



Latest Biomedical Waste Management Guidelines

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Abstract

All those who support and fund healthcare operations have a social and legal obligation to handle biological waste in a safe and sustainable manner. Effective and efficient biomedical waste management is essential to achieving a cleaner environment where humans and health can flourish. An effective method of managing biomedical waste can be achieved through a collaborative effort with committed government support in terms of finance and infrastructure development, committed healthcare workers and facilities, ongoing monitoring of biomedical waste management procedures, strict legislation, and powerful regulatory bodies. Trash minimization and waste segregation at the source are the best options. In addition, a lot of fieldwork and research must be done to effectively manage biomedical waste.

Keywords: Biomedical Waste, Types of biomedical waste, Biomedical waste guidelines, biomedical waste treatment methods

Introduction

Wastes produced during the laboratory diagnosis, treatment, or immunization of people or animals, as well as during related research and the manufacture of biologicals, as well as during the testing of biological products in health facilities, is referred to as bio-medical waste. It is more likely that injuries and infections will occur in hospital trash. Therefore, secure, dependable techniques of hospital waste segregation and disposal are crucial.^[1]

BMW is covered by the Biomedical waste management (BMWM) Rules 2016 and BMWM (Amendment), 2018; and 2019 regulations. The improper handling of biomedical waste poses a serious threat to public health. BMW should be disposed of properly to prevent the spread of infectious diseases, cancer, fetal abnormalities, chronic cardio-pulmonary ailments, antibiotic resistance, endocrine disruptions, and contamination of the air, land, and water for future generations. It is

essential to handle BMW using eco-friendly and effective approaches.^[2,3]

Background status

By passing the Biomedical waste (management and handling) regulations 1998 in accordance with sections 6 and 25 of the environmental protection act of 1986, the Indian government made a significant advancement. The Biomedical Waste (Management and Handling) Rules of 1998, which constitute Indian law, are identical to the Medical Waste Tracking Act of 1988, which defines medical waste in the United States. The laws cover with the rules governing the production, storage, handling, treatment, and disposal of biomedical waste in effect.^[4-7]

Importance of Biomedical Waste Management

Management of biomedical waste is crucial to protecting the environment and public health. Direct health risks to the general population, healthcare

professionals, and the environment result from improper waste management in healthcare institutions. It is equally important that all service medical, dental, nursing officers, other paramedical staff and waste handlers such as housekeepers be well oriented to the basic requirements of handling and management of biomedical waste.^[8]

Situation in india

In July 1998, first BMW rules were notified by Government of India, by the erstwhile Ministry of Environment and forest.^[4] The BMW 1998 rules were modified in the following years – 2000, 2003, 2011, 2016, 2018 and 2019. The gross generation of BMW in India, according to the ministry of environment and forest (MoFF), is estimated to be 484 tonnes per day. Only 447 tonnes per day were sadly treated, and 37 tonnes per day were not. Karnataka is ranked first among all Indian states in the generation of BMW, followed by Maharashtra.^[5-7]

Types of biomedical waste^[9,10]

Medical waste: That fraction of the overall waste stream from a hospital or research facility that includes radioactive materials, dangerous chemicals, or possibly infectious agents.

Solid Medical Waste: wastes from medical diagnosis, treatment, or research, including needles, infusion sets, bandages, anatomical wastes, isolation wastes, and any other materials contaminated or possibly contaminated with blood and/or bodily fluids.

Liquid Medical Waste: waste products from medical procedures or research, including blood, bodily fluids, dialysis solutions, chemical reagents, solvents, acids, heavy metal solutions, film developers, and other medications.

Isolation Waste: To prevent the spread of a highly contagious disease, all disposable items related to a medical patient are kept apart from other patients.

Classification of health care waste by WHO^[10,11]

1. **Infectious waste:** waste from laboratory operations, including infectious agent cultures and stocks as well as wasted diagnostic samples contaminated with blood and other body fluids. trash from autopsies, contaminated laboratory

animals, and sick patients' bodies (swabs, bandages, and disposable medical equipment);

2. **Pathological waste:** human body parts, tissues, & fluids, and contaminated animal carcasses;
3. **Sharps waste:** syringes, needles, disposable scalpels and blades, etc.;
4. **Chemical waste:** all solvents and reagents used for laboratory preparations, testing, disinfectants, sterilant and heavy metals contained in medical device.
5. **Pharmaceutical waste:** pharmaceutical drugs, immunization vaccine etc.
6. **Cytotoxic waste:** waste containing substances with genotoxic properties such as cytotoxic drugs used in cancer treatment and their metabolites;
7. **Radioactive waste:** such as products contaminated by radionuclides including radioactive diagnostic material or radiotherapeutic materials.
8. **Non-hazardous or general waste:** waste that does not pose any particular biological, chemical, radioactive or physical hazard.

Sources and Generation of Biomedical waste.^[12]

Major Sources

Govt. hospitals/private hospitals/nursing homes/dispensaries. Primary health centers. Medical colleges and research centers/ paramedic services. Veterinary colleges and animal research centers. Blood banks/mortuaries/autopsy centers. Biotechnology institutions.

Minor Sources

Physicians/ dentists' clinics, Animal houses/slaughter houses, Blood donation camps, Vaccination centers, psychiatric clinics.

Waste segregation in hospitals^[10]

Biomedical waste 2016 rules Segregation of waste should be done by using containers of different colors.

1. Yellow bags- Infectious non- plastic waste
2. Red begs- Infectious plastic begs
3. White sharp containers- Metal sharp

4. Blue containers – Broken glass items, metal implants .

Steps of BMW management^[13]

1. Putting waste into bins with different colors
2. Pre- treatment for laboratory liquid waste
3. Transportation of wastes from the waste generating facility to the hospital's central storage area
4. Transport of waste from central storage area to common bio-medical waste treatment facility
5. Treat the waste within 48 hours.

Biomedical waste management rules.(BMWM)

As per BMWM (Principal) rules 2016 and BMWM (Amendment) rules 2018^[13-19]

Biomedical waste categories and their segregation, collection, treatment, processing and disposal options in Hospital. Only pretreatment and segregation will be done in the hospital and the final disposal, recycling will be done by common biomedical waste treatment and disposal facility (CBMWTF). The hospital has provided the colour coded bags with its name inscribed over them along with logo for bio-medical hazard. The segregation of wastes is done at source of generation into yellow, red, blue and white categories.

Waste receptacles: The waste receptacles should have the following properties.

1. Plastic bags must be labelled with biohazard logos and should be non-inflammable, autoclave stable and non-chlorinated with a thickness of $\geq 50 \mu\text{m}$
2. Containers should have well-fitting lids, either removable by hand or preferably operated by a foot pedal
3. Sharp box should be puncture-proof, leak-proof and tamper-proof impermeable container.

Securement: All the bags used for waste collection need to be sealed once they are filled to 3/4th of their capacity.

Labelling: Bags and containers should be labelled properly with the date and place.

Pre-treatment: The laboratory liquid waste should always be pre-treated either with chemical (1–2%

hypochlorite) or autoclave before segregating into appropriate containers.

Transport: The waste should be transported within 24 hours by dedicated trolley to the central BMW storage facility of the hospital. Separate routes should be used for transport to prevent exposure to staff and patients and to minimize the passage of loaded carts through patient care and other clean areas.

Central storage area: This is a short-term storage location inside a hospital where various waste kinds should be delivered for secure holding until they are treated or collected for shipment to CBMWTF.

Yellow Category

Human Anatomical Waste: Human tissues, organs, body parts and fetus below the viability period (as per the Medical Termination of Pregnancy Act 1971): Yellow colored non-chlorinated plastic bags. Dead Fetus below the viability period (as per the Medical Termination of Pregnancy Act 1971, will be considered as human anatomical waste. This waste should be handed over to the CBMWTF in yellow bag with a copy of the official Medical Termination of Pregnancy certificate from the Obstetrician or the Medical Superintendent with stamp.

Animal Anatomical Waste: Yellow colored non-chlorinated plastic bags.

Soiled Waste: Items contaminated with blood, body fluids like dressings, plaster casts, cotton swabs and bags containing residual or discarded blood and blood components are disposed in yellow bag.

Cytotoxic Waste: Cytotoxic drug vials shall not be handed over to unauthorized person under any circumstances. Expired cytotoxic drugs to be returned back to the manufacturer or supplier for incineration at temperature $>1200^\circ\text{C}$. Leftover cytotoxic drugs cytotoxic drugs and items contaminated with cytotoxic drugs along with glass or plastic ampoules, etc. to common biomedical waste treatment facility for incineration at >1200 in yellow bag or container with cytotoxic label

Chemical Waste: Chemicals used in production of biological and used or discarded solid disinfectants, residual or discarded chemical solid waste and chemical sludge are discarded in yellow colored non-chlorinated plastic bags or containers and disposed of by CBMWTF. Incineration Liquid waste generated

due to use of chemicals in production of biologicals, used or discarded disinfectants, infected secretions, aspirated body fluids liquid from laboratory, labor room, OT and disinfecting activities etc. should be collected separately and made safe by disinfection by chemical treatment using 1- 2% sodium hypochlorite solution for a contact period of 30 min and directed to effluent treatment system or then discharged into drains/sewers.

Discarded items: Linen, Mattresses, beddings contaminated with blood or body fluid non-chlorinated (lime/alcoholic: 5 % Lysol for 30 minutes, 5% Phenol for 30 min) chemical disinfection followed by shredding and customized to fit in yellow bag for incineration.

Microbiology, biotechnology waste Microbiology, biotechnology waste i.e., laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines, humans and animals cell culture used in research, residual toxins culture plates dishes have to be pretreated on site by autoclaving in an autoclave safe plastic bag/container there after sent for final disposal in their respective category to CBMWTF for disposal. The discarded blood bags are to be counted, sealed, weighed and all the records to be made and then packed in autoclave safe plastic bags or containers to be autoclaved on site and then sent in yellow bag to CBMWTF for incineration.

Red category Contaminated Waste (Recyclable)

Wastes generated from disposable items such as tubing, drains, oxygen mask, bottles, intravenous tubes and sets (with needles cut), catheters, urine bags, and gloves are nicked, wherever applicable and put in red bag. The needles of syringes are cut with the needle destroyer/needle cutter preferably. The cut/mutilated syringe is disposed finally in red colored non chlorinated plastic bags or containers. Pipette tips and other disposables are pretreated (disinfected in 1-2% Sodium hypochlorite solution), which is prepared fresh every day and then disposed in red category.

White Category

Translucent (White) Category Waste sharps including Metals: Needles, needles from needle tip cutter or burner, scalpels, blades or any other contaminated sharp object that may cause puncture and cuts. The needles of syringes are cut with the

needle destroyer/needle cutter preferably. This includes both used, discarded and contaminated metal sharps. These are stored in tamper proof, leak proof and puncture proof containers for sharps storage. Collect and send for final disposal when 3/4 full. These are sent to central common waste site in tamper proof, leak proof and puncture proof containers for final disposal to CBMWTF.

Blue category:

Glass and metallic implants the uninfected glass like medicine bottles or ampoules are noninfected and are put in puncture proof and leak proof boxes or containers with blue colored marking. The discarded and contaminated glass like slides and coverslips etc., have to be disinfected (1-2% sodium hypochlorite for 30 minutes at-least) to be packed in puncture proof and leak proof boxes or containers with blue colored marking and then sent to common central disposal CBMWTF. Waste site for final to the metallic implants are pretreated in the same manner and are to be packed in separate puncture proof and leak proof boxes or containers with blue colored marking.

Articles: bins, bags, trolleys

Bags: The bags used for storing and transporting biomedical waste shall be in compliance with the Bureau of Indian Standards. Till the Standards are published, the carry bags shall be as per the Plastic Waste Management Rules, 2016. Yellow, Blue, Red and translucent bags/bins/containers are marked with Biohazard symbol, hospital logo and with barcoding to be supplied by CBMWTF.

BINS:

Containment of waste: An optimum number of easy to use, standard, uniform, covered, foot operated bins of colors i.e., yellow, red bins of appropriate size would be placed at identified places in all clinical areas.

DISINFECTION OF BINS:

Chemical disinfection of the waste bins using hypochlorite solution (1-2%) should be done frequently at a separate washing facility in the hospital, daily preferably, at least once a week.

Segregation, package and then transport and storage to common waste site: All the biomedical waste is labeled as waste type, site of generation, date of generation before transportation from the

generation site. The BMW register is maintained on site regularly at the point of generation. Waste is stored in the areas of generation at an identified safe area, for an interim period after which it is transported to CBMWTF for final treatment and final disposal. During this period, it is the responsibility of the administration, BMWU sanitation and security staff to ensure the safety and prevention of pilferage and recycling of the waste. No untreated bio-

medical waste shall be kept stored beyond a period of 48 hours. Collection is done: Daily from all areas. Done twice daily or more frequently from labor rooms/ OTs/laboratories. Label is filled up by staff on duty and given to waste collectors. Each patient care area has been provided with the waste receipt book to record the quantity /number of yellow, blue, red, white (translucent) bags handed over to HCW. All the staff are required to duly fill in the waste log book color code wise mentioning the number and size of bags handed over and sign the slip for further record. Hospital waste is transported in securely tied bags from the site of generation to central waste storage site through designated route, on dedicated, color coded, covered and leak proof wheel barrows/

Trolleys. At the waste treatment premises verification of the number/size of the bags is done for each trolley by the sanitation staff for recording and quantification and barcoding is done of the BMW bags and containers as per Barcoding guidelines before handing over to CBMWTF vehicle. The central waste storage site is cleaned daily. Chemical disinfection of the trolleys using hypochlorite solution is being done at the waste storage site, should be cleaned and disinfected daily.^[18,19]

Transportation to CBWTF: The operator of CBWTF shall transport the bio-medical waste from the premises of an occupier to any off-site bio-medical waste treatment facility only in the vehicles having label as per BMW (Principal) rules, 2016 and BMW (amendment), rules 2018, 2019.1.2 The vehicles used for transportation of bio-medical waste shall comply with the conditions stipulated by the SPCB in addition to the requirement contained in the Motor Vehicles Act, 1988 (59 of 1988), or the rules made there under for transportation of such infectious waste. Global positioning system has been added by the CBMWTF.^[19]

Table.1 Biomedical waste Management Rules in India

Category	Type of Waste	Type of Bag or Container to be used	Treatment and Disposal options
Yellow	Human Anatomical Waste:	Yellow colored non- chlorinated plastic bags	Incineration by CBMWTF
	Animal Anatomical Waste:		
	Soiled Waste: Items like as bandages, casts made of plaster, cotton swabs, and other bodily fluids		Incineration by CBMWTF
	Expired or Discarded Medicines:	Yellow colored non-	Submitting expired cytotoxic medications to the manufacturer or supplier

	antibiotics, cytotoxic drugs	chlorinated plastic bags or containers with cytotoxic labels	for burning at a temperature more than 1200 °C. Transfuse glass or plastic ampoules, vials, and other things with leftover cytotoxic medications and items contaminated with cytotoxic drugs to a facility that treats common biomedical waste for burning at a temperature of more than 1200 °C.
	Chemical Waste: Solid discarded chemicals	Yellow colored non-chlorinated plastic bags or containers	Disposed of by incineration by CBMWTF
	Chemical Liquid Waste: Liquid Waste generated due to use of chemicals and used or discarded disinfectants.	Separate collection system leading to effluent treatment plant (ETP) system.	The chemical liquid waste must first undergo pre-treatment after resource recovery before being combined with other wastewater. The combined discharge must adhere to the discharge standards outlined in the 2016 BMWM guidelines.
	Discarded linen: contaminated with blood or body fluid, Routine mask and gown	Non-chlorinated yellow plastic bags or suitable packing material	Non-chlorinated (alcoholic: 5% lysol, 5% phenol) chemical disinfection followed by incineration. Incineration
	Microbiology, Biotechnology and clinical laboratory waste, PVC Blood bags	Autoclave safe plastic bags or containers	Autoclave or pre-treat to disinfect. Treated waste to be sent to CBMWTF for incineration.

Red Contaminated Waste (Recyclable)	Plastics tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles and fixed needle syringes) and vacutainers with their needles cut) and gloves	Red colored non-chlorinated plastic bags or containers	Autoclaving/Chemical disinfection. Treated waste to be sent to CBMWTF who would send such waste to registered or authorized recyclers or for energy recovery
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<p>White (Translucent)</p>	<p>Waste sharps</p>	<p>Puncture proof, Leak proof, tamper proof containers</p>	<p>Disinfection/Autoclaving or dry heat sterilization/ sent to CBMWTF and who will ensure final disposal to iron foundries (having consent to operate from the SPCB/PCC.</p>
<p>Blue</p>	<p>Glass: medicine glass vials or broken or discarded and contaminated glass</p>	<p>Puncture proof and leak proof boxes or containers with blue colored marking</p>	<p>Autoclaving/Microwaving/hydroclaving by CBMWTF and then recycling.</p>
	<p>Metal implants/metal guns etc.</p>	<p>Puncture proof and leak proof boxes or containers with blue colored marking</p>	<p>Contaminated glass slides require pretreatment (disinfection by sodium hypochlorite)</p>

Biomedical waste disposal methods.^[13,14]

There are several methods of disposal of biomedical waste. Though incineration is widely used, the recently developed of waste falls in the alternative methods are becoming increasingly popular.

1. Incineration
2. Chemical disinfection
3. Autoclaving
4. Microwaving
5. Shredder
6. Plasma Pyrolysis
7. Inertization

Incineration:^[13]

The volume and weight of waste are significantly reduced through the high temperature dry oxidation process known as incineration, which transforms organic and combustible waste into nonorganic incombustible materials. Incineration is usually done for those wastes that cannot be reused, recycled or disposed off in a landfill act site.

Example, human and animal anatomical waste, safe microbiological waste, solid non-plastic infectious waste

Chemical disinfection:^[15]

Chemical Disinfection A chemical such as hypochlorite 1-2% is mixed to waste which results in disinfection. It is more suitable for liquid waste such as discarded blood and body fluid and also for hospital sewage.

Autoclaving:^[14]

Charles Chamberland developed the autoclave in 1879, but Denis Papin had already developed the steam digester in 1679. The name "auto-locking device" is derived from the Greek auto-, which ultimately means "self," and the Latin clavis, which means "key."

Autoclaving is a thermal process where steam is brought into direct contact with waste in a controlled manner and for sufficient duration to sterilize the wastes. It is mainly used for the treatment of infectious plastic and sharp waste.

According to the size of the load and the contents, many autoclaves employ pressured saturated steam at 121 °C (250 °F) for 30 minutes at a pressure of 15 (Pound per square inch) psi to disinfect equipment and supplies.

An autoclave is a device used to perform industrial and scientific procedures that call for higher pressure or temperature than the ambient conditions. In the chemical industry, autoclaves are used to vulcanize rubber, cure coatings, and sterilize objects prior to medical procedures. They are also used for hydrothermal synthesis. Industry applications use industrial autoclaves, particularly when making composite materials.

Microwaving:^[13]

Microwaves are radio-frequency waves, used at a frequency of 2450 MHz. They produce friction of water molecules which generates heat. Large size microwaves are used for disposal of BMW—mainly infectious plastics and sharp wastes.

Shredder:

Shredder Shredding is a process by which wastes are de-shaped or cut into smaller pieces so as to make the wastes unrecognizable. It helps in prevention of reuse of BMW and also helps to reduce the waste volume

Plasma Pyrolysis.^[17]

Plasma pyrolysis uses ionized gas in the plasma state to convert electrical energy to temperatures of several thousand degrees using plasma arc torches or electrodes. The system provides high temperatures combined with high UV radiation flux which destroys pathogens completely

Inertization:

The process of inertization involves mixing waste with cement and other substances before disposal to minimize the risk of toxic substances contained in the waste migrating to surface or groundwater. It is especially suitable for pharmaceuticals and for incinerated ashes with a high metal content.

Conclusion

Biomedical waste management should be a joint team effort with dedicated government support, BMW good practices followed by both health professionals and HCFs, continuous monitoring of BMW practices and strong legislation. It is our basic right to live in a clean and safe environment. The pillar of BMW is waste sorting at source and WR. The current BMW rules 2016 and 2019 are improvements to previous rules for better methods of containment, transport and disposal to reduce environmental pollution and

ensure the safety of workers, patients and the public. In addition, the use of non-PVC medical devices and the development of newer, environmentally friendly systems for BMW disposal should be encouraged. All BMW participants must commit to ensure a cleaner and greener environment.

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