A GENERAL STUDY OF BIOMEDICAL WASTE MANAGEMENT: FOR AWARENESS AND PRACTICES

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Abstract

Biomedical Waste Management has become a significant concern for both professional and general community as improper management poses risks to the health care workers, waste handlers, patients, community in general and largely the environment. The objective of this study is to provide the awareness about various aspects of biomedical wastes to professionals and general community. It should be helpful to implement biomedical waste management procedures/rules for all.

1. Introduction:

Bio-medical waste means 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 biological. 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.

Biomedical Waste consists of solids, liquids, sharps, and laboratory waste that are potentially infectious or dangerous. It must be properly managed to protect the general public, specifically healthcare and sanitation workers who are regularly exposed to biomedical waste as an occupational hazard. Biomedical waste differs from other types of hazardous waste, such as industrial waste, in that it comes from biological sources or is used in the diagnosis, prevention, or treatment of diseases. Common producers of biomedical waste include hospitals, health clinics, nursing homes, medical research laboratories, offices of physicians, dentists, and veterinarians, home health care, and funeral homes.

The Government of India specifies that Hospital Waste Management is a part of hospital hygiene and maintenance activities. This involves management of range of activities, which are mainly engineering functions, such as collection, transportation, operation or treatment of processing systems, and disposal of wastes.

2. Sources of Bio-Medical Waste:

While urban solid waste has attracted the attention of town planners, environmental activists and civic administrators, there is yet lack of concern for some special sources of waste and its management. One such waste is bio-medical waste generated primarily from health care establishments, including hospitals, nursing homes, veterinary hospitals, clinics and general practitioners, dispensaries, blood banks, animal houses and research institutes. The other sources of biomedical waste are the following: Households, Industries, education institutes and research centres, Blood banks and clinical laboratories, Health care establishments (for humans and animals).

Table1: Major and Minor Sources of Healthcare Wastes

Major sources of Healthcare wastes	**Minor Sources of Healthcare wastes**
Hospitals	Doctors' offices
Clinics	Dentists
Nursing homes	Ophthalmologists
Dispensaries	Homes
Laboratories	Acupuncturists
Medical Colleges and research centres	Psychiatric clinics
Veterinary colleges and animal research centres	Cosmetic piercing
Blood banks	Funeral services
Mortuaries	Institutions for disabled persons
Paramedic services	Blood donation camps
Autopsy centers	Households
Old age homes	Industries

	Education institutes
	Research Centers

3. Need for Biomedical Waste Management:

With growing world population today, there is a great need to manage the civic amenities including solid waste collection and disposal. Within the domain of municipal solid waste, biomedical waste acquires a special dimension, since it is infectious and hazardous. It is capable of spreading disease or be harmful to individuals. The content of infectious waste in the total waste generated in a hospital may be about 20 percent only, but it has potential to infect whole of hospital waste if not segregated or transported in a prescribed manner. Waste generated at hospitals and health care facilities is different from, general municipal waste. The municipal waste by and large may need only one of these systems for collection, transportation and final disposal. Against this the biomedical waste may need more systems, since it includes body parts, human and animal tissues, radioactive waste, gauze, cotton, plastics, plaster-of-paris casts, infected liquid waste, blood and laboratory wastes. Medical waste generated at different health care facilities presents environmental and public health risks. An inappropriate treatment and disposal can spread infectious diseases like tuberculosis, hepatitis, enteric fever, HIV infection, or even AIDS.

4. Biomedical Waste Management Process:

There is a big network of Health Care Institutions in India. The hospital waste like body parts, organs, tissues, blood and body fluids along with soiled linen, cotton, bandage and plaster casts from infected and contaminated areas are very essential to be properly collected, segregated, stored, transported, treated and disposed of in safe manner to prevent nosocomial or hospital acquired infection[8].

5. Health impacts of Bio-medical Waste:

Exposure to infectious BMW can result in disease or injury. It may contain infectious agents, toxic or hazardous chemicals or pharmaceuticals, radioactive wastes and waste sharps. The infectious wastes may contain any of the great variety of pathogenic microorganisms. Pathogens in infectious wastes may enter the human body through a number of routes like a puncture or cut in the skin, mucous membranes, by inhalation or ingestion.

Sharps may not only cause cuts and punctures but also infect the wounds if they are contaminated with pathogens. Because of this dual risk – of injury and disease transmission – sharps are considered as a very hazardous waste class.

- Epidemiological studies indicate that a person who experiences one needle - stick injury from a needle used on an infected patient, has risks to be infected with:

•HBV - 30% , •HCV - 1.8%, •HIV - 0.3%

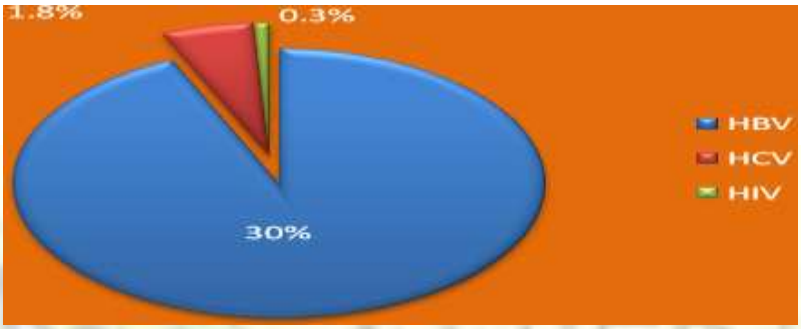

Figure1: Needle Stick Injury Possibilities.

- In 2002, the results of a WHO assessment conducted in 22 developing countries showed that the proportion of healthcare facilities that do not use proper waste disposal methods ranges from 18% to 64% .

Poor hospital waste management may cause the following:

- Hepatitis B & C
- HIV infection
- Gastro-enteric infection
- Respiratory infection
- Blood stream infection
- Skin infection
- Radioactive toxicity
- Health problems associated with air and water pollution.

6. **Waste Recycling/Minimizing:**

Recycling is a resource recovery practice that refers to the collection and reuse of waste materials such as empty beverage containers. The materials from which the items are made can be reprocessed into new products. Material for recycling may be collected separately from general waste using dedicated bins and collection vehicles are sorted directly

from mixed waste streams and are known as kerb-side recycling, it requires the owner of the waste to separate it into various different bins (typically wheelie bins) prior to its collection .

As far as possible, purchase of reusable items made of glass and metal should be encouraged. Select non PVC plastic items. Adopt procedures and policies for proper management of waste generated, the mainstay of which is segregation to reduce the quantity of waste to be treated. Establish effective and sound recycling policy for plastic recycling and get in touch with authorised manufactures.

7. Need for The Segregation of BMW at Source:

- If the proper segregation of the waste is not done at source, then the bio-medical waste might get mixed up with the municipal waste of the hospital.
- The un-segregated BMW may jeopardize the entire process of the bio-medical waste treatment.
- The un-segregated BMW may endanger human and the animal lives.
- It is vital that all the health care units – both in the Government and in the Private Sector – strictly follow the recommended segregation system for bio-medical waste at source.
- Waste segregation is the key to waste minimization and efficient waste collection, transportation, treatment and disposal.

8. Collection of Wastes:

Collection of bio-medical waste should be done as per Bio-medical waste (Management and Handling) Rules. At ordinary room temperature the collected waste should not be stored for more than 24 hours.

9. Transportation:

Within hospital, waste routes must be designated to avoid the passage of waste through patient care areas. Separate time should be earmarked for transportation of bio-medical waste to reduce chances of it's mixing with general waste. Desiccated wheeled containers, trolleys or carts should be used to transport the waste/plastic bags to the site of storage/ treatment.

10. Treatment:

The following methods of treatment are used to decontaminate the infectious/biomedical waste:

Table2: infectious/biomedical treatment

Infectious/Biomedical Waste Type	**Treatment**
Cultures, Stocks of Etiological Agents	Steam sterilization
Infectious Lab waste.	Steam sterilization
Sharps Containers	On-site steam sterilizing or off-site treatment
Infected Body Fluids	Chemical decontamination
Human Body Fluids	Chemical decontamination, steam sterilization, sanitary sewer, or absorbed
Human Pathological Waste	On-site cremation (Magnuson Health Sciences) Pathology or O.R. pathological waste discard station (HMC)
Recombinant DNA Lab Liquid/Solid	Chemical decontamination, steam sterilization, off-site treatment
Prions	Contact the Biosafety Officer
All Other Infectious/Biomedical Waste	On-site steam sterilizing or off-site treatment
ABSL-3 Animal Tissue /Carcasses//Bedding	On-site steam sterilization, then off-site incineration

ABSL-2 Animal Tissue/Carcasses /Bedding	On-site steam sterilization or off-site incineration
Non-Human Primate Bedding	On-site steam sterilization.

11. Disposal:

- Biomedical waste must ***not*** be compacted or placed into the regular garbage before it is decontaminated.
- Trash chutes must ***not*** be used to transfer biomedical waste.
- Biomedical waste, except sharps, must be treated or delivered to a biomedical waste storage/ treatment operator within fourteen (14) days, unless otherwise approved by the health officer.
- Sharps waste must be disposed of or be transported to a storage treatment facility within ninety (90) days starting from the time the sharps container is sealed.

12. **Infectious Causes:**

Some infectious caused by biomedical waste are given below:

Table3: Types of Infectious Caused by Biomedical Waste

Infection Type	Pathogen Agents	Transmission Path
Gastrointestinal infections	Enterobacteria: Salmonell, Shigella spp. Vibrio cholera Helminths	Faeces or/and vomiting liquid
Respiratory infections	Mycobacterium tuberculosis Measles virus Stresptococcus pneumonae	Respiratory secretions, saliva
Eye infections	Herpes Virus	Eye secretions

Genital Infections	Neisseria gonorrhoeae Herpes virus	Genitalsecretions
Skin Infections	Streptococcus spp.	Purulent secretions
Anthrax	Bacillus anthracis	Secretions of skin lesions
Meningitis	Neisseria meningitidis	LCR
AIDS	HIV	Blood, semen, vaginal secretions
Haemorrhagic fevers	Junin Viruses, Lassa, EbolaMarburg	Biological fluids and secretions
Septicemia	Staphylococcus ssp	Blood
Viral Hepatitis type A	VHA	Faeces
Viral Hepatitis Type B and C	VHB, VHC	Blood, biological fluids

13. Categories of Bio-Medical Waste:

Biomedical wastes are categories according to rules 1998 by Ministry of Environment and Forests, India:

Table4: Categories of Bio-Medical Waste

Waste Category No.	**Waste Category [Type]**	**Treatment ad Disposal [Option+]**
Category No. 1	**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	incineration@/deep burial*

	from hospitals, animal houses)	
Category No. 3	**Microbiology & Biotechnology Waste** (wastes from laboratory cultures, stocks or specimens of microorganisms live or attenuated vaccines, human and animal cellculture 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/microwaving/ 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 treat- ment@01/auto claving/micro-waving and multilation/ shredding"
Category No. 5	**Discarded Medicines and Cytotoxic drugs** (wastes comprising of outdated, contaminated and discarded medicines)	inc incineration @/destruct ion and drugs disposal in secured landfills
Category No. 6	**Solid Waste** (Items contaminated with blood, and body fluids including cotton, dressings, soiled plaster casts, lines, beddings, other material contaminated with blood)	incineration@ autoclaving/microwa ving
Category No. 7	**Solid Waste** (wastes generated from disposable items other than the waste [sharps] such as	disinfection by chemical treatment@@ autoclaving/microwa ving and multilation/

	tubings, catheters, intravenous sets etc).	shredding##
Category No. 8	**Liquid Waste** (waste generated from laboratory and washing, cleaning, housekeeping and disinfecting activities)	disinfection by chemical treatment@@ and discharge
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 indisinfection, as insecticides, etc.)	chemical treatment@@ and discharge into drains for liquids and secured landfill for solids.

@ Chemicals treatment using at least 1% hypochlorite solution or any other equivalent chemical reagent. It must be ensured that chemical treatment ensures disinfection.

Multilation/shredding must be such so as to prevent unauthorized reuse.

@ There will be no chemical pretreatment before incineration. Chlorinated plastics shall not be incinerated.

* Deep burial shall be an option available only in towns with population less than five lakhs and in rural areas.

14. Colour Coding for Disposal of BMW:

Colour coding and type of container for disposal are defined in rules 1998 by Ministry of Environment and Forests, India:

Table5: Colour Coding And Type Of Container For Disposal Of BMW

Colour Coding	Type of Container -I WasteCategory	Treatment options as Per Schedule I

Yellow	Plastic bag Cat. 1, Cat. 2, and Cat. 3, Cat. 6.	Incineration/deep burial
Red	Disinfected container/plastic bag Cat. 3, Cat. 6, Cat.7.	Autoclaving/Microwaving/ Chemical Treatment
Blue/ translucent	Plastic bag/puncture proof Cat. 4, Cat. 7. Container	Autoclaving/Microwaving/ Chemical Treatment and destruction/shredding
Black	Plastic bag Cat. 5 and Cat. 9 and Cat. 10. (solid)	Disposal in secured landfill

Notes:

1. Colour coding of waste categories with multiple treatment options as defined in Schedule I, shall be selected depending on treatment option chosen, which shall be as specified in Schedule I.

2. Waste collection bags for waste types needing incineration shall not be made of chlorinated plastics.

3. Categories 8 and 10 (liquid) do not require containers/bags.

4. Category 3 if disinfected locally need not be put in containers/bags

15. Present Scenario:

Waste management is one of the important public health measures. If we go into the historical background, before discovery of bacteria as cause of disease, the principle focus of preventive medicine and public health has been on sanitation. The provision of potable water, disposal of odor from sewage and refuse were considered the important factors in Prevention of epidemics. The current status of practice in India is given in Figure.

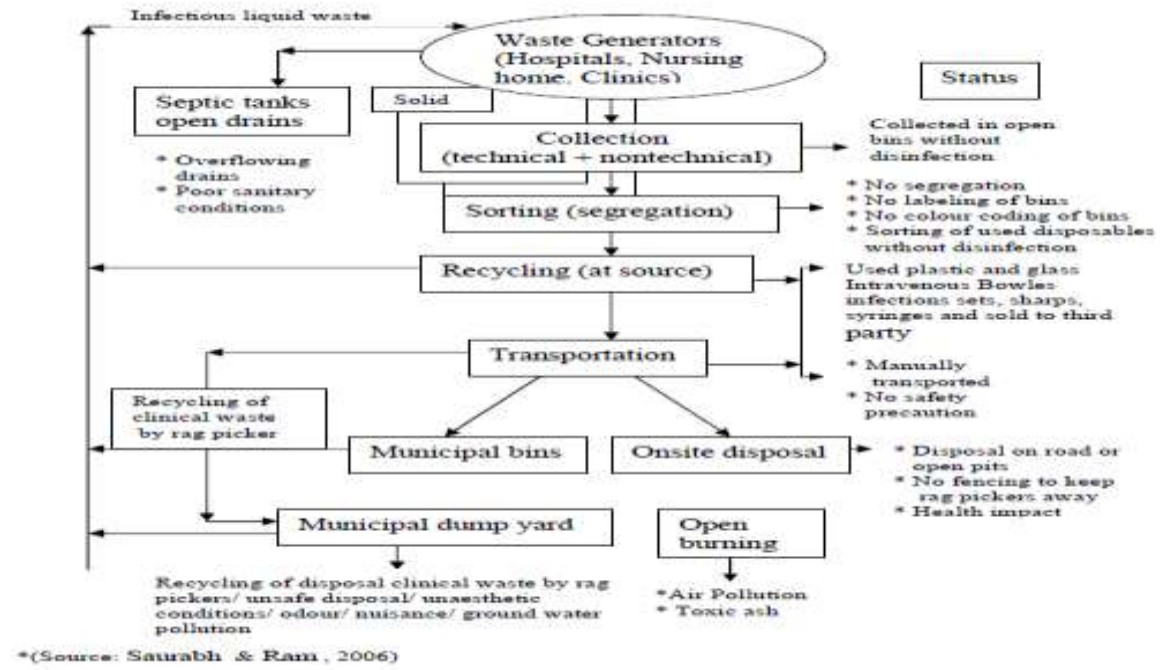

Figure2: Current status of medical waste disposal in India [5].

16. BIO-MEDICAL WASTE MANAGEMENT RULES, 1998 (AMENDED IN 2000 AND 2003):

Under the Environmental Protection Act 1986, the Bio-Medical Waste Management Rules were introduced. These Rules are directly relevant to the health sector. The salient features of these Rules are as follows:

- Bio-medical wastes mean waste that 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 biological.
- It is the duty of every occupier of an institution generating bio-medical waste which includes a hospital, nursing home, clinic, dispensary, veterinary institution, animal house, pathological laboratory, blood bank by whatever name called to take all steps to ensure that such waste is handled without any adverse effect to human health and the environment.
- Bio-Medical waste shall not be mixed with other wastes.
- Bio-Medical waste shall be segregated into containers/bags at the point of generation in accordance with Schedule II of these Rules prior to its storage,

transportation, treatment and disposal. The containers shall be labelled according to Schedule III of these Rules.

- Bio-Medical waste shall be treated and disposed of in accordance with Schedule I of these Rules, which gives the categories of waste and methods for treatment and disposal. The Rules also require compliance with the standards prescribed in Schedule V, which gives standards for different treatment technologies. These are covered in the Operational Framework of this IMEP Policy Framework.
- Every occupier of an institution generating, collecting, receiving, storing, transporting, treating, disposing and/or handling bio-medical waste in any other manner shall make an application in Form 1 to the prescribed authority for grant of authorization. This is NOT required for clinics, dispensaries, pathological laboratories, blood banks that provide treatment / service to less than 1000 (one thousand) patients per month.
- Each state or union territory in India is responsible for implementing the Bio-Medical Waste Management Rules, and State Pollution Control Boards in states or Pollution Control. Committees in the union territories are designated as the prescribed authorities.

17. **Bio-Medical Waste Rules 2011: Key Provisions**:

The new Rules on BMW are elaborate, stringent and several new provisions have been added in it. The Rules are not applicable for the radioactive waste, hazardous waste, municipal solid waste and battery waste which would be dealt under the respective rules.

Table6: BMW Rules 2011 vs. 1998

2011	**1998**
Every occupier generating BMW, irrespective of the quantum of wastes comes under the BMW Rules and requires to obtain authorisation	Occupiers with more than 1000 beds required to obtain authorisation
Duties of the operator listed	Operator duties absent
Categories of Biomedical Waste reduced to Eight	Biomedical waste divided in ten categories
Treatment and disposal of BMW made	Rules restricted to HCEs with more

mandatory for all the HCEs	than 1000 beds
A format for annual report appended with the Rules	No format for Annual Report
Form VI i.e. the report of the operator on HCEs not handing over the BMW added to the Rules	Form VI absent

18. Guidelines for Packaging Wastes:

The following are some guidelines to remember when packaging waste:

- Double bag if necessary to prevent perforations.
- Add absorbent material if the possibility of large volumes of liquid exists.
- Ensure the bags are well sealed.
- Do not overfill the containers/bags.
- If the outside of the bag is contaminated, double bag.
- Secondary containment should also be labeled with the **biohazard symbol**.

19. Bio hazard symbol:

• Developed by the Dow Chemical Company in 1966 for their containment products.

•This sign been developed by in such a way that it should be memorable but meaningless, so that we could educate people as to what it means.

Figure3: Bio-hazard SymbolOverview of Biomedical Waste Disposal Procedures:

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Appendix B - Overview of Biomedical Waste Disposal Procedures

	Biological Lab Waste		Sharps	Anatomical/Animal Waste		Blood an Bodily Fluid Waste		
Identification	Cultures, stocks or specimens of microorganisms, live or attenuated vaccines, human or animal cell cultures and laboratory material that has come into contact with these (solid and liquid).		Needles, syringes with needles, lancets, scalpels, razor blades, and precision knives. Contaminated broken glass, pipettes, test tubes, microscope slides, blood vials or any other material capable of causing punctures or cuts.	Animals carcasses, tissues and body parts, infectious bedding, liquid or semi-liquid blood and blood products, body fluids, items contaminated with blood bodily fluids		Fluid blood and blood products, items saturated or dripping blood, body fluids contaminated with blood and body fluids removed for diagnosis during surgery, treatment or autopsy. This does not include urine or feces.		
Segregation	Solid	Liquid		Radioactive carcasses		Saturated items	Vials	Fluids
Containment	Orange autoclavable biohazard bag	Rigid, leak-proof container (i.e flask)	Approved sharps container	Black garbage bag		Black garbage bag	Approved sharps container	Rigid, leak-proof container
Labeling	University of Ottawa Hazardous waste label		University of Ottawa Hazardous waste label	University of Ottawa yellow necropsy label (individual bags)		University of Ottawa yellow necropsy label (individual bags)	University of Ottawa Hazardous waste label	University of Ottawa Hazardous waste label
Treatment	Autoclave or chemical decontamination							Autoclave or chemical decontamination
Packaging for disposal	Once treated affix a 'non-hazardous waste' sticker Place inside a sealed black garbage bag		Place inside approved cardboard box double lined with 2 yellow biohazard bags	Place inside designated Place inside approved cardboard drum double lined with 2 red biohazard bags		Place inside approved cardboard drum double lined with 2 red biohazard bags	Place inside approved cardboard box double lined with 2 yellow biohazard bags	⊗ For larger volumes (+ 300ml) contact ORM
Storage			Designated biomedical waste cage	Store in designated cold storage (at least 4°C) Allow to decay in designated freezer		Store in designated cold storage (at least 4°C)	Designated biomedical waste cage	
Records			Sharps disposal log	Radioactive carcass disposal log			Sharps disposal log	
Disposal	Regular garbage	Pour down drain*	Picked up by ORM – sent off-site	ORM will arrange for off-site disposal		Picked up by ORM – sent off-site for incineration	Picked up by ORM – sent off-site	Pour down drain*

* In accordance with the sewer use by-laws

Detailed information is available in the Biomedical Waste Disposal Procedures

Figure4. B**iomedical Waste Disposal Procedures**

Source: . BM**W Disposal Procedures, University of Ottawa, 2007 [7].**

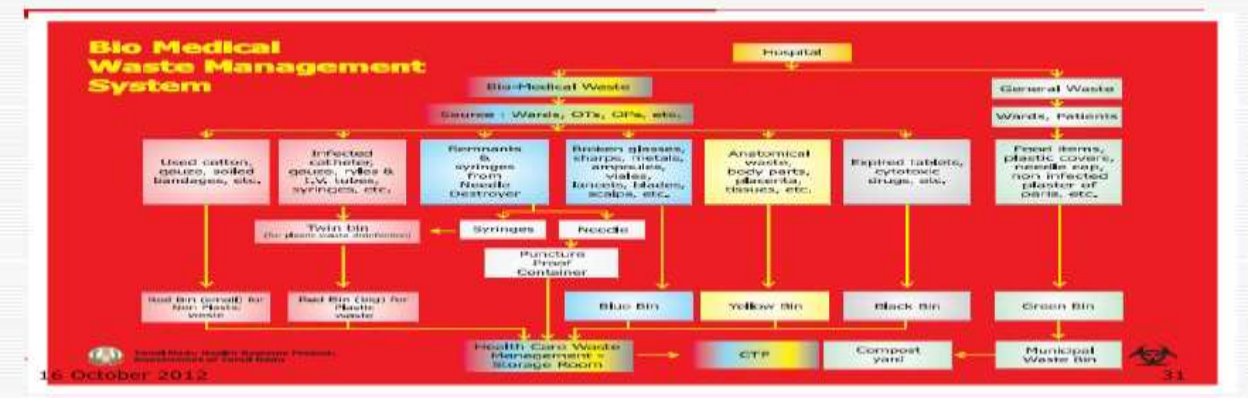

Figure5. B**iomedical Waste Management System**

Source: . **Unified Protocol of BMW Management System [1].**

Figure6. Disposal of B**iomedical and General Wastes.**

Source: . **Unified Protocol of BMW Management System [1].**

20. Recommendations

All the generators of bio–medical waste should adopt universal precautions and appropriate safety measures while doing therapeutic and diagnostic activities and also while handling the bio-medical waste. It should be ensured that:

- Wash your hands with soap and warm water after handling biomedical waste. Also, wash all areas of your body with soap and water that you think may have come into contact with biomedical waste, even if you are not sure your body actually touched the biomedical waste.
- Drivers, collectors and other handlers are aware of the nature and risk of the waste.
- Workers are protected by vaccination against tetanus and hepatitis B.
- Employment of cost-effective and available relevant technology.
- Keep all sores and cuts covered.
- Protective gears provided and instructions regarding their use are given.
- Segregation should start at the source of generation and by the generator itself.
- Segregation of the hospital wastes according to the available disposal technology.
- Immediately replace wet bandages with clean, dry bandages.
- To institute awards for safe hospital waste management and universal precaution practices.
- Wear disposable latex gloves when handling biomedical waste. Discard the gloves immediately after use.

- Training should be conducted to all categories of staff in appropriate language/medium and in an acceptable manner.
- Proper labeling of the waste should be done.
- Wear an apron or another type of cover to protect your clothes from contact with the waste. If your clothes become soiled, put on fresh clothes, and take a shower, if possible.
- Safety of medical staff/rag-pickers, by the use of gloves and masks and housekeeping aspects (drinking water, sewage system of the hospitals).
- Transportation of Black and Yellow bag should preferably be done separately to avoid mixing of waste.
- Transportation should be done in closed trolleys and by separate route.
- Setting up of common medical waste treatment facilities for/by different hospitals such as transportation of the hazardous waste to the common disposal system to reduce expenditure.
- Launder or throw away clothes soiled with biomedical waste.
- Implementation of recycling etiquette by medical and paramedical personnel.
- Promptly clean and disinfect soiled, hard-surfaced floors by using a germicidal or bleach solution and mopping up with paper towels.
- Sensitization of waste generators and health care providers should be done more frequently, and separate sensitization programs should be organized for sweepers and fourth class health care workers in local language emphasizing the importance of using personal protective measures and immunization for Hepatitis B.
- Implementations of legislations pertaining to hygiene of freelance workers such as rag pickers in the recycling industry.
- Written instructions, provided regarding the procedures to be adopted in the event of spillage/ accidents.
- Training of Municipality workers by medical personnel in handling of medical waste to avoid risks and health hazards.
- Each and every hospital must have well planned awareness and training programme for all categories of personnel including administrators (medical, paramedical and administrative).

- Effective implementation of rules by surprise visits and inspection by appropriate authorities and fixing accountability of each and every person involved in management of Bio- Medical waste.
- Possibilities of recycling to be explored in a scientific and hygienic manner for permissible items.
- All the medical professionals must be made aware of Bio-medical Waste (Management and Handling) Rules 1998.

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