



SCIENTIFIC DISPOSAL OF BIO-MEDICAL WASTE ARISING OUT OF COVID-19 TREATMENT

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Abstract

Medical care is vital for our life, health and well being. But the waste generated from medical activities can be hazardous, toxic and even lethal because of their high potential for diseases transmission. The sudden outbreak of the Covid-19 virus led to an exponential rise in the quantity of biomedical waste. To combat this serious problem in a timely manner, the government has formulated various standard operating procedures and has amended the existing rules and guidelines. This study emphasized the challenges of increased waste disposal during the COVID-19 crisis and its scientific disposal. Data obtained from the scientific research papers, publications from the governments and multilateral organizations, and media reports were used to quantify the effect of the pandemic towards waste generation.

Keywords

Bio Medical Waste, COVID-19 waste management, CBWTF (Common Biomedical Waste Treatment Facility)

Introduction

The term “Health Care Waste” or “Bio-Medical Waste” includes all the wastes from any medical procedure in healthcare facilities, research centres and laboratories (WHO, 2017).¹

Biomedical waste (BMW) is hazardous and infectious waste. According to BMW management rules 2016 and the amendment rules 2018 “Bio medical waste is defined as any waste, which is generated during the diagnosis, treatment, or immunization of human beings or animals, or in research activities pertaining thereto, or in the production or testing of biologicals”.² After China, India is the second-most populous country and after the United

States of America, the second worst-hit nation by the coronavirus disease 2019 (COVID-19) (As of November 9, 2020).^{3&4} India faces severe consequences during the COVID-19, due to the flawed biomedical waste management system and lack of resources.⁵ Untreated and improperly managed BMW is a potential source of infection.⁶ The diligent handling and management of BMW can prevent the occurrence of hospital-acquired infection and lower the rates of disease transmission.

The outbreak of Covid-19 has not only exposed the poor healthcare infrastructure and lack of preparedness to battle a pandemic but also loopholes in the waste management process in the country. According to a report filed by the Central Pollution Control Board (CPCB) in 2020-21 the National Green Tribunal in July, India generates about 101 Metric Tonnes per day (MT/day) of COVID-19 related bio-medical waste.⁷ This quantity is in addition to the regular bio-medical waste generation of about 609 MT per day. Available capacity for incineration of COVID-19 biomedical waste in the country is about 840 Metric Tons (MT) against the total generation of about 710 MT per day (comprising of 609 MT/day of regular biomedical waste and 101 MT/day of COVID related biomedical waste).

In the above context, it is clear that the on going pandemic has aggravated the severity of challenges of the BMW sector in India. The current study provides a scientific disposal of BMW generation during the COVID-19 pandemic.

Materials and Methods

This study was performed by reviewing the data published in scientific research papers, news articles, publications from the governments and non-government organizations, media reports and websites were used to quantify the effect of the pandemic towards waste generation. We also used data from various sources such as WHO, CPCB, Ministry of Health and Family Welfare (MoHFW), MoEFCC, etc. This report specifically observed the disposal of biomedical waste in a scientific way.

Result and Discussion

1. What is BM Waste and what categorises of BM Waste do hospitals generate?

- The Bio-Medical Waste Management Rules 2016 (“**2016 Rules**”) define BM Waste as any waste, which is generated during the diagnosis, treatment or immunisation of human beings or animals or research activities pertaining there to or in the production or testing of biological or in health camps.⁸ The 2016 Rules apply to all persons who generate, collect, receive, store, transport, treat, dispose, or handle bio medical waste in any form.
- BM Waste generated from a hospital could be human anatomical waste, animal waste- microbiology & biotechnology, waste sharps, discarded medicines and cytotoxic drugs, solid & liquid waste.

2. Present status of BMW in states and UTs

- As per the information submitted by State Pollution Control Boards/Pollution Control Committees as well as daily data received from COVID19BWM tracking App., currently average quantity of COVID-19 related biomedical Waste generation during May, 2021 is about 203 TPD (till 10.05.2021).
- Peak generation of about 250 TPD was reported on 10/05/2021. The earlier peak generation in the year 2020 was in the range of 180 – 220 TPD. Despite more number of patients, there is no proportional growth in quantity of COVID-19 biomedical waste generated, mainly due to proper segregation of waste. Common

facilities have reported that unlike last year, hospitals and isolation wards are not mixing food waste with COVID19 waste.

- There is gradual increase in quantity of COVID BWM generation since February, 2021. Trend of average monthly generation of COVID-19 biomedical waste in top ten is shown in table 1.

Table 1. Top ten COVID-19 waste generator states/UTs in India, generation during May, 2021 (i.e. till 10/05/2021) is given.

S. No.	Name of states and UTs	Covid -19 BMW Tones Per Day
1	Kerala	23.71
2	Gujarat	21.98
3	Maharashtra	19.02
4	Delhi	18.79
5	Karnataka	16.91
6	Uttar Pradesh	15.91
7	Tamil Nadu	13.57
8	Haryana	13.11
9	Andhra Pradesh	9.99
10	Madhya Pradesh	7.32

3. Biomedical waste Management Rules in India during the on going COVID-19 pandemic

- **CPCB Guidelines** : Due to hospitals being flooded with suspected and confirmed cases of Covid-19, the Ministry of Health and family welfare (“**MoHFW**”) and the CPCB have issued various guidelines for handling and management of waste generated from COVID-19 facilities.⁹ The Pictorial Guide on Biomedical Waste Management (BMWM) Rules, 2016 (amended in 2018 & 2019) is a product of joint research by the Centre for Chronic Disease Control (CCDC), Centre for Environmental Health (CEH) –Public Health Foundation of India (PHFI) and Health Care Without Harm (HCWH). The pictorial guide provides a quick, user-friendly view of the important elements of biomedical waste handling, treatment and disposal through its illustrative components. These are based on the specifications provided in the BMWM Rules, 2016 and its subsequent amendments. Importantly, the guide also includes the provisions for COVID-19 waste management as prescribed in the Central Pollution Control Board Guidelines 2020.¹⁰
- **Steps of Bio Medical Waste Management:** The management of BMW at health care facility can be summarized in following seven steps:









Figure 1: Management of Bio Medical Waste

First five steps (Segregation, Collection, Pre-treatment, Intramural transportation, Storage and Treatment) is the exclusive responsibility of Health Care Facility. While Treatment and Disposal is primarily responsibility of Common Biomedical Waste Treatment Facility.

- **Colour Coding and Type of Container/bags for Collection and Segregation of BMW:** Collection of waste from COVID-19 isolation wards should be used double layered bags (using 2 bags), store separately and labelled as “COVID-19 Waste”. This marking would enable CBWTFs (Common Biomedical Waste Treatment Facility) to identify the waste easily for priority treatment and disposal immediately upon the receipt. (Table-2).

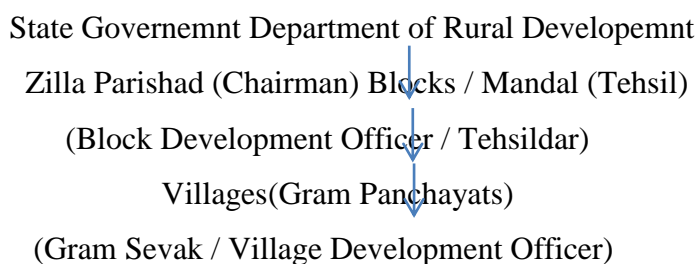
Table 2. Colour Categories of BMW as per BMWM rules, 2016, amendments 2018,2019 and CPCB guidelines 2020.

S No.	Category	Type of waste	Colour / Type of Container
1	Yellow Category	- Human Anatomical Waste - Animal Anatomical Waste - Soiled Waste - Discarded or Expired Medicine - Microbiology, Biotechnology and of clinical laboratory waste - Chemical Waste	Yellow coloured non chlorinated / biodegradable bags having thickness more than 50 microns 
2	Red Category	Contaminated Waste (Recyclable)	Red coloured non chlorinated / biodegradable bags having thickness more than 50 
3	White Category	Waste Sharps including metals	White Coloured translucent, puncture proof, leak proof, Temper Proof containers  
4	Blue Category	Glassware Metallic Body Implants	Cardboard boxes with blue colored marking or blue colored puncture proof, temper proof containers  

- ❖ Barcode label will have to be made available on every bag or container as per CPCB guidelines.
- ❖ For disinfection of BMWM articles freshly prepared 1–2% Sodium hypochlorite is recommended.
- ❖ 1% Sodium hypochlorite is 1:100 dilution (525–615 ppm of available chlorine).

- ❖ Hospital supply of sodium hypochlorite is 10% or 4% (please see label and manufacturers instructions).
- ❖ All lab waste: patient's samples, blood bags, toxins, live and attenuated vaccines, cultures (liquid /solid), devices used to transfer cultures need pretreatment by autoclaving/microwaving/hydroclaving etc-then their respective category plastic (red)/glass (blue).
- **Intramural Transportation of BMW:** BMW must be transported in the covered trolley through a separate route. Central waste collection area could be easily accessed through this route. Safe transportation is undertaken to avoid spillage and scattering of waste
- **Model Plan for COVID-19 Biomedical Waste Management at Village Panchayats and Sub-Divisions:** During the COVID-19 pandemic situation, COVID-19 related biomedical waste gets generated at villages from symptomatic persons in village quarantine centers, test centers at PHC and in homecare or home quarantine of COVID-19 patients. Biomedical waste may also generate from households from persons suffering pre-existing diseases.

In villages, civic amenities including services of waste management is the responsibility of Gram Panchayats, Panchayat Samitis, Group-Gram Panchayats, Gram Sewaks, Block/Tehsil level Offices, along with Zilla Parishad to implement over-all waste management, which includes safe disposal of domestic hazardous waste and COVID-19 related biomedical waste at villages. The prevailing hierarchy of responsible stakeholders for overall waste management at village panchayat levels are shown schematically as below.



- **Liquid waste treatment facilities:** As per mandate of BMW, rules 2016, all hospital and bedded health care facilities need to install effluent treatment plant (ETP) onsite.¹¹ Health care facilities with effluent treatment plants need to follow all guidelines for disinfection prior to discharge into general sewage lines. In hospitals with ETP chemical wastewater should be collected with separate drainage system leading to ETP.¹¹ Persons working in effluent treatment plants and wastewater treatment facilities should be equipped with PPE, gloves, masks and goggles.¹² Training the workers on standard precaution, respiratory etiquette, hand hygiene, etc can reduce the risk of any accidental exposure. The reuse of waste water should be avoided during pandemic. If this wastewater is released into the surrounding it can pollute the environment and can be a potential source of infection. Many studies had reported that aerosol generated in sewer lines can act as a potential source of coronavirus infection.^{13&14}
- **Monitoring system:** Record of waste generated from COVID-19 isolation wards should be maintained separately, bags tagged with barcodes and GPS and monitor at all levels internally by internal BMW auditors and also externally by SPCB. CPCB has created an app 'COVID19BWM' for daily updates on COVID19 waste management and follow-up.¹²
- **Duties of different governing bodies for COVID-19 WASTE management**
 - **Duties of CBWTF:** Adequate training and protective gear should be provided to the sanitation worker. All COVID-19 waste must be processed or treated on the very same day it gets collected.

Vehicles, trolleys, and storage areas must be sanitized daily with 1% sodium hypochlorite. Daily report should be updated into the COVID-19 tracking app.

- **Duties of SPCBs:** It is the duty of SPCB (State Pollution Control Board) to communication between all isolation camps/quarantine homes and CBWTF must be established and monitored. Violations by any of the participants are dealt under BMW rules 2016 as amended.
- **Duties of ULBs:** ULBs (Urban Local Bodies) are responsible for awareness, safe collection and transport of all waste from waste generating facility to CBWTF. They must create different teams for doorstep collection of BMW which will prevent any mixing of COVID19 waste with nonCOVID19 waste. Sanitation workers must be provided with adequate training and protective gear.
- **Safe disposal of dead bodies of unknown/suspected/confirmed cases of COVID19 patients :** Dead bodies is sanitized with 1% hypochlorite and packed in a body bag. During handling of dead bodies PPE, gloves, masks, gowns and goggles to be used. ¹⁵Burial and ash possess no additional threat to environment. Morgue, vehicles used for transportation should be sanitized with 1% hypochlorite ^{15&16}

3. How Can India Tide Over The Crisis Of Bio-Medical Waste Even After The Coronavirus Pandemic Is Over?

India needs to take up challenges in bio-medical management on a war footing. COVID-19 did not break the system instead it only helped in revealing a broken system. Giving out tips on how India can reduce its COVID specific bio-medical generation. Three crucial steps for reducing BMW –

- First step should be on spreading awareness among concerned stakeholders on waste segregation and management that is 2Rs (reduce and reuse) for covid-19 waste.
- Second step, augmenting the capacities of BMW treatment units in our country with appropriate monitoring strategies
- Third step, appropriate public private partnership models that allow innovation and widespread network for linking health care facilities to BMW treatment units can help to tide over the crisis.

4. Common Bio-medical Waste Treatment Facility should treat the bio-medical waste as per BMW Rules

- **Incineration/Plasma Pyrolysis** - Incineration is a controlled combustion process where waste is completely oxidized and harmful microorganisms present in it are destroyed/ denatured under high temperature without pre-treatment. Plasma pyrolysis is an alternate to incinerator. In the plasma pyrolysis process waste is converted into small clinker which can be disposed in secured landfills. In the Bio-medical Waste (Management and Handling) Rules, Incineration has been recommended for human anatomical waste, animal waste, cyto-toxic drugs, discarded medicines and soiled waste.
- **Autoclaving** – This is a process of steam sterilisation under pressure. It is a low heat process in which steam is brought into direct contact with the waste material for duration sufficient to disinfect the material. These are also of three types : Gravity type, Pre-vacuum type and Retort type. Autoclave treatment has been recommended for microbiology and biotechnology waste, waste sharps, soiled and solid wastes (as mentioned

in the table above). This technology renders certain categories (mentioned in the rules) of bio-medical waste innocuous and unrecognisable so that the treated residue can be landfilled.

- **Hydroclaving** - Hydroclaving is similar to that of autoclaving except that the waste is subjected to indirect heating by applying steam in the outer jacket. The waste is continuously tumbled in the chamber during the process. The hydroclave can treat the same waste as the autoclave plus the waste sharps. The sharps are also fragmented. This technology has certain benefits, such as, absence of harmful air emissions, absence of liquid discharges, non requirement of chemicals, reduced volume and weight of waste etc.
- **Microwaving** - In microwaving, microbial inactivation occurs as a result of the thermal effect of electromagnetic radiation spectrum lying between the frequencies 300 and 300,000MHz. Microwave heating is an inter-molecular heating process. The heating occurs inside the waste material in the presence of steam. Microwave technology has certain benefits, such as, absence of harmful air emissions (when adequate provision of containment and filters is made), absence of liquid discharges, non requirement of chemicals, reduced volume of waste (due to shredding and moisture loss) and operator safety (due to automatic hoisting arrangement for the waste bins into the hopper so that manual contact with the waste bags is not necessary). However, the investment cost is high at present. According to the rules, category nos, 3 (microbiology and biotechnology waste), 4 (waste sharps), 6 (soiled waste) and 7 (solid waste) are permitted to be microwaved.
- **Chemical disinfection**- Though chemical disinfection or alternates as stipulated under the BMWM Rules is also an option for treatment of certain categories of biomedical waste such as glass waste but looking at the volume of waste to be disinfected at the CBWTF and the pollution load associated with the use of chemical disinfectants, the chemical disinfection for treatment of bio-medical waste as part of a CBWTF may be used sparingly or avoided as far as possible.
- **Dry heat sterilization** - This is the additional option for treatment of waste sharps as stipulated under the BMWM Rules. In this method, waste sharps are treated using Revised Guidelines for Common Bio-medical Waste Treatment Facilities 12 dry heat (hot air) at a temperature not less than 1850 C, at least for a residence period of 150 minutes in each cycle (with sterilization period of 90 minutes).

5. Conclusion

This article provides an overall position of India in management of BMW during the outbreak of COVID-19. With a judicious planning and management, not only the waste generation is reduced, but overall expenditure on waste management can be controlled. Studies have shown that stringent monitoring mechanism, operational and functional efficiency of CBWTFs and transparency aspects is required to ensure safe and proper disposal of the BMW. The scientific disposal of bio medical waste requires continuous involvement of a long chain of people, such as, doctors, nurses, ward boys, cleaning staff etc. Therefore, all staff should know about their precise role – what is expected of them and why it is important for them to act according to the directions given to them. The experience of BMW management in this global crisis can be a learning for authorities to develop a well-equipped system for safe disposal in post-COVID-19 scenario. Such expenditure will worth its value and will ensure safe and sound BMW management with adequate capacity to get the country prepared for any future disaster.

Conflict of Interest

Authors would hereby like to declare that there is no conflict of interests that could possibly arise.

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