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Status of Biomedical Waste Management System: A Review

Lingaraju H G*[1], Megha M[1] and Uma S M[2]

[1]Division of Environmental Sciences, Department of Water and Health, Faculty of Life Sciences, JSS Academy of Higher Education and Research, Mysuru– 570015, India.
E-Mail: lingarajuhg@jssuni.edu.in
[2]School of Planning and Architecture, University of Mysore, Karnataka, India

ABSTRACT

Medical care is important for our life, health and wellbeing. But the waste generated from medical activities can be hazardous, toxic and even lethal because of their high potential for diseases transmission. The hazardous and toxic parts of waste comprise infectious, medical and radioactive material as well as sharps constitute a grave risk to mankind and the environment, if these are not properly treated / disposed. This article intends to describe various health care wastes and its controlling, as creating good practices for proper handling and disposal of health care waste is an important part of the health care delivery system. The aim of this paper is to highlight the present condition of medical waste and a review on scientific method of hospital waste management.

KEY WORDS: Bio-medical waste, hospitals, toxic, health, environment, dispose

***Corresponding author**

Lingaraju H G

Department of Water and Health

Academy of Higher Education and Research

Mysuru– 570015, Karnataka, India.

E-Mail: lingarajuhg@jssuni.edu.in

1. INTRODUCTION

The Government of India (notification, 2016) specifies that the Bio-medical Waste Management is an integral part in cleanliness and maintenance activities of hospital. This can be only possible by adopting a wide number of activities such as collection, segregation, processing, treatment and disposal of the medical waste. Today, one of the biggest challenges that India faces is to change the attitudes of the operators of the medical care providers to incorporate good health care waste management practices in their day to day routine. World Health Organization (WHO) states that 85% of hospital wastes are non-hazardous, whereas 10% are infectious and 5% are non-infectious but they are included in hazardous wastes. This range is dependent on the total amount of waste generated[1].

The best BMW management (BMWM) methods aim at avoiding generation of waste or recovering as much as waste as possible, rather than disposing. Therefore, the various methods of BMW disposal, according to their desirability, are prevent, reduce, reuse, recycle, recover, treat, and lastly dispose. Hence, the waste should be tackled at source rather than "end of pipe approach"[2].

Table 1: Different types of biomedical waste

Types of Biomedical Waste	Description
Human Anatomical Waste	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).
Animal Anatomical Waste	Experimental animal carcasses, body parts, organs, tissues, including the waste generated from the animals used in experiments or testing in veterinary hospitals or colleges or animal houses.
Solid waste	Items contaminated with blood, body fluids like dressings, cotton swabs and bags containing residual or discarded blood and blood components.
Expired or Discarded Medicines	Pharmaceutical waste like antibiotics and cytotoxic drugs.
Chemical Liquid Waste	Liquid waste generated due to use of chemicals in production of biological or discarded disinfectants, Silver X-ray film developing liquid, discarded formalin, infected secretions, aspirated body fluids, liquid from laboratories and floor washings, cleaning, housekeeping and disinfecting activities etc.
Microbiology and Biotechnology laboratory waste	Blood bags, Laboratory cultures, stocks or specimens of microorganisms, live or attenuated vaccines, Human and animal cell cultures used in research, industrial laboratories, production of biological and residual toxins.
Contaminated Waste (Recyclable)	Wastes generated from disposable items such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes and gloves.
Waste sharps including Metals	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.

1.1 Definition

Biomedical waste, also known as, the infectious waste or the medical waste is defined as "any waste, which is generated during the diagnosis, treatment or immunization of human beings or animals or research activities pertaining to or in the production or testing of biological or in the health camps[3].

1.2 Types of bio-medical waste

According to the Bio-medical Waste Management Rules, 2016, the different types of biomedical waste are as follows[4, 5].

1.3 Sources of bio-medical waste

Hospitals produce waste, which is increasing over the years in its amount and type[6, 7].

Table 2: Sources of biomedical waste.

Major Sources	Minor Sources
•Government hospitals/private hospitals/nursing homes/ dispensaries.	• Physicians/ dentists' clinics
•Primary health centers.	• Animal houses/slaughterhouses.
•Medical colleges and research centers/paramedic services.	
•Veterinary colleges and animal researchcenters.	
•Blood banks/mortuaries/autopsy centers.	
•Biotechnology institutions.	

1.4 Waste generation

Studies carried out in India, shows generation of bio-medical waste in the range of 0.3 to 1.0 kg/bed/day of which around 50% of the wastes is collected as infectious wastes. However, effective segregation of these human & anatomical wastes would reduce the quantity of infectious waste needing incineration/deep burial[7].

2 HEALTH HAZARDS RELATED TO MEDICAL WASTE

2.1 Injuries and accidents

There is a risk of injuries related to medical waste handling and carrying by waste hauler and/or cleaner. Akter[9] reported that, there were several incidents of injury due to exposure tomedical wastes inside or outside of hospital premises. These were as follows:

- ✓ Hands cut due to handling broken glass.
- ✓ Injured by needle and fingers permanently damaged/ became curved.
- ✓ Right hands became paralyzed by the injury by a needle.

- ✓ Two legs became paralyzed due to injury by the needle.
- ✓ Skin diseases on legs and hands/ body.
- ✓ Pus due to injury sometimes.

2.2 Infectious medical waste risk

Infectious waste contains different kind of pathogens or organisms that is potential for infection or disease if it is not properly disposed[8].

Table 3: Examples of different pathogen and diseases associated with biomedical waste.

Bacterial	Tetanus, gas gangrene, anthrax, cholera, enteric fever, shigellosis, plague etc.
Viral	Various hepatitis, poliomyelitis, HIV-infections, HBV, TB, STD, rabies etc.
Parasitic	Amoebiasis, Giardiasis, Ascariasis, Ankylomastomiasis, Taeniasis, echinococcosis, malaria, filariasis etc.
Fungal infections	Various fungal infections like candidiasis, cryptococcoses, coccidiodomycosis etc.

2.3 Environmental hazards related to medical waste

The following are environmental impacts associated with the improper disposal of medicalwastes[10].

1. Pollutants from medical waste (e.g. heavy metals and PCBs) are persistent in the environment.
2. Public nuisance (e.g. odors, scenic view, block the walkway, aesthetics, etc.
3. Combination of both degradable and non-degradable waste increase the rate of habitat destruction due to the increasing number of sites necessary for disposal of wastes.
4. Plastic-bags, plastic containers, if not properly destroyed may contaminate the soil and reduces the chance for water percolation into the soil during precipitation.
5. Open air burning does not guarantee proper incineration and releases toxic fumes(dioxin) into the atmosphere from the burning of plastics i.e., PCB's.
6. Open dumping cause's higher risks of disease transmission, acute pollution problems and open access to scavengers and animals.

2.4 Microorganisms associated with health care waste

Several pathogenic bacteria, including *Pseudomonas* spp., *Lactobacillus* spp., S*taphylococcus* spp., *Micrococcus* spp., *Kocuria*spp., *Brevibacillus*spp., *Micro bacterium oxydans* and *Propionibacterium acnes*, were identified and reported from the various medical wastes[11]. In addition, pathogenic viruses such as nor viruses and hepatitis B virus have been also detected in human tissue

wastes[12]. Medical waste should be carefully controlled and monitored to prevent nosocomial infection associated with the exposure to these wastes[13].

The following groups of persons are at the risk of healthcare waste: doctors, nurses, sanitary staff and hospital maintenance personnel; In and out-patients receiving treatment in healthcare facilities as well as their visitors[14].

The lack of regional legislation concerning segregation, treatment and final disposal of waste may expose different populations to risks of transmission of infectious diseases associated with multi-resistant microorganism[15].

3. MANAGEMENT OF BIO-MEDICAL WASTE

The key steps that are used in the management of the biomedical waste are waste minimization, segregation, collection, storage, transportation, treatment and disposal[16]. Apart from these, non-infectious wastes should be segregated as a separate category and these wastes shall not be mixed with other categories.

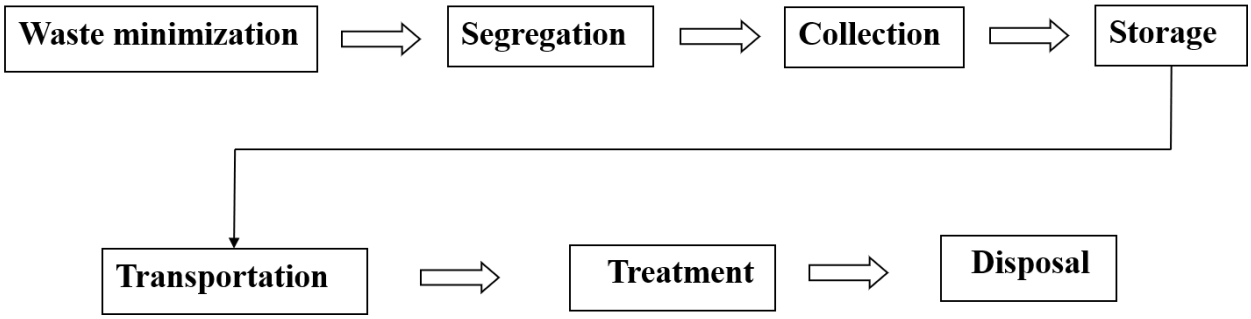

Fig. 1: Steps of Bio-medical Waste Management[4 17].

4. TREATMENT AND DISPOSAL TECHNOLOGIES OF BMW

Based on Bio-medical Waste (Management and Handling) Rules 1998, notified under the Environment Protection Act, 1986 by the Ministry of Environment and Forest (Government of India) the following are the procedures that needs to be followed for safe disposal of waste[18].

4.1 Segregation of waste

Segregation is the essence of BMWM and should be done at the source of generation of bio-medical waste e.g. all patient care activity areas, diagnostic services areas, operation theaters, labor rooms, treatment rooms etc. The responsibility of segregation should be with the generator of

biomedical waste i.e. doctors, nurses, technicians etc. (medical and paramedical personnel). The biomedical waste should be segregated as per categories mentioned in the rules[19].

Infectious waste must be kept separately in lidded bins lined with polyethylene bags wherever needed. Under no circumstances should the infections waste be mixed with non-infectious bags. The bag lining the bin should be only three fourth full to ensure that the waste does not spill out. While carrying the bag containing infectious waste, it must be sealed[20].

Table 4: Type of container and color code for collection of bio-medical waste.

Category	Waste class	Type of container	Color
1	Human anatomical waste	Plastic	Yellow
2	Animal waste	-do-	-do-
3	Microbiology and Biotechnology waste	-do-	Yellow/red
4	Waste sharp	Plastic bag, puncture proof containers	Blue/white Translucent
5	Discarded medicines and Cytotoxic waste	Plastic bags	Black
6	Solid(biomedical waste)	-do-	Yellow
7	Solid (plastic)	Plastic bag puncture proof containers	Blue/white Translucent
8	Incineration waste	Plastic bag	Black
9	Chemical waste	-do-	-do-

4.2 Collection of bio-medical waste

Collection of bio-medical waste should be done as per Bio-medical waste (Management and Handling) Rules. At ordinary room temperature the collected waste should not be stored for more than 24 hours[21].

4.3 Transportation

Within hospital, waste routes must be designated to avoid the passage of waste through patient care areas. Separate time should be earmarked for transportation of bio-medical waste to reduce chances of its mixing with general waste[22].

Trolleys or carts should be thoroughly cleaned and disinfected in the event of any spillage. The wheeled containers should be so designed that the waste can be easily loaded. Hazardous biomedical waste needing transport to a long distance should be kept in containers and should have proper labels.

The transport is done through desiccated vehicles specially constructed for the purpose having fully enclosed body, lined internally with stainless steel or aluminum to provide smooth and impervious surface which can be cleaned. The driver's compartment should be separated from the load compartment with a bulkhead[23].

4.4 Treatment of hospital waste

The objective of treatment of waste is as follows:

- ✓ To disinfect the waste so that it is no longer the source of infection.
- ✓ To reduce the volume of the waste.

4.5 Disposal of bio medical waste

The standard procedures mentioned in the Bio-medical waste (Management and Handling) Rules 1998, for different categories are as follows.

4.5.1 Deep burial

The waste under category 1 and 2 only can be accorded deep burial and onlyin cities having less than 5 lakh population[24].

4.5.2 Autoclave treatment

The waste under category 3, 4, 6 and 7 can be treated by these techniques[25].An autoclave is a large pressure cooker that uses high temperatures and steam to deeply penetrate all materials and kill any microorganisms. Depending on the type and amount of waste you will need to sterilize, you can purchase an appropriately sized autoclave for your facility. These appliances range from 100 liters to 4,000+ liters in volume for bulk waste treatment. Modern autoclaves are also automated to minimize human involvement and therefore reduce needle-stick injuries and contamination [26].

4.5.3 Microwave treatment

A microwave treatment system, like an autoclave, also uses heat to decontaminate medical waste. These systems work best for waste that is not 100% dry or solid, as the moisture allows the heat to penetrate deeper, and the steam sterilizes.

4.5.4 Shredding

The plastic (IV bottles, IV sets, syringes, catheters etc.), sharps (needles, blades, glass etc.,) should be shredded but only after chemical treatment/microwaving/autoclaving. Needle destroyers can be used for disposal of needles directly without chemical treatment.

4.5.5 Secured landfill

The incinerator ash, discarded medicines, cytotoxic substances and solid chemical waste should be treated by this option. It is the terminal method of disposal of ashes after incineration. Disposal of biomedical waste ash in landfill May cause contamination of groundwater as metals are not destroyed during incineration.

4.5.6 Incineration

This process is usually selected to treat wastes that cannot be recycled, reused or disposed of in a land fill site. The waste under category 1,2,3,5 and 6 can be incinerated depending upon the local policies of the hospital and feasibility. The polythene bags made of chlorinated plastics should not beincinerated[28].

Incineration of medical waste should be performed in a controlled facility to ensure complete combustion and minimize any negative effects for the environment**.** The advantage of incinerators is that it can be operated in any weather. The incineration process destroys pathogens and reduces the waste volume and weight but leaves a solid material called biomedical waste ash as residue.

Demerits of incinerators are it is expensive to build, maintain and operate. The air-borne by-product of incineration is detrimental to the ozone layer. The air-borne particles have noxious smell and vermin tend to congregate in the facility, potentially spreading disease throughout the area. High energy is required for the process and requires skilled personnel and continuous maintenance.

4.5.7 Plasma pyrolysis

Direct use of waste products as combustion fuel or their indirect processing into another kind of fuel helps in harnessing the energy contents. In this context pyrolysis has been found as a related form of thermal treatment wherein high temperatures are used for treating waste materials with limited supply of oxygen.

5. PROBLEMS RELATED TO BIO-MEDICAL WASTE

A major issue related to current bio- medical waste management in many hospitals is that the implementation of bio-waste regulation is unsatisfactory as some hospitals are disposing of waste in a haphazard, improper and in discriminate manner [28].

Lack of segregation practices, results in mixing of hospital wastes with general waste making the whole waste stream hazardous. In appropriate segregation ultimately results in an incorrect method of waste disposal. Inadequate bio-medical waste management thus will cause environmental pollution, unpleasant smell, growth and multiplication of vectors like insects, rodents and worms and may lead to

the transmission of diseases like typhoid, cholera, hepatitis and AIDS throughinjuries from syringes and needles contaminated with human[29].

Various communicable diseases, which spread through water, sweat, blood, body fluids and contaminated organs, are important to be prevented. The bio medical waste scattered in and around the hospitals invites flies, insects, rodents, cats and dogs that are responsible for the spread of communication disease like plague and rabies. Rag pickers in the hospital, sorting out the garbage areat a risk of getting tetanus and HIV infections.

It becomes primary responsibility of health administrators to manage hospital waste in most safe and eco-friendlymanner[17]. The problem of bio-medical waste disposal in the hospitals and other health care establishments has become an issue of increasing concern, prompting hospital administration to see new ways of scientific, safe and cost-effective management of the waste, and keeping their personnel informed about the advances in this area.

The need of proper hospital waste management system is of prime importance and is an essential component of quality assurance in hospitals[6].

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