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TREATMENTAND DISPOSAL METHOD OF HOSPITAL WASTE MANAGEMENT IN AMRAVATI CITY

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Abstract—Healthcare services provided by hospitals may generate some infectious wastes. Although a large percentage of hospital waste is classified as general waste, which has similar nature as that of municipal solid waste and, therefore, could be disposed in municipal landfills, a small portion of infectious waste has to be managed in the proper manner in order to minimize risk to public health. The management of biomedical waste continues to be a major challenge, particularly, in most healthcare facilities of the developing world. The poor management of clinical solid waste is a significant problem in most economically developing countries. It is estimated that annually about 0.33 million tons of waste is generated in India. Due to recent regulations (the Biomedical Wastes (Management & Handling) Rules, 1998), biomedical waste management in India is receiving greater attention to avoid significant health hazards and environmental pollution due to the infectious nature of the waste. Proper segregation, handling, storage, treatments & disposal of biomedical waste are necessary in order to develop biomedical waste management system in better way. Proper disposal of hospital waste is of paramount importance because of its infectious and hazardous characteristics.

Keywords— Waste, Healthcare services, environmental pollution, treatment and disposal, segregation

I. INTRODUCTION

In recent years, concern over the solid waste from healthcare facilities (HCFs) (i.e., hospitals, clinics, pathological laboratories, pharmacies and other supported healthcare services) has increased throughout the world. This is because waste from HCFs, arising principally from hospitals and clinics, is potentially dangerous since it can spread diseases because of the infectious nature of the wastes, and/or cause injury through the mismanagement of biomedical waste. It is well known that inappropriate biomedical waste management is pressing both health hazards and environmental pollution, facing many healthcare centres of this developing world. Improper clinical solid waste management practice impacts both directly and/or indirectly to healthcare staffs, patients and hospitals environment. Diseases like cholera, dysentery, skin infection, infectious hepatitis can spread epidemic way due to the mismanagement of clinical solid waste. Therefore, it is required to determine appropriate methods for the safe management of clinical solid wast The rules framed by the Ministry of Environment and Forests (MoEF), Govt. of India, known as 'Bio-medical Waste (Management and Handling) Rules, 1998,' notified on 20th July 1998, provides uniform guidelines and code of practice for the whole nation. It is clearly mentioned in this rule that the 'occupier' (a person who has control over the concerned institution /premises) of an institution generating bio-medical waste (e.g., hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank etc.) shall be responsible for taking necessary steps to ensure that such waste is handled without any adverse effect to human health and the environment. In this 21st century, hospitals waste still find it way to road side heaps of rubbish, where it mixes with municipal solid waste rendering its hazardous for the environment and the public. Indian cities are presently practicing random disposal of hospital waste without any uniform standards and policies. In order to prevent health hazardous, proper hospital waste management and codification of its operational directives are required to be formulated urgently which contains health risk. In Amravati city in last few years many super specialty hospital, multi-specialty clinics and nursing homes have been established and no proper care of hospital waste is taken.

II. THE OBJECTIVES OF THE PRESENT STUDIES ARE SUMMARIZED AS FOLLOWS

1 To segregate and categorize the various types of waste generated in hospitals within Amravati Municipal Corporation area

2 To assess the quantity of BMW generated per bed per day at hospitals since its pre-requisite to develop and effective waste management system.

3 To suggest the appropriate treatment technology for the sound hospital waste management system.

4. To suggest installation of incinerators at different places within corporation area and planning of suitable BMW treatment plant for Amravati.

2.2 Waste Generation Point

2.2.1 Hospital

Hospital facilities are among the largest generators of solid waste today on per capita basis. Much of the waste from hospital comes from the trash basket at the side of the patient bed, and includes newspaper, magazines, paper bags, packaging and discarded flowers. In addition, broken syringes discarded splints, masks, rubber gloves and broken glass ampoules, etc., generated by other routine activities add to the daily waste stream. During last decade, there has been an increasing trend towards the use of disposal products or single purpose Items, which now account for more than, one half of the total hospital waste generated. Depending on the hospital preference for using throwaway materials, the waste generation rate can vary substantially from hospital to hospital. (Banerjee, 1999)

2.2.2 Pathological Laboratories

Waste generated from pathological laboratories is considered to be infectious. The waste generation rate is estimated to be 0.2 kg/patient/day (Banerjee, 1999) and the total quantity of infectious waste from these facilities is higher. Pathological laboratory waste contains very high percentage of plastics.

2.3 Waste Characterization

In practice it is very difficult to identify and segregate every article of medical waste from the solid waste stream. Therefore, the medical waste is categorized into groups, which are amenable to specific treatment/disposal method. As per Bio-Medical Waste (management and handling) Rules, 1998 (Sengupta, 1998), the bio-medical waste has been groped into the following Categories:

Category No. 1 Human Anatomical Waste: Human tissues, organs, body parts etc.

Category No. 2 Animal Waste: Animal tissues, organs, body parts, carcasses, bleeding parts, fluid, blood and experimental animal used in research, waste generated by veterinary hospital, colleges, discharge from hospital, animal houses.

Category No. 3 Microbiology & Biotechnology Waste: Waste from laboratory cultures, stock or specimens of micro-organism, live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, waste from production of biological, toxins, dishes and devices used for transfer of cultures.

Category No. 4 Waste Sharps: Needles syringes, scalpels, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps.

Category No. 5 Discarded Medicines and Cytotoxic Drugs:Waste comprising of outdated, contaminated, and discarded medicines.

Category No. 6 Soiled Waste: Items contaminated with blood and body fluids including cotton,

dressing, soiled plaster casts, linen, beddings, other materials contaminated with blood.
Category No. 7 Solid Waste: Wastes generated from disposal items other than the waste sharps such as tubing's, catheters, intravenous sets etc.
Category No. 8 Liquid Waste: Waste generated from laboratory and washing, cleaning, housekeeping and disinfecting activities.
Category No. 9 Incineration Ash: Ash from incineration of any bio-medical waste.
Category No. 10 Chemical Waste: Chemicals used in production of biological, chemicals used in disinfections, as insecticides, etc. Banerjee (2002) have carried out study on hospital waste of Calcutta city

Table 1 Average characteristics of hospital waste

Bag Color	Nature of the waste	Description of waste components	Component weight %
Red bag	Infected	Human anatomical Plastics Swab and absorbents Cotton (Wet)	67.6 17.6 12.6 2.0
Orange bag	Infected	Animal anatomical infected Plastics Glass Beddings, Savings Paper, Fecal matter	56.6 20.3 12.0 5.0 6.0
Yellow bag	Infected	Gauze, Pads, Swabs, garments Paper, Cellulose Plastics, PVC, Syringes Sharps, Needles Fluid, Residuals Cotton	73.6 16.6 5.16 3.16 0.8
Yellow bag	Infected	Plastics Sharps Cellulosic Materials Fluid Residuals Cotton Glass	59.0 8.0 8.3 6.0 2.0 16.6
Blue Bag	Non infected	Animal Anatomical Plastics Glass Tin Cans Paper Beddings	57.3 15.6 12.3 8.3 4.6 4.6

2.3 Waste Segregation and Storage

The medical waste is divided into different categories, and collected in different colored bins or containers, as to help in segregation of hazardous and non-hazardous waste, needing different types of treatment. The process is known as waste segregation. The correct classification for collection of different waste items in different colored dustbins is to be done by the various hospitals, and it is the duty of the hospital doctor and nurses to ensure correct disposal of different waste items in their respective dustbins or containers. The system of using different colored bins and bags to collect different type of medical wastes is known as color-coding. Such a system, eventually help in

separately collecting the non-hazardous medical waste items, such as the uncontaminated packaging material like plastics, paper, cardboard, food and kitchen waste, garden waste etc. (garg, 2001)
Proper segregation of waste helps in the following ways:
(i) It minimizes the amount of potentially hazardous waste that requires the specialized and costly treatment and disposal.
(ii) It facilitates proper packaging and labeling of wastes.
(iii) It reduces occupational health and safety risk to the health care worker and rag pickers.
(iv) It improves infection control within the hospital.
(v) It helps in establishing uniform waste management practice and to comply with national laws and legislation. According to the notification 1998 [4] for the disposal of biomedical wastes, such waste are to be segregated in the bins or containers of different colors namely; Yellow, Red, Blue/white and Black as per the specification given in table 2.

Table 2. Color-coding for disposal of Bio-Medical waste (garg, 2001)

Category	Waste type	Color coding
1.	Human anatomical waste	Yellow
2.	Animal wastes	Yellow
3.	Microbiological and biotechnology wastes	Yellow/red
4.	Wastes sharp	Blue/white
5.	Discarded medicines and Cytotoxic drugs	Black
6.	Solid wastes	Yellow
7.	Disposable solid waste like tubes, catheters, Blood or urine bags, gloves etc.	Red/blue
8.	Liquid waste	Red/blue
9.	Incinerated ash	Black
10.	Chemical solid wastes	Black

The most important aspect of management of biomedical waste is that the hazardous biomedical waste should not be mixed with the non-hazardous general waste.

III. TRANSPORTATION OF HOSPITAL WASTE

The medical waste, except the general and non hazardous wastes, should never be transported with general municipal wastes, and these should be kept separate at all stages. Special vehicle must be used so as to prevent access to and direct contact with the waste by the transportation operators, scavengers and the public. The transport containers should be properly enclosed. The effects of traffic accidents should be considered in the design, and the driver must be trained in the procedures he should follow if there is an accidental spillage. It should be possible to wash the interior of the body thoroughly. (CPCB, 1998) While transporting solid waste (Banerjee, 1999) infectious and non-infectious should be transported separately. Infectious wastes should be transported in closed leak proof truck. These wastes should be placed into rigid or semi rigid container before transporting offsite. Cars used for transportation of the wastes should be sterilized regularly.

IV. TREATMENT OF HOSPITAL WASTE

There are five broad categories of medical waste treatment technologies:
(i) Mechanical process
(ii) Thermal process
(iii) Chemical process
(iv) Irradication process
(v) Biological process

4.1Mechanical Processes
Mechanical 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 compaction and shredding. Compaction involves compressing the waste into containers to reduce its volume. Shredding, which also includes granulation, grinding, pulping etc. is used to break the waste into smaller pieces. Compaction and shredding are not considered acceptable medical waste treatment systems. Compaction and shredding of untreated medical waste may result in aero soling or spilling of microorganisms. Typically, compaction and shredding are adopted after the waste has been decontaminated in order to reduce the volume and make it unrecognizable. (CPCB, 1998).

4.2Thermal Processes
Thermal processes use heat to decontaminate or destroy medical waste. Most microorganisms are rapidly destroyed at temperatures ranging from 49^0C to
91^0C and most living organisms are killed at 100^0C. There are two categories of thermal processes, namely low-heat systems and high-heat systems. Low - heat systems use steam, hot water, or electromagnetic radiation to heat and decontaminate the waste. They typically operate at temperatures of less than 150^0C, which is insufficient to combust, or destroy the materials. High-heat systems employ combustion, Paralysis and high-temperature plasmas to decontaminate and destroy the waste. These systems operate at temperatures ranging from as low as 600^0C to more than 5500^0C.The basic thermal treatment processes are as follows.

4.3 Autoclaving
Autoclave (steam sterilization) is a low-heat thermal process and is designed to bring steam into direct contact with the waste in a controlled manner and for sufficient duration to disinfect the waste. The three basic types of steam autoclave systems are gravity, pre-vacuum, and retort systems.
(i) Gravity-type autoclaves: in which pressure alone is used to evacuate air from the treatment chamber, typically operate with steam temperatures of about 121^0C. These systems require a typical cycle time of approximately 60-90 minutes in order to achieve full steam penetration into the most densely packed waste loads.
(ii) Pre-vacuum-type autoclave: systems evacuate air from the treatment chamber using vacuum pumps. This enables them to reduce cycle time to about 30-60 minutes, as the time to heat the air within the chamber is eliminated. Pre-vacuum systems typically operate at about 132^0C.
(iii) Retort-type autoclaves: basically comprise large volume treatment chambers designed for much higher steam temperatures and pressures, and therefore their cycle times can be substantially less than those of the other systems.

4.4Hydroclave: - in this method, indirect heating is provided in the outer jacket of a double-walled container, while the waste inside the wall is turned on by a mechanism. This causes the waste to be fragmented and continuously tumbled against the hot vessel walls. The moisture content of the waste turns to steam, and the vessel starts to pressurize. In the absence of enough moisture in the waste to pressurize the vessel, a small amount of steam is added until the desired pressure is reached. The treatment time is 15 minutes at 132^0C, or 30 minutes at 121^0C to achieve sterilization. In the process, resultant waste is fragmented and dehydrated with reduction in volume & weight.

4.5Microwave Treatment
Unlike other thermal treatment systems, which heats wastes externally, microwave heating occurs inside the waste material. This process involves pre-shredding the waste, injecting it with steam, and heating it for 25 minutes at 95^0C under a series of microwave units. Microwave radiation is

designated as that portion of the electromagnetic radiation spectrum lying between the frequencies and 300,000 MHz and the microbial inactivation occurs as a result of the thermal effect of the radiation and not from any intrinsic non-thermal property.

4.6Incineration

Incineration systems USG high-temperature combustion under controlled conditions to convert waste containing infectious and pathological material to inert mineral residues and gases. The three types of incinerators used for hospital waste treatment are multi-hearth, rotary kiln, and controlled-air. All three types can have primary and secondary combustion chambers to ensure maximum combustion of the waste.

(i) Multiple-hearth incinerators consist of two or more combustion chambers. The primary chamber is for solid-phase combustion, whereas the secondary chamber is for gas-phase combustion. These incinerators are often referred to as excess-air incinerators because they operate with excess air levels in both the primary and secondary combustion chambers.

(ii) The rotary kiln is a cylindrical refractory-lined shell that is mounted at a slight incline from the horizontal plane to facilitate mixing the waste materials with circulating air. Rotary-kiln systems usually have a secondary combustion chamber after the kiln to ensure complete combustion of the waste. The kiln acts as the primary chamber to volatilize and oxidize combustible in the waste. Both the secondary combustion chamber and kiln are usually equipped with auxiliary fuel-firing systems to bring the units up to the desired operating temperatures.

(iii)Controlled-air incinerators burn waste into two or more chambers under conditions of both low and excess stoichiometric oxygen requirements. In the primary chamber, waste is dried, heated, and burned at 400^0C-800^0 C of the stoichiometric oxygen requirement Combustible gas produced by this process is mixed with excess air and burned in the secondary chamber at usually between 1000-1050 of the stoichiometric requirement. A supplementary fuel burner is used to maintain elevated gas temperatures and provide for complete combustion. One advantage of using low levels of air in the primary chamber is that there is very little entrainment of particulate matter in the flue gas.

V. DISPOSAL METHOD

5.1Land Filling

Land filling of category 5, 9 and 10 is recommended but the landfill site should always be away from the residential areas, as it could be dangerous for the community health and difficulty posed in safe transport.

5.2 Deep Burial

Deep burial of category 1 and 2 is recommended but deep burial may contaminate the ground water and pose health threat to community. To avoid any adverse effect of deep burial. The standard for deep burial have been laid down by MOEF, which are reproduced below; (Goi, 1998)

A pit trench should be dug about 2 meters 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 any access to burial sites. Cover of galvanized iron/ wire meshes may be used.

On each occasion, when wastes are added to the pit, a layer of 10 cm of soil shall be added to cover the wastes.

Burial must be performed under close and dedicated supervision.

The deep burial 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 prescribed authority will authorize the location of the deep burial site.

The institution shall maintain a record of all pits for deep burial.

VI. CONCLUSIONS

1. The total average waste generated in Hospital – A is 42.03 kg/day out of which 59 % is non-infectious waste, 31 % is infectious waste and 10 % is sharp waste.
The waste generation rate per bed per day in hospital – A is 1.401 kg.
2. Non- Infectious waste generated in hospital –A is 24.78 kg/day the maximum non-infectious waste found in the medical & surgical wards
Infectious waste generated in hospital –A is 13.17 kg/day the maximum infectious waste found in the
3. Sharp waste generated in hospital - A is 4.08kg/day and the maximum sharp waste is found in the medical & surgical wards
4. The total average waste generated in Hospital – B is 33.11 kg/day out of which 31% is non-infectious waste, 62% is infectious waste and 7% is sharp waste.
The waste generation rate per bed per day in hospital – B is 1.65 kg.
5. Non- Infectious waste generated in hospital –B is 10.38 kg/day the maximum non-infectious waste found in the medical & surgical wards
6. Infectious waste generated in hospital –B is 20.64 kg/day the maximum infectious waste found in the
7. Sharp waste generated in hospital - B is 2.09 kg/day and the maximum sharp waste is found in the medical & surgical wards
8. The total average waste generated in Hospital – C is 34.14 kg/day out of which 48 % is non-infectious waste, 36 % is infectious waste and 16 % is sharp waste.
The waste generation rate per bed per day in hospital – C is 1.406 kg.
9. Non- Infectious waste generated in hospital –C is 16.78 kg/day the maximum non-infectious waste found in the medical & surgical wards
Infectious waste generated in hospital –C is 12.64 kg/day the maximum infectious waste found in the
Sharp waste generated in hospital - C is 5.72 kg/day and the maximum sharp waste is found in the medical & surgical wards
10. A common waste treatment facility for a group of hospitals at two or three location to cater the need of cluster is best for private hospitals of Amravati City

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