Review on Biomedical Waste Management
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Abstract—Biomedical waste is waste that is either putrescible or potentially infectious. Biomedical waste is generated from biological and medical sources and activities, such as the diagnosis, prevention, or treatment of diseases. Common generators of biomedical waste include hospitals, health clinics, nursing homes, medical research laboratories, offices of physicians, dentists, and veterinarians, home health care, and funeral homes. In healthcare facilities (i.e., hospitals, clinics, doctors offices, veterinary hospitals and clinical laboratories), waste with these characteristics may alternatively be called medical or clinical waste. Biomedical waste may be solid or liquid. Examples of infectious waste include discarded blood, sharps, unwanted microbiological cultures and stocks, 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. Waste sharps include potentially contaminated used (and unused discarded) needles, scalpels, lancets and other devices capable of penetrating skin. Biomedical waste is distinct from normal trash or general waste, and differs from other, types of hazardous waste, such as chemical, radioactive, universal or industrial waste. Medical facilities generate waste hazardous chemicals and radioactive materials. While such wastes are normally not infectious, they require proper disposal.

Key words: Biomedical Waste Management, Biomedical Waste

I. INTRODUCTION

In India, environment preservation has become one of the prime concerns of society. As population increases, the solid waste management in urban cities is one of the critical activities, which needs through planning and execution so as to avoid unsightly dumps of garbage spread indiscriminately posing a serious threat to public health. According to WHO (2000) almost 80% of medical wastes are comparable to domestic waste. The remaining approximate of 20% is considered hazardous, as it may be infectious, toxic or radioactive.

The hospital solid waste includes anatomical, pathological, infectious hazardous waste and other waste generated in health care facilities and pathological laboratories, which require special handling.

A. Need of Biomedical Waste Management

Bacteria are most successful organism on this planet & may be able to be hazardous or even fatal to humans & animal alike. The highest concentration of such organism can be found in hospital & consequently hospital wastes poses a potential risk for staff, patients & operators responsible for its’ eventual disposal. So proper hospital waste management is essential. Improper disposal of wastes generated in hospital impacts on those who work in hospital, the general public & on environment such proactive may contributes to spread disease (HBV, HCV, HIV), as well as pollution of air, soil and water.

B. Composition of Medical Waste

1) Definition:
“Biomedical waste may be defined as any solid, fluid or liquid waste, including its container & any intermediate product, which is generated during the diagnosis, treatment or immunization of human beings or animals, in research pertaining thereto, in the hospitals or in the production of testing of biological & the animals waste from slaughter houses or any other similar sort of establishments.”

These waste are produced by Health Care Establishments like hospitals, nursing homes, clinics, dental institutes veterinary facilities, medical laboratories, animal houses, research institutions, pathology labs and blood bank.

C. What World Health Organization (WHO) Says?

According to a recent World Health Organization (WHO) publication “Safe Management of Waste from Health-care activities”, apart from categorization, assessment of current situation, the management of the hospital should develop and implement an effective Waste Management Programme.

WHO states that 85% of the hospital waste actually non–hazardous waste, around 10% is infectious waste & around 5% of non–infectious but hazardous waste. In India this could range from 15 – 35% depending on the total amount of waste generated.

D. The Hazards Associated With Poor Health Care Waste Management:

Proper disposal of biomedical waste is of paramount importance because of its infectious and hazardous characteristics. Improper disposal can result in the following:

− Injuries from sharps to all categories of health care personnel and waste handlers
− Increase risk of infections to medical, nursing and other hospital staff
− Injuries from sharps to health workers and waste handlers
− Poor infection control can lead to nosocomial infections in patients particularly HIV, Hepatitis B & C

II. CLASSIFICATION OF WASTE

According to WHO, health care waste can be classified into eight categories.

− General Waste: General waste represents minimal or no risk to human health as it is largely composed of the domestic or household type of waste, i.e. kitchen waste, packaging material.
− Anatomical waste: Pathological waste consists of tissues, organs, body parts, animal carcasses; and mostly blood and body fluids.
− Radioactive waste: Radioactive waste includes solid, liquid and gaseous waste that is contaminated with radio nuclides. Generated from, in vivo body organ imaging and tumor localization, and therapeutic procedures.
Chemical Waste: Hazardous chemical waste is toxic, corrosive, flammable, reactive, and gene-toxic.

Infectious waste: Infectious wastes are those wastes which contain pathogens, i.e. disposable towels, gowns, aprons.

Sharps: This category includes needles, syringes, saws, blades, and nails etc which can cause a cut or puncture.

Pharmaceutical waste: Pharmaceutical waste includes pharmaceutical products, drugs and chemical.

Pressurized container: Pressurized container includes those, which are used for demonstration or instructional purpose.

A. Classification suggested by High Power committee on Urban Solid Waste Management in India:
This committee has suggested that all “health care wastes” should be broadly categorized into 2 categories based on source of origin.

- General or non – hazardous waste: waste which has minimal or least potential & can be disposed off by municipal civic authorities.
- Hazardous waste: Hazardous waste definitely poses a health hazard to all personnel associated with it.

B. Classification & Categorization of Biomedical Waste According To MOEF (Ministry of Environment & Forests) Wastes

<table>
<thead>
<tr>
<th>Waste category</th>
<th>Waste class &amp; description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Human anatomical waste</td>
</tr>
<tr>
<td>2</td>
<td>Animal wastes</td>
</tr>
<tr>
<td>3</td>
<td>Microbiology &amp; biotechnology waste (wastes from laboratory culture, stocks or specimens of micro-organisms)</td>
</tr>
<tr>
<td>4</td>
<td>Waste sharps (needles, syringes, blades, glass etc.)</td>
</tr>
<tr>
<td>5</td>
<td>Discarded medicines &amp; cytotoxic drugs (outdated &amp; contaminated &amp; discarded medicines)</td>
</tr>
<tr>
<td>6</td>
<td>Solid waste (items contaminated with blood &amp; body fluids, example cotton, dressings, beddings etc.)</td>
</tr>
<tr>
<td>7</td>
<td>Solid wastes (example tubing, catheters etc.)</td>
</tr>
<tr>
<td>8</td>
<td>Liquid waste (waste from laboratory cleaning, washing.)</td>
</tr>
<tr>
<td>9</td>
<td>Incineration ash (ash from incineration of any biomedical waste)</td>
</tr>
</tbody>
</table>

Table 1: Categories of Biomedical Wastes

III. BIO MEDICAL WASTE TREATMENT TECHNOLOGIES

Treatment is the term used for those processes that modify the waste in some way before it is finally disposed off so that following objectives are achieved.

- Making it free from pathogenic microorganisms
- To reduce the volume of waste
- To make it unrecognizable & hence more acceptable for final disposal.

There are five categories of biomedical waste treatment technologies:-

1) Chemical Process.
2) Thermal treatment.
3) Mechanical Process.
4) Biological treatment.
5) Irradiation.

A. Chemical Process

Disinfection is defined as the “process by which most the pathogenic microorganisms are destroyed from any inanimate body, surface or material”. Bleaching power, mentholated spirits, etc. chemicals are used for disinfections. For effective disinfections, contact period of 30 minutes is required.

B. Mechanical Processes

Mechanical processes are used to change the physical form or the 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 the compressing waste into containers to reduce its volume. Shredding, which also includes granulation, grinding,
pulping, etc. is used to break the waste in to the smaller pieces.

C. Thermal Process
Thermal process uses heat to decontaminate or destroy medical waste. Most microorganisms are rapidly destroyed at temperatures ranging from 49 to 91°C and most living organization are killed at 100°C. There are two categories of thermal processes viz. low heat systems and high heat systems. They typically operate at temperature of less than 150°C. High heat systems employ combustion, pyrolysis and high temp ranging from as low as 600°C to more than 5500°C.

D. Biological Process
A system is being developed using biological in enzymes for the treating medical waste. It is claimed that biological reactions will not only decontaminate the waste but also causes the destruction of all the organic constituents so that only plastic, glass and other inner will remain in the residues.

E. Irradiation (Electron Beam Gun) Technology
This involves exposing the medical waste to ultraviolet or ionizing radiation in an enclosed chamber. Process utilizing cobalt 60, & electron beam accelerator unit or electron beam gun for irradiating & sterilizing the medical waste have been developed. These radiation help in sterilization of wastes by destruction of pathogenic organisms & including chemical & biological changes in waste materials.

IV. EMERGING TECHNOLOGIES:
A. On-Site Treatment and Disposal:
Aegis Bio-Systems in the United States is offering a mobile system for on-site treatment and disposal of medical wastes. The patented JYD-1500 unit incorporates an advanced proprietary shredding plus a steam sterilization system that thoroughly documents all aspects of the treatment cycle. It pre-shreds wastes prior to sterilization and during sterilization, waste is stirred in a pressurized steam-laden environment. This ensures that all the waste surfaces are exposed to 250°C saturated steam. “Log 6” sterilization healthcare level is achieved.

JYD-1500 employs reusable sealed containers, thereby eliminating recurring costs of disposable holders. Up to 900 kg/h of infectious wastes could be treated when operated at optimal capacity. Transportation expenses are lowered since the weight of wastes is reduced by nearly 85 per cent of its original volume, about 15 per cent more than traditional processes. This unit is more reliable than presently available counterparts since the shredding system is self-cleaning and designed to overcome obstructions that destroy competing systems. A couple or more of these mobile units offer full redundancy and can be operated 24 h a day at one or more sites with zero down time.

B. Treatment for Liquid Waste:
The institutions, which generate biomedical liquid waste, should have treatment facilities installed at the tail end of the sewage stream before entering the municipal sewer. The treatment could consist of chemical disinfections using pre-chlorination with a contact time of 15 to 45 minutes (to be determined from plant studies) and dosing of 6-25 mg/L of chlorine and post chlorination with 1-5 mg/L of chlorine. The resultant effluent can be let into the public sewers. The resultant effluent should conform to the standards prescribed in Schedule V of the Bio-Medical Waste (Management and Handling) Rules, 2000.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Autoclave</th>
<th>Hydroclave</th>
<th>Microwave</th>
<th>Incinerator</th>
<th>Chemical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Steam Sterilization (direct heating)</td>
<td>Steam sterilization (indirect heating) simultaneous shredding and dehydration</td>
<td>Microwave heating of pre shredded waste</td>
<td>High temperature waste incineration</td>
<td>Mixing pre-ground waste with chemicals such as chlorine</td>
</tr>
<tr>
<td>Sterilization</td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
<td>Dependant on chlorine strength through the waste.</td>
</tr>
<tr>
<td>Capital cost</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Moderate</td>
</tr>
<tr>
<td>Operating cost</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td>Operator maintenance skills</td>
<td>Low skill required</td>
<td>Low skill required</td>
<td>Automated but highly complex and high level.</td>
<td>High level operator and maint. skill reqd.</td>
<td>High level required for chemical control and grinder</td>
</tr>
<tr>
<td>Air emission</td>
<td>Odorous but non toxic</td>
<td>Somewhat odorous but non toxic</td>
<td>Somewhat odorous but non toxic</td>
<td>Can be highly toxic</td>
<td>Some chlorine emissions</td>
</tr>
<tr>
<td>Water emissions</td>
<td>Odorous may contain live microorganism</td>
<td>Odorous but sterile</td>
<td>Negligible</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>

Table 2: Comparison of Treatment Technologies

V. CONCLUSION
The disposal of biomedical wastes has become issue of growing concern. Various technology options are currently available & some of these are being practiced for collection, treatment & disposal of biomedical wastes.

– In order to completely eliminate the spread of infection from these wastes, either while handling or after disposal, care must be taken by authorities to ensure that the best available technology is employed for handling such ways.
Studies reveal that much of the biomedical wastes produced by smaller generators is improperly disposed of in municipal or privately owned solid waste landfill or other improper ways.

As public awareness is increasing, some of the large producers of biomedical waste such as hospitals are now equipped with their own treatment such as incinerator to tackle the problem.

There is a need for a national medical waste management policy and national waste disposal and management guidelines.

Proper identification and segregation of hazardous hospital waste will reduce the health risks involved by a great sum.

Safe and sensible technology for the treatment of infectious waste must take into consideration all the difficulties, from collection to transportation and disposal.

REFERENCES


