

Biomedical Waste: Management Strategies and Their Importance

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ABSTRACT

The infectious, dangerous, and occasionally poisonous nature of biomedical waste (BMW) produced by healthcare facilities presents serious environmental and public health issues. In order to reduce environmental pollution, safeguard healthcare personnel, and stop the spread of illness, biological waste must be managed effectively. This essay examines biological waste management techniques, such as source segregation, secure collection, transportation, treatment and disposal. Modern technologies including autoclaving, incineration, chemical disinfection, and sophisticated recycling techniques are emphasized. Regulatory frameworks, best practices, and the importance of healthcare staff awareness and training are also highlighted in the report. Effective biomedical waste management is crucial to sustainable healthcare systems because it not only guarantees adherence to legal requirements but also dramatically lowers the danger of infection and environmental damage.

Keywords: *Biomedical waste management, Infection control, Segregation, Treatment and disposal, Regulatory compliance, Sustainable healthcare*

1. INTRODUCTION

"Bio-medical waste" means any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or research activities pertaining thereto or in the production or testing of biological or in health camps. (CPCB, 2016). According to WHO defines medical waste as waste generated by health care activities, ranging from used needles and syringes to soiled dressings, body parts, diagnostic samples, blood, chemicals, pharmaceuticals, medical devices and radioactive materials.

Table 1 shows average composition of waste obtained from 10 large hospitals in Mumbai, Kolkata, Deli and Nagpur during the period 1993-1996

Table 1: Average composition of Hospital waste in India

Material	Percentage (wet weight basis)
Paper	15
Plastics	10
Rags	15
Metals (Sharps etc.)	1
Infectious waste	1.5
Glass	4.0
General waste (food waste, sweeping from hospital premises)	53.5

Source : National Institute of Environmental Engineering Institute ,1997

The quantity of solid waste generated in hospitals and nursing homes generally varies from 0.5 to 4 kg per bed per day in Govt. hospitals, 0.5 to 2 kg per bed per day in private hospitals and 0.5 to 1 kg per bed per day in nursing home. (Balg and Asma, 2024).

Classification of biomedical waste:

The biomedical wastes are broadly classified as follows: (Dr. Navpreet,2023)

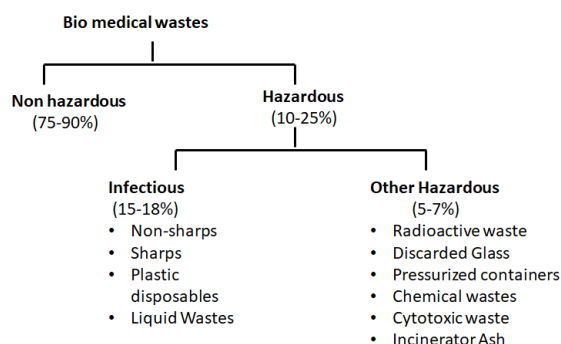


Fig 1: Classification of the waste in healthcare

According to the World Health Organization, high-income nations produce up to 0.5 kg of hazardous waste per hospital bed each day on average, whereas low-income nations produce 0.2 kg. However, in low-income nations, health care waste is frequently not segregated into hazardous and non-hazardous wastes, resulting in a significantly greater actual amount of hazardous waste. This paper examines biological waste management techniques, such as source segregation, secure collection, transportation, treatment and disposal. Modern technologies including autoclaving, incineration, chemical disinfection, and sophisticated recycling techniques are emphasized. Regulatory frameworks, best practices, and the importance of healthcare staff awareness and training are also highlighted in the report.

Health Hazards of healthcare waste

Exposure of hazardous health-care waste can result in disease or injury due to one or more of the following reasons:

- i) It may contain infectious agents;

- ii) It may contain toxic or hazardous chemicals, pathological waste or pharmaceuticals;
- iii) It may contain sharps;
- iv) It may be genotoxic;
- v) It may be radioactive; and
- vi) Non-hazardous or general waste.

All individuals exposed to such hazardous healthcare waste are potentially at risk, including those who generate the waste or those who either handle such waste or are exposed to it as consequences of careless management. The main groups at risk are:

- Medical doctors, nurses, healthcare auxiliaries and hospital maintenance personnel;
- Patients;
- Visitors;
- Workers in support services allied to healthcare establishments such as laundries, waste handling and transportation; and
- Workers in waste disposal facilities such as land-fills or incinerators scavengers.

Biological Waste Management Techniques:

It is also emphasized in the rules that no healthcare facility shall establish on-site treatment and disposal facility for BMW, if a service of CBWTF is available within 75 kilometres of travelling distance of the facility. All the public healthcare facilities within reach of 75 kilometres of CBWTF need to dispose of the BMW through such CBWTF only and are not allowed to establish its own treatment and disposal facility. For the public health care facilities especially in rural areas where there is no CBWTF within range of 75 kilometres, the disposal of BMW can still be made through a CBWTF who is willing to provide treatment services and authorized by the concerned SPCB/PCC to operate in an area beyond 75 Km radial distance. In case of no reach to any CBWTF, the BMW generated from HCFs should be disposed in captive treatment and disposal facility or by deep burial pit as authorised by the respective SPCB/and as specified in these guidelines (CPCB,2016)

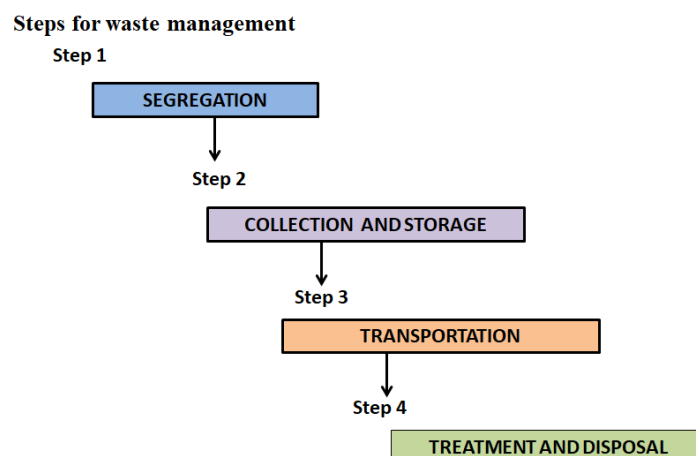


Fig 2: Steps for waste management





Bio Medical Waste Management Rules, 2016 categorises the bio-medical waste generated from the health care facility into four categories based on the segregation pathway and colour code.

Various types of bio medical waste are further assigned to each one of the categories, as detailed below:

1. Yellow Category
2. Red Category
3. White Category
4. Blue Category

These categories are further divided as per the type of waste under each category as follows:

Table 2 Categories as per the type of waste based on the colour code

Category	Type of Bag/ Container used	Type of Waste	Treatment/ Disposal options
 Yellow	non-chlorinated plastic bags Separate collection system leading to effluent treatment system	a) Human Anatomical Waste b) Animal Anatomical Waste c) Soiled Waste d) Expired or Discarded Medicines e) Chemical Waste f) Micro, Bio-t and other clinical lab waste g) Chemical Liquid Waste	Incineration or Plasma pyrolysis or deep burial*
 Red	non-chlorinated plastic bags or containers	Contaminated Waste (Recyclable) tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles) and gloves	Autoclaving/ microwaving/ hydroclaving and then for recycling not to landfill
 White	(Translucent) Puncture, Leak, tamper proof containers	Waste sharps including Metals	Auto or Dry Heat Sterilization followed by shredding or mutilation or encapsulation
 Blue	Cardboard boxes with blue colored marking	Glassware	Disinfection or autoclaving, microwaving, hydroclaving and then sent for recycling

Collection and Storage:

Labelling:

Each container must be labelled with the location where the waste was generated to trace it back to the source along with bar code and label.

• Safety during collection:

Minimize manual handling and wear personal protective equipment. Bags should not be completely filled to allow for a secure grip at the neck.



Storage

- Temporary storage: The waste is stored temporarily in a central location before final disposal.
- Time limits: Large hospitals (over 250 beds): Storage time should not exceed 8–10 hours.
- Nursing homes: Storage time should not exceed 24 hours.

• Storage area:

The area must be clearly marked with a caution sign and the biohazard symbol. It should be clean, secure, and have adequate ventilation.

• Disinfection:

The container must be cleaned with an appropriate disinfectant after the bag is removed.

Transportation of biomedical waste requires specialized vehicles, proper packaging in leak-proof containers, and strict safety protocols to prevent exposure to people and the environment and should be given to the approved biomedical waste management centre usually Common Biomedical Waste Treatment Facility (CBWTF).

TREATMENT AND DISPOSAL TECHNOLOGIES FOR HEALTH CARE WASTE (Balg and Asma, 2024).

Incineration: It is a High temperature dry oxidation process it leads to significant reduction in waste volume and weight (upto 70-80%)

Characteristics of waste suitable for incineration:

Type of incinerators

- a) Double chamber pyrolytic
- b) single chamber pyrolytic
- c) Rotary kilns

Temperature in an incinerator > 1200 Celsius

Primary chamber 800 degree +- 50 degree Celsius

Secondary chamber 1050 degree+_ 50 degree Celsius

- Waste types not to be incinerated
 - Pressurized gas container
 - Reactive chemical waste
 - Halogenated chemical waste
 - Silver/ radiographic/photographic wastes/ sealed ampoules/ Waste with high mercury

2) Chemical disinfection

- Chemicals are added to waste to kill or inactivate the pathogens it contains , this treatment usually result in disinfection rather than sterilization
- Chemical disinfection is most suitable for treatment of liquid waste such as blood , urine , stool or hospital sewage

3) Wet and Dry thermal treatment

- Wet thermal treatment :It is based on exposure of shredded infectious waste to high temperature , high pressure steam and is similar to the autoclave sterilization process
- Screw – feed technology is the basis of non burn , dry thermal disinfection process in which waste is shredded and heated in a rotating auger ; the waste is reduced by 80% in volume and by 20-35% in weight

4) Microwave irradiation

- Most microorganism are destroyed by the action of microwave of a frequency of about 2450 MHZ and a wavelength of 12.24 nm
- The water contained within the waste is rapidly heated by the microwave and the infectious components are destroyed by heat conduction

5) Land disposal

- There are two types of disposal land –open dumping and sanitary landfills
- Health care waste should not be deposited on or around open dumps
- Sanitary landfills are designed to have atleast four advantages over open dumps
 1. Geological isolation of waste from environment
 2. Appropriate engineering preparation before the site is ready to accept waste
 3. Staff present on site to control operation
 4. Organization deposits and daily coverage of waste

5) Inertization

- Mixing biomedical waste with cement and other substances before disposal .So as to minimize risk of toxic substances contained in waste to contaminate ground / surface water
- A typical composition of mixture is:
 - 65% pharmaceutical waste
 - 15% lime
 - 15% cement
 - 5% water

Bio-medical Waste Management: A Legal Requirement: (CPCB, 2016)

The Environment Protection Act 1986, the Bio Medical Waste (Management and Handling) Rules in July 1998, subsequently revised in 2011 and now the “Bio-medical Waste Management Rules, 2016” are an attestation to the commitment of the Govt of India.

The law works on a simple “the polluter pays principle.” The responsibility of hospital administrator as regards to proper handling and disposal of Biomedical waste had become a statutory requirement with the promulgation of Government of India (Min of Environment, Forests & climate change) gazette notification no. 460

dated 27 Jul 1998 & notification of the Bio-medical Waste (Management and Handling) Rules in July 1998 & subsequently revised in 2011.

“Bio-medical Waste Management Rules, 2016” came into force in supersession of the 1998 rules with gazette notification no. G.S.R. 343(E) dated 28th March 2016. The Central Pollution Control Board and the State Pollution Control Committees have the authority to cancel the Consent to Operate and the Authorization of Healthcare Institutions and under the Bio-medical Waste Management Rules 2016 for non-compliant Hospitals. Indeed there have been such instances in India.

Schedules under biomedical waste management Rules, 1998.

- Schedule I: Categories of BMW, treatment & disposal
- Schedule II: Colour coding and type of container for BMW disposal
- Schedule III: Labels of BMW container s/Bags
- Schedule IV: Labels for transport of BMW container/Bags
- Schedule V: Labels for transport of BMW containers/Bags

The following figure illustrates the other relevant rules and appropriate disposal technics on Hospital wastes.

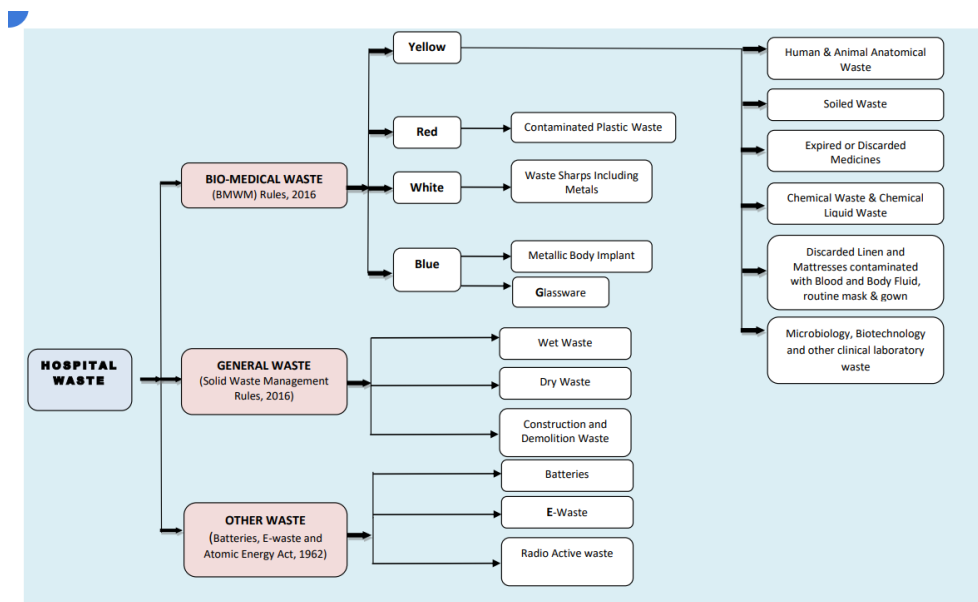


Fig: Categorization & Classification of Wastes in Health Care Facilities.

Benefits of Managing Biomedical Waste

1. A healthier and cleaner environment.
2. A decrease in the prevalence of general and hospital-acquired infections.
3. A decrease in the hospital's infection control expenses.
4. Reuse and repackaging of infectious disposables reduces the risk of illness and death.
5. Minimal prevalence of occupational and societal health risks.
6. Lowering waste management expenses and generating income by properly treating and disposing of garbage.
7. An enhanced quality of life and a better reputation for the healthcare system.

2. CONCLUSION

Training programs need to focus on empowering the healthcare professionals on biomedical waste management with broad scope and practical knowledge in all aspects. Training the staff with checklists and regular inspections can bring about accountability in the staff. Improper Biomedical waste management leads to environmental pollution, multiplication of vectors like insects, rodents & worms leading to transmission of diseases like typhoid, cholera, plague, hepatitis & AIDS. Recycling of disposable syringes, needles, intravenous sets, and glass bottles without proper sterilization leads to hepatitis, tetanus, HIV & viral diseases. Benefits of biomedical waste management include healthy surroundings, reduction in hospital acquired infections & cost of infection control, reduction in reuse of infectious disposables & prevention of occupational health hazards.

Awareness about hazards of biomedical waste & its proper disposal is required for a safe & healthy future. All health care professionals regardless of their designation, experience and qualification, designation must be included in these interventions, so that it can avoid cross infections among the professionals and patients in the health care sectors.

REFERENCE

- CPCB, Guidelines for Management of Healthcare Waste as per Biomedical Waste Management Rules, 2016
- Deepika Kanyal, LAta Butola, Ranjit Ambad, 2021, Biomedical Waste Management in India- A Review, Indian Journal of Forensic Medicine & Toxicology, April-June, 2021, Vol 15, No.2, 108-113.
- Dr. Navpreet, 2023 Assistant Professor, Department of Community Medicine, Govt. Medical College & Hospital, Chandigarh. Biomedical waste management ppt <https://gmch.gov.in/sites/default/files/documents/Biomedical%20Waste%20Management.pdf>
- Dr. Parmeshwar Kumar, Dr. K.Vamsi Krishna Reddy and Dr. Siddharth Mishra, AIIMS Bio-medical Waste Management Manual
- Dr.M.Shamsheer Balg and Dr.Asma, 2024, Preventive & Social medicine, Third edition, SIA Publications p.495.
- <https://www.who.int/en/news-room/fact-sheets/detail/health-care-waste>
- <https://www.who.int/india/health-topics/medical-waste>
- Marrow edition 8, Dr. Awareness about hazards of biomedical waste P.321