Biomedical Waste Management in India - A Review Article

Parmieka

Abstract: The safe and sustainable management of biomedical waste (BMW) is social and legal responsibility of all people supporting and financing health-care activities. In order to attain a cleaner environment where health and humans can thrive effective and efficient methods of biomedical waste management is mandatory. A collective teamwork with committed government support in terms of finance and infrastructure development, dedicated health-care workers and health-care facilities, continuous monitoring of Biomedical Waste Management practices, tough legislature, and strong regulatory bodies can lead to an efficient way of managing the biomedical waste. The best way is to segregate waste at source and waste reduction. Besides, a lot of research and development need to be done in the field to efficiently manage biomedical waste.

Keywords: Biomedical Waste, Waste Management, Indian Scenario of Waste Management

1.Introduction

Everything is made for a definite purpose. Anything which is not intended for further used is termed as WASTE. In densely populated urban areas, land for proper waste treatment disposal and overall management is required. Therefore it is quite needed that people should understand the need for waste management[2].

The waste generated in the course of health care activities is called Biomedical Waste i.e. any waste which is generated during diagnosis, treatment or immunization of human being or animal or in the research activities pertaining thereto in the production or testing of biologicals or in health camps[3] is termed as BIOMEDICAL WASTE.

2.Background

Although, cleanliness and hygiene were taken special care of since ancient civilization but the passage for Public Health Act of 1948 was precipitated only after the conduction of research by the British sanitary reformer Edwin Chadwik on poor condition of prisons and hospitals. After whom US colonel George E Waring was inspired regarding waste management.

In the year 1987, the beaches of New Jersey and New York shores were closed due to extensive, almost 30 miles long, mass of medical and household waste that overtook the shores. Therefore, Congress enacted the Medical Waste Tracking Act of 1988, a United States federal law that addressed the handling and disposal, from generation to segregation to transportation and destruction. But these waste management practices are not uniform among countries (developed and developing countries), regions (urban and rural areas) and sectors (residential and industrial)[4].

The government of India took a major step by enacting the Biomedical waste (management and handling) rules 1998, under section 6 and 25 of the environmental protection act of 1986. The definition adopted in Indian law i. e. the Biomedical Waste (Management and Handling) rules 1998 is similar to that of the definition adopted in U. S in the Medical Waste Tracking Act of 1988. The rules deal with the generation /storage /handling /treatment and disposal of Biomedical waste laws in practices.[5]

The Need for Biomedical Waste Management

It is equally important that all service medical, dental, nursing officers, other paramedical staff and waste handlers such as safaiwalas be well oriented to the basic requirements of handling and management of biomedical waste[7]. Even though, only 15% to 20% of hospital waste i. e. biomedical waste generated from biological sources or used in diagnosis, prevention or treatment of diseases is infectious or hazardous, but if it is not segregated at the source of generation and is mixed with other non-hazardous waste then 100% waste becomes hazardous[8]. Biomedical waste is distinct from normal trash or general waste. There is a lot of confusion among the generator, operator, decision maker and general community about safe management of biomedical waste. One of the reasons may be due to the lack of awareness[9].

What is Actually Biomedical Waste?

As per Ministry of Environment and Forest Gazette Notification, dated 20 July, 1998[10].

Biomedical Waste means any waste which is generated during the diagnosis, treatment or immunization of human beings or in research activities pertaining there to or in the production or testing of biologicals and including categories mentioned in schedule.

As per **WHO[11]**,

1: Medical waste: That portion of a healthcare or research facility's total waste stream that contains potentially infectious agents, hazardous chemicals, or radioactive materials.

(a) Solid Medical Waste: Wastes such as needles, infusion sets, bandages, anatomical wastes, isolation wastes, and all other materials contaminated or potentially contaminated with blood and/or body fluids from medical diagnosis, treatment or research.

(b) Liquid Medical Waste: Wastes such as blood, body fluids, dialysis solutions, chemical reagents, solvents, acids, heavy metal solutions, film developers, cytotoxic and other pharmaceuticals resulting from medical treatment or research.

(c) Isolation Waste: All disposable materials associated with a medical patient isolated from other patients to prevent transmission of a very infectious disease.

Classification of health care waste by WHO[12]

1. Infectious waste: waste suspected to contain pathogens e. g. Laboratory cultures, waste from isolation wards, tissues (swabs), materials, or equipment that have been in contact with infected patients, excreta.
2. Pathological waste: Human tissue or fluids e. g. body parts, blood and other body fluids, foetuses.
3. Sharps: Sharp waste e. g. needles, infusion sets, scalpels, knives, blades, broken glass.
4. Pharmaceutical waste: Waste containing pharmaceuticals e. g. Pharmaceuticals that are expired or no longer needed, items contaminated by or containing pharmaceuticals.
5. Geno toxic waste: Waste containing substances with Geno toxic properties e. g. waste containing cytotoxic drugs, Geno toxic chemicals.
6. Chemical waste: Waste containing chemical substances e. g. Laboratory reagents, film developer, disinfectant that are expired or no longer needed, solvents.
7. Waste with high content of heavy metals: Batteries, broken thermometers, blood pressure gauges etc.
8. Pressurized containers: Gas cylinders, gas cartridges, aerosol cans.
9. Radioactive waste: Waste containing radioactive substances e.g. unused liquid from radiotherapy or laboratory research, contaminated glassware, packages or absorbent paper, urine and excreta from patients treated or tested with unsealed radionuclides, sealed sources.

Sources and Generation of Biomedical Waste

Major Sources

- 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.

Minor Sources

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

The reports and figures available from developed countries indicate a range from 1-5 kg/ bed /day, with substantial inter country and inter specialty differences. Occasional data from developing countries indicate that the range is essentially similar but the figures are lower i. e.1-2 kg / day / patient[11]. According to Indian Society of hospital waste management, the quantum of waste generated in India is estimated to be 1-2 kg/bed/day in a hospital and 600gm/bed/day in a general practitioner's clinic.1[3]

According to a WHO report around 85% of the hospital wastes are actually non-hazardous, 10% are infective (hence, hazardous), and the remaining 5% are non-infectious but hazardous (chemical, pharmaceutical and radioactive) [18].

Segregation

As per the Bio Medical Waste (Management and Handling) Rules, 1998 segregation is defined as "separation of different types of wastes by sorting". Thereby reducing the risks as well as the cost of handling and disposal[11].

Segregation of hospital wastes in a proper manner will depend upon the following factors[11]:

i. Type of hospital/health care institution-super specialty, with research facilities available or not.
ii. The motivation and training level of the generators of waste v/z doctors, nurses and paramedics
iii. Sound hospital waste policies and procedures in consonance with health legislation.
iv. The final treatment options available for hospital waste.

Collection

Collection of hospital waste is the process which is done after segregation and in a way both can be considered as being complementary to each other[11].

There are several guidelines suggested for categorization of hospital wastes, enunciated by various authorities, some of which are given below.

Colour coded classification for developing countries-[11]

S No.	Category of waste	Recommended colour
1.	General non-hazardous waste	BLACK
2.	Sharps (whether infected or not)	YELLOW
3.	Infected waste (not containing sharps)	YELLOW
4.	Chemicals and pharmaceuticals (other than cytotoxic drugs, radioactive wastes, high pressure container)	RED
5.	Chemical wastes that require autoclaving	BLUE

Storage[11]

According to Biomedical Waste (Management and Handling) Rules, 1998 storage means, "The holding of biomedical waste for such period of time, at the end of which waste is treated and disposed-off."

It means the duration of time the waste is kept in the areas of generation, transit, till the point of disposal. Authorized person handling bio medical wastes shall ensure that,

(a) No untreated bio medical waste shall be stored beyond a period of 48 hours.
(b) If for any reason, it becomes necessary to store the waste beyond such period, the authorized person must take permission of the prescribed authority and take measures to ensure that waste doesn't adversely affect human health and environment.

Transportation

Waste disposal is a multiphase activity, in which the different stages (i. e. Generation, segregation, collection, interim storage, transportation, treatment and final disposal) are highly inter dependent, both technically and organizationally. In this entire spectrum of activities, collection and transport form the vital link between the point of generation and final disposal.

There are two types of transport of wastes[11]:

- **Intramural (Internal) Transport** It refers to the transport of waste from the point of generation, collection and storage in the wards to the point outside the building premises, where it is kept, pending the transport to the actual site of disposal.
- **Extramural (external) Transport** It refers to the transport of wastes from a central collection point outside building premises to the site of final disposal. However, it may be noted that in small health care organizations which have their own final disposal facilities inside their premises, both these combine together to form transportation of hospital waste.

The persons involved in the waste collection and transport should be given all personal protection measures such as gloves, caps, uniform or apron, gumboots or shoe cover etc. They should be vaccinated for Hepatitis – B[14, 15].

Final Disposal of Waste

After the various treatment of waste the residue which remains can be disposed-off by following means.

(i) Incineration ash and other solids.

- **Sanitary Landfilling (Controlled tipping)**

Landfilling is done by any of the following three methods.

a. Trench method—Long trench 2-3 meters deep and 3-10 meters wide depending upon local condition, is made. The treated waste is ideally compacted and filled up to 2 meters, covered with excavated earth.
b. Ramp method-This is well suited where the terrain is moderately slopping: and some excavation is done to secure the covering material.
c. Area method-This method is used for terrain land depressions, disused quarries and clay pits. The treated waste is deposited, packed and consolidated in uniform layers up to 2-2.5 meters deep Each layer is sealed on its exposed surface with a mud cover at least 12" thick to prevent infestation of flies, rodents etc[29].

(ii) The solid waste if not incinerated

- **Inertization**

The process of inertization involves mixing waste with cement and other substances before disposal, in order to minimize the risk of toxic substances contained in the waste migrating into the surface water or ground water. A typical proportion of mixture is; 65 % waste, 15% lime, 15% cement and 5% water. A homogenous mass is formed and cubes or pellets are produced on site and then transported to suitable storage sites.

- **Encapsulation**

This procedure involves filling containers, made of high density polyethylene or metal drums, with waste. These containers are then filled up with a medium of immobilizing material such as plastic foam, cement mortar or clay.

Once the medium has dried, the containers are sealed and disposed of in landfill sites.

It is a simple, low cost and safe method but not recommended for non-sharp infectious waste.3[9]

(iii) Liquids

Sanitary sewer sanitary sewer can be used if the waste has been diluted and / or neutralized and it is acceptable to local authorities except for cytotoxic drugs[26]. Fixer solution used for radiograph contains silver so before lading into sewer, silver should be extracted from it.

(iv) Radioactive waste

This should be done in accordance with the guidelines laid down by Bhabha Atomic Research Commission (BARC) India. This waste can be disposed-off in the normal channels under strict supervision, if they are stored till their radio activity is finished[16].

Recent Advances in Technologies for Treatment of Waste[11]

(1) Molten Salt Technology

In this process, combustible wastes and air are introduced continuously beneath the surface of a bath of molten salt. The hazardous material is thus combusted at temperatures below its ignition point. Salts like sodium carbonate, alkali salts are used as the melt, but others can also be used. The process can be batch fed or continuous feed, but the capacity is generally small. The temperature range is 1500-1850°C and residence time is around 5 seconds for the gas phase of combustion, and hours for solid phase of combustion. The containers are made up of ceramics, aluminium, stainless steel or iron.

(2) Electric Reactors

These are designed to pyrolyse waste contaminants on particles through the use of an electrically heated fluid wall reactor. These units have been used successfully in other chemical processes and are being tried out for waste treatment.

(3) Plasma System/Plasma Torch Technology

In these systems, the extremely high temperature of plasma is employed to destroy waste materials, and it offers an innovative approach to destroying highly toxic chemicals. A plasma is defined as "a material in which the temperature is so high that some of its electrons are separated from its atoms. These systems basically utilize a plasma torch or burner for heating (pyrolysing) the wastes to super high temperatures beyond 1150° C (at times furnace temperatures go as high as 10000° C for periods up to 1 second to produce combustible gases and "vitrions" or glass like rock substances.

(4) Molten Glass Technology

Molten glass technology uses a pool of molten glass as the heat transfer mechanism to destroy waste material. The attractiveness of this is based upon the extremely good quality of residue from the process, which is essentially non-leachable glass.

(5). Infrared System

The unit has infrared lamps (powered by electricity) strung in a row that can be expanded as desired. Wastes are conveyed into the radiation zone by a steel belt, and are carried along until fired with propane at about 2400° F.

(6) Detoxification Technology (Superheated steam sterilization)

This system consists of a heated shredder where the waste is heated to 480-700° C and simultaneously shredded. This causes medical equipment to melt into a sterilized mass in an hour; the remaining residues are cooled and dropped into a collection bin. The process employs a continuous batch system and has been shown to reduce medical waste by 50-80% of its original volume.

(7) Wet Oxidation Technology (Advanced)

This is similar to mechanical/chemical type of technology with use of proprietary catalyst for rapid disinfection of shredded waste. Weighed plastic drums filled with medical waste are placed on top of a shredder. The shredded waste drops into a spinning basket in an oxidation chamber. Once the chamber is full, it is closed and a water based solution containing 10% sulfuric acid, an iron ion catalyst and co-catalyst is introduced. The sulphuric acid maintains a highly acidic pH, and the agitation ensures that entire mass is saturated with the solution.

This solution is pumped out into a rear holding tank while water is sprayed into a spinning basket to rinse any remaining solution. The remaining waste is than doused with a finishing rinse of de ionized water. It is claimed that this can oxidize most of the organic matter at a quick rate of 225 kg/hr.

(8) Thermal Dry Heat Technology (TAPS)

TAPS are small desk top units which sterilize, encapsulate and compact the waste, with a volume reduction of 10: 1. The waste is kept in a special type of plastic bag in a chamber which can be heated up to 190° C for three hours either by electricity, recirculation of convectional heat, infrared rays or any combination of these components.

(9) Electro kinetic Gasification Technology

In this technology, gases comprising of hydrogen, carbon monoxide and carbon dioxide are produced in an electric furnace. Carbon dioxide is then converted into carbon monoxide in a coke bed electric arc furnace, to produce mixture of carbon monoxide and hydrogen. This gas can be used for power generation through gas turbine.

Present Scenario of Biomedical Waste Management Nut Shell[17]

The present scenario in the area of bio-medical waste, in India, presents a very grim picture. Even after the implementation of bio-medical rules in July, 1998, the condition remains more or less unchanged. The awareness regarding bio-medical waste rules is very low even among qualified medical personnel, including superintendents of hospitals and hospital administrators.
Hospital waste still finds its way to road side heaps of rubbish, where it mixes with municipal solid waste rendering it hazardous for the environment and the public.

The low quality incinerators that have been installed in many hospitals cause more harm than good. They only reduce the amount of garbage and give rise to harmful fly ash which is disposed with municipal solid waste.

The management of wastes usually is delegated to poorly educated laborers who perform most activities without proper guidance and insufficient protection.

The Bio Medical Waste scattered in and around the hospitals invites flies, insects, rodents, cats and dogs that are responsible for the spread of communicable diseases 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 blood borne diseases.

3.Conclusion

Management of bio medical waste is a global humanitarian issue today. If the bio medical waste is not managed properly, it can create various health hazards and environmental pollution. Among the wastes generated in health care facility, 75-90 % waste is of non-hazardous nature. If the waste is not segregated properly it can cause enhanced risk to the involved personnel and public or will cost more money.

To achieve effective waste management, waste should be segregated, collected and stored in proper colour coded bags or containers at the point of generation and treated at on site and off site effectively by the suitable technology as per the available facility and economic constraint.

Reference

[1] Lal Sunder, Nandy S. Text book of community medicine preventive and social medicine.2nd ed. CBS Publishers & Distributors; 2009. P.441-443.
[2] www.civilserviceindia. com
[3] Published in the Gazette of India, Extraordinary, Part II, Section 3, Sub-section (i) Government of India Ministry of Environment, Forest and Climate Change
[4] Davidson, Gary (June 2011). “Waste Management Practices: Literature Review”. Dalhousie University - Office of Sustainability. Retrieved 3 March 2017
[5] Govt of India. Ministry of Environment and Forests Gazette notification No 460 dated July 27, New Delhi.1998: 10–20
[6] Zile Singh, R Bhalwar, J Jayaram, VW Tilak VSM. An introduction to essentials of bio-medical waste management. Medical Journal Armed Forces India.2001 Apr; 57 (2): 144–147.
[7] Hem Chandra. Hospital waste an environmental hazard and its management. International society of environmental botanists.1999. Vol.5, No.3
[8] Almuneef M, Memish Z. Effective medical waste management: it can be done. American Journal of Infection Control.2003.31, 188–192.
[9] http://www.bwaste.com/3-stages-of-medical-waste-disposal/
[10] Joseph Joe, Ajithkrishnan C. G. Hospital Waste Management in the union territory of Pondicherry-An exploration [cited 2017, Mar 17]
[11] Anand, RC., Satpathy S. Hospital Waste Management: A Holistic Approach. Jaypee Brothers. Medical Publishers (p) Limited, 2000. P 5-15.
[12] Safe management of wastes from health care activities, 1999.
[13] Gupta and MahaJan. Textbook of preventive and social medicine. New Delhi: Jaypee Brothers; 2005. P 99 – 106
[14] Practical guidelines for infection control in health care facilities. .
[15] Work on biomedical waste management begins. The Hindu: TN News, 2006; Mar 30; 1
[16] Diaz LF, Eaggreth LC, Enkhtsetseg S., Savage GM. Characteristics of healthcare waste. Waste Management., 2016
[17] Acharya, D. B., and Meeta Singh. The book of hospital waste management. Minerva Press, 2000

Paper ID: SR22111213957 DOI: 10.21275/SR22111213957