BHM-102
Health Care Waste Management : Concepts, Technologies and Training

Block

3

HEALTH CARE WASTE MANAGEMENT AND EMERGING ISSUES

UNIT 26
International Environmental Policies and their Relation with Health Care Waste Management

UNIT 27
Liquid Waste Management in Health Care Facilities

UNIT 28
Occupational Safety for Health Care Workers
This block has three units which highlight the emerging issues in the health care waste management. The world is going through difficult times; global pollution and temperatures are rising and so are pollution related illnesses. As custodians of human health, the health care sector is morally responsible to contributing positively to a healthier world. In Unit 26, you would read about various international environmental conventions and treaties and many multilateral bodies which are trying to control and limit pollution and problems arising from mismanagement of health care waste. This would give you a global scenario and significance of managing your waste.

Hospital wastewater is the water released after use for various activities in the hospital. Since this may contain many chemical and biological contaminants, it becomes a source of environmental pollution which also poses a threat to human health. In the Unit 27, you will learn about sources of generation of wastewater, the hazards associated with it and the final treated wastewater disposal options.

You are by now aware about the threats of health care waste to the health care workers handling and managing the health care waste. In the Unit 28, you will learn about the hazards and infection risks that the health care workers may encounter, and the prevention and control measures that must be adopted.

Did you know?

Health Care Waste includes all the waste generated within health care facilities, research centres and laboratories related to medical procedures. In addition, it includes the same types of waste originating from minor and scattered sources, including waste produced in the course of health care undertaken in the home.

Bio-Medical Waste means any waste, which is generated during the diagnosis, treatment or immunisation of human beings or animals or research activities pertaining thereto or in the production or testing of biological or in health camps, including the categories mentioned in Schedule- I appended to the Bio-Medical Waste Management Rules, 2016, as amended.
26.0 OBJECTIVES

After studying this unit, you should be able to:

- describe the various International Environmental Conventions and Treaties, which are related to HCWM
- discuss the impact of these Conventions and Treaties on global environment
- exemplify the relation of some of these conventions to bio-medical waste management in the country
- design your hospital waste management policy to synchronise it with global conventions

26.1 INTRODUCTION

In the units of the previous blocks of this course and the BHM-101, you have learnt about environment and our dependence and relation to it. You have also read about the various methods to be followed for segregation, techniques and technologies involved in treatment and disposal of various categories of bio-medical waste generated from health care facilities.

Bio-medical waste management started with a need to protect local communities from spread of infections and later became an issue of global significance. Earlier, segregation of waste was all that was expected from the hospitals but now this is just the primary goal for them. In the new environmental paradigm, they are expected to evolve to secondary and then tertiary issues. After you have gone through this unit, you will be able to understand the relation that the various international policies have with bio-medical waste management.

In this unit, the Minamata Convention on mercury has been elaborated, its implementation over the years and the role of health sector to control mercury emissions including the ones from health care diagnosis equipment. You may like to revisit the material on Minamata convention discussed in Unit 10, Block 3, BHM-101 of your course.

26.2 INTERNATIONAL ENVIRONMENTAL LAWS AND POLICIES

Environment plays an important role in the critical balance between health and disease of the individual. Equally relevant is the concern regarding the degradation and safe guarding the environment from the human activities. In this section, you will get an overview of the background that led to the laying down of the various international environmental laws and policies. We shall then move on to sensitising you to the progression of the environment laws in India.

26.2.1 Background

Whenever we engage with the issue of bio-medical waste management, we want our readers to view it in a very different light, from how it is generally seen. This waste is not only about some dirty bandages/ syringes, but it is about the global environment. It affects not just in the transmission
of various communicable diseases but also leads to various non-communicable
diseases and global warming. WHO’s report “Preventing disease through
healthy environments confirms that the fraction of the global burden of
disease due to the environment is 22%”.

You would have surely read and heard about the famous Montreal
Protocol, Agenda 21. Montreal protocol which was signed in 1987,
aimed at regulating the production and use of ozone depleting
chemicals. It is a protocol to the Vienna Convention for the Protection
of the Ozone Layer and is an international treaty designed to protect the
ozone layer by phasing out the production of numerous substances that
are responsible for ozone depletion.

Why did the world, get together and start to talk about local and global
environment? Well, this did not happen in a day. Over the years, global
communication and knowledge about environmental risks for humans
increased and resulted in the awareness that most environmental problems
have a transboundary nature and often a global scope, and they can only be
addressed effectively through international co-operation. For this reason,
International Treaties were established to promote measures at international
level to deal with regional, national and worldwide environmental problems,
and in particular combating climate change.

The international environmental policy has grown rapidly and
dramatically over the last four decades. This was driven by concern
over unprecedented and large-scale global environmental change,
including:

i. climate change,
ii. bio-diversity loss,
iii. deforestation,
iv. marine degradation, and
v. expanding trade and consumption.

Box 26.1: Environmental changes responsible for formulation of
policies related to environment

International environmental policy now directly and indirectly, affects the
policy, work and decisions of governments, corporations, NGOs, local
communities and individuals.

International environmental agreements like the Basel Convention, Stockholm
Convention and Minamata Convention are important because they enable
countries to work together to address vital environmental issues that are
transboundary or global in nature, such as air pollution, climate change,
protection of the ozone layer, and ocean pollution.

In India, the quality of our environment depends not only on what we do
at home but also on activities outside our borders. Our domestic actions
alone are often insufficient to protect our environment, our resources, and
our health. We need to work with other countries to develop common
solutions to international environmental problems that impact us directly.
Countries have increasingly recognised this and have developed a wide
range of international environmental agreements to enable them to work
 together on global environmental issues (Fig. 26.1).
You have read about waste minimisation; need to segregate efficiently; but how do you convince people to do it?

Everyone in the medical set up is wise enough to understand what to do; but what one fails to understand is why to do? To the senior staff, waste management may look too petty a thing to indulge in. Thus when you talk to doctors, senior administrators and senior nurses, you need to give them a bigger picture. This unit is all about that big picture. How one manages waste in a hospital can affect infection control, patient safety and occupational health in the hospital. And it also helps to cut down emissions of greenhouse gases, Persistent Organic Pollutants (POPs), mercury and other hazardous substances. No wonder all multilateral bodies are interested in it and are talking about it.

**Fig. 26.1: Let us join hands to save the world**

### 26.2.2 Progression of Environment Laws in India

After the UN Conference on the Human Environment at Stockholm in 1972, India developed a framework of environmental legislations. A new authority for environmental protection known as National Council for Environmental Policy and Planning within the Department of Science and Technology was set up in 1972. This Council later evolved into a full-fledged Ministry of Environment and Forests (MoEF) in 1985, which today is called as Ministry of Environment and Forests and Climate Change (MoEF&CC), the apex body in the country for regulating and ensuring environmental protection. MoEF&CC as it is now called is also the nodal agency for almost all of the multinational agreements on issues relating to environmental protection.

India started making and strengthening environmental policies in the country after a huge setback. Remember the Bhopal gas tragedy in 1984, the gas leak that changed the way we looked at our world.

Our government and our people had no idea of what was being used in the factory, what safeguards should be taken or what antidotes to be used. The incident brought to light the importance of having an environment protection law. The Environment Protection Act 1986, empowers the Central Government to take measures necessary to protect and improve the quality of the environment by setting standards for emissions and discharges,
regulating the location of industries, management of hazardous wastes, and protection of public health and welfare. The Environment (Protection) Act, 1986, also confers power on the Central Government to make rules in respect of matters delineated in the Act. All the rules made for protection of environment are made under the said act. Under the E (P) Act, 1986, the MoEF&CC has issued several notifications to tackle the problem of waste management. Some of these are enumerated in Box 26.2.

| c. Solid Waste Management Rules, 2016 |

Box 26.2: Rules for protection of environment w.r.t waste management made in India under the Environment Protection Act, 1986

Indian Constitution is amended - It is very interesting to know that after the Stockholm Conference 1972, the Constitution of India was amended to incorporate the provisions relating to environmental protection. Enactment of the Constitution (Forty-second Amendment) Act, 1976 expressed constitutional commitment to safeguard the environment in the country. The Constitution of India calls upon the State ‘to protect and improve the environment and to safeguard the forests and wildlife of the country’. It also imposes a duty on every citizen ‘to protect and improve the natural environment including forests, lakes, rivers and wildlife, and to have compassion for living creatures’.

The constitutional commitment was the major step taken by any nation on Earth as India became the first country to change its constitution to protect its environment. Our constitution is referred to as a ‘living document’. It is not static, the constituent committee wanted the constitution to change with times and be meaningful at all times.

Thus our constitution has done its bit, it’s time we do ours (Fig 26.2). Since the 1970s, an extensive network of environmental legislation has grown in the country, we need to comply to them with a respect.

Case Study 1. Example of Bhutan’s Constitution

Here we will give you a beautiful example of Bhutan’s constitution. In 2008, on behest of the then monarch, country changed from a monarchy to a constitutional democracy. Their constitution states, “The Government shall ensure that, in order to conserve the country’s natural resources and to prevent degradation of the ecosystem, a minimum of sixty per cent of Bhutan’s total land shall be maintained under forest cover for all time”.

Health Care Waste Management and Emerging Issues


Fig. 26.2: Constitution of India committed to safeguard environment

Check Your Progress 1

1. What is the need for international environmental laws?
2. What was the trigger for progress of environmental laws in India?
3. How did the MoEF&CC came into being?
4. How would compliance to environment rules contribute towards the goal of holistic healing?

26.3 BASEL CONVENTION ON TRANSBOUNDARY MOVEMENT OF HAZARDOUS WASTES AND THEIR DISPOSAL

The Basel Convention was drafted in response to a public outcry following the discovery of massive imports of toxic wastes to the developing world. Let us read more about how this convention came into being and it’s important features.

26.3.1 Background and Basic Objectives of the Convention

The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal, usually known as the Basel Convention, is an international treaty that was designed to reduce the transboundary movements of hazardous waste between nations, and specifically to prevent transfer of hazardous waste from developed to less developed
countries (LDCs). It does not, however, address the movement of radioactive waste. The Convention is also intended to prevent and minimise the amount and toxicity of wastes generated, to ensure their environmentally sound management as closely as possible to the source of generation, and to assist LDCs in environmentally sound management of the hazardous and active promotion of transfer and use of cleaner technologies.

The management of hazardous wastes has been on the international environmental agenda from the early 1980s. How did the Basel convention come into existence? Let us read about its evolution summarised in Box 26.3.

The Convention was opened for signature on 22 March 1989, and entered into force on 5 May 1992. As of February 2018, 185 states and the European Union are parties to the Convention. Haiti and the United States have signed the Convention but not ratified it.

| a. As science progressed newer chemicals were introduced in products and processes and then these chemicals started showing up in the waste. |
| b. The developed world soon realised that these waste piles were hazardous to the environment and the people. |
| c. Awakening environmental awareness and corresponding tightening of environmental regulations in the industrialised world in the 1970s and 1980s led to increasing public resistance to the disposal of hazardous wastes. This reaction and response of people came to be known as NIMBY (Not In My Back Yard) syndrome. This led to problems in finding land for treatment and disposal of waste and an escalation of disposal costs. |
| d. This in turn led some operators to seek cheap disposal options for hazardous wastes in Eastern Europe and the developing world, where environmental awareness was much less developed and regulations and enforcement mechanisms were lacking. |
| e. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (hereinafter referred to as “the Basel Convention”) was adopted in 1989. |

**Box 26.3: Evolution of the Basel Convention**

### 26.3.2 Relevance to Bio-Medical Waste and Global Significance

The overarching objective of the Basel Convention is to protect human health and the environment against the adverse effects of hazardous wastes. Clinical waste produced from the health care sector is one of the categories.

The provisions of the Convention center around the following principal aims listed in Box 26.4.
Box 26.4: Principle aims of the Basel Convention

In 2002, the sixth Conference of Parties (COPS) to the Basel Convention adopted technical guidelines on the environmentally sound management of bio-medical and health care wastes. The primary objective of the guidelines was to provide guidance on measures to minimise the amount of medical waste generated, ensure their separation and segregation at source and promote their safe handling, storage, transportation inside and outside health care establishments, treatment and final disposal. In 2004, the seventh COP adopted a guidance paper on hazard characteristic (infectious substances), which was intended to assist in determining whether a given waste displays the characteristic to a degree sufficient to render it hazardous. In practice, the Basel Convention is rarely invoked to ensure the sound management and disposal of hazardous medical waste, since this type of waste is mostly treated within the country where it is generated. But, it surely made all the party countries (to the convention) to have rules on managing it.

Remember, what you do in the wards is your contribution to SDGs. Political leaders will talk about it, but it is people like us who change the ground. Our small efforts in segregation and waste minimisation go a long way to prevent the creation of hazardous waste. We also help to decide how and where it is recycled.

The bio-medical waste rules specify that the waste needs to be sent to a centralised treatment facility (disinfected and shredded) and then sold to an authorised recycler. The intention is that the waste is recycled in an environment friendly manner. So, it is your duty to ensure that the waste reaches the proper place. Also under the new Rules, it is the duty of the operator of the centralised facility to let the occupier inspect the waste treatment site.

Actually, practically talking, a needlestick injury is directly related to climate change and waste minimisation. Most of you would say, ‘Not again’.

Let us see the difference if an injection is prescribed instead of an oral tablet by a doctor and a needlestick injury occurs (Box 26.5).

| a. Reducing generation of hazardous waste |
| b. Promotion of environmentally sound management of hazardous waste at the place of disposal |
| c. Restriction of transboundary movements of hazardous wastes which is not in accordance with the principles of environmentally sound management |
| d. Help in the implementation of the Sustainable Development Goals (SDGs) |

Think and reflect
Do you think we have the provisions in your rules wherein the operator of the central facility lets the occupier inspect the waste treatment site? If you are not sure, go back to the rules and find out.

a. If a doctor prescribes an oral medication as opposed to an injection, a lot of waste is minimised. E.g. a syringe, a needle, the packaging, a pair of gloves, a swab etc. So one has achieved waste minimisation by replacing an injection with oral therapy.
b. Now imagine that the pill was replaced by an injection and the health care worker gets a needlestick injury.

c. If the preliminary review points towards a possible sero conversion, the person might be put on a Post Exposure Prophylaxis (PEP).

d. PEP means taking antiretroviral medications (ARVs) as soon as possible after exposure to HIV (but certainly within 72 hours).

i. So that the exposure will not result in HIV/ HBV/ HCV infection.

ii. Treatment with 2 or 3 ARVs should continue for 4 weeks, if tolerated.

iii. PEP reduces the rate of infection from workplace exposures by 79%.

iv. However, it is still possible for health care workers who take PEP to get HIV infection.

v. PEP costs between $600 and $1,000 (depending on the severity of exposure).

vi. The medications have serious side effects. About 40% of health care workers do not even complete PEP because of the side effects.

**Box 26.5: A pill versus an injection resulting in a needlestick injury**

Thus any needlestick injury is taxing for the recipient, in terms of physical and mental trauma. A needlestick injury is also very taxing both economically and environmentally. Pharma processes are environmentally taxing, typical E-factors or MI’s are greater than 100. That means the typical manufacturing process consumes more than 100 kg of materials to produce 1 kg of API (Active Pharmaceutical Ingredient). Thus a needlestick injury should be strictly avoided with proper training and waste disposal practices in place. Some innovative strategies adopted by two hospitals in Delhi to counter the menace of unmanaged needles in the ward is given in the Box 26.6.

**Two of the hospitals in Delhi, had worked out innovative strategies to counter the menace of unmanaged needles in the ward.**

a. One of the hospitals imposed a fine of Rs. 50/- on all nurses on duty in a ward where an undestroyed/ recapped needle-syringe was found.

b. The other cancelled half day leave of all the staffs present in a ward where an undestroyed needle was found.

A single needlestick is a big personal and environment disaster and thus should be taken very seriously. The take away point is that health care waste management is very important. It helps you achieve the MDGs. Now you can proudly flaunt your contribution in achieving the important MDGs.

**Box 26.6: Innovative strategies to counter the menace of unmanaged needles in the ward**
26.3.3 Status of Compliance in India

When India signed the Basel convention it had to define hazardous waste and make legal provisions to address this waste stream in the country. It was then that the country got the Bio-Medical Waste (Management and Handling) Rules, 1998. Some features of these Rules have been highlighted in the Box 26.7.

- Define hazardous waste and make legal provisions to address this waste stream in the country
- Govt. of India notified the Hazardous Wastes (Management & Handling) Rules, 1989 under the Environment (Protection) Act, 1986 in order to regulate and ensure environmentally sound management of the hazardous wastes
- The Bio-Medical Waste Rules were drafted in 1995
- These draft rules proposed setting up incinerators in all 30 bedded and above hospitals
- After Public Interest Litigation (PIL) in the Supreme Court of India and NGO activism, the draft rules were changed
- The new rules incorporated standards for incineration and the alternatives to incineration i.e. non-burn technologies. It was then that the country got the Bio-Medical Waste (Management and Handling) Rules, 1998

Box 26.7: Some features of Bio-Medical Waste (Management and Handling) Rules, 1998

Is this what development is?

Fig. 26.3: Holistic development includes environmental and human health
26.4 STOCKHOLM CONVENTION ON PERSISTENT ORGANIC POLLUTANTS

The Stockholm Convention on Persistent Organic Pollutants (POPs) is a global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods. These chemicals are transboundary pollutants (that travel long distances), persistent (i.e. have long half-lives) and they bio-accumulate in the environment. Given their long range transport, no government acting alone can protect its citizens or its environment from POPs.

In response to the global problem of POPs, the Stockholm Convention, came into existence.

26.4.1 Background and Basic Objectives of the Convention


The entire world acknowledges the problem and the treaty has 181 parties. As set out in Article 1, the objective of the Stockholm Convention is to protect human health and the environment from persistent organic pollutants.

Main provisions of the convention

Among others, the provisions of the Convention require each party to follow certain guidelines given in Box 26.8.

a. Prohibit and/or eliminate the production and use, as well as the import and export, of the intentionally produced POPs that are listed in Annex A to the Convention (Article 3). The import and export of chemicals listed in Annex A can take place under specific restrictive conditions, as set out in paragraph 2 of Article 3.

b. Restrict the production and use, as well as the import and export, of the intentionally produced POPs that are listed in Annex B to the Convention (Article 3). The import and export of chemicals...
listed in Annex B can take place under specific restrictive conditions, as set out in paragraph 2 of Article 3.

c. Reduce or eliminate releases from unintentionally produced POPs that are listed in Annex C to the Convention (Article 5).

d. The Convention promotes the use of best available techniques and best environmental practices for preventing releases of POPs into the environment.

e. Ensure that stockpiles and wastes consisting of, containing or contaminated with POPs are managed safely and in an environmentally sound manner (Article 6).

f. To target additional POPs (Article 8). The Convention provides for detailed procedures for the listing of new POPs in Annexes A, B and/or C. A Committee composed of experts in chemical assessment or management - the Persistent Organic Pollutants Review Committee, is established to examine proposals for the listing of chemicals, in accordance with the process set out in Article 8 and the information requirements specified in Annexes D, E and F of the Convention.

g. Other provisions of the Convention relate to the development of implementation plans (Article 7), information exchange (Article 9), public information, awareness and education (Article 10), research, development and monitoring (Article 11), technical assistance (Article 12), financial resources and mechanisms (Article 13), reporting (Article 15), effectiveness evaluation (Article 16) and non-compliance (Article 17).

**Box 26.8: Guidelines of the Stockholm Convention**

Source: http://chm.pops.int/TheConvention/Overview/tabid/3351/

“Best” means most effective in achieving a high general level of total protection to the entire environment. “Available” means those techniques that are accessible to operators and that are developed on a scale that allows implementation in the relevant industrial sector, under economically and technically viable conditions, taking into consideration the costs and advantages. “Techniques” includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned. “Best environmental practices” means the application of the most appropriate combination of environmental control measures and strategies.

### 26.4.2 Relevance to Bio-Medical Waste Management and Global Significance

Article 5 of the Stockholm Convention requires parties to take all appropriate measures to reduce the unintentional release of the chemicals listed in Annex C (lists dioxins and furans that are unintentionally formed and released from thermal processes like medical waste incineration). The goal is continuous minimisation and, where feasible, ultimate elimination of such pollutants. Medical waste incinerators are included in the list of industrial source categories that can result in significant emissions of these chemicals into the environment. Open burning of waste, including burning of landfill sites, is included in the list of other source categories that may generate dioxins and furans.
The BAT/BEP guidelines systemically illustrated different incineration techniques, and has listed the process design and operating parameters to rotary kiln, pyrolysis, fluidised bed, and incinerators, and also give related requirements of medical waste process of generation, collection, segregation, storage, transportation, treatment and final disposal. In addition, BAT/BEP guidelines illustrated the alternative technologies of medical waste treatment, such as autoclave, microwave and soon, and suggested prioritising alternative technology when build a new treatment /disposal facility.

**Dioxins and furans**

Health care waste contains a high proportion of polyvinyl chloride (PVC), a chlorinated plastic that is used in containers for blood, catheters, tubing and numerous other applications. When burned, and under favourable conditions, PVC releases polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans, (listed as two of the hazardous POPs in the convention). They are family of 210 POPs that are unintentionally formed and released from health care waste incineration, as a result of incomplete combustion.

In the late 1980s, developed countries began to adopt strict regulations to reduce the amount of dioxins released into the atmosphere as a result of combustion and incineration processes. In the European Union, emissions of dioxins and furans were reduced by 80 per cent between 1990 and 2007.

**26.4.3 Status of Compliance in India**

The Compliance to the Stockholm convention by India has been elaborated in Box 26.9.

- India signed the Stockholm Convention in May 2002 and ratified it in 2006.
- A National Implementation Plan (NIP) was developed as a First Step to Implement the Stockholm Convention on POPs.
- India was the first country to ban the incineration of Polyvinyl chloride in the Bio-Medical Waste (Management & Handling) Rules notified in 1998 under the Environment (Protection) Act, 1986.
- Indian Bio-Medical Waste (Management & Handling) Rules, 1998 allowed both on-site (decentralised) and off-site waste treatment. However, subsequent to the notification of Bio-Medical Waste Management Rules, 2016 as amended in supersession of the Bio-Medical Waste (M & H) Rules, 1998, decentralised systems are allowed only if the service of a common bio-medical waste treatment facility is not available at a distance of seventy-five kilometer.
- The new BMWM Rules, (2016) also have the following requirements
  - call for phase out use of chlorinated plastic bags (excluding blood bags) and gloves by the 27th March, 2019.
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Dis you know?
An assessment of small-scale health care waste incinerators in developing countries showed widespread deficiencies in the design, construction, siting, operation and management of these units. These deficiencies often resulted in poor incinerator performance; and dioxin emissions were recorded to be even 40,000 times higher than the emission limits established by the Stockholm Convention. They were also releasing significant amounts of other hazardous pollutants. For further information visit the website http://www.who.int/publications/waste_management/en/assessment_ISSIs.pdf.

Box 26.9: Compliance to the Stockholm convention by India

Some categories of waste like soiled waste (which includes - soiled bandages, swabs, plaster casts and linen) and Microbiological waste which had an option of incineration/ autoclaving in the last Rules, have all been put under incineration now. The earlier Rules gave an option of autoclaving also, but it has now been removed. Practically speaking, most of the hospitals had chosen the incineration method for all these years. But, there were a couple of environment champions who autoclaved this waste and believed in yellow bag minimisation.

26.4.4 Projects Aiming at Reduction of POPs through Reduction of BMW Incineration

UNDP and GEF initiated a project to demonstrate and promote best techniques and practices for reducing health care waste to avoid environmental releases of dioxins and mercury. The project demonstrated the effectiveness of non-burn health care waste treatment technologies and waste management practices in seven strategically selected countries – Argentina, India, Latvia, Lebanon, the Philippines, Senegal and Vietnam.

The project expected to reduce the release of an estimated 187 g TEQ of dioxins and 2,910 kg of mercury to the environment each year from participating countries’ health care sectors (if the models that were created during the project were replicated). GEF funds are still used to introduce non-burn alternatives for the treatment of bio-medical waste in the developing world.

Case Study 2. King Georges Medical University (KGMU)

King Georges Medical University (KGMU), Lucknow, Uttar Pradesh was chosen as a project site. The status of BMWM practices at KGMU was dismal till the University was selected to be a priority model site in May 2010. At the beginning of the project, there was hardly any segregation at the point of generation and all the categories of waste were being mixed. This was attributable to lack of infrastructure, knowledge and commitment. The University was paying a waste disposal company for terminal disposal and it was not getting any revenue for the waste it was generating. There was also a significant risk to the health care workers, waste sorters, community at large, besides significantly contributing to an increased burden of incinerable waste.
A comparison of generation of the waste before and after the waste generation system (Fig. 26.4) shows that the magnitude of incinerable waste has significantly decreased and has become largely plastic-free, thereby reducing dioxin and furan emissions, as required by the Stockholm Convention. By virtue of segregation at point of generation and further segregation and recycling of autoclaved plastic waste, the university has started generating revenue. As a consequence, finances generated as a result of recycling plastic bio-medical waste offset the cost of BMW disposal by approximately 25%. Project started with sensitisation of the administration towards the issue of poor BMW. They were then motivated to form a dedicated Waste Management Committee along with the establishment of a BMW Cell. A member secretary for BMW was formally appointed and faculty members/staff were selected and designated as nodal officers for the individual departments. A centralised policy for segregation at point of generation into various categories of waste based on colour codes was formulated. A strategy was formulated for the regular and clean collection and transport of BMW from the various departments of the University. A dedicated and isolated place for terminal collection and temporary storage of BMW was identified and constructed. The hospital continues to serve as a model in waste management practices.

Check Your Progress 3

1. Write a short note on Stockholm Convention.

2. What are the major provisions of Stockholm Convention?
3. What problems have been encountered with small scale incinerators?

4. How have the Indian BMW Rules, 2016 addressed the issue of POPs?

26.5 MINAMATA CONVENTION ON MERCURY

The Minamata Convention on mercury is an international treaty designed to protect human health and the environment from anthropogenic emissions and releases of mercury and mercury compounds. This Convention was approved by delegates representing close to 140 countries on 19 January 2013 in Geneva.

26.5.1 Basic Highlights of the Convention

The evolution of the Minamata Convention have been outlined in the Box 26.10.

- An Intergovernmental Negotiating Committee (INC) was established and it held five sessions to discuss and negotiate a global agreement on mercury.
- The Minamata Convention was adopted and opened for signature on 10 October 2013, at a Diplomatic Conference in Kumamoto, Japan.
- It entered into force on 16 August 2017.
- This naming is of symbolic importance, as the city of Minamata in Japan went through devastating incident of mercury poisoning in 1956.

Box 26.10: Evolution of the Minamata Convention

The Convention has now been ratified by more than 88 countries and 144 signatories including India, which signed it on 30 September 2014 and ratified in 2018.

The Major highlights of the Minamata Convention have been outlined in the Box 26.11.

- Ban on new mercury mines and phase-out of existing ones.
- Phase out and phase down of mercury use in a number of products and processes.
- Control measures on emissions to air and on releases to land and water.
d. International regulation of the informal sector for artisanal and small-scale gold mining.

e. It addresses its interim storage and its disposal once it becomes waste.

f. It also addresses the sites contaminated by mercury as well as health issues.

Box 26.11: The basic objectives of the Minamata Convention

26.5.2 Mercury and its Health Impacts

You have already read about mercury and its health impacts in detail in Unit 10, Block 3, BHM-101 and in Unit 2, BHME-102. So, let us read a short story which is very interesting and at the same time very inspiring too.

This story is about a dental assistant, Ms Klausen, who had worked as a dental assistant in a municipal dental clinic in Norway for 23 years during the 1970-80s. During this period, nurses prepared amalgam by hand. They heated amalgam (containing 69% mercury) in a spoon until the mercury appeared in droplets on the surface and then kneaded the amalgam in their bare hands. Starting in 1978, the dental nurse Ms. Tordis Klausen began to experience symptoms consistent with mercury intoxication. In 2005 Norwegian Television Broadcasting aired a documentary on her struggle. Two documentaries were produced: the first was about occupational exposure and health damage to dental assistants from mercury called Kvikksølvjentene (The Mercury Girls) and the second was about health damage and birth defects to children of dental assistants called Kvikksølvbarna (The mercury Children). Phone lines were set up to receive calls from viewers after the broadcast. Within two months, 394 women had called. It became clear that many dental nurses had worked while pregnant and breastfeeding. A high number reported that their children had been born with birth defects, had severe depressions, learning difficulties, immunological and muscular/skeletal problems. In addition, the mothers had severe bleedings and multiple late abortions. These results were similar to those found in New Zealand where dental nurses were exposed to similar levels of mercury. In January 2006, Ms Klausen was awarded the prestigious Zola prize for her work in spreading information about the damage to health from exposure to mercury in dental clinics. The Zola prize is awarded in Norway to persons who, “Openly and courageously have revealed or opposed conditions in Norway that threaten basic values in Norwegian society: human rights, democracy and legal protection.” Effective 1 January 2008, the Norwegian government has prohibited the production, import, export, sale and use of substances and products that contain mercury to protect the environment. As a result, a general ban on the use of dental amalgam materials now applies in Norway.

Source: http://www.unep.org/hazardoussubstances/Portals/9/Mercury/AwarenessPack/English/UNEP_Mod4_UK_Web.pdf
Let us look at another mercury spill tragedy.

In another mercury spill tragedy, a mercury thermometer factory in Kodaikanal, Tamil Nadu (India) has significantly polluted the land and water of the area. Some estimates put the contamination at 25 mg/kg of soil. In addition to this the workers at the plant who were handling mercury without any proper protective equipment have suffered and are still faced with medical problems. After 15 years of struggle and a lot of global campaigning by environmental activists, finally the workers have got some compensation. But, the environment degradation still lingers on.

You have already read about effects of mercury on health. We shall recall what we read in Unit 10, Block 3, BHM-101 and in Unit 2, BHME-102. You have opted for the elective course **Box 26.12**.

a. Methyl mercury has a capability to interfere with cell division.
b. It can cross blood brain and placental fluids, and pregnant women and children are most vulnerable to the effect of mercury.
c. Mercury is a potent neurotoxin and even at very low levels of exposure, it can cause permanent damage to the human central nervous system.
d. At higher concentrations, mercury can damage vital organs such as lungs, liver and kidneys.

**Box 26.12: Effects of mercury on health**

### 26.5.3 Major Provisions of the Convention with Respect to Health Care Sector

Major provisions of the convention with respect to health care sector are highlighted in **Box 26.13** and **Box 26.14**.

**Article 4 of the treaty talks about mercury-added products-**

1. Each Party shall not allow, by taking appropriate measures, the manufacture, import or export of mercury-added products listed in Part I of Annex A (which includes thermometers; sphygmomanometers) after the phase-out date specified for those products ie 2020.

2. Each Party shall take measures for the mercury-added products listed in Part II (includes dental amalgam) of Annex A in accordance with the provisions set out therein.

**Annex A, Part I: Products subject to Article 4, paragraph 1**

Mercury-added products-Phase-out date-2020 (Date after which the manufacture/import/export of the product shall not be allowed).

Includes the following non-electronic measuring devices except non-electronic measuring devices installed in large-scale equipment or those used for high precision measurement, where no suitable mercury-free alternative is available:

a. barometers;
b. hygrometers;
c. manometers;
d. thermometers;
e. sphygmomanometers.

**Box 26.13: Major provisions of the convention with respect to health care sector**
Annex A, Part II: Products subject to Article 4, paragraph 3
Mercury added products Dental amalgam: Provisions

Measures to be taken by a Party to phase down the use of dental amalgam shall take into account the Party’s domestic circumstances and relevant international guidance and shall include two or more of the measures from the following list:

i. Setting national objectives aiming at dental caries prevention and health promotion, thereby minimising the need for dental restoration;

ii. Setting national objectives aiming at minimising its use;

iii. Promoting the use of cost-effective and clinically effective mercury-free alternatives for dental restoration;

iv. Promoting research and development of quality mercury-free materials for dental restoration;

v. Encouraging representative professional organisations and dental schools to educate and train dental professionals and students on the use of mercury-free dental restoration alternatives and on promoting best management practices;

vi. Discouraging insurance policies and programmes that favour dental amalgam use over mercury-free dental restoration;

vii. Encouraging insurance policies and programmes that favour the use of quality alternatives to dental amalgam for dental restoration;

viii. Restricting the use of dental amalgam to its encapsulated form;

ix. Promoting the use of best environmental practice in dental facilities to reduce releases of mercury and mercury compounds to water and land.

Box 26.14: Major provisions of the convention with respect to health care sector

India is a signatory to the treaty and the treaty talks about a phase out of mercury medical instruments by 2020 and phase down of dental amalgam. Thus India would have to seriously consider taking steps to reduce the use of mercury in the health care sector. India is the first country which has stopped using mercury in the Chlor alkali plants (one of the biggest users) and has completely shifted to membrane based technology for manufacture of caustic soda and chlorine.

26.5.4 Case Studies of Successful Phase Out in Hospitals

Case Study 3: Sir Ganga Ram Hospital

“The environmental and health impact concerns of mercury motivated the hospital to adopt a mercury phase out programme in the year 2004. The hospital drafted a mercury policy and decided to implement the programme in two phases. In the first phase mercury thermometers
were phased out. Also in the dental wing 80% of the restorations were switched to mercury alternatives. The hospital then implemented the second phase in which the sphygmomanometers were replaced with aneroid units. The hospital also held mercury awareness campaigns for the staff. Over 3000 nursing staff were trained on mercury spill prevention and management."

According to the hospital administrators, the success largely depended on a number of milestones enumerated below:

a. The communication between the administration and the staff and the commitment to phase out mercury.

b. The hospital received ISO 14,000 and NABH Certification both of which required the hospital to curtail the use of hazardous substances in the hospital.

c. The hospital is now successfully mercury free. The hospital was one of the first five hospitals in Delhi which announced that they would go mercury free voluntarily, without a mandate from the government.

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Cate Study 4. Himalayan Institute Hospital Trust (HIHT)

a. The hospital started with some meticulously articulated steps to phase out mercury voluntarily.

b. They researched for reliable, verifiable aneroid blood pressure instruments on the net and scanned lists of approved BP aneroids from the British Hypertension Society and Dabl Educational Trust.

c. A committee (comprising the Head of Departments of Physiology and Cardiology, Director of Medical OPD, Nursing Superintendent, and the Director) was created to develop a standardised procedure for taking blood pressures at the hospital. The new BP procedure was developed and disseminated at Continuing Medical Education (CME) Programme for all physicians. At the CMEs, they also introduced the aneroid BPs and digital thermometers and described the published research on mercury vs aneroid BP instruments.

d. The Physiology Department of the Medical College played a major role in introducing the medical and nursing faculty to the importance of replacing mercury BP instruments and thermometers. Continuing Education Programmes were also held for all the nursing faculty in the College of Nursing and Nursing Managers in the hospital who in turn were responsible for educating all staff nurses and nursing students on the use of the new aneroid BPs and digital thermometers.

e. Use of mercury fillings in the dental department was discontinued.

f. The programme for verifying the accuracy of the aneroid BP instruments every 6 months was started to regularly verify the accuracy of the aneroid BP machines and digital thermometers. This has to be part of any successful programme.
Even in the field of dentistry, many hospitals and some dentists have taken measures like – going absolutely mercury free. Some dentists who still use mercury, use dental chairs with amalgam filters, use of mechanical trituration, use of encapsulated mercury, etc. to prevent its release into the environment.

26.5.5 Country Scenario and Problems Facing the Phase Out

You can learn how India is on the phasing out of mercury from the health sector in India after reading Box 26.15.

Indian Health Care sector has initiated work in gradually phasing out the use of mercury thermometers and sphygmomanometers.

a. Ministry of Health and Family Welfare issued a guideline on phasing out the use of mercury in the health care sector. These guidelines were circulated to all the states and the nine central government ministries running their health care setups.

b. The Indian Public Health Standards (IPHS) recommend use of mercury alternates by the hospital and also recommends the adoption of policy on preventing environmental mercury pollution.

c. Various state directives (Delhi, Punjab, Manipur, Hubli- Dharward) limiting use of mercury, have hastened the process of shifting to alternates.

d. Many private and public hospitals in the country have phased out use of mercury, as a requirement for obtaining NABH and ISO certification. IMA has also issued a mercury phase out policy to all its members.

e. Under the WTO commitment India has already made Draft Quality Control order for Digital thermometers, Aneroid and mercury Sphygmomanometers, in 2006, and these had to be notified through a Gazette, making these standards mandatory; however this has yet not been done.

Box 26.15: Phasing out mercury in India

Most of the health care facilities are facing a challenge of identifying accurate and reliable non-mercury products in the market. BIS standards exist for these products, but non-mercury products are still not covered under mandatory certification in India. This is posing a serious challenge in finding reliable alternative products in the country.

Issuance of quality control order and notifying mandatory certification for these products will be of immense help to the health care facilities in procuring quality products and providing quality health services to the citizens.

Some issues with the Phase Out in India and their counter arguments are given in Box 26.16.
1. **Attitudes**: Most hospitals felt that it was difficult to change the mindset of personnel who were used to mercury-based thermometers.

*On the other hand two of the hospitals had a different story to tell. Max Health Care, Saket started as a mercury free facility and thus did not face any resistance. Himalayan Institute Hospital Trust (IIHT) did extensive research before introducing the equipment and were able to handle any apprehensions on accuracy and personally convince the doctors.*

2. **Finances**: Some hospitals felt that the cost of digital thermometers was higher than the mercury equipment.

*True, if the only consideration is one time replacement cost of mercury versus non-mercury instruments. A study in a few hospitals has shown that the recurring cost with mercury instruments far exceeds this cost difference in addition to the extra environmental and occupational hazard cost which the health care system does not even acknowledge at the moment.*

3. **Accuracy**: Most hospitals and clinicians feel comfortable with mercury equipment. Physicians are apprehensive about the accuracy of digital equipment. Accurate mercury free products are available, though relatively less readily. Hospitals have to proactively take up checking for accurate products and adopt them.

4. **Storage**: Hospitals have been storing mercury in glass bottles in water; however they feel that it evaporates due to poor sealing at the top. In dentistry, where people have put traps for the amalgam waste feel disheartened as there is no collection system for this waste and finally when this waste piles up they have to discard it in normal bins. Recently the Central Pollution Control Board had made guidelines on environmentally sound management of mercury waste. The guidelines still need to be adopted to bring some visible change on ground.

For further information visit the website [http://www.cpcb.nic.in/Guidelines_for_ESM_%20MercuryW_fromHCFs.pdf](http://www.cpcb.nic.in/Guidelines_for_ESM_%20MercuryW_fromHCFs.pdf)

5. **Calibration**: Some hospitals felt that if calibrated properly the non-mercury products work better. Half yearly calibration for BP instruments and yearly calibration for the thermometers is good enough, though these time spans may vary with the type of product used.

*Source: Mercury Movement in India, Toxics Link, 2009.*

### Box 26.16: Issues related to phasing out of mercury

#### 26.6 INTERNATIONAL STAKEHOLDER AND OTHER RELEVANT CONVENTIONS/AGREEMENTS

There are a number of multilateral bodies involved in the medical waste management. Let us learn about some of them in the following sections.
26.6.1 WHO and Health Care Waste Management

WHO has elaborated a number of policy, management and advocacy tools to minimise the risks that the improper management of health care waste pose to health care workers, patients, waste handlers, the community at large and the environment. These include a policy paper on safe health care waste management (2004) and core principles for achieving safe and sustainable management of health care waste (2007). WHO has also developed a handbook on the safe management of wastes from health-care activities 2014, policy document to facilitate the elaboration of a national plan of action on health care waste management, as well as specific guidelines for the safe management of particular categories of medical waste, such as solid health care waste, and mercury-containing equipment.

Other important documents include training modules and implementing GEF funded HCWM global and regional (AFRO) projects. WHO has also included indicators on waste management under the SDG 6 and waste management into the WASH fit.

26.6.2 UNDP and GEF

A partnership between UNDP, the World Health Organisation (WHO), and other major donors and stakeholders, is assisting several countries (including Argentina, India, Latvia, Lebanon, Philippines, Senegal and Vietnam, among others) in developing and maintaining best health care waste management practices in ways that are both locally appropriate and globally replicable. The programme’s ultimate goal is protection of public health at the local level as well as the protecting the global environment from the impacts of dioxin and mercury releases.

The project “Demonstrating and Promoting Best Techniques and Practices for Reducing Health Care Waste to Avoid Environmental Releases of dioxins and mercury” is a partnership between UNDP, the World Health Organisation (WHO) and the international NGO Health Care Without Harm, as well as other major donors and stakeholders. In each participating country, the project has developed model hospitals to demonstrate best practices in health care waste management.

You have already read about the KGMU success story in the previous section.

Implementing agency for the Global Environment Facility (GEF), UNDP supports implementation of projects on POPs, mercury, lead and waste in 84 countries. UNDP helps countries strengthen their waste management systems, including waste prevention, reuse/recycling, treatment and disposal. Safe and effective treatment of hazardous medical waste (e.g. from the Ebola crisis in West Africa) through innovative technologies is also underway.
26.6.3 UNHRC: Human Rights and Impact of Health Care

Report to the Human Rights Council by Special Rapporteur Calin Georgescu UN rights expert noted that Medical waste was becoming an increasing problem. The Special Rapporteur noted that much more remained to be done to ensure the effective enjoyment of the inherent right to life, as set out in Article 6 of the International Covenant on Civil and Political Rights, and the right to the highest attainable standard of health, as defined in article of the International Covenant on the Economic, Social and Cultural Rights in the context of the management and disposal of medical waste. *The improper handling or disposal of hazardous medical waste can result in death, permanent or temporary disability or injury.* The Special Rapporteur was of the view that time is ripe to give to the impact that the improper management and disposal of medical waste continue to have on the enjoyment of human rights the attention it deserves. He therefore called on all relevant stakeholders, to strengthen their efforts to achieve safe and sustainable management of medical waste.

Safe and sustainable management of health care waste is a public health imperative and a responsibility of all. However, in many countries, including some developed countries, improper management and disposal of medical waste continue to pose a significant, although underestimated threat to the enjoyment of several human rights, including the right to life, the right to highest attainable standard of physical and mental health, the right to safe and healthy working conditions and the right to an adequate standard of living.

All individuals exposed to health care waste are potentially at risk of being injured or infected. List of those who can be affected is given in **Box 26.17**.

- **a.** Medical staff: doctors, nurses, sanitary staff and hospital maintenance personnel;
- **b.** In- and out-patients receiving treatment in health care facilities, and the visitors;
- **c.** Workers in support services linked to health care facilities such as laundries, waste-handling and transportation services;
- **d.** Workers in waste-disposal facilities, including scavengers;
- **e.** Communities living close to municipal waste facilities or illegal dump sites where medical waste is disposed of, and more specifically children playing with discarded items they find in the waste.

**Box 26.17: Individuals who can be exposed to health care waste**

**GAVI (vaccine, injection safety and waste)**

As an Alliance, with regard to vaccine production and procurement, Gavi relies on the environmental sustainability standards and policies of its implementing partners as they relate to its mission. WHO sets technical
standards that guide Gavi-supported programmes, such as the prequalification process for vaccines, which requires manufactures to adhere to Good Manufacturing Practices.

In order to reduce the environmental footprint of its programmatic investments as well as its operations, Gavi will assess key opportunities for reducing greenhouse gas emissions, promoting resource efficiency, and increasing recycling and other proper disposal of waste material.

It is integrating sharps waste management component to make immunisations safer. By focusing on safe disposal of immunisation-related sharps waste, GAVI would be in a unique position to stimulate and build consensus on global- and country-level waste management policies, strategies, and priorities, and to catalyse other parts of the public health system. GAVI could instigate a major and rapid improvement in the management of sharps waste, thus improving safety for patients, health care workers, and communities.

Check Your Progress 4

Across
7. Countries which ratify an international convention become party to it

Down
1. Conventions help in the implementation of which development goals?
2. Convention that protect human health and the environment against the adverse effects of hazardous wastes
3. An Alliance, with regard to vaccine production and procurement
4. Medical waste contains a high proportion of this substance which is a chlorinated plastic and on burning releases a large amount of furans and dioxins
5. Convention that protect human health and the environment against the adverse effects of mercury

6. Because the hazardous waste rules did not include clinical waste from the hospitals while drafting the Hazardous Waste Management and Handling rules which separate rules had to be formulated?

8. Which protection act of 1986 is the act which prompted the formulation of many important rules for safeguarding environment?

9. Name given to mercury used for dental fillings.

10. Convention that protect human health and the environment against the adverse effects of persistent organic pollutants

26.6.4 Millenium and Sustainable Development Goals (SDGs)

The Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. These 17 Goals build on the successes of the Millennium Development Goals, while including new areas such as climate change, economic inequality, innovation, sustainable consumption, peace and justice, among other priorities. The goals are interconnected – often the key to success on one will involve tackling issues more commonly associated with another.

The SDGs work in the spirit of partnership and pragmatism to make the right choices now to improve life, in a sustainable way, for future generations. They provide clear guidelines and targets for all countries to adopt in accordance with their own priorities and the environmental challenges of the world at large. The SDGs are an inclusive agenda. They tackle the root causes of poverty and unite us together to make a positive change for both people and planet.

As can be depicted in Box 26.18, it provides direction on the management of hazardous waste, which has a direct impact on the health from environmental determinants. The different SDGs such as 3 and 6 are affected directly by good waste management practices.

- State-of-the-art recycling in accordance with agreed standards could create business opportunities and safe jobs;

- Realising this potential might also lessen the incentives for illegal recycling operations, through providing legal, safe and economically rewarding alternatives. Thus whenever you plan your waste management programmes you must realise that the entire waste, be it solid waste, bio-medical waste, e-waste etc. needs to be minimised and the waste needs to be recycled in an environmentally safe manner (Fig. 26.5);

- A higher yield of secondary raw materials;
d. Conservation of precious resources through extraction and re-use rather than primary mining; and

e. Better protection of the air, soil, water and thus human health.

Box 26.18: SOG, provide direction to management of hazardous waste.

![Fig. 26.5: Everyone generates waste but few take ownership](image)

In line with the UN Sustainable Development Goals (SDGs), particularly Goal 3 on health, Goal 6 on safely managed water and sanitation and Goal 12 on sustainable consumption and production, the Water, sanitation and hygiene (WASH) in health care facilities: Global action plan aims to ensure that all health care facilities have basic WASH services by 2030. This includes safe health care waste management involving segregation, collection, transportation, treatment and waste disposal.

The WHO/UNICEF Joint Monitoring Programme (JMP) has the official mandate of reporting on progress towards achieving SDG 6 on safely managed water and sanitation. This will involve capturing and reporting data from households, schools and health care facilities. Harmonised monitoring indicators to assess WASH services in health care facilities include one on health care waste and specifically proper segregation and safe treatment and disposal.

### 26.6.5 Other Relevant Declarations and Conventions

**The Bali Declaration** on Waste Management for Human Health and Livelihood.

Another word which you would have often heard is “The Bali Declaration on Waste Management for Human Health and Livelihood”, this was adopted by 9th Conference of Parties (COP) 9 held in 2008. When the party countries meet they call it COP. Bali declaration has affirmed at the political level that waste, if not managed in a safe and environmentally sound manner, may have serious consequences for the environment, human health and sustainable livelihood.

**Rotterdam Convention**

The Rotterdam Convention (formally, the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade) is a multilateral treaty to promote shared responsibilities in relation to importation of hazardous chemicals.

The convention promotes open exchange of information and calls on exporters of hazardous chemicals to use proper labelling, include directions...
on safe handling, and inform purchasers of any known restrictions or bans. Signatory nations can decide whether to allow or ban the importation of chemicals listed in the treaty, and exporting countries are obliged to make sure that producers within their jurisdiction comply. The “prior informed consent principle” as embodied in various international treaties is designed to protect public health and the environment from hazardous waste. It requires that affected communities and other stakeholders be apprised of the hazards and risks and that their consent be obtained. In the context of health care waste, the principle could apply to the transport of waste and the siting and operation of waste treatment and disposal facilities.

Think and reflect
What do you think could be reasons, why countries are not signing specific conventions? What are the advantages of the countries in being part of international conventions? What is happening if a country has joint a convention but is not reaching the aims and activities?

Check Your Progress 5

1. How does Basel convention help the countries to achieve MDGs?

2. How did NIMBY Syndrome change the way the world looked at it’s a hazardous waste?

3. What did Bali Declaration affirm?

26.7 LET US SUM UP

The concepts covered in this unit have been summarised in Fig. 26.6. As we wind up this unit we realise that health care waste management is not a trivial thing. Scientific and adequate management of this waste is important to protect the environment and public health. Gear up your hospital policies and change the mindset of health care personnel and make them aware of the dangers of medical waste mismanagement.
INTERNATIONAL ENVIRONMENTAL POLICIES

1. Environment laws in India - under the Environment Protection Act 1986
   a. Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016,
   b. Bio-Medical Waste Management Rules, 2016,
   c. Solid Waste Management Rules, 2016,
   d. E-waste (Management) Rules, 2016,
   e. Plastic Waste Management Rules 2016,
   f. Lead Acid Battery (Management and Handling) Rules 2001

2. Basel convention on transboundary movement of hazardous waste and their disposal
   a. Evolution
      - Hazardous waste because of new chemicals fining way into waste
      - Cheap disposal options
   b. Developments related to the convention
      - Bali Declaration on Waste Management for Human Health and Livelihood
      - conventions also help in the implementation of the Sustainable Development Goals (SDGs)
      - state-of-the art recycling
      - higher yield of secondary raw materials
      - conservation and reuse of precious resources through extraction
      - better protection of the air, soil, water and thus human health
   c. Aims of convention
      - Reducing generation of hazardous waste
      - Promotion of environmentally sound management of hazardous waste
      - the restriction of transboundary movements of hazardous wastes
      - implementation of the Sustainable Development Goals (SDGs)

3. Stockholm convention on persistent organic pollutants
   a. Guidelines of the Stockholm Convention
      - Reduce or eliminate releases from unintentionally produced
      - Use of best available techniques (BAT) and best environmental practices (BEP) for preventing releases of POPs into the environment.
      - Ensure that stockpiles and wastes consisting of, containing or contaminated with POPs are managed safely and in an environmentally sound manner
   b. India signed the Stockholm Convention in May 2002 and ratified it in 2006.

4. Minamata Convention on mercury - Objectives
   a. ban on new mercury mines and phase-out of existing ones
   b. phase out and phase down of mercury use in a number of products and processes
   c. control measures on missions to air and on releases to land and water
   d. international regulation of the informal sector for artisanal and small-scale gold mining

5. Medical waste management and other multilateral bodies
   a. World Health Organization (WHO) and health care waste management
   b. UNDP and GEF
   c. UNHRC

**Fig. 26.6: Mind Map**

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**26.8 GLOSSARY**

**BAT/BEP**: Best Available Techniques/Best Environmental Practices

**POPs**: Persistent Organic Pollutants

**HCWM**: Health Care Waste Management (this has been interchangeable been used as medical waste or bio-medical waste)

**NIP**: National Implementation Plan “King Georges Medical University (KGMU) Global Environmental Facility” (GEF)
   Ministry of Environment and Forests and Climate Change (MoEF&CC)

**SDG**: Sustainable Development Goals
26.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. In any country, the quality of its environment depends not only on what it does at home but also on activities outside its borders. Its domestic actions alone are often insufficient to protect its environment, its resources, and its health. International environmental agreements are important because they enable countries to work together to address vital environmental issues that are transboundary or global in nature, such as air pollution, climate change, protection of the ozone layer, and ocean pollution.

2. After the UN Conference on the Human Environment at Stockholm in 1972, India developed a framework of environmental legislations. A new authority for environmental protection known as National Council for Environmental Policy and Planning was also set up in 1972.

3. After the UN Conference on the Human Environment at Stockholm in 1972, India developed a framework of environmental legislations. A new authority for environmental protection known as National Council for Environmental Policy and Planning within the Department of Science and Technology was set up in 1972. This Council later evolved into a full-fledged Ministry of Environment and Forests (MoEF) in 1985, which today is the apex body in the country for regulating and ensuring environmental protection. MoEF& CC (Ministry of Environment and Forests and Climate change) as it is now called is also the nodal agency for almost all of the multinational agreements on environmental protection.

4. Prevention is better than Cure. The hospitals cannot play their role merely by treating diseases. They have to start playing the critical role of controlling the onset and spread of diseases. How one manages waste in a hospital can affect infection control, patient safety and occupational health in the hospital. And it also helps to cut down emissions of greenhouse gases, POPs, mercury and other hazardous substances. One cannot have healthy people on a sick planet, thus compliance to environment rules contribute towards the goal of holistic healing.

Check Your Progress 2

1. The principal aim of the Basel Convention are:
   a. The reduction of hazardous waste generation and the promotion of environmentally sound management of hazardous wastes, at the place of disposal;
b. The restriction of transboundary movements of hazardous wastes except where it is perceived to be in accordance with the principles of environmentally sound management.


Check Your Progress 3

1. The Stockholm Convention on Persistent Organic Pollutants is a global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods. These chemicals are transboundary pollutants (that is, they travel long distances), persistent (i.e. they have long half lives) and they bio-accumulate in the environment. Exposure to Persistent Organic Pollutants (POPs) can lead to serious health effects including certain cancers, endocrine disruption, birth defects, dysfunctional immune and reproductive systems, greater susceptibility to disease and damages to the central and peripheral nervous systems.

In response to this global problem, the Stockholm Convention, which was adopted in 2001 and entered into force in 2004, requires its parties to take measures to eliminate or reduce the release of POPs into the environment.

2. Among others, the provisions of the Convention require each party to:
   a. Reduce or eliminate releases of unintentionally produced POPs that are listed in Annex C to the Convention (Article 5).
   b. The Convention promotes the use of best available techniques and best environmental practices (BAI/BEP) for preventing releases of POPs into the environment.
   c. Ensure that stockpiles and wastes consisting of, containing or contaminated with POPs are managed safely and in an environmentally sound manner (Article 6).

3. Small-scale medical waste incinerators in developing countries showed widespread deficiencies in the design, construction, siting, operation and management of these units. These deficiencies often resulted in poor incinerator performance; and dioxin emissions were recorded to be even 40,000 times higher than the emission limits established by the Stockholm Convention. They were also releasing significant amounts of other hazardous pollutants.

4. Indian Rules are against onsite (decentralised) waste treatment and favour centralised treatment facilities. The new rules (2016) call for a phase out of use of chlorinated plastic bags, gloves and blood bags within two years from the date of notification of the rules.

The new Rules have set in standards for total dioxins and furan release at 0.1ngTEQ/Nm³. Also the residence time of waste in the secondary chamber has been changed from 1 sec to 2 seconds.
Check Your Progress 4

Across
7. Conference of parties

Down
1. Sustainable
2. Basel
3. Gavi
4. PVC
5. Minamata
8. Environment
9. Amalgam
10. Stockholm

Check Your Progress 5

1. Basel convention aims at proper treatment and disposal of clinical waste and toxic waste generated by hospitals. If the spread of infections can be stopped and exposure to toxic waste controlled it would help in achieving Millennium Development goals, like environment sustainability, maternal and child health and combat HIV and other diseases.

2. NIMBY (Not In My Back Yard) syndrome started as a response to people’s uprising against environmental degradation. This led to problems in finding land for treatment and disposal of waste and an escalation of disposal costs in developed countries. This in turn led some operators to seek cheap disposal options for hazardous wastes in Eastern Europe and the developing world. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (hereinafter referred to as “the Basel Convention”) was adopted in 1989. This convention was drafted in response to a public outcry following the discovery of massive imports of toxic wastes to the developing world. After this each country started drafting regulations for management of hazardous waste.

3. Bali declaration has affirmed at the political level that waste, if not managed in a safe and environmentally sound manner, may have serious consequences for the environment, human health and sustainable livelihood.

26.10 REFERENCES AND FURTHER READINGS

1. http://www.basel.int


Health Care Waste Management and Emerging Issues

UNIT 27 LIQUID WASTE MANAGEMENT IN HEALTH CARE FACILITIES

Structure

27.0 Objectives

27.1 Introduction

27.2 Sources of Wastewater Generation in Health Care Facilities

27.3 Characteristics and Hazards of Wastewater Generated from Health Care Facilities

27.4 Wastewater Management in Health Care Facilities
   27.4.1 Water Conservation and Water Efficiency
   27.4.2 Source Reduction and Segregation to Reduce Environmental Pollution Load
   27.4.3 Source Separation

27.5 Hospital Wastewater Treatment Options
   27.5.1 Compliance Requirements of Wastewater Generated from Health Care Facilities
   27.5.2 Pre-treatment of Liquid Chemical Waste of Health Care Facilities
   27.5.3 Silver Recovery from Fixer or Hypo-solution from X-Ray Processing
   27.5.4 Liquid Waste Treatment Options: On-site/ Terminal Wastewater Treatment Plants
   27.5.5 Expected Problems of Wastewater Treatment Plants
   27.5.6 Liquid Waste Management by the Non-bedded Health Care Facilities

27.6 Treated Wastewater for Final Disposal Options

27.7 Case Study

27.8 Let Us Sum Up

27.9 Glossary

27.10 Answers to Check Your Progress

27.11 References and Further Readings
27.0 OBJECTIVES

After studying this unit, you should be able to:

- enlist the sources, characteristics and hazards of wastewater generated from health care facilities
- describe the functioning of wastewater treatment systems in health care facilities
- replicate the methods of pre-treatment of chemical liquid waste
- enumerate the compliance requirement of the treated infectious wastewater as per Bio-Medical Waste Management Rules, 2016, as amended
- explain different health care facility wastewater treatment methods
- extrapolate from case studies for wastewater treatment systems
- describe the different disposal methods of treated wastewater generated from health care facilities

27.1 INTRODUCTION

You have already read about the various treatment and disposal options of the infectious solid bio-medical waste in the Units 21 to 25. In this unit, we shall elaborate on the characteristics, hazards and treatment methods of wastewater generated from the health care facilities.

Wastewater refers to water used for various purposes at home, in industries, commercial areas and which has lost its quality with its intended purpose. In hospitals, water is used for various activities such as for inpatient care, surgery rooms, laboratories, laundry, toilets, and kitchen etc. The used water which is released by the hospital with changes in its physical, chemical and biological quality is called ‘wastewater’. Hospital wastewater may contain different microorganisms, organic materials and chemical contaminants including heavy metals. Hence hospital wastewater is a source of environmental pollution if released into the environment without any treatment. Release of untreated wastewater in the environment will pollute drinking water sources and soil and cause water-borne diseases and infections.

There is some evidence indicating discharges by the health care facilities as hotspots for antimicrobial-resistant bacteria and antimicrobial-resistant (AMR) genes. Patients in hospitals are constantly and extensively being treated with antibiotics and other antimicrobial agents. The solid, faecal and liquid wastes from these patients have been documented as important sources of antibiotics and other antimicrobial agents contributing to the release of antimicrobial-resistant bacteria and AMR genes in the environment (Mach & Grimes, 1982; Korzeniewska, Korzeniewska & Harnisz, 2013; Leclercq et al., 2013; Varela et al., 2013; Zhang et al., 2013; Amaya et al, 2012).
In this unit, you will understand sources of generation of wastewater in health care facilities, characteristics and hazards associated with the wastewater, wastewater treatment methods and final treated wastewater disposal options. Such knowledge is very useful to the concerned staff in health care facilities in day-to-day activity and helps to take adequate steps to comply with the effluent discharge norms stipulated under guidelines and regulations of the respective countries.

### 27.2 SOURCES OF WASTEWATER GENERATION IN HEALTH CARE FACILITIES

In health care facilities, water is consumed in inpatient wards, surgery room, labour room, laboratories, radiotherapy, radiology, C.T. Scan room, clinic, sterilisation section, laundries, disinfectant section, kitchens, health services and administrative units and therefore decreases its physical, chemical and biological quality and is converted to wastewater (Mahvi et al., 2009).

In India, the water requirement for the hospital ranges from 340 to 450 liter per bed per day depending on the type of hospital (excluding the water demand required towards firefighting, hospital staff housing).

The quantity of wastewater produced in a HCF depends on the amount of water consumed for different purposes. The water consumption in HCFs depends on various factors such as the kind of health care services or its activity, number of beds, % of occupancy, accessibility to water use, climatic conditions, level of care and water-use practices by the patients/health care staff and treated water reuse or water consumption management. The amount of hospital wastewater generated varies from country to country. E.g., in America hospitals, the wastewater generation per capita is determined to be about 1000 liter per day per bed (Tchobanoglous et al., 2004).

In general, about 80 to 85% of total water consumed is generated as wastewater from the above sources. Typical wastewater generation rates in health care facilities (Anonymous, 2001) are detailed below in **Box 27.1**.

<table>
<thead>
<tr>
<th>Size of Health Care Facility</th>
<th>Wastewater Generation (in liter per day per bed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>small-medium-sized hospitals</td>
<td>300–500</td>
</tr>
<tr>
<td>large health care settings</td>
<td>400–700</td>
</tr>
<tr>
<td>university hospitals</td>
<td>500–&gt;900 l per inpatient per day</td>
</tr>
</tbody>
</table>

**Box 27.1: Typical Wastewater Generation Rates in Health Care Facilities**

Sources of wastewater generation in Health Care Facilities are given in **Fig. 27.1**.
Various sources of wastewater generation in the health care facilities (Source: WHO- Safe Management of Wastes from Health Care Activities, 2nd Edition, 2014) and their characteristics are described in Fig. 27.2.

a. General medical areas

General medical areas generate wastewater comparable to domestic wastewater. The urine of patients from some wards (oncology, infectious disease) will probably contain higher amounts of antibiotics, cytotoxics, their metabolites and X-ray contrast media. Additionally, higher concentrations of disinfectants can be found.

b. Theatres and intensive-care units

Theatres and intensive-care units generate wastewater with high contents of disinfectants (glutaraldehyde), detergents and pharmaceuticals. Additionally, the organic content can be high due to the disposal of body fluids and rinsing liquids (such as those from suction containers).

c. Laboratories

Laboratories are a possible source for chemicals in the wastewater stream. Of special relevance are halogenated and organic solvents, colorants from histology and haematology (Gram staining), cyanides (haematology) and formaldehyde and xylene (pathology). Laboratories may also contribute to the presence of blood in wastewater from the emptying of samples into the sinks.

d. Radiology

Radiology departments are the main generator of photochemical (developing and fixing) solutions in wastewater and potentially contaminated rinsing water. In some countries, this source of wastewater contamination is declining due to the increasing use of digital X-ray technology.
e. **Haemodialysis**

Haemodialysis requires the disinfection of the dialysers and sometimes the used filters. Accordingly, the concentration of disinfectant in the wastewater can be high.

f. **Dental departments**

Dental departments can contaminate wastewater with mercury (amalgam) from the filling of dental cavities if no amalgam separators are installed in the sink waste pipe system.

g. **Central sterile supply departments**

Central sterile supply departments are one of the main consumers of disinfection solutions, including aldehyde-based disinfectants. Hot water from the sterilisers and detergents from the CD-machine (cleaning and disinfectant) might also increase pollution load in the wastewater.

h. **Laundries**

Laundries are places where the highest quantity of greywater is produced. Often, the wastewater is hot, has a high pH (alkaline) and may contain high rates of phosphate and absorbable organic iodinated compounds (AOX), if chlorine-based disinfectants are used. Shower blocks also create large volumes of greywater containing dilute concentrations of detergents.

i. **Kitchens**

Kitchens at hospitals often generate a polluting wastewater stream containing food leftovers, waste from food processing and high concentrations of disinfectants and detergents. Starch, grease, oil and an overall high organic content have the potential to create problems during wastewater management.

---

**Fig. 27.2 : Characteristics of water from different sources of wastewater generation in the health care facilities**

---

**Check Your Progress 1**

1. In the word search below find the words related to sources of wastewater generation

   K S F C Z P T B U C J E Y K
   Y B N Z J Q Q H X Y N F R K B
   Y G O L O I D A R E B D T Y Z
   H Y F I Y C E Y H W M I A A R
   E F Q B P H N C N O V L E V Q
   E H P X X Q T M G J A O H A I
   K Q K L L I A T O B P M T R B
   S L H A K V L G O O L C W P
   U V T F P X L R K Y R H P J X
   E M H Q U P A I C U J H N H Y
   X O J D H T U T C L C I T I X
   N Y D V O Y N M Q M V L Y A B
   Y S L R W S D C L T V Q Q X B
   C T Y N S T R A H X R V F G C
   M F A M Q A Y Z R U I T J D M

---
### 27.3 CHARACTERISTICS AND HAZARDS OF WASTEWATER GENERATED FROM HEALTH CARE FACILITIES

Although the quality of health care facility wastewater is similar to municipal wastewater, but the hospital wastewater may comprise of various constitutions that have been enumerated in **Box 27.2**.

- **a.** Infectious liquid waste: These include cultures, stocks and associated biological from bio labs, some types of microbial pathogens (including bacteria, viruses and parasites) pathogens persistent to antibiotics as well as liquids contaminated with blood, blood products, body fluids, sewage generated from toilets and bathrooms, Clinical testing laboratories.

- **b.** Liquid chemical waste.

- **c.** Liquid waste from oncology (chemotherapeutic) and pathology (formaldehyde).

- **d.** Photochemical solutions (hydroquinone) developer and fixer solutions, and X-ray contrast media containing absorbable organohalogen compounds (AOX) (Boillot, 2008; Carballa et al., 2004; Jolibois and Guerbet, 2006).

- **e.** Chlorinated organic compounds and heavy metals such as Hg (Mercury generated from broken and obsolete equipment used for diagnosis of patients and dental clinics- residual dental amalgam or laboratory chemicals) and Pb (Kummerer and Helmer, 2006).

- **f.** Solvents (include halogenated compounds, such as methylene chloride, chloroform, trichloroethylene, and refrigerants, and non-halogenated compounds such as xylene, methanol, acetone, isopropanol, toluene, ethyl acetate, and acetonitrile).

- **g.** In addition to persistent and hard biodegradable chemicals, liquid waste may contain non-metabolised pharmaceutical compounds which include antibiotics, anaesthetics, disinfectants (formaldehyde, glutaraldehyde), radioactive elements etc.

- **h.** Organic chemicals: Include disinfecting and cleaning solutions such as phenol-based chemicals; perchlorethylene used in workshops and laundries.

- **i.** Oils such as vacuum-pump oils, used engine oil from vehicles (particularly if there is a vehicle service station on the hospital premises), insecticides and rodenticides.

- **j.** Inorganic chemicals: Consist mainly of acids and alkalis (e.g. sulphuric, hydrochloric, nitric and chromic acids, sodium hydroxide and ammonia solutions) and also include oxidants, such as KMnO₄, (K₂Cr₂O₇), and reducing agents, such as sodium bisulphate (NaHSO₃) and sodium sulphate (Na₂SO₄).
k. Pharmaceuticals: Small quantities of pharmaceuticals are usually discharged to the sewers from hospital pharmacies and from the various wards. These contain antibiotics and genotoxic drugs. Other pharmaceuticals which have been detected in WWTP effluents include lipid regulators, analgesics, antibiotics (cf. above), antidepressants, antiepileptics, antineoplastics, antipyretics, antiphlogistics, antirheumatics, β-blockers, bronchlytics, β₂-sympathomimetics, estrogens, secretolytics, vasodilators and X-ray contrast media.

l. Radioactive wastes and Nuclear medicine: Most of the radioactive waste is liquid, with lesser amount of solid and minimal gaseous. These include technetium-99m (Tc-99m), Iodine-131(I-131), Iodine-125 (I-125), Iodine-123(I-123), Flourine-18(F-18). The maximum limit of total discharge of liquid radioactive material into sanitary sewerage system should not exceed the prescribed limits.

m. Housekeeping/washing activities in all wards: (Mortuaries, OTs, Laboratories) containing phenol and cleaning acids including soaps and detergents.

n. Domestic Sewage: Discharge from Kitchens.

**Box 27.2: Constituents of effluent of hospital wastewater**

A typical characteristics of wastewater generated from a HCF is given in the Box 27.3.

Resalat hospital located in the city of Masal located in Guilan Province, Iran, with 50 beds and generates wastewater about 30 m³ per day. A typical characteristics of wastewater network before discharging in a septic tank is given below.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>pH</th>
<th>BOD5 (mg/l)</th>
<th>COD (mg/l)</th>
<th>TSS (mg/l)</th>
<th>NH₄-N (mg/l)</th>
<th>PO₄³⁻-P (mg/l)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>6.4-8.1</td>
<td>320</td>
<td>790</td>
<td>385</td>
<td>68</td>
<td>18</td>
</tr>
<tr>
<td>SD</td>
<td>78</td>
<td>SD=78</td>
<td>SD=127</td>
<td>SD=48</td>
<td>SD=9</td>
<td>SD=3</td>
</tr>
</tbody>
</table>

Note:

BOD- Biological Oxygen Demand, COD- Chemical Oxygen Demand, TSS-Total Suspended Solids,

NH₄- Ammonium, PO₄ -Phosphate

**Source**: Advances in Life Sciences 2014, 4(3): 178-183 DOI: 10.5923//j.als.20140403.14 a

**Box 27.3: A typical characteristics of wastewater generated from a HCF**

**Think and reflect**

Which kinds of waste water are generated from which source in your health care facility? Based on the data you find in this unit, how much water is generated in average per day?
Various chemical contaminants that may be expected in the hospital wastewater or liquid waste is given in Fig. 27.3.

Fig. 27.3: Expected chemical contaminants in wastewater generated from HCFs

From the Fig. 27.3, it is evident that the composition of health care wastewater includes numerous persistent chemical compounds and complex mixtures of organic matter including pharmaceuticals, radionuclides, detergents, antibiotics, antiseptics, surfactants, solvents, medical drugs, heavy metals, radioactive substances and microorganisms. After usage, some of these compounds and non-metabolised drugs excreted by patients are detected in the wastewater entering the municipal sewage network. For this reason, this composition leads to extensive levels of toxicity, genotoxicity and organic load and, if not disposed properly can causes an adverse impact on the natural ecosystem and inherent hazard to human health. It can also interfere with the municipal wastewater terminal sewage treatment system. According to WHO report, 80% of hospital sludge is composed of biodegradable domestic wastewaters. The remaining fraction includes great amount of unbiodegradable and high toxic risk pollutants.

(Source: International Journal of PharmTech Research, Vol.8, No.4, p 702-708, 2015). The hazards from different wastes in wastewater from health care facilities are presented in Fig. 27.4.

Fig. 27.4: Hazards of wastewater from health care facilities
a. **Microbiological Pathogens**

The principal area of concern is wastewater with a high content of infection causing organisms. The load of infection becomes especially high during outbreaks and epidemics. Improper management, collection, treatment and disposal of wastewater and sludge will result in the pollution of surface water body sources and ground water and stagnant water may serve as breeding sites for vectors. This can cause numerous waterborne and vectorborne diseases (e.g. malaria and filariasis) and soil transmitted helminthic infections (e.g. Roundworms or Ascaris lumbricoides). Disposal of untreated wastewater in the environment, will result in depletion of oxygen in the water bodies. It also has high content of chemicals like nitrate. The infectious organisms especially bacteria are of the resistant strains which do not respond to the conventional antibiotics. Hazards of microbial pathogens are given in Fig. 27.5.

![Diagram of Hazards of Microbial pathogens](image)

**Fig. 27.5 :** Hazards of Microbial pathogens present in wastewater from health care facilities

b. **Hazardous Chemical Waste**

In hospitals, major part of liquid chemical waste comprising anaesthetics, disinfectants, chemicals from laboratory activities, developer and fixer solutions from photographic film processing, and iodinated X-ray contrast media as well as mercury due to breakage of the mercury based medical instruments are intentionally or unintentionally disposed of in the sink. Wastewater from hospitals, may also contain constituents which are known neurotoxins (affecting the nerves of the body). These are environmentally persistent and bio-accumulates in the food chain. Discharge of chemicals such as Glutaraldehyde, Formaldehyde- based disinfectants (formalin) can cause severe water pollution and operational problems within a wastewater treatment plant if discharged into the sewer. Mercury waste might get into wastewater if they are not disposed or stored safely.

c. **Pharmaceutical Waste**

A recently recognised problem is that the antibiotics and cytotoxic drugs which are generally used for treatment of patients in the hospitals are excreted in urine and faeces and end up in the wastewater stream. Therefore, hospital wastewaters are a source of bacteria with acquired resistance against antibiotics with a level of at least a factor of 2 to 10 times higher than in domestic wastewater. Other pharmaceuticals that have been found in wastewater include lipid regulators, analgesics, antidepressants, antiepileptics, antineoplastics, antipyretics, antiphlogistics, antirheumatics, β-blockers, broncholytics, β₂-sympathomimetics, estrogens, secretolytics and vasodilators.

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**Did you know?**

X-ray contrast media contain absorbable organic iodinated compounds (AOX) and little is known about the risk associated with their spread in the environment.

Developing solution may contain formaldehyde, which is a known human carcinogen.
Indiscriminate discharge of these pharmaceuticals may interfere with the end of pipe wastewater treatment plants as well as ecosystems. Therefore, the pharmaceutical waste such as outdated or counterfoil drugs need to be disposed in accordance with the prevailing rules notified under the Environment (Protection) Act, 1986. Hospitals should use the utmost care in the use and handling of cytotoxic drugs as these cytotoxic wastes could induce mutations in the nearby flora and fauna. Disposal options of cytotoxic drugs include return to the original supplier and incineration at high temperature (1200°C).

d. **Radioactive Waste**

Radioactive waste should be categorised on the basis of the available options for treatment, conditioning, storage and disposal. Possible categories are half-life, activity and radionuclide content, physical and chemical form, liquid aqueous and organic, non-homogenous particles (e.g., containing sludge or suspended solids). The fundamental objective of safe disposal of radioactive waste is to ensure that the radiation exposure to public, radiation workers and environment does not exceed the prescribed safe limits. Liquid radioactive waste with activity less than microcurie level can be disposed of into the sanitary sewerage system with adequate flushing with water following the disposal. However, the maximum limit of total discharge of liquid radioactive material into sanitary sewerage system should not exceed the prescribed limits and the gross quantity of radioactive material released into the sewerage system by any hospital should not exceed 37 GBq (1 Curie) in one year. (GBq means Gigabecquerel)

**Check Your Progress 2**

Below are some words related to the constituents of a wastewater which have got jumbled. Try to find the correct words

<table>
<thead>
<tr>
<th>Term</th>
<th>Correct Word</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEAMONMAGIROC</td>
<td>NOAMINERGICO</td>
</tr>
<tr>
<td>LIO</td>
<td>OIL</td>
</tr>
<tr>
<td>TEEENERTO</td>
<td>ONEETERTO</td>
</tr>
<tr>
<td>LETOVOIN</td>
<td>VOLEOTIN</td>
</tr>
<tr>
<td>LAATRES</td>
<td>TLAARES</td>
</tr>
<tr>
<td>RUHETSAFILCAM</td>
<td>RUHETSAFILCAM</td>
</tr>
<tr>
<td>MARECHLIS</td>
<td>SAMECHLIS</td>
</tr>
</tbody>
</table>

**27.4 WASTEWATER MANAGEMENT IN HEALTH CARE FACILITIES**

Waste effluent from hospitals and clinics contain high numbers of resistant bacterial strains and residual antibiotics at a concentration to which susceptible bacterial growth is inhibited. The basic principle underlying effective wastewater management is prescribing limit for discharge of hospital wastewater as stipulated under Schedule-II of the Bio-Medical Waste Management Rules, 2016, apart from efficient water consumption and additional measures for source reduction and segregation of contaminated
wastewater for ensuring further treatment and disposal to comply with the discharge norms.

**27.4.1 Water Conservation and Water Efficiency**

Water efficiency means doing more with less water and reducing wastage or leakage in the system. Water efficiency can also lead to significant savings in money and energy. Running health care facilities requires a water efficient system as health care systems are among a community’s largest consumers of water. Some of the suggested measures for water efficient systems are mentioned in **Box 27.4**.

- a. Water leakages throughout the system including changing of old rusted pipelines.
- b. Recycling of wastewater for cooling towers, toilets and irrigation.
- c. Reduce wastage through regular maintenance of taps, shower heads and replacement with efficient ones (e.g. aerated taps).
- d. Recycling of treated wastewater for washing of toilets, use in toilets and for gardening.
- e. Use of toilets with efficient flush models which consume less water for flushing.
- f. Efficient management of steam sterilisers – use of heat exchanger to utilise heat energy for hot water.

**Box 27.4: Suggestions for water efficient system**

**27.4.2 Source Reduction and Segregation to Reduce Environmental Pollution Load**

Hospital wastewater is a complex matrix and following principles should be kept in mind while managing the water cycle. Source reduction and water use efficiency should be adopted as the first and most important measure as given in **Box 27.5**. Proper planning should be done in this regard at the time of construction of the health care facilities with all the desired amenities to facilitate proper wastewater management during its operation.

- a. Domestic wastewater, liquid chemical waste and the infectious wastewater should be segregated to minimise total wastewater to be treated with a suitable sewer system.
- b. Recycling principle adoption helps the health care facility to minimise water consumption as well as wastewater discharge into the environment.
- c. The process of recycle/reuse is also a form of waste reduction.
- d. Recycling and reuse of wastewater is possible only after adequate treatment and meeting norms for recycle or reuse.

**Box 27.5: Suggested steps for source reduction and segregation**
27.4.3 Source Separation

Webb et al. (2003), suggests source separation of urine of patients which have undergone X-ray imaging. Such urine containing ICMs, can be processed as chemical waste. Similarly, urine source separation could be applied to the urine of pregnant women in the hospital maternity department. The WWTP involved in the treatment of pregnancy urine would have a small footprint with higher efficiencies and lower costs.

27.5 HOSPITAL WASTEWATER TREATMENT OPTIONS

There are a number of treatment options available for the hospital wastewater. Let us look at some of the options in the following sub-sections.

27.5.1 Compliance Requirements of Wastewater Generated from Health Care Facilities

Considering the hazards of liquid wastes generated from the HCFs, such liquid waste must be adequately treated to comply with the discharge norms prior to its disposal. The degree of treatment and level of treatment of liquid waste depends on the quality of treated water for discharge into the environment. The wastewater being discharged from the health care facility and operator of a CBMWTF should comply with effluent concentration limits as prescribed under Schedule-II of the Bio-Medical Waste Management Rules, 2016 and further amendments before discharge into the sewer is given in Table 27.1.

Table 27.1: Wastewater effluent discharge standards prescribed under Schedule-II of the BMWM Rules, 2016 and further amendments made thereof

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Permissible Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td></td>
<td>6.5-9</td>
</tr>
<tr>
<td>Biochemical Oxygen Demand (BOD)</td>
<td>mg/l</td>
<td>30</td>
</tr>
<tr>
<td>Chemical Oxygen Demand (COD)</td>
<td>mg/l</td>
<td>250</td>
</tr>
<tr>
<td>Suspended Solids (TSS)</td>
<td>mg/l</td>
<td>100</td>
</tr>
<tr>
<td>Oil and Grease</td>
<td>mg/l</td>
<td>10</td>
</tr>
<tr>
<td>Bio-assay Test</td>
<td>% survival of fish after 96 hours in 100% effluent</td>
<td>90%</td>
</tr>
</tbody>
</table>


Note:

1. Above limits are applicable to the occupiers of Health Care Facilities (bedded) which are either connected with sewerage network without terminal sewage treatment plant or not connected to public sewers.
2. For discharge into public sewers with terminal facilities, the general standards as notified under the Environment (Protection) Act, 1986 (29 of 1986) shall be applicable.

3. Health Care Facilities having less than ten beds shall have to install Sewage Treatment Plant (STP) by the 31st December, 2019.

4. Non-bedded Occupiers shall dispose infectious liquid wastes only after treatment by disinfection as per Schedule-II (6) of the principal rules.

27.5.2 Pre-treatment of Liquid Chemical Waste of Health Care Facilities

Wastewater streams especially from hospitals such as laboratory chemical liquid waste and chemical laden wastewater generated from laundry should not be discharged directly into the drain or wastewater treatment plants as it interferes with the treatment system and such wastewater is required to be segregated, collected or channelised separately and pre-treatment is recommended for such chemical liquid waste. Pre-treatment of chemical liquid waste depends on the nature and type of chemical waste and in general is required to be neutralised using either acid or base as the case may be and then discharged into the domestic wastewater stream for further treatment and safe disposal. A Typical flow diagram of neutralisation or pre-treatment of chemical liquid wastewater generated from health care facility is given in Fig. 27.6.

Fig. 27.6: Neutralisation or pre-treatment of Chemical Liquid Waste

27.5.3 Silver Recovery from Fixer or Hypo-Solution from X-Ray Processing

Silver is a valuable natural resource present in photo-processing waste generated from Health Care Facilities. In photo-processing, silver compounds are the basic light-sensitive material used in the photographic films and papers. During processing, particularly in the fixing bath or bleach-fix, silver is removed from the film or paper and is carried out in the solution, usually in the form of a silver thiosulphate complex. As much as 80 per cent of the total silver processed for black and white positives and almost 100 per cent of the silver processed in colour work will end up in the fixer solution. Silver is also present in the rinse water following the fixer or bleach-fix due to carry-over. Presently, most of the hospitals have adopted using digital X-ray processing and the generation of fixer or hypo-solution is obsolete.
However, few health care facilities adopt manual X-ray processing method where fixer or hypo-solution is generated commonly.

Several silver recovery technologies exists from X-ray solution and the most common methods of silver recovery from the fixer and bleach-fix processing solutions involve metallic replacement, electrolytic recovery and chemical precipitation. Ion exchange and reverse osmosis are other methods that can be used alone or in combination with conventional silver recovery systems. However, these are generally considered suitable only for dilute solutions of silver. Source: http://infohouse.p2ric.org/ref/01/00048.htm

Bio-Medical Waste Management Rules, 2016 stipulates that the X-ray solution or hypo-solution is required to be disposed of only through the recyclers registered under the Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016. At present, there are few registered recyclers involved in silver recovery from hypo-solution. For list of such registered recyclers, you may please refer to CPCB website (i.e., www.cpcb.nic.in) or State Pollution Control Boards (SPCBs) /Pollution Control Committees (PCCs) websites.

Check Your Progress 3

Complete the crossword

Across

4. The wastewater should be adequately treated so as to have the set standards before discharge

Down

1. One of the ways of this method is source separation of the urine of patients who have undergone X-ray imaging containing ICMs
2. Judicious or beneficial reduction in the water loss
3. Water used once is reused for washing toilets or gardening
5. Neutralising the wastewater with acids or bases before discharge
6. Accomplishing more with less water and reducing water wastage
27.5.4 **Liquid Waste Treatment Options: On-site/ Terminal Wastewater Treatment Plants**

Wastewater generated from health care facilities is required to be provided with a separate drainage conveyance pipes for collection of domestic sewage (Kitchen) and the wastewater contaminated with pathogens from laboratories, operation theatres and other patient treatment and discharge areas. Segregation of domestic sewage and contaminated wastewater from health care activities helps in reduction of cost of treatment. Since the treatment of wastewater is not identical for domestic sewage and contaminated wastewater. Following Fig. 27.7(a) and Fig. 27.7(b) shows segregation of wastewater and schematic diagram of wastewater treatment generated from health care facilities and other sources.

![Diagram of wastewater treatment](image)

**Fig. 27.7**: (a) Segregation of wastewater and schematic diagram of wastewater treatment for health care facilities

**Fig. 27.7**: (b) Exemplary wastewater treatment strategy of a hospital

(Source: WB, Vietnam Hospital Waste Management Support Projectoperational Manual E, 2591)

Various wastewater treatment options for health care facilities are given in Box 27.6.

i. On-site wastewater treatment followed by reuse or recycle or discharge into the drain complying to the discharge norms as prescribed under Schedule-II of the BMWM Rules, 2016, as amended and further amendments made thereof;

### Think and reflect

Of the three options suggested for the treatment of wastewater, which of the option is being followed in your institution? Do you think it is the right option?
ii. Discharging of wastewater generated from a health care facility into the municipal sewerage system for further treatment through municipal wastewater treatment plant; and

iii. Combination of on-site as well as municipal sewage-treatment plant prior to final discharge.

Box 27.6: Options for wastewater treatment in health care facilities

Discharge of wastewater into municipal sewage treatment plants-
In countries that do not experience epidemics of enteric disease and that are not endemic for intestinal helminthiasis, it is acceptable to discharge the sewage of health care establishments to municipal sewers without pre-treatment, provided that the requirements enumerated in Box 27.7 are met.

| a. the municipal sewers are connected to efficiently operated sewage treatment plants that ensure at least 95% removal of bacteria; |
| b. the sludge resulting from sewage treatment is subjected to anaerobic digestion, leaving no more than one helminth egg per liter in the digested sludge; |
| c. the waste management system of the health care establishment maintains high standards, ensuring the absence of significant quantities of toxic chemicals, pharmaceuticals, radionuclides, cytotoxic drugs, and antibiotics in the discharged sewage; |
| d. excreta from patients being treated with cytotoxic drugs may be collected separately and adequately treated (as for other cytotoxic waste). |

Box 27.7: Conditions to be met before discharge of sewage of health care establishments to municipal sewers without pre-treatment. This is applicable in countries that do not experience epidemics of enteric disease and that are not endemic for intestinal helminthiasis

All the health care facilities irrespective of the size, quantity of wastewater generation and type of treatment system are required to take adequate steps for treatment of wastewater generated from the health care facilities and should comply with the effluent discharge standards prescribed under Schedule-II of the Bio-Medical Waste Management Rules, 2016 and further amendments made thereof.

Larger health care facilities, particularly those that are not connected to any terminal municipal wastewater treatment plant, should operate their own wastewater-treatment plant. This could include physical, chemical and biological processes to remove contaminants from the wastewater generated from the HCFs.

Various advantages and disadvantages of wastewater treatment are given in Table 27.2.
Table 27.2: Advantages and disadvantages of treatment and disposal of hospital wastewater

<table>
<thead>
<tr>
<th>Hospital Wastewater Treatment and Disposal Option</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Discharge</td>
<td>No investment, maintenance costs and process control</td>
<td>A Major danger of pollution in the environment due to harmful bacteria and virus. Serious threat to aquatic life and contamination of aquatic bodies. In case of epidemic, complete chlorination of wastewater required which can further harm environment.</td>
</tr>
<tr>
<td>Co-treatment in Municipal Terminal Wastewater Treatment Plant</td>
<td>No direct discharge in the environment</td>
<td>Stormwater creates dilution. Toxic substances may severely harm or hamper the biological wastewater treatment process.</td>
</tr>
<tr>
<td>On-site Wastewater Treatment Plant</td>
<td>90% reduction in pollution load</td>
<td>Additional cost of investment and maintenance to the HCFs. Very strict monitoring and process control necessary by the plant operators and regulatory authorities.</td>
</tr>
<tr>
<td>Onsite + Municipal Terminal WWTP</td>
<td>Double treatment and maximal safety</td>
<td>Expensive and complex.</td>
</tr>
</tbody>
</table>


Hospitals, which are situated in peripheral areas, are not connected to the centralised city sewerage system, if available. Instead of being treated adequately, the wastewater is often discharged directly into a nearby river or open drain. As a result, the specific requirements on compliance to the wastewater discharge norms prescribed under the BMWM Rules, 2016 and further amendments made thereof is not complied or discharge norms prescribed in the country. Many hospitals, in particular those that are not connected to any municipal treatment plant, have to have their own sewage treatment plants.

In cases where HCFs are connected with the terminal municipal sewage treatment plants, the HCFs are required to take adequate measures to comply with the general discharge norms prescribed under Schedule-VI of the Environment (Protection) Act, 1986.

The most efficient unit operations for treatment of wastewater generated from health care facilities should include primary, secondary and tertiary treatment units are deposited below. Unit operations suggested are
only indicative. However, adequate treatment unit operations need to be adopted depending upon the characteristics of wastewater generated by a health care facilities on case-to-case basis.

i. **Primary Treatment**

The purpose of primary treatment is to remove solid material, oil & grease, sand, grit and coarse material present in the wastewater. Large debris may be removed by screens, whereas inorganic solids can be removed by the grit channels. Oil and Grease may be removed by the O & G Trap system, by adopting physical separation techniques. The settled solid called primary sludge or primary effluent contains about 60-70% of solids. Partly treated wastewater is then subjected to next treatment. Examples of processes in this category are given below (Fig. 27.8).

a. Screens, O & G Traps, Grit Chambers

b. Septic Tanks or Imhoff Tanks

c. Sedimentation Tanks

![O & G Trap](image1)

![Settling or Sedimentation Tanks](image2)

**Fig. 27.8 (a): Examples of primary wastewater treatment processes**

![Septic tank](image3)

**Fig. 27.8 (b): Septic tank, commonly found in developing countries**
i. **Secondary Treatment**

Secondary treatment is a treatment process for wastewater (or sewage) to achieve a certain degree of effluent quality by using a sewage treatment plant with physical phase separation to remove settleable solids and a biological process to remove dissolved and suspended organic compounds.

Examples of processes in this category are listed in **Box 27.8**.

| a. Activated Sludge Process  |
| b. Trickling Filters         |
| c. Rotating Biological Contractors |
| d. Fluidised Aerated Bed (FAB) Reactor |
| e. Sequential Batch Reactors (SBR) |
| f. Membrane Bio-Reactors (MBR) |
| g. Moving Bed Bio-Reactors (MBBR) |
| h. Stabilisation Ponds       |
| i. Aerobic Lagoons           |
| j. Constructed Wetlands      |

**Box 27.8: Processes of biological treatment processes**

Secondary biological purification (Fig. 27.9)-Most helminths will settle in the sludge resulting from secondary purification, together with 90–95% of bacteria and a significant percentage of viruses; the secondary effluent will thus be almost free of helminths, but will still include infective concentrations of bacteria and viruses.

![Figure 27.9: Process of secondary wastewater treatment](image)

**ii. Tertiary Treatment**

Tertiary treatment, also called “effluent polishing”, is the final step in a wastewater-treatment process before the effluent is discharged to the receiving environment. More than one tertiary treatment process can be used. Most often tertiary treatment involves further removal of suspended solids or removal of the nutrients as well as the disinfection. (Fig 27.10) Examples of tertiary treatment processes are enumerated in **Box 27.19**.
1. Membrane Filtration
   a. Micro-filtration membrane
   b. Ultra-filtration membrane
   c. Nano-filtration membrane
   d. Reverse Osmosis
2. Chlorination
3. Ozonation
4. UV treatment

Box 27.9: Examples of tertiary processes

Fig. 27.10: Tertiary wastewater treatment process

Check Your Progress 4

1. Fill in the blanks
   a. Large debris may be removed by ____________, whereas inorganic solids can be removed by the ____________. The settled solid is called as ____________.
   b. Secondary treatment is a biological treatment process removes ____________ present in soluble and colloidal form from the wastewater.
   c. Wastewater flows into secondary clarifier, where solids settle down by gravity which is called as ____________.
   d. the secondary effluent is almost free of ____________, but will still include infective concentrations of ____________ and ____________.
   e. Tertiary treatment is also called ____________

2. Give some examples of processes in primary category include.
3. Give some examples of tertiary treatment processes.
Chlorine disinfection

To achieve pathogen concentrations comparable to those found in natural waters, the tertiary effluent is subjected to chlorine disinfection to the breakpoint (Fig. 27.11). Disinfection of the effluents is particularly important if they are discharged into coastal waters close to shellfish habitats, especially if local people are in the habit of eating raw shellfish.

![Chlorine disinfection diagram](image)

**Fig. 27.11: Process of Chlorine disinfection**

**Sludge treatment:** The sludge from the sewage treatment plant requires anaerobic digestion to ensure thermal elimination of most pathogens. Alternatively, it may be dried in natural drying beds (pre-condition: sufficient space) and then incinerated together with solid infectious health care waste (Fig. 27.12a and b).

![Sludge treatment and anaerobic sludge digester](image)

**Fig. 27.12:** (a) Sludge treatment and (b) anaerobic sludge digester

### 27.5.5 Expected Problems of Wastewater Treatment Plants

Based on an informal survey of STPs (including Water Treatment plants) carried out over the last 4 years by Arghyam NGO, the most common problems encountered are enumerated below.

(Source: www.indiawaterportal.org)

1. **Initiation of a STP failing to treat sewage:** An STP is normally designed for the total sewage that can be expected when a building or premises is fully occupied. Full occupation in most cases usually takes up to a year or more. During this period when occupancy can be as low as 30% or so and gradually increases over a year or more, consequently the sewage that comes in initially does not provide the minimum load needed for satisfactory operation of an STP. It results in a situation...
which can only be called “sewage-in-sewage-out”. Many STPs which face this situation take a long time to stabilise.

2. **Poor design/under-design of the STP**: Often STPs which initially ‘struggle’ to overcome the first problem described above also cannot function because
   a. the balancing tank is undersized
   b. aeration tank is undersized or clarifier is badly designed
   c. the total inflow of sewage is higher than the volume the STP was designed to handle.

   The tanks mentioned in a) & b) above are part of the primary and secondary treatment portions of an ASP system.

3. **Consistent mal-operation of the STP**: Another very common feature is that a majority of plant operating personnel employed by agencies that take on Operation & Maintenance (O&M) contracts are illiterate, untrained and supervised by people with little or no knowledge of what O&M involves. Such agencies generally charge O&M charges that residents’ associations consider affordable. Companies with well-trained operation personnel and experienced supervisory staff charge for services an amount that reflect their skill and expertise which residents’ Associations are reluctant to pay and thereby lose out on a well-run/operated water infrastructure. They often do not realise that even the charges which they consider as cheaper/lower are going to waste if the sewage is only partially treated.

4. **Strong smell/odour from the STP**: This is a very common complaint from numerous housing communities and even commercial buildings which have an STP in operation. The smell is often very strong and quite often unbearable. It is caused by any one or all of the problems listed above.

5. **Very high noise levels from the STP**: High noise levels from an STP are due to the operation of electric motor driven equipment such as pumps, air blowers, air compressors, etc. may cause in convenience to the public living nearby. The old designs are also the cause of high energy consumption in addition to very high noise levels. As per the law, the noise level permitted in a residential area is 55 dB (dB= decibels of sound) during day time, i.e. from 6:00 am to 10:00 pm and 45 dB during night time (10:00 pm to 6:00 am). As compared to these limits, the actual noise levels are likely to be as high as 75 dB or higher.

a. **Methods to avoid or resolve common problems in STPs**

Various methods to resolve common problems in STPs include the following as mentioned in **Box 27.10**.

<table>
<thead>
<tr>
<th>Methods to avoid or resolve common problems in STPs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>a. Modern designs</strong> for STPs having expertise in the field of wastewater treatment. Such an installation would be able to handle the initial lower load of sewage with one module in operation with remaining modules being commissioned as the sewage volume increases. In short, there is a stand-by always available. Choosing Modular STPs and using microbial agents regularly helps alleviate many problems.</td>
</tr>
</tbody>
</table>
b. **Effective consumption of water:** It is equally important to know and be able to control the volume of fresh water used in the hospital so that it does not exceed the design capacity of an STP. This involves installing water meters at all crucial points to measure water flow (consumption) and thereafter taking action to curb excess consumption of fresh water to prevent overloading the STP.

c. **Proper operation and maintenance:** To avoid poorly operating or malfunctioning of an STP leading to untreated sewage and unpleasant odours from it, an operator should be chosen well trained professional and having knowledge on proper operation and maintenance of the STP.

d. **Prevention of shock loads:** One of the major reasons for STPs not working properly is the fluctuations in input loads. Flow of sewage in a hospital may not be uniform. It varies with peak flows in the morning (most patients and attendants using the washrooms), very low or almost no flows later in the day with another peak in the evening. Raw sewage should be collected in a sewage balancing tank to ensure uniform flow. The balancing tank should be sized to hold at least 6 to 8 hours flow of sewage. This ensures that the sewage collected in the balancing tank is homogenised, thereby avoiding input fluctuations in input load on the STP. Do not compromise on the size of a raw sewage balancing tank.

e. **Control of noise levels and energy consumption:** To reduce noise levels and high energy consumption, it is necessary to replace most of the critical rotary motor driven equipment with the latest noiseless high efficiency equipment.

**Box 27.10: Resolutions for common problems in STP**

**Check Your Progress 5**

Match the following methods with the problems they can solve.

<table>
<thead>
<tr>
<th>Method</th>
<th>Problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Effective consumption of water</td>
<td>a. handle the initial lower load of sewage with one module in operation with remaining modules being commissioned as the sewage volume increases</td>
</tr>
<tr>
<td>2. Modern designs</td>
<td>b. the balancing tank should be sized to hold at least 6 to 8 hours flow of sewage</td>
</tr>
<tr>
<td>3. Proper operation and maintenance</td>
<td>c. involves installing water meters at all crucial points to measure water flow (consumption)</td>
</tr>
</tbody>
</table>
27.5.6 Liquid Waste Management by the Non-bedded Health Care Facilities

Any liquid waste generated from non-bedded health care facilities is required to be treated by disinfection using 1 to 2% sodium hypochlorite solution before discharge into drain. A Typical flow diagram of liquid waste treatment by non-bedded health care facilities is given in Fig. 27.13.

Fig. 27.13: Liquid Waste Management by the Non-Bedded Health Care Facilities

27.6 TREATED WASTEWATER FOR FINAL DISPOSAL OPTIONS

Treated wastewater can be recycled/reused as a source of water for a multitude of water demanding activities such as agriculture, aquifer recharge, aquaculture, firefighting, flushing of toilets, snow melting, industrial cooling, parks and golf course watering, formation of wetlands for wildlife habitats, recreational impoundments, and essentially for several other non-potable requirements. Potential reuses of wastewater depend on the hydraulic and biochemical characteristics of wastewater, which determine the methods and degree of treatment required. While agricultural irrigation reuses, in general, require lower quality levels of treatment, domestic reuse options (direct or indirect potable and non-potable) reuses need the highest treatment level. Level of treatment for other reuse options lie between these two extremes.

27.7 CASE STUDY

Following case study would make you to understand the wastewater treatment systems required for the health care facilities.
Case Study 1. Aspirus Wausau Hospital, Wausau, Wisconsin, USA

Aspirus Wausau Hospital is a 665,000 square-feet, 321-bed regional general medical and surgical hospital serving North Central Wisconsin and the Upper Peninsula of Michigan. It specialises in cardiovascular care and is recognised for providing distinguished treatment for cancer, trauma, women’s health, and spine and neurological health.

The newly constructed, Leadership in Energy and Environmental Design® (LEED) Gold, 9,200 square-feet Aspirus Women’s Health Birthing Center/Newborn ICU which, opened in August 2009 incorporates many environmental features that enhance the care of newborns. In the new construction, the hospital focused on strategies and technologies intended to significantly limit water usage. The benefits of the project have been summarised in Box 27.11.

Details of the new project included the following:

a. New construction was completely financed by the hospital’s annual construction budget.

b. The unit is metered separately from the rest of the hospital.

c. The hospital installed low-flow toilets, which discharge a third of a gallon less water per flush than their conventional counterparts.

d. Low-flow kitchen sinks, which flow at a rate of 0.9 gallons of water per minute less than traditional sinks, were installed.

e. Low-flow showers were incorporated.

f. Energy efficient star-rated equipment was chosen for 90 per cent of appliances.

Benefits

a. The hospital’s total water sewage is expected to be reduced from 265,000 gallons to 185,000 gallons annually.

b. The annual water sewage waste is expected to be lowered to levels 30 per cent below code.

Box 27.11: Benefits of the new project

So it is always best to invest early in a project and have a green outlook. This leads to significant savings and a much lower carbon footprint in the long run.

27.8 LET US SUM UP

In this unit you have learnt about the hazards of wastewater generated in the health care facility and the different ways to minimise these hazards. The guidelines for liquid wastewater management as per number of beds in health care facility is explained through Fig. 27.14.

A summary of the sections covered in this unit is presented in Fig. 27.15 for you to be able to recall, the important concepts. Through the case study presented in the unit you have learnt about the establishment and running of ETPs and their benefits to the health care facility and the community at large.
Fig. 27.14: Liquid wastewater management as per number of bed in health care facilities

As per BMWM Rules, 2016, as amended and further amendments made thereof, the health care facilities are required to take adequate measures for compliance to the liquid waste discharge norms.

Fig. 27.15: Mind map

27.9 GLOSSARY

**Biological Oxygen Demand**: The amount of oxygen required by aerobic microorganisms to decompose the organic matter in a sample of water, such as that polluted by sewage. It is used as a measure of the degree of water pollution.
Chemical Oxygen Demand: The amount of oxygen needed to oxidise reactive chemicals in a water system, typically determined by a standardised test procedure. The chemical oxygen demand (COD) test is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water (e.g., lakes and rivers), making COD a useful measure of water quality.

Multidrug Resistant Bacteria: Multidrug resistant strains of microorganisms are bacteria that develop resistant to most of the available antibiotics in the wastewater.

Sewage Treatment: Sewage treatment is the process that removes the majority of the contaminants from wastewater and produces a liquid effluent suitable for disposal to the natural environment and also produces a sludge.

27.10 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1
Theatre Laboratory Radiology Haemodialysis ward ICU Dental Laundry Kitchen bathroom

Check Your Progress 2
Microorganism, oil, detergent, solvent, metals, pharmaceuticals, chemicals

Check Your Progress 3
Across
4. compliance

Down
1. segregation
2. conservation
3. recycling
5. pre-treatment
6. efficiency
1. a. Screens, primary sludge or primary effluent
   b. dissolved inorganic materials
   c. secondary sludge
   d. helminths, bacteria and viruses.
   e. effluent polishing
2. Examples of processes in primary category include –
   — Screens, O & G Traps, Grit Chambers
   — Septic Tanks, Imhoff Tanks
   — Sedimentation Tanks

3. Examples of tertiary treatment processes include
   a. Membrane Filtration
      i. Micro-filtration membrane
      ii. Ultra-filtration membrane
      iii. Nano-filtration membrane
      iv. Reverse Osmosis
   b. Chlorination
   c. Ozonation

Check Your Progress 5
Ans 1. c 2. a 3. d 4 e. 5. b

27.11 REFERENCES FURTHER READINGS
6. WHO (2014), Safe management of waste from health care activities.
28.0 OBJECTIVES

After studying this unit, you should be able to:

- discuss the concept of occupational safety
- describe occupational risks to health care workers
- discuss the preventive measures
- define Hierarchy of Controls
- enumerate the minimum approaches to health and safety practices

28.1 INTRODUCTION

You have already read about the impact of chemical and infectious health care waste in the Units 9 and 10, Block 3, BHM-101. Since the health care personnel are the ones working in maximum proximity to the waste, they are more prone to the impact. However, the occupational safety of health care personnel of all cadres of including workers — handling the waste is often overlooked. The purpose of this unit is to explain the hazards and the infection that they may encounter as well as the prevention and control measures. Bio-Medical Waste (BMW) Management Rules, 2016 of India, as amended include policies or plans incorporating arrangement for continuous monitoring of workers’ health and safety. This is to ensure that correct handling, treatment, storage and disposal procedures are followed. Occupational health and safety measures should be included in all procedures performed on patients from generation of BMW till its final disposal.

You must read the Unit 18, Block-1, BHM-102, on infection prevention and control, before you proceed reading this unit, since many of the concepts discussed here have been also elaborated there.

In this unit you shall learn about the various risks. The various risks that a health care worker is exposed to have been enumerated. In case you have also opted for the BIIME-102, you shall learn in detail about each type of risk that a worker could be exposed to in different situations. In this unit, you will learn in detail the different methods of preventing the risk or the exposure to various hazards. We are sure that with this knowledge you shall be able to prevent or minimise the risks.

28.2 CONCEPT OF OCCUPATIONAL SAFETY

Occupational safety of the employees is of importance, not only for their own health, but also for the patient’s safety.

As per the Indian rules, the occupational safety has to be ensured in the different ways mentioned in Box 28.1.

- a. Ensuring that the staff involved in the handling of BMW are immunised at least against Hepatitis B and Tetanus
- b. Providing adequate and appropriate PPE to the staff involved in handling health care waste
c. Conducting health check-up of all employees at the time of induction and also at least once a year

d. Taking remedial steps in accordance to the accident occurred, leading to any harm to the employee, during the handling of the health care waste.

Box 28.1: Components of occupational safety to be ensured by the occupier as per BMWM Rules, 2016, as amended

In order to achieve the above objectives, it is required that the strategies are in place Box 28.2.

a. A standardised set of management rules and operating procedures for health care waste

Standardised and written health care waste management procedures, should be in place, respected by all the personnel working in the health care institutions and monitored by the hospital management. This can dramatically reduce the risk of accidents. Hospital staff should be taught and kept informed about the health care waste management system and procedures that are in place.

b. Waste workers are adequately trained so that they perform their duties properly and safely

Training in health care safety should be in place, to ensure that workers understand the potential risks associated with health care waste. They must also be made aware about the rules and procedures they are required to abide by, for safe management of health care waste. They should also realise the importance of proper hand hygiene and PPE.

c. Waste workers should be involved in the identification of hazards and strategies for its prevention and control.

It is equally important to have medical surveillance and post exposure prophylaxis for those exposed to injuries. Health care personnel should be trained for emergency response, if injured by a waste item and the necessary equipment for managing the emergency should be readily available at all times. Written procedures for the different types of emergencies should be drawn up. For dangerous spills of hazardous chemicals or highly infectious materials, the clean-up operation should be carried out by designated personnel specially trained for the purpose. To limit the risks, the hospital management must set up management rules and operating procedures for health care waste and establish standardised emergency procedures. It is the responsibility of everybody involved in handling waste to know the emergency procedures and to act accordingly. One person should be designated as responsible for handling of the emergencies, including coordination of actions, reporting to managers and regulators, and liaising with emergency services. A deputy should be appointed to act in case of absence of nodal person.

Box 28.2: Strategies for ensuring occupational safety
1. The responsibility of the occupier to ensure worker safety consists of the following components. However, the names of these components have got jumbled up. Can you guess the components?

NIISIATUUMON
LAEOSNP-TIOEPTV-TEC-TIRQUSLEA
LEAHU-PUCHEX
CADBNTI-PERNOIAT

2. What are the strategies for adopting occupational safety?

28.3 TYPES OF RISKS TO HEALTH CARE WORKERS

Cadres of Workers at risk of acquiring infection and injury include health care providers, hospital cleaners, maintenance workers, operators of waste-treatment equipment, and all personnel involved in waste handling and disposal within as well as outside health care facilities. In fact anyone working in the health care environment is at risk of one or more hazards.

Types of health risks to health care waste workers include exposure to infectious biological agents, chemical exposures such as chemotherapeutic drugs, disinfectants and sterilants; physical risks such as ionising radiation; and ergonomic hazards such as manual lifting and transporting of heavy waste loads. (Table 28.1).

<table>
<thead>
<tr>
<th>Risk Factor</th>
<th>Impact of Risk</th>
<th>Prevention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sharps injuries and resulting exposure to bloodborne pathogens</td>
<td>Infections with hepatitis B or C, HIV, malaria or other bloodborne infections</td>
<td>Immunisation against hepatitis B virus (WHO, 2009a). Appropriate disposal of sharps at site of use into a puncture-resistant container without recapping. Use of engineered needles which automatically retract, blunt, resheath, or disable the sharp</td>
</tr>
<tr>
<td>Other biological hazards</td>
<td>SARS, Tuberculosis, Influenza</td>
<td>Exhaust ventilation (natural or respiratory protection with N95, respirators for high-risk cough-inducing procedures.</td>
</tr>
<tr>
<td>Chemicals, Chlorine disinfectants (e.g. sodium hypochlorite)</td>
<td>Skin and respiratory sensitisation. Eye and skin irritation, weakness, exhaustion, drowsiness, dizziness, numbness and nausea</td>
<td>Substitute with soap and water. Dilute chemicals appropriately according to manufacturer for less toxic exposure.</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>High-level disinfectants (e.g. glutaraldehyde)</td>
<td>Irritation of the eyes, nose and throat, skin sensitisation. Occupational asthma where the symptoms in affected individuals include chest tightness and difficulty in breathing</td>
<td>Substitution by steam sterilisation except for pressure sensitive instruments. Ensure appropriate dilution and use in closed, ventilated system</td>
</tr>
<tr>
<td>Sterilants: ethylene oxide</td>
<td>Eye and skin irritation, difficulty breathing, nausea, vomiting, and neurological problems such as headache and dizziness. Reproductive hazard, linked to nerve and genetic damage, spontaneous abortion and muscle weakness. Carcinogen</td>
<td>Substitution by steam sterilisation for ethylene oxide except for pressure-sensitive instruments. Use only in a closed and ventilated system</td>
</tr>
<tr>
<td>Heavy lifting Handling heavy loads over long periods Back injuries and musculoskeletal disorders</td>
<td>Degenerative diseases of the lumbar spine</td>
<td>Reduce mass of objects or number of loads carried per day. Use waste carts with wheels, automated waste transfer from cart to truck and treatment. Use lifts and pulleys to assist in transferring loads</td>
</tr>
<tr>
<td>Ionising radiation</td>
<td>Irreversible damage of cells, anaemia, leukaemia, lung cancer from inhalation</td>
<td>Safe waste management, in full compliance with all relevant regulations, must be considered and planned for at the early stages of any projects involving radioactive materials. It should be established from the outset that the waste can be properly handled, treated and ultimately disposed of. (See International Atomic Energy Agency for national regulatory standards and safety guidance).</td>
</tr>
</tbody>
</table>

You will learn more about the various risks, their effects and preventive measures and management in the optional BHME-101 on worker safety and patient safety.
28.4 PREVENTING THE RISKS

Let us now read one by one what are the different measures to be adopted to minimise the risk to the health care worker and other staff.

![Fig. 28.1: Preventing risks to health care workers](http://www.who.int/occupational_health/activities/1am_hcw.pdf)

### 28.4.1 Immunisation of the Health Care Workers

Health care waste handlers are at greatest risk from infectious hazards, especially from sharps that are not disposed of into puncture-resistant containers. The risk of acquiring a secondary infection following injury from a contaminated sharp depends on the amount of the contamination and nature of the infection from the source patient. The risk of infection following a needlestick injury with needle from an infected source patient is ~0.3% for HIV, 3% for hepatitis C and 6–30% for hepatitis B.

The hospital is also required to maintain immunisation records of all staff with dates of immunisation and due date of first dose, second dose and the booster dose.

### 28.4.2 Identification and Management of Health Care Waste

You have read in the previous sections that health care waste poses a risk to the worker and staff. In order to remove the risk we must follow the proper guidelines for management and disposal of waste. Although you have already read about the guidelines, we shall quickly recap them here.

**Steps for safe management of the health care waste is explained in box 28.3.**

- **Minimisation of waste**
  - When less waste is generated, the risk from the waste also reduces.

- **Segregation**
  - Should be done at the site of generation of waste, so that the risk of infection while transferring the waste is avoided
  - Segregation reduces the amount of risk wastes

---

Did you know?

As per the Bio-Medical Waste Management Rules, 2016 as amended, it is essential that all health care workers are immunised against the communicable diseases especially tetanus and Hepatitis B. The organisation head or the occupier must ensure that the evaluation of the immunisation status is included in the annual health checkup.
iii. The waste should be disposed of in the correct colour coded containers
iv. In case of error, it should not be corrected, and waste should be treated as the higher risk category

c. **Collection of waste**
   i. Should be done following all the universal precautions like hand washing, wearing PPE, etc
   ii. Collected in the correct colour coded container,
   iii. Secured by tying the bag before transportation,
   iv. Filling the bags only up to ¾ full, and then replacing them
   v. Fixed schedules and timely collection so that the microorganisms will not increase

d. **Pre-treatment**

This is essential for some waste classes to prevent the increase in risk to the health workers. Infectious waste like the laboratory and microbiological waste is required to be pre treated before it can be sent for further treatment.

e. **Storage**

The waste collected from various locations are stored in a safe and secure storage site which is far from the patient area and the visitor area.

f. **Transportation**
   i. Tie the bags
   ii. Put bar code and label the waste
   iii. Carry the colour coded waste in the trolley of the same colour
   iv. Proper body mechanics should be maintained so that the risk to the person transporting the waste is minimal.

g. **Treatment**

All health care facilities having a central bio-medical treatment facility within 75 km of their premises, are required to send their waste to the central treatment facility. Those health care facilities not having the central treatment facility within 75 km, will have to treat and dispose the waste in their own facility
   i. All the equipments must be operating as per recommended operating norms.
   ii. Safety precautions should be adhered to.

h. **Disposal**

It is important to dispose of the waste in a safe and secure manner, so that there is no leachate which can be harmful to health.

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**Box 28.3: Steps for safe management of health care waste**

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**Occupational Safety for Health Care Workers**

**Question**
Do you remember the four colour coded bins?
I am sure you do!

**Answer**
The four colour coded bins are yellow, red, white and blue.

**Think and reflect**
Do you remember the precautions to be followed for storing waste? Does your facility have a central storage facility? Do they follow the precautions that are required as per the BMWM Rules, 2016? If not, what are the other precautions that need to be followed?

**Question**
How does the bar code help?

**Answer**
Bar code helps to track the waste. This helps to fix accountability and also check pilferage of the disposables from the waste.

**Think and reflect**
In case you have got a chance to visit a central treatment facility, did you analyse if the norms were being followed for all the treatment technologies. Would you like to give any suggestion?
28.4.3 Personal Hygiene

The measures as mentioned in Box 28.4 must be kept in mind for personal hygiene.

a. Convenient washing facilities (with warm water and soap) should be available to all, including cleaning staff and waste workers.

b. Appropriate PPE should be available and used to reduce exposures.

c. Cuts/abrasions should be covered with waterproof dressing to help reduce exposure of the affected area.

d. Personnel should be trained in personal hygiene issues that reduce the risks from handling hazardous waste.

Box 28.4: Measures for personal hygiene

All workers and staff must wash hands for all the occasions mentioned in the Box 28.5.

a. Immediately after arriving for work

b. Always after handling health care waste

c. After removing gloves and/or coveralls

d. After using the toilet or before eating

e. After cleaning up a spill

f. Before leaving work

Box 28.5: Moments of hand washing for a health care workers

The details of how and why to wash hands has been adequately covered in the Unit 18, Block 1, BHM-102.

28.4.4 Personal Protective Equipment (PPE)

You have already read in details about the use of PPE in the Unit 18. You must have understood how important it is to wear the proper PPE to protect yourself from getting infected. The PPE includes gloves, face mask, cap, gown, apron, shoe covers, or heavy duty gloves. All personnel generating waste also need protection and not just the people who are collecting, transporting, storing or treating the waste.

Not all the PPE is worn in all situations. The type of protective clothing used will depend on the extent upon the risk associated with the health care waste.

1. Heavy duty boots

Heavy duty boots must be worn by the waste handlers to protect themselves from the injuries and infections of sharps and infectious waste (Fig. 28.2).
2. **Boots and Shoe cover**

Shoe covers are required in locations when splashes or contaminated floors occur. It protects the wearer from contaminating the shoes or boots (Fig. 28.3).

- **Selecting Boots/Shoe Covers**: Shoes covers should be disposable and waterproof. Waterproof boots should be washable.
- **Wearing Boots/Shoe Covers**: Waterproof boots should be worn, if needed and shoe covers are often worn over personal shoes so as to cover the shoes adequately.
- **Removing Boots/Shoe Covers**: Shoe covers should be removed first with gloved hands and discarded, while the boots are removed last, before leaving the room. Wash hands thoroughly.

**Did you know?**

Heavy duty boots are required by waste handlers to protect from sharps injuries to the foot.

**Think and reflect**

Shoe covers and boots are both part of PPE. Discuss where shoe covers are worn and where boots are. Is this practice followed in your facility?

3. **Caps**

Caps must be worn in locations like the operation theatre and wards and during procedures in which splashes can occur (Fig. 28.4).

- **Selecting Cap**: Use a disposable, waterproof cap of an appropriate size which completely cover the hair.
- **Wearing Cap**: Wear before masking. Place or tie cap over the head so as to cover hair adequately.
- **Removing Cap**: Remove cap after removing mask. Remove by holding inside of the cap and folding inside out. Discard in proper container. Wash hands immediately.

**Did you know?**

The mask should completely seal the face at all times to ensure effective filtering of microorganisms.

4. **Masks**

A surgical mask protects health care providers from inhaling respiratory pathogens transmitted by the droplet route. It prevents the spread of infectious diseases such as varicella (chickenpox) and meningococcal diseases (meningococcal meningitis). An N95 mask protects health care providers from inhaling respiratory pathogens that are transmitted via the airborne route. This helps to prevent the spread of infectious diseases such as TB, MDR-T and SARS (Fig. 28.5).

**Question**

What are the characteristics of a mask which ensures effective filtering of microorganisms?

**Answer**

An N95 mask.

**Question**

Is it also useful to wear the mask from the patient safety point of view?

**Answer**

Yes, infections from the health workers can also be transmitted to the patients. Hence the mask can also protect the patients.

**Fig. 28.3**: Boots and shoe cover

**Fig. 28.4**: Caps

**Fig. 28.5**: Surgical masks and procedure for wearing and removing mask
5. **Apron**

An apron protects the wearer and the uniform from contact with the contaminated body fluids. Plastic aprons are used over the gown when caring for patients where possible splashes with blood and body substances may occur. Need not be used if the gown is of impermeable material (Fig. 28.6).

![Apron](image)

**Selecting the Apron**
Select water repellent, plastic aprons, which are disposable. If disposable ones are not available then reusable plastic aprons can be used.

**Size:** Long enough to protect the uniform but the gown should not touch the ground. Should cover the front and sides. It should open in the back. A tie around the waist keeps the apron in place.

**Wearing the Apron**
Wash hands. Ensure that the sleeves are rolled above the elbows before putting on the apron. Wear the apron over the uniform and tie around the waist at the back.

**Removing the Apron:** Wash hands and dry. Remove touching only the inside part of apron. Discard folding the outside part in. Decontaminate or dispose according to the health care facility guidelines. Wash hands thoroughly before touching anything else.

![Fig. 28.6: Selecting, wearing and removing the apron](image)

6. **Gown**

Gowns made of impervious material are worn to protect the wearer’s clothing/uniform from possible contamination with microorganisms and exposure to blood, body fluids secretions and excretions. The gown should be used only once for one patient and discarded or sent for laundering. Health care workers should remove gowns before leaving the unit (Fig. 28.7).

![Gown](image)

**Selecting a Gown**
Gowns should be clean and non-sterile. The gown should be impervious and water repellent. It should be long enough to cover the clothing of the wearer and should have long sleeves and high neck. Disposable gowns are preferable. If they are not available, cotton reusable gowns can be used with a plastic apron underneath.

**Wearing the Gown**
Wash hands, and dry. Hold the gown at the neck on the inside permitting to unfold. Slide hands and arms down the sleeves. Fasten the ties at the neck. Overlap the gown at the back as much as possible and secure the waistband. Request assistance to fasten the neck and the waist ties.

**Removing the Gown**
Remove the gown after removing gloves. Unite the waist-band with a gloved hand if it is tied in front before removing the gloves. Remove gloves and wash hands. Unite the neck ties (be sure not to touch outside of the gown). Slide the gown down the arms and over the hands by holding in inside of the sleeves. Hold the gown with both hands (inside the shoulders) at the shoulder seams. Turn the gown inside out (contaminated side in). The hands are then brought together and the gown is rolled and discarded appropriately in the container provided. If reusable—discard if visibly contaminated. If there is shortage of gowns they may be reused during one shift for the same patient. Hang gown with outside facing in when not in use. Discard at the end of each shift. Wash hands thoroughly before touching anything else.

![Fig. 28.7: Selecting, wearing and taking off gown](image)

7. **Protective Eyewear**

Protective eyewear/goggles should be worn at all times during patient contact when there is a possibility that a patient’s body fluids may splash or spray onto the caregiver’s face/eyes (e.g., during throat, endotracheal and tracheostomy suctioning, removal of catheter, etc.). The amount of exposure can be reduced through the use of protective eyewear. Full face shields may also be used to protect the eyes and mouth of the health care worker in such high-risk situations (Fig. 28.8).
8. Gloves

Use gloves when there is a probability of exposure to blood, body fluid, excretions of secretions. Change gloves between patients, between tasks and procedures on the same patient, and when they become soiled. Remove gloves promptly after touching contaminated items and environmental surfaces and before moving to another patient. Remove gloves before leaving the patient’s bedside and wash hands immediately. After glove removal and hand washing ensure that hands do not touch potentially contaminated environmental surfaces or items in the patient’s room. Discard gloves after attending to each patient (Fig. 28.9).

The procedure for taking of the gloves can be understood from the Fig. 28.10.
You can also see the live demonstration by visiting the website at https://www.youtube.com/watch?v=S4gyNAsPCbU

**Question**
What type of gloves are recommended for routine care of patients with highly transmissible infections?

**Answer**
Disposable gloves.

**Fig. 28.10:** Procedure for removing the disposable gloves


It is important for availability and access to soap and water, and alcohol hand rub, for hand hygiene. The hand hygiene must be performed before and/or after using PPE. This also important to maintain cleanliness and prevent the transfer of infection via dirty hands.

**Managing PPE in the facility**
The PPE listed in **Box 28.6** should be made available to all personnel who collect or handle waste.

**Obligatory**

a. Disposable gloves (medical staff) or heavy-duty gloves (waste workers)
b. Industrial aprons - overalls (coveralls)
c. Leg protectors and/or industrial boots
Depending on type of operation

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>eye protectors (safety goggles)</td>
</tr>
<tr>
<td>b.</td>
<td>face masks (if there is a risk of splash into eyes)</td>
</tr>
<tr>
<td>c.</td>
<td>helmets, with or without visors may also be required.</td>
</tr>
</tbody>
</table>

**Box 28.6: List of PPE to be used**

Sequence of donning PPE is explained in **Box 28.7**. The hand hygiene must be performed first and then the gown worn followed by mask, eyewear and then gloves in the end.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Perform hand hygiene</td>
</tr>
<tr>
<td>b.</td>
<td>Scrub suit and boots</td>
</tr>
<tr>
<td>c.</td>
<td>Gown</td>
</tr>
<tr>
<td>d.</td>
<td>Face Mask</td>
</tr>
<tr>
<td>e.</td>
<td>Face shield or goggles if required</td>
</tr>
<tr>
<td>f.</td>
<td>Head cover/cap if available</td>
</tr>
<tr>
<td>g.</td>
<td>Perform hand hygiene</td>
</tr>
<tr>
<td>h.</td>
<td>Gloves</td>
</tr>
<tr>
<td>i.</td>
<td>Water proof apron</td>
</tr>
</tbody>
</table>

**Box 28.7: Sequence of donning PPE**

**Sequence of removing PPE**

The PPE also must be removed in a particular sequence (Fig. 28.8). The first to be removed is the gloves, followed by gown, then goggles, followed by mask. In the end hand hygiene should be performed.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>Water proof apron (assume front and sleeves are contaminated)</td>
</tr>
<tr>
<td>b.</td>
<td>Gown (assume front and sleeves are contaminated) and Gloves (assume outside of gloves is contaminated)</td>
</tr>
<tr>
<td>c.</td>
<td>Boots (without touching them)</td>
</tr>
<tr>
<td>d.</td>
<td>Perform hand hygiene</td>
</tr>
<tr>
<td>e.</td>
<td>Head cover/cap from behind</td>
</tr>
<tr>
<td>f.</td>
<td>Face shield or goggles (assume outside is contaminated)</td>
</tr>
<tr>
<td>g.</td>
<td>Face Mask from behind (assume front is contaminated)</td>
</tr>
<tr>
<td>h.</td>
<td>Perform hand hygiene</td>
</tr>
</tbody>
</table>

**Box 28.8: Sequence of removing PPE**

**Check Your Progress 2**

1. Enumerate the important personal protective clothing.

   ........................................................................................................................................................................
   ........................................................................................................................................................................
   ........................................................................................................................................................................
   ........................................................................................................................................................................
   ........................................................................................................................................................................
   ........................................................................................................................................................................
   ........................................................................................................................................................................
   ........................................................................................................................................................................
   ........................................................................................................................................................................
Across
3. One must always adopt this procedure before wearing and after removing gloves (4,7)
6. Gum boots are made up of this material
7. If the gown has to be reused it should be made of
8. used to protect the wearer from splashes of blood

Down
1. helps to prevent the inhaling of microorganisms (4,4)
2. cover the shoes adequately (4,5)
4. protects the wearer and the uniform from contact with the contaminated body fluids
5. All procedures on a patient should always be performed wearing
8. Protects the feet from sharp injuries to the workers (3,5)

28.4.5 Dealing with Spillages

Spillages require clean-up of the area contaminated by the spilt waste.

In general, the most hazardous spillages occur in laboratories rather than in medical care departments. Procedures for dealing with spillages should specify safe handling operations and appropriate protective clothing.

The immediate measures to be taken to protect yourself from harm is mentioned in Box 28.9.

<table>
<thead>
<tr>
<th>Question</th>
<th>How should you protect yourself while cleaning a spill?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Answer</td>
<td>It is important to be donned in the proper PPE attire which consists of heavy duty boots, rubber gloves, gown, apron, mask, head cap and goggles. The area should be properly decontaminated and all waste material appropriately disposed of.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>a.</th>
<th>Appropriate equipment for collecting the waste and new containers should be available, as should means for disinfection.</th>
</tr>
</thead>
<tbody>
<tr>
<td>b.</td>
<td>Special attention should be paid to the eyes and any open wounds. In case of skin and eye contact with hazardous substances, there should be immediate decontamination. In case of eye contact with corrosive chemicals, the eyes should be irrigated continuously with clean water for 10–30 minutes; the entire face should be washed in a basin, with the eyes being continuously opened and closed.</td>
</tr>
</tbody>
</table>
c. An exposed person should be removed from the area of the incident for decontamination, generally with copious amounts of water.

**Box 28.9: Immediate measures during a spill for self protection**

**General procedure for dealing with spillages**

You have already read about how to deal with an infectious spill in Unit 18, Block 1, BHM-102. This could be blood or any other body fluid. Salient points of managing a spill have been summarised in the **Box 28.10**.

a. Restrict the activity around the spill
b. The individual(s) cleaning the blood spill need to use the proper PPE after hand hygiene.
c. Spray the blood contaminated surfaces with a 1–10 solution of bleach and water.
d. Use absorbent material to absorb and remove all traces of the spill.
e. Re-spray the cleaned area with the bleach solution and allow to air dry.
f. Place all waste materials, including disposable PPE, into a plastic autoclavable biohazard bag.
g. Perform hand hygiene.
h. Report the incidence.

**Box 28.10: Managing an infectious spill**

**Mercury/chemical spill**

You have already read the procedure of management of a mercury spill in the Unit 10, Block 3, BHM-101. The procedure has been summarised in **Box 28.11** for your reference.

a. Put on protective GLOVES and MASK to reduce dust inhalation. Increase ventilation by opening a window.
b. Use two pieces of firm straight edge paper, (e.g. copying paper) and slowly guide the droplets together into a pool.
c. Use glass pipette with rubber ball to suck up the mercury and collect it in the smallest size possible bottle (glass or plastic) with a tightly fitting lid.
d. For picking up tiny droplets in cracks or uneven surfaces, use pieces of metallic Zinc rinsed in 10% HCl. Run the Zinc along the cracks and touch visible droplets directly with it. To neutralise unreachable mercury in crevices etc., drizzle area with sulphur flour or zinc powder.
e. Label the bottle with “Mercury waste”.
f. Tightly close the container.

**Box 28.11: Summary of procedure of management of a mercury spill**
28.4.6 Injury Management

The steps mentioned in Fig. 28.11, must be followed in case of an injury.

- Ensure immediate first aid measures
- Immediately report injury
- Identify source of injury
- Obtain additional medical information
- Maintain medical surveillance
- Conduct blood tests if needed
- Investigate the causes
- Implement prevention measures for similar incidents Post-Exposure

Fig. 28.11: Managing injuries

28.4.7 Occupational Post Exposure Prophylaxis

Post-exposure prophylaxis (PEP) is short-term antiretroviral treatment (for HIV) or immunisation (for hepatitis B) to reduce the likelihood of infection after potential exposure, either occupationally or through sexual intercourse. Within the health sector, PEP should be provided as part of a comprehensive universal precautions package that reduces staff exposure to infectious hazards at work. PEP for HIV comprises a set of services to prevent development of the infection in the exposed person. These include first-aid care; counselling and risk assessment; HIV blood testing; and, depending on the risk assessment, the provision of short-term (28 days) antiretroviral drugs, with follow-up and support. Most incidents linked to occupational exposure to bloodborne pathogens occur in health care facilities.

Health care workers are normally at a very low risk of acquiring infection during management of the infected patient. Most exposures do not result in infection. In addition to blood, the other body fluids that can result in risk of infection are semen, vaginal secretions, cerebro-spinal fluid, synovial fluid, peritoneal, pericardial amniotic and other body fluids contaminated with visible blood.

The risk of infection varies with the type of exposure and other factors as mentioned in Fig. 28.12.

- The amount of blood/potentially infectious material involved in the exposure.
- The amount of virus in the source of blood at the time of exposure.
- Whether PEP was taken within the recommended time, on exposure to HIV infected blood/body fluids and contaminated sharps

Fig. 28.12: Factors deciding the risk of exposure

Immediately following an exposure, steps should be taken as shown in Fig. 28.13.
Fig. 28.13: Procedure adopted following an exposure to infectious waste list of Do's and Don't

a. Do not use antiseptic
b. If using contact lens leave them in place while irrigating; remove them once eyes are cleaned and then clean
c. For splashes in the mouth – Do not use soap or disinfectant
d. Do not squeeze
e. Do not put the exposed / cut / bleeding finger in your mouth

"Please refer to NACO website for latest guideline on PEP for HIV."

The World Health Organisation (WHO) has published guidelines on PEP to prevent HIV infection. A summary of PEP recommendations from these guidelines as given in Fig. 28.14.

Fig. 28.14: Guidelines for post exposure prophylaxis

Check Your Progress 3

1. Could you find the words associated with PEP in the word search?

OCFYGMFCPAXNH
CAREPGYBSQOOE
QSYUPMOSRTIBWIP
RQQJNXKJTTUNMTA
PETNSSSTAIDZWAT
JDICIESRBFXKCI
IASROLILKASMZIT
IHLRNESLPIFMNI
GZSRUAIEFICMHS
HTVMORBZANWTMM
YSMSHEHALPSGMG
HIPROPHYLAXISOD
GQESUEEALSFABCL
IBBLBWUHTRGZKLW
VHYKJOJENCUCUHYRM
28.4.8 Employee Health Check Up

As per Bio-Medical Waste Management Rules, 2016, every HCF must ensure that a comprehensive health check-up of each employee and other staff involved in BMW handling is carried out at the time of induction and also as a mandatory procedure to be followed for each year for every employee.

Comprehensive Health Check-up includes suggestive examination and investigations but not limited to these as given in Fig. 28.15.

Fig. 28.15: Suggestive comprehensive health check-up


http://www.cpcb.nic.in/wast/biomedicalwast/

Check-up records of all the employees are needed to be maintained in the personal record of each employee for proving compliance. Please refer to:

28.4.9 Training of Health Care Workers

As per Bio-Medical Waste Management Rules, 2016, as amended it is mandatory for all the employees of the health care facility to be trained in handling of bio-medical waste management and handling.

a. Training need analysis

It is mandatory for each health care worker inducted in the HCF to undergo the training in management of Bio-Medical Waste at the time of induction. As per BMW Rules, 2016, as amended an annual training for the entire health care staff of HCF on Bio-Medical Waste Management is a mandatory requirement.
Training need analysis of the staff should be carried out based on following parameters:

i. Theoretical Knowledge

ii. Demonstration of methods of handling of health care waste

iii. Practical Implementation

iv. If any scope of improvement is observed by the committee or designated person, training must be provided to the relevant section of staff.

b. Training schedule

As per the BMWM Rules, 2016, as amended the minimum requirements for health care facilities is to conduct the training on BMW activities at least annually for all the staff of the facility and also whenever a new staff is inducted into Health Care Facility. It is preferable for each health care facility to create a training calendar for imparting the training on Health Care Waste Management Handling Training must be provided as per the training plan.

c. Trainers

The trainers for the training could be selected by the health care facility from among the nodal officers or as endorsed by the legislative or regulatory authorities of the respective countries.

As per the BMWM Rules, 2016, as amended it is the responsibility of the SPCB/PCC and CBMWT to impart training on BMW Management in the health care facilities. SIHFW may take the responsibility to provide induction trainings. It is a requirement of BMWM Rules, 2016 to have a standard training module for imparting the training in the health care facilities. For this purpose, the guidelines can be used as training material for imparting the training or any other relevant material published by approved authorities like SPCB/PCC, State Guidelines can be used as training material. IGNOU’s programme of CHCWM is also endorsed by the MOEF&CC and MOHFW. Various state pollution control boards have also endorsed it.

d. Training records

Health care facilities need to ensure that all the training records pertaining to the health care waste management including the induction training records and in service training, for all the staff is needed to be kept for proving compliance. Attendance records of each training needs to maintained and signed by the trainees with name and designation. In India in compliance to the BMWM Rules, 2016, as amended, HCFs need to maintain, compile and provide details of trainings provided for BMW handling to State Pollution Control Board (SPCB)/Pollution Control Committee (PCC).

These details have to be submitted along with the annual report to the prescribed authority i.e. SPCB/PCC, on or before 30th June of every year.
e. The training details could include the following:

i) Total Number of trainings conducted along with the date of imparting the training

ii) Total number of participant of each training

iii) Attendance Record

iv) Total Number of staff trained on BMW Handling

v) Total number of staff trained on BMW handling at the time of Induction

vi) Total number of staff, not undergone any sought of training on BMW Handling.

f. Training effectiveness

Effectiveness of the training can be evaluated by observing the same parameters as listed in training need analysis of the staff or through a test mock/verbal or written, to be conducted after training.  

Implementation of standardized management procedures;

Hepatitis B vaccination (in addition to compulsory vaccinations) for all personnel who are at risk of exposure to blood (these personnel include cleaners and waste handlers);

Provision of sharps boxes where injections are taking place;

Implementation of standard precautions, such as no recapping of needles after use;

Promotion of proper hand hygiene;

Availability, as a minimum, of gloves to provide personal protection from patients’ body fluids;

Allocation of an additional role (e.g. for an infection-control nurse) to assume responsibility for promoting better worker safety.

---

Box 28.12: Training in health care waste management

28.4.10 Reporting Accidents and Incidents

All waste-management staff should be trained in emergency response and made aware of the correct procedure for prompt reporting. Accidents or incidents, including near misses, spillages, damaged containers, inappropriate segregation and any incidents involving sharps, should be reported to the waste-management officer (if waste is involved) or to another designated person. Box 28.13 outlines the content that each report must contain.

i. the nature of the accident or incident

ii. the place and time of the accident or incident Question

iii. the staff who were directly involved

iv. any other relevant circumstances.

The cause of the accident or incident should be investigated by the waste-management officer (in case of waste) or other responsible officer, who should also take action to prevent recurrence. The records of the investigation and subsequent remedial measures should be kept.

---

Box 28.13: Content of Accident Report
Remedial steps must be considered for implementing in the health care facility following the accident/incident (Box 28.14).

| a. Elimination of hazard – e.g Avoid unnecessary injections |
| b. Substitution – e.g Jet injectors may substitute syringes and needles |
| c. Engineering Controls – Puncture-resistant containers to isolate sharps |
| d. Administrative Controls – e.g training |
| e. Work Practice Controls – e.g no recapping of needles |
| f. Personal Protective Equipment (PPE) e.g gloves etc |

Box 28.14: Suggestive remedial steps following an accident/incident.

FORM-I

[See rule 4(o), 5(i) and 15(2)]

ACCIDENT REPORTING

1. Date and time of accident:
2. Type of Accident:
3. Sequence of events leading to accident:
4. Has the Authority been informed immediately:
5. The type of waste involved in accident:
6. Assessment of the effects of the accidents on human health and the environment:
7. Emergency measures taken:
8. Steps taken to alleviate the effects of accidents:
9. Steps taken to prevent the recurrence of such as accident:
10. Does you facility has an Emergency Control policy? If yes, give details.

Date : ................................ Signature........................................
Place : .......................... Designation...........................................

*Responsibility of Occupier 4 (o): Report major accidents including accidents caused by fire hazards, blasts during handling of bio-medical waste and the remedial action taken and the records relevant thereto, (including nil report) in Form I to the prescribed authority and also along with the annual report;
28.5 HIERARCHY OF CONTROLS

Methods to control occupational hazards have traditionally been discussed in terms of hierarchy and presented in order of priority for their effectiveness in preventing exposure to the hazard or preventing injury resulting from exposure to the hazard. The methods in decreasing order of effectiveness is explained in Box 28.15.

a. Elimination of hazard – e.g. Avoid unnecessary injections.
b. Substitution – e.g. Jet injectors may substitute syringes and needles.
c. Engineering Controls – Puncture-resistant containers to isolate sharps.
d. Administrative Controls – e.g. training.
e. Work Practice Controls – e.g. no recapping of needles.
f. Personal Protective Equipment (PPE) e.g. gloves etc.

Box 28.15: Preventing Occupational hazards

You will learn more about these methods if you have opted for the optional course BHME-102 on worker safety and patient safety.

Check Your Progress 4

1. Try unjumbling the words related to hierarchy of controls.

28.6 MINIMUM APPROACHES TO HEALTH AND SAFETY PRACTICES

The minimum approach to health and safety practices for health care personnel and waste workers are enumerated in Fig. 28.16.
Implementation of standardized management procedures;

Hepatitis B vaccination (in addition to compulsory vaccinations) for all personnel who are at risk of exposure to blood (these personnel include cleaners and waste handlers);

Provision of sharps boxes where injections are taking place;

Implementation of standard precautions, such as no recapping of needles after use;

Promotion of proper hand hygiene;

Availability, as a minimum, of gloves to provide personal protection from patients’ body fluids;

Allocation of an additional role (e.g. for an infection-control nurse) to assume responsibility for promoting better worker safety.

Fig. 28.16: Minimum Approach to health and safety practices for health care personnel and waste workers

1. Desirable improvements to the minimum approach

Desirable improvements or additions to the minimum approach to health and safety practices are given in **Fig. 28.17**.

**Implementation of safer needle devices**

**Establishment of health and safety discussions among staff or committees in the local workplace**

**Establishment of surveillance systems and use of data to prevent further injuries**

**A system for post-exposure prophylaxis**

**Occupational health services formally established at a health-care facility**

Fig. 28.17: Desirable improvements to the minimum approach

### 28.7 LET US SUM UP

Exposures and injuries are preventable Most of the health care waste is not hazardous. However, segregation of the waste is essential so that risks and non-risks wastes are separated and the small proportion of risk waste can be handled safely. Standard safe working precautions are the principle management approach to protect patients and workers from health care-associated infections. The waste generation and segregation activities in medical areas have a significant impact on workers involved in waste handling and treatment. Training of medical staff and other users of sharps should include explaining the impact of incorrect waste practices on cleaners and waste handlers. The intention is to emphasise their responsibility to segregate waste properly, to protect not only themselves and their patients, but also other workers and the community as a whole. Preventive measures to protect staff performing injections will also protect waste handlers. Placing used sharps in puncture-proof containers is a major part of eliminating needlestick injuries. Safer needle devices, such as retractables or needles that blunt or automatically resheath after use, offer added protection but also added cost. Adequate measures need to be taken to protect health care workers from exposure, injury and occupational disease. Provide all three doses of
hepatitis B immunisation to health care and waste workers. Identify a responsible person for occupational health. Allocate sufficient budget to the programme and procure the necessary personal protective equipment. Provide training to health care workers and involve them in the identification and control of hazards. Promote knowledge of the transmission of HIV, hepatitis and tuberculosis through orientation or pre-screening for HIV and tuberculosis, and vaccinate against hepatitis B. Prevent exposure to bloodborne pathogens by applying the hierarchy of controls (see Annex 4 of Joint ILO/WHO guidelines on health services and HIV/AIDS; ILO & WHO, 2005). Maintain a continuous effort to prevent needle-stick injuries and occupational exposures to blood. This could include eliminating unnecessary injections and sharps use, and applying standard precautions (e.g. prohibiting the recapping of needles and ensuring safe disposal immediately after use). Provide free access to post-exposure prophylaxis for HIV and tuberculosis following an injury. Promote a “no blame” approach to incident reporting and monitor the quality of services provided. Fig. 28.18 presents the summary of this unit.
28.8 GLOSSARY

Biological : That caused by some living organism

Contamination : Containing micro organisms which can cause disease.

Comprehensive health check up : Examination and investigations to detect most of the problems that the person could be suffering from.

Occupational health and safety : The safety health and welfare of people at work.

Surveillance : To keep a close watch.

28.9 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. Immunisation, personal protective equipment, health check-up, accident reporting

2. a. A standardised set of management rules and operating procedures for health care waste
   b. Waste workers are adequately trained so that they perform their duties properly and safely
   c. Waste workers should be involved in the identification of hazards and strategies for it’s prevention and control.

Check Your Progress 2

1. The PPE includes gloves, face mask, cop, gown, apron, shoe covers, or heavy duty gloves


Check Your Progress 3

Hepatitis, splashes, abrasions, injury, prophylaxis, counselling, immunisation, risk, communication, barrier.

Check Your Progress 4

Elimination, substitution, engineering, administrative, work practice, personal protective.

28.10 REFERENCES AND FURTHER READINGS


3. HSE (Health and Safety Executive) (2005). Controlling the risks of
infection at work from human remains – a guide for those involved in funeral services (including embalmers) and those involved in exhumation. Suffolk, Health and Safety Executive (http://www.hse.gov.uk/pubns/web01.pdf).


10. UNDP presentations.