

# Biomedical Waste Management : A Review

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## Abstract

As a result of economic development in industrial, infrastructure, medical, information technology and agriculture sector in India in the past 20 years, the citizens have become more content, lavish and comfortable but this has also affected the environment badly because of tremendous increase in environmental pollution as the rate of waste generation is very high in India. Waste product which is infectious, hazardous, and sometimes radioactive and is generated during the various medical related activities such as diagnosis, treatment and immunization is known as biomedical waste. Today, biomedical waste management has become one of major issue of concern in India taking into account the rate of growth of population and rapid urbanization. This paper includes biomedical waste, its classification and various practices adopted for its management. Biomedical waste may be solid or liquid and is generated majorly from hospitals and laboratories. Biomedical waste include discarded blood samples, sharps, unwanted microbiological cultures, identifiable body parts other human or animal tissue, used bandages and dressings, discarded gloves, other medical supplies that may have been in contact with blood and body fluids, and laboratory waste that exhibits the similar characteristics. Biomedical waste is distinct from normal trash or general waste. Medical facilities also generate hazardous chemicals and radioactive materials. While such wastes are normally not infectious; but they require proper disposal. Disposal of this waste is also an environmental concern, as many medical wastes are classified as infectious and could potentially lead to the spread of infectious disease. Biomedical waste must be properly managed and disposed of to protect the environment, general public and workers, especially healthcare and sanitation workers who are at risk of exposure to biomedical waste as an occupational hazard. Steps in the management of biomedical waste include generation, accumulation, handling, storage, treatment, transport and disposal.

**Key-Words:** biomedical, waste, management, medical, hospital, infectious

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## Introduction

Medical care is vital for our life and health, but the waste generated from medical activities represents a real problem of our environment. Improper management of waste generated in health care facilities causes a direct health impact on the community, the health care workers and on the environment. Every day, relatively large amount of potentially infectious and hazardous waste are generated in the health care facilities and hospitals around the world. Indiscriminate disposal of biomedical waste (BMW) and exposure to such waste poses a serious threat to environment and to human health that requires specific treatment and management prior to its final disposal. It also intends to create awareness amongst the health care professional involved in health care unit. Biomedical waste management has recently emerged as an issue of major concern not only to hospitals, nursing home authorities but also to the environment. The biomedical waste generated from health care units depend upon a number of factors such as waste management methods, type of health care units, occupancy of healthcare units, specialization of healthcare units, ratio of reusable items in use, availability of infrastructure and resources etc. The proper management of biomedical waste has become a worldwide humanitarian topic today. Now, it is a well established fact that there are many adverse and harmful effects to the environment including human beings which are caused by the biomedical waste generated during the patient care. The problems of the waste disposal in the hospitals and other health-care institutions have become issues of increasing concern.

## About Biomedical Waste

According to Biomedical Waste Management and Handling Rules, 1998 of India; "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 biological." The Government of India (notification, 1998) specifies that Hospital Waste Management is a part of hospital hygiene and maintenance activities. This involves management of range of activities, which are mainly engineering functions, such as collection, transportation, operation or treatment of processing systems, and disposal of wastes.

One of India's major achievements has been to change the attitudes of the operators of health care facilities to incorporate good management practices in their daily operations and to purchase on-site waste management services from the private sector. World Health Organization (WHO) states that 85% of hospital wastes are actually non-hazardous, whereas 10% are infectious and 5% are non-infectious but they are included in hazardous wastes. About 15% to 35% of hospital waste is regulated as infectious waste. This range is dependent on the total amount of waste generated.

## Classification & Sources of generation of biomedical Waste

The World Health Organization (WHO) has classified medical waste into eight categories such as General Waste, Pathological, Radioactive, Chemical, Infectious to potentially infectious waste, Sharps, Pharmaceuticals, Pressurized containers whereas; In India, Ministry of Environment and Forest, Government of India (1998) has notified Bio-medical Waste Management & Handling Rules -1998, which describes ten categories.

Although the solid waste management has become one of the major topics of importance but still local bodies are unable to give the proper attention towards some special sources of wastes out of which biomedical waste is one.

The sources of biomedical waste can be categorized as primary and secondary sources according to the quantities produced. While minor and scattered sources may produce some biomedical waste in categories similar to Biomedical waste, their composition will be different. Hospitals produce waste, which is increasing over the years in its amount and type. The hospital waste, in addition to the risk for patients and personnel who handle them also poses a threat to public health and environment.

## Major Sources of Biomedical Waste

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

## Minor Sources of Biomedical Waste

- Physicians/ dentists' clinics
- Animal houses/slaughter houses
- Blood donation camps
- Vaccination centres
- Acupuncturists/psychiatric clinics/ cosmetic piercing
- Funeral services
- Institutions for disabled persons

## Problems Related to Biomedical Waste

A major issue related to current biomedical waste management in many hospitals is that the implementation of biomedical waste regulation is unsatisfactory as some hospitals are disposing of waste in a haphazard, improper and indiscriminate manner. Lack of segregation practices results in mixing of hospital wastes with general waste making the whole waste stream hazardous. Inappropriate segregation ultimately results in an incorrect method of waste disposal. Inadequate biomedical 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 through injuries from syringes and needles contaminated with human. Various communicable diseases, which spread through water, sweat, blood, body fluids and contaminated organs, are important to be prevented. The biomedical 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 are at a risk of getting tetanus and HIV infections. The recycling of disposable syringes, needles, IV sets and other article like glass bottles without proper sterilization are responsible for Hepatitis, HIV, and other viral diseases. It becomes primary responsibility of Health administrators to manage hospital waste in most safe and eco-friendly manner.

The problem of biomedical waste disposal in the hospitals and other healthcare establishments has become an issue of increasing concern, prompting hospital administration to seek 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.

#### **Need of biomedical waste management in hospitals**

The reasons due to which there is great need of management of hospitals waste such as:

1. Injuries from sharps leading to infection to all categories of hospital personnel and waste handler.
2. Hospital acquired infections in patients from poor infection control practices and poor waste management.
3. Risk of infection outside hospital for waste handlers and scavengers and at time general public living in the vicinity of hospitals.
4. Risk associated with hazardous chemicals, drugs to persons handling wastes at all levels.
5. "Disposable" being repacked and sold by unscrupulous elements without even being washed.
6. Drugs which have been disposed of, being repacked and sold off to unsuspecting buyers.
7. Risk of air, water and soil pollution directly due to waste, or due to defective incineration emissions and ash.

#### **Biomedical Waste Management Process**

There is a big network of Health Care Institutions in India. The hospital waste like body parts, organs, tissues, blood and body fluids along with soiled linen, cotton, bandage and plaster casts from infected and contaminated areas are very essential to be

properly collected, segregated, stored, transported, treated and disposed of in safe manner to prevent hospital acquired infection.

1. Waste collection
2. Segregation
3. Transportation and storage
4. Treatment & Disposal
5. Transport to final disposal site
6. Final disposal

Biomedical Waste Treatment and Disposal Health care waste is a heterogeneous mixture, which is very difficult to manage as such. But the problem can be simplified and its dimension reduced considerably if a proper management system is planned.

#### **Incineration Technology**

This is a high temperature thermal process employing combustion of the waste under controlled condition for converting them into inert material and gases. Incinerators can be oil fired or electrically powered or a combination thereof. Broadly, three types of incinerators are used for hospital waste: multiple hearth type, rotary kiln and controlled air types. All the types can have primary and secondary combustion chambers to ensure optimal combustion. These are refractory lined.

#### **Non-Incineration Technology**

Non-incineration treatment includes four basic processes: thermal, chemical, irradiative, and biological. The majority of non-incineration technologies employ the thermal and chemical processes. The main purpose of the treatment technology is to decontaminate waste by destroying pathogens. Facilities should make certain that the technology could meet state criteria for disinfection.

#### **Autoclaving**

- The autoclave operates on the principle of the standard pressure cooker.
- The process involves using steam at high temperatures.
- The steam generated at high temperature penetrates waste material and kills all the micro organism
- These are also of three types: Gravity type, Pre-vacuum type and Retort type.

In the first type (Gravity type), air is evacuated with the help of gravity alone. The system operates with temperature of 121°C and steam pressure of 15 psi. for 60-90 minutes. Vacuum pumps are used to evacuate air from the Pre vacuum autoclave system so that the cycle is reduced to 30-60 minutes. It operates at about 132 °C. Retort type autoclaves are designed much higher steam temperature and pressure. Autoclave treatment has been recommended for microbiology and biotechnology waste, waste sharps, soiled and solid wastes. This technology renders certain categories (mentioned in the rules) of bio-medical waste innocuous and unrecognizable so that the treated residue can be land filled.

#### **Microwave Irradiation**

- The microwave is based on the principle of generation of high frequency waves.
- These waves cause the particles within the

waste material to vibrate, generating heat.

- This heat generated from within kills all pathogens.

#### **Chemical Methods**

1 % hypochlorite solution can be used for chemical disinfection

#### **Plasma Pyrolysis**

Plasma pyrolysis is a state-of-the-art technology for safe disposal of medical waste. It is an environment-friendly technology, which converts organic waste into commercially useful byproducts. The intense heat generated by the plasma enables it to dispose all types of waste including municipal solid waste, biomedical waste and hazardous waste in a safe and reliable manner. Medical waste is pyrolysed into CO, H<sub>2</sub>, and hydrocarbons when it comes in contact with the plasma-arc. These gases are burned and produce a high temperature (around 1200°C).

#### **Biomedical Waste Management Rules**

Safe disposal of biomedical waste is now a legal requirement in India. The Biomedical Waste Management & Handling) Rules, 1998 came into force on 1998. In accordance with these rules, it is the duty of every "occupier" i.e. a person who has the control over the institution or its premises, to take all steps to ensure that waste generated is handled without any adverse effect to human health and environment.

#### **Option Treatment & Disposal Waste Category-(According to Bio Medical Waste Management and Handling Rules, 1998)**

Category No. 1 Incineration /deepburial Human Anatomical Waste (human tissues, organs, body parts)

Category No. 2 Incineration /deep burial Animal Waste Animal tissues, organs, Body parts carcasses, bleeding parts, fluid, blood and experimental animals used in research, waste generated by veterinary hospitals / colleges, discharge from hospitals, animal houses)

Category No. 3 Local autoclaving/ micro Microbiology & Biotechnology waste waving/incineration (wastes from laboratory cultures, stocks or specimens of micro-organisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, wastes from production of biological, toxins, dishes and devices used for transfer of cultures)

Category No. 4 Disinfections (chemical Waste Sharps (needles, syringes, scalpels treatment /autoclaving/micro blades, glass etc. that may cause waving and mutilation shredding puncture and cuts. This includes both used & unused sharps)

Category No. 5 Incineration / destruction & drugs Discarded Medicines and Cytotoxic disposal in secured landfills drugs (wastes comprising of outdated, contaminated and discarded medicines)

Category No. 6 Incineration ,autoclaving/ micro Solid Waste (Items contaminated with waving blood and body fluids including cotton, dressings, soiled plaster casts, line beddings, other material contaminated with blood)

Category No. 7 Disinfections by chemical Solid Waste (waste generated from treatment autoclaving/micro disposable items other than the waste waving& mutilation shredding, sharps such as tubing, catheters, intravenous sets etc.)

Category No. 8 Disinfections by chemical treatment Liquid Waste (waste generated from and discharge into drain laboratory & washing, cleaning, housekeeping and disinfecting activities)

Category No. 9 Disposal in municipal landfill Incineration Ash (ash from incineration of any bio-medical waste)

Category No. 10 Chemical treatment & Chemical Waste (chemicals used in discharge into drain for production of biological, chemicals, used liquid & secured in disinfection, as insecticides, etc) landfill for solids

**Benefits of Biomedical Waste Management**

- Cleaner and healthier surroundings.
- Reduction in the incidence of hospital acquired and general infections.
- Reduction in the cost of infection control within the hospital.
- Reduction in the possibility of disease and death due to reuse and repackaging of infectious disposables.
- Low incidence of community and occupational health hazards.
- Reduction in the cost of waste management and generation of revenue through appropriate treatment and disposal of waste.
- Improved image of the healthcare establishment and increase the quality of life.

**Colour Type Waste Treatment Options as per Coding of Containers Category**

Yellow Plastic bag Disinfected 1,2,3,6 Incineration/deep burial

Red Disinfected 3,6,7 Autoclaving/Micro waving/Container/Plastic bag Chemical Treatment

Blue/White Plastic bag/puncture 4,7 Autoclaving/Micro waving/chemical

Translucent proof container treatment and

destruction/shredding

Black Plastic bag 5,9,10 (solid) Disposal in second landfill

**Recommendations**

- For the use of incinerator Training should be given to some number of persons from staff.
- Specific fund should be allocated for the use of incinerator.
- Every hospital should have special boxes to use as dustbin for bio-medical waste.
- Bio-medical waste should not be mixed with other waste of Municipal Corporation.
- Private hospitals should also be allowed to use incinerator, which is installed, in govt. hospital. For this purpose a specific fee can be charged from private hospitals.
- Special vehicle i.e. bio-medical waste vehicle should be started to collect waste from private hospitals and private medical clinics and carry it up to the main incinerator.
- As provided by bio-medical waste rules, the whole of the waste should be fragmented into colours due to their hazardous nature.
- Bio-medical waste Management Board can be established in each District.
- Either judicial powers should be given to the management board or special court should be established in the matters of environment pollution for imposing fines and awarding damages etc.
- Housekeeping staff wear protective devices such as gloves, face masks, gowned, while handling the waste.
- There is biomedical waste label on waste carry bags and waste carry trolley and also poster has put on the wall adjacent to the bins (waste) giving details about the type of waste that has to dispose in the baggage as per biomedical waste management rule.
- Carry bags also have the biohazard symbol on them.

**Conclusion**

Medical wastes should be classified according to their source, typology and risk factors associated with their handling, storage

and ultimate disposal. The segregation of waste at source is the key step and reduction, reuse and recycling should be considered in proper perspectives. We need to consider innovative and radical measures to clean up the distressing picture of lack of civic concern on the part of hospitals and slackness in government implementation of bare minimum of rules, as waste generation particularly biomedical waste imposes increasing direct and indirect costs on society. The challenge before us, therefore, is to scientifically manage growing quantities of biomedical waste that go beyond past practices. If we want to protect our environment and health of community we must sensitize ourselves to this important issue not only in the interest of health managers but also in the interest of community.

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