COVID-19 pandemic, emerging in late 2019, has engendered profound challenges worldwide, notably in the management of medical and biodegradable waste. This manuscript presents a comprehensive examination of India's response to this critical issue during the pandemic, emphasizing the urgent need for robust waste management strategies. The study synthesizes insights from 102 articles, employing the PRISMA guideline. The results underscore the escalation of hazardous medical waste in India and reveal inadequacies in implementing BMW 2016 standards. This manuscript critically examines the impact of the pandemic on India's management of medical and biodegradable waste, emphasizing the need for robust strategies to address the surge in hazardous waste. The study also draws on global experiences, offering insights for sustainable waste management practices in the aftermath of the pandemic. The discussion emphasizes the interconnectedness of global waste management challenges, advocating for collaborative efforts to fortify global readiness for future pandemics. The conclusion calls for immediate action, aligning waste management strategies with Sustainable Development Goals for a resilient and adaptable healthcare infrastructure.

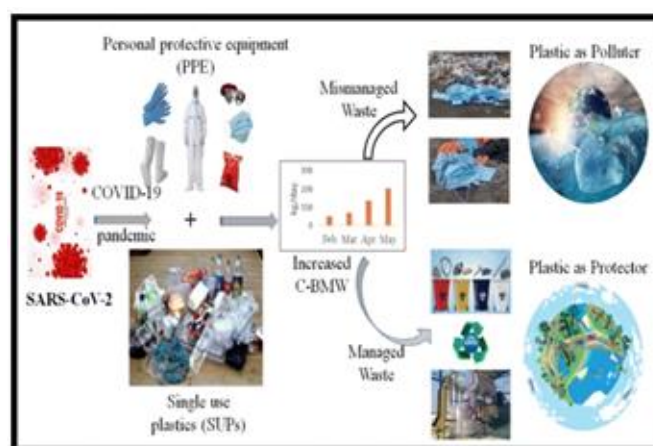
**Keywords:-** Biodegradable Waste; Waste Management; India; Covid-19; Challenges; Sustainable Solutions.

## I. INTRODUCTION

The rapid and widespread impact of the COVID-19 pandemic has reverberated across various facets of daily life, with a particularly pronounced effect on waste management practices globally. This manuscript addresses the multifaceted challenges posed by the pandemic to waste management in India, focusing on both biodegradable and medical waste. As the nation grapples with the surge in waste generation, exacerbated by the pandemic-induced shifts in lifestyle and consumption patterns, the need for sustainable solutions becomes increasingly urgent. The COVID-19 pandemic has

led to a significant increase in biomedical waste generation globally, including in India. Biomedical waste refers to any waste that is generated during the diagnosis, treatment, or immunization of human beings or animals, or in research activities pertaining to these areas. This waste includes items like used syringes, gloves, masks, PPE kits, testing kits, and other materials potentially contaminated with infectious agents.<sup>[1]</sup> Increased Biomedical Waste Generation. The surge in COVID-19 cases has resulted in a substantial increase in the use of personal protective equipment (PPE), masks, gloves, and testing kits. Hospitals, diagnostic centers, and quarantine facilities have witnessed a higher volume of biomedical waste due to increased testing, treatment, and healthcare activities.<sup>[2]</sup>

### A. Types of COVID-19 Related Waste:



**Fig 1: Types of COVID-19 Related Waste**

- PPE Kits: Disposal of used PPE kits poses a unique challenge due to the combination of different materials.
- Testing Kits: The testing process generates biohazardous waste, including swabs and other testing materials.

- **Vaccination Waste:** Disposal of syringes and other materials used in the vaccination process contributes to biomedical waste. <sup>[3]</sup>

#### B. Challenges in Biodegradable Waste Management:

- **Segregation:** Proper segregation of biomedical waste is crucial, and the handling of COVID-19 related waste requires specific protocols to prevent the spread of infection.
- **Transportation:** Safe transportation of hazardous biomedical waste from healthcare facilities to treatment and disposal sites is a critical aspect.

#### C. Surge in Biodegradable Waste Generation:

The restrictive measures imposed during lockdowns, coupled with changes in lifestyle, have led to a substantial increase in the generation of biodegradable waste. The prevalence of home-cooked meals and the surge in online food deliveries contribute significantly to this rise.

#### D. Disruption of Formal Waste Collection Systems:

The imposition of lockdowns and the pervasive fear of contagion have disrupted formal waste collection systems. This disruption results in inadequate collection and disposal of biodegradable waste, further compounding the challenges.

#### E. Limited Composting Facilities:

India faces a shortage of adequate composting facilities, creating hurdles in the effective disposal of biodegradable waste. The existing facilities often prove inadequate to handle the heightened volume generated during the pandemic.

#### F. Insufficient Waste Treatment Infrastructure:

India's limited waste treatment infrastructure poses a significant hurdle in managing the escalating volume of medical waste generated during the pandemic. This inadequacy creates a potential environmental and public health hazard.

#### G. Non-compliance with BMW 2016 Standards:

A synthesis of reports from government and non-government agencies, combined with data from the Central Pollution Control Board (CPCB), underscores shortcomings in adhering to BMW 2016 standards. This non-compliance contributes to inadequate medical waste management practices. <sup>[4] [5] [6] [7] [8] [9]</sup>

#### H. India's Ranking and Challenges in Medical Waste Management:

Transitioning to the challenges in medical waste management during the pandemic, the manuscript draws attention to India's ranking of 120 among 165 nations for sustainable development. This sets the stage for an in-depth exploration of the deficiencies in managing medical waste, particularly in adhering to the BMW 2016 standards. <sup>[2] [10]</sup>

#### I. Urgent Need for Comprehensive Monitoring Systems:

The sudden onset of the COVID-19 virus necessitates immediate attention to establish comprehensive monitoring and implementation systems. This urgency is vital to ensuring the safe and regulated disposal of the surging volume of hazardous medical waste. <sup>[11] [12]</sup>

## II. COVID-19 WASTE MANAGEMENT – DO'S & DON'TS:

A dedicated section outlines essential guidelines for home-care and quarantine centers, emphasizing proper handling and disposal of biomedical waste. This includes specific do's and don'ts for caretakers and individuals responsible for managing waste generated during home-care and quarantine. <sup>[13]</sup>

#### A. Guidelines for Handling, Treatment, and Disposal of COVID-19 Waste:

The manuscript provides specific guidelines for healthcare facilities with isolation wards, sample collection centers, laboratories, and quarantine centers/camps/home-care. Emphasis is placed on proper segregation, labeling, and training for waste handlers to ensure the safe disposal of COVID-19 biomedical waste. The Indian government, through the Ministry of Environment, Forest and Climate Change, has established guidelines under the Biomedical Waste Management Rules, 2016. During the COVID-19 pandemic, specific guidelines have been issued to manage the increased biomedical waste generated due to the virus. These guidelines focus on safe disposal, segregation, and transportation of COVID-19 related biomedical waste. <sup>[14] [15] [16] [17]</sup>

#### B. Duties of Common Biomedical Waste Treatment Facility (CBWTF):

Detailed responsibilities of Common Biomedical Waste Treatment Facilities (CBWTFs) are outlined, including reporting to regulatory bodies, ensuring worker safety, and maintaining proper records for the collection, treatment, and disposal of COVID-19 waste. <sup>[16] [18]</sup>

#### ➤ Sustainable Solutions for Biodegradable Waste:

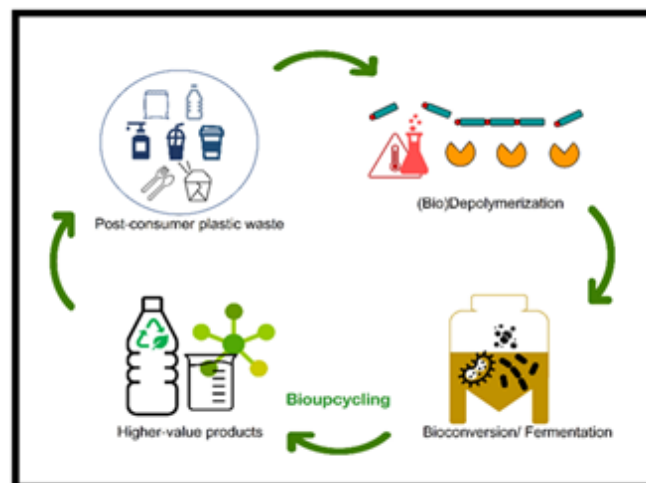


Fig 2: Bioupcycling Process

➤ *Community-Based Composting Initiatives*

Encouraging community-based composting initiatives emerges as a viable strategy to decentralize waste management. Empowering local communities to take charge of composting their biodegradable waste can significantly contribute to a more sustainable waste management approach.

➤ *Technology-Driven Waste Tracking Systems:*

The implementation of technology-driven waste tracking systems can enhance monitoring and efficiency. Mobile applications designed for citizens to report waste collection issues, along with real-time tracking of waste management vehicles, can contribute to a more streamlined process.

➤ *Public Awareness Campaigns:*

Raising awareness about the proper segregation of biodegradable waste at the source is crucial. Comprehensive public awareness campaigns, spanning both online and offline channels, play a pivotal role in educating citizens about the environmental impact of their waste disposal habits.

### III. REVIEW METHODOLOGY

This study employed a systematic approach to gather and analyze relevant literature on the management of biomedical waste during the COVID-19 pandemic. Initial keyword selection, including "biomedical waste" and "COVID-19," facilitated searches in prominent open-access databases such as PubMed, Science Direct, Scopus, and Google Scholars. A comprehensive total of 2124 articles were initially retrieved, which underwent subsequent stages of refinement. These included the removal of duplicates (765 articles) and exclusion of irrelevant content through scrutiny with predefined inclusion criteria, resulting in a final set of 102 articles for in-depth analysis. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline guided the systematic review process. This approach ensured a comprehensive exploration of biomedical waste management practices during the pandemic. Additionally, to enrich the study with real-time insights, information gathered from personal communication with Bio Genetic Laboratories (BGL) Private Ltd. (India) and the Ministry of Environment (South Korea) was incorporated. The amalgamation of database searches, manual screening, and direct interactions provided a thorough and up-to-date synthesis of literature on the challenges and strategies associated with biomedical waste management amid the COVID-19 crisis. <sup>[19] [20] [21]</sup>

### IV. RESULT AND DISCUSSION

Despite study limitations, urgent reevaluation of biomedical waste management systems, including healthcare infrastructure, is emphasized. The proposal includes establishing Infectious Disease and Hospital Administration Departments at various levels, advocating for a broader global healthcare strategy and sustained investments to prepare for future pandemics and ensure a healthier future. <sup>[22]</sup>

➤ *Introduction of Environmental Impact:*

WHO reports indicate the potential long-term environmental effects of COVID-19, leading to a shift in focus from plastic waste concerns to the preference for plastic packaging for infection control. <sup>[2] [3]</sup>

➤ *Surge in Plastic Waste:*

The pandemic prompts countries to modify waste management policies due to a sudden rise in plastic waste, emphasizing the need for adaptive measures. <sup>[23] [24]</sup>

➤ *Altered Lifestyle and Consumption Patterns:*

Drastic changes in individual lifestyles and consumption patterns during the pandemic impact waste generation and management practices. <sup>[25]</sup>

➤ *Socioeconomic Impact:*

Despite improvements in the global economy, the ongoing pandemic, marked by modified lockdowns, continues to impact societies significantly. <sup>[26]</sup>

➤ *Shift in Waste Generation Patterns:*

While some countries witness a decrease in municipal solid waste (MSW) due to lockdowns, there is a substantial global increase in biomedical waste (BMW) attributed to higher medical waste production and increased use of personal protective equipment (PPE). <sup>[27] [28]</sup>

➤ *Interdepartmental Collaboration for Waste Management:*

Effective BMW management necessitates collaboration across different departments, underscoring the importance of robust policy implementation. <sup>[29]</sup>

❖ *Lessons Learned and Reevaluation of Public Health Infrastructure:*

➤ *The pandemic highlights the need for sustained commitment to improving public health infrastructure, advocating for population-based measures over individual institutional care for cost-effective outcomes.* <sup>[30]</sup>

### V. STRATEGIES, POLICY, AND GUIDELINES

Reevaluation of waste management systems and formulation of supplementary country-specific rules for healthcare and non-healthcare facilities. <sup>[31]</sup>

➤ *Handling of Infectious Waste:*

Essential knowledge about virus viability, requiring modification of waste handling practices and improved PPE use and hand hygiene among waste handlers.

➤ *Suitable Disposal Methods:*

Selection of appropriate treatment methods based on international guidelines and local factors, with interim treatment methods suggested for developing countries. <sup>[32]</sup>

➤ *Information, Education, and Communication (IEC):*

Capacity building for the public through user-friendly channels is crucial for safe waste handling.

➤ *Data Management and Research:*

Emphasis on correct data collection for planning and policy development, necessitating collaboration with academic institutions.

➤ *Rethinking the Role of Hospitals:*

Calls for reconsideration of hospitals' roles and the establishment of Infectious Disease departments at every level. <sup>[32]</sup>

➤ *Expanding Telehealth Services:*

Acknowledges the sustained demand for telehealth, requiring systemic amendments for broader use during and beyond the pandemic.

➤ *Fund Raising and Collaboration:*

Local governments need to recognize the importance of collaborative efforts at national and international levels, creating intermediary bodies for streamlined planning and response.

The escalating challenges in biomedical waste management during the COVID-19 pandemic necessitate proactive and innovative solutions. This section outlines a set of comprehensive strategies to address the surge in biomedical waste, emphasizing the importance of community involvement, technological advancements, and international cooperation. The proposed solutions aim to strengthen waste management practices, ensuring both public safety and environmental sustainability in the face of unprecedented global health crises. <sup>[33]</sup>

➤ *Implement Robust Segregation Practices:*

Strict guidelines for segregating different types of biomedical waste at the source, ensuring proper categorization and minimizing contamination.

➤ *Enhance Public Awareness and Education:*

Conduct comprehensive awareness campaigns to educate the public about the safe disposal of biomedical waste, emphasizing the importance of following guidelines and using designated bins.

➤ *Leverage Technology for Monitoring:*

Implement technology-driven systems for real-time monitoring of biomedical waste collection and disposal, utilizing mobile applications for reporting issues and tracking waste management vehicles.

➤ *Community-Based Initiatives:*

Encourage and support community-based initiatives for biomedical waste management, empowering local communities to take responsibility for proper waste disposal.

➤ *Strengthen Waste Treatment Infrastructure:*

Address the shortage of proper waste treatment facilities by investing in and expanding infrastructure, ensuring that the capacity aligns with the increased volume of biomedical waste during pandemics. <sup>[34]</sup>

➤ *Innovative Treatment Methods:*

Explore and adopt innovative and environmentally friendly treatment methods, such as advanced sterilization technologies, to manage biomedical waste effectively.

➤ *Adherence to International Guidelines:*

Emphasize adherence to international guidelines for biomedical waste management, with a focus on standardizing practices to ensure consistency and safety. <sup>[35]</sup>

➤ *Capacity Building for Healthcare Workers:*

Provide training and capacity-building programs for healthcare workers involved in biomedical waste management, emphasizing infection prevention measures and proper handling protocols. <sup>[36]</sup>

➤ *Regular Audits and Inspections:*

Conduct regular audits and inspections of healthcare facilities to ensure compliance with biomedical waste management protocols, with penalties for non-compliance.

➤ *Encourage Research and Innovation:*

Promote research and innovation in biomedical waste management, supporting the development of sustainable and efficient solutions tailored to the challenges posed during pandemics. <sup>[37]</sup>

➤ *Public-Private Partnerships:*

Foster collaboration between public and private sectors to improve biomedical waste management infrastructure and share resources, expertise, and responsibilities. <sup>[38]</sup>

➤ *International Cooperation:*

Facilitate international cooperation and knowledge exchange on best practices in biomedical waste management, considering the global nature of pandemics and the interconnectedness of healthcare systems. <sup>[39] [40] [41]</sup>

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