

# Conceptual Overview of the Biomedical Waste Management System

KR Mahalaxmi, Ramya Arumugam

Department of Management Studies, Anna University (BIT Campus), Tiruchirappalli, Tamil Nadu, India

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## Abstract

Biomedical waste management is one of the significant public health measure. Proper management of biomedical waste is needed to maintain the hygiene and health of the people and to control the environmental pollution. The waste from the hospitals have to be properly segregated, categorized, treated, stored, transported and disposed. Improper management of waste involves a greater risk of causing infections and injuries. This study gives a picture of the concepts of biomedical waste management and also includes the approach of categorization, segregation, collection, treatment, processing and disposal of biomedical waste as per the latest biomedical waste Management rules, 2016. It aims to create awareness among the medical practitioners involved in the management of biomedical waste. It plays a crucial part in the life of the people and has an impact over the environment. Thus a proper management of biomedical waste is needed for a healthier living.

## 1. Introduction

According to Biomedical Waste (Management and Handling) Rules, 1998 of India[1], Biomedical waste means any waste, which is generated during diagnosis, treatment or immunization of human-beings or animals, in research activities pertaining thereto or in the production or testing of biologicals. The sources of biomedical waste includes government hospitals, private hospitals, primary health centres, dispensaries, nursing homes, labs, etc. Infectious and non-infectious are being generated from the hospitals [2-3]. There is a need for segregation of waste. If there is no proper management of biomedical waste, then it might lead to major consequences like transmission of infections of the Hepatitis B virus, HIV, etc. Management of biomedical waste is of utmost importance for the safety of the medical practitioners as well as the public and the environment.

## 2. Literature Review

Deshmukh and Rathod [4] highlighted certain aspects of hospital waste management and also about the impacts of improper waste management. It was found that factors such as the reusable items, waste management plan, social, economic and cultural status of the patients will have an effect over the quantity of waste generated. Awareness has to be provided and proper biomedical waste management should be given importance. Awodele et al. [5] assessed the medical waste management in seven hospitals in Lagos, Nigeria and also determined the impact of Lagos Waste Management Authority. They highlighted the challenges involved which includes lack of policies/legislation, budget allocation, rules and regulations, training and implementation. Sarsour et al. [6] Estimated the medical waste management within selected hospitals in Gaza Strip Palestine and found that the healthcare facilities irrespective of government or private suffer from inappropriate management of biomedical waste, there was deficiency in the implementation of training courses and hence concluded that the Ministry of Health and healthcare institutions should provide adequate consideration towards policies for the proper management of waste and disposal of healthcare wastes.

Agunwamba et al. [7] Prepared a comparative analysis of hospital waste management in Calabar metropolis and developed countries. This study involved the estimation of waste generated, evaluation of waste segregation and determination of level of knowledge towards the waste management. The evaluation of the waste management practice was made using the listed criteria such as the waste management responsibility, segregation, storage, packaging, transport, recycling and reuse, treatment and disposal [8-9]. They have also added that when waste management is given the right funding and supervision, waste could be minimised.

Rastogi et al.[10] studied the bacteriological profile of biomedical waste and gave management guidelines for the proper management of biomedical waste. They mentioned that the

\*Corresponding Author,

E-mail: ramya.sep@gmail.com

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quantity of waste generated is important and a lesser amount of biomedical waste means lesser burden on the disposal work, cost saving and also have an efficient waste disposal system.

## 3. Classification of Biomedical Waste

WHO classifies waste as [11]:

- Sharps
- Infectious
- Pathological
- Radioactive
- Pharmaceuticals
- Chemical
- Geno toxic
- General

## 4. Process of Biomedical Waste Management

Waste generation (Segregation and Categorization)

Waste treatment

Waste storage

Waste transportation

Waste disposal

### 4.1 Waste Segregation

The most important step is the segregation of waste at the point of generation. It is essential to segregate the infectious waste from that of the non-infectious waste. This has to be done prior to treatment and disposal of waste. The hospitals should segregate the waste on the basis of the color coding of bags.

### 4.2 Waste Treatment

#### 4.2.1 Double-Chambered Incineration

Incineration is a process used to burn the waste at high temperature and reduce its volume. Pathological and cytotoxic waste can be treated by using an incinerator but it generates highly toxic gases such as dioxins and furans.

#### 4.2.2 Autoclaving

Autoclave operates on the circulation of steam through the infectious waste in order to decontaminate the waste. It is used for microbiological waste, blood, blood products, body fluids and used sharps. It is not suggested for pathological waste.

#### 4.2.3 Microwaving

Microwave produces radiations to break the molecular bonds apart and thereby disinfecting the waste. It does not produce

hazardous emissions but it cannot be used to treat body parts and tissues.

#### 4.2.4 Hydroclaving

In case of Hydroclave, steam is introduced into the walls of the hydroclave but it does not come in contact with the waste. There is more volume reduction in this type of treatment when compared to the autoclave.

#### 4.2.5 Plasma Torch

It has very high temperature to treat the waste. It is very costly but safe. There is no need for segregation of waste which is a major advantage.

#### 4.2.6 Chemical Treatment

1% hypochlorite solution or any other equivalent reagent can be used to treat the waste in order to disinfect it.

#### 4.3 Waste Storage and Transportation

Once the waste is treated and stored, it has to be transported for the final disposal of waste.

#### 4.4. Waste Disposal

The waste is disposed through land filling, deep burial and sewage. Incineration is also a way of disposal besides treatment. Infectious waste can be disposed through land filling or deep burial after the treatment of waste.

#### 5. Latest Biomedical Waste Management Rules, 2016

Under the Environment (Protection) Act, 1986, Bio –medical Waste Management Rules, 2016 came into force from 28th March. It states the following.

**Table 1-** Represents the way by which the biomedical wastes should be categorised and segregated, collected, treated, processed and disposed as per the Bio-Medical Waste Management Rules, 2016

Category	Type of Waste	Type of Bag or Container to be Used	Treatment and Disposal options
1	2	3	4
Yellow	<b>(a) Human Anatomical Waste</b> Human tissues, organs, body parts and fetus below the viability period (as per the Medical Termination of Pregnancy Act 1971, amended from time to time). <b>(b) Animal Anatomical Waste</b> Experimental animal carcasses, body parts, organs, tissues, including the waste generated from animals used in experiments or testing in veterinary hospitals or colleges or animal houses.	Yellow coloured non-chlorinated plastic bags	Incineration or Plasma Pyrolysis or deep burial*
	<b>(c) Soiled Waste</b> Items contaminated with blood, body fluids like dressings, plaster casts, cotton swabs and bags containing residual or discarded blood and blood components.		Incineration or Plasma Pyrolysis or deep burial* In absence of above facilities, autoclaving or microwaving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent for energy recovery.
	<b>(d) Expired or Discarded Medicines</b> Pharmaceutical waste like antibiotics, cytotoxic drugs including all items contaminated with cytotoxic drugs along with glass or plastic ampoules, vials etc.	Yellow coloured non-chlorinated plastic bags or containers	Expired cytotoxic drugs and items contaminated with cytotoxic drugs to be returned back to the manufacturer or supplier for incineration at temperature >12000C or to common bio-medical waste treatment facility or hazardous waste treatment, storage and disposal facility for incineration at >12000C Or Encapsulation or Plasma Pyrolysis at >12000C. All other discarded medicines shall be either sent back to manufacturer or disposed by incineration.
	<b>(e) Chemical Waste:</b> Chemicals used in production of biological and used or discarded disinfectants.	Yellow coloured containers or non-chlorinated plastic bags	Disposed of by incineration or Plasma Pyrolysis or Encapsulation in hazardous waste treatment, storage and disposal facility.
	<b>(f) Chemical Liquid Waste</b> Liquid waste generated due to use of chemicals in production of biological and used or discarded disinfectants, Silver X-ray film developing liquid, discarded Formalin, infected secretions, aspirated body fluids, liquid from laboratories and floor washings, cleaning, house-keeping and disinfecting activities etc.	Separate collection system leading to effluent treatment system	After resource recovery, the chemical liquid waste shall be pre-treated before mixing with other wastewater. The combined discharge shall conform to the discharge norms.
	<b>(g) Discarded linen, mattresses, beddings contaminated with blood or body fluid.</b>	Non-chlorinated yellow plastic bags or suitable packing material	Non-chlorinated chemical disinfection followed by incineration or Plasma Pyrolysis or for energy recovery. In absence of above facilities, shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent for energy recovery or incineration or Plasma Pyrolysis.

	<b>(h) Microbiology, Biotechnology and other clinical laboratory waste</b> Blood bags, Laboratory cultures, stocks or specimens of micro- organisms, live or attenuated vaccines, human and animal cell cultures used in research, industrial laboratories, production of biological, residual toxins, dishes and devices used for cultures.	Autoclave safe plastic bags or containers	Autoclave safe plastic bags or containers
<b>Red</b>	<b>Contaminated Waste (Recyclable)</b> (a) Wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles and fixed needle syringes) and vaccutainers with their needles cut) and gloves	Red coloured non-chlorinated plastic bags or containers	Autoclaving or micro-waving/ hydroclaving followed by shredding or mutilation or combination of sterilization and shredding. Treated waste to be sent to registered or authorized recyclers or for energy recovery or plastics to diesel or fuel oil or for road making, whichever is possible. Plastic waste should not be sent to landfill sites.
<b>White (Translucent)</b>	<b>Waste sharps including Metals</b> Needles, syringes with fixed needles, needles from needle tip cutter or burner, scalpels, blades, or any other contaminated sharp object that may cause puncture and cuts. This includes both used, discarded and contaminated metal sharps	Puncture proof, Leak proof, tamper proof containers	Autoclaving or Dry Heat Sterilization followed by shredding or mutilation or encapsulation in metal container or cement concrete; combination of shredding cum autoclaving; and sent for final disposal to iron foundries (having consent to operate from the State Pollution Control Boards or Pollution Control Committees) or sanitary landfill or designated concrete waste sharp pit.
<b>Blue</b>	<b>(a) Glassware</b> Broken or discarded and contaminated glass including medicine vials and ampoules except those contaminated with cytotoxic wastes. <b>(b) Metallic Body Implants</b>	Cardboard boxes with blue coloured marking	Disinfection (by soaking the washed glass waste after cleaning with detergent and Sodium Hypochlorite treatment) or through autoclaving or microwaving or hydroclaving and then sent for recycling.

\*Disposal by deep burial is permitted only in rural or remote areas where there is no access to common bio-medical waste treatment facility. This will be carried out with prior approval from the prescribed authority and as per the Standards specified. The deep burial facility shall be located as per the provisions and guidelines issued by Central Pollution Control Board from time to time [11].

## 6. Result and Discussion

The biomedical waste that is being produced in the healthcare activities carries a greater potential risk for infection and injury than any other waste. Wastes have to be properly managed to avoid consequences that will have an influence over the medical practitioners. Therefore, it is vital to have a safe and reliable method for handling the waste. Inadequate and improper management of the biomedical waste may have severe public health consequences and has a significant impact over the environment.

## 7. Conclusions

After surveying the review of literature related to the management of biomedical waste, it is found that various factors influence the management of the waste such as the awareness, knowledge, policies, rules and regulations, etc. Training programs can be conducted to bring into light the need for proper biomedical waste management. Medical institutions should have a proper guiding principle to manage the waste. The quantity of waste generated has to be taken into account. A lesser amount of waste means lesser burden to manage the waste. Awareness about the importance of the biomedical waste has to be given to the medical practitioners.

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