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# Hospital Waste Management

A Guide for  
Self Assessment  
and Review

A diagonal photograph of medical waste, including syringes and needles, is overlaid on the cover. The waste is shown in a pile, with some syringes lying horizontally and others vertically. The background of the cover is dark blue, and the bottom right corner is a light greenish-yellow.

**Shishir Basarkar**

**JAYPEE**

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# **Hospital Waste Management**

## **A Guide for Self Assessment and Review**

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To  
*My Family Members*  
and  
*Teachers*



## *Preface*

---

This book is a humble attempt to familiarize all medical and paramedical professionals with the importance of hospital waste management. The purpose of the book will be well served if the finer points are inculcated and brought into attitude. Indeed, the objective of this book is not to make the specialist but rather to serve as an appetizer for further reading on the subject.

Our own wrong habits make authorities to bring out various laws and rules which then force us to abide them, hence the book attempts to emphasize and to enhance the competency of the professionals by having proper knowledge about hospital waste and hazards associated with it.

Any waste, whatever it may be, should not be handled indiscriminately because it may lead patients as well as health care workers to catastrophic situation culminating to fatal infections. The situation further gets more difficult if negligence is done in treatment, reporting and preventing further occurrence.

I have tried to simplify the subject by presenting each topic in short answers form so that each question is well understood. I also tried to give line diagrams of complex processes and machines, thus making them easy to understand. However, it does not resist the reader to the classical reading scheme as one does not necessarily have to begin from first page and run through to the end. Attempts have been made to make every chapter complete in itself, therefore, it is possible to pick out single chapter without losing the track.

**Shishir Basarkar**





## *Acknowledgments*

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I wish to express my sincere thanks and indebtedness to my entire teachers for their valuable teaching which made me capable to conceptualize and bring out this book.

I like to thank my family members who every time supported me.

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Last but not the least I would like to thanks M/s Jaypee Brothers Medical Publishers (P) Ltd, New Delhi, for publishing and printing of this book.



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## *Abbreviations*

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<b>BMWM</b>	- Biomedical Waste Management
<b>CPCB</b>	- Central Pollution Control Board
<b>SPCB</b>	- State Pollution Control Board
<b>CBWTF</b>	- Common Biomedical Waste Treatment Facility
<b>COD</b>	- Chemical Oxygen Demand
<b>BOD</b>	- Biological Oxygen Demand
<b>CE</b>	- Combustion Efficiency
<b>PPM</b>	- Parts Per Million
<b>RPM</b>	- Revolutions Per Minute
<b>ETP</b>	- Effluent Treatment Plant
<b>HBV</b>	- Hepatitis B Virus
<b>HCV</b>	- Hepatitis C Virus
<b>APCD</b>	- Air Pollution Control Device
<b>PSI</b>	- Pounds Per Square Inch
<b>HCW</b>	- Health Care Worker
<b>EC</b>	- Exposure Code
<b>SC</b>	- Status Code
<b>HIV</b>	- Human Immunodeficiency Virus



## *Introduction*

---

The serious concern of the health care facilities is the generation of Biomedical waste which is hazardous to health of community and people who are associated with handling of the waste. Various National and International environmental and health agencies have shown their concern towards these waste as they may cause serious infectious diseases like Hepatitis, tuberculosis and HIV/AIDS. Most of the hospitals do not have effective disposal system leading to complex problem of hygiene and sanitation in hospitals.

Hospital generated waste is disposed off illegally into the Municipal garbage and drainage system.

In developing countries very frequently the Municipal workers get pricking injuries from needles, sharps and broken glass pieces. The other infectious waste which creates complex environmental problem is radioactive waste which has prolonged half-life and needs very sophisticated and appropriate system for ultimate disposal.

Though the use of disposal items have reduced the rate of infection but at the same time has increased the volume of the waste which needs to be disposed properly.

Because of the concerns shown by National and International agencies the notification of the Biomedical Waste (Management and Handling) Rules, 1998 was brought out by Union Ministry of Environment and Forests under the provision of Environment (Protection) Act, 1986. Under these rules, all health care institutions are found to make necessary arrangements for proper handling and management of waste, failing of which, the head of the institution is liable for punishment.

Effective waste disposal can be achieved only by considering the various components of the waste management system and this should be made integral part of the hospital planning and designing of the hospital.





## *Our Environment*

**1. What is the definition of Environment?**

It is the constant interaction between living beings and various surrounding factors like physical (water, soil, heat) social (habits, customs, occupation), and biological (human, plants, animal).

**2. What is biosphere and what are its main subdivision?**

Biosphere is the part of earth where people live and it has 3 subdivision namely lithosphere (solid) hydrosphere (liquid) and atmosphere (gas).

**3. What is 10% law?**

At every level of trophic level 10% of energy is transferred to next level of the previous level, and this is due to energy loss at every level because of:

- a. Part of energy utilized by organism for its body activities.
- b. Part of energy is not available to organism itself.
- c. Some organisms are not consumed by next trophic level so undergo decomposition.

**4. What do you understand by ecosystem?**

It is a self-sustaining and self-regulating system which is the result of the interaction of individual organisms with each other and at the same time with physical components of environment too.

**5. What is top soil?**

It is the fertile soil which covers the few inches of the earth surface and is rich in organic matter.

**6. What are essential components of ecosystem?**

Two components are of ecosystem:

*Abiotic:* These are non-living like light, soil, air, water, etc.

*Biotic:* These are living components like plant, animals, human and microbes.

Biotic components is dependent on abiotic component for survival.

**7. What do you understand by biomagnification?**

When there is gradual increase in the concentration of chemicals as they pass through higher levels in the food chain is known as biomagnification. It is also called bioaccumulation.

**8. Few words about trophic level.**

Organism belongs to certain class as per their source of food supply and this class is called trophic level.

The word trophic (Gr) means nourishment

**9. How many trophic levels are there?**

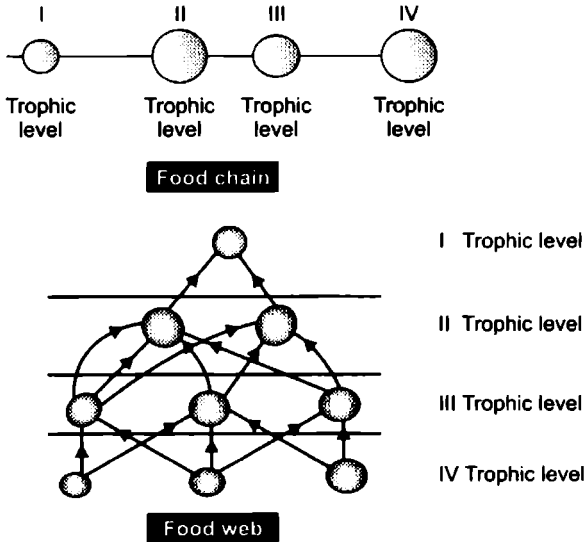
There are 3 trophic levels:

Ist level	Producer	Plants	Grass
II level	Primary consumer	Grazers	Dear
III level	Secondary consumer	Predator	Tiger

**10. What is the difference between food chain and food web?**

*Food chain:* When the food energy is transferred through the chain of organisms from one trophic level to another.

*Food web:* Network of the food chains at different trophic level and at one level the source may be different (Fig. 1.1).



**Figure 1.1:** Food chain and food web

**11. Write few word about different types of food chain?**

- Predator – prey food drain – Butterfly
- Detritus (decomposed organic matter) food chain – vultures
- Parasitic food chain – worms in bowel.

## *Hospital Waste*

**1. What is waste?**

Waste is the discarded material much of which can be recycled or reused depending on the type of waste.

**2. What is the WHO definition of hospital?**

A hospital is an integral part of a social and medical organization the function of which is to provide for the population complete health care both curative and preventive and whose outpatient services reach out to the family and its home environment.

It is also a center for the training of health workers and biosocial research.

**3. How many types of waste are there?**

There are various types of waste generated in the health care setting. Types of waste are general waste or non-infectious waste, biomedical waste, contaminated waste, pathological waste, animal waste, pressurized cans, infectious waste, chemical waste, liquid waste, hazardous waste cytotoxic waste, blood and its products waste, radioactive waste, sharps, etc.

**4. What is the difference between sewage and sullage?**

Sewage it is the waste water containing solid and liquid excreta having very unpleasant smell. Sullage it is the waste water which does not contain human excreta. Example waste water from kitchen, bathroom, etc.

**5. What is an average percentage distribution of waste in hospital?**

80%—General waste.

15%—Infectious waste

01%—Sharp waste

3%—Chemical and pharmacological waste.

<1%—Special waste, i.e. radioactive, cytotoxic pressurized containers.

**6 What is an average percentage of paper and plastic in hospital waste?**

Plastic        70%

Paper         15%

**7. What are hazardous waste?**

These are the waste products which by their characteristics poses threat to environment or human life. For example, radioactive waste, pressurized cans, infectious waste, etc.

**8. What is biomedical waste?**

The waste generated in diagnosis treatment or immunization of human beings or animals, in research or in the production of testing of biological products including all categories of infected and toxic waste that is potential threat to human beings and environment. Biomedical waste can also be termed as regulated waste/ medical waste or health care waste.

**9. What is hospital waste?**

All discarded biological and non-biological material which is not intended for further use.

**10. How biomedical waste / Medical waste is generated?**

It can be generated during:

- Diagnosis
- Treatment
- Immunization
- Biomedical research
- Production and testing of biological products.

**11. What is infectious waste/clinical waste?**

Waste capable of producing an infectious disease based on four factors namely.

- Presence of virulent pathogenic organism
- Portal of entry
- Sufficient dose of pathogen
- Resistance of the host.

**12. What are the characteristics of general waste?**

It is:

- Non-hazardous
- Non-toxic
- Non-infectious
- Disposed through local municipal authorities.

**13. Give examples of infectious waste?**

- Waste from infectious wards
- Human blood and blood products
- Cultures and stocks of infectious agents
- Waste from surgery and autopsy
- Contaminated sharps
- Dialysis unit waste
- Contaminated animal carcasses
- Contaminated equipments.

**14. What is the hazards of pressurized containers?**

They may explode if punctured or incinerated and cause damage nearby. They should be returned to manufacturer as far as possible.

**15. What is net wastivity?**

It is the net quantity of waste generated in proportion inputs. This excludes the recyclable waste.

**16. How will you calculate the average quantity of waste generated?**

By using the formula:

$$\text{Average quantity of } = \frac{\text{Total quantity of waste per day}}{\text{Total no. of beds occupied at a time}}$$

**17. How the hospital waste can be classified?**

It can be classified as follows:

- As per biomedical waste (Management and handling rules 1998), there are 10 categories.
- As per WHO there are 8 categories.
- As per environment protection Act of USA there are 7 categories.

**18. Why housekeeping department is “police” of the hospital?**

P – Planning      O – Organize      L – Liaison  
I – Implementation   C – Control/Monitor   E – Evaluation

**19. What are the categories of waste as per WHO?**

- General waste
- Pathological waste
- Radioactive waste
- Chemical waste
- Infectious waste
- Sharps
- Pharmaceutical waste
- Pressurized containers.

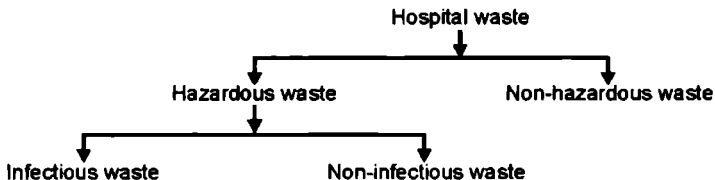
**20. What is an average quantity of waste per day?**

It ranges between 1–3 kg per day per bed of which .2 kg is incinerable waste.

**21. Name the sources of biomedical waste.**

- Hospital, nursing homes, clinics, dispensaries
- Blood banks
- Industries
- Household (generates less than .5% of total waste).

**22. Classify the hospital waste.**





**23. Give examples of biodegradable and non-biodegradable waste?**

*Biodegradable waste:* Peel of fruits, paper, vegetable skin, left over food, etc.

*Non-biodegradable waste:* Foils, wrapping plastics, etc.

**24. Classify the hospital waste in percentage?**

- Hazardous waste                    10–25%
- Non-hazardous waste            75–90%
- Infectious waste                    15–18%
- Non-infectious waste            5–7%

**25. What are the types of hazardous waste?**

- a. Injurious
- b. Cytotoxic
- c. Infectious
- d. Chemical.

**26. What are routes through which waste may cause transmission of disease?**

- Inhalation
- Absorption
- Ingestion
- Injury.

**27. What are the hospital waste which needs special disposal?**

- Pharmaceuticals waste
- Radioactive waste (solid, liquid and gaseous)
- Laboratory waste.

**28. How the radioactive waste is disposed?**

It is disposed as per the regulations laid down by Atomic Energy Commission (AEC).

**29. How the radiological waste is disposed?**

- *Solid:* By storage during which it's radioactivity is reduced to acceptable level over a period of time or by size reduction

in which under controlled condition waste is incinerated and ashes are disposed safely.

- **Liquid:** By diluting the waste and released into existing sewage system into very small amount over extended period of time.

**30. When the chemical waste is considered hazardous?**

If the chemical waste is:

- Corrosive
- Toxic
- Genotoxic/cytotoxic
- Toxic in general
- Reactive.

**31. Which are the potential toxic waste from hospitals?**

- Radioactive waste—Radiotherapy isotopes
- Pharmaceutical waste (antibiotics, cytotoxic analgesics, etc.)
- Chemical waste (disinfectants, reagents, X-ray dark room chemicals).

**32. What effect cytotoxic waste may produce?**

- a. Immune suppression
- b. Cancer
- c. Fetal abnormalities
- d. Pan cytopenia
- e. Genetic abnormalities.

**33. What are the diseases biomedical waste can cause?**

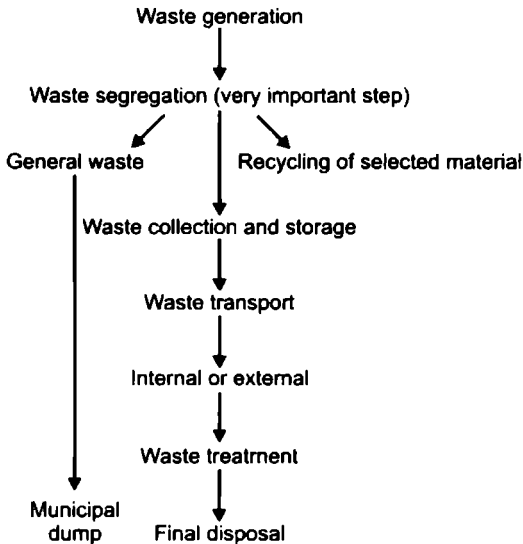
- Tuberculosis
- Hepatitis B/C
- HIV/AIDS
- Gastroenteritis
- Tetanus
- Skin injection
- Typhoid fever (Enteric fever)
- Fetal abnormalities.

**34. Who are the persons at risk of getting infected with BMW?**

- Health care workers (doctors, nurses, lab tech, attendants, sweeper, waste handlers, etc.)
- Patients and their attendants
- Workers of hospital support services (Worker's of laundry, waste store room, transportation, etc.)
- Rag pickers.

**35. What are different steps in health care waste management?**

These steps can be represented in the form of flow chart.



**36. What are the goals of biomedical waste management?**

- Cost containment by reducing waste
- Reduction in environmental pollution
- Protecting community health
- Reduction in hazards
- Enhancement of hospital image.

**37. What should be the measures to ensure proper waste management rules?**

- Regular inspection of the site of BMW generation regarding other steps being followed or not

- Sufficient supply of the material needed for BMW
- Daily record maintenance of incinerator temperature
- Feedback from staff and people involved in BMW
- Periodic communication with central and state pollution control board
- Training and update to the staff and waste handlers.

**38. Mention the characteristics of the bags used for BMW.**

- Bags used for incineration should be of non-chlorinated material
- Bags used for autoclaving should be heat resistant.

**39. What are the main characteristics of the waste?**

- Compaction characteristics
- Bulk density
- Acidity
- Viscosity
- Moisture
- Volatile matter
- Calorific value
- Ash
- Fixed carbon.

**40. Describe briefly each of characteristic.**

- **Compaction characteristics:** To what extent the waste can be made compact so as to reduce transport contained dispersal space as volume of waste is reduced considerably. Moisture affects the compaction characteristics adversely.
- **Bulk density:** It is the weight of a unit volume of a material ( $\text{gm}/\text{cm}^3$ ). It is more for all solid waste before treatment and compaction. It is inversely related to the cost of collection and transportation.
- **Acidity:** pH of waste needs special attention because strong acidic waste are corrosive and reactive and require special treatment to reduce the acidity.
- **Viscosity:** It is fluidity of the waste and inversely related with temperature, i.e. if temperature increases viscosity decreases this waste become more fluid in nature.

- **Volatile matter:** The presence of volatile matter in waste which turns into gaseous form on high temperature. This is estimated by heating the waste material in furnace at 200°C for 10 minutes.
- **Calorific value:** This is the amount of heat released from combustion of unit weight of substance.
- **Ash contents:** This is amount of ash produced when material is completely burnt. Ash of a material may be toxic or non-toxic and knowledge about composition of ash guides about suitable disposal.
- **Moisture contents of waste:** This can be estimated by drying the waste at 104–110°C for 24 hours and then weighting and finding the difference in weight before drying and after drying. More moisture content leads to incomplete and low quality boring.
- **Fixed carbon:** It is the portion of the waste which is left after eliminating moisture and volatile matter excluding ash. It is calculated using the following formula.  
Fixed carbon% = 100 – (Moisture% + Volatile matter%)  
Total carbon = Volatile matter + Fixed carbon.

## *Effect of Hospital Waste on Environment and Health*

### 1. Define Macronutrients and Micronutrients.

Those elements which required in large amount are known as macronutrients while those in very small amount called micronutrients.

### 2.. What is INSOLATION?

It is the combination of words:

- Incoming
- Solar
- Radiation.

### 3. How many types of radiation are there from the ground?

*Terrestrial radiation:* These are long waves, low frequency infrared (heat) radiations ( $> \text{mm}$ ) emitted by earth including it's atmosphere. They are the electromagnetic radiations.

*Counter radiation:* Redirection of part of the earth's terrestrial radiation back to the surface due to green house effect.

### 4. What is green house effect?

This is the natural phenomena to keep the earth temperature balanced by virtue of trapping heat energy.

This can be produced artificially in house by using glass, which acts as a barrier.

### 5. How hospital waste contribute to green house effect?

Due to emission of methane gas, which is a natural byproduct of decomposition of solid waste, from landfills. By reducing the amount of landfill solids the emission can be reduced and in turn the green house effects.

**6. What is the advantage of green house effect?**

Because of trapping of heat energy by green house gases (water vapor, carbon dioxide, methane, nitrous oxide, chloro fluoro carbons, ozone, etc.) the earth surface is warmer, (mean temp. 15°C) and comfortable. Had this effect not been there the average temp. could have gone below zero degree (Mean temp. -19°C). Due to increase in green house gas there is already increase in global temperature.

**7. Why health care waste became hazardous?**

Because of following reasons:

- It may contain infectious or radioactive agent
- It may contain sharp
- It may be genotoxics
- It may contain hazardous chemicals.

**8. What is the source of green house gases?**

These gases comes out from natural sources and human activity like, fuel use, industrial growth incineration of waste. The carbon dioxide is the main green house gas and its residence time is about 230 years and it has been noted that its concentration on 280 ppm of preindustrial era has been increased to 360 ppm.

**9. Which causes the green house effect?**

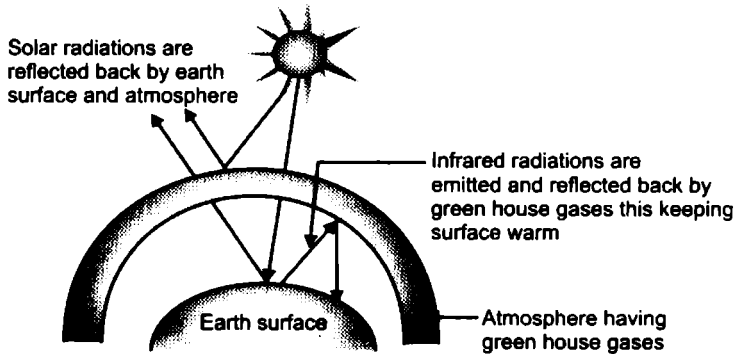
The infrared radiations (heat) which when reflected back towards space from earth surface. This heat is absorbed by green house gases (Fig. 3.1).

**10. Why the level of green house gases is increasing?**

Due to imbalance between emmission and absorption of these gases in the atmosphere.

**11. What is environmental pollution?**

This is an undesirable and excessive addition of the substances to water, land and air thus adversely altering natural quality of the environment. This can be defined as alterations of the natural environment that are harmful to life.



**Figure 3.1:** Green house effect

According to Katyal and Satake. It is the unfavorable alteration of our surroundings wholly or largely as a byproduct of man's action, through direct or indirect effects of changes in energy patterns, radiation levels, chemical and physical constitution and abundance of organisms.

**12. What is pollutant?**

It is the wrong constituent; in wrong amount at wrong time or wrong place.

**13. What do you understand by primary pollutants and secondary pollutants?**

**Primary pollutants:** These are the pollutants which are produced due to direct natural or atmospheric activity. These pollutants don't undergo any chemical change.

**Secondary pollutants:** These are the pollutants which are formed due to chemical reactions of primary pollutants and other chemical or physical constituents present in the atmosphere.

**14. How the pollutants are categorized broadly?**

- Chemical
- Biological
- Physical (energy)
- Radiological.



**15. Describe local and global pollutants.**

**Local pollutants:** These are the substances whose concentration cross the threshold concentration within small area or volume of water, land (Soil) or air.

For example, House, place of work, etc.

**Global pollutants:** Global pollutants are those substances whose concentration level over years have cumulative built up in water, soil, or air.

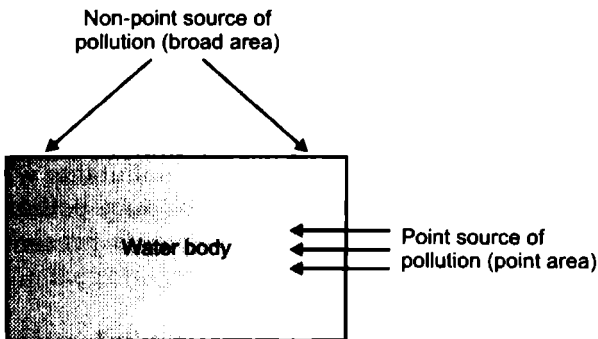
For example, Global warning, ozone depletion (ozone hole).

**16. Can pollution be eliminated?**

No, it can not be eliminated completely however, can be reduced to great extent because pollution of any kind is the result of human activity and this can not be eliminated so the pollution.

**17. How will you describe point source and non-point source pollution?**

- **Point source** pollution is a single, identifiable localized source of pollution.
- **Non-point source** pollution is different non-identifiable, diffuse source of pollution both the type effect the water, soil, and air (Fig. 3.2).



**Figure 3.2:** Point and non-point source of pollution

**18. Give examples of point and non-point source pollution.**

Point source pollution:

- Industry/hospital waste water discharge outlet
- Noise of jet engine
- Smoke from incinerator

Non-point source pollution:

- Sediments
- Bacteria
- Nitrogen.

**19. What is water pollution?**

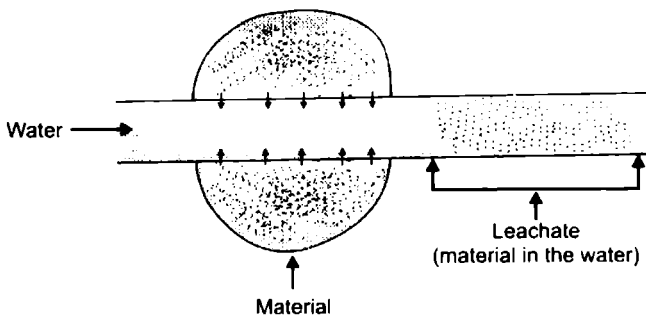
It is any chemical or physical change in water mainly due to human activities that restricts its use by human being and other live forms.

**20. What is leaching and leachate?**

**Leaching:** It is the process in which chemicals from the material dissolves into water while it is being filtered through that material. The resulting mixture is called leachate which is consisting of residues from decomposed organic matter and material (Fig. 3.3).

**21. What are the sources of water pollution?**

- Sewage
- Industrial waste



**Figure 3.3:** Process of leaching

- Biomedical waste
- Physical pollutants
- Agricultural pollutants
- Poor land filling leading to leachate.

**22. What are the agents causing water pollution?**

1. **Physical agents:** Insoluble particles of silt and soil.
2. **Chemical agents:**
  - a. **Organic:** Oil, animal and human manure
  - b. **Inorganic:** Heavy metals, nitrates, phosphates, acid, etc.
  - c. Radioactive substances.
3. **Biological agents:** Bacteria, virus, protozoa and worm.

**23. Describe eutrophication.**

It is the process of increase in chemical nutrients (Phosphate, nitrate) in water body's ecosystem and results in increasing its productivity.

By this process there would be growth of plankton which will consume all dissolved oxygen of that water body thus making water unsuitable for life of fishes and other aquatic animals as water because hypoxic and stagnation of lack.

**24. What are the effects of eutrofication?**

- a. Reduction in resource value of water
- b. Economic loss
- c. Health problem if such water is consumed.

**25. Eutrofication results from:**

- a. Nutrient pollution like sewage effluent, runoff lawn fertilizers
- b. Natural accumulation
- c. Human activities.

**26. Which is the main culprit for eutrofication?**

Phosphorous is often regarded as the main culprit.

**27. What do mean by algae boom?**

The nutrients which flows to the water body acts as fertilizers leading to population explosion of algae and this process is called algae boom and this results in green colors of the water body.

**28. How the foaming is caused in water supplies?**

Due to presence of oil, greasy material and other organic material in the water flow where, it is disturbed or agitated the bubbles form and remain for sometime then eventually burst. These bubbles are formed because of dissolved organic compounds which in turn formed due to metabolism of aquatic organisms.

**29. Write the effects of plant nutrients (phosphates and nitrates).**

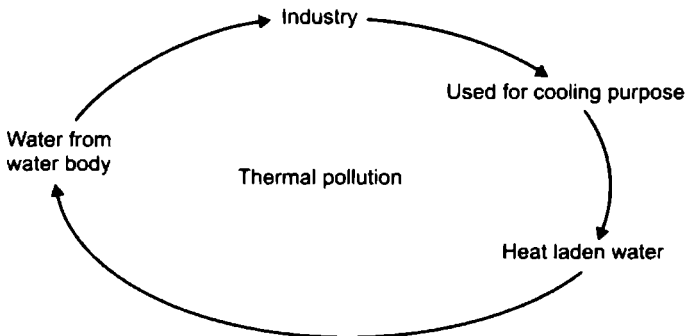
- Algae boom
- Fish death
- Upsetting of aquatic ecosystem
- Eutrofication
- Toxic for live stock
- Foul odor.

**30. How thermal pollution of water is caused?**

This is caused by reentry of the heat laden water into water body.

**31. What do you understand by thermal pollution of water?**

When the water which is used from the water body is used by industries for cooling purpose and when this heat laden water goes back to the water body results in the increase in temp. of the water.



**32. What are the sources of land pollution by Biomedical waste?**

- Infectious waste
- Discarded chemicals and medicines
- Incinerator waste
- Heavy metals (Cd, Pb, Hg) present in waste
- Leachate from landfills.

**33. What is land pollution?**

It is the addition of undesirable matter to the land that damages the terrestrial organisms, reduces the uses of the land by man for agricultural, recreational, residential purposes and increases the risk of health hazard.

**34. What are the international recommendations for waste management?**

- a. Minimization of waste production
- b. Recycle and reuse the waste to the maximum possible limit
- c. Choose safe and environment friendly options for waste treatment.
- d. Careful final disposal of waste in confined and designated land fill area.

**35. What are the general principles of BMW management?**

These principles are followed by all stakeholders who are involved in BMW management.

- a. Do no harm to any one who come in contact with such waste this is achieved by safe collection, segregation, treatment and disposal of the waste.
- b. Encouraging use of non disposable items instead of disposable items because they are environment friendly and their safety are used if they are properly sterilized.
- c. Following 3 'R' Principle (Reduce Recycle, reuse) So as to minimize the waste
- d. Well monitored and supervised flow of biomedical waste (Life cycle approach).

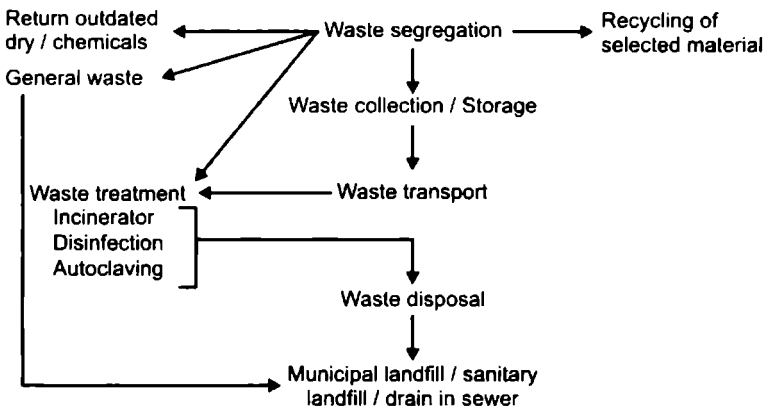
**36. What are the benefits of waste minimization?**

- a. Occupational safety
- b. Financial profit to hospital
- c. Environmental protection.

**37. Mention the various steps which are involved in waste minimization?**

- a. Good purchase procedure to reduce waste
- b. Composting of organic waste
- c. Use of recyclable sharp
- d. More use of biodegradable products
- e. Follow FIFO principle (First in First out) that means consume the oldest items first
- f. Strict check on inventory to maintain it optimum
- g. Adopting procedures for recovery for mercury, lead, silver, etc
- h. Recycling of the hospital waste papers
- i. Purchase of multiple use product and in bulk
- j. Use item before it's expiry.

**38. Draw waste cycle diagram.**



**39. What are POPs?**

These are the persistent organic pollutants and are global treat to environment and because of their chemical stability they

stay and accumulate in environment and living organisms for an extended period of time (years or decades). In initial list of 12 POPs were more commonly referred as dirty dozen divided into 3 categories:

- a. Pesticides
- b. Industrial chemicals
- c. Unintended byproducts.

**40. What are the characteristics of Dioxins?**

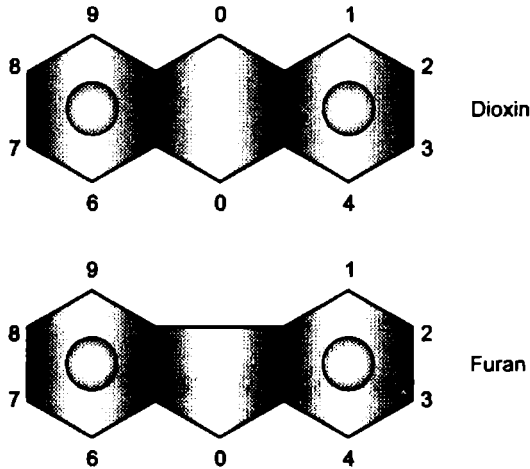
- They are unintended byproduct of human activities.
- These are also known as repeat offenders
- Fat soluble
- Persistent organic pollutants
- Very stable chemical structure
- Half life is about seven years and tend to bio accumulate in food chain so high in food chain more concentration of dioxin
- Dioxins are strong adsorbent to soil and degrade by photodegradation.
- In soil dioxins tend to remain near surface and moves towards water bodies through soil erosion and get bioaccumulated in aquatic life.

**41. What are the sources of Dioxins?**

- a. Industrial processes
- b. Forest fire
- c. Volcanic eruptions
- d. Thermal processing of product like smelting
- e. Incinerators giving incomplete combustion
- f. Effluent discharge from paper mills that use chlorine bleaching.

**42. What are the effects of short-term and long-term exposure to Dioxin effects of short-term exposure?**

- a. Skin lesions
- b. Attend liver functions  
Long-term exposure impaired immune, endocrine and reproductive system.
- c. What is the chemical structure of Dioxin and Furan (Fig. 3.4).



**Figure 3.4:** Chemical structure

Dioxins and furans contain chlorine atoms located at positions 1-4 and 6-9. There are 75 different Dioxin congeners and 135 different furan congeners.

**43. What is the major toxicity of Dioxin and Furans?**

They have been implicated as potential endocrine disruptors as they can interfere with normal functions of hormones and thus affect reproductive success.

**44. What are the qualities of environment friendly product?**

These products are:

- Creating minimum pollution
- With high recyclable contents
- Less toxic
- With less packing materials
- More energy efficient
- Safer for patients, staff and environment.

**45. How Dioxin and Furan are formed?**

Dioxins and furans are a family of polycyclic aromatic hydrocarbons and are formed when chlorinated plastic or any chlorine-containing material is burned in the presence of organic



material. Chlorine molecules gets combined with organic matter to form Dioxin and Furan and the presence of heavy metal acts as catalyst for this chemical process.

**46. What is DEHP?**

*Diethylhexyl phthalate:* It is a chemical compound which is added to PVC to make the item flexible, moldable and strong. The ratio of PVC with DEHP is 80-60 : 20-40.

It does not bind with PVC hence leachout from PVC products during medical interventions.

**47. What are the adverse effects of DEHP?**

- Suppressed ovulation
- Reduced liver and kidney functions
- Bradycardia
- Respiratory distress
- Testicular damage.

**48. How adverse effect of DEHP be eliminated?**

Use non DEHP products.

**49. How waste causes indirect risk to environment and public health?**

By:

- a. Contamination of water and air due to indiscriminate disposal and burning of waste in open.
- b. If waste is disposed in pit which is near water then leachate and contaminate the water thus causing public health problem.

**50. How improper BMW spread the infection?**

- a. Through vectors (housefly, mosquito, insects)
- b. Through injury or contact with infectious material
- c. Through unauthorized recycling of infectious material
- d. Through improper use of discarded medicines
- e. Through sharp injuries
- f. Through indiscriminate disposal of incinerator ash/residue
- g. Toxic emission from improper burning of waste.

## *Generation and Segregation*

**1. What is the average quantity of waste per day?**

In India an average quantity of waste generated in between 0.5–2 kg whereas in developed countries this quantity may range from 3 to 10 kg because of excessive use of disposable items. India has around 6,88,160 beds this producing 876.72 tones of waste per day.

**2. Mention the items contained in solid waste generated in hospital.**

Various items are contained the solid waste in hospital and segregation is important as by this procedure infectious waste content is reduced to considerable limit.

Contents of solid waste are:

- Bandages, linen, etc.
- Disposable plastic syringes
- Plastic and papers
- General waste including food, fruit and vegetable pills
- Other waste.

**3. What is the percentage of plastic in hospital solid waste?**

It is around 8-12% and if use of plastic is not restricted then it may increase further.

**4. Why so much plastic items used in hospital?**

This is because of qualities of plastic which are:

- Transparency
- High resale value in market
- Single use (disposable)

- Low cost
  - Low infection rate because of single use.
- 5. Name the plastics which are in common use in hospital item.**
- PVC – poly vinyl chloride
  - PET – Polyethylene terephthalate
  - Polyamide
  - Polyethylene
  - Polycarbonate
  - Polyurethylene
  - Polyurethane.
- 6. Why plastic (PVC) containers should not be used for solution?**
- As PVC contains lead cadmium and phthalate which may slowly leach into the contained solution and cause toxicity on prolonged use.
- 7. What happens when PVC item is burned?**
- It produces furans and dioxins which are known for causing various health problems like
- Cancer
  - Allergies
  - Disturbances in liver enzymes
  - Depression in body immune system
  - Factotoxicity.
- 8. What is the best solution for plastic nuisance?**
- Minimize plastic use which can be achieved through following practices:
- Use material when absolute necessary
  - Replace disposable item with more conventional and reusable item
  - Purchase eco-friendly material/items
  - Buy in bulk so as to reduce the making material which sometimes contain plastics.

**9. How effectively waste can be collected in bags for segregation?**

- Specified color bag should be fixed in containers
- Waste should not spill out of bag
- There should be no mixing of infectious and non-infectious waste
- Bag should be removed from container when it is  $\frac{3}{4}$  filled and tied so that waste does not spill out
- Needle should be destroyed first by needle destroyer and head of syringe be mutilated
- Plastic items should be disinfected with 1% hypochlorite solution for 30 min contact period
- Containers and bags should bear biohazard symbol.

**10. Define segregation.**

It is the process of segregation of different types of waste as per their treatment and disposal option.

**11. What is the minimum thickness of plastic bag used to collect the waste?**

55 micron thickness (high density polythene).

**12. On what factors does effective segregation depends?**

- Type of hospital/institution
- Motivation of the hospital staff
- Training of the staff
- Health care waste management of the hospital.

**13. What is the main purpose of segregation?**

To separate different categories of hospital waste (as per BMW management and handling rule 1998) and place it in different containers/bags. It is the key to effective BMW.

**14. What should be the characteristics of the containers?**

They should be of:

- Appropriate size
- Smooth inside lining

- Well rounded
  - Well labeled
  - Not too heavy
  - Easily handled by one person
  - Can be cleaned and disinfected easily
  - Foot operated lid.
- 15. On what factor does choice of size of container depend?**
- a. Frequency of collection
  - b. Expected amount of waste.
- 16. Write basic principles of segregation.**
- a. Elimination of segregation at waste disposal site
  - b. Reduction in volume of waste to be treated
  - c. Maintain safety standards for workers
  - d. Facilitation of recycling process.
- 17. Which is the best place of waste segregation?**
- At the sites of waste generation, i.e. ward, OT, Lab, Clinic, etc. because here it becomes simple and cost effective, less harming and responsibility lies with the generator like doctor, nurse, technician, etc.
- 18. Mention the principles through which effective segregation can be achieved.**
- a. By education and training of the staff (generator and waste handlers)
  - b. Placement of proper color coded bins at place of generation.
  - c. Regular identification of waste composition.
  - d. Developing simple and realistic goals and targets
  - e. Effective regular communication between generator, handler and contractors
  - f. Proper coding and labeling of waste bins
  - g. Making effective work environment and making suitable changes in work practices
  - h. Make the segregation single stage, i.e. The segregated material remains in the same beg during collection, storage, transport and disposal.

**19. What are the benefits of effective segregation?**

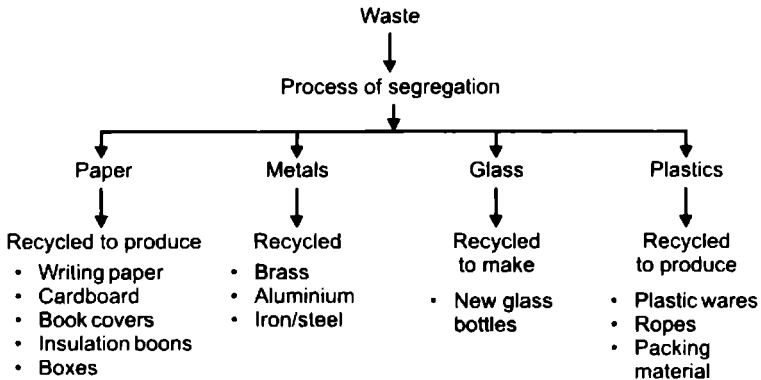
- Improved infection control
- Protection of staff from infectious diseases
- Proper disposal of waste and reduce hazards
- Establish uniform waste management practices among staff
- Cost reduction
- Training of the staff
- Enhanced image of hospital
- Effective plan should be simple and time efficient.

**20. Why generator of the waste is responsible for the segregation?**

This is because the generator (doctor, nurse and technician) are aware of that:

- Material is infectious
- Material is hazardous
- Used material is sharp and can cause injury
- They are wearing proper protective equipment
- They have already handled the waste.

**21. Mark flow diagram of segregation and recycling of non hazardous health care waste.**



**22. What are the advantages of segregation?**

- a. General waste does not become infectious
- b. Total cost of waste treatment is lowered
- c. Reduction in chances of infecting health care workers.

- 23. What percentage of hospital waste is non-hazardous**  
50-80% waste is non-hazardous and can be disposed off easily.
- 24. Where is the pretreatment of segregated waste done?**  
At the site of generation of waste.
- 25. What are the advantages of pretreatment of the waste?**
- To make recyclable items unusable
  - To meet obligation of BMW rules
  - To disinfect the waste so it is no longer infectious.
- 26. How the general waste is segregated?**
- Waste which will go for composting
  - Waste that will go to landfill
  - Waste which can be recycled like paper
  - Cardboard, glass, aluminum cans, etc.
- 27. Write about color coding of containers for waste segregation.**
- Yellow - Waste cat 1, 2, 3, 6  
Red - Cat 3, 6, 7  
Blue/transparent white - Cat 4, 7  
Black - Waste cat 5, 9, 10.
- Category 8 and 10 do not require any container
  - Cat 3 is disinfected locally and need not be put in container.
- 28. What are the benefits of color coding?**
- Assistance in proper segregation of waste
  - Identification of hazardous and infectious waste so that staff is aware.
  - Marking segregated waste for prescribed treatment and disposal required.
  - Identification of the waste in bags.
- 29. Mention advantages of using plastic bags.**
- Easy transportation of waste
  - Spillage preventions
  - Waste is out of site of view of patients and visitors
  - Original container remains always clean.

**30. What precautions should be used while using plastic bags?**

- Plastic bags should not be reused
- Bag should not be over filled
- Sharp should not be collected in ordinary plastic bags
- Red colored bag should not be sent for incineration
- Bags should be stored secured and inaccessible to animals.

**31. What are the characteristics of waste containers?**

Container should be:

- Leak proof
- Rigid
- Puncture resistant
- Foot operated lids
- Non-reactive to any of the biomedical waste substance which are put in these containers.

**32. How the requirement of bags calculated for 200 bedded hospital?**

Waste generated per bed	- 1 kg
Total waste generated	- 200 kg
If one bag can accommodate waste	- 10 kg
Total no. of bags needed	- (20) bags
If there is improper segregation of infected waste then.	- 50-60%
Then no. of yellow bags needed	- (10-12) bags
If there is proper segregation of waste then	- 10-15%
% of infected waste	- 1-2 bags
% of plastic waste with strict segregation	- 5%
	- 1-2 bags
For general waste no. of bags needed	- (6-8)

**33. Is labeling of containers/bags essential?**

Yes

**34. Why?**

Labeling of containers of bags in transport vehicle ensures safe and efficient transfer of waste from point of generation to treatment area thus reducing the risk of injuring.



- 35. What are the specifications of labeling?**
- a. Biohazard to be placed on containers having infectious/ pathological waste.
  - b. Cytotoxic hazard to be placed on cytotoxic waste.
  - c. Recommended size of symbol and words to be 80 mm.
  - d. Labels should be made of permanent marker, so that does not get washed off on cleaning of container.

## *Transport and Storage*

**1. Define waste transportation.**

It is the process of carrying away the segregated waste from point of generation to the site of its treatment and disposal.

Waste can be transported to on-site or off-site storage and treatment area.

**2. What are the components of transport chain?**

- a. Point of generation
- b. Nursing station
- c. Kerb collection point
- d. Waste storage area
- e. Treatment area.

**3. Give the types of the waste transport.**

There are two types of waste transport:

- a. Within the health care facility known as internal or intramural transport
- b. Outside the health care facility known as external or extramural transport.

**4. Give brief account of intramural and extramural transport.**

***Intramural transport:*** If the transport of waste from the point of generation to the place where it is temporarily stored before taking for final treatment and disposal.

***Extramural transport:*** This is the transport of the waste from temporary storage area to the final treatment and disposal.

5. Name the vehicles for transport of waste.

Vehicles for internal transport:

- a. **Waste trolley:** It has inbuilt component in which segregated bags of waste are kept.
- b. **Push cart:** This is four wheeled cart having side railings and in the middle of cart space is available to keep big containers. Cart may accommodate 2-3 bins.

Vehicles for external transport:

- a. **Cycle rickshaw:** It is used by the institutions where disposal site is nearby. It should be covered from all sides and secured on top.
- b. **Van or waste lorry:** It is the collection vehicle – generally used for off site (TWF) transportation of waste: It has bio hazard symbol and biomedical waste labeling along with telephone number of the treatment facility owner.

6. What care should be taken while transporting the waste?

- a. Waste bag should be properly tied and labeled (Fig. 5.1)
- b. Bag should be picked up by the neck and placed straight vertical so that it is again picked up by neck only

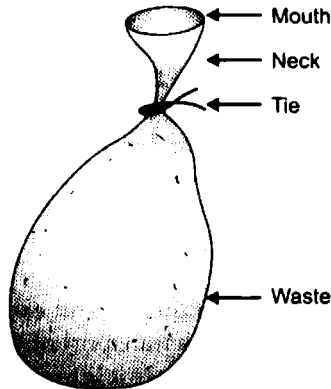


Figure 5.1: Waste bag

- c. Waste bag/container should not be thrown or dropped
- d. Pick up one bag at a time

- e. Handling of the bag should be minimal to avoid needle prick injury
- f. During transportation segregated bags should be kept in designated compartment or area or container
- g. Waste should be routed through predestinated and shortest route and this route should not be changed
- h. Vehicle being used for waste transportation should not be used for any other purpose
- i. Bags should not be handled till securely tied
- j. After removing the bag container should be properly cleaned and disinfected
- k. If lift is being used for waste transportation then it should be reserved for this purpose only
- l. Waste should not spill during transportation
- m. For internal transport the route should be such that it is not being used by public and should be transported when there is minimum movement in the health care facility
- n. The waste handler transporting the waste should use the protective gear while transporting
- o. Waste should not be mixed while transporting
- p. Hand should not be put into the bags.

**7. What is on-site transportation?**

It is the transportation of waste from the point of generation to final waste storage area in the hospital itself.

**8. Mention the qualities of the trolley used for waste transport.**

- a. Trolley or cart should be reserved for waste transportation only
- b. It should not have any sharp projection or corners
- c. It should be easy to clean
- d. It should be easy to load and unload
- e. Trolley / cart should be easy to move
- f. It should be maintained regularly
- g. Vehicle handler should use protective gear
- h. Trolley should be able to accommodate 3 big containers—yellow, red and black.

**9 What are the protective gears?**

- Cap
- Mask
- Heavy duty rubber gloves
- Plastic apron
- Gum boots.

**10. What should be the contents of the label on container?**

Date of collection

Date of generation

Place of generation

Waste category

For off-site/on-site treatment

Waste handler's name.

**11. Why is labeling of the bag/container important?**

Because:

- a. In case of accident person /staff affected or responsible can be exactly traced.
- b. It warns the general public about the hazardous nature of waste.
- c. Labeling can be done as hand written or filling of preprinted labels.

**12. How is the BMW transported for off-site storage and treatment?**

It is transported in bigger vehicle which is having leak proof and corrosive resistant compartments and door having lock facility to secure the waste.

**13. Transport vehicle should have what types of characteristics in it?**

- a. Detailed information, i.e. name, address, telephone number of the transporter
- b. Body should be leak proof, corrosive resistant and fully enclosed
- c. All the corners should be made rounded for easy cleaning

- d. There should be no projected part inside the cabin otherwise it will tear the bag
- e. There should be separate cabin for different class of waste
- f. Vehicle should have enough space so there is no overcrowding of bags
- g. Vehicle should be designed in such a way that it prevents the discharge of infectious fluid into environment or enroot
- h. Vehicle should be cleaned thoroughly and disinfected immediately after unload
- i. Door of vehicle should be close tightly and locked
- j. Inside should be lined with aluminum

**14. What details are noted about waste before transport of waste?**

Following details are noted on consignment note in duplicate of which one cape is given to generator and counter cape is carried by the transporter:

- a. Details of name, address and telephone number of waste generator and transporter
- b. Name and signature of authorized representative from generator and who is receiving waste
- c. Date, type and quantity (category wise) of the waste collection (Fig. 5.2).

**Name of the Institution** .....

**Date** .....

**Time** .....

<i>Category of waste</i>	<i>Quantity (kg)</i>	<i>Signature of generator</i>	<i>Signature of collector</i>

**Figure 5.2:** Format for waste collection record

- 15. What are the minimum requirement for off-site transportation?**
- Transport plan and route is approved by the competent authorities
  - Waste is transported in leak proof container
  - Waste is transported routinely
  - Health care facility is aware of final disposal of it's waste.
- 16. What are the specification for the route of transportation of internal and /or external waste?**
- The route for transportation is fixed and logically planned
  - Revised or contingency route plan should also be kept ready in case original plan is not feasible or need alteration
  - Route plan should be practically feasible
  - The collection should starts from the farthest place to nearest place to the storage or treatment area
  - Collection and waste should ideally be start at the beginning of working shift
  - Transport route should be shortest possible route and away from general area.
- 17. What is storage of waste?**
- It is the process of storing the waste before it is sent for final treatment / disposal, storage may be in the hospital or outside hospital.
- 18. What is the maximum period of untreated waste storage?**
- 48 hrs and if this time is to be prolonged then permission from the competent authority is needed.
- 19. What are the recommendation for proper storage?**
- All waste containers should be securely closed and sealed
  - Filled plastic bags are placed in containers and they are also sealed
  - Storage area should be specified and there should be no mixing of the waste.

**20. Mention the recommendation for storage facilities?**

- a. Location of the storage area should be big enough to accommodate required no. of bags at a time
- b. Storage area should have hard cemented flooring with proper drainage facility, so it is easy to clean and disinfect and does not allow any liquid to seep through
- c. Waste collection vehicle has easy access to storage area
- d. Not accessible to unauthorized person and stray animals
- e. Should have double channel door for proper security
- f. There should be protection from sun
- g. Facility should be provided if waste is to be stored for more than 48 hours and in that case area should be earmarked whose temperature does not exceed 10°C
- h. There should be continuous water supply
- i. Storage area should have good ventilation and light facilities
- j. It should be quite far from general water and food storage area of the health care facility
- k. There should be sufficient supply of protective clothing for the workers
- l. For on-site treatment facility storage should be in proximity to treatment facility
- m. Walls and floor of storage area should be free of any crack, gap or breaks
- n. First aid box should be made available in storage area
- o. Fire extinguisher should be available in store area
- p. Separate area should be marked for infectious and non-infectious waste.



## *Treatment and Disposal of Waste*

**1. What do you understand by treatment of waste?**

The process of changing the composition and characteristics of any biomedical waste so as to make it non-infectious and neutral in reaction.

**2. What should be the prerequisite for choosing treatment method?**

Method should be:

- Effective in treating the waste
- Cost effective
- Operable
- Safe for human health and environment.

**3. What is pretreatment?**

The infectious waste cannot be sent for final disposal without being disinfected first and process of disinfection of waste is called pretreatment.

**4. What are the methods which are used for treatment?**

- a. Chemical disinfection
- b. Microwave
- c. Autoclave
- d. Hydroclave.

**5. What are the main methods for treatment of biomedical waste?**

There are mainly 5 broad categories of treatment methods:

- a. Thermal treatment burn

- b. Mechanical treatment
  - c. Chemical treatment
  - d. Irradiation treatment
  - e. Biological treatment.
6. Give brief account of various methods of waste treatment.
- a. **Thermal treatment:** This method uses heat in order to decontaminate the waste. Various methods are being used:
    - Incinerator
    - Plasma cytolysis/buses technologies
    - Autoclave
    - Hydroclave/non-buses technologies
    - Microwave.
  - b. **Mechanical treatment:** Mechanical methods are used to destroy the biomedical waste. These methods used once the waste has been made non-infectious:
    - Granulation
      - Pulping
      - Grinding
      - Compaction
    - Shredding
  - c. **Chemical treatment:** This method uses chemical disinfectant and mainly used for sharps and plastic wastes. Main solution used are hypochlorite and common bleach.
  - d. **Irradiation treatment:** Using ionizing radiation the waste is decontaminated. Not much used routinely.
  - e. **Biological treatment:** This technology uses enzymes for treating medical waste. This method is useful for the waste other than strays, incinerator ash, plastic, and human tissues. Methods are:
    - Composting
    - Vermiculture
    - Biodigestion.
7. Which material is suitable for incinerator?
- Human waste
  - Animal waste
  - Laboratory waste

- Contaminated solid waste—like cotton, dressing material, linen, plaster cast, etc.

Category 1, 2, 3, 6 material are directly sent for incineration without chemical pretreatment.

**8. Name the items which should not be incinerated.**

- a. Chemical waste
- b. Chlorinated plastic waste
- c. Pressurized containers
- d. Waste with high cadmium and mercury contents
- e. Sealed ampules.

**9. What are the characteristics of waste which is suitable for incinerator?**

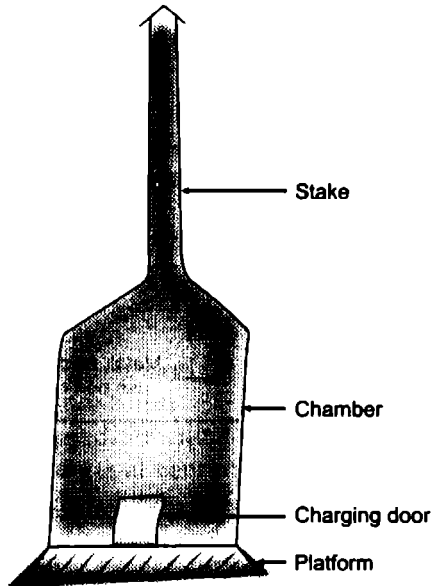
- a. Waste having more than 60% of combustible material
- b. Waste having less than 30% of moisture contents
- c. Waste having low heating value, i.e. burns at low temp
- d. Waste having less than 5% of non-combustible solids.

**10. What is the principle of incinerator?**

By using heat at very high temperature and dry oxidation process it reduces the organic and combustible material into non-combustible and inorganic material reducing the weight and volume of the waste.

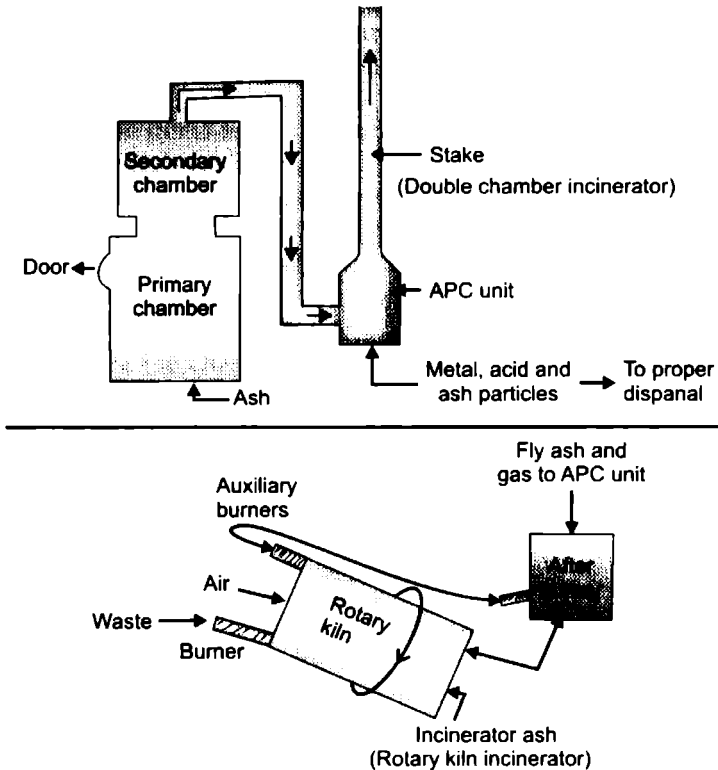
**11. Briefly describe the types of incinerators.**

- a. **Single chamber:** Only one chamber with dormancy. This can be made either with iron drum or bricks. This is the simplest form of incinerator (Fig. 6.1). These incinerators don't have air pollution control devices thus cause pollution hence not advocated.
- b. **Double chamber incinerators:** Commonly used incinerator. First chamber is called pyrolytic chamber while second chamber is called post-combustion chamber
- c. The temperature in 1st chamber is about 800 (+/-) 50°C and in second chamber 1000 (+/-) 50°C.



**Figure 6.1:** Single chamber incinerator

- d. First chamber has less oxygen supply while second chamber has excessive  $O_2$  supply to minimize odor and smoke (Fig. 6.2).
  - e. **Rotary kilns:** It consists of rotating cylindrical chamber lined with fire bricks and a post-combustion chamber. This is specifically used for incinerating chemical waste. The rotating oven is inclined at a slight angle and moves 3-5 rotations per minute. The charging of the waste done from the top. The residence time in post-combustion chamber is 2 sec.
  - f. **Controlled air incinerator:** In this type of incinerator the  $O_2$  requirement in primary chamber is 40-80% while in secondary chamber 100-150%. In primary chamber the waste is dried, heated and burnt.
- 12. What are main pollutants released from incinerators?**
- a. Carbon mono-oxide, carbon dioxide and nitrogen oxide.
  - b. Dioxin and furans



**Figure 6.2:** Double chamber incinerator

- c. Hydrogen chloride
- d. Particulate matter
- e. Toxic metal fumes.

**13. Why air pollution control unit be associated with incinerator?**

Because the chemicals in the waste on burning produces new chemicals which goes into air with emersion and causes air pollution. APC unit does not prevent the formation of pollutants but prevents the release of pollutants into air and get collected either in ash or in air filter.

- 14. Name the various type of APC units.**
- Scrubber (wet and dry)
  - Gravity settler
  - Exhaust fan
  - Dilution equipment
  - Acid gas control, etc.
- 15. What are characteristics of high pressure ventury scrubber?**
- Has minimum pressure drop
  - Temperature of gas at outlet of scrubber is 70-80°C to ensure saturation of gas
  - Made of stainless steel (316 liters) or mild steel lined with acid resistance bricks
  - Scrubbing medium circulates at the rate of 2-2.5 liters/m<sup>3</sup> of saturated gas at venturi outlet
  - Caustic soda solution is added to ventery system to make medium with pH of around 6.5-7.
- 16. What are other types of scrubbers system?**
- Dry scrubber using lime as filter
  - Wet scrubber uses water as filter
  - Cyclonic scrubber in which gas circulates in high speed spiral movements with centrifugal force thus particulate matter are separated.
  - Centrifugal type droplet separator removes water droplets. The gas/smoke passes through the scrubber.
- 17. What do you understand by flue (exhaust) gas?**
- The emission from the incinerator is known as flue gas which contains fly ash.
- The flue gas contains heavy metals, water duplets, dioxin furans, carbon dioxide, SO<sub>2</sub>, NO<sub>2</sub>, H<sub>2</sub>S, and particulate matters.
- They are treated in two stages:
- Dedusting—to remove fly ash
  - Washing of gas with alkaline solution—to neutralize oxides of sulfur and halides of hydrogen.

**18. How flue gas can be neutralized?**

The temperature of flue gas is around  $800^{\circ}\text{C}$  and needs cooling before going for dedusting and the cooling system which is used for flue gas has hot water which can further be used to preheat the waste.

**19. Why incinerator ash be disposed carefully?**

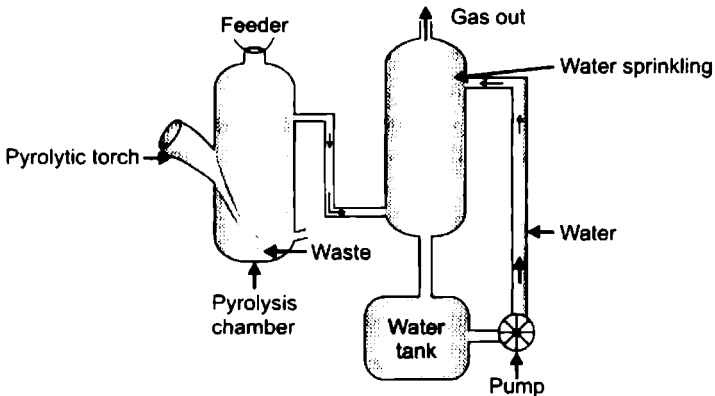
Because it contains toxins and heavy metals which may produce adverse health and environment effect hence, should be disposed in secured land fill rather than disposing in municipal containers of sewer system.

**20. What is principle of plasma pyrolysis?**

The principle of plasma pyrolysis is to reduce the material to its basic chemical components by means of very high temp. of gas plasma in the absence of oxygen.

**21. What is plasma arc?**

It is the thermal treatment system in which the temperature is raised upto 10,000 degrees (Fig. 6.3).



**Figure 6.3:** Thermal treatment

**22. What are advantages of plasma pyrolysis?**

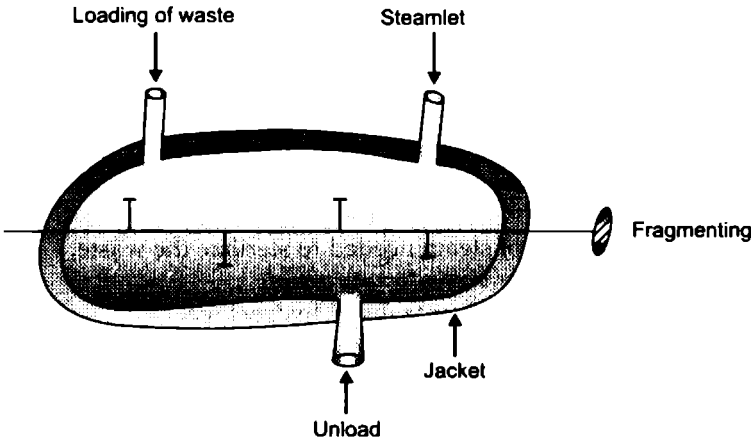
- Waste is reduced to 1/200th of original volume
- Waste is reduced to its basic chemical components
- No furans or dioxin as there is no burning in absence of oxygen
- It produces a combustible gas as byproduct which can be reutilized
- Process is not interfered by moisture content of waste.

**23. Mention the disadvantages of plasma pyrolysis?**

- To produce very high temperature it requires large amount of electrical energy to operate
- Running cost of system is very high
- It does produce environment pollution though at lesser degrees.

**24. What is the principle of hydroclave?**

It works on indirect thermal treatment in which the steam of outer jacket heats up the inner jacket which again produces the steam from the moisture contents of the waste (Fig. 6.4).



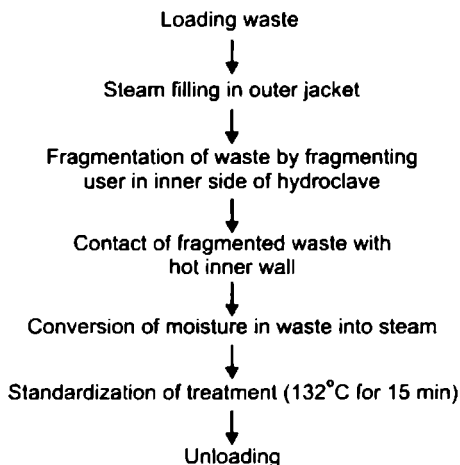
**Figure 6.4: Hydroclave**



**25. What is the main difference between autoclave and hydroclave?**

In autoclave there is direct contact of steam with the waste while this is not so in hydroclave.

**26. Make the process flow chart of hydroclave.**



**27. Mention the advantages of hydroclave.**

- The waste is reduced in volume as well as in weight by 60-80%.
- No hazardous by product as incinerator
- There is no need of waste fragmentation of waste after autoclaving
- Less amount of steam needed to sterilize the waste.

**28. Enumerate the disadvantages of hydroclave.**

- Not suitable for certain types of waste like chemical, pharmaceuticals and radioactive waste
- Costly installation and operation as compared to autoclave.

**29. What is the basic principle of autoclave?**

Steam at high temperature and under high pressure inactivates the microorganism then making the waste non-infectious.

**30. What are the types of autoclave?**

- a. **Pre-vacuum type autoclave:** Vacuum pump is used to remove the air from treatment chamber then steam is introduced.
- b. **Gravity type autoclave:** Steam under pressure is used to evacuate the air from chamber.

**Pre-vacuum**

- a. More efficient
- b. Cycle time 30-60 min.
- c. Operating temp 132°C

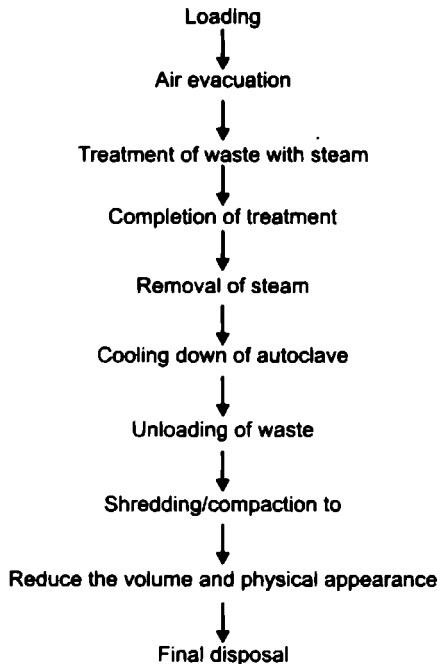
**Gravity type**

- a. Less efficient
- b. 60-90 min
- c. 120°C

**31. What is the process difference between microware and autoclave?**

In autoclave process followed by shredding and microware shredding followed by process.

**32. Mention the step in autoclave process.**



**33. How X-ray waste is disposed off?**

*Developer:* Should not be mixed with fixer solution. Developer can be drained into hospital sewer system.

*Fixer:* Considered hazardous because high silver contents ionic silver acts as an enzyme inhibitor in metabolic process. Fixer is sent to silver recovery system.

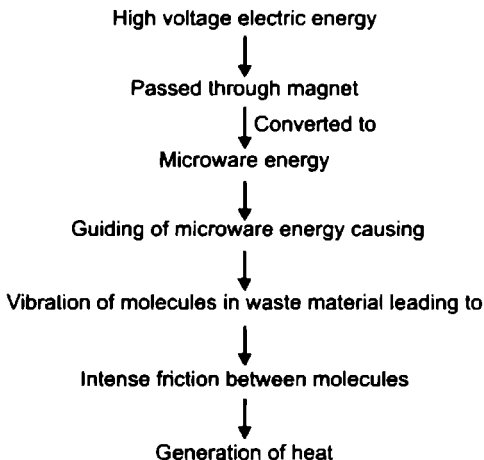
*X-ray lead foil/lead shield:* Contains pure lead hence sent to recycle system.

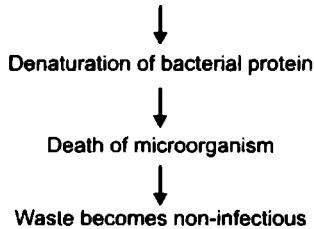
**34. What are the advantages of autoclave?**

- No hazardous byproduct
- Easy to operate
- Effective treatment of waste
- Low capital and operating cost
- Can be adjusted in small available space as available in different capacities.

**35. What are the disadvantages of autoclave?**

- Physical appearance not changed hence post-treatment mechanical treatment is needed
- Fumes emitted have offensive odor
- Not suitable for cytotoxic, radioactive wastes.

**36. What is the working principle of microwave?**



**37. What is sterilization by superheated steam?**

In this method sterilization of the waste is done with the steam at very high temperature (500 to 700°C) under increased pressure. The shredder is also incorporated with sterilization.

**38. What are the advantages of superheated steam sterilization?**

- This technology can handle low level radioactive and chlorinated plastic waste
- 50 to 80% reduction in waste achieved.

**39. What is wet oxidation technology?**

This technology uses oxidation chamber and shredder for the complete treatment of the waste.

The shredded waste is placed in chamber and treated with 10% sulphuric acid and iron ion catalyst where former causes oxidation while the agitation of the chamber ensures treatment of all waste material. The treated waste then placed in rinse chamber where water is sprayed over treated material to remove extra solution.

The technology resembles the washing machine and the method is so rapid that it can treat larger quantity of waste in short time.

**40. Write characteristics of microware.**

- They are electromagnetic radiation
- Frequency in between 300-300,000 mega Htz.
- Cause heating of material from inside.
- Presence of water intensifies the heating process.

- 41. What are the advantages of microware?**
- Easy to use
  - Due to provision of filters absence of harmful air
  - Automatic safe process
  - Reduced volume of waste
  - Volume of waste reduced significantly
  - Absence of liquid discharge.
- 42. What are the disadvantages.**
- High capital cost
  - Offensive odor
  - May omit toxic contaminants
  - Unsuitable for cat. 1 waste.
- 43. Mention the methods of treatment in short for sharps, disposable item and liquid waste.**
- Brokenglass, scaper blades—disinfection with hypochlorite solution
  - Needle and syring nozzle—shredded in needle destroyer and syringe cutter
  - Culture plates—autoclave then media disposed off and culture plate reused
  - Disposable item—disinfection in freshly prepared 1% sodium hypochlorite solution for 30-60 min. then shredded before disposal
  - Teeth with amalgum—disinfection in glutaraldehyde for 30 min. It should not be sent for incineration because it will lead to emission of mercury in air
  - Non-infectious liquid waste—neutralized with reagent
  - Infectious liquid waste is treated with chemical disinfectant then neutralized.
- 44. Describe briefly other treatment methods for waste.**
- Methods in used are:
- Demolizer
  - KC medical waste technology
  - Electronic beam
  - Pyroxidizer
  - Steam reforming.

**45. What are the basic types of chemical treatment methods?**

- a. Non-chlorinated
- b. Chlorinated

In non-chlorinated methods glutaraldehyde, peroxyacetic acid or ozone is used.

In chlorinated method sodium hypochlorite is mainly used.

**46. What are the suitable articles for chemical disinfection?**

- a. Plastic
- b. Rubber
- c. Metallic item.

**47. What is the prerequisite for chemical disinfections?**

Shredding of the waste material is the prerequisite for chemical disinfection. It has following purpose:

- a. Shredding reduces the volume of waste
- b. It increases the surface area for action of chemicals
- c. Shredding eliminates the closed space of waste item.

**48. What is the recommended dilution of sodium hypochlorite for blood spill treatment?**

100 ml/liter with 1% available chlorine (10 gm/ltr = 10,000 ppm).

**49. What is the contact period for different chemical agents?**

Household bleach contains 4-5% of available chlorine however, it can be utilized after diluting to have 1% available chlorine. The minimum contact period is 30 minutes.

**50. What are other chemical disinfectants effective in activating HIV?**

70% ethanol	3-5 min
2% povidone Iodine	15 min
2% glutaraldehyde (cidex)	30 min
6% hydrogen peroxide	30 min
4% formaline	30 min.

**51. How sodium hypochlorite is formed?**



- 52. Which waste is unsuitable for chemical treatment?**
- Cytotoxic agents
  - Volatile and semivolatile organic compounds
  - Mercury
  - Radiological waste.
- 53. What are the advantages of chemical treatment?**
- Liquid effluent can be safely discharged into sewer system
  - Waste unrecognizable
  - No byproduct.
- 54. What are the disadvantages of chemical treatment?**
- Chemical itself is hazardous
  - Ineffective for large quantity of waste at a time.
- 55. Why radiations are not used for waste treatment?**
- Because there is no change in volume, weight and shape of the waste
  - Y radiations are ionizing radiation extremely harmful
  - Not suitable for cat 1 and chemical waste.
- 56. What precautions should be taken while handling and storing chemical?**
- Proper labeling of the chemical containers
  - Prompt identifications of chemical hazard
  - SOP for chemical safety
  - Workers training to reduce hazards from chemicals
  - Replacement of chlorinated solvents by less hazardous chemicals
  - Unused/expired chemical to be returned to supplier as mentioned in contract
  - Proper record-keeping of all chemicals
  - Record keeping of chemical exposures and immediate mgt. of such exposure
  - Use of personal protective measures.

57. Which biological methods are used for hospital waste?

- a. Bio-digestion
- b. Vermiculture
- c. Pit composting

These are suitable for rural health institutions.

58. Which type of waste is suitable for biological methods?

Waste which is not infectious is suitable for biological treatment and disposal. Hospital kitchen waste, left over food, fruit peels, vegetables, etc.

59. Briefly describe the biological process (Fig. 6.5).

a. **Biodigestion:** also called aerobic digestion. This is similar to gobar gas system however, instead of gobar other waste like kitchen waste, leftover food is used. The process is fed daily and equal quantity of slurry is formed which is released into slurry pit where manure is formed. Cow dung may be used as initial biodigester. In the process methane gas is formed which is collected at the dome of the system and is ready for being used as cooking fuel. This method is suitable for rural area institution where considerable non-infectious waste is produced.

b. **Vermiculture:** This is another ecofriendly treatment and disposal method suitable for biodegradable waste. In this method cow dung, coconut husk and earthworms (*Eisenia factida*) are used.

*Dimensions of pit:* 3 feet wide and 8-10 inches deep made of wooden box of the same size used.

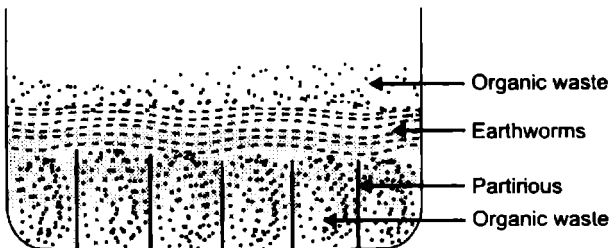


Figure 6.5: Vermiculture box



*Layers in pit*

- First layer rubber to prevent worm from escaping
- Second layer coconut husk to retain moisture.
- Third layer cowdung about 6 inches in height.
- 4th layer earthworm half the wt. of cow dung.

*Mature:* Pit should be watered daily for few days. Then divide the pit in 7 segments and one segment is used for a day and at the end of week first week is refed, while keeping the pit moist.

*After 6 weeks:* Remove the manure and put them in direct sunlight and reuse the pit.

*Precautions:* Avoid putting plastic or metal waste in pit.

- c. **Pit composting:** Here instead of earthworm cowdung is used for treating and disposing biodegradable waste.

**60. On what factors the efficiency of chemical disinfectants depend?**

- a. Type of chemical
- b. Contact time
- c. Amount of chemical used.
- d. Operating temperature, pH
- e. Organic load of the waste.

**61. What factors are considered before a chemical disinfectant is chosen for the use?**

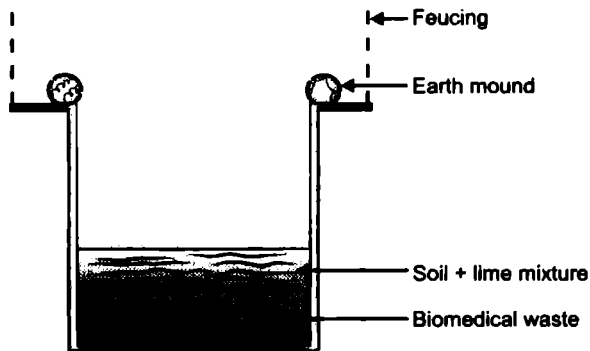
- a. Cost
- b. Effectivity
- c. Duration of effectivity
- d. Post use disposal.

**62. What are the commonly used disposal methods?**

- a. Deep burial
- b. Sanitary land fills
- c. Encapsulation
- d. Shredding.

**63. Explain in brief the disposal methods of waste.**

- a. **Deep burial:** It is a small pit which is secured by high barbed wire fence. The pit is usually 1-2 meters in diameter and 2-5 meters depth. The waste is disposed in pit and covers with soil or soil plus lime of 10-20 cm thick layer. When the pit is filled about 50 cm from the brain it is covered with a layer of cement or wire wash over which soil is filled which gives about 50 cm cover. On the basis of pit earth wound are made to prevent water entering into pit (Fig. 6.6).



**Figure 6.6:** Deep burial pit

- b. **Sanitary land fills:** There are land fills with advanced engineering complexity. These have following central measures:
- a. Gas control
  - b. Environmental monitoring points
  - c. Bore holes for monitoring round water and air quality.
- This needs following specialized components:
- a. Trained workforce
  - b. Security of the land fill area
  - c. Overhead cover to prevent rain water retaining into it
  - d. License for using the place
  - e. Site away from residential area
  - f. Easy approach for transport vehicle
  - g. Depth of land fill should be around 2 mts. to avoid scavenging and accidental recovery of waste

- h. Pit should be at least 100 mts. away from ground water source
- i. Should not be located near the flood prone area.

**64. What are the types of needle destroyers?**

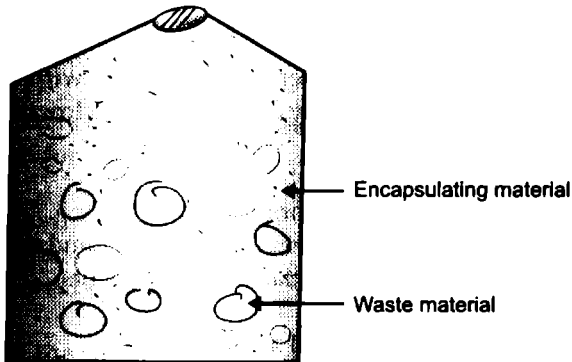
- a. Mechanical
- b. Electrically operated

In mechanical type needle destroyer the needle is sheared from the syringe with the help of lever and collected in Box.

In electrically operated needle destroyer the needle is either sheared or destroyed by platinum plate leaving a residue of steel at heated around 700–800°C. In both the types only one needle can be sheared at a time along with this the lever is also able to destroy the tip of syringe to make it unusable.

**65. What is encapsulation?**

This is the process of mixing the waste with encapsulating material to make the whole material hard and unusable. This can be done either in drum or ground pit. This is mainly used for sharp waste (Fig. 6.7).



**Figure 6.7:** Encapsulation

**66. What are the encapsulating material used?**

- a. Cement
- b. Clay
- c. Bituminous sand, etc.

**67. What is shredder?**

Shredder is a machine which is used to make waste unrecognizable after treatment. This is mainly used for plastic waste which after shredding can be recycled.

This can be either multiple shaft or single shaft shredder. It has automatic safety device which shuts off the machine in case the operation is not correct to avoid any accident.

**68. What is the composition of encapsulation material?**

- 1 part cement
- 1 part lime
- 4 parts sand
- ½ part water

**69. What precautions should be taken after needles are mutilated?**

They should be disinfected in 0.5% hypochlorite solution with contact period of around 30 min. This should strictly be done at the point of waste generation.

**70. Why chlorine compound be used for chemical disinfection?**

Because they are:

- Very effective
- Easy available at cheaper prize
- Easy to use.

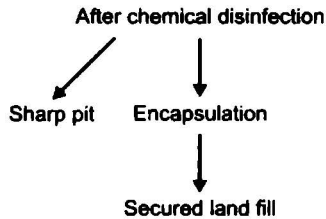
**71. What are demerits of chemical disinfectants?**

- a. Not effective against spores
- b. Loses effectiveness if chlorine content is lost
- c. Need fresh preparation.

**72. What should be the main quality of sharp container?**

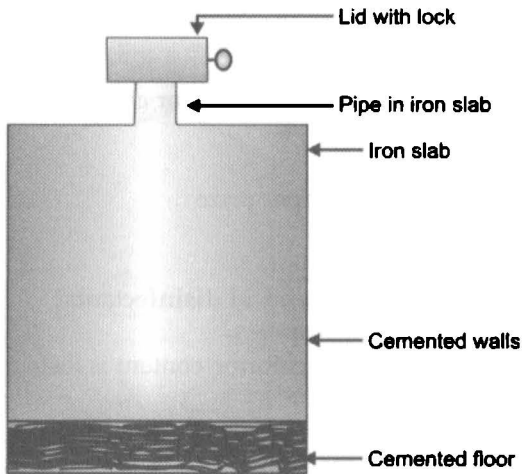
- a. It should be puncture proof to avoid sharp injury
- b. It's mouth should be narrow so that sharp can't be accidentally recovered.

**73. How sharps are finally disposed?**



**74. What are the characteristics of sharp pit?**

- It has cemented walls and floor (Fig. 6.8)
- It is covered with thick iron or cement slab having circular in which 6 " diameter pipe is fitted with lid and lock facility
- Size of pit depends on the waste generation and space availability
- Once it is filled around 1 feet below cover, then cement slurry is used to fill the pit and next one is prepared.

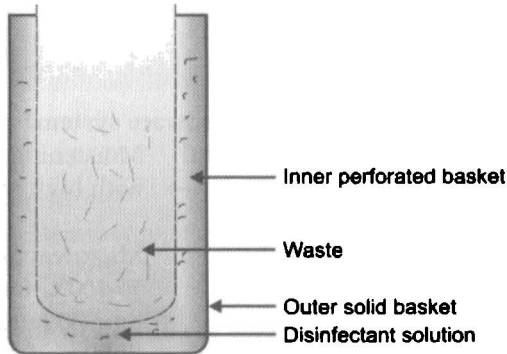


**Figure 6.8:** Safe pit for sharps

**75. How the plastic syringes can be disinfected at the point of generation?**

This can be done by using two baskets—outer rigid and inner perforated in between hypochlorite solution is filled and

syringes are put into inner side which came in contact with disinfectant after contact period of 30 min. then the bin can be emptied in larger one (Fig. 6.9).



**Figure 6.9:** Two-basket system

**76. Which methods are commonly used for disposal of liquids?**

- Soak pit
- Sewers
- Waste stabilizing plant having aerobic filter and activated sludge technology.

**77. What is average frequency and average length of microware?**

Frequency	2450 mHz.
Wavelength	12.24 cm.

**78. How is 1% type chlorite solution prepared?**

By dissolving 10 gm of bleaching powder in 1 liter of water. The solution has to be prepared fresh every time and changed every 12 hrs.

**79. What are the disposal options for treated medical waste?**

- a. Treated solid waste—Municipal land fill
- b. Encapsulated sharps—Municipal land fills
- c. Disinfected and shredded—Municipal land fills or recycling
- d. Incineration ash—Secured land fill
- e. Oil and grease—Incineration.

**80. How the sharps and plastic should be treated before shredding?**

They should be treated by:

- Chemical disinfectants
- Microwaving
- Autoclaving.

**81. What is working pattern of microwave system?**

Shredding of material → Pushing of material into treatment chamber → Moistening of waste with high temp steam



Microwaving at 95-100°C for residence time 30 min and cycle time around 50 min.



Further fragmentation by second shredder



Discharge of waste into container for land fill

**1. What is training?**

It is the systemic way of giving an information to person about a process or skills.

**2. Which type of training is given in case of BMW?**

The training is given based on androgogy model.

**3. What are the assumptions of this model?**

- a. Adults have need to know the reason for learning
- b. Adults are free to determine what, when and how they should learn
- c. Adults are self-directed learners
- d. Adults have very sharp sense of understanding
- e. Adults learn more in non-formal and unorganized and loosely structured programs.

**4. Which are the target groups for training?**

- Doctors
- Nurses
- Patients' attendants
- Paramedical staff
- Waste handlers.

**5. Why do waste handlers need training?**

Because:

- They may be in any service bracket
- They may be from any educational back ground
- They are less motivated



- They are less aware of gravity of hazards posed by BMW
  - Belong to low socioeconomic group
  - Sometimes they may bypass the precautionary measures
  - They usually take the instructions lightly.
- 6. What are the objectives of training and education?**
- a. To make HCW aware of hazards related to BMW and its indiscriminate handling
  - b. To prevent the exposure to BMW
  - c. To highlight the various stages of BMW and their importance
  - d. To initiate better waste handling practices.
- 7. Which type of teaching is appropriate for waste handlers?**  
Teacher – student – content centered
- 8. What methodology is useful for training?**
- a. Group discussion
  - b. Problem solving situation
  - c. Lectures
  - d. Modular training
  - e. Field visits.
- 9. On what factor the methodology depends?**
- a. Contents of the case
  - b. Proficiency of trainer
  - c. Motivation level of learner
  - d. Type of training to be imparted.
- 10. What should be main characteristics of training program?**  
It should be:
- Consistent
  - Universal
  - Applied carefully based on evaluation reports
  - Periodic evaluation
  - Modification of future response.

**11. What training aids useful?**

- a. Posters
  - Booklets
  - Manuals
  - Flip chart
- b. OHP
  - Video films
- c. Practical demonstration
  - Hands on training.

**12. What are the characteristics of androgogy?**

- a. Adults are self-directed and show need for training due to inner motivation
- b. Adults expect the respect from trainer
- c. They have precious experience and knowledge as well
- d. Adults are practical in their approach
- e. They are result oriented.

**13. What are the qualities of good trainer?**

- a. Has good communication skills
- b. Able to coordinate with trainee through constructive approach
- c. Should be well versed with area of specialization and should be able to identify the gaps
- d. Should be willing participant in training programme
- e. Should keep on updating knowledge, techniques and new methodologies
- f. Should be able to get regular feedback from trainees and modify training approach accordingly.

**14. What are the characteristics of good trainees?**

- a. Regular for training program
- b. Give in time proper feedback to trainer
- c. Ask questions to clear doubts
- d. Remain attentive during training session
- e. Show cooperation and coordination with fellow trainees
- f. Actively participate in training program.

**15. What are the characteristics of effective communication?**

- a. Proper preparation of subject and training materials
- b. Understanding needs of trainees
- c. Ensure that trainees are listening and understanding the subject
- d. Does not use too much of technical language
- e. Quickly establishes good interpersonal relations with trainees
- f. Trainer should make trainee listen actively.

**16. What are the possible gaps in BMW?**

- a. KSA (knowledge, skill, and attitude) gap
- b. Technology gap
- c. Policy and procedures gap
- d. Effective supervisory gap.

**17. What is evaluation of training?**

It is a process of collecting information which can be utilized for decision-making about present and future training activities.

**18. What are basic questions arise while doing evaluation?**

- Why to do evaluation?  
When to do evaluation?  
What to evaluate?  
How to evaluate?

**19. What are the basic principles of evaluation?**

- a. Clarity of purpose
- b. Reliability of results
- c. Tailor made evaluation tools
- d. Objectivity of evaluation
- e. Evaluation is a process not the end product of training
- f. Feasibility.

**20. What are the basic qualities of evaluator?**

- a. Committed to the process
- b. Good interpersonal relationship

- c. Helps to realize benefits of training
- d. Encourages others to get evaluated.

**21. What are different evaluation methods?**

Pre-training:

- a. TNI ( Training Need Identification)
- b. Evaluation of training objectives
- c. Evaluation of performance standard
- d. Evaluation of trainees profile.

Post-training:

- a. Reaction evaluation
- b. Learning evaluation
- c. Job behavior evaluation.

**22. What measures should be taken while giving training to waste handlers?**

- a. Training should be given in local language
- b. Highlights the importance of proper management
- c. Brief account of infectious waste and diseases caused by them
- d. Brief introduction of biomedical waste management rules
- e. How to cope with accident/injuries
- f. How to maintain personal hygiene
- g. Appreciation to those who follow instructions and punishment for dereliction of duty and non-compliance.

**23. What is capacity building?**

It consists of various activities which strengthen the knowledge, skill, ability, and behavior of individual in order to achieve organizational goals.

# *Managerial Issues in Biomedical Waste Management*

1. **What is the role of Hospital Manager in BMWWM?**

Hospital Manager should ensure that biomedical waste is managed in environmentally safe manner.
2. **What are the prerequisites for safe BMWWM?**
  - a. Hospital should have BMWWM committee
  - b. Hospital should develop the policy approved by committee.
  - c. Committee should involve everyone in the hospital in the process
  - d. Policy and procedures should be reviewed periodically
  - e. Committee should also evolve the strategy for waste management.
3. **Why should there be strategy?**

To ensure that all the regulatory requirements related to BMWWM are fulfilled.
4. **What are the basic components of an effective strategy?**
  - a. Clear out living the commitment of the hospital management
  - b. Clearly defining the commitment towards allocation of resources
  - c. Precisely rendering the accountability and responsibilities in terms of BMWWM
  - d. Defining the categories of waste being produced
  - e. Clearly defining the disposal procedures for each category of waste
  - f. Ensuring continuous training and education.

**5. What is waste audit?**

It is a valuable tool which helps to understand the type and quantity of waste and involves data collection, analysis, and recommendations, data can be analyzed manually or through computer software. It is the methodical process of characterizing, quantifying and delineating different waste streams through the waste survey to evolve the waste management policies.

During audit following information are collected— quantity of waste, type of waste, waste moment functioning, states of equipment / machines, condition of protective personal clothing, incidence of sharp injuries, disinfection process and spill management process.

**6. What is the main purpose of waste audit?**

Waste audit is required to understand the type and quantity of waste generated. It also helps in formulation of plan for segregation handling and management.

**7. What are main managerial issues in BMW?**

- a. Waste recognition
- b. Recognition of waste generation
- c. Recognizing the cause of generation of particular type of waste
- d. Planning of corrective action.

**8. What are the benefits of methodical waste management?**

- Scientific handling of waste
- Efficient collection of waste
- Economic disposal of waste
- Elimination of occupational hazards related to waste.

**9. What are the characteristics of audit team?**

- a. Team should be multidisciplinary
- b. Every member should have authorized access to all staff member and departments of the hospital
- c. Has expertise in waste management practices.

**10. During waste survey what should be the frequency of data collection?**

Wards, OPD, ICU, casualty, laboratory – Every shift  
OT, Dialysis, Radiation unit – Every procedure  
Lab chemical, Liquid waste – before each discard into drain.  
Pharmacy, Surrounding, Administrative area, Cleaning and washing water using flow meter, incinerator ash – Once a day  
Kitchen – twice a day.

**11. What are the prerequisite of effective survey?**

- a. The survey team should be dedicated towards thin aim
- b. No portion of total waste be missed out
- c. Team should take each and every detail related to waste
- d. A suitable place should be earmarked to carryout.

**12. What should be the minimum period for carrying out survey?**

3-4 days a week for 4-6 weeks.

**13. What do you understand by waste tracking?**

This is the process of documentation of the movement of the waste from the place of generation to the place of final disposal.

**14. What are the advantages of waste tracking?**

- a. Proper monitoring of waste management program
- b. Pinpointing the responsibility and liability
- c. Records of quantities and type of waste generated, treated and disposed
- d. Help in finding out the gaps and TNI.

**15. Who do you mean by extended producer responsibility?**

This is the part of waste minimization program in which produce of the product is responsible for the recovery of that particular product in case of not used/expired from date of manufacture, etc.

**16. What are other components of waste minimization?**

- Product substitution (more ecofriendly product)
- Product change to get more user friendly product

- Procedural change in patient care to minimize the waste generation
- Preference for reusable items.

**17. What steps a health care facility should take to prepare a waste management plan?**

- a. Have commitment to deliver the highest standard of pt. care and safety of employee
- b. Conduct baseline waste audit
- c. Prepare waste minimization policy
- d. Concentrate on 3'R' recycle, reduce and reuse concepts
- e. Take detailed accounts of segregation, storage, transport, treatment and disposal
- f. Comply with regulatory requirement of waste management
- g. Prepare risk management strategies
- h. Training and development of all who are involved in hospital facility and BMW
- i. Ensure in time feedback on various components of plan
- j. Update regularly and periodically.

**18. What is the difference between waste management and waste disposal?**

**Waste management:** It is a comprehensive process in which all steps of waste management are well planned and strictly executed. It is a problem solver.

**Waste disposal:** Unplanned process in which waste is disposed off in discriminately. It is problem creator.

**19. What is PDCA cycle?**

It is a system to monitor systemic management of waste consisting of four steps—plan – do – check – act. It is also known as PDSA Plan – do – study – Act cycle. PDCA cycle was originally conceived by Walter Shewhart in 1930 and later adapted by W Edward Deming in 1950, hence, also known as Deming cycle.



## 20. What are the details of each component?

<i>Plan</i>	<i>Do</i>	<i>Check</i>	<i>Act</i>
Establish policy based on requirement	Carry out changes initially on small scale by leading examples and showing commitments	Periodic review of objectives	If expected results are obtained then complexity of cycle is increased
Define objectives aimed at improvement	Collect data thoroughly	Results analyzed and trend of change is monitored	If no expected results then repeat the cycle till objective achieved
Plan and provide resources	Implement corrective actions	This step is also called assessment step	Document the process and revise plan
Develop implementation of plan	Communicate action to be taken to all concerned		

## 21. What are the objectives of PDCA cycle?

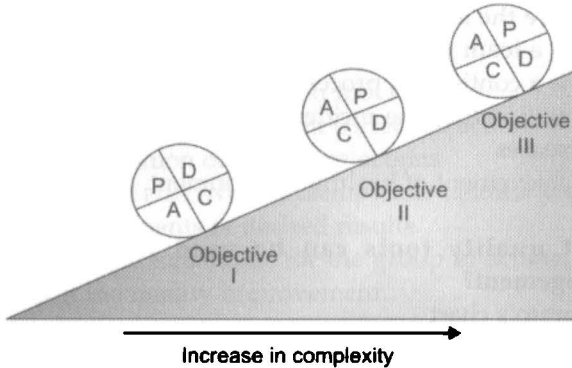
- a. To generate thought among health care workers that BMWM is continuous process
- b. Effective achievement of BMWM.

## 22. What is ramp of improvement?

It is upward going ramp of complexity on which once the PDCA's objective achieved then leading to new and slightly complex project in order to achieve continual improvement (Fig. 8.1).

## 23. Mention the advantages of PDCA cycle?

- a. Immediacy, accuracy and ease of the application of the system
- b. It gives competitive edge to organization
- c. It helps to determine the improvement priorities
- d. It helps to apply measurement and charts to track process performance results.



**Figure 8.1:** Ramp of improvement

- e. It helps to create and deploy high performance process improvement team.
- 24. What are the key elements for improvement in BMW?**
- Building up a comprehensive system for waste management
  - Resource allocation
  - Addressing responsibilities and authorities
  - Handling and disposal.
- 25. What type of waste audit can be done?**  
There are two types of waste audit:
- Internal waste audit:** Done by hospital senior staff
  - External audit:** Carried out by some designated external agencies.
- 26. Can six sigma approach be applied in hospital waste management?**  
Yes
- 27. How six sigma approach will be effective in BMW management?**  
Because:
- It is a scientific, innovative and strategic way of doing work
  - The decisions are system based not the individual based
  - It reduces the defects in the systems.

**28. What are the advantages of six sigma approach?**

- a. It is a team work
- b. It is a continuous process
- c. It will reduce the incidences of occupational injuries and diseases
- d. Achievement of healthy environment.

**29. What quality tools can be used in hospital waste management?**

- a. Parato's chart
- b. Ishikawa diagram
- c. 5 whys
- d. Process maps.

**30. How the quality of BMW management can be improved?**

The elimination of the defects in the process of BMW will improve the waste management process. The elimination of the defects can be achieved by:

- a. Training of the staff dealing with the waste generation and waste disposal process
- b. Brainstorming of the staff members
- c. Mistake proofing.

**31. How ISO 14001 is related to hospital waste management?**

ISO 14001 is related to environment management and for hospital the proper waste management and this includes:

- Recognition of team leader for waste management
- Improved risk management profile
- Self-regulation
- Decrease in release of air borne contaminants
- Employee awareness toward environment.

**32. What is EPP?**

It means environmentally preferable purchasing and it consists of sourcing the products which are:

- Less toxic
- Reusable
- Leave less residue or waste behind when used
- Not having excessive packaging material.

**33. What is PROFIT model of quality improvement?**

P—problem identification

R—root cause identification and analysis

O—optimal solution based on root cause(s)

F—finalize how to implement corrective actions

I—implementation of corrective actions

T—tracking of effectiveness of implementation and verification of achievements of desired results.

PROFIT is the mnemonic for the group of actions which are taken for the quality improvement.

**34. What are the strategic recommendations for improving hospital waste management?**

- Define the problem clearly in waste management
- Focus on segregation
- Institute sharp management practices
- Keep focus on reduction of generation of waste
- Ensure worker's safety through protective equipment, education and training
- Secured collection and transportation
- Plan and policies for ensuring clarity and continuity of management practices
- Invest in employees training and eco friendly waste treatment and disposal technologies
- Development of infrastructure for safe disposal and recycling of hazardous and general waste.

# *New Concept in Biomedical Waste Management*

## 1. What is 3R?

- Reduce
- Recycle
- Reuse.

## 2. What is difference between recycle and reuse?

**Recycle:** Process of using waste products as a raw material to produce either similar material or other material. Examples of work to new product:

- Glass → Glass
- Paper → Paper, card board
- Plastic → Plastic

**Reuse:** Process of using the waste product for the same purpose for which it was originally used.

Glass syringe → used → washed and sterilized → Reuse.

## 3. What are the benefits of waste minimization?

- a. Economic reduction of waste generated
- b. Efficient handling of waste
- c. Economic disposal
- d. Reduction in health hazards.

## 4. What is waste to energy concept?

This is the concept of regeneration of energy from the waste either in the form of fuel or gas.

## 5. What is the concept of sustainable hospital?

The concept of sustainable hospital concepts as following:

- a. Efficient biomedical waste management
- b. Elimination of environmental or occupational hazards
- c. Maintenance of total quality in patient care
- d. Cost contaminant.

**6. Define Green purchasing.**

This is the system of purchasing hospital items which are:

- Non-toxic
- Environmental friendly
- More energy efficient
- Highly recyclable
- Safer for patient and staff.

**7. What is zero waste?**

It is the logical planning approach incorporating principles of effective human and material resource utilization to convert discards into efficient form of energy.

Waste of one type acts as resource for the other type new product.

Waste paper – card board boxes.

Nature makes no waste – it is the invention of human beings.

**8. What are the strategies to achieve zero waste?**

- a. Adopt resource management plan because it is easier to manage the resource than waste
- b. Make 3R the heart of the plan
- c. Composting of the waste
- d. Make participative and meaningful program for waste management
- e. Zero waste certification as an incentive
- f. Development of market for recyclable items
- g. Top level management involvement
- h. Extended responsibility of manufacturer
- i. Development of toxic release inventory to educate those who are concerned with waste management
- j. Focusing on renewable resources so as to get and do more with less resources.

- 9. What are end results of zero waste?**
- Reduced occupational risks to employees
  - Reduce risk to environment
  - Elimination of toxins from environment
  - Cost contaminant.
- 10. Can solar energy be utilized in BMW.**
- Yes:
- Box type solar cooker
  - Portable autoclave powered by solar energy.
- 11. How waste minimization be achieved in day to day practice?**
- Use material in least required quantity and only when it is absolutely essential
  - Prepare group purchasing or bulk purchasing
  - Purchase ecofriendly/biodegradable material
  - More preference to reusable item
  - Bulk/expiry/excess item to be returned to supplier/manufacturer as dealt in the initial contract.

## *Laws Related to Biomedical Waste Management*

**1. What are biomedical waste (Mgt. and handling) Rules, 1998?**

These rules prescribed by Ministry of Environment and Forest as per the provisions contained in section 6, 8, and 25 of Environment (Protection) Act, 1986 in order to protect the environment from the pollutants produced by Biomedical waste in any form. These rules have been amended two times first in 2000 and later in 2003.

These rules were notified on 20th July 1998, however, draft rules were Gazetted on 16th Oct. 1997 and public opinion and suggestions were invited within 60 days and they were considered before finalization of the rules.

**2. What are hazardous substances?**

There are substances or preparations which due to their physiochemical or chemical properties or handling liable to cause harm to human beings or other living creatures, plants, property or environment.

**3. What is authorization?**

Permission granted by the prescribed authority for generation, collection, reception, storage, transportation, treatment, disposal and/or any other form of handling of biomedical waste in accordance with these rules and any guidelines issued by central govt.

**4. Who are the occupiers?**

Any institution generating biomedical waste includes hospital, clinic, dental clinic, laboratory, veterinary institution, animal house, nursing home, blood bank and others by any name who has control over the institution and/or its premises.



5. **What types of waste is taken by Municipal body?**
  - a. General waste
  - b. Treated biomedical waste for disposal.
  
6. **Who laid down the standards for treatment technology of BMW?**

Central pollution control board.
  
7. **What is the period of authorization?**

Initial authorization is given for 3 years including one year provisional authorization. Subsequent authorization is also granted for 3 years.
  
8. **Who are the prescribed authorities?**

For states—State Pollution Control Boards  
For Union Territories—Pollution Control Committees.
  
9. **What is the period for application disposal for authorization?**

Within 90 days from the date of receipt of application for authorization.
  
10. **What are the powers and responsibilities of prescribed authority?**

The powers and responsibilities of the prescribed authority are:

  - Grant of authorization to the institutions covered under this rule
  - Implementing various provisions of this rule for proper management and handling of biomedical waste
  - Call for information in prescribed form as per Form 1
  - To make such enquiries as it deems fit
  - To conduct surveys, inspections and investigations for the purpose of implementation of this rule
  - To refuse grant of authorization. This has to be in writing and reasonable opportunity should be given to the applicant
  - To dispose of application of authorization within ninety days of receipt of application
  - To give a reasonable opportunity to the applicant before cancellation or suspension.

**11. What are Powers/Responsibilities of occupier?**

The occupier/ operator/ applicant has the following powers/ responsibilities:

- a. Specific procedure of grant of authorization or its cancellation or suspension
- b. To submit application in prescribed application form for authorization
- c. To give all the relevant information's including necessary fee, as prescribed by the prescribed authority, for grant of authorization
- d. To renew the authorization within the specified period
- e. Refusal or suspension of authorization only when recorded in writing giving reasons
- f. Automatic grant of authorization if the application not disposed by the prescribed authority within 90 days of receipt of the application, provided the application is complete in all respects
- g. Authorization granted for three years including an initial trial period of 1 year from the date of issue
- h. Provisional authorization may be granted by the prescribed authority for the trial period
- i. Specific time limit for compliance of provisions of the BMW Rules 98.

**12. Which occupiers are exempted from taking authorization?**

Dispensaries, clinics, pathological labs and blood banks which are providing services to less than 1000 patients per month however, there have to comply with rules for management of waste generated.

No hospital or nursing home is exempted irrespective of bed strength and number of patients per month.

**13. When the annual report be submitted by the occupier?**

Annual report should be submitted by the occupier to prescribed authority by 31st January every year who in turn sends it to CPCB by 31st March every year.

**14. What forms are used by occupiers?**

- Form I For application for authorization
- Form II For annual report
- Form III For accident report
- Form IV For authorization for operating a facility for collection
- Form V For application for filing appeal against order passed by prescribed authority.

**15. How many Schedules are there in BMW (Mgt. and handling) Rules 1998?**

- Schedule I Classification of biomedical waste in different categories
- Schedule II Types and color coding of the containers to be used for each category of BMW
- Schedule III Proforma for the label to be used on container/bags
- Schedule IV Proforma for the label for transport of waste container/bags
- Schedule V Standards for treatment and disposal of waste
- Schedule VI Deadlines for creation of waste treatment facilities.

**16. What is the time deadline for establishing waste management facilities by occupiers as per the Schedule VI?**

The deadline for time limit as per Schedule VI of BMW Rules was by 31 December 2002, for all hospitals and nursing homes.

**17. When appeal against the orders passed by the prescribed authority be done?**

Within 30 days from the date on which the order communicated to the occupier. Beyond this time appeal can be entertained in case authority feels that appellant was prevented by sufficient cause from filing the appeal in time.

**18. What are minimum terms and conditions for authorization?**

- a. Authorization shall comply with the provision given in Rules.

- b. Authorization letter or renewed authorization letter shall be produced for inspection on and when asked by person authorized by prescribed authority.
- c. No change in personnel equipment or working conditions mentioned in application be done without prior permission from prescribed authority.
- d. There should be no procedural change in BMWM without prior permission from prescribed authority.
- e. Before closing down the facility prior permission of prescribed authority is essential.

**19. What is the minimum space requirement for waste management?**

<i>S.No.</i>	<i>Hospital type</i>	<i>Free area required (in hectare)</i>
	Non bedded hospitals, clinical labs	0.02
	Bedded hospitals	
1	Less than 50 beds	0.25
2	50-200	1.00
3	More than 200	2.5
4	Research centre and Diagnostic centre	0.1

**20. How the charges are fixed for BMWM?**

Charges in hospital are fixed as per bed per day basis and on approximate weight basis for other establishment where there are no beds.

**21. What are the prescribed regulatory authorities responsible for BMWM?**

- a. Ministry of health and family welfare
- b. Ministry of environment and forests
- c. Director general of Armed Forces Medical Services
- d. DG Health of respective states for central pollution control boards
- e. State pollution control boards
- f. Municipal authorities.

**22. Under which Act the non-compliance to Rules is punishable?**

Non-compliance to Rules is punishable under Section 16 and 17 of Environment (Protection) Act 1986. Punishment can be any or all of the following:

- Imprisonment for 5 years extendable to 7 years
- Fine upto Rs 1 lakhs
- Both of the above.

**23. What are the responsibilities of CPCB for BMW?**

- a. Monitoring of implementation
- b. Preparation of codes, manuals and guidelines.
- c. Compilation of data
- d. Monitoring of implementation of rules
- e. Providing technical assistance to state pollution control boards.
- f. Organizing CME
- g. Laying down standards for:
  - Incinerator
  - Hydroclave
  - Autoclave
  - Microwave
- h. Preparation of guidelines for:
  - Design and construction for incinerator
  - Common BMW treatment facility
  - Management of waste from universal immunization program.

**24. What are the responsibilities of state pollution control boards?**

- a. Giving authorization for BMW by facility
- b. Renewal of authorization
- c. Collection of annual reports
- d. Periodic checking of facilities for compliance to Rules.
- e. Checking of all records maintained by occupier
- f. Issuing notice for violating the norms of BMW disposal
- g. Checking of various emission standards for incinerator and standards for liquid waste.
- h. Creating awareness among their own staff and other health care workers.

**25. What authorities have been empowered to govt. under Environment (Protection) Act 1986?**

The authority is given to Govt. to implement there rules under various sections of this Act:

- Section 3 To undertake various steps for protection and improvement of the environment
- Section 6 Govt is empowered to make rules to regulate environmental pollution
- Section 8 Waste handlers have to comply with procedural safeguards given in rules
- Section 10 Authority to enter and inspect the premises handling and managing the waste
- Section 15 Govt can take punitive actions against the defaulters
- Section 17 In case offender is any govt. department then head of the dept. is deemed to be guilty and liable for punishment accordingly.

**26. How the notice of offense is given to occupier?**

- a. Notice is given in Form IV and copy to different authority in state/UT.

If offence has taken place in state:

- State pollution control board.
- Environment secretary in State Govt.
- Secretary in Ministry of E and F.

If offence has taken place in UT:

- Central pollution control board
- Secretary in Ministry of E and F

- b. Notice is sent by registered post with acknowledgement due (Registered AD).

- c. A period of 60 days as mentioned in Clause (b) of Section 19 of Environment (Protection) Act 1986, be calculated from the date it is first received by one of the authorities mentioned above.

**27. What is the coverage area for CBWTF ?**

- It extends its facility upto 10,000 beds within area of radius of 150 km.
- Beyond 150 km, another unit is to be established.

**28. What treatment facilities should be made available at CBWTF?**

- a. Autoclave/Hydroclave because more stress is given on non-burn techniques
- b. Microware
- c. Incinerator with APCD
- d. Shredder
- e. Sharp pit
- f. Secured land fill
- g. Effluent treatment plant
- h. Washing facilities.

**29. What are the operating standards for incinerators?**

- a. Combustion efficiency shall be at least 99%

$$CE = \frac{\%CO_2}{\%CO_2 \times \%CO} \times 100$$

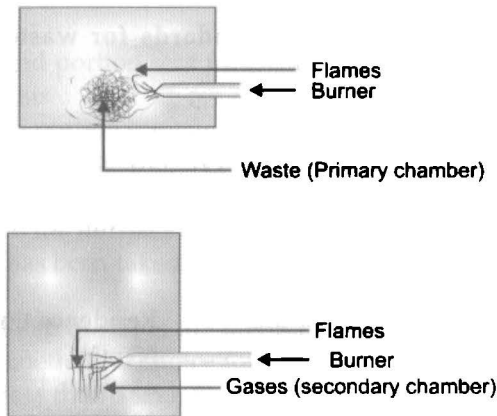
- b. Temp of binary chamber 800 + 50°C
- c. Temp of secondary chamber 1050 + 50°C with gas residence time at least one second and minimum 3% oxygen in stock gas.
- d. Only low sulphur diesel shall be used.
- e. Minimum stake height for incinerator should be 30 meters.
- f. Chlorinated plastic, toxic metals should not incinerated.
- g. Waste should not be chemically pretreated with chlorinated disinfectant.

**30. What are the emission standards for incinerators?**

<i>Incinerators parameters</i>	<i>Concentration mg/Nm<sup>3</sup> at 12% CO<sub>2</sub> correction</i>
Particulate matter	150
Nitrogen oxides	450
Hydrogen chloride	50
Volatile organic compounds in incinerator ash	Less than 0.1%

**31. What are the standards for incinerators at CBWTF?**

- Capacity minimum 50 kg/hr
- Separate burners for primary and secondary chambers with automatic on/off switch to avoid fluctuation in temperature
- Flame in primary chamber point towards waste while in secondary chamber the gases pass through flames (Fig. 10.1).

**Figure 10.1: Flames in chamber**

- Chambers should be lined with refractory and insulation bricks with 11-12 cm thickness.
  - Incinerator should have emergency vent and should be opened only in case of emergency.
  - Around incinerator there should be a clear area of 1.5 mt all around between incinerator and room wall.
  - Stock emission monitoring and incinerator ash analysis should be done quarterly and record should be maintained by operator.
- 32. What are the standards for liquid waste generated from facility?**
- |                    |           |
|--------------------|-----------|
| pH                 | 6.5 – 9.0 |
| Suspendable solids | 100 mg/L  |
| Oil and grease     | 10 mg/L   |



BOD	30 mg/L
COD	250 mg/L
Bioassay test	90% survival of fish after 96 hr in 100% affluent

These parameters are applicable to hospitals which are:

- Connected to sewers without terminal sewage treatment plant
- Not connected to public sewers.

**33. What are the operating standards for waste treatment autoclave?**

***Vacuum type:***

Temperature	Pressure	Residence time
121°C	15 psi	45 min
135°C	31 psi	30 min

***Gravity type:***

Temperature	Pressure	Residence time
121°C	15 psi	60 min
135°C	31 psi	45 min
149°C	52 psi	30 min

**34. How the autoclaving of waste is validated?**

- By chemical strip indicator which changes its color when certain temperature is achieved. For adequate autoclave it is essential to use more than one strip at different locations.
- By spore testing using *Bacillus stearothermophilus* spores in the form of vial or strips ( $1 \times 10^5$  spores/ml). Appropriate autoclaving will kill the spores.

**35. What spores testing is used in case of microwave?**

Spores of *Bacillus subtilis* (either vials or strips having  $1 \times 10^4$  spores/ml).

**36. What precautions to be taken while dealing with radioactive waste?**

- Radioactive waste should not be disposed in regular trash or poured in drains
- Use short lived isotopes whenever possible

- c. Use specially designed area for storage of radioactive waste
- d. Monitor closely
- e. Take help of experts as and when needed.

**37. How the sampling of the liquid waste is done?**

It is done by designated person who is empowered to take sample. The sample is divided into 3 equal parts.

One portion handed over to facility with acknowledgement.

Second portion sent forthwith to environment laboratory for analysis.

Third portion is retained by officer to be produced in court in case any proceeding is instructed in court of law.

The samples are marked and sealed by the person who has taken the samples and also by the facility from where the sample has been taken.

**38. Where deep burial is the method of choice for Cat 1 and 2?**

It is the method of choice for Cat 1 and 2 waste only in cities having less than 5 lakh populations.

**39. What should be minimum specification for shredder?**

- a. Should need minimum maintenance
- b. Should have electrical and mechanical safety device to avoid any accident
- c. Should have low rotation speed for better gripping and cutting of waste
- d. Maximum rotation 50 rpm
- e. Discharge outlet should be at least 3 feet above ground to adjust the collection container for shredded waste
- f. Should have heavy motor to ensure efficient cutting of waste
- g. Should be designed to allow minimum manual handling.

**40. What should be precaution of storage at CBWTF?**

There is need of two store room, one for treated waste and another for untreated waste and both should have smooth, fine surface which can be easily washed and has well ventilation. Floor should be impermeable to liquid.

- 41. What difficulties are faced by CBWTF from health care institution?**
- Health care facilities don't enroll themselves voluntarily to CBWTF.
  - Declaration of less number of beds
  - Irregular payments by hospitals and other health care institutions
  - Unsegregated waste given to the facility
  - Some institutions are located in very congested area where vehicle cannot enter.
  - Waste is not being kept ready when vehicle comes leading to unnecessary delay.
  - Bags are not properly tied leading to spillage of waste.
- 42. What deficiencies may be encountered at incinerator?**
- Unsegregated waste is incinerated
  - Power backup for incinerator is not available
  - Record keeping is not proper
  - Operation and maintenance of incinerator is not as per the laid down norm
  - Incinerator ash is not disposed off properly
  - Monitoring platform and porthole for stock is not proper.
- 43. Which is a good measure for incinerator efficiency?**
- Carbon monoxide is a good measure because:
- It is produced on incomplete combustion
  - Temperature of incinerator is less
  - Oxygen concentration is less than required.
- 44. What are the financial aspects involved in proper BMW?**
- Provision of proper BMW is mandatory under BMW (Mgt. and handling) Rules 1998
  - Avoidance of cost of accident and compensation due to streamlined process of BMW
  - Financial facilities are available.

**45. What is the schedule for hospital waste incinerator monitoring?**

**Daily:**

- a. Checking of oxygen monitor
- b. Cleaning of ash kit after each shift
- c. Checking of operation of thermocouples
- d. Checking of doors seals for proper fitting, air leakage or wear and tear
- e. Check and clean under fire air ports.

**Weekly:**

- a. Checking and cleaning of air blowers from debris
- b. Lubrication of all latches and hinges
- c. checking and cleaning of burner flame rods.

**Fortnightly:**

- a. check and cleaning of burners and any fuel leakage
- b. Checking of control panels.

**Monthly:**

- a. Checking and cleaning of external surface of incinerator and stock
- b. Repair of any minor wear and tear
- c. Cleaning of both chambers from inside
- d. Readjustment of burners if required.

**Six monthly:**

- a. Checking and painting of hot external surface
- b. Check and paint equipment enamel if needed.

**46. What are the operational problems of incinerator?**

- a. Excessive stock emission
- b. Leakage of smoke
- c. Excessive consumption of fuel
- d. Incomplete burning of waste
- e. Black smoke from stack
- f. White smoke from stake.

**47. What are the reasons for excessive stake emission?**

- a. Over charging
- b. Problem causing waste

- c. Excessive infiltration of air from charging door
- d. Temperature in secondary chamber is not adequately high
- e. Inadequate air in secondary chamber
- f. Excessive under fire air in primary chamber.

**48. What are the reason for leakage of smoke from primary chamber?**

- a. Excessive charging of primary chamber
- b. Too high temperature of primary chamber
- c. Excessive combustion air.

This all lead to high positive pressure in primary chamber  
The remedy for controlling the leakage is to:

- Reduce the feed
- Reduce the temperature
- Adjust ash discharge from chamber to wet sump. A sump is a low space that collects any often-undesirable liquid such as water or chemicals.

**49. Give the reasons for excessive fuel consumption.**

- a. Inconsistent charging of chamber
- b. Leakage from door seal
- c. Improper functioning of fuel burners
- d. Improper primary chamber combustion air level an distribution.

**50. What are the reasons for incomplete burning of waste?**

- a. Overcharging of the chamber
- b. Too much wet waste charging
- c. Malfunctioning of primary chamber
- d. Insufficient under fire
- e. Improper maintenance of the incinerator.

**51. Why sometimes there is black smoke emission from stake**

This indicates presence of unburned carbonaceous materi which may be because of following reasons:

- a. Incomplete combustion of waste
- b. Overcharging of volatile material
- c. Secondary chamber temperature is less

The problem can be eliminated by rectifying these problem

**52. What is the indications of white smoke from the stake?**

This indicates that the presence of small aerosols in effluent gas. The white smoke is the result of finely divided non-combustible minerals present in the waste and this is being carried out of the stake. One of such minerals is calcium chloride.

**53. What are the causes of white smoke from stake?**

- a. Temperature of secondary chamber is too low leading to premature cooling of combustion gases
- b. Increased under fire air
- c. Under used secondary burner.

The problem of white smoke can be eliminated by removing the cause.

## *Infection Control*

### 1. Why infection control is essential?

It is essential for well-being of patients and safety of both patients and staff of the institution. This is considered as quality standard of patient care.

### 2. What are the modes of infection transmission?

The infection can be transmitted from patient to health care workers and vice versa. There are four main routes for infection transmission:

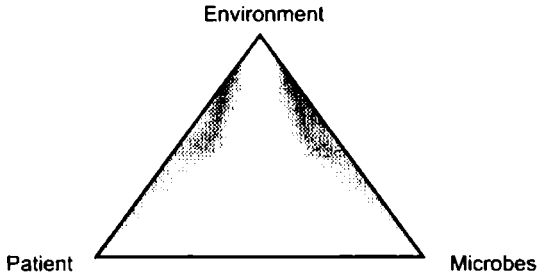
- a. **Blood borne:** Infected blood reaching to healthy blood through cuts, sharp injuries or through mucocutaneous and percutaneous route
- b. **Contact:** Hands contaminated from patients' infected body fluids, secretions, excretions or contaminated items coming in contact with mucous membrane or skin lesions. Very often large droplets from respiration tract contaminate the environment close to patient and infection is transmitted by contact of such infected secretion with mucous membrane or skin lesion
- c. **Fecooral route (drinking and eating):** Here the fecal flora of patients contaminate the water, hands or food thus spreading infection
- d. **Air borne:** Inhalation of droplet nuclei are disposed in air.

### 3. What are the risk factors for acquiring infection?

**Environment:** A highly contaminated environment of the health care setting or high risk procedures whether diagnostic or therapeutic.

**Patient:** Malnutrition, suppressed immune system extremes of age, injuries

**Microbes:** Highly virulent organism, bacterial load and presence of new strain or new minerals (Fig. 11.1).



**Figure 11.1:** Risk factors for infection

#### 4. How the surveillance of infection is done?

Surveillance of the infection involves:

- Collection of data on infection
- Analysis of collected data
- Feedback/Recommendation to hospital staff

Surveillance is mainly done in high risk areas like labor room, OT, laboratory, NICU, PICU, ICUS, etc. The data collected for surveillance are essential for developing and reviewing/revising infection control.

#### 5. What are the principles of infection control?

##### a. *Environment:*

- Designing of health care institution so as to have good ventilation
- Meticulous cleaning
- Positive pressure ventilation in high risk area
- Effective BMW handling/treatment/disposal
- Effective disinfections and sterilization of equipment.

##### b. *Patients:*

- Admit those patients when absolute necessary
- Barrier nursing for patients with depressed immunity



- Provision of isolation ward for patients with communicable diseases
  - Hospital stay should be minimum possible
- c. *Microbes (Agents)*
- Identification of the causative agent
  - Specific measures to prevent their spread.
6. **Which health care workers are at high risk of transmission of blood borne infection?**  
They are doctors, nurses, paramedical staff, lab technicians, housekeeping and laundry staff morticians.
7. **Which are the common organisms transmitted through blood/body fluids?**
- Hepatitis B, C, virus
  - Cytomegalovirus
  - HIV
  - Epstein-Barr virus
  - Malaria parasites
  - Salmonella/Brucella.
8. **What is the most common way of blood borne infection?**  
Through accidental sharp injuries.
9. **What are the standard precautions in infection control?**
- a. Barrier protection
  - b. Hand washing
  - c. Safe handling of sharps
  - d. Safe handling of spill of body fluid/blood
  - e. Meticulous housekeeping
  - f. Use of properly sterilized items
  - g. Use of safe techniques
  - h. Use of resuscitation bag or mouth piece instead of mouth-mouth resuscitation in case of emergency
  - i. Standardized laundry services
  - j. Regular medical checking.

- 10. Where hand washing is mandatory?**
- Before and after patients examination and patient care
  - Immediately after contact with blood/body fluids
  - Before handling food/drink/leaving the work place
  - After removing gloves/gown, etc.
- 11. How the sharps be handled in health care setting?**
- All chipped and broken glassware be discarded properly
  - Disposable needles should not be reapped, burnt, broken or removed from syringes
  - Dispose own sharp taking due care
  - Sharp container should be located near the generation point
  - Care taken not to get autoinoculated
  - Sharp container should be puncture proof and sent for disposal when three fourth full
  - Use needle destroyer to mutilate sharp needle and prevent reuse
  - Used needles are disinfected with 5-1% hypochlorite solution or common bleach solution for 30 minutes
  - Used sharps should not be passed from one person to another person
  - Chemical disinfections should not be used as method of sterilization.
- 12. How the spill of blood/body fluids be handled effectively?**
- Cover the spill with paper napkin / gauge piece / dry cloth pour disinfectant solution (1% hypochlorite freshly prepared leave it for 30 mts. with gleaned hand paper napkin / dry / gauge piece is removed.
- Wash area with detergent soap and water
- All used material is treated and disposed as infectious waste
- 13. What precautions should be taken while handling soiled linen?**
- Soiled linen be handled minimum so as to prevent gross microbial contamination of air and staff handling linen
  - Solid linen be decontaminated with bleach before sending to laundry

- c. Linen washed in hot water (more than 70°C) and detergent
- d. Gloves must be worn while handling soiled linen.

**14. Who all are involved in infection control?**

Infection control committee consists of:

- HOD, Microbiology – Chairman
- Infection control officer – Secretary
- Infection control nurse
- Medical supdt.
- Nursing supdt.
- Quality assurance officer
- HOD of all major/minor clinical deptts.

**15. Why infection surveillance in hospital required?**

This is done in order to:

- a. Determine the incidence of endemic infection in different areas of hospital
- b. Determine the effectiveness of day to day control measures
- c. Recognize any change in incidence of infection
- d. Desirability and recommending any specific measure to control infection in hospital.

**16. What are the functions of infections control committee?**

- a. Review efficacy of control measures
- b. Formulation of hospital policy to review the infection related problem
- c. To provide adequate isolation facilities
- d. To recommend policies for disinfections and sterilization
- e. Assigning appropriate role to all members of the committee
- f. Preparation of SOPs
- g. Developing mechanism for dissemination of information.

**17. What is the composition of infection control team (ICT)?**

- a. Infection control officer (ICO)
- b. Microbiologist (if he/she is not ICO)
- c. Infection control nurse
- d. Epidemiologist
- e. Clinician interested in Hospital Acquired Infection.

- 18. Mention day-to-day function of infection control team.**
- Surveillance (discovery and recording) of infection
  - Monitoring of carriers
  - Regular training of all staff members on infection control
  - Advice control measures and periodically check its efficacy
  - Prepare fact sheet on available data related to infection
  - Outbreak management
  - Day-to-day momentary sterilization, disinfection processes
  - Report back to infection control committee.
- 19. Which parameters are monitored by waste management officers?**
- Amount of waste generated (categorywise) in each deptt. each month and their daily segregation, transport and treatment.
  - Planning and calculation of financial aspect of health care waste mgt. this includes direct cost of material used in mgt. training cost, cost for centralized services, cost of operations and maintenance of on site treatment facilities.
  - Public health aspect of BMW and reporting of waste related injury.
  - Ensure compliance of BMW system with National Legislation.
  - Training awareness and coordination and conduction of BMW training.
  - Liaison with central and state pollution control board.
- 20. What is the role of Department head in BMW?**
- Ensure that all staff members are aware of segregation process of waste and comply to the hospital policy on waste management.
  - Ensure key members are given periodic training on BMW
  - Continuously liaison with Waste Management Officers to monitor working practices in their deptt.
  - Encourage medical and nursing staff to stick with standardized practices of BMW.

- 21. What are the causes of spillage of blood/body fluids?**
- a. Breakage of container
  - b. Over filling
  - c. Leaking
  - d. Tipping over container
  - e. Dropping of/ from container
  - f. Splashing.
- 22. What should be contents of spill kit?**
- a. Bucket
  - b. Adsorbent (Saw dust, gauge piece, etc.)
  - c. Gloves
  - d. Face mask
  - e. Disposable bag
  - f. Disinfectant.

# *Occupational Hazards and Universal Precaution*

1. **Which are the diseases caused by BMW?**
  - a. Tuberculosis
  - b. Dermatitis and skin infections, bliss
  - c. Hepatitis B, C
  - d. HIV
  - e. Tetanus
  - f. Diarrheal diseases
  - g. Pneumonia
  - h. Conjunctivitis
  - i. Typhoid.
  
2. **Who all can be affected by BMW?**
  - a. Doctors
  - b. Nurses
  - c. Paramedical staff
  - d. Waste handlers
  - e. General public.
  
3. **Which are the routes through which BMW can cause infection?**
  - a. Inhalation
  - b. Ingestion
  - c. Injury
  - d. Absorption
  - e. Contamination of wounds.
  
4. **How the waste handlers are affected by BMW?**

They are mostly affected by:

  - a. Emission from incinerator

- b. Sharp injury
  - c. Exposure to radioactive waste
  - d. Inhalation of toxic waste products.
5. **What safety measures be taken by staff handling BMW?**
- a. Personal protection items:
    - Plastic apron
    - Heavy duty rubber gloves
    - Mask
    - Eye shield
    - Gum boots about 6" above ankle
    - Covering of all cuts, wounds and abrasions.
  - b. Immunization against tetanus and hepatitis B
  - c. Accident reporting
  - d. Adoption of universal precaution
  - e. Awareness about hazards of BMW.
6. **What are the determinant factors for occupational exposure of HIV?**
- a. Number of exposures
  - b. Type of exposures, i.e. percutaneous, mucosal, cutaneous
  - c. Type of body fluid – blood, body fluid
  - d. Viral load at time of exposure
  - e. Fresh or old fluid at the time of exposure.
7. **On what factors does the severity of injury depend?**
- a. Depth of injury
  - b. Duration of contact
  - c. Hollow or solid needle
  - d. Size of wound
  - e. Bore size of needle
  - f. Vascularity of area of injury
  - g. Amount of blood / fluid injected.
8. **What factors are preventive for a health care worker?**
- a. Healthy immunological status
  - b. Protective precautions while working
  - c. Attentive and careful worker

- d. Methodological working sticking to SOPs for particular task/process
  - e. Availability of first aid and PEP in case of exposure.
- 9. Why are universal precautions essential?**
- a. Any percutaneous or permucosal exposure to blood or body fluids which may be potential source
  - b. It is a part of patient care strategy to prevent discrimination against HIV injected patients and non-HIV
  - c. If health care workers feel that they can protect themselves from dreaded infections then they provide better care.
- 10. What are the components of universal precautions?**
- a. Precautions for exposure to blood and body fluids:
    - Personal protective equipment
    - Engineering control
    - Work practice control.
  - b. Ensure universal precaution
  - c. Behavior modification
  - d. Ensure adherence to universal precautions
  - e. Implications to surgeons.
- 11. Who is responsible for preventing occupational hazards?**  
It is the prime responsibility of employer by following the under mentioned procedures:
- a. Proactive action to prepare guidelines to avoid occupational hazards
  - b. Creating awareness among health care workers
  - c. Training and retraining about safe BMW.
- 12. What are down stream risks?**  
These are the risks related to biomedical waste beyond the health care settings. The causes may be:
- a. Accidental contact with pathogen or toxic material
  - b. Discarded pharmaceutical products
  - c. Used but intact medical devices like blood set, syringes, blades, etc.



**13. What heavy metals are common in BM waste?**

- a. Mercury
- b. Nickel
- c. Cadmium
- d. Copper
- e. Chromium
- f. Lead.

**14. What are most common occupational health hazards related to BM waste?**

- a. Respiratory tract problems
- b. Needle stick injuries
- c. Lead poisoning from the burning of material containing lead
- d. Back and joint injury due to lifting heavy waste loads
- e. Nausea and headache due to unhygienic waste dump site and abnoxious smell
- f. Infections.

**15. What is the role of counseling in prevention of occupational hazards?**

Counseling allows staff and workers to receive individually targeted information about the risk related to waste and preventive aspects and methods of occupationally acquired infections.

**16. How the occupational hazards are classified?**

- a. Physical
- b. Biological
- c. Chemical
- d. Psychological
- e. Ergonomic.

**17. What is Ergonomics?**

It is concerned with the factors that come into interplay when work is adopted to the worker.

- 18. What are usual Ergonomic hazards?**
- Incorrect postures
  - Wrong equipments and tools
  - Bad design of workplace.
- 19. Which organs are most vulnerable to microware radiations?**  
Cornea and lens because of absence of heat dissipating blood vessels.
- 20. What are the employers responsibilities to prevent occupational health hazards?**
- Provision of safe work place complying with all standards, rules and regulations
  - Periodic examination of the work place ensure compliance to standards
  - Liberal use of posters, signs, labels to aware employees constantly about occupational hazards
  - Regular and proper maintenance of equipment and tools and machines
  - Preparation of guidelines and SOPs
  - Regular medical examination of staff exposed to hazards
  - Training as and when required.
- 21. When the health surveillance of an employee be done?**
- Health assessment before staff is appointed on the job
  - During employment periodic medical examinations
  - Health assessment of employee when they are returning after long leave
  - At the time of retirement, release, termination and resignation.
- 22. How occupational safety in health care institution be established?**  
By developing following health and safety program in the institution:
- Identification of hazards by regular record check and personal observations
  - Evaluation of hazard by regular waste evaluation program

- c. Training of employees and all other concerned staff
- d. Implementation of appropriate control measures
- e. Maintenance of all surveys related records meticulously
- f. Top management support for implication of program
- g. Financial supports to safety programs.

**23. What is the meaning of PEP?**

Post exposure prophylaxis. This is most useful in case of HIV and hepatitis B infection.

**24. What the immediate steps to be taken in case of exposure?**

- a. Wash the needle stick or cut area with soap and plenty of water
- b. Irrigate eye with water or saline
- c. Mucous membrane splash to be flushed with water
- d. Never put pricked finger in mouth reflexly.

**25. Which forms are used for accident reporting and needle stick injury?**

- Accident injury Form No.1
- Needle stick injury Form No.2.

**26. What percentage of inhaled mercury fumes are absorbed in the body?**

- About 75-85% of dose is absorbed.

**27. What is the sero-conversion rate for HBV, HCV and HIV due to?**

- Biomedical waste hazards
- It is 30%, 3% and 0.3% respectively.

**28. Who is the health care workers?**

Any person whose activities involve contact with patients or patients' blood or body fluids in a health care or laboratory setting.

**29. What steps are taken on exposure to HIV infected blood or body fluids and contaminated sharp?**

- a. Immediate action:
  - Washing of injured or splash area with soap and water
  - Eye should be irrigated with plenty of water or saline
  - Don't put pricked finger in mouth.
- b. Exposure incident reported to appropriate authority in the institution.
- c. PEP (Post-exposure prophylaxis) given based on:
  - Degree of exposure to HIV
  - HIV status of the source.
- d. PEP as per the protocol
- e. HIV testing and counseling
- f. PEP should be started as early as possible because after 72 hours it is of no use and not recommended and once started the therapy should continue for 4 weeks
- g. If HIV testing is found to be positive within 12 weeks then HCW should be referred to physicians for treatment.

**30. What is the schedule for HIV testing in case of exposure?**

Base line HIV testing – at time of exposure

Repeat HIV test – 6 weeks after exposure

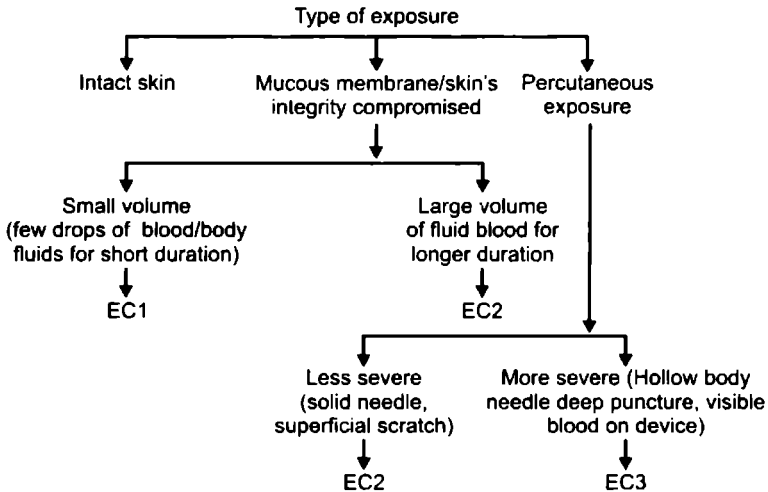
Second repeat HIV test – 12 weeks after exposure.

**31. What precautions should be taken by HCW during this period?**

- a. Abstain from sexual intercourse
- b. Refrain from donation of blood, semen, organ or tissue
- c. Surgeon refrain from doing surgery
- d. Females not to breastfeed their babies.

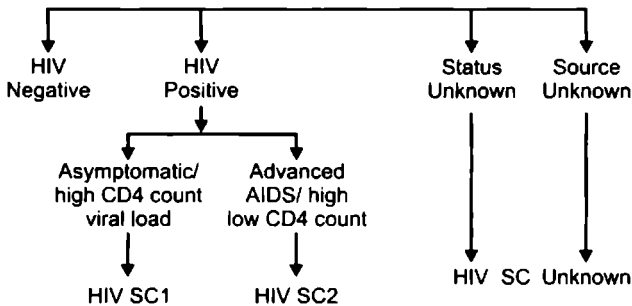
**32. What is exposure code?**

It is the code given to the degree exposure in severity based on exposure, intactness of skin and /or mucous membrane and volume of the body fluid/blood.



### 33. How HIV status of source is determined?

With the help of following flow chart.



### 34. What are PEP recommendations based on EC and HIV SC?

EC	HIV SC	PEP recommendation
1	1	No PEP warranted
1	2	Consider basic regimen
2	1	Recommend basic regimen
2	2	Recommend expanded regimen
3	1 or 2	Recommend expanded regimen
2 or 3	Unknown	Basic regimen

**35. Which drugs are used in basic regimen and expanded regimen?**

*Basic regimen:* Zidovudin 600 mg is divided dose plus lamivudin 150 gm twice a day for 4 weeks

*Expanded regimen:* Basic regimen plus Indinavir 800 gm three times a day for 4 weeks.

**36. What is the protocol for gloves to prevent occupational exposure?**

- a. Gloves must be disposable
- b. Change gloves after one hours. Total time a gloves can be used is 3 hours
- c. In high risk patient care double gloves must be used
- d. In routine single glove is sufficient
- e. Wash hand thoroughly with soap before wearing gloves and after degloving
- f. Don't touch the area which is not involved in diagnostic or treatment procedures
- g. Cover the cuts/wounds on hand with water proof band aid before putting on gloves
- h. Check the gloves for any defect before putting them on
- i. Discard gloves at the least suspicious of puncture.

**37. What is the protocol for mask wearing?**

- a. Mask preferably should be disposable
- b. Mask should be of good fitting
- c. Mask should be discharged after any surgical procedure which is lasting more than 20 minutes or where aerosol spray expected or surgical procedure on high risk patient
- d. Mask should be disinfected with liquid bleach before washing.

## *Management of Specialized Waste*

1. **What are the specialized wastes in hospital?**
  - a. Heavy metals like lead, cadmium, mercury
  - b. Radiological waste
  - c. Radioactive waste
  - d. Pharmaceutical waste
  - e. Cytotoxic waste
  - f. Pressurized containers.
  
2. **Why are they called specialized waste?**

Because their management process is different from the general process and each special waste needs individualized treatment, storage and disposal option.
  
3. **Why mercury is considered most toxic metal of hospital waste?**

Because mercury is easily vaporized and may remain in atmosphere for long period causing long-term adverse effects.
  
4. **How mercury causes its adverse effects?**

Through the inhalation of mercury vapors which is due to spill of mercury and which is not cleared properly.
  
5. **Which instrument / equipment in hospital contains mercury?**
  - a. Sphygmomanometer
  - b. Thermometer
  - c. Ryle's tube
  - d. Dilators
  - e. Laboratory reagents.

6. **How the mercury spill is handled?**
  - a. Area specified where spill has occurred with the help of colored chalk
  - b. Open all windows and door to the outside
  - c. Wear gloves, mask and apron
  - d. Syringe containing water is used to suck the mercury
  - e. Mercury collected in glass container which is sealed
  - f. Area of spill is thoroughly cleaned with detergent and water.
  
7. **What is amount of mercury in BP apparatus and thermometer?**

BP apparatus 60 gm/BP apparatus  
Thermometer 0.61 gm/thermometer
  
8. **Which is most hazardous to human body?**

Methyl mercury is most toxic to human body and it is formed due to chemical modification of elemental mercury to methyl mercury. It affects CNS, lungs, skin, eyes, and kidneys.
  
9. **What should never be done in case of mercury spill?**
  - a. Never use vacuum cleaner to clean mercury because vacuuming will put mercury into air and increase exposure
  - b. Don't touch the mercury with bare hands
  - c. Never pour mercury into drain
  - d. Never use broom to clean mercury because it will break it into small droplets which can be easily inhaled
  - e. Never wash soiled cloth in washing machine as latter may get contaminated and water from it may further contaminate sewer
  - f. Never walk around with the shoes which are contaminated with mercury spills
  - g. Remove all jewellery while handling mercury because it reacts with mercury.
  
10. **How mercury use be reduced in hospital?**

By observing following practices:

  - a. Recycling of mercury containing product



- b. Proper management of mercury spills
- c. Use of alternative mercury free products
- d. Proper management of mercury and mercury containing equipments
- e. Waste management practices which reduce the discharge of mercury into environment.

**11. What are the advantages of mercury pollution precaution?**

- a. Reduction in occupational exposure
- b. Cost contaminant in recycling and tackling hazards related to mercury pollution
- c. Increased awareness of community population.

**12. How cytotoxic waste is disposed?**

It is disposed in one of the following manners

- a. Incineration at very high temp. (more than 1200 °C)
- b. Return to original supplier
- c. Chemical degradation so that it turns into nontoxic compounds
- d. Inertisation and encapsulation.

**13. Which methods are utilized for chemical degradation of cytotoxic waste?**

Sulfuric acid or potassium permanganate for oxidation process while hydrobromic acid for denitrosation.

**14. How pressurized containers are managed?**

Undamaged containers returned to suppliers for reuse or recycle while damaged containers are crushed and disposed in secured land fills.

**15. What precautions should be taken during segregation of pressurized containers?**

These should not be placed in yellow container or bag which goes for incineration because on burning of sealed container there is risk of explosion.

- 16. Give treatment and disposal action for pharmaceutical waste.**  
There are different options for such waste depending on the quantity:

***Small quantity***

- a. Encapsulation
- b. Land fill
- c. Dilution and discharge in Sewer slowly (not for antibiotics and cytotoxic waste)
- d. Safe burial
- e. If less than 1% of total waste then incineration at high temperature ( $> 1200^{\circ}\text{C}$ )

***Large quantity***

- a. Encapsulation
- b. Incineration at high temperature
- c. Returned to original suppliers

- 17. How the sealed vials and ampoules be managed?**

These are crushed on hard surface and with help of sieve the medicine and glass is separated. The medicine is treated by inertisation or encapsulation and glass is treated and disposed as sharp waste.

- 18. How is radioactive waste managed?**

It is managed as per the guidelines provided by BARC and atomic energy regulatory body.

- 19. How many types of radioactive waste are there?**

These are of 3 types:

- a. Radioactive solid waste
- b. Radioactive liquid waste
- c. Radioactive gaseous waste.

- 20. What is radioactive waste?**

It is the waste type containing radioactive elements that don't have a practical purpose hence need to be treated and disposed to avoid exposure and health problem related to radioactive waste.

**21. What is ionizing radiation?**

It is the radiation which has the power to penetrate the tissue and infuse the energy into them leading to death of tissue.

**22. How radioactive waste causes contamination of human body?**

It contaminates the human body through:

- Ingestion
- Inhalation
- Injection
- Absorption

**23. What is phasing out mercury in the hospital?**

It is the process of replacement of mercury containing equipment by non-mercury equipment. Many hospitals have phased out thermometer and sphygmomanometer under this program.

**24. What is effluent?**

It is an out-flowing of water from the hospital's various departments. It is considered highly pollutant.

**25. How many types of radioactive waste are there?**

- a. **Low level waste:** Has short lived radioactivity, dormant, needs shielding during handling and transport and is suitable for shallow land burial. This type of waste is generated by hospitals
- b. **Intermediate level waste:** Contains higher amounts of radioactivity, may need shielding, disposed off after encapsulation disposed in deep underground
- c. **High level waste:** Very high level of radioactivity arises in nuclear reactors.

Majority of radioactive wastes are low level waste.

**26. What is radioactive decay?**

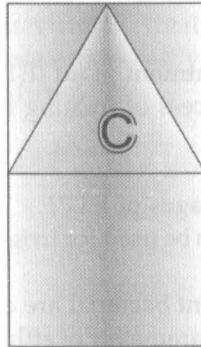
This is the process of continuous spontaneous disintegration of radioactive material. During decay radioactive material keeps emitting ionizing radiations either alfa, beta or gama.

**27. How radioactive waste are disposed?**

**Low activity waste:** Can be discharged into sewer where disposal occurs by dilution

**High activity waste:** Subjected to pretreatment before disposal. Radionuclides are separated by ion exchange, precipitation or coagulation and then disposed of safely by burial

**Very high activity waste:** Have to be stored indefinitely. They are stored in concrete filled steel drum and placed in the sea at the depth of 6000 feet for all time.

**28. Which does this sign signify?**

This sign signifies the cytotoxic waste.

**29. What does this sign indicate?**

This is biohazard sign.

**30. How is liquid chemical waste from hospital managed?**

The liquid chemical waste is fresh neutralized with reagent (acidic to basic and vice versa) and then flushed in sewer system after adding large quantity of water.

It is to note that hospital liquid waste should never be discharged into natural water.

**31. What is lagooning?**

Collection of water in large ponds which are with sedimentation devices. It provides settlement and further biological improvement through storage in large man-made ponds.

**32. What is effluent treatment plant (ETP)?**

This is stepwise process of treating the effluent produced in the hospital.

**33. What are the advantages of ETP?**

- a. Effluent water can be used for irrigation, sanitary purposes, etc.
- b. Multidrug resistant bacterial are completely inactivated
- c. Physiochemical parameters of effluent water remain within the acceptable limit
- d. Sludge which is a byproduct can be used as manure
- e. ETP is cost effect and environment friendly.

**34. What are the components of ETP and their function?**

- a. Bar screen—removal of course suspended particles
- b. Oil and grease trap—removal of oil and grease
- c. Collection and equalization tank—collection and equalisation of raw effluent
- d. Aeration tank—mixing of effluent with excess of air to remove the organic matter
- e. Clarifier tank—separates suspended biological material from effluent and returned to aeration tank and excess to sludge tank
- f. Filter feed tank—treated effluent is stored before passing to pressure and filter

- g. Pressure sand filter—removes fine suspended particles from treated effluent
- h. Chlorination tank—continuous chlorination of treated effluent
- i. Clean treated water tank—collection of clean treated water before final use
- j. Sludge tank—filling of sludge for drying and later use as manure.

**35. How the mercury produces its effects?**

It gets absorbed in the body because of lipid solubility though metallic mercury is not rapidly absorbed however, absorption of methyl mercury is virtually total, i.e. 90-95%. If mercury vapors are inhaled these vapors easily cross alveolar membrane and enter the blood stream.

## *Disinfectants in Hospital*

1. **What is the difference between disinfections, sterilization, disinfectants, antiseptics, sanitizers, and decontamination?**

**Disinfections:** It is the process of killing microorganisms, but not usually spores, for prevention or control of infectious disease

**Sterilization:** It is the process of destruction of all the microorganisms including spores from materials and making them bacteria free

**Disinfectants:** These are the germicidal agents capable of destroying microorganisms but not necessarily their spores. Due to their toxic nature. They are used only for disinfections of inanimate objects

**Antiseptics:** When disinfectants are suitably diluted so as to be suitable for human requirements they are called antiseptics. Due to non-toxic nature they are recommended for superficial application of human tissue

**Sanitizers:** These are the substances which reduce the number of microorganisms to a safe level

**Decontamination:** It is the process of removal of disease producing microorganisms to leave an item safe for further handling.

2. **What are the types of disinfections?**

a. **Concurrent disinfection:** When the disinfection is carried out in the presence of infectious patients. For example, linen clothes, dressing material, gloves, instruments, etc.

b. **Terminal disinfections:** When disinfection is carried out after the discharge or death of the patients. For example, bedding, linen soiled cloths, etc.

3. **What is the difference between disinfectant and sanitizer?**  
The disinfectant at a specified dilution has higher pathological microbacterial killing capability than sanitizer.
4. **What are the principle guidelines for disinfectants?**
  - a. Use of particular type of disinfectant for particular purpose
  - b. Dilution of disinfectant
  - c. Contact time of particular disinfectant
  - d. Safety aspects for disinfectant
  - e. Frequency of use of disinfectant.
5. **What are the properties of disinfectant?**
  - a. Inexpensive and non-corrosive
  - b. Offers complete sterilization
  - c. Has wide spectrum of activities
  - d. It is non-toxic.
6. **What factors affect the potency of a disinfectant?**
  - a. Dilution reduces the potency of a disinfectant
  - b. Presence of organic materials
  - c. Chemical nature of disinfectants
  - d. Degree of contamination
  - e. Contact time and temperature
  - f. pH and interaction with other compounds.
7. **What is phenol coefficient?**

This is the relative effectiveness of a disinfectant when compared to that of phenol. To measure the phenol coefficient *S typhi* or *S aureus* microbes are used. If the disinfectant is more effective than phenol then the coefficient is more than one (>1) and those disinfectant which are less effective have coefficient less than one (<1).
8. **What are non-critical, semi-critical and critical items (instrument/devices) used in patient care?**

*Noncritical items:* These are the items which come in contact with intact skin but not mucous membrane or don't directly contact the patients.



The disinfections done by cleaning and/or low level disinfection.

**Semicritical item:** These are the items which come in contact with non-intact skin or mucous membrane but non-necessarily penetrate them.

The disinfection done by meticulous cleaning followed by high level disinfections.

**Critical items:** These are instruments or devices which enter sterile tissues including the vascular system.

The disinfections involve meticulous cleaning followed by sterilization because of high risk of infection.

**9. What are the levels of disinfections?**

- a. Low level disinfection
- b. Intermediate level disinfection
- c. High level disinfection.

**10. What is the criteria for this classification?**

The level of disinfections done by any disinfectants is based on the basis of cidal (killing) activity for microorganism.

**11. Describe in brief low, intermediate and high level disinfectants.**

**Low level disinfectants:** These disinfectants kill most vegetative bacteria and some fungi and evolved (lipid) virus like HBV, HCV, HIV but don't kill spores and mycobacteria. These disinfectants are used to clean environmental surfaces.

**Intermediate level disinfectants:** These disinfectants kill vegetative bacteria and most of virus and fungi but not resistant bacterial spores.

**High level disinfectants:** Kill vegetative bacteria, fungi and viruses but not necessarily spores.

**12. Which alcohols are used as disinfectants and what are disadvantages?**

- a. Ethanol (Ethyl alcohol)
- b. Isopropyl alcohol

**Disadvantages:**

- a. Fire hazards
- b. Limited residual activity due to evaporation
- c. Brief contact time
- d. Limited activity in presence of organic material.

**13. Why alcohols are more effective when combined with purified water?**

Because higher water content allows greater diffusion through cell membrane and that is why 70% alcohol is more effective than 90% alcohol.

**14. What is the mechanism action of oxidising agents?**

Oxidising agent oxidises the cell membrane of microorganisms thus causing loss of structure leading to lyses of cells.

**15. Give examples of oxidising agents.**

- a. Sodium hypochlorite
- b. Hydrogen peroxide
- c. Chloramine
- d. Iodine
- e. Peracetic acid.

**16. Give examples of low level, intermediate level and high level disinfectants.*****Low level disinfectants:***

- a. Phenol
- b. Quaternary ammonium compounds.

***Intermediate level disinfectants:***

- a. Alcohols
- b. Hypochlorite
- c. Iodophores.

***High level disinfectants:***

- a. Hydrogen peroxide
- b. Formaldehyde
- c. Gluteraldehyde
- d. Peracetic acid.

**17. What are the advantages and disadvantages of sodium hypochlorite?**

**Advantages:**

- a. Rapid action
- b. Broad range of activity
- c. Low cost
- d. Unaffected by water hardness
- e. Low incidence of serious toxicity.

**Disadvantages:**

- a. Presence of organic matters makes than ineffective
- b. Chemical instability because chlorine is lost rapidly
- c. Corrosive
- d. Imitating at high concentration.

**18. What are iodophores?**

Iodophore is a combination of carrier and iodine and this carrier allows continuous release of iodine in small amounts. The cidal action of iodophores is due to disruption of protein and nucleic acid structure and their synthesis. The iodophores have two main demerits:

- a. Plastic and rubber items get discolored or stained
- b. Metallic items get corroded when disinfected for prolonged period.

**19. What are quaternary ammonium compounds?**

These compounds are low level disinfectants and contain  $\text{NH}_4^+$  and as they contain strong positive charge they make easy contact with negatively charged surface and this makes them very good cleaning agents. These compounds are not effective against non-enveloped virus, fungi and spores.

**Merits:**

- Low toxicity
- Good cleaning agents.

**Demerits:**

- Ineffective in presence of hard water
- Irritating on prolonged contact
- Less microbicidal in presence of organic matters.

**20. Give examples of concentration of disinfectant used.**

Lysol	2%
Sodium hypochlorite	1%
Glutaraldehyde	2%
Isopropyl alcohol	70%
Hydrogen peroxide	3%

**21. What is the common name of sodium Hypochlorite?**

House hold bleach (4-6% Sodium Hypochlorite).

**22. What steps should be taken to prevent the environmental pollution from disinfectants?**

- Select the right product
- Frequency of disinfection to be kept minimum
- Use of controlled product mix as per the direction of manufactures (usual dilution is 1 part concentrated disinfectant in 125-500 parts water)
- Use correct method of using disinfectant so as to use it effectively at lower concentration and less quantity.

**23. What is the advantages of orthophthal aldehyde (OPA) over glutaraldehyde?**

OPA has following advantages:

- Excellent stability over wide range of pH-3 to pH-9
- Not irritant to mucous membrane of eyes and nasal cavity
- Does not require exposure monitoring
- Needs no activation.



# Annexures

## Annexure A

### Checklist for Infection Control Measures

---

Date \_\_\_\_\_ Time \_\_\_\_\_ Name of inspector \_\_\_\_\_

---

1. Decontamination of instruments:
  - a. Is sterilizer available Yes/No
  - b. Is it in good working condition Yes/No
  - c. Are clean instruments stored in cupboard under lock Yes/No
  - d. Are instruments rust free Yes/No
2. Handling of sharp:
  - a. Is puncture proof container available Yes/No
  - b. Are sharps popping out of containers Yes/No
  - c. Is sharp lying outside containers Yes/No
  - d. Is there any recapping of needles/syringes Yes/No
  - e. Is needle cutter available Yes/No
  - f. Is it in good working condition Yes/No
3. Close of protective barrier:
  - a. Are protective barriers available Yes/No
  - b. Are they in good condition Yes/No
  - c. Are they of good quality Yes/No
  - d. Are they being used by staff having the risk of exposure Yes/No
4. Hand washing practices:
  - a. Is soap and running clean water available Yes/No
  - b. Is paper towel/clean towel available Yes/No
  - c. Is staff aware of hand washing practices Yes/No
  - d. Are staff members washing their hands properly Yes/No
5. Waste management:
  - a. Is waste being managed as per rules Yes/No
  - b. Is there any contaminated waste littered around Yes/No
  - c. Are the container in good condition Yes/No
  - d. Does staff handle the waste with bare hands Yes/No
  - e. Are containers color coded as per rules Yes/No

# *Annexure B*

## **Checklist for Maintenance of Incinerator**

---

Day \_\_\_\_\_ Time \_\_\_\_\_ Name of inspector \_\_\_\_\_

---

1. Is surrounding of incinerator is clean Yes/No
2. What is temp of primary chamber .....°C
3. What is temp of secondary chamber .....°C
4. Is auto switch off system working Yes/No
5. What is condition of primary chamber lining intact/broken
6. Loading of primary chamber optimum/under loading /over loading
7. Is record book of waste incinerator is available Yes/No
8. Is this record maintained up to date Yes/No
9. Has medical examination of incinerator staff is being done periodically Yes/No
10. Is such record of Medical Examination available Yes/No
11. Is incinerator ash is being disposed off as per rule Yes/No
12. Is APCU working properly Yes/No
13. What is color of smoke from stake black/white
14. Is record of maintenance of incinerator available Yes/No
15. How is the surrounding of incinerator clean/unclean

*Comment of Inspector* \_\_\_\_\_

*Signature*

# *Annexure C*

## **Checklist for Biomedical Waste Management Audit**

1. Does the occupier has authority to set up its own treatment facility or having any other alternative option Yes/No
2. Is the segregation of waste is being done at the point of generation Yes/No
3. Is BMW mixed with other general waste Yes/No
4. Are waste collection containers available Yes/No
5. Are containers color coded as per the rule Yes/No
6. Does the waste marked for incineration have plastic waste mixed in it Yes/No
7. Does the institution has system for waste classification Yes/No
8. Are the containers in good condition Yes/No
9. Is institution taking steps for BMWM as per the category and recommended method of treatment and disposal for that particular category Yes/No
10. Is spill treatment kit available Yes/No
11. Is institution having SOP for mercury spill management Yes/No
12. Is liquid waste being treated with 1% hypochlorite solution before discharge into sewers Yes/No
13. Are needle destroyer available in sufficient number Yes/No
14. Are needle destroyer in good working condition Yes/No
15. Is there proper storage and internal and external transport facility available Yes/No
16. Are these facilities as per BMWM rule 1998 Yes/No
17. Do employees wear protective barrier while on the job Yes/No
18. Is there any incidence of occupational injury Yes/No
19. Is the record of such injury along with phone number is available Yes/No
20. Is record of every day's generation of waste is available as per the category Yes/No
21. Is there any accessibility of unauthorized person to waste storage Yes/No
22. Is separate facility for treated and untreated waste storage is available Yes/No
23. In case Institution is using CBTF, then is record of agreement available Yes/No
24. Is there any separate route for waste transport Yes/No



25. Is institution having recorded policy on the waste type, collection time and weighing of waste Yes/No
26. Is medical examination record of waste handlers available Yes/No
27. Is the vehicle, which is carrying waste from institution to off site authorized for such specialized work Yes/No
28. Is training manual for staff available Yes/No
29. Is record of employees training available Yes/No
30. Are colored plastic bags in good condition Yes/No
31. Is waste generator aware of difference between soiled and unsoiled waste Yes/No

# ***Annexure D***

**Forms as per the Gazette of India  
Ministry of Environment of Forest, New Delhi, 20th July 1998**

**Form I  
Notice of Intention to have Sample Analyzed**

---

To

.....

Take notice that it is intended to have analysed the sample of ..... which has been taken today, the day of 19 from (Name and designation of the person who takes the sample) Specify the place from where the sample is taken.

(Seal)

Date: .....

**Form II  
Memorandum to Government Analyst**

---

From

.....

To

The Government Analyst

.....

The portion of sample described below is sent herewith for analysis under rule 6 of the Environment (Protection) Rules, 1986. The portion of the sample has been marked by me with the following mark. Details of the portion of sample taken.

Name and designation of  
Person who sends sample  
(Seal)

Date: .....

**Form III**  
**Report by Government Analyst**

---

Report No. ....

Date: .....

I hereby certify that I .....  
Government Analyst duly appointed under section 13 of the Environment  
(Protection) Act, 1986 received on the ..... day of  
..... from .....  
.....  
a sample of ..... for analysis.

The sample was in a condition fit for analysis as reported below.

I further certify that I have analyzed the above mentioned sample on  
..... and declare the result of the analysis  
to be as follows:

\*\* .....  
.....

The condition of seals fastening of sample on receipt was as follows:  
.....  
.....

Signed this.....day of.....19.....

Address.....

Signature  
(Government Analyst)

To

Here write the name of the officer / authority from whom sample was  
obtained.

\*\*Here write full details of analysis and refer to method of analysis.

**Form IV**  
**Form of Notice**

---

By registered post acknowledgement due

Form (1)

Shri .....

.....

To

.....

Notice Under Section 19(b) of the Environment (Protection) Act, 1986 whereas an offence under the Environment (Protection) Act, 1986 has been committed/is being committed by .....

..... (1) I/We hereby give notice of 60 days under Section 19(b) of the Environment (Protection) Act, 1986 of my/our intention to file a complaint in the court against .....

..... (2) for violation of Section of the Environment (Protection) Act, 1986.

In support of my/our notice, I am/we are enclosing the following documents (3) as evidence of proof of violation of the Environment (Protection) Act, 1986.

Place: .....

Signature (s)

Dated: .....

**Explanation:**

1. In case the notice is given in the name of a company, documentary evidence authorizing the person to sign the notice on behalf of the company shall be enclosed to this notice.  
Company for this purpose means a company defined in explanation to subrule (6) of rule 4.
2. Here given the name and address of the alleged offender. In case of a manufacturing /processing /operating unit, indicate in the name/ location/nature of activity, etc.
3. Documentary evidence shall include photographs/technical reports/ health reports of the area, etc. for enabling enquiry into the alleged violation/offence.

# *Annexure E*

## Schedules of BMW (Handling and Management) Rules, 1998

### Schedule I Categories of Biomedical Waste

---

Category No. 1	Human anatomical waste (humans tissues, organs body part(s))	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 and biotechnology waste (wastes from laboratory cultures, stocks or specimens of microorganisms live or attenuated vaccines, human and animal cell culture used in research and infectious agents from research and industrial laboratories, waste from production of biologicals, toxins, dishes and devices used for transfer of cultures)	Local autoclaving microwaving / incineration*
Category No. 4	Waste sharpe (needles, syringes, scalpels, blades, glass, etc. that may cause puncture and cuts. This includes both used and unused sharpe).	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	Solid waste (items contaminated with blood, and body fluids including cotton, dressings, soiled plaster caste, linens, beddings, other material contaminated with blood)	Incineration* subclaving/ microwaving
Category No. 7	Solid waste (items generated from disposable items other than the waste sharpe such as tunings, 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, housekeeping and disinfecting activities)	Disinfection by chemical treatment@@ and discharge into drains
Category No. 9	Incineration Ash (ash from incineration of any biomedical waste)	Disposal in municipal landfill
Category No. 10	Chemical waste (Chemical used in production of biologicals, chemical used in disinfection, 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.*

*\*\*Mutilation/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 populations less than five lakhs and in rural/areas.*

## Schedule II

## Color Coding and Type of Container for Disposal of Biomedical Waste

<i>Color coding</i>	<i>Type of container</i>	<i>Waste category</i>	<i>Treatment option as per Schedule I</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 /White translucent	Plastic bag/puncture proof container	Cat. 4, Cat. 7	Autoclaving/ microwaving/ chemical treatment and destruction/ shredding
Black	Plastic bag	Cat. 5 and Cat. 9 and Cat. 10 (solid)	Disposal is secured landfill

## Note

1. Color coding of waste categories with multiple treatment options as defined in Schedule I, shall be selected depending on treatment option chose, 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 (liquids) do not require container/ bags.
4. Category 3 if disinfected locally need not be put in container/bags.

Schedule III  
Label for Biomedical Waste Container / Bags

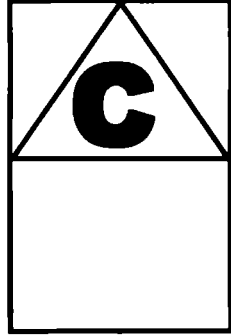
---

Biohazard symbol



Biohazard

Cytotoxic hazard symbol



Cytotoxic

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



**Schedule IV**  
**Label for Transport of Biomedical Waste Containers / Bags**

---

Day ..... Month .....

Year .....

Date of generation .....

Waste category No. ....

Waste class .....

Waste description .....

Sender's name and address

Receiver's name and address

Phone No. ....

Phone No. ....

Telex No. ....

Telex No. ....

Fax No. ....

Fax No. ....

Contact person .....

Contact person .....

In case of emergency, Please contact .....

Name and address .....

Phone No. ....

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

**Schedule V**  
**Standards for Treatment and Disposal of Biomedical Wastes**

---

**Standards for Incinerators**

All incinerators shall meet the following operating and emission standards:

**Operating Standards**

1. Combustion efficiency (CE) shall be at least 99.00%
2. The combustion efficiency is computed as follows:

$$CE = \frac{\%CO_2}{\%CO_2 + \%CO} \times 100$$

3. The temperature of the primary chamber shall be  $800 \pm 50^\circ\text{C}$ .
4. The secondary chamber gas residence time shall be at least 1 (one) second at  $1050 \pm 50^\circ\text{C}$ , with minimum 3% oxygen in the stack gas.

**Emission Standards**

Parameters	Concentration mg/Nm <sup>3</sup> at (12% CO <sub>2</sub> correction)
1. Particulate matter	150
2. Nitrogen oxides	450
3. HCl	50
4. Minimum stack height shall be 30 meters above ground.	
5. Volatile organic compounds in ash shall not be more than 0.01%.	

**Note**

1. Suitable designed pollution control devices should be installed/retrofitted with the incinerator to achieve the above emission limits, if necessary.
2. Wastes to be incinerated shall not be chemically treated with any chlorinated disinfectants.
3. Chlorinated plastics shall be incinerated.
4. Toxic metals in incineration ash shall be limited within the regulatory quantities as defined under the Hazardous Waste (Management and Handling Rules), 1989.
5. Only low sulfur fuel like LDO/LSHS/Diesel shall be used as fuel in the incinerator.

### Standards for Waste Autoclaving

The autoclave should be dedicated for the purpose of disinfecting and treating biomedical waste.

1. When operating a gravity flow autoclave, medical waste shall be subjected to:
  - a. A temperature of not less than 121°C and pressure of 15 pounds per square inch (psi) for an autoclave residence time of not less than 60 minutes; or
  - b. A temperature of not less than 135°C and a pressure of 31 psi for an autoclave residence time of not less than 45 minutes; or
  - c. A temperature of not less than 149°C and a pressure of 52 psi for an autoclave residence time of not less than 30 minutes.
2. When operating a vacuum autoclave, medical waste shall be subjected to a minimum of one pre-vacuum pulse to purge the autoclave of all air. The waste shall be subjected to the following:
  - a. A temperature of not less than 121°C and pressure of 15 psi for an autoclave residence time of not less than 45 minutes; or
  - b. A temperature of not less than 135°C and pressure of 31 psi for an autoclave residence time of not less than 30 minutes.
3. Medical waste shall not be considered properly treated unless the time, temperature and pressure indicators indicate that the required time, temperature and pressure were reached during the autoclave process. If for any reasons, time, temperature or pressure indicator indicates that the required temperature, pressure or residence time was not reached, the entire load of medical waste must be autoclaved again until the proper temperature, pressure and residence time were achieved.
4. Recording of operational parameters: Each autoclave shall have graphic or computer recording devices which will automatically and continuously monitor and record dates, time of day, load identification number and operating parameters throughout the entire length of the autoclave cycle.
5. Validation test  
Spore testing: The autoclave should completely and consistently kill the approved biological indicator at the maximum design capacity of each autoclave until. Biological indicator for autoclave shall be *Bacillus stearothermophilus* spores using vials or spore strips, with at least  $1 \times 10^4$  spores per milliliter. Under no circumstances will an autoclave have minimum operating parameters less than a residence time of 30 minutes, regardless of temperature and pressure, a temperature less than 121°C or a pressure less than 15 psi.

6. **Routine test:** A chemical indicator strip/tape that changes color when a certain temperature is reached can be used to verify that a specific temperature has been achieved. It may be necessary to use more than one strip over the waste package at different locations to ensure that the inner content of the package has been adequately autoclaved.

### **Standards for Liquid Waste**

The effluent generated from the hospital should confirm to the following limits:

Parameters	Permissible limits
pH	6.6-9.0
Suspended solids	100 mg/l
Oil and grease	10 mg/l
BOD	30 mg/l
Bioassay test	90% survival of fish after 96 hours in 100% effluent

These limits are applicable to those hospitals which are either connected with sewere without terminal sewage treatment plant or not connected to public sewers. For discharge into public sewere with terminal facilities, the general standards as notified under the Environment (Protection) Act, 1986 shall be applicable.

### **Standards of Microwaving**

1. Microwave treatment shall not be used for cytotoxic, hazardous or radioactive wastes, contaminated animal carcasses, body parts and large metal items.
2. The microwaves system shall completely with the efficacy test/ routine tests and a performance guarantee may be provided by the supplier before operation of the unit.
3. The microwave should completely and consistently kill the bacteria and other pathogenic organisms that is ensured by approved biological indicator at the maximum design capacity of each microwave unit. Biological indicators for microwave shall be Bacillus Subtilis spores using vials or spore strips with at least  $1 \times 10^4$  spores per milliliter.

### **Standards of Deep Burial**

1. A pit or trench should be dug about 2 metres deep. It should be half filled with waste, then covered with lime within 50 cm of the surface, before filling the rest of the pit with soil.
2. It must be ensured that animals do not have any access to burial sites. Covers of galvanized iron/wire meshes may be used.
3. On each occasion, when wastes are added to the pit, a layer of 10 cm of soil shall be added to cover the wastes.

4. Burial must be performed under close and dedicated supervision.
5. The deep burial site should be relatively impermeable and no shallow well should be close to the site.
6. The pits should be distant from habitation, and sited so as to ensure that no contamination occurs of any surface water or ground water. The area should not be prone to flooding or erosion.
7. The location of the deep burial site will be authorized by the prescribed authority.
8. The institution shall maintain a record of all pits for deep burial.

# *Annexure F*

**Forms as per BMW (Handling and Management) Rules, 1998**

**Form I**  
**Application of Authorization**  
(To be submitted in duplicate)

---

To,

The Prescribed Authority

(Name of the State Govt/ UT Administration)

Address

1. Particulars of Applicant

- a. Name of the applicant .....  
(in block letters and in full)
- b. Name of the institution .....  
Address .....  
Tele No., Fax No., Telex No. ....

2. Activity for which authorization is sought

- a. Generation
- b. Collection
- c. Reception
- d. Storage
- e. Tr

3. Please state whether applying for fresh authorization or for renewal: (In case of renewal previous authorization number and date)

- 4. a. Address of the institution handling biomedical wastes
- b. Address of the place of the treatment facility
- c. Address of the place of disposal of the waste

5. a. Mode of transportation (in any) of biomedical waste
- b. Mode(s) of treatment
6. Brief description of method of treatment and disposal (attach details):
7. a. Category (see Schedule I) of waste to be handled.
- b. Quantity of waste (categorywise) to be handled per month.
8. Declaration

I do hereby declare that the statements made and information given above are true to the best of my knowledge and belief and that I have not concealed any information.

I do also hereby undertake to provide any further information sought by the prescribed authority in relation to these rules and to fulfill any conditions stipulated by the prescribed authority.

Date .....

Signature of the applicant .....

Place .....

Designation of the applicant .....

**Form II**  
**Annual Report**

(To be submitted to the prescribed authority by 31 January every year)

---

1. Particulars of the applicant
  - i. Name of the applicant:
  - ii. Name of the institution:  
Address  
Tel no.  
Telex no.  
Fax no.
2. Categories of waste generated and quantity on a monthly average basis:
3. Brief details of the treatment facility:  
In case of off-site facility:
  - i. Name of the operator
  - iii. Name and address of the facility:  
Tel no.    Telex no.                  Fax no.
5. Categorywise quantity of waste treated:
6. Mode of treatment with details
7. Any other information:
8. Certified that the above report is for the period from .....

Date .....

Signature .....

Place .....

Designation .....



**Form III**  
**Accident Reporting**

---

1. Date and time of accident:
2. Sequence of events leading to accident:
3. The waste involved in accident:
4. Assessment of the effects of the accidents on human health and the environment:
5. Emergency measures taken:
6. Steps taken to prevent the recurrence of such an accident:

Date .....

Signature .....

Place .....

Designation .....

# Annexure G

## Needle Stick Injury Report Form

Form No. 2

### Reporting of Needle Stick Injuries

---

Name and full address of Hospital.....  
.....

Needle Stick Sharp Injury Protocol:

Name of health care worker: .....

Category of health care worker: .....

Employment no. ....

Date of Needle Stick/Sharp Injury .....

Date of Reporting to Casualty .....

Site and Depth of Injury .....

**Nature of Injury: Needle Prick/Sharp Cut/Laceration/Splach of Fluids/  
Splattered Glass**

Action taken in casualty: .....

Hep. B vaccination given:                      Yes/No

HBIG:                                                      Yes/No

If Immunized: Date ..... Intradermal/ Intramuscular

Anti HBsAg Titre .....

HbsAg                                                      Positive/Negative

HIV antibody                                              Postive/Negative

#### Information about source of contamination (if available)

- Whether the patient has symptoms of HIV infection or no symptoms
- Serum sent for: (Reports to be entered in follow up visit)
  01. Anti-HIV
  02. HBsAg
  03. Anti-HCV
  04. CD4/CD8 counts

# *Annexure H*

## **Incinerator Function Monitoring**

<i>Days</i>	<i>Time</i>	<i>Primary chamber</i>		<i>Secondary</i>	<i>Surrounding of the incinerator</i>
		<i>Temp (°C)</i>	<i>Brick lining</i>	<i>chamber temp (°C)</i>	
Monday					
Tuesday					
Wednesday					
Thursday					
Friday					
Saturday					
Sunday					

Signature

Name of Inspecting Officer

**Note:**

Comments on brick lining—Intact/Broken

Comments on surrounding of incinerator—Clean/Satisfactory/Dirty

# *References*

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# Hospital Waste Management

## A Guide for Self Assessment and Review

This book is written with the objective of providing all the essential information which are of utmost importance to health care workers of all levels.

The issues of environment protection has already spread far and wide and proper management of hospital waste is one valuable contribution from health care providers towards this global concern.

The book has attempted to simplify the subject and to inculcate the valid concept of biomedical waste management (BMWM). The text has been detailed in Questions and Answers form.

The comprehensive text addresses various dimensions of hospital waste management in sequential manner thus allowing readers to understand each step in detail.

The book will certainly bring changes in terms of knowledge, skill and attitude of the health care workers who are closely associated with biomedical waste management.

**Dr (Major) Shishir Basarkar** is a medical graduate with Postgraduate Diploma in Hospital Management and Master Diploma in HRM. Besides this he has many other qualifications in his credit.



He has been trained in various fields of management through special trainings and workshops.

Entrepreneur by nature he has been experienced in varied areas of hospital management and other administrative appointment in civil and armed forces. His areas of interest other than hospital management are training and development, health care waste management and voluntary work for people living with HIV/AIDS (PLWHA).

He has presented papers in various national and international conferences and has many publications in his name as well.

He is an accredited management teacher by All India Management Association and also worked as resource faculty.



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