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Biomedical Waste Management: Need of Today A Review

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Abstract: ***Medical care is vital for our life and health, but the waste generated from medical activities represents a real problem of living nature and human world. Improper management of waste generated in health care facilities causes a direct health impact. The present review article deals with the basic issues as definition, categories, problems relating to biomedical waste and procedure of handling and disposal method of Biomedical Waste Management. It also intends to create awareness amongst the personnel involved in health care unit.***

Keywords: Biomedical waste, Treatment process, health hazardous.

1. Introduction

All human activities produce waste. We all know that such waste may be dangerous and needs safe disposal. Industrial waste, sewage and agricultural waste pollute water, soil and air. It can also be dangerous to human beings and environment. Similarly, hospitals and other health care facilities generate lots of waste which can transmit infections, particularly HIV, Hepatitis B & C and Tetanus, to the people who handle it or come in contact with it.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 proper management of biomedical waste has become a worldwide humanitarian topic today. Although hazards of poor management of biomedical waste have aroused the concern world over, especially in the light of its far-reaching effects on human, health and the environment. [1]

Hospital waste is a potential health hazard to the health care workers, public and flora and fauna of the area. The problems of the waste disposal in the hospitals and other health-care institutions have become issues of increasing concern. Most countries of the world, especially the developing nations, are facing the grim situation arising out of environmental pollution due to pathological waste arising from increasing populations and the consequent rapid growth in the number of health care centres. India is no exception to this and it is estimated that there are more than 15,000 small and private hospitals and nursing homes in the country. This is apart from clinics and pathological labs, which also generate sizeable amounts of medical waste.[2]

India generates around three million tonnes of medical wastes every year and the amount is expected to grow at eight per cent annually. Creating large dumping grounds and incinerators is the first step and some progressive states such as Maharashtra, Karnataka and Tamil Nadu are making efforts despite opposition.Barring a few large private hospitals in metros, none of the other smaller hospitals and nursing homes have any effective system to safely dispose of their wastes. With no care or caution, these health establishments have been dumping waste in local municipal bins or even worse, out in the open. Such irresponsible dumping has been promoting unauthorized reuse of medical waste by the rag pickers for some years now. If we want to protect our environment and health of community we must sensitize our selves to this important issue not only in the interest of health managers but also in the interest of community.[4] Surveys carried out by various agencies show that the health care establishments in India are not giving due attention to their waste management. After the notification of the Bio-medical Waste (Handling and Management) Rules, 1998, these establishments are slowly streamlining the process of waste segregation, collection, treatment, and disposal. Many of the larger hospitals have either installed the treatment facilities or are in the process of doing so.[5]

Bio Medical waste consists

- Human anatomical waste like tissues, organs and body parts
- Animal wastes generated during research from veterinary hospitals
- Microbiology and biotechnology wastes
- Waste sharps like hypodermic needles, syringes, scalpels and broken glass
- Discarded medicines and cytotoxic drugs
- Soiled waste such as dressing, bandages, plaster casts, material contaminated with blood, tubes and catheters
- Liquid waste from any of the infected areas
- Incineration ash and other chemical wastes

Classification of Bio-Medical Waste- The World Health Organization (WHO) has classified medical waste into eight categories:

- General Waste
- Pathological
- Radioactive
- Chemical
- Infectious to potentially infectious waste
- Sharps
- Pharmaceuticals
- Pressurized containers

Sources of Biomedical Waste- 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.[3]

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.
- Production units.

Minor Sources

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

Treatment of Biomedical waste - There are mainly five technology options available for the treatment of Bio-Medical Waste or still under research can be grouped as[7,3]-

1. Chemical processes
2. Thermal processes
3. Mechanical processes
4. Irradiation processes
5. Biological processes

1. Chemical processes - These processes use chemical that act as disinfectants. Sodium hypochlorit, dissolved chlorine dioxide, peracetic acid, hydrogen peroxide, dry inorganic chemical and ozone are examples of such chemical. Most chemical processes are water-intensive and require neutralizing agents.

2. Thermal processes - These processes utilise heat to disinfect. Depending on the temperature they operate it is been grouped into two categories, which are Low-heat systems and High-heat systems. Low-heat systems (operates between 93-177°C) use steam, hot water, or electromagnetic radiation to heat and decontaminate the waste.

3. Mechanical processes- These processes are used to change the physical form or characteristics of the waste either to facilitate waste handling or to process the waste in conjunction with other treatment steps. The two primary mechanical processes are-

a) Compaction - used to reduce the volume of the waste .
b) Shredding - used to destroy plastic and paper waste to prevent their reuse. Only the disinfected waste can be used in a shredder.

4. Irradiation processes- Exposes wastes to ultraviolet or ionizing radiation in an enclosed chamber. These systems require post shredding to render the waste unrecognizable.

5. Biological processes - Using biological enzymes for treating medical waste. It is claimed that biological reactions will not only decontaminate the waste but also cause the destruction of all the organic constituents so that only plastics, glass, and other inert will remain in the residues.[8]

2. Processing Process of the Waste-

1. Incineration

- Incinerators should be suitably designed to achieve the emission limits.
- Wastes to be incinerated shall not be chemically treated with any chlorinated disinfectants.
- Toxic metals in the incineration ash shall be limited within the regulatory quantities
- Only low sulphur fuel like Diesel shall be used as fuel in the incinerator.

2. Autoclaving- The autoclave should be dedicated for the purpose of disinfecting and treating biomedical waste.

A. When operating a gravity flow autoclave, medical waste shall be subjected to:

- A temperature of not less than 121 oC and pressure of about 15 pounds per square inch (psi) for an autoclave residence time of not less than 60 minutes; or
- A temperature of not less than 135 oC and a pressure of 31 psi for an autoclave residence time of not less than 45 minutes; or
- A temperature of not less than 149 oC and a pressure of 52 psi for an autoclave residence time of not less than 30 minutes.

B. When operating a vacuum autoclave, medical waste shall be subjected to a minimum of one per vacuum pulse to purge the autoclave of all air. The waste shall be subjected to the following :

- A temperature of not less than 121 oC and a pressure of 15 psi per an autoclave residence time of not less than 45 minutes; or
- temperature of not less than 135 oC and a pressure of 31 psi for an autoclave residence time of not less than 30 minutes; or Medical waste shall not be considered properly treated unless the time, temperature and pressure indicate stipulated limits. If for any reason, these were not reached, the entire load of medical waste must be autoclaved again until the proper temperature, pressure and residence time were achieved.

3. Microwaving

- Microwave treatment shall not be used for cytotoxic, hazardous or radioactive wastes, contaminated animal carcasses, body parts and large metal items.
- The microwave system shall comply with the efficacy tests/routine tests
- The microwave should completely and consistently kill bacteria and other pathogenic organism that is ensured by the approved biological indicator at the maximum design capacity of each microwave unit.

4. Deep Burial

- A pit or trench should be dug about 2 m deep. It should be half filled with waste, and then covered with lime

within 50 cm of the surface, before filling the rest of the pit with soil.
- It must be ensured that animals do not have access to burial sites.
- Covers of galvanised iron/wire meshes may be used.
- On each occasion, when wastes are added to the pit, a layer of 10cm of soil be added to cover the wastes.
- Burial must be performed under close and dedicated supervision.
- The site should be relatively impermeable and no shallow well should be close to the site.
- The pits should be distant from habitation, and sited so as to ensure that no contamination occurs of any surface water or ground water.
- The area should not be prone to flooding or erosion.
- The location of the site will be authorized by the prescribed authority.
- The institution shall maintain a record of all pits for deep burial.

5. Disposal of Sharps

Sharps are discarded needles and lancets that have been used in animal or human patient care/ treatment or in medical, research, or industrial laboratories. Sharps include items such as hypodermic needles, syringes, dental carpules, and scalpel blades. Please note that certain exemptions apply to farmers.
- Blades and needles waste after disinfection should be disposed in circular or rectangular pits.
- Such pits can be dug and lined with brick, masonry, or concrete rings.
- The pit should be covered with a heavy concrete slab, which is penetrated by a galvanized steel pipe projecting about 1.5 m above the slab, within internal diameter of upto 20 mm.
- When the pipe is full it can be sealed completely after another has been prepared.

3. Radioactive waste from medical establishments

- It may be stored under carefully controlled conditions until the level of radioactivity is so low that they may be treated as other waste.
- Special care is needed when old equipment containing radioactive source is being discarded.
- Expert advice should be taken into account.

Mercury control - Wastes containing Mercury due to breakage of thermometer and other measuring equipment need to be given
- Proper attention should be given to the collection of the spilled mercury, its storage and sending of the same back to the manufacturers.
- Must take all measures to ensure that the spilled mercury does not become part of biomedical wastes .
- Waste containing equal to or more than 50 ppm of mercury is a hazardous waste and the concerned generators of the wastes including the health care units are required to dispose the waste as per the norms.

Standard For Liquid Waste- The effluent generated from the hospitals must confirm to the following[11]:

Parameter	Permissible limit
pH	6.5 – 9.0
Suspended solids	100 mg/l
Oil and grease	10 mg/l
BOD	30 mg/l
COD	250 mg/l
Bioassay test	90% survival of fish after 96 hours in 100% effluent

Waste minimization: Waste minimization is an important first step in managing wastes safely, responsibly and in a cost effective manner. This management step makes use of reducing, reusing and recycling principles. There are many possible routes to minimize the amount of both general waste and biomedical wastes within the health care or related facility. Alternative technologies for biomedical waste minimization (e.g., microwave treatment; hammer mill) have been investigated and are not considered to be practical. Some of the principles of waste minimization are listed below and will be developed further in the long-term strategy. [9]

Health hazards- According to the WHO, the global life expectancy is increasing year after year. However, deaths due to infectious disease are also increasing. A study conducted by the WHO reveals that more than 50,000 people die everyday from infectious diseases. One of the causes for the increase in infectious diseases is improper waste management. Blood, body fluids and body secretions which are constituents of bio-medical waste harbour most of the viruses, bacteria and parasites that cause infection.

This passes via a number of human contacts, all of whom are potential 'recipients' of the infection. Human Immunodeficiency Virus (HIV) and hepatitis viruses spearhead an extensive list of infections and diseases documented to have spread through bio-medical waste. Tuberculosis, pneumonia, diarrhea diseases, tetanus, whooping cough etc., are other common diseases spread due to improper waste management. [8,12]

A. Occupational health hazards

The health hazards due to improper waste management can affect
- The occupants in institutions and spread in the vicinity of the institutions
- People happened to be in contact with the institution like laundry workers, nurses, emergency medical personnel, and refuse workers.
- Risks of infections outside hospital for waste handlers, scavengers and (eventually) the general public.
- Risks associated with hazardous chemicals, drugs, being handled by persons handling wastes at all levels.
- Injuries from sharps and exposure to harmful chemical waste and radioactive waste also cause health hazards to employees.

B.Hazards to the general public

The general public's health can also be adversely affected by bio-medical waste.

- Improper practices such as dumping of bio-medical waste in municipal dustbins, open spaces, water bodies etc., leads to the spread of diseases.
- Emissions from incinerators and open burning also lead to exposure to harmful gases which can cause cancer and respiratory diseases.
- Exposure to radioactive waste in the waste stream can also cause serious health hazards.
- An often-ignored area is the increase of in-home healthcare activities. An increase in the number of diabetics who inject themselves with insulin, home nurses taking care of terminally ill patients etc., all generate bio-medical waste, which can cause health hazards.

4. Recommendations

- 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.
- 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.
- 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.[6]

5. Conclusion

The problem of bio-medical 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 proper management of biomedical waste has become a worldwide humanitarian topic today. Although hazards of poor management of biomedical waste have aroused the concern world over, especially in the light of its far-reaching effects on human, health and the environment.

Healthcare waste container colour coding summary

The chart below summarises waste container colour coding **recommended** by the Department of Health in their Healthcare Waste Technical Memorandum HTM 07-01. All other waste duty of care and hazardous waste legislation still apply

Bag Colour	Description
Yellow	**Infectious waste contaminated with chemicals** Clinical waste, infectious, containing chemicals from healthcare For clinical waste incineration only Classed as Hazardous waste
Orange	**Infectious waste (not containing chemicals or medicinal contamination)** Clinical waste, infectious, containing chemicals from healthcare Suitable for alternative treatment or clinical waste incineration Classed as Hazardous waste
Purple	**Cytotoxic and cytostatic waste** Clinical waste, cytotoxic and cytostatic waste, infectious For incineration only Classed as Hazardous waste
Yellow &Black	**Offensive/hygiene waste** Offensive waste, municipal or from healthcare For incineration, landfill ,energy from waste or other authorised disposal/recovery Classed as Non-hazardous waste
Red	**Anatomical waste for incineration** Indicative treatment/disposal required is **incineration** in a suitably permitted facility. For clinical waste incineration only Classed as Hazardous waste
Blue	**Medicinal waste for incineration** Indicative treatment/disposal required is **incineration** in a suitably permitted facility. Can be classed as Hazardous waste
Black	**Domestic (municipal) waste** Mixed municipal waste Classed as Non-hazardous waste
White	**Dental Amalgam** Dental amalgam and mercury including spent and out-of-date capsules, excess mixed amalgam and contents of amalgam separators For recovery Classed as Hazardous waste

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