BIOMEDICAL WASTE MANAGEMENT

Biomedical waste management-Types of waste, Major And minor sources of biomedical waste, Categories and classification of biomedical waste, Hazards of biomedical waste, Need for disposal of biomedical waste, Waste minimization, Waste segregation and labeling, Waste handling and disposal

1. Biomedical Waste Management P10

Biomedical waste is any waste which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining there to or in the production or testing of biological and its categories.

- It includes the waste originating from minor or scattered sources.
    - eg: waste produced during healthcare at home (i.e.) dialysis, insulin, injections.
- Between 75% to 90% waste from housekeeping and administrative functions. (i.e.) domestic waste can be disposed.
- But remaining 10% to 25% healthcare waste is regarded as hazardous and may create a variety of health risks.

1.1 Types of waste P10

Infectious waste

- It is suspected to contain pathogenic organisms i.e. bacteria, viruses, parasites or fungi in sufficient concentration or quantity to cause disease in susceptible hosts. This category includes the following wastes:
- Cultured and stocks of infectious agents from clinical laboratories.
- Wastes from surgery and autopsies done on patients suffering from infectious diseases (e.g. tissues, materials or equipment that have been in contact with blood or other body fluids).
- Excreta, dressing from infected/ surgical wounds, clothes heavily soiled with human blood or other body fluids from infected patients in insolation wards.
- Dialysis equipment such as tubing and filters, gown, aprons, gloves, disposable tower and laboratory coats which have been in contact with infected patients undergoing hemodialysis.
- Infected research animals from laboratories.
- Any other instruments or materials that have been in contact with infected persons or animals.
- Cultures and stocks of highly infectious organisms, waste from autopsies, animal bodies other waste items inoculated, infected, or in contact with such agents are called highly infectious wastes.

Pathological waste

- It consists of tissues, organs, body parts, human fetuses and animal carcasses, blood and body fluids.
- Anatomical waste i.e. recognizable human or animal body parts also comes under this category.
- Even-though this category may include healthy body parts, it should be considered as a subcategory of infectious waste.

Sharps

- Sharps are items that could cause cuts or puncture wounds including needles, hypodermic needles, scalpel and other blades, knives, infusion sets, saws, broken glass and nails irrespective of the associated infection potential, such items are usually considered as highly hazardous healthcare waste.

Pharmaceutical waste

- It includes expired, unused, spilt and contaminated pharmaceutical products, drugs, vaccines and sera that are no longer required and require appropriate disposal also included are the discarded items used in the handling of pharmaceuticals such as bottles or boxes with residues, gloves, masks, connecting tubing and drug vials.

Genotoxic waste

- It is highly hazardous and it may have mutagenic, teratogenic or carcinogenic properties.it poses serious safety threats, both inside hospitals and after disposal.
- It includes certain cytostatic drugs, feces, urine or vomit from patients treated with cytostatic drugs, chemicals and radioactive materials.
- The principal substances in this category, cytotoxic or antineoplastic drugs, have the ability to kill or stop the growth of certain living cells.
- Due to this property, they are used in chemotherapy of cancer.

Most common genotoxic products used in healthcare

A. Classified as carcinogenic
    - chemicals, benzene
    - Cytotoxic and other drugs
B. Classified as possibly or probably carcinogenic.

Chemical Waste

- It consists of discarded solids, liquids and gaseous chemicals, i.e. those generated from diagnostic and experimental work and from procedures like cleaning, housekeeping and disinfection.
- Chemical waste from healthcare may be hazardous and non-hazardous.

Properties of hazardous chemical waste

- Toxic
- Corrosive
- Flammable
- Reactive(explosive, water-reactive, shock-sensitive)
- Genotoxic (e.g. cytostatic drugs)

Properties of non-hazardous chemical waste

- Sugars
- Amino acids
- Organic and inorganic salts
- Formaldehyde chemical used for cleaning and disinfectant of equipment, specimens, preservation, pathology, dialysis and nursing units.
- Solvents containing waste from various departments contain halogenated and nonhalogeneted compounds.

TYPES OF WASTE **P11**

Photographic/Radiographic Chemicals

- The fixer and developer solutions used in X-ray departments contain hazardous chemicals.
- The fixer contains hydroquinone 5 to 10 percent, potassium hydroxide 5%, silver<1 % and acetic acid.

Organic Chemicals

- In hospitals, disinfecting and cleaning solutions (phenol, perchlorethylene)
- Vaccum-pump oils use engine oil from vehicles
- Insecticides and rodenticides.

Inorganic Chemicals

- Waste inorganic chemicals consists of acids (e.g. sulfuric, hydrochloric, nitric and chromic acids)
- Alkalis (e.g. sodium hydroxide and ammonia solutions)
- Oxidants (e.g. potassium permanganate and potassium dichromate)
- Reducing agents (e.g. sodium sulfite and sodium bisulfite)

Waste with high content of heavy metals

- Mercury, cadmium, lead, arsenic are highly toxic.
- Mercury volume of the waste is decreased with the substitution of equipment with solid-state electronic sensing instruments (e.g. thermometers, blood pressure, gauges).
- Cadmium waste enters the waste stream mainly from discarded batteries.
- Lead containing reinforced wood panels are used as protection against X-rays and diagnostic departments.
- Arsenic compounds used in pharmaceutical purposes.

Pressurized containers

- Gases used in healthcare are often stored in pressurized cylinders, cartridges and aerosol cans.
- It may explode if incinerated or accidently punctured.
- Commonly used gases in health care are as follows

Anesthetic gases

- Nitrous Oxide and volatile halogenated hydrocarbons

Applications

- Hospital operating theaters
- Maternity hospital
- Ambulances
- In general hospital wards during painful procedures.
- In dentistry for sedation

Elhylene oxide

- For sterilization of surgical equipment and medical devices
- In central supply areas
- In operating rooms

Oxygen

- Stored in tanks or cylinders in the form liquid or gaseous state.

Applications

- Inhalation supply for patients

Compressed air

Applications

- In laboratory works
- Inhalation therapy equipment
- Maintenance equipment
- Environmental control systems

Radioactive waste

- It includes solids, liquids and gaseous wastes contaminated with radionuclides from nuclear medical diagnostic and therapeutic procedures.
- Disposal of such waste require special techniques in sealed sources and unsealed sources.

1.2 Major and Minor Sources Of Healthcare Waste P12

Major sources of Healthcare Waste

- In hospitals
    - Healthcare teaching institutions and hospitals
    - General hospitals
    - District hospitals
- Other Hospital Establishments
    - Emergency medical care services
    - Obstetric and maternity clinics
    - Healthcare centers and dispensaries
    - Outpatient clinics
    - Transfusion clinics
    - Military medical services
    - Dialysis centers
    - First-aid posts and sick bays
    - Long-term healthcare establishments and hospitals

- **Minor Sources of Healthcare Waste**

  Small Healthcare Establishments
    - Physician's offices
    - Dental clinics
    - Chiropractors
    - Acupuncturistics

  Specialized Healthcare Establishments and Instructions with Low waste generation
    - Psychiatric hospitals
    - Convalescent nursing homes
    - Disabled person's institutions

  Intravenous or Subcutaneous Intervention Activities other than healthcare
    - Cosmetic body-piercing and tattoo parlors
    - Illicit Drug Users.

1.3 Categories And Classification Of Biomedical Waste P13

1.3.1 Categories of biomedical waste

OPTION	Waste category	Treatment and disposal
Category 1	Human anatomical waste	Incineration /deep burials
Category 2	Animal waste	Incineration /deep burials
Category 3	Microbiology and Biotechnology waste	Local autoclaving/microwaving incineration
Category 4	Waste Sharps	Disinfection
Category 5	Discarded medicines and Cytotoxic drugs	Incineration/destruction and drugs disposal in secured landfills
Category 6	Solid waste (contaminated with blood)	Incineration autoclaving/microwaving
Category 7	Solid waste (disposable items waste)	Disinfection by chemical treatment, microwaving, mutilation/shredding.
Category 8	Liquid waste (lab waste, housekeeping, cleaning)	Disinfection by chemical treatment, microwaving, mutilation/shredding.
Category 9	Incineration ash	Disposal in municipal landfill
Category 10	Chemical waste	Chemical discharge into drains for liquids and secured landfill for solids.

Color Coding And Type Of Container For Disposal Of Biomedical Wastes

Color coding	Container type	Waste category	Treatment options
Yellow	Plastic bag	Cat1, 2, 3, 6	Incineration/deep burial
Red	Disinfected container/plastic bag	Cat3, 6, 7	Autoclaving/microwaving/chemical treatment
Blue/white translucent	Plastic bag/puncture proof container	Cat 4, 7	Autoclaving/microwaving/chemical treatment/destruction/shredding.
Black	Plastic bag	Cat5,9, 10(solid)	Disposal in secured landfill

1.3.2 Classification of Biomedical waste P13

Methods used by various agencies for the classification of biomedical waste

1. **WHO Classification for developing countries**
    a. General nonhazardous waste
    b. Infected waste (not containing sharps)
    c. Sharps
    d. Chemical and pharmaceutical wastes
    e. Other hazardous waste-cytoxic and radioactive

2. Classification based on nature of waste -Hazardous waste

A. Potentially infectious waste

1. Potentially infected material such as excised tumors and organs, placenta removed during surgery.
2. Potentially infected animals which are used in diagnostic and research studies.
3. Laboratory waste such as lab culture stocks of infectious agents.
4. Dressings and swabs contaminated with blood, pups and body fluids.
5. Blood and blood products.
6. Sharps including blades, needle, syringes.

B. Potentially toxic waste

1. Radioactive waste

It means waste contaminated with radio-nuclides in the form of solid, liquids or gaseous waste. These wastes are generated during in vitro analysis of body fluids and tissue, therapeutic procedures and in vitro imaging.

2. Chemical waste

It includes disinfectants (sodium hypochlorlite, glutaraldehyde, phenolic derivatives, iodophors and alcohol-based preparations), X-ray processing solutions.

3. Pharmaceutical waste

It includes antibiotics, anesthetics, analgesics, analgesics, sedatives, etc.

Nonhazardous waste

- It constitutes about 85% of the waste generated in most healthcare establishments. This includes waste comprising of food remnants, fruit peels, waste paper, packaging material.

1.4 Hazards Of Biomedical Waste P14

- Waste from healthcare establishments should be collected and segregated for proper treatment in a hygienic manner.
- But, municipalities collect this waste and dispose it off in outskirts of cities and towns.
- Thus, biomedical waste emits foul smell during the rainy season and spreads various diseases such as dengue, HIV infections and remains dormant in human body for many years like hepatitis B, C and cancer.

1.4.1 Types Of Hazards

The exposure to hazardous healthcare waste can result into:

1. Infection
2. Physical injuries
3. Chemical injuries
4. Radioactivity hazards
5. Genotoxicity and cytotoxicity
6. Public sensitivity

Infection

- Portal of entry of the infectious agent into the body may be:
    1. Through a puncture, abrasion or cut in the skin
    2. Through mucous membranes
    3. ion and ingestion
- Most common infections, which can result from mishandling of hospital/healthcare waste are:
    1. Gastroenteric infections through feces or vomit.
    2. Respiratory infections through inhaled secretions, saliva.
    3. Genital infections
    4. Ocular infections through eye secretions
    5. Skin infection through pus
    6. AIDS through blood and sexual secretions
    7. Meningitis through cerebrospinal fluid
    8. Septicemia and bacteremia through blood
    9. Viral hepatitis B and C through blood and body fluids
    10. Hemorrhagic fevers through body fluids

Physical injuries

- Can be attributed to sharps, chemicals and explosive agents.

Chemical injuries

- Various chemicals and pharmaceutical drugs which are used in hospitals for different purposes have potentially harmful effects.
- These effects may be due to the physical properties and chemical nature of these products.
- They may result in toxicity by both acute or chronic exposure and injuries like burns.

Radioactivity hazards

The exposure to radioactive waste may cause headache, dizziness, vomiting, tissue damage, genotoxicity, etc.

Genotoxicity and cytotoxicity

- Most cytotoxic drugs are extremely irritant.
- Their direct contact with skin and eyes also produces harmful local effects.
- Many pharmaceutical drugs are carcinogenic and mutagenic, secondary neoplasia is known to be associated with chemotherapy.

Public sensivity

- Every individual who is exposed to hazardous healthcare waste is potentially at risk, including those within healthcare establishments that generate hazardous waste, and those outside these sources who either handle such waste or are exposed to it as a consequence of careless management.
- The main groups at risks are the following:
    - Doctors, dentists, nurses, healthcare assistants and hospital maintenance personnel.
    - Patients in healthcare establishments or receiving home care and visitors at these sites.
    - Workers in allied support services to healthcare establishments such as laundries, waste handling and transportation.
    - Workers in waste disposal facilities (such as landfills or incinerators) including scavengers.

1.4.2 Hazards From Infectious Waste And Sharps

- Transmission of human immune deficiency virus (HIV) and Hepatitis viruses B and C via healthcare waste has emerged as a serious threat to public.
- These viruses are generally transmitted through injuries from sharps contaminated with human blood.
- The practice of reusing the syringes/ needles is still going on in rural India. Hence, putting an innumerable and recorded number of persons at risk.
- The evolution and spread of bacteria resistant to antibiotics and chemical disinfectants may also be related to poorly managed healthcare waste.
- FOR EG, plasmids from laboratory strains contained in healthcare waste can be transferred to indigenous bacteria via the waste disposal system.

Contaminated sharps (Particularly hypodermic needles) are probably the most acute potential hazards to health because:

1. Sharps, if they are contaminated with pathogens, may not only cause cuts and punctures, but also infect these wounds.
2. The infections that amy be transmitted by subcutaneous introduction of the causative agent.eg, viral blood infections as hypodermic needles are often contaminated with patient's blood.

Impacts Of Infectious Waste And Sharps

- A part from spreading serious infections such as HIV/AIDS, HBV AND HCV to healthcare workers (especially nurses), contaminated sharps (particularly hypodermic needles) can put at risk other hospital workers, waste management operators outside hospitals and scavengers on waste disposal sites.

- Certain infectious may spread through other media or caused by more resistance strains/agents. Such infectious may pose a significant risk to hospital's patients and to the general public.
- So another impact is spread of epidemics due to uncontrolled discharge of sewage from hospital down the drains to municipal sanitary sewer.

1.4.3 Hazards From Chemical And Pharmaceutical Waste

- Most of the chemicals and pharmaceutical used in healthcare establishments are hazardous (e.g. toxic, genotoxic, corrosive, flammable, reactive, explosive, shock-sensitive).
- Their intoxication can occur either by acute or by chronic exposure.
- The intoxication and injuries (including burns) are potential hazards.
- Intoxication can result from Inhalation, Ingestion, Absorption of a chemical or pharmaceutical through the skin or the mucous membranes.
- Contact with flammable, corrosive or reactive chemicals (e.g. formaldehyde and other volatile substances) can cause injuries to the skin, eyes or the mucous membranes of the airways, the most commons injuries being the chemical burns
- These substances are commonly present in small quantities in healthcare waste, larger quantities in unwanted or outdated chemicals and pharmaceuticals are disposed off.
- Disinfectants are used in large quantities and often corrosive.
- When their chemicals residues are discharged into the sewage system, they may affect the operation of biological sewage treatment plants adversely and have toxic effects on the natural ecosystems of receiving waters.
- Pharmaceutical residues, including antibiotics and other drugs, heavy metals such as mercury, phenols and its derivatives, disinfectants and antiseptics may pose similar challenges.

Impacts Of Checimal And Pharmaceuticals Waste

- Although chemicals or pharmaceuticals waste from hospitals has not been related to widespread illness among the general public, extensive intoxication caused industrial chemical waste is a well known fact.
- Fish in Sutlej river in Punjab die in masses due to discharge of untreated industrial waste into the river which has raised many eyebrows.

1.4.3 Hazards from genotoxic waste

The severity of the hazards of genotoxic waste is governed by a combination of two factors:

1. Substance toxicity itself
2. The extent and duration of exposure.

Exposure to genotoxic substances in healthcare occurs during:

1. The preparation of particular drug/chemicals.
2. Treatment with particular drugs or chemicals
3. Handling and disposal

The main pathways of exposure are:

1. Inhalation: Inhalation of dust or aerosols
2. Ingestion of food accidently contaminated with cytotoxic drugs, chemicals or waste.
3. Ingestion as a result of bad practice such as mouth pipetting.

4. Contact: absorption through the skin
   Contact with body fluids and secretions of patients undergoing chemotherapy.

Impacts from genotoxic waste

- An increased risk of absorption and increased urinary levels of mutagenic compounds were noted in workers who handled these antineoplastic drugs.
- The exposure of personnel cleaning hospital urinals is found to be more than that of nurses and pharmacists because these individuals were less aware of the danger and take fewer precautions.

1.4.4 Hazards from radioactive waste

- The type and extent of exposure determines the type of diseases caused by radioactive waste. It can range from minor symptoms like headache, dizziness and vomit to more serious problems.
- Because radioactive waste is genotoxic, it may affect genetic material. Handling of highly active sources may cause more severe injuries such as destruction of tissues, necessitating amputation of body parts.
- The exposure surfaces to low-activity waste any arise from contaminated of external surfaces of containers or improper mode or duration of waste storage.
- Healthcare workers or waste-handling or cleaning personnel exposed to his radioactivity are at potential risk.

Impacts of radio active waste

- Improper disposal of nuclear therapeutic materials have led to several accidents in history.a large number of persons are presently suffering from the results of exposure while many of the go unreported.
- The others sources of accidental exposure to ionizing radiations in healthcare settings have resulted from unsafe operation of X-ray apparatus, improper handling of radiotherapy solutions or inadequate control of radioactive waste in New Delhi in april 2010 eft five persons critically.

1.4.5 Public sensitivity

- The general public is very sensitive about the visual impact of anatomical waste, which is recognizable human body parts, including fetuses.
- It is unacceptable to dipose of this anatomical waste such as on a landfill where it is visible to public or to stray animals.
- In Asia, according to the religious beliefs, the human bodies are buried in cemeteries as well as keeping in coffins.

1.5 Need for disposal of biomedical waste P15

- Effective and efficient methods of biomedical waste disposal should be employed to prevent such harms.
- This requires huge investment in terms of money, material, material and machinery.

1.5.1 Health Reasons

- Injuries may lead to infectious to healthcare workers and waste handlers.
- Hospital acquired infection can spread due to poor practices of infection control and waste management.
- Risk of infection for waste handlers, scavengers and general public in the vicinity of hospitals.
- Risks due to drugs and hazardous chemicals to persons handling waste at each level.
- Disposable items being repacked and marketed by unscrupulous elemnts without any disinfectants.
- Repacking and resale of discarded drugs.
- Risk of air, water and soil pollution due to waste itself or its defective disposal.
- Tubercle bacilli spores remain suspended in the air and can spread tuberculosis.
- Soil may be polluted by tetanus spores.
- Pollution of water and food by biological agents results in alimentary infections like typhoid, cholera, infective hepatitis, polio, dysentery, ascariasis and hookworm diesaeas.
- Various vectors of disease transmission such as worms and pests breed on the waste.
  e.g. mosquitoes transmit malaria and filarial.
- Hospital acquired infections like AIDS, hepatitis b,c.

1.5.2 Ethical aspects

- It is the morale duty of healthcare workers to prevent hospitals from becoming centers of disease rather than center of cure.
- The rationale of biomedical waste management includes:
- Raising awareness on public health and environmental hazards associated with
- inappropriate segregation, collection, storage, transport, handling, treatment and disposal of healthcare waste.
- Providing information on hazards and sound management practices of healthcare waste for the policy making, development and improvement of legislation and technical guidelines.
- Identifying safe, efficient, sustainable, economic and culturally acceptable waste management practices and technologies and enabling the participants to identify the systems according to their particular needs.
- Enabling managers of healthcare establishments to develop their waste management plans
- Enabling course participants to develop training programs.

1.5.3 Environmental reasons

Biomedical waste can cause air, water and soil pollution. Although pollution cannot be eliminated completely, efforts can be done to minimize it

Air pollution It is of three types

1. Biological
2. Chemical
3. Radioactive

Biological

A) Air Pollution Inside The Premises

- Pathogens or their spores can enter and remain suspended in the air building of the healthcare establishments for a prolonged period.
- This can result in nosocomial infections or occupational hazards.
- This puts healthcare workers, patient's as well as their attendants at risk of contracting airborne infections.

b) Indoor air pollution can be attributed to:

- Poor ventilation: improper planning and faculty air conditioning results in poor circulation of air within the rooms.so design of the buildings has an important role to play in maintaining proper ventilation.
- Use of chemicals: disinfectants, fumigants release acidic or hazardous gases or vapors into the air.

Outdoor Air Pollution

- When untreated waste is transported outside the healthcare establishments, dumped openly, pathogens in the waste can contaminate drinking water, foodstuff, soil.
- These may also remain in the ambient air and cause airborne diseases in animals and human beings.

Chemicals pollutants

Chemicals pollutants arise in two major sources

A) Open burning, Incinerators

- Open burning of biomedical waste is most harmful practice.
- The plastics and hazardous materials present in the waste generate oxides of sulfur and nitrogen, CO_2, dioxin, furans, suspended particulate matter.
- When inhaled, these harmful chemicals can cause respiratory diseases.
- Out of these, dioxin and furans are carcinogenic.

Radioactive emissions

- Small quantities of radioactive gas are generated durning research and radioimmunoassay activities.
- The clinical application of Kr and Xe are the principal sources of gaseous radioactive waste.

Water pollution

- Improper disposal of biomedical waste for eg dumping in low-lying areas, into lakes and water bodies can lead to severe water pollution.
- Water can be polluted by biological, chemicals or radioactive substances.
- The pathogens and harmful chemicals present in the waste can leach out and contaminate the ground water or surface water.

E**utrophication**

- Algal brooms over surface of water bodies. This occurs mainly because of excess nutrient leachates e.g. nitrates and phosphates from landfills.
- Water pollution can alter parameters such as Ph, biological Oxygen Demand (BOD). Dioxins have been reported from water body from the air.

- Radioactive effluents also pollute water.

Land pollution

- As all types of biomedical waste is finally disposed off on the land, land pollution is inevitable. Even liquid effluent after treatment is spread on land.
- However, if treated in a proper way, pollution can be minimized to a large extent.
- The main sources of soil pollution from biomedical waste are infectious waste, discarded medicines, chemicals waste and other waste generated during treatment processes.
- Heavy metals present in the waste such as cadmium, lead, mercury will get absorbed by plants and can then enter the food chain.
- Excessive amounts of trace nutrient elements and heavy metals in soil are harmful to crops, animals and human beings.
- Open dumping of biomedical waste is the greatest cause for land pollution and landfilling is also not a totally safe method.

1.6 WASTE MINIMIZATION **P16**

Waste minimization is the process and policy of reducing the amount of waste produced by a person or a society.

Need for waste minimization

- A huge stock of waste is generated when hazardous and non-hazardous biomedical waste is mixed which carries a increased environmental hazards, increased risk to the person in direct, indirect contact with waste, increased cost of handling and disposal.
- To overcome such challenges, it is advised to minimize the waste as much as possible.
- It is the duty of the hospital authorities to identify and quantify the waste generated.
- Effective measures should be taken to reduce the amount of waste by controlling demand/inventory and recycling of certain wastes such as paper, glassware, plastic material.
- Healthcare establishments encourages the purchase of reusable items made up of glass. Substitute PVC (Polyvinyl chloride).

Advantages of waste minimization

- Reduced potential for exposures of employees, patients, visitors and waste management personnel to hazards associated with wastes in term of health and safety.
- Reduced volume and toxicity of unavoidable waste.
- Improved transportation, storage, treatment and disposal of waste.
- Proper containment of hazardous materials.
- Prompt removal of hazardous materials from the workplace.
- Long-term economic benefit.

How to do waste minimization?

Apart from protecting people and the environment, waste minimization can save hospitals a great deal of money in the long run. Waste can be minimized by various methods:

1. **Sources reduction:**
    - The amount of waste generated at the source itself can be minimized through product substitution, technology change and good operating practices.
    - By changing the purchasing policies and product substitution, toxicity of the waste generated can be also reduced. The methods that can be adopted are:
    - Prevent wastage of products in nursing and cleaning activities.
    - Prefer physical cleaning methods over chemicals ones.
    - Select supplies that are less wasteful or less hazardous.
    - Centralize the purchasing of hazardous chemicals at hospital level.

2. **Resource recovery and recycling**

- The majority of waste from healthcare facilities is same as that of an office, e.g. paper, cardboard and food wastes.
- Healthcare establishments can implement very simple programs that divert these materials from the solid waste stream, lowering disposal costs.
- Wherever applicable, recycling should be adopted as a method of disposal and recycling should be bought and used.

3. **Waste disposal**
    - For those things that cannot be reduced, reuse or recycled, we ensure that they are disposed in safer manner without affecting environment.
    - E.g: Safer disposal of mobiles and batteries.

Significance

- Cost savings that go directly to the bottom line
- Reduced impact on the environment
- Improved public perceptions
- Development of new and more sustainable processes
- Development of new products.

1.7 Waste segregation P17

Waste segregation refers to the separation of wet waste and dry waste, the purpose is to recycle dry waste easily and to use wet waste as compost.

Persons responsible for Segregation

Duty of Care

- A duty of care on any person who produces imports, carries, keeps, treats or disposes of controlled waste or, as a broker, has control of such waste.
- These are individually called the waste holders.

Those subject to the Duty of Care must try to **achieve** the following:

- To prevent any other person committing any of the offences under s.33 of the Act, namely, disposing of controlled waste or treating or storing it.
- Without an environmental permit; or
- Breaking the conditions of a permit; or in a manner likely to cause pollution of the environment or harm to human health.
- To prevent the escape of waste
- To ensure that, if the waste is transferred, it goes only to an 'authorized person' or to a person for `authorized transport purposes';
- When waste is transferred, to make sure that there is also transferred a written description of the waste, which is sufficient to enable each person receiving it.

Procedure for segregation

What is waste segregation?

- Waste segregation refers to the separation of wet waste and dry waste, the purpose is to recycle dry waste easily and to use wet waste as compost.

Why should we segregate waste?

- When we segregate waste, there is reduction of waste that gets landfilled and occupies space, air and water pollution rates are considerably lowered.
- Segregating waste also makes it easier to apply different processes - composting, recycling and incineration can be applied to different kinds of waste.

Steps to manage and segregate waste:

1. Keep separate containers for dry and wet waste in the kitchen.
2. Keep two bags for dry waste collection- paper and plastic, for the rest of the household waste
3. Keep plastic from the kitchen clean and dry and drop into the dry waste bin.
4. Keep glass/plastic containers rinsed of food matter.
5. Send wet waste out of your home daily.
6. Store and send dry waste out of the home, once a week.
7. Keep a paper bag for throwing the sanitary waste.

Rules for segregation

Keeping wet and dry wastes separately, so that dry can be recycled and wet can be composted.

Dry waste

It does the compost process.

e.g. coconut shells, vegetable waste, bones, dust….etc

Wet waste

It does the reuse and recycle process

e.g. paper, plastic, metal, glass, rexine…etc

Advantages of segregation

- Segregation reduces the amount of waste needs special handling and treatment.
- Effective segregation process prevents the mixture of medical waste like sharps with the general municipal waste.
- Prevents illegally reuse of certain components of medical waste like used syringes, needles and other plastics.
- Provides an opportunity for recycling certain components of medicine waste like plastics after proper and through disinfection.
- Recycling helps to reduce energy usage, reduce the consumption of fresh materials, reduce air pollution and water pollution.
- Reduces the greenhouse emissions.
- Building more space in landfills which takes up valuable space.

1.7.1 Containers For Waste Collection

- Waste must be safely contained during handling and to the point of its disposal.The packaging must remain intact throughout handling, storage, transportation, and treatment.
- When selecting packaging, the following factors should be considered: the type of waste being contained; appropriate colour-coding and labelling (see color coding section); special transportation requirements; the method of disposal; transport requirements; and requirements of the disposal facility.
- To simplify their selection and use, waste containers should be classified as reusable or single-use/disposable.

1.7.2 Reusable Containers:

- Reusable waste containers made of metal or rigid plastic and able to withstand exposure to common cleaning agents.
- They must be colour-coded according to the type of waste for which they are intended ; and labelled with the biohazard symbol.
- Reusable waste containers should be inspected for holes or leaks each time they are emptied and their colour coding and labelling renewed if necessary.
- Holes or leaks must be repaired or the waste container replaced.
- Reusable waste containers must be cleaned regularly to prevent odours and as soon as possible if waste materials leak or spill within the containers.

Single-use Containers

- Single-use waste containers should be classified as one of the following types: sharps container; waste-holding plastic bag; or cardboard container.

Sharps Containers

- The critical characteristic of any sharps container is that it be sturdy enough to resist puncture under conditions of use and to the point of disposal.
- Until a method is devised to determine this objectively, sharps containers should be tested and evaluated under actual conditions of use.

Category	Type of Waste	Type of Bag or Container to be used	Treatment and Disposal options
RED	a) Contaminated Waste (Recyclable)	non-chlorinated plastic bags or containers	Autoclaving or micro-waving followed by shredding or mutilation
White Translucent	Waste sharps including Metals	Puncture proof, Leak proof, tamper proof containers	Autoclaving or Dry Heat Sterilization followed by shredding or mutilation or encapsulation
Blue	a) Glassware b) Metallic Body Implants	Cardboard boxes with blue colored marking	Disinfection (by soaking the washed glass waste in Sodium Hypochlorite) or through autoclaving or microwaving and then sent for recycling

1.7.3 Pickup containers

- This includes moving medical/biohazardous waste more than a few feet within a room.
- Wear and use personal protective equipment (PPE) appropriately when handling medical/biohazardous waste.

- Wear PPE (e.g., lab coat, gloves, safety glasses) to prevent potential contact with and exposure to infectious material.
- In addition, prevent the spread of infectious material by:
  - changing gloves that have been used or may be contaminated,
  - not touching doorknobs or other "clean" surfaces with gloved hands, and
  - washing hands after removing gloves.
- Seal the biohazard bag closed (tape, rubber band, etc.).
- The bio hazard bag must be secondarily contained during transport in a labeled biohazard container with a lid.
- Remove the biohazard bag and deposit it into the pickup container.
- The pickup container must be lined with a red biohazard bag.
- Close the lid on the pickup container after adding the waste.

1.8 Labeling P17

- Proper labeling of hazardous chemical and waste is extremely important to reduce exposure, prevent accidents and extra disposal costs
- OSHA's Hazard Communications Program (HazCom) covers the labeling of hazardous chemicals in use.
- Once the chemical becomes a hazardous waste, a different set of labeling rules apply under EPA's RCRA program (provide link).
- To add to the challenge of labeling all hazardous materials, to prepare hazardous waste for shipment, another set of rules apply under the Department of Transportation (DOT).
- HazCom requires that all containers of hazardous chemicals must be labeled, tagged, or marked with the identity of the material and appropriate hazard warnings.
- Chemical manufacturers, importers, and distributors must ensure that every container of hazardous chemicals they ship is appropriately labeled with such information and with the name and address of the producer or other responsible party.
- The primary information to be obtained from an OSHA-required label is the identity for the material and appropriate hazard warnings.
- The identity is any term which appears on the label, the MSDS, and the list of chemicals, and thus links these three sources of information.
- The identity used by the supplier may be a common or trade name ("Black Magic Floor Cleaner"), or a chemical name (1, 1, 1 - trichloroethane).
- The hazard warning is a brief statement of the hazardous effects of the chemical ("flammable," "causes lung damage").

- Labels frequently contain other information, such as precautionary measures ("do not use near open flame") but this information is provided voluntarily and is not required by the rule.
- Labels must be legible and prominently displayed. There are no specific requirements for size or color or any specified test.
- Proper labeling is extremely important to prevent accidents and extra disposal costs
- Ensure proper labeling of all incoming materials as they are received (Include product name, weight, concentration, lot number, date, hazard class and any other information useful in tracking material location, quality, age or use.)
- Always label hazardous waste at its point of generation where it can still be easily identified (Testing later to determine the contents is expensive.)
- Label all areas in the plant, including stationary tanks, pipelines, etc. containing hazardous materials or wastes
- If a chemical was in a labeled container and is subsequently transferred to another container, the employer must label the new container.
- Shelving the chemical stored may be labeled with additional labeling if when the chemical is removed from the labeled shelf, it will be used in its entirety. If not, it will require an additional label.
- Specifically, HazCom requires the following types of information to ensure that labeling is properly implemented in your facility:
- Designation of person(s) responsible for labeling system implemented throughout the facility;
- Designation of person(s) responsible for ensuring labeling of all containers in each department/area
- Designation of person(s) responsible for ensuring re-labeling of hazardous waste or to prepare waste for shipping
- Description of labeling system(s) used and comprehensive training program
- Description of written alternatives to labeling of containers (if used)
- Procedures to review and update label information when necessary.

1.9 Waste handling and disposal P18

1.9.1 Waste handling

- It is an activity associated with the handling of solid waste until they are placed in containers.
- Waste handling depends on type of waste materials separated for reuse and recycling.
- Also it an activity to move the loaded containers to the collection point and to return containers to the point where they are stored between collectors.
- Hospital waste handlers bear the responsibility of keeping waste tightly contained upon receipt.
- Unfortunately, awareness of the need for safety and caution among staff members who routinely handle hospital waste may decrease over time, increasing the possibility for contamination or injury.
- All staff members handling waste products should receive periodic reminders and refresher training that includes information on the techniques and risks associated with the handling of waste, procedures for dealing with spillages and other accidents and instructions on the use of protective clothing.
- Additionally, staff should be required to demonstrate the procedure of proper waste handling to confirm their compliance.

1.9.2 Treatment and waste disposal

Several methods are used for treatment and disposal of waste. They are

1. Composting
2. Incineration
3. Landfilling
4. Pyrolysis
5. Recycling

1.COMPOSTING

- It is a process in which organic matter of solid waste is decomposed and converted to humus and mineral compounds.
- Compost is the end product of composting, which used as fertilizer.
- Three methods of composting
    - Composting by trenching
    - Open window composting
    - Mechanical composting

Composting by trenching

- Trenches 3-12m long, 2-3m wide and 1-2m deep with spacing 2m.
- Dry waste are filled up in 15cm.on top of each layer 5cm thick sandwiching layer of animal drugs is sprayed in semi liquid form.
- Biological action starts in 2-3 days and decomposition starts.
- Solid waste stabilize in 4-6 months and changed into brown colored odour less powdery form known as humus.

Open window trenching

- Large materials like broken glass, stone, plastic articles are removed.
- Remaining solid wastes is dumped on ground in form of piles of 0.6-1m height.
- Temperature increases in side pile.
- After pile for turned for cooling and aeration to avoid anaerobic decomposition.
- The complete process may take 4-6 week.

Mechanical composting

- It require small are compare to trenching and open window composting.
- The stabilization of waste takes 3-6 days.
- The operation involved are
    - Reception of refuse
    - Segregration
    - Shredding
    - Stabilization
    - Marketing the humus.

2.Incineration

- Incineration is the waste treatment process that involves the combustion of organic substances contained in waste materials
- Incineration and other high temperature waste treatment systems are described as thermal treatment.4incineration of waste materials converts the waste into ash, flue gas,etc..

Advantages

- Less space required.
- Most hygienic method
- Heat generated can be used for steam powder.

Disadvantages

- Large initial expense.
- Large number of vehicles are required for transportation.

3.Landfilling

- It is site for the disposal of waste materials by burial nd is the oldest form of waste treatment.
- The dumping is done with layers of 1-2 m.
- The layer is covered with soil of 20cm in thickness.

Advantages

- Simple method
- Separation is not required
- unused lands can be used

Disadvantage

- Large land is required
- Odor problem.
- Green house gas problem

4.Pyrolysis

- Heating of the solid waste at very high temperature is absence of air.
- Carried out at temp between 500c – 1000c.
- Gas, liquid and chars are the by products.

5.Recycling

- Recycling is the process used materials into new products.
- It reduce the consumption of fresh raw materials,reduce air pollution and water pollution.
- Recycling is the key component of modern waste reduction and it is third component of the reduce, reuse and recycle waste hierarchy.

PART A (2MARKS)

1. What is Biomedical waste management?

- Biomedical waste is any waste which is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining there to or in the production or testing of biological and its categories.

2. What are the different types of waste?

- Infectious waste
- Pathological waste
- Pharmaceutical waste
- Genotoxic waste
- Chemical waste
- Photographic/radiographic chemical waste
- Organic chemicals
- Inorganic chemicals

3. What are the major and minor sources of healthcare waste?

Major sources of healthcare waste

In hospitals

  - Healthcare teaching institutions and hospitals
  - General hospitals
  - District hospitals

- Other Hospital Establishments
  - Emergency medical care services
  - Obstetric and maternity clinics
  - Healthcare centers and dispensaries

Minor sources of healthcare waste

- Small Healthcare Establishments
  - Physician's offices
  - Dental clinics
  - Chiropractors

4. What are the various methods used for the biomedical waste?

- WHO classification for developing countries
- Classification based on nature of waste

5.What are types of hazards of biomedical waste?

- Infection
- Physical injuries
- Chemical injuries
- Radioactivity hazards
- Genotoxicity and cytotoxicity
- Public sensitivity

6. Explain public sensitivity?

- Every individual who is exposed to hazardous healthcare waste is potentially at risk, including those within healthcare establishments that generate hazardous waste, and those outside these sources who either handle such waste or are exposed to it as a consequence of careless management.
- The main groups at risks are the following:
    - Doctors, dentists, nurses, healthcare assistants and hospital maintenance personnel.
    - Patients in healthcare establishments or receiving home care and visitors at these sites.
    - Workers in allied support services to healthcare establishments such as laundries, waste handling and transportation.
    - Workers in waste disposal facilities (such as landfills or incinerators) including scavengers.

7.What are the impacts of radioactive waste?

- The type and extent of exposure determines the type of diseases caused by radioactive waste. It can range from minor symptoms like headache, dizziness and vomit to more serious problems.
- Because radioactive waste is genotoxic, it may affect genetic material. Handling of highly active sources may cause more severe injuries such as destruction of tissues, necessitating amputation of body parts.
- The exposure surfaces to low-activity waste any arise from contaminated of external surfaces of containers or improper mode or duration of waste storage. Healthcare workers or waste-handling or cleaning personnel exposed to his radioactivity are at potential risk.

8.Write any two ethical aspects of health reasons in biomedical waste?

- Enabling managers of healthcare establishments to develop their waste management plans
- Enabling course participants to develop training programs

9.What are types of air pollution?

Air pollution is of three types

- Biological
- Chemical
- radioactive

10.What is radioactive emissions?

Radioactive emissions

- Small quantities of radioactive gas are generated durning research and radioimmunoassay activities.
- The clinical application of Kr and Xe are the principal sources of gaseous radioactive waste.

11.Define eutrophication?

- Algal brooms over surface of water bodies. This occurs mainly because of excess nutrient leachates e.g. nitrates and phosphates from landfills.

- Water pollution can alter parameters such as Ph, biological Oxygen Demand (BOD). Dioxins have been reported from water body from the air.
- Radioactive effluents also pollute water.

12.Define waste minimization?what are the needs of waste minimization?

- Waste minimization is the process and policy of reducing the amount of waste produced by a person or a society.

Sources reduction:

- Prevent wastage of products in nursing and cleaning activities.
- Prefer physical cleaning methods over chemicals ones.

Resource recovery and recycling

- The majority of waste from healthcare facilities is same as that of an office, e.g. paper, cardboard and food wastes.
- Healthcare establishments can implement very simple programs that divert these materials from the solid waste stream, lowering disposal costs.

Waste disposal

- For those things that cannot be reduced, reuse or recycled, we ensure that they are disposed in safer manner without affecting environment.
- E.g: Safer disposal of mobiles and batteries.

13.Define duty of care?

- A duty of care on any person who produces imports, carries, keeps, treats or disposes of controlled waste or, as a broker, has control of such waste.
- These are individually called the waste holders

14. Why should we segregate waste?

- When we segregate waste, there is reduction of waste that gets landfilled and occupies space, air and water pollution rates are considerably lowered.
- Segregating waste also makes it easier to apply different processes - composting, recycling and incineration can be applied to different kinds of waste.

15. What are the advantages of segregation?

- Recycling helps to reduce energy usage, reduce the consumption of fresh materials, reduce air pollution and water pollution.
- Reduces the greenhouse emissions.

16.What are the several methods for treatment and waste disposal?

Several methods are used for treatment and disposal of waste. They are

- Composting
- Incineration
- Landfilling
- Pyrolysis
- Recycling

PART-B

1. Explain different types of waste?
2. What is biomedical waste? Explain the ways of classification of biomedical waste?
3. Classify types of hazards in biomedical waste management with eg?
4. What is air pollution? Mention the ways to control the air pollution?
5. Explain water pollution?
6. What are the ways to control the pollution?
7. Explain procedure for segregation and its advantages?
8. With a neat diagram explain the containers for waste collection?
9. Explain labelling with its features and advantages of using it?
10. What are the several methods of waste handling treatment and its disposal?
11. Illustrate the method of recycling with suitable eg?
12. Define waste segregation and write the rules for segregating the waste?
13. What is waste handling and explain disposal treatment?
14. List out the reasons for waste minimization?
15. Discuss about the categories and classification of biomedical waste?