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Biomedical Waste Management- A Review

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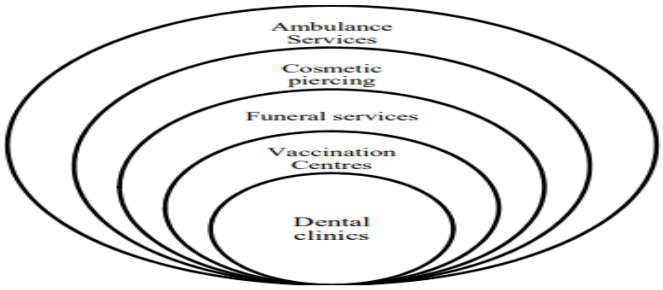
Introduction

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 bio-medical wastes 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.

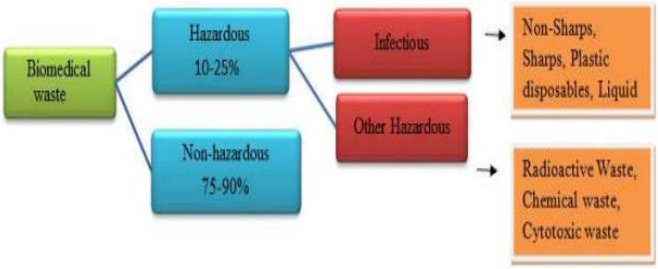
The proper management of biomedical waste has become a worldwide humanitarian topic today. Although hazards of poor management of biomedical waste have aroused the concern world over, especially in the light of its far-reaching effects on human, health and the environment. Now it is a well-established fact that there are many adverse and harmful effects to the environment including human beings which are caused by the "Hospital waste" generated during the patient care. Hospital waste is a potential health hazard to the health care workers, public and flora and fauna of the area[1]. The problems of the waste disposal in the hospitals and other health-care institutions have become issues of increasing concern. The responsibility of medical administrators as regards proper handling and disposal of this category of waste has now become a statutory requirement with the promulgation of Government of India (Min of Environment and Forests) gazette notification no. 460 dated 27 July 1998[2].

Definition- 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 biologicals[2].

Sources of BMW[3]



Classification of biomedical waste



Quantum of waste

The quantity of biomedical waste generated per bed per day wil1 vary depending upon the type of health problems, the type of care provided and the hospital waste management practices. It varies from 1-2 kg in developing countries to 4.5 kg in developed countries such as USA[4,5]. 10-15% of the waste is infectious in developed countries whereas it varies from 45.5 to 50% in India, requiring special handling[5]. Infective waste was found to be only 6% at Command Hospital (Air Force) Bangalore[6].

Hazards

The following properties of biomedical waste make it hazardous

a. Infectious
b. Cytotoxic
c. Chemical
d. Genotoxic
e. Radioactive waste

Infectious- Pathogens in infectious waste may enter the human body through a puncture, abrasion or cut in the skin. There is particular concern about infection with HIV and hepatitis virus B and C, for which there is a strong evidence of transmission via health – care waste. Bacteria's resistant to antibiotics and chemical disinfectants, may also contribute to the hazards created by poorly managed waste.

ORGANISM	DISEASES CAUSED	RELATED WASTE ITEM
VIRUSES HIV, Hepatitis B, Hepatitis A,C, Arboviruses, Enteroviruses	AIDS, Infectious Hepatitis, Infectious Hepatitis, Dengue, Japanese encephalitis, tick-borne fevers, etc.	Infected needles, body Fluids, Human excreta, soiled linen, Blood, body fluids.
BACTERIA Salmonella typhi, Vibrio cholerae, Clostridium Tetani, Pseudomonas, Streptococcus	Typhoid, Cholera, Tetanus Wound infections, septicemia, rheumatic fever, endocarditis, skin and soft tissue infections	Human excreta and body fluid in landfills and hospital wards, Sharps such as needles, surgical blades in hospital waste.
PARASITES Wucheraria Bancrofti, Plasmodium	Cutaneous leishmaniasis, Kala Azar, Malaria	Human excreta, blood and body fluids in poorly managed sewage system of hospitals.

Chemical and pharmaceutical waste- Many of the chemicals and pharmaceuticals used in health care establishments are toxic, genotoxic, corrosive, flammable, reactive, explosive or shock sensitive. Although present in small quantity they may cause intoxication, either by acute or chronic exposure and injuries including burns.

Genotoxic waste- The severity of the hazards for health – care worker responsible for handling or disposal of genotoxic waste is governed by a combination of the substance toxicity itself and the extent and duration of exposure. Exposure may also occur during the preparation of or treatment with particular drug or chemical. The main pathway of exposure is inhalation of dust, aerosols, absorption through the skin, ingestion of food accidentally contaminated with cytotoxic drugs, chemicals or wastes.

Radioactive waste- Radioactive waste exposure may cause headache, dizziness, vomiting, genotoxicity and tissue damage.

Biomedical Waste Management Process

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

Principles of bio-medical waste management[8]

The principles of biomedical waste management are as follows:

a. **General principles of hygiene and sanitation**. Observance of general principles of hygiene and sanitation such as cleanliness, good housekeeping, adequate supply of safe water, sanitary facilities and proper ventilation are essential components of a good bio-medical waste management plan.
b. **Waste minimization**- It is essential that every waste generated from the hospital should be identified and quantified. Hospitals should endeavor to reduce waste by controlling inventory, wastage of consumable items and breakages etc. Waste can also be

minimized by recycling certain waste such as glassware, plastic material etc. after proper cleaning and disinfection.

c. **Waste segregation**- Segregation of waste at source and safe storage is the key to whole hospital waste management process. Segregation of various types of wastes into different categories according to their treatment/disposal options should be done at the point of generation in color coded plastic bags/containers as per schedule II of the gazette notification. The needles and syringes should be disinfected and mutilated before segregation.

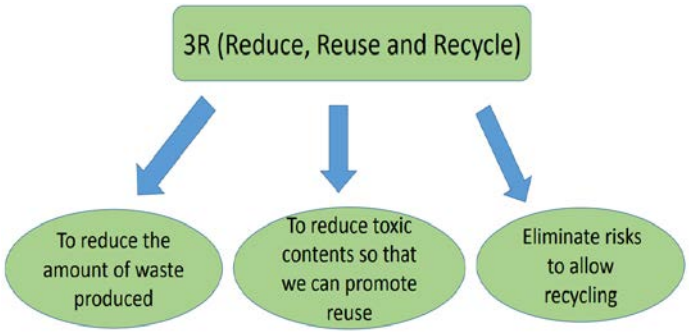
d. **Waste treatment on site** - Microbiological and biotechnology waste being highly infectious should be treated on site by autoclaving/microwaving/chemical treatment.

e. **Waste transportation-** The waste should be transported to kerb collection area in covered container. All containers should have biohazard label according to schedule III of the gazette notification. If a container is transported from the premises where biomedical waste is generated to any waste treatment facility outside the premises, the container shall, apart from the label prescribed in schedule III also carry information prescribed in schedule IV. The containers and the vehicles used for transportation of biomedical waste should not be used for any other purpose. Care should be taken to avoid spills.

f. **Final disposal -** The various disposal options after treatment are incineration, secured landfill, vermicomposting and public sewers. Biomedical waste should be treated and disposed off finally in accordance with schedule I of the rules and the prescribed standards given in schedule V of Govt of India gazette notification

1. Chemical treatment - sharps, solid, liquid and chemical wastes
2. Autoclaving/Microwaving - microbiology/biotechnology, sharps, soiled and solid wastes.
3. Incineration human, animal, microbiology/biotechnology and solid waste.
4. Deep burial in secured landfills - discarded medicines. incineration ash and chemical solid waste such as mercury.
5. Drainage - liquid waste, chemical liquid waste, cytotoxic waste in addition to being toxic are mutagenic hence should never be diluted and discharged into the sewers.

3 R's of BMW Management[9]



Reducing the amount of waste at source -- Generate less waste: less wrapping material, returning gas cylinders to the supplier for refilling. -- Equipment that can be reused such as tableware that can be washed rather than disposable tableware. It is prohibited to re-use needles or syringes.

Sorting at source – Segregating waste is the best way to reduce the volume of hazardous wastes requiring special treatment.

Recycling – Recycling of batteries, paper, glass, metals and plastic.

– Composting of plant waste (kitchen and garden wastes).

– Recycling of the silver used in photographic processing.

Biomedical Waste Management in India[10]

Safe disposal of biomedical waste is now a legal requirement in India. The Biomedical Waste Management & Handling Rules, 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.

It consists of six schedules. Schedule I Schedule II Schedule III Schedule IV Schedule V Schedule VI

Schedule 1. Categories of BMW

Category No. I	Human Anatomical Waste (human tissues, organs, body parts)	incineration/deep burial
Category No. 2	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)	incineration/deep burial
Category No 3	Microbiology & Biotechnology Waste (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 biologicals, toxins, dishes and devices used for transfer of cultures)	local autoclaving/micro-waving/incineration
Category No 4	Waste sharps (needles, syringes, scalpels, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharps)	disinfection (chemical treatment/autoclaving/microwaving and mutilation/shredding
Category No 5	**Discarded Medicines and Cytotoxic drugs (wastes comprising of outdated, contaminated and discarded medicines)**	**incineration@/destruction and drugs disposal in secured landfills**
Category No 6	Soiled Waste (Items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines, beddings, other material contaminated with blood)	Incineration/ autoclaving/microwaving
Category No. 7	Solid Waste (wastes generated from disposable items other than the waste sharps such as tubings, catheters, intravenous sets etc).	disinfection by chemical treatment/autoclaving/ microwaving and mutilation/ shredding
Category No. 8	Liquid Waste (waste generated from laboratory and washing, cleaning, house-keeping and disinfecting activities).	disinfection by chemical treatment and discharge into drains
Category No. 9	Incineration Ash (ash from incineration of any bio-medical waste)	disposal in municipal landfill
Category No. 10	Chemical Waste (chemicals used in production of biologicals, chemicals used in disinfection, as insecticides, etc.)	Chemical discharge into drains for liquids and secured landfill for solids

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.

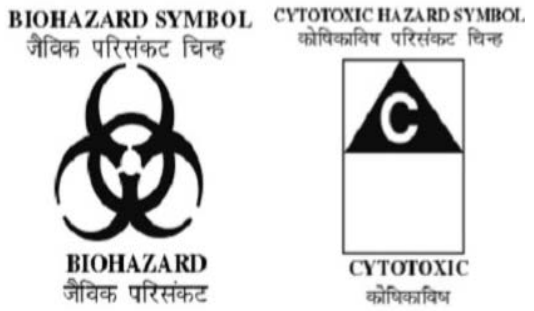
Autoclaving - The autoclave operates on the principle of the standard pressure cooker. The process involves using steam at high temperatures. The steam generated at high temperature penetrates waste material and kills all the microorganism ´ These are also of two types: Gravity type, Pre-vacuum type.

- **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.
- **Shredder:** Shredding is a process by which waste are reshaped or cut into smaller pieces so as to make the wastes unrecognizable. It helps in prevention of reuse of bio-medical waste and also acts as identifier that the wastes have been disinfected and are safe to dispose off. A shredder is to be used for shredding in bio-medical waste with minimum requirements (Singh & Sharma 1996; Shah et al, 2001; Rasheed et al, 2005).

Rule 1998 schedule II

Color coding	Type of container	Waste categories
Yellow 	Plastic bags	Cat 1 human anatomical waste Cat 2 Animal Waste Cal 3 Microbiological Waste Cat 6 Solid Waste
Red 	Disinfected container plastic bags	Cat 3 Microbiological Cat. 6 Soiled Dressing
Blue/white 	Plastic bags, puncture proof containers	Cat. 4 Waste sharp Cat.7 Plastic disposable
Black 	Do	Cat. 5 Discarded medicine Cat. 9 Incineration ash Cat 10 Chemical Waste

Schedule III: Label for Bio-Medical Waste Containers/Bags



Schedule IV Waste description

Sender's Name & Address

Receiver's Name & Address

Phone No ….....….. Phone No .....……

Telex No ….....Telex No ……..…….

Fax No ……..... Fax No ……..…….

Contact Person …….....

Contact Person …… In case of emergency please contact Name & Address: Phone No.

Note: Label shall be non-washable and prominently visible.

Schedule-V - Standards for Treatment and Disposal of Bio-Medical Wastes

Standards For Incinerators.

All incinerators shall meet the following operating and emission standards:

A. Operating Standards

1. Combustion efficiency (CE) shall be at least 99.00%.
2. The temperature of the primary chamber shall be 800 ± 50c .
3. The secondary chamber gas residence time shall be at least 1 (one) second at 1050 ± 50c with minimum 3% Oxygen in the stack gas**.**

B. Emission Standards

Parameters	**Concentration mg/Nm^3 at (12% CO2 correction)**
(1) Particulate matter	150
(2) Nitrogen Oxides	450
(3) HCl	50

(4) Minimum stack height shall be 30 metres above ground.

(5) Volatile organic compounds in ash shall not be more than 0.01%.

Schedule VI- Schedule for waste management facilities like incinerator/autoclave / microwave system.

e management facilities like incinerator/autoclave / microwave system.

SCHEDULE FOR WASTE MANAGEMENT FACILITIES LIKE INCINERATOR/AUTOCLAVE / MICROWAVE SYSTEM

A. Hospitals and nursing homes in towns with population of 30 lakhs and above	By 30th June, 2000 or earlier
B. Hospitals and nursing homes in towns with population of below 30 lakhs -	
(a) with 500 beds and above	By 30th June, 2000 or earlier
(b) with 200 beds and above but less than 500 beds.	By 31st December, 2000 or earlier
(c) With 50 beds and above but less than 200 beds	By 31st December, 2001 or earlier
(d) With less than 50 beds	By 31st December, 2002 or earlier
C. All other institutions generating bio-medical waste not included in A and B above.	By 31st December, 2002 or earlier

Benefits of Biomedical Waste Management[1]

- 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.

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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