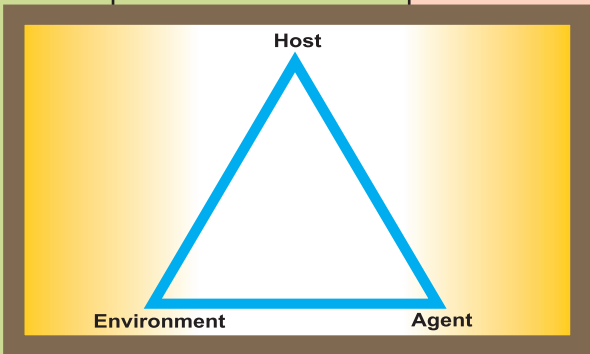


BHME-101 INTER-RELATIONSHIP BETWEEN HEALTH AND ENVIRONMENT



“Education is a liberating force, and in our age it is also a democratising force, cutting across the barriers of caste and class, smoothing out inequalities imposed by birth and other circumstances.”

—Indira Gandhi

“शिक्षा मानव को बन्धनों से मुक्त करती है और आज के युग में तो यह लोकतंत्र की भावना का आधार भी है। जन्म तथा अन्य कारणों से उत्पन्न जाति एवं वर्गगत विषमताओं को दूर करते हुए मनुष्य को इन सबसे ऊपर उठाती है।”

—इन्दिरा गांधी

BHME-101

Inter-relationship between Health and Environment

Block

1

INTER-RELATIONSHIP BETWEEN HEALTH AND ENVIRONMENT

UNIT 1

Environment and Health

5

UNIT 2

Impact of Health Care Waste on Human Health

30

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COURSE INTRODUCTION

Health and environment are interrelated. There are a number of human activities that have led to the degradation of the natural environment. You have read about the pollutions, acid rain, greenhouse gases and about the climate change in the **Block 1** of BHM-101. All these have an impact on the human health. It is important to live in harmony with the environment and work towards a sustainable development. In the **first unit** of this course, you will learn about the basic concepts of health and how the various environmental factors have a bearing on health.

In **Unit 2** of this course you will learn about the impact of health care waste on human health. You have already read about the impact of the infectious waste and the chemical waste on health and environment in the **Unit 9** and **Unit 10** respectively of the **Block 3** of BHM-101. Here we shall be reading in details about the impact on human health and how to prevent and manage these problems. It is important that the health care waste is minimised, managed properly and adequate precautions are taking while handling this waste to protect ourselves from the eminent dangers and risks posed by the health care waste.

UNIT 1 ENVIRONMENT AND HEALTH

Structure

1.0 Objectives	1.6.2 The Built Environment
1.1 Introduction	1.6.3 Impacts of Waste on Human Health
1.2 Concept and Definition of Health	1.7 Impact of Environmental Hazards on Population
1.2.1 Dimensions of Health	1.8 Reducing the Disease Burden through Environmental Interventions
1.2.2 Dynamics of Development of Disease	
1.3 Determinants of Health	1.9 Let Us Sum Up
1.4 Causation of Disease	1.10 Glossary
1.5 Natural History of Disease	1.11 Answers to Check Your Progress
1.6 Environment and its Effect on Health	1.12 References and Further Readings
1.6.1 The Natural Environment	

1.0 OBJECTIVES

After studying this unit, you should be able to :

- define health and explain it's concept
- describe the dimensions of health and discuss the dynamics of development of disease
- outline the determinants of health
- explore the causation of disease and trace the natural history of disease
- enumerate and discuss the various environmental factors affecting human health
- identify the affected population and the ways of reducing the disease burden of the environment risk

1.1 INTRODUCTION

Environment and health are closely linked with each other. You have already read about the environment in the Block 1, BHM-101. You must have realised the importance of safeguarding the environment from degradation for sustainable development and preservation of ecological balance.

The human activities and interference leads to pollution, climate change and ecological imbalance. All these facts impact health.

In this unit you will learn in detail about environment, health and the relationship between environment and health. Before you can understand how the environment can impact health, you need to learn more about the concept of health and the genesis of disease. There are a number of environmental factors which have an impact on human health. If the delicate balance between the three factors – environment, agent and host is disturbed, it will result in disease. This interplay has been described here.

1.2 CONCEPT AND DEFINITION OF HEALTH

Definitions of health have evolved over time. Health is difficult to define but easier to understand. To many of us it may mean absence of disease or infirmity and to many it may mean sound body and sound mind and sound function of the body. In keeping with the bio-medical perspective, early definitions of health focused on the theme of the body's ability to function; health was seen as a state of normal function that could be disrupted from time to time by disease.

Did you know ?

WHO defines health as 'physical, mental, social well-being and not merely an absence of disease and infirmity'.

Think and reflect

Look around yourself and try to analyse how many people around you are really healthy. Which definition or parameters did you consider in deciding the status of health of the people ? Are you correct in considering these factors ?

WHO defines health as “physical, mental, and social well-being, and not merely the absence of disease and infirmity”. This definition characterises an ideal state of a human being, and a state which is almost never reached by any human in the world. It is also highly debatable whether it is at all adequate to capture the notion of health. Although this definition was welcomed by some as being innovative and exciting, it was also criticised as being vague, excessively broad, and immeasurable. For a long time it was set aside as an impractical ideal and most discussions of health returned to the practicality of the bio-medical model.

Again, the WHO played a leading role when it fostered the development of the health promotion movement in the 1980s. This brought in a new conception of health, not as a state, but in dynamic terms of resiliency, in other words, as “a resource for living” (WHO, 1986). The 1984 WHO revised definition of health defined it as “the extent to which an individual or group is able to realise aspirations and satisfy needs, and to change or cope with the environment. Health is a resource for everyday life, not the objective of living; it is a positive concept, emphasising social and personal resources, as well as physical capacities”. Thus, health referred to the ability to maintain homeostasis and recover from insults. Mental, intellectual, emotional, and social health referred to a person's ability to handle stress, to acquire skills, to maintain relationships, all of which form resources for resiliency and independent living. Health is perceived in different ways giving rise to various concepts of health. Health has evolved over the centuries as a concept from an individual concern to a worldwide social goal. These concepts are mentioned in **Box 1.1**.

- a. **Bio-medical Concept:** Health means “absence of disease”. It was felt that human body is a machine and disease is an outcome of the breakdown of the machine, and one of the doctor's tasks was to repair the machine. Developments in medical and social sciences led to the conclusion that the bio-medical concept of health was inadequate.

- b. Ecological Concept:** Ecologists viewed health as a dynamic equilibrium between man and his environment, and disease – a maladjustment of the human organism to environment.
- c. Psychosocial Concept:** Advances in social sciences showed that health is not only a bio-medical phenomenon, but one which is influenced by social, psychological, cultural, economic and political factors of the people concerned. Thus health is both a biological and social phenomenon.
- d. Holistic Concept:** Holistic concept recognises the strength of social, economic, political and environmental influences on health. It has been variously described as multidimensional process involving the well-being of the person as a whole and with emphasis is on the promotion and protection of health.

Box 1.1: Evolution of concept of Health

Check Your Progress 1

1. What is the definition of health as defined by WHO ?

.....

.....

.....

.....

.....

1.2.1 Dimensions of Health

Health is multidimensional and is interrelated, each has its own nature. There are many paths to wellness such as spiritual, environmental, emotional and physical health. Ensuring that all aspects of your health are functioning well will help you develop a better sense of overall wellness. The term wellness can refer to a variety of conditions within the body. While many people associate their wellness to their physical health it can also be used to describe your environmental, mental, intellectual, occupational, emotional or spiritual well-being. These different dimensions of health will interact together to help determine your full quality of life. Let us learn more about the different dimensions of health by reading about them as given in the **Box 1.2**.

- a. Physical Dimension:** Physical wellness can refer to any of the aspects that are needed to keep your body in top condition. Consuming a healthy diet and getting an adequate amount of exercise to build cardiovascular health, endurance or flexibility are essential to this goal. You are responsible for your health care, which means treating minor conditions and consulting a professional to manage more serious conditions.
- b. Intellectual Dimension:** Finding a way to engage in creative and stimulating activities that allow you to share your gifts and expand your knowledge is essential to your overall health. Those that have high intellectual wellness, engage in the exploration and their understanding of new ideas, cherish stimulation and mental growth and get involved in cultural and intellectual activities.

- c. Emotional Dimension:** Emotional wellness focuses on ensuring that you are attentive to your feelings, thoughts and behaviour. This includes both positive and negative reactions, though overall you should seek an optimistic approach to life, enjoying life in spite of occasional disappointment and adjust to change and express your emotions appropriately.
- d. Spiritual Dimension:** Spiritual health refers to “something” that transcends physiology and psychology. Spiritual wellness involves discovering a set of beliefs and values that brings purpose to your life. While different groups and individuals have a variety of beliefs regarding spiritualism but the general search for meaning to our existence is considered essential to create harmony with yourself and others regardless of the path to spirituality you choose to follow.
- e. Social Dimension:** Social wellness refers to your ability to interact with people, respect yourself and others, develop meaningful relationships and develop quality communication skills. This allows you to establish a support system of family and friends. Those with high social wellness believe that it is important to live in harmony with the environment and others and consider the common welfare of the community over their own.
- f. Occupational Dimension:** The ability to find peace between your leisure time and work time while managing stress from your relationships with coworkers effectively is essential to occupational health. Your work takes up a great deal of your time so it is important to find something that you love to do and gives you a sense of purpose. To achieve occupational wellness it is important to feel as though you enjoy your work most days, feel like you can talk openly with your employer and coworkers and have a manageable workload.
- g. Environmental Dimension:** The environment can have a significant impact on our feelings about overall health. For developing environmental wellness, you should live in harmony with your environment, take action to protect this environment from harm, minimise behaviour that could impact your environment while protecting yourself from environmental hazards and realise the effects of your daily habits on the world around you.

Box 1.2: Dimensions of Health

Trevor Hancock’s Mandala of health

Trevor Hancock in 1993 had framed a mandala of health (**Fig. 1.1**). This is a model of health and the community ecosystem that represents health determinants as concentric nested influences, beginning with the person at the centre (distinguishing body, mind, and spirit), then moving outwards to the social and physical environment, and then moving further out to culture, economic, and societal influences. The mandala is intended to draw attention to the wide range of health determinants, and to the need to address many levels in developing strategies for improving health.

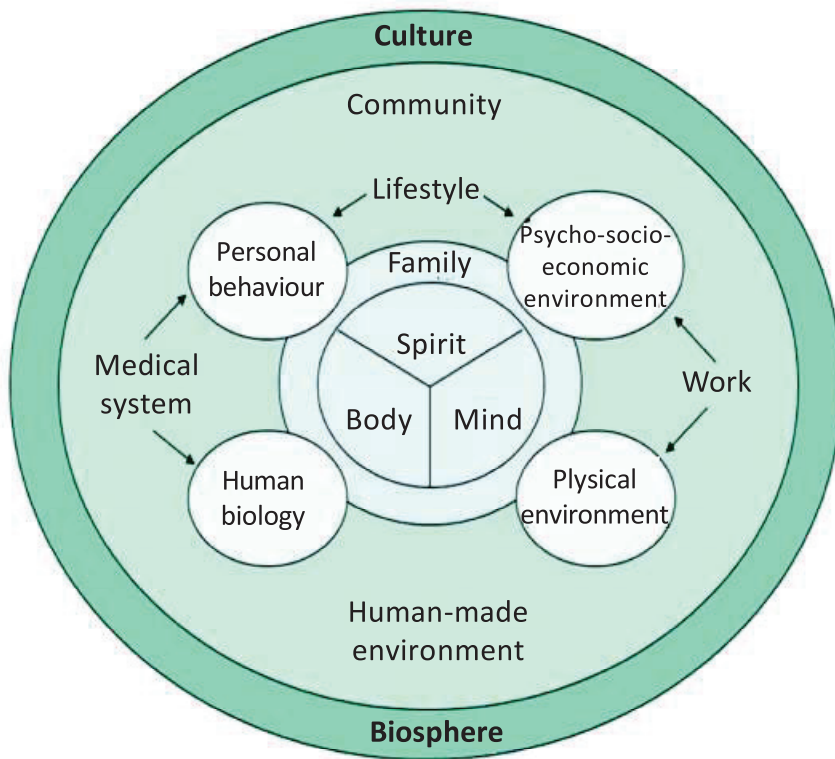
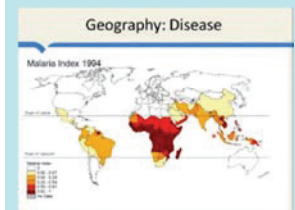


Fig.1.1: The Mandala of Health
 Source: Trevor Hancock, 1993.

1.2.2 Dynamics of Development of Disease

Although the Oxford dictionary defines disease as ‘a disorder of structure or function in a human, animal, or plant, especially one that produces specific symptoms or that affects a specific location and is not simply a direct result of physical injury’ disease is often looked upon as a deviation from health. In this section we will try to understand why some individuals under certain circumstances start deviating from the state of being healthy. There are a range of personal, social, economic, and environmental factors that influence health status known as determinants of health. It is the interrelationships among these factors that determine individual and population health. Because of this, interventions that target multiple determinants of health are most likely to be effective. Determinants of health reach beyond the boundaries of traditional health care and public health sectors; sectors such as education, housing, transportation, agriculture, and environment can be important allies in improving population health.

Better understanding on the dynamic of can be disease development can be seen in the video link: <https://www.youtube.com/watch?v=ouMTbJiMVWA>



Check Your Progress 2

1. List the seven dimensions of health.

.....

2. What are the determinants of health?

.....

1.3 DETERMINANTS OF HEALTH

There are a number of determinants of health. Let us look at some of these, details which have been explained in **Box 1.3**.

Did you know ?

You are pre disposed to certain ailments because of the traits that you inherit from your parents.

a. Biology and Genetic Endowment

The basic biology and organic make-up of the human body are a fundamental determinant of health. Genetic endowment provides an inherited predisposition to a wide range of individual responses that affect health status. Although socio-economic and environmental factors are important determinants of overall health, in some circumstances genetic endowment appears to predispose certain individuals to particular diseases or health problems.

b. Income and Social Status

Health status improves at each step up the income and social hierarchy. High income determines living conditions such as safe housing and ability to buy sufficient good food. The healthiest populations are those in societies which are prosperous and have an equitable distribution of wealth.

c. Social Support Networks

Support from families, friends and communities is associated with better health. Such social support networks could be very important in helping people solve problems and deal with adversity, as well as in maintaining a sense of mastery and control over life circumstances. The caring and respect that occurs in social relationships, and the resulting sense of satisfaction and well-being, seem to act as a buffer against health problems.

d. Employment and Working Conditions

Unemployment, underemployment, stressful or unsafe work are associated with poorer health. People who have more control over their work circumstances and fewer stress related demands of the job are healthier and often live longer than those in more stressful or riskier work and activities.

e. Social Environments

The importance of social support also extends to the broader community. Civic vitality refers to the strength of social networks within a community, region, province or country. It is reflected in the institutions, organisations and informal giving practices that people create to share resources and build attachments with others. The array of values and norms of a society influence, in varying ways, the health and well-being of individuals and populations. In addition, social stability, recognition of diversity, safety, good working relationships, and cohesive communities provide a supportive society that reduces or avoids many potential risks to good health.

f. Physical Environments

The physical environment is an important determinant of health. At certain levels of exposure, contaminants in our air, water, food and soil can cause a variety of adverse health effects, including cancer, birth defects, respiratory illness and gastrointestinal ailments. In the built environment, factors related to housing, indoor air quality, and the design of communities and transportation systems can significantly influence our physical and psychological well-being .

g. Personal Health Practices and Coping Skills

Personal health practices and coping skills refer to those actions by which individuals can prevent diseases and promote self-care, cope with

Think and reflect

Look around yourself and try to assess, the factors in the environment which expose you to a greater risk of disease as compared to other members of your family.

challenges, and develop self-reliance, solve problems and make choices that enhance health. Definitions of lifestyle include not only individual choices, but also the influence of social, economic, and environmental factors on the decisions people make about their health. There is a growing recognition that personal life “choices” are greatly influenced by the socioeconomic environments in which people live, learn, work and play.

h. Health Services

Health services, particularly those designed to maintain and promote health, to prevent disease, and to restore health and function contribute to population health. The health services continuum of care includes treatment and secondary prevention.

i. Gender

Gender refers to the array of society – determined roles, personality traits, attitudes, behaviours, values, relative power and influence that society ascribes to the two sexes on a differential basis. “Gendered” norms influence the health system’s practices and priorities. Many health issues are a function of gender-based social status or roles.

j. Culture

Some persons or groups may face additional health risks due to a socio-economic environment, which is largely determined by dominant cultural values that contribute to the perpetuation of conditions such as marginalisation, stigmatisation, loss or devaluation of language and culture and lack of access to culturally appropriate health care and services.

Think and reflect

Can you recollect some of the personal hygiene practices which can help protect you from infections.

Did you know ?

“Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social and psychosocial factors in the environment. It also referred to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that can potentially affect adversely the health of present and future generation”, WHO 2005.

Box 1.3: Determinants of Health

1.4 CAUSATION OF DISEASE

Occurrence of a disease is based on a web of several factors and is widely referred to as multifunctional causation. The factors can be categories as discussed in Fig. 1.2.

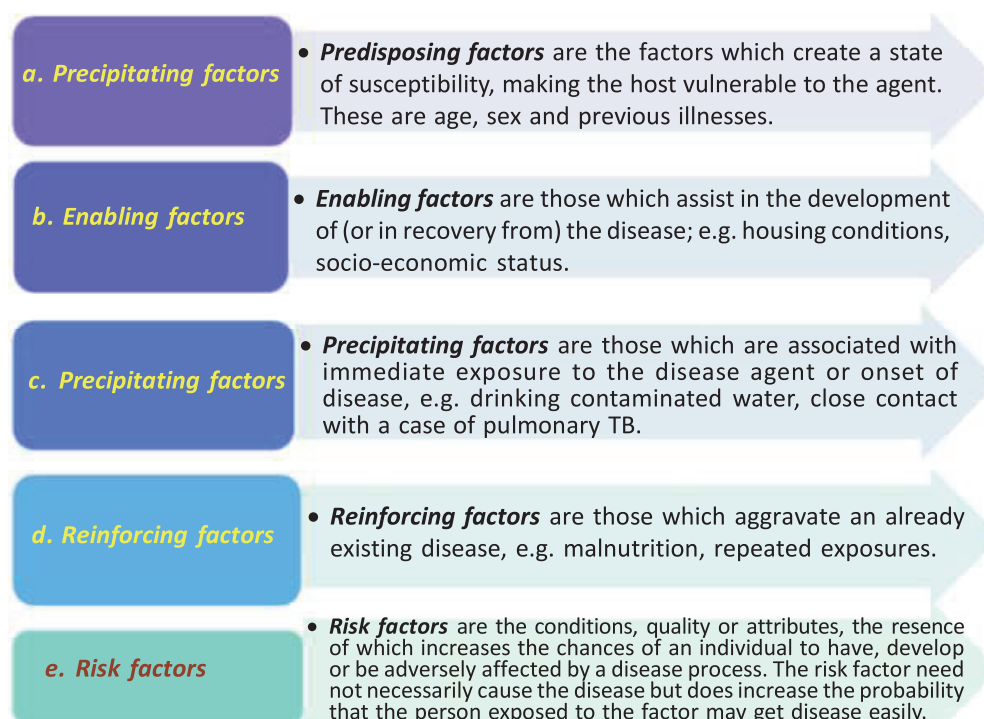


Fig. 1.2: Multiple factors implicated in the development of disease

All these factors can be grouped under three domains, viz., the agent, host and environment. The dynamic interactions between them can be represented in model called epidemiological triad (**Fig. 1.3**). The Epidemiologic Triangle is a model that scientists have developed for studying health problems. It helps one understand infectious diseases and how they spread. The mission of an epidemiologist is to break at least one of the sides of the triangle, disrupting the connection between the environment, the host, and the agent, and stopping the continuation of disease.

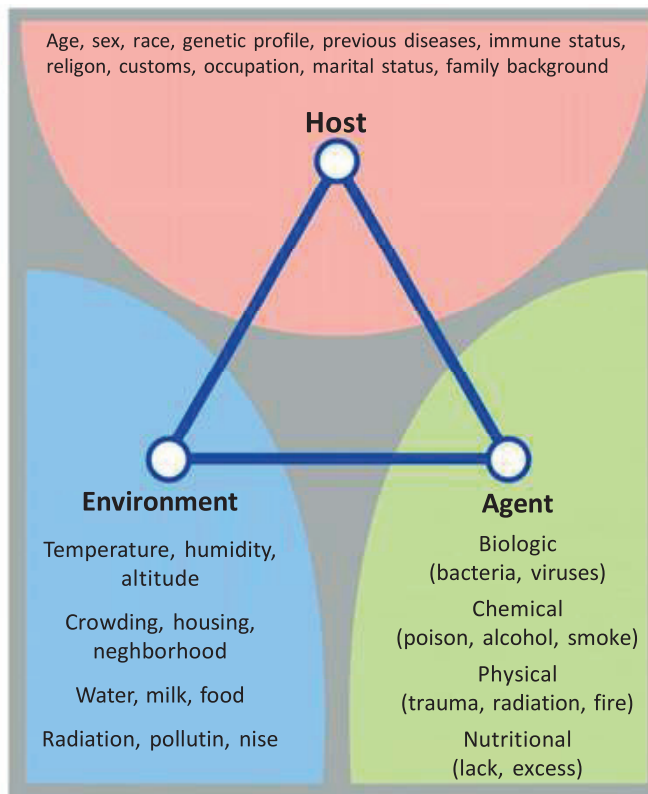


Fig. 1.3: Epidemiological Triad

Source: <https://www.pinterest.com/pin/292663675767>

The Triangle has three corners (called vertices) as mentioned in **Box 1.4**.

- Agent, or microbe that causes the disease (the “what” of the Triangle)
- Host, or organism harbouring the disease (the “who” of the Triangle)
- Environment, or those external factors that cause or allow disease transmission (the “where” of the Triangle)

Box 1.4: Factors of Epidemiological triad

The **agent** is the cause of the disease. When studying the epidemiology of most infectious diseases, the agent is a microbe – an organism too small to be seen with the naked eye. Disease-causing microbes are bacteria, virus, fungi, and protozoa (a type of parasite). They are what most people call “germs”.

The **hosts** are the organisms, usually humans or animals, which are exposed to and harbor a disease. The host can be the organism that gets sick, as well as any animal carrier (including insects and worms) that may or may not get sick.

The **environment** is the favourable surroundings and conditions external to the host that cause or allow the disease to be transmitted. Some diseases live best in dirty water. Others survive in human blood. Still others, like *E.coli*, thrive in warm temperatures but are killed by high heat. Other environment factors include the season of the year.

Think and reflect

Try to find out the factors of epidemiological triad for an infection of Hepatitis B after a needlestick injury.

In the center of the triangle is **time**. Most infectious diseases have an incubation period, the time between when the host is infected and when disease symptoms occur. Or, time may describe the duration of the illness or the amount of time a person can be sick before death or recovery occurs. Time also describes the period from an infection to the threshold of an epidemic for a population.

1.5 NATURAL HISTORY OF DISEASE

Natural history of a disease is the sequence of events that cover the entire process of the evolution and determination of a disease in the absence of any treatment or presentation. In fact natural history of disease is actually the natural course of a disease. The natural history can be divided into a Pre-pathogenesis and Pathogenesis Phase.

Pre-pathogenesis Phase

It is the period before the onset of the disease and the pathogenic phase or the course of disease once the agent enters the body of an individual. As far as the environmental health is concerned, pre-pathogenic phase is the most important part of the natural history of a disease. The disease causing agent is yet to gain access inside the human host but the interactions between agent, host and the environment as shown in epidemiological triad are most vital during this period. This is a phase when both the man and the disease agent are living side by side in the same environment and are trying to get an edge over the other. The result of this interaction shall determine the vulnerability of individuals towards a disease and the nature and load of sickness on the population. It may range from a single case to a rapid spreading epidemic.

Pre-pathogenesis phase refers to the period preliminary to onset of disease. During this phase the factors which favour the interaction of causative agent with the man already exist but disease process has not yet begun. Potentially most of us are in pre-pathogenesis phase of many diseases, both communicable and non communicable.

Pathogenesis Phase

During this phase interaction between the host, disease cause and environment occurs to initiate the disease process. In **pre-symptomatic stage**, there is no clinical manifestation; and in **clinical stage**, recognisable signs and symptoms pathognomonic to disease appear. Variation in the onset of disease and its outcome in an individual depend on varying degree of host's reaction. The goal of medicine is to promote health, to preserve health, to restore health when it is impaired, to minimise suffering and distress. These goals are embodied in the word "**prevention**". The termination of late pathogenesis phase can be total recovery, disability or death. In many diseases, especially in the chronic ones, the early pathogenesis and late pathogenesis phases are also as pre-symptomatic and symptomatic phases.

You may read more about the Epidemiological triad from the following link.
https://www.youtube.com/watch?v=BfGyEyDz_uc



Question

Can you name a disease which has a long pre pathogenic phase?

Answer

AIDS.

Check Your Progress 3

1. What is an epidemiological triad ?

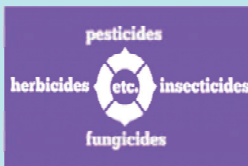
.....

2. What are the two phase for disease development?

.....

1.6 ENVIRONMENT AND ITS EFFECT ON HEALTH

A clear understanding on the human impact on environment is shown in the video link: https://www.youtube.com/watch?v=IKZMGBA_0Ik



Did you know ?

In 2012, an estimated 12.6 million deaths globally were attributable to the environment. air pollution, unsafe water, lack of sanitation, poor hygiene and unsafe food and the ecosystems which sustain us are estimated to be responsible for 23 per cent of all deaths worldwide.

Read an article. <https://today.mims.com/the-ironic-man-made-crisis-that-threatens-the-continuing-survival-of-human-societies>



Source:

http://cdrwww.who.int/quantifying_ehimpacts/publications/preventing_diseasebegin.pdf



There is growing concern about the links between the environment and health. Humans are responsible for polluting the environment which in turn has shown its effect on the human health. The Health and environment are interlinked. An elaborate discussion on its features, its importance and human impact on environment are discussed in Unit 1, Block 1, BHM-101. Worldwide about one quarter to one third of the burden of disease appears to be attributable to environmental factors. Vulnerability and exposure, however, vary markedly between different groups and areas, with children and the elderly being particularly at risk. The surroundings in which people live affect their health. Air and water quality, public safety, the houses in which people live, and the availability of parks and green space all contribute to an individual's health status **Box 1.5**. The health hazards are categorised into short-term, long-term and transient health hazards for better understanding and discussed in detail in Block 1, BHM-101.

This map (**Fig. 1.4**) shows the proportion of people who died in 2015 due to a pollution-related cause as estimated by The Lancet Commission on Pollution and Health using data from the Institute for Health Metrics and Evaluation and the World Health Organisation .

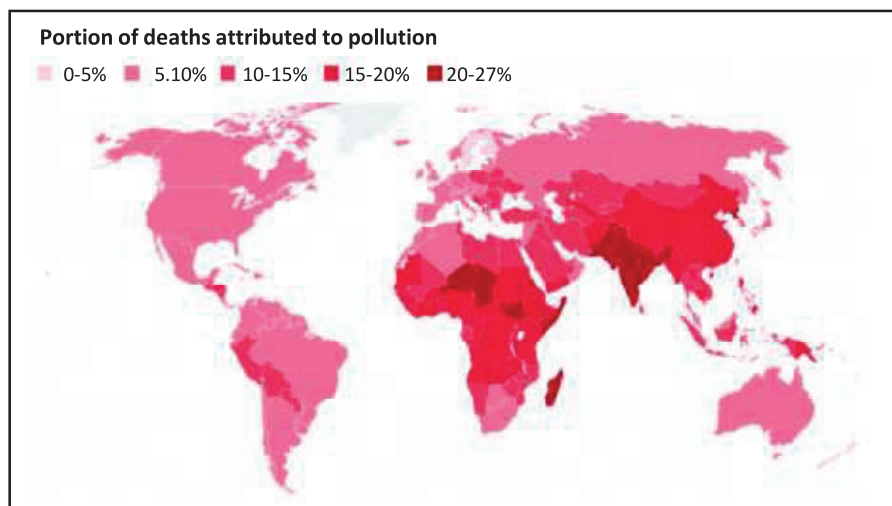


Fig.1.4 : Proportion of people who died in 2015 due to a pollution-related cause
(Source: Institute for Health Metrics and Evaluation, Lancet Commission on pollution and Health)

- In 2015, nearly **one in six deaths, an estimated nine million worldwide, was related to pollution in some form – air, water, soil, chemical or occupational pollution**. Air pollution is by far the largest contributor to early death, according to the new research produced by The Lancet Commission on Pollution and Health. This form of pollution is linked to 6.5 million fatalities in 2015.
- Water pollution, responsible for 1.8 million deaths, and workplace-related pollution, which led to 0.8 million deaths, pose the next largest risks, the report noted.**
- It has been estimated that **24% of the global burden of disease and 23% of all deaths were due to modifiable environmental factors (for example, pollution, occupational risks, land use practices and sanitation)**.
- Diseases with the largest absolute burden from environmental exposure included **diarrhoea, lower respiratory infections and malaria**.

For further reading <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1479630/>



Source https://www.eea.europa.eu/publications/environmental_assessment_report_2003_10/kyiv_chapt_12.pdf/at_download/file



http://www.who.int/quantifying_ehimpacts/publications/preventingdisease6.pdf



Source: <http://www.who.int/ceh/publicationschildrensunit.pdf>



- e. One of the most prominent examples of the human-environment relationship is climate change—a human-induced progression of changes to the global environment primarily caused by the burning of fossil fuels and land use practices.
- f. WHO in 2002 estimated that **25-33% of disease is attributable to environmental factor**, though this varies considerably between regions of the world. According to a study published in (Lancet, in 2002). **Environmental attributable fraction is slightly higher for men than for women (25%; 22-28%, versus 22%; 20-25%)**, partly because occupational risks were higher in men.
- g. In **children 0-4 years old, 36% (31-40%) of the overall disease burden is attributable to modifiable environmental risk factors**, while that **fraction is 34% among children 0-14 years of age**. The burden of disease attributed to modifiable environmental factors varies across population groups and world regions.
- h. Children suffer a disproportionate share – **the per capita number of disability-adjusted life year (DALYs) lost to environmental factors was about five times greater in children under five years of age than in the total population**.

Box 1.5: Contribution of environmental factors to the burden of disease

Global estimates of environmental disease burden are likely to be conservative due to difficulties in quantifying the complex pathways between environmental factors and health. Nevertheless, the estimates reflect how much death, illness and disability could be avoided as a result of reduced human exposures to environmental hazards.

Let us understand how environmental factors determine the state of health. There are number of pressures on the environment. These pressures include population growth, inequitable resource distribution and technological development. These pressures in turn lead to a number of health hazards. Specifically, the physical, chemical, radioactive contaminants, biological and psychological aspects are the important environmental factors, which play an important role in determining the state of our health (Fig.1.5).

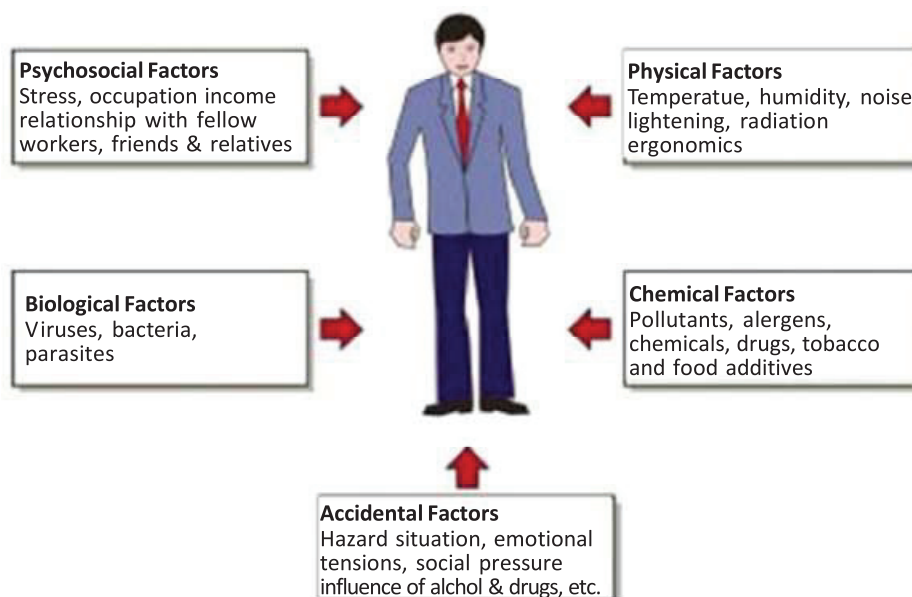


Fig. 1.5: Environmental factors affecting human health

Source: <https://www.slideshare.net/vicksy02/public-health-according-to-park-2>

Inter-Relationship between Health and Environment

Did you know ?

The environmental health burden was also much higher in the developing world, although in the case of certain non-communicable diseases, such as



cardiovascular diseases and cancers, the per capita disease burden was found to be larger in developed countries.

Thus you can realise that environment quality is an important direct and indirect determinant of human health. In the developing countries the population are at risk mainly from “traditional” environmental health hazards. These hazards include unsafe water supply and poor sanitation, poor housing, poor indoor air quality, unsafe food and high prevalence of vectors or agents that spread disease. There are a number of diseases that are directly the result of poor environment quality. Acute diarrhoeal disease and acute respiratory infections are the two most common ones. Other conditions include occupational hazards and vector-borne diseases.

Environmental factors affect human health in important ways, both positive and negative. Positive environmental factors are mentioned in **Fig.1.6**.

Positive environmental factors sustain health, and promoting them is preventive medicine. They include:

- a. sources of nutrition (farming: soil quality, water availability, biodiversity/bio-integrity, genetically modified organisms (GMOs); hunting, fishing: wildlife, fish populations.)
- b. water (drinking, cooking; cleaning / sanitation)
- c. air quality
- d. radiation exposure (protection from UV, cancers, etc)
- e. space for exercise and recreation
- f. housing quality
- g. sanitation / waste recycling and disposal
- h. hazardous waste management
- i. noise control

Fig.1.6: Positive environmental factors

Negative environmental factors are mentioned in **Fig.1.7**.

Negative environmental factors are threats to health and controlling them is public environmental health. They include:

- ✓ environmental conditions favoring disease vectors (endemic and exotic vectors)
- ✓ invasive biota (viruses, bacteria, etc), their hosts and vectors
- ✓ environmental disruptions: floods, droughts, storms, fires, earthquakes, volcanoes;
- ✓ air quality: pollen and pollution leading to respiratory diseases or cancers
- ✓ water quality: biotic and abiotic contaminants; integrity of water transport and treatment infrastructure
- ✓ monitoring and management of municipal, agricultural, industrial, health care and e waste outflows to the environment (gases, liquids, solid wastes)
- ✓ human changes of the environment that
 - create conditions that favour disease
 - disturb and release noxious levels of previously bound chemicals (e.g. mercury released becomes poison) or biota) (e.g. methane released from thawed peat contributes to climate change)
 - create temporary, intense, life-threatening heat islands (e.g. urban heat waves exacerbated by climate change)
 - result from nuclear, biological or chemical warfare or terrorism
 - disruption caused by other war and violence

Fig.1.7. Negative environmental factors

1.6.1 The Natural Environment

Let us read more about the various components of the natural environment.

A. Air temperature

Temperature is a physical property that commonly underlies our notions of hot and cold, although other environmental and personal factors determine human health. Earth's average temperature has risen by about 0.8°C (1.4°F) over the past 100 year due to climate change, which has led to global warming. Health risks related to climate change due to rise in ambient temperature are on the rise worldwide. Climate change will bring new and emerging health issues, including heatwaves and other extreme events which lead to heat stress. Heat stress can make working conditions unbearable and increase the risk of cardiovascular, respiratory and renal diseases. Additionally, it is estimated that 22.5 million people are displaced annually by climate or weather-related disasters, Climate-induced human mobility has a socioeconomic cost and can affect mental and physical health.

Studies on 'U'- or 'V'-shaped relationship between daily temperature and mortality has been documented, with mortality rates increasing above (and below) an optimum (for human health) range of temperatures (between 15°C and 25°C in different countries). Finding of the few studies are listed in **Box. 1.6**.

- a. Studies published between 1993 and 2003 have attributed a 0.7–3.6% increase in all causes of mortality for each °C increase in temperature above a (local) threshold in several European cities.
- b. According to O'Neil & Ebi in 2009 has concluded that only exposure to elevate temperature causes health issues, exposure to cold also has adverse health effects such as increased blood pressure and heart rate, thrombosis and hypothermia. Breathing cold air may also exacerbate respiratory conditions.
- c. They have also concluded that those living in areas where extreme heat is rare are more likely to be affected by heat-related health problems. In contrast, few studies have concluded that some populations who are subject to regular hot spells may develop adaptive behaviours and thus be less affected by heat. A number of studies suggest that air temperature (especially heat) may exacerbate the health effects of air pollution and increase the risk of biological hazards (Ren & Tong 2006).

Box.1.6. Studies related to air temperature

B. Ultraviolet radiation

Ultraviolet radiation (UVR) is also one of the sources of causing health impacts to human (**Fig. 1.8**). UVR exposure can have both beneficial and detrimental effects on health. Low UVR exposure can cause vitamin D deficiency, which is associated with rickets and osteoporosis. It can also cause psychiatric disorders, such as seasonal affective disorder, mood disorders and schizophrenia. High UVR exposure can also cause chronic skin and eye diseases, cancer of the eye, cataract and pterygium can also cause.

Did you know ?

Elevated temperatures can cause heat cramps, heat syncope (fainting), heat exhaustion, heat stroke and dehydration (State Government of Victoria DoHS, 2009).

Did you know ?

- a. A 0.9% increase in mortality for every 1°C increase in maximum temperature in Sydney with mortality 7.8% higher than expected when the maximum temperature reached 32°C (Hu et al. 2008).
- b. 4.5-12.1% increase in mortality for every 10°C increase in maximum temperature in Sydney (Vaneckova et al. 2008). Similar increases in New Zealand (Hales et al. 2000) and East Asian capital cities (Chung et al. 2009).

Source: <http://www.theozonehole.com/images/04-Vulnerabilities-schematic.jpg>



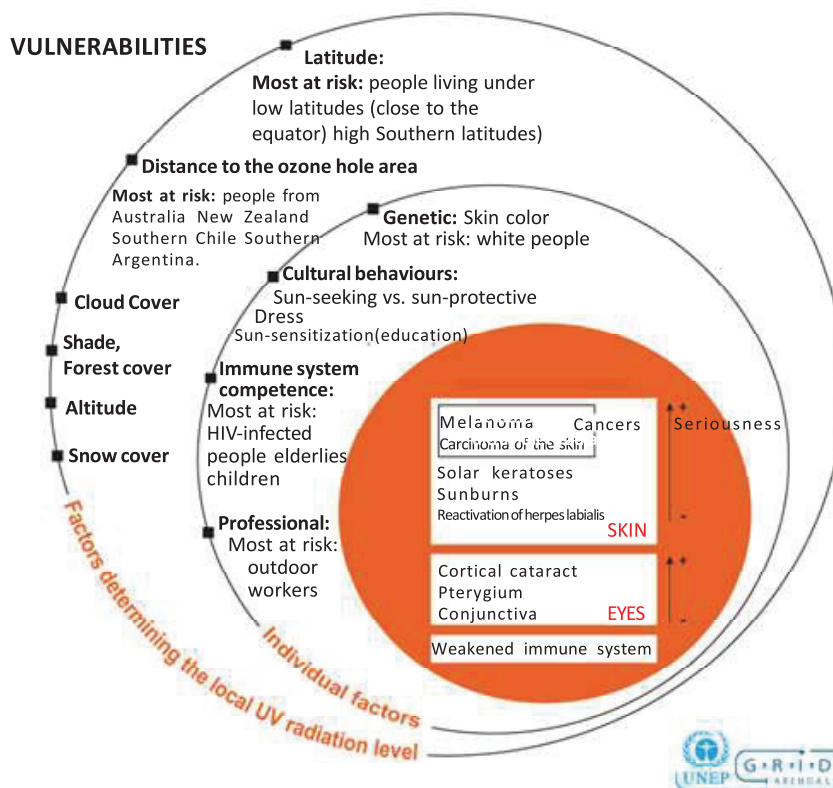


Fig.1.8: Vulnerabilities of Ultraviolet radiations

Source: World Health Organisation Global burden of disease from solar ultraviolet radiation 2006

Note: This figure is for your understanding and not for recall or assessment

C. Outdoor air quality

An extensive body of evidence links exposure to outdoor air pollution and health effects. The effects of short-term exposure include exacerbation of pre-existing respiratory disease (especially asthma and COPD) and pre-existing cardiovascular disease (including ischemia, arrhythmias, and cardiac failure), with increased hospitalisation and emergency department visits. Long-term exposure to air pollution is associated with increased mortality, increased incidence of lung cancer and pneumonia, and development of atherosclerosis. Combustion of fossil fuels for transportation, home heating and cooling, and industry are the main sources of air pollution. Reducing exposure, especially from traffic, is the most effective strategy to mitigate the effects of pollution.

As well as being a leading source of greenhouse gas (GHG) emissions, the transport sector is responsible for a large proportion of urban air pollution. An estimated 3.7 million premature deaths are attributed to ambient (outdoor) air pollution, based on WHO data from 2012. Air pollution-related deaths and illness are linked most closely to exposures to small particulate matter (PM) of less than 10 or 2.5 microns in diameter (PM10 and PM 2.5). Small particulates bypass the body’s defences against dust, penetrating deep into the respiratory system. They also comprise a mixture of health-harming substances, such as heavy metals, sulphurs, carbon compounds, and carcinogens including benzene derivatives. Road transport is estimated to be responsible for up to 30% of particulate emissions (PM) in European cities and up to 50% of PM emissions in OECD countries – mostly due to diesel traffic. However, the total contribution of transport to particulate air pollution can vary widely, from 12%-70% of the total pollution mix. Low- and middle-

D. Climate change and its impact on Health

Climate change may directly or indirectly affect human health via changing weather patterns and extreme events; impacts on ecosystems, agriculture, and livelihoods; exacerbation of existing environmental problems, such as poor air quality, water scarcity and deterioration of water quality; and damage to infrastructure, for example, water and energy supplies (Fig. 1.9). Numerous studies have often proven that climate change is already contributing to the global burden of disease and premature deaths. According to WHO 2011, climate change-related health effects depend largely on population vulnerability and its ability to adapt, linked to ecological, social, economic and cultural factors. Vulnerable population groups include the elderly and children, the urban poor, traditional societies, subsistence farmers, and island and coastal populations. In simple words, the poor and less privileged suffer the adverse consequences of climate change.

<http://www.who.int/sustainable-development/transport/health-risks/air-pollution/en/>

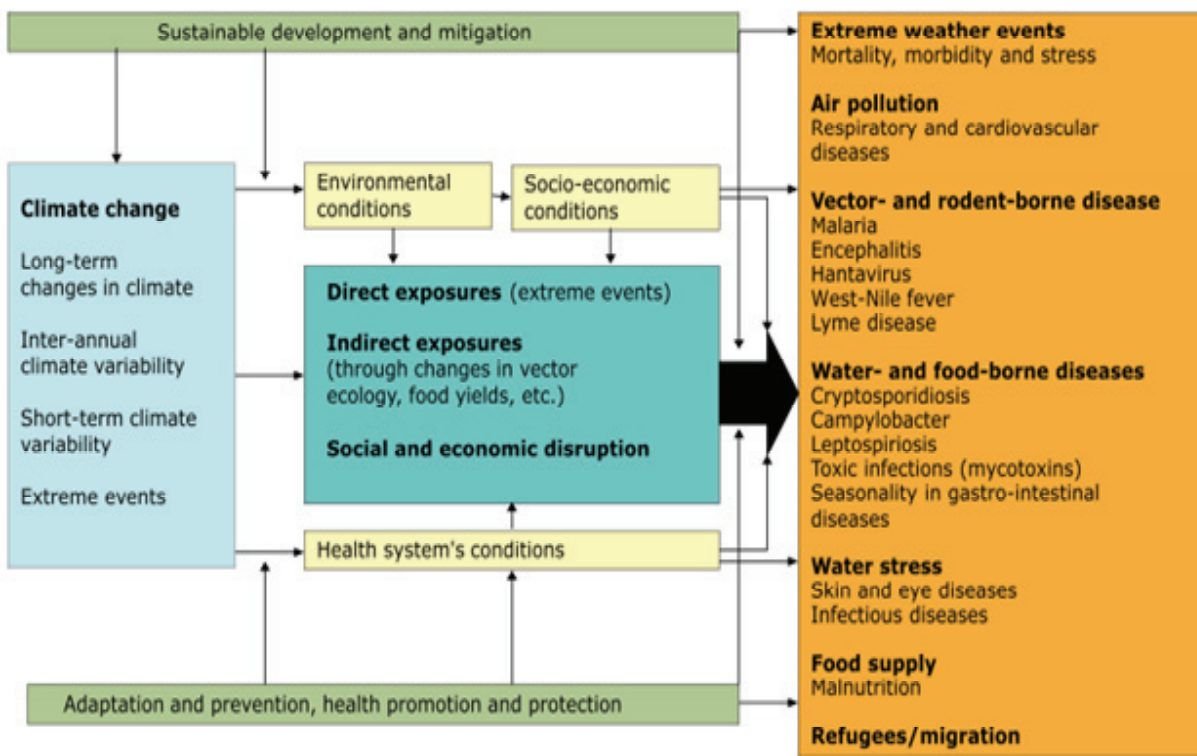


Fig.1.9: Impact of climate change on health

Source: Wolf, 2011

A Conceptual diagram Fig. 1.10, illustrating the exposure pathways by which climate change affects human health. Exposure pathways exist within the context of other factors that positively or negatively influence health outcomes (gray side boxes). Key factors that influence vulnerability for individuals are shown in the right box, and include social determinants of health and behavioural choices. Key factors that influence vulnerability at larger scales, such as natural and built environments, governance and management, and institutions, are shown in the left box. All of these influencing factors can affect an individual's or a community's vulnerability through changes in exposure, sensitivity, and adaptive capacity and may also be affected by climate change.

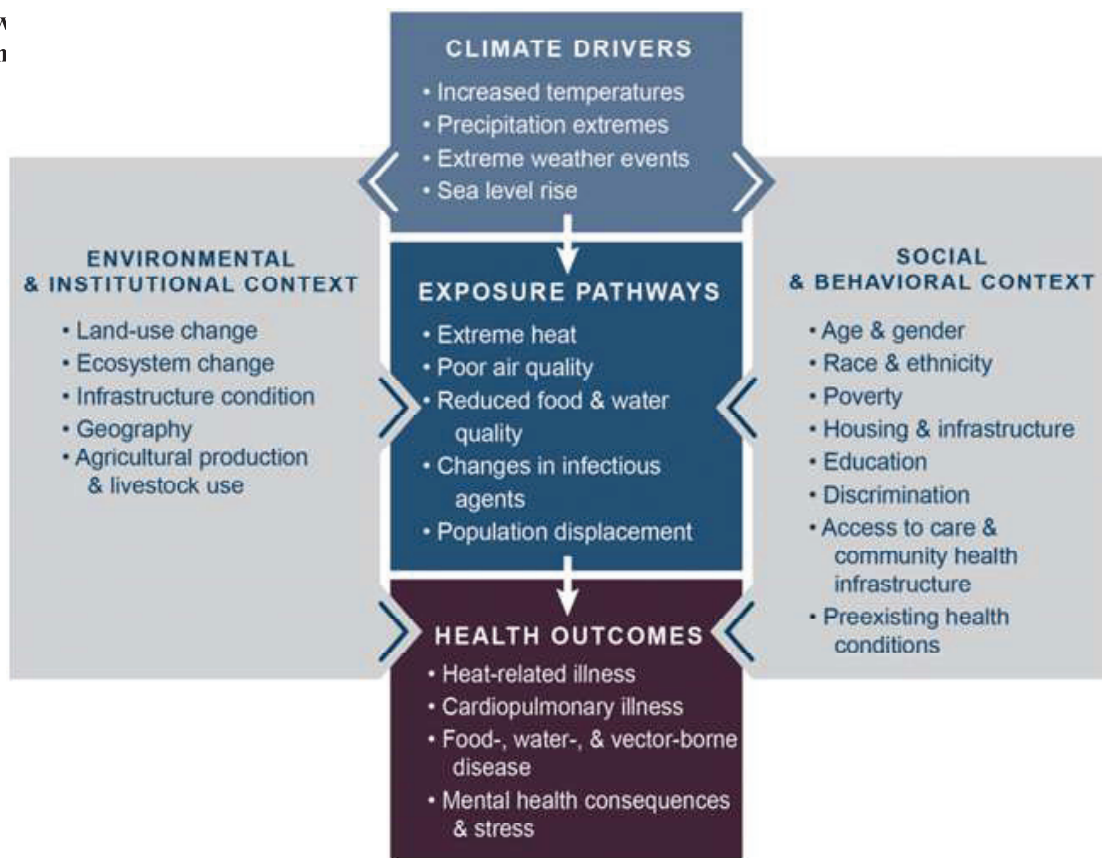


Fig. 1.10: Climate change and health

Source: globalchange.gov

Think and reflect

How do you think can water be contaminated? Can you take some measures to prevent the water from getting contaminated in the hospitals?

E. Food safety and water quality

Food is said to be unsafe when it is likely to cause physical harm to a person who may later consume it. The two major food borne illnesses are Salmonellosis (caused by the Salmonella bacterium) with symptoms such as fever, headache, nausea, vomiting, abdominal pain and diarrhoea. Examples of foods involved in outbreaks of salmonellosis are eggs, poultry and other meats, raw milk and chocolate and the other disease is Campylobacteriosis (caused by certain species of Campylobacter bacteria) with symptoms such as severe abdominal pain, fever, nausea and diarrhoea. Food borne cases are caused mainly by raw milk, raw or undercooked poultry and drinking water. Water-borne diseases are infectious diseases spread primarily through contaminated water. Hepatitis, cholera, dysentery, and typhoid are the more common water-borne diseases that affect large populations in the tropical regions. Exposure to polluted water can cause diarrhoea, skin irritation, respiratory problems, and other diseases, depending on the pollutant that is in the water body. According to WHO, chemical contaminants in water may provoke various health issues such trouble breathing, dermatitis, methaemoglobinaemia, etc.

F. Vector populations

Vector-borne diseases are infections transmitted by the bite of infected arthropod species, such as mosquitoes, ticks, triatomine bugs, sandflies, and blackflies. Arthropod vectors are cold-blooded (ectothermic) and thus especially sensitive to climatic factors. Vector-borne diseases are maintained in complex transmission cycles involving blood-feeding arthropod vectors (and usually reservoir hosts) that depend on specific ecological conditions for survival. In areas with limited or deteriorating public health infrastructure and an

increase in temperatures (along with adequate rainfall) will cause certain vector-borne diseases (including malaria, dengue, and leishmaniasis).

1.6.2 The Built Environment

Let us now read about some of the components of the built environment.

A. Indoor air quality

The National Health and Medical Research Council (NHMRC) defines indoor air as any non-industrial indoor space where a person spends a period of an hour or more in any day. It includes the air inside homes, offices, classrooms, cars and public transport and commercial premises such as shopping centres and restaurants. Main sources of indoor pollution include combustion sources (oil, gas, kerosene, coal, wood and tobacco products), volatile organic compounds, building materials (asbestos), carpets, house cleaning and maintenance, personal care or hobbies, central heating and cooling system and humidification devices, lack of ventilation, too much humidity, water infiltration or leakage, carbon monoxide and other gases, radon and other noxious agents. Few indoor air pollutants are listed in the **Table 1.1**.

Table 1.1: Indoor air pollutants and health effects

Sl. No	Pollutant	Sources	Potential Health Effects
1.	Environmental tobacco smoke, carbon monoxide, nitrogen oxides and other gases, organic chemical, pesticides, formaldehyde	Cigarette and cigar smoke, unventilated or malfunctioning gas appliances, wood stoves, tobacco smoke, cooking gases, gas heaters, formaldehyde, volatile organic compounds, odours, products for household cleaning and maintenance, combustion pollution, aerosol sprays, solvents, glues, cleaning agents, pesticides, paints, moth repellents, air fresheners, drycleaned clothing, treated water, products used to kill pests such as insecticides, termiticides and herbicides. Also lawn and garden products, pressed wood products such as plywood and particleboard; furnishings; wallpaper; durable press fabrics	Headache, fatigue, poor memory, cough, respiratory irritation, bronchitis, pneumonia in children, emphysema, lung cancer, heart disease, eye, nose and throat irritation, nausea, angina, impaired vision and mental functioning, fatal at high concentrations, wheezing, nasal congestion, skin irritation, dizziness, confusion, asthma, loss of coordination, damage to liver, kidney and brain; various types of cancer, damage to the central nervous system and liver, allergic reactions; cancer
2.	Respirable particles, asbestos	Cigarettes, wood stoves, fireplaces, aerosol sprays, and house dust, textile, wallboard, wood, decorating hazards, insulation, damaged or deteriorating insulation, fireproofing, and acoustical materials	Eye, nose and throat irritation, increased susceptibility to respiratory infections and bronchitis, lung cancer, asbestosis, mesothelioma

Did you know ?

Of the total amount of waste generated by health-care activities, about 85% is general, non-hazardous waste comparable to domestic waste. The remaining 15% is considered hazardous material that may be infectious, chemical or radioactive.

3.	Radon	Soil under buildings, some earth-derived construction materials, and groundwater	Lung cancer
4.	Lead	Sanding or open-flame burning of lead paint; house dust	Nerve disorders, anaemia; damage of kidney; growth retardation
5.	Biological organisms and other organic pollutants	House dust, dust mites, pets, bedding; poorly maintained air conditioners, humidifiers and dehumidifiers, wet or moist structures, furnishings, insects, cockroach parts, pollen, animal dander and saliva, protein in animal urine, bacterial endotoxins and fungal materials	Coughing, shortness of breath, allergic rhinitis, asthma, eye, nose, and throat irritation, humidifier fever, influenza, other infectious diseases, myalgia, malaise, fatigue, hypersensitivity pneumonitis, digestive problems, itching

Source: file:///C:/Users/User/Downloads/zuskin_37_40.pdf

B. Walkability

Walkability is a relatively new concept that captures how conducive an area is to walking for leisure, exercise or transport. Inadequate physical activity is associated with an increased risk of ill-health and death, and has been linked to increased rates of overweight and obesity, cardiovascular disease, diabetes and some cancers.

C. Green space

Physical and psychological benefits have been linked to green spaces through their purported effects on physical activity. Several researches have shown that numerous health benefits of physical activity have been documented, such as the effects on cardio- and cerebro-vascular disease, diabetes, colorectal cancer, osteoporosis, depression and fall-related injuries. It also improves mental functioning, mental health and well-being¹⁶⁻²² and may have long-lasting psychological benefits. According to WHO, those who used woods and forests for physical activity had a lower risk of poor mental health. Furthermore, higher levels of green space had a more positive effect on stress regulation in women than in men.

D. Environmental noise

Acute noise events which do not cause permanent health impairments are considered as non-substantial. However, effects of long term noise exposure, which do not habituate but increase the long-term risk of physical damage, are assessed as health hazards. Exposures to high environmental levels can cause nervous and cardiovascular system problems and even some psychological disorders leading to annoyance, irritation and mood swings.

E. Overcrowding in housing

Overcrowding has the potential to influence physical and mental health through a variety of channels. For example, it may place stress on bathroom, kitchen and laundry facilities and on sewerage systems such as septic tanks. It may alter the relationships between household members, induce psychological stress or affect childhood development. The poor can not afford bigger spaces, have

higher number of household members and hence fall prey to the consequences of over crowding. Crowded living condition, close proximity of a group of people, increase the risk of spread of infectious diseases and leads to poor health in the communities.

F. Housing condition

Housing-related health risks include, respiratory and cardiovascular diseases from indoor air pollution; illness and deaths from temperature extremes; communicable diseases spread because of poor living conditions, and risks of home injuries. Housing condition is related to the main physical structures of the dwelling such as walls, floors, foundations, roof, electrical wiring and plumbing. Problems may include rising damp, major cracks in walls and floors, sinking or moving foundations or sagging floors. WHO estimates that nearly 2 million people in developing countries die from indoor air pollution caused by the burning of biomass and coal in leaky and inefficient household stoves.

Inadequate ventilation is also associated with a higher risk of airborne infectious disease transmission, including tuberculosis, as well as the accumulation of indoor pollutants and dampness, which are factors in the development of allergies and asthma. Poor housing quality and design also can exacerbate the health impacts from exposure to temperature extremes, which are occurring more frequently due to climate change. Adverse health effects associated with damp and mouldy dwellings have been widely observed. Diseases are also cause by exposure to asbestos fibres which causes cancers (mesothelioma and lung cancer) and asbestosis.

Did you know ?

Researchers found that dampness and mould increased the risk of a variety of respiratory and asthma-related health outcomes by 30-52%.

1.6.3 Impacts of Waste on Human Health

Improper waste management and illegal waste shipments can have negative impacts on both environment and public health. Negative impacts can be due to different handling and disposal activities resulting in soil, water and air pollution. Inadequately disposed of or untreated waste may cause serious health problems for populations surrounding the area of disposal. Leaks from the waste may contaminate soils and water streams, and produce air pollution through emissions of e.g. heavy metals and persistent organic pollutants (POPs), ultimately creating health hazards. Other nuisances caused by uncontrolled or mismanaged waste disposal which may affect citizens negatively include impacts at local level, such as landscape deterioration, local water and air pollution, as well as littering. Managing waste properly and in an environmentally sound way is therefore important for health reasons.

Unattended waste lying around attracts flies, rats, and other creatures that in turn spread disease. Normally it is the wet waste that decomposes and releases a bad odour. This leads to unhygienic conditions and thereby to a rise in the health problems.

A. Solid waste

The group at risk from disposal of **solid waste include** the population in areas where there is no proper waste disposal method, especially the pre-school children; waste workers; and workers in facilities producing toxic and infectious material. Other high-risk group includes population living close to a waste dump and those, whose water supply has become contaminated either due to waste dumping or

Use full link for better understanding:<https://www.youtube.com/watch?v=e01c20ArZso>



leakage from landfill sites. Uncollected solid waste also increases risk of injury, and infection. In particular, organic domestic waste poses a serious threat, since they ferment, creating conditions favourable to the survival and growth of microbial pathogens. Direct handling of solid waste can result in various types of infectious and chronic diseases with the waste workers and the rag pickers being the most vulnerable.

Waste from agriculture and industries can also cause serious health risks. Other than this, co-disposal of industrial hazardous waste with municipal waste can expose people to chemical and radioactive hazards. Uncollected solid waste can also obstruct storm water runoff, resulting in the forming of stagnant water bodies that become the breeding ground of disease. Waste dumped near a water source also causes contamination of the water body or the ground water source. Direct dumping of untreated waste in rivers, seas, and lakes results in the accumulation of toxic substances in the food chain through the plants and animals that feed on it.

Did you know ?

Annually, about 12 million tons of inert waste are generated in India from street sweeping and construction and demolition debris waste and in the landfill sites, it occupies about one-third of total MSW.

Case studies:

A study studies on the health hazards associated with waste disposal in the localities of Kolkata, India found that high volume of solid waste generation, inadequate collection space, and the presence of open-dump sites observed that the people living in this area have poor health like allergy, asthma, skin irritation and other gastro intestinal diseases.

Similar condition was observed in Varanasi City, India.

Source: <https://timesofindia.indiatimes.com/city/varanasi/Improper-municipal-waste-management-is-hazardous-for-human-life/articleshow/29238355.cms>

Did you know ?

Of the total amount of waste generated by healthcare activities, about 85% is general, non hazardous waste comparable to domestic waste. The remaining 15% is considered hazardous material that may be infectious, chemical or radioactive.

B. Hazardous waste

Exposure to hazardous waste can affect human health, children being more vulnerable to these pollutants. In fact, direct exposure can lead to diseases through chemical exposure as the release of chemical waste into the environment leads to chemical poisoning. Many studies have been carried out in various parts of the world to establish a connection between health and hazardous waste.

C. E-Waste

E-waste like refrigerators, computers, washing machines etc. comprises a source of a variety of materials that can be recovered and brought back into the production cycle. Over 1,000 different chemicals (as heavy metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and brominated flame retardants) are identified in the e-waste streams. The population exposed to potentially hazardous substances through inappropriate and unsafe management practices related to e-waste is increasing. Given the pollutants involved, health effects from treatment of e-waste may include neurodevelopmental outcomes. A recent review recorded plausible outcomes related to alterations in thyroid function, associations of exposure to chromium, manganese and nickel with lung function, adverse birth outcomes (preterm birth, low birth weight, stillbirth, and congenital malformations), behavioural alterations, as well as DNA damage and chromosomal aberrations in lymphocytes. This relatively recent and growing problem needs to be addressed by suitable epidemiological studies in vulnerable populations (such as pregnant women and children).

D. Health Care Waste

Disposal of hospital and other medical waste requires special attention since this can create major health hazards. This waste generated from the hospitals, health care centres, medical laboratories, and research centres such as discarded syringe needles, bandages, swabs, plasters, and other types of infectious waste are often disposed with the regular non-infectious waste.

The major sources of health care waste are mentioned in **Fig.1.11**.

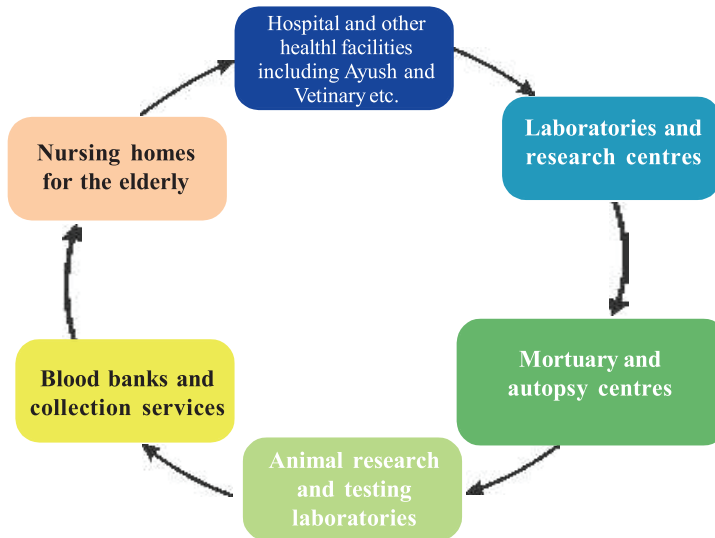


Fig.1.11: Major sources of health care waste

Health care waste contains potentially harmful microorganisms that can infect hospital patients, health workers and the general public. Other potential hazards may include drug-resistant microorganisms which spread from health care facilities into the environment.

Hazards associated with health care waste and by-products are mentioned in **Fig. 1.12**.

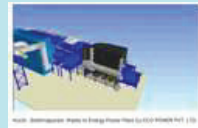
Hazards associated with health care waste

- Sharps-inflicted in injuries;
- toxic exposure to pharmaceutical products, in particular, antibiotics and cytotoxic drugs released into the surrounding environment and to substances such as mercury or dioxins, during the handling or incineration of health care wastes;
- chemical burns arising in the context of disinfection, sterilisation or waste treatment activities;
- air pollution arising as a result of the release of particulate matter during medical waste incineration;
- thermal injuries occurring in conjunction with open burning and the operation of medical waste incinerators; and
- Radiation burns.

Fig. 1.12: Hazards associated with health care waste

Useful links for safe disposal of waste and converting them to wealth for cleaner environment: Effect of hazardous and solid waste on human health:

Solid waste to energy at Kochi:<https://www.youtube.com/watch?v=sAzf4RQkZc0>



Plastic waste to energy:<https://www.youtube.com/watch?v=8I2cVnGliTE>



Recycling Process of bio-hazardous waste :<https://www.youtube.com/watch?v=PVioKDIIIfUE>



Check Your Progress 4

1. What are the environmental factors that affect human health ?

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2. List few indoor air pollutants that is hazardous to human health.

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Learn more about understanding the population vulnerable to environmental health hazard by visiting the following links or references.

1. Ebi K, Kovats R, Menne B. 2006. An Approach for Assessing Human Health Vulnerability and Public Health Interventions to Adapt to Climate Change. Environmental Health Perspectives 114(12): 1930-1934. doi: 10.1289/ehp.8430

2. ANIDA Workshop Papers: Improving the Urban Environment and Reducing Poverty; December 5, 2000; Copenhagen, Denmark.
3. https://www.youtube.com/watch?v=l7hT5c_-8I8



1.7 IMPACT OF ENVIRONMENTAL HAZARDS ON POPULATION

Globally, the per capita number of healthy life years lost to environmental risk factors was about 5-times greater in children under five years of age than in the total population. Diarrhoea, malaria and respiratory infections all have very large fractions of disease attributable to environment, and also are among the biggest killers of children under five years old. In developing countries, the environmental fraction of these three diseases accounted for an average of 26% of all deaths in children under five years old. Perinatal conditions (e.g. prematurity and low birth weight); protein-energy malnutrition and unintentional injuries – other major childhood killers – also have a significant environmental component, particularly in developing countries.

On average, children in developing countries lose 8-times more healthy life years, per capita, than their counterparts in developed countries from environmentally-caused diseases. In certain very poor regions of the world, however, the disparity is far greater; the number of healthy life years lost as a result of childhood lower respiratory infections is 800-times greater, per capita; 25-times greater for road traffic injuries; and 140-times greater for diarrhoeal diseases. Even these statistics fail to capture the longer term effects of exposures that occur at a young age, but do not manifest themselves as disease until years later .

Check Your Progress 5

1. Who is the most vulnerable population to environmental health hazard?

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1.8 REDUCING THE DISEASE BURDEN THROUGH ENVIRONMENTAL INTERVENTIONS

Environmental health intervention helps to achieve reduction of the diseases in several ways. Providing clean water and latrines at school (particularly latrines for girls) will encourage primary school students to come to school.

Interventions that provide fuel for houses and improving household ventilation will also prevent respiratory diseases in the women.

Environmental interventions can contribute by providing a safe home environment, which is of great importance to the health of children and pregnant mothers. An unprotected or contaminated home environment is a threat to the mother and her unborn child. Childbirth, for example, requires safe water and sanitary conditions.

Environmental interventions could also reduce the number of deaths from diarrhoea and lower respiratory infections by over 3 million each year. With the exception of HIV/AIDS, all of these diseases affect children in large number, and even HIV/AIDS can have a major indirect impact on the health of children.

Providing sustainable sources of safe water and clean energy are key environmental interventions. Environmental interventions will likely have a great impact on improving the health of slum dwellers, who are among those most affected by the combined health hazards associated with polluted water, inadequate sanitation, urban ambient air pollution, and indoor air pollution from solid fuel use.

In summary, environmental health interventions can make a valuable and sustainable contribution towards reducing the global disease burden and improving the well-being of people everywhere. Many interventions can be cost-effective and have benefits beyond improving people’s health, benefits such as helping to alleviate poverty and reducing gender inequalities.

Both the health sector and non-health sector actors can, and need, to take joint action to effectively address environmentally-mediated causes of disease. To do this global partnerships are essential. Many such alliances already exist in the field of children's environmental health; occupational health; in joint health sector and environment sector linkages; and in actions in the water, chemical and air pollution sectors. Such global partnerships need to be strengthened and reinforced, harnessing the full range of policy tools, strategies and technologies that are already available- to achieve the interrelated goals of health, environmental sustainability, and development.

Did you know?
 Every year, there are over half a million deaths from malaria worldwide and over a quarter of a million deaths from HIV/AIDS that are related to environmental and occupational causes. Targeted environmental interventions could reduce the impact of major diseases such as these and help to achieve the MDG. Environmental interventions could also reduce the number of deaths from diarrhoea and lower respiratory infections by over 3 million each year. With the exception of HIV/AIDS, all of these diseases affect children in large number, and even HIV/AIDS can have a major indirect impact on the health of children.

Did you know?
 Over half of the world’s population still relies on biomass fuels and coal meet their energy needs, resulting in 1.5 million deaths a year from respiratory diseases (a combination of lower respiratory infections, chronic obstructive pulmonary disease and lung cancer) (WHO, 2006).

Check Your Progress 6

1. List two interventions for protecting our environment.

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1.9 LET US SUM UP

This unit provides a brief discussion on how the environment and the health hazard to human are interrelated. The environmental factors responsible for diseases are elaborated in detail. With this discussion, the most vulnerable population to the disease has been identified and the recommendations for reducing the disease burden on environment are listed. The summary of the concepts covered in this unit are also placed in the **Fig. 1.13** for your reference and recall.

Inter-Relationship between Health and Environment

<https://www.youtube.com/watch?v=tupJDf13jBo>

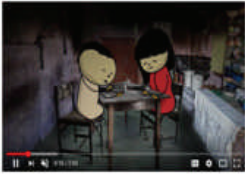


Fig. 1.13: Mind Map

1.10 GLOSSARY

- Disease:** Disease is any condition which results in the disorder of a structure or function in a living organism that is not due to any external injury.
- Health:** Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.
- Vulnerable:** Exposed to the possibility of being attacked or harmed, either physically or emotionally.
- WHO:** World Health Organisation

1.11 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

WHO defined health as physical, mental, and social well-being, and not merely the absence of disease and infirmity

Check Your Progress 2

1. The seven dimension of health are: Physical Dimension, Intellectual Dimension, Emotional Dimension, Spiritual Dimension Social Dimension, Occupational Dimension, Environmental Dimension .
2. There are a range of personal, social, economic, and environmental factors that influence health status known as determinants of health.

Check Your Progress 3

1. The Epidemiologic Triad is a model that scientists have developed for studying health problems. It helps us understand infectious diseases and how they spread. The mission of an epidemiologist is to break at least one of the sides of the Triangle, disrupting the connection between the environment, the host, and the agent, and stopping the continuation of disease.
2. The two phases for disease development are: The early pathogenesis and late pathogenesis phases

Check Your Progress 4

1. Physical, chemical, radioactive contaminants, biological and psychological aspects are the important environmental factors that affect human health.
2. Respirable particles, asbestos, Radon, Lead, Biological organisms and other organic pollutants are indoor air pollutants affecting human health.

Check Your Progress 5

1. Children

Check Your Progress 6

1. Eradication of extreme poverty and hunger and by achieving universal primary education

1.12 REFERENCES AND FURTHER READINGS

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UNIT 2 IMPACT OF HEALTH CARE WASTE ON HUMAN HEALTH

Structure

2.0 Objectives	2.4.1 Mercury
2.1 Introduction	2.4.2 Cadmium
2.2. Impact of Infectious Agents in Health Care Waste	2.4.3 Chromium
2.2.1 Sources of Infectious Agents in Health Care Waste	2.4.4 Risks from Toxic Chemical Laboratory Waste
2.2.2 Types of Infectious Agents in Health Care Waste	2.4.5 Common Disinfectants
2.2.3 Modes of Transmission	2.4.6 Gaseous Pollutants
2.2.4 Chances of Infections	2.4.7 Exposure to Chemicals from Emissions
2.2.5 Type of Infections as per Nature of Waste and Exposure	2.4.8 Chemical Injuries
2.2.6 Historical Incidents of Hazards Due to Infectious Waste	2.5 Effect of Radiological Pollutants
2.3 Impact of Physical Agents in Health Care Waste	2.5.1 Sources of Radioactive Waste in Hospitals
2.3.1 Risks from Effects of Treatment Technologies and Disposal Methods	2.5.2 General Impact of Radioactive waste on Human Health
2.3.2 Physical Injuries	2.6 Effects of Genotoxic Waste
2.4 Impact of Chemicals in Health Care Waste	2.7 Impact of Health Care Waste on Visitors and Community
	2.8 Let Us Sum Up
	2.9 Glossary
	2.10 Answers to Check Your Progress

2.0 OBJECTIVES

After studying this unit, you should be able to:

- identify health hazards from infectious health care waste
- list types of sources of infectious agents in health care waste
- access risk and susceptibility of target population to the hazards and
- discuss the impact of infectious agents on the health care providers and waste workers

2.1 INTRODUCTION

Health care facilities are meant to protect life and restore health but, in the process they can also generate large amounts of potentially hazardous and infectious waste which can impact human health.

Among the health care wastes, infectious waste causes the greatest risk to human health. Nearly 5-10 % of healthcare associated infections in the hospitalised patients are due to infectious waste. The complexity of infectious waste and rise in infections like AIDS, SARS, EBOLA through mishandling and unsafe disposal practices, are a matter of concern.

Proper management of health care waste is of paramount importance. Improper management poses occupational and public health risks including risks to health care workers, waste handlers, patients and community at large. This also leads to contamination of air, water and soil, which affects not only human health but also all forms of life.

Toxins from the health care waste that is dumped into ocean affect sea life. Organisms that eat plants or fish who have ingested or absorbed such waste then pass it along the food chain in the ocean and affects humans who eat these contaminated seafood or plant. The harmful toxins affect human growth development and health.

Health care waste washed down ocean lines may contain harmful bacteria or viruses, which could pose a risk of infection to the humans and other living beings.

Health care waste also containing chemicals can affect the human health, if not segregated at source. Toxic waste containing constituents like mercury and lead which can accumulate in human and animal tissues and continued exposure to these heavy metals, increases their toxicity. In the environment, these effects can assimilate through the food chain and can bio-accumulate.

Other harmful agents in the health care waste could be physical, radiological and genotoxic pollutants.

At times the treatment technologies adopted for treatment of infectious waste themselves could be a cause of increase in health hazards. One such example is open burning of waste as well as Incineration. Incineration process releases dioxins and other by products if the incinerator is not operated in accordance with the operating standards prescribed under the Bio-Medical Waste Management Rules, 2016 as amended and not operated with the required air pollution control devices. Long term exposure to these carcinogenic chemicals can cause cancers, nervous system disorders, while short term exposure can lead to skin lesions and may also affect liver functions.

In this unit we will focus on the impact of different kinds of infectious and hazardous waste like infectious anatomical waste, pathological waste, sharps, pharmaceutical wastes, genotoxic and chemical wastes i.e., wastes with high content of heavy metals, pressurised containers and radioactive waste on human health. We will also discuss the impact of different physical, chemical, biological and radiological pollutants on human health.

2.2 IMPACT OF INFECTIOUS AGENTS IN HEALTH CARE WASTE

A large number of infectious organisms are found in the Health care waste. If proper precautions are not taken, these infectious agents could have an effect on the health care functionaries generating and handling health care waste.

2.2.1 Sources of Infectious Agents in Health Care Waste

Let us first look at the different categories of infectious health care waste generated during various health care activities (**Box 2.1**).

Think and reflect

How many people do you think consider items like soiled cotton swabs, and microbiological waste as infectious? Make a small proforma and interview few health care workers and few patients or their relatives and see if there is any difference in the response of the two groups.

1. Anatomical waste -The anatomical waste in hospitals consists of human anatomical waste like human tissues, organs, body parts, placenta and aborted foetuses. It also includes animal waste, from animal tissues, organs, body parts, carcasses, body fluids, blood and experimental animals used in research. Waste generated by veterinary hospitals also forms part of anatomical waste.
2. Waste contaminated with blood and body fluids - This could be soiled waste consisting of the dressings, plaster casts, cotton swabs and bags containing residual or discarded blood and blood components. Linen and bedding or mattress contaminated with blood or body fluids also could contain infectious organisms.
3. Chemical liquid waste - Infected secretions, aspirated body fluids and wastewater from hospitals.
4. Contaminated recyclable waste - Recyclable waste contaminated with blood and body fluids – such as tubing, bottles, intravenous tubes and sets, catheters, urine bags, syringes (without needles and fixed needle syringes) and vacutainers with their needles cut) and gloves. These also include – Waste from infected patients in isolation wards (e.g., excreta, dressing materials from infected surgical wounds, clothes heavily soiled with human blood or body fluids). Waste that has been in contact with infected patients undergoing haemo-dialysis (e.g. dialysis equipment such as tubing and filters, disposable towels, gowns, aprons, gloves and laboratory coats).
5. The microbiological and biotechnology waste like laboratory cultures, stocks, specimens of microorganism, live or attenuated vaccines, human and animal cell cultures used in research and infectious agents from research laboratories and wastes from culture dishes and devices used to transfer of cultures are also part of biological health care waste.
6. Sharps waste consisting of needles, scalpels, knives, blades, syringes.
7. Contaminated broken glass vials and metallic body implants etc.

Box 2.1: Types of health care waste as a source of biological pollutants

The effects of these infectious wastes on health of the personnel depends upon the dosage of infective agent, the susceptibility of the individual and portal of entry as well as on the methods of disposal. We shall read more about these factors in the subsequent sub-sections. If the cultures and infectious materials, toxins etc. are not disposed of properly they constitute an obvious hazard of infection to people handling them. If disposed of in common municipal waste dumps, they may infect rag-pickers and children playing in these dumps.

2.2.2 Types of Infectious Agents in Health Care Waste

Infectious agents include bacteria, viruses, fungi, other microorganisms and their accompanying toxins. These organisms are prevalent in all natural environments; in water, soil, plants, and animals.

Infectious waste is generated as a result of activities pertaining to patient care, they are suspected to contain pathogens i.e., bacteria, viruses, parasites or fungi in sufficient concentration or quantity to cause diseases in susceptible hosts.

Did you know ?

The infectious agents have the capability to adversely affect human health in multiple ways, ranging from relatively mild, allergic reactions to serious medical conditions, even death.

Almost any pathogen can cause health care associated infections, but those that are able to survive in hospital environment for longer periods. Development of resistance to antibiotics and disinfectants are particularly important. Pathogenic microorganisms have limited ability to survive in the environment. This ability is specific to each microorganism and is a function of its resistance to environmental conditions, such as humidity, temperature, ultraviolet irradiation, and availability of organic substrate material.

Table 2.1 Provides a list of the potential microorganisms that can be found in health care settings along with their routes of transmission.

Think and reflect

What do you think are the main reasons for resistance to antibiotics?

Table 2.1: Types of organisms and their modes of transmission

Type of Infection	Examples of causative organisms	Transmission vehicles
Gastroenteric infections	Enterobacteria, e.g. Salmonella, Shigella spp., Vibrio cholerae, Clostridium difficile, helminthes	Faeces and /or vomit
Respiratory infection	Mycobacterium tuberculosis, measles virus, Streptococcus pneumonia, severe acute respiratory syndrome (SARS)	Inhaled secretions, saliva
Ocular infection	Herpesvirus	Eye secretions
Genital infections	Neisseria gonorrhoeae, herpesvirus	Genital secretions
Skin infections	Streptococcus spp.	Pus
Anthrax	Bacillus anthracis	Skin secretions
Meningitis	Neisseria meningitides	Genebrospinal fluid
Acquired immunodeficiency syndrome (AIDS)	Human immunodeficiency virus (HIV)	IBlood, sexual secretions, body fluids
Haemorrhagic fevers	Junin, Lassa, Ebola and Marburg viruses	All bloody products and secretions
Septicaemia	Staphylococcus spp.	Blood
Bacteraemia	Goagulase-negative Staphylococcus spp. (including methicillian-resistant S. aureus), Enterobacter, Enterococcus, Klebsiella and Streptococcus spp.	Nasal secretion, skin contact
Candidaemia	Candida albicans	Blood
Viral hepatitis A	Hepatitis A virus	Faeces
Viral l hepatitis B and C	Hepatitis B and C viruses	Blood and body fluids
Avian influenza	HSN1 virus	Blood, faeces

Source : Safe management of wastes from health-care activities, WHO 2014.

Check Your Progress 1

1. Indicate True (T) or False (F):
 - a. Biological waste consists of human anatomical waste like human tissues, organs, body parts, placenta. (True/False)

b. Aborted foetus is considered as biological waste. (True/False)

c. The waste from animal tissues, organs, carcasses are not considered as biological waste. (True/False)

d. Body fluids, blood, experimental animals used in research are not part of biological waste. (True/False)

2. What is infectious waste?

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3. What are the sources of infectious waste?

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2.2.3 Modes of Transmission

All infectious waste should always be assumed to contain pathogenic microorganisms. The infections from the infectious health care waste can be contacted through various routes. These are referred to as the modes of transmission. You have already read in details about the routes of transmission in Unit 18, Block 1, BHM-102.

The infectious agents could be transmitted through a variety of routes. The most common ones are mentioned in **Box 2.2**.

Modes of transmission of infections from infectious waste.
- Through puncture, abrasion, or cut in the skin
- Through the mucous membrane
- By inhalation
- By ingestion
- By vectors

Box 2.2: Modes of transmission

In evaluating the survival or spread of pathogenic microorganisms in the environment, the role of vectors such as rodents and insects should be considered. This applies to management of health care waste both within and outside health care facilities. Vectors such as rats, flies and cockroaches, which feed or breed on organic waste, are well-known passive carriers of microbial pathogens; their populations may increase dramatically where there is mismanagement of waste (WHO Blue book).

2.2.4 Chances of Infections

The chances of contacting infections from infectious waste depend upon a number of factors (**Box 2.3**).

a. Type of organism

A large number of organisms are present both in the environment and the waste. However, not all organisms result in infections. The infectivity or the virulence of the organism is an important factor determining if the organism will cause the disease. For example, Hepatitis C Virus has a relatively high virulence and generally contributes to the development of diseases, once the host is infected. In contrast, *Candida albicans* is routinely found associated with human skin, mucosal surfaces and the digestive system, but is not generally the cause of significant disease in healthy individuals.

b. Load of infection

When only a few organisms are present, an infection may not necessarily develop. However, when a critical number is exceeded, it is very likely that an infection will become established. For every type of microorganism, the minimal infective dose can be determined. This is the lowest number of bacteria, viruses or fungi that cause the first clinical signs of infection in a healthy individual. For most causative agents of nosocomial infections, the minimal infective dose is relatively high. For example, for *Klebsiella* and *Serratia* spp. and other Enterobacteriaceae, it is more than 10⁵ colony-forming units (CFUs)/gram, but for hepatitis B virus it is less than 10 plaque-forming units (PFUs)/ gram.

Source:

Safe management of wastes in health-care activities WHO, 2014.

c. Type of exposure

Many pathogenic microorganisms require some deliberate or accidental break in the skin, such as cuts or intravenous lines, to enter the host. Alternatively, infectious agents in the form of particulates or aerosols, may be inhaled or accidentally transferred to the eyes, nose or mouth. The size of the particle containing the microorganism or the organism itself will govern the level within the pulmonary tree upon which it will be deposited. Large particles may never be inhaled into the lungs, but remain trapped on the nasal cilia. Small particles which are less than 5 microns in diameter can generally reach the lowest areas within the lungs, where they may initiate infection. Pathogenic microorganisms often gain access through the host’s ingestion of contaminated food or water. In addition, medical procedures such as endoscopy, can introduce infectious agents to the gastrointestinal tract. The catheterisation of the host as part of standard medical procedures may lead to infections of the urinary tract and the blood. Once the pathogenic agent has gained a portal of entry into the host, it may simply colonise the entry site without any evidence of disease. Alternatively, the same agent in contact with a different site may be capable of causing an infection and potentially the development of disease.

Source:

http://www.who.int/water_sanitation_health/medicalwaste/en/microbhzards0306.pdf

d. Susceptibility of the host

Whether an individual will contract the disease or not will depend upon his susceptibility. This depends upon a number of factors like age, sex, immunity, genetic predisposition, other associated infections and disorders. For example, the children and elderly are generally more prone to contract infections. Similarly people suffering from diabetes or cancer are more prone to contract infections.

Source:
http://www.who.int/water_sanitation_health/medicalwaste/en/microbhzards0306.pdf



2.2.5 Type of Infections as per Nature of Waste and Exposure

Let us learn more about the type of infections that can be contacted based on the type of waste or exposure. See **Box 2.4**.

a. Needlestick injury or accidental exposure to blood/body fluids during spill or splashes

The most common infections that are transmitted during such an exposure are Hepatitis B, Hepatitis C and HIV. The risk of acquiring a secondary infection following needlestick injury from a contaminated sharp depends on the amount of the contamination and nature of the infection from the source patient (**Table 2.2**).

Table 2.2: Risk of transmission of infection following occupational exposure

Bloodborne virus	Risk of transmission of infection
HIV	0.3% ^{a-c}
Hepatitis B	18-30% ^d
Hepatitis C	1.8% ^e

^a post-exposure prophylaxis can reduce the risk of HIV transmission by 80% (Cardo et al, 1997)

^b WHO & ILO (2007)

^c Bell (1997)

^d Pruss-Ustun et al. (2005)

^e Pro et al. (2010)

Source : Management of wastes from health-care activities WHO, 2014.

There is particular concern about infection with human immunodeficiency virus (HIV) and hepatitis viruses B and C, for which there is strong evidence of transmission from injury by syringe needles contaminated by human blood, which can occur when sharps waste is poorly managed. Although theoretically any needlestick injury can lead to the transmission of bloodborne infections, there is some evidence that hollow needles are associated with a higher risk of transmission than solid needles, such as suture needles (Puro, Petrosillo & Ippolito, 1995; Trim & Elliott, 2003; Ganczak, Milona & Szych, 2006).

The hepatitis B virus is very persistent in dry air and can survive for up to one week under optimal conditions, and has been detected in discarded needles (Cocchi et al., 1984; Paintsilet al., 2010; Walsh Pierce & Hart, 1987). It is also resistant to brief exposure to boiling water and remains viable for up to 10 hours at a temperature of 60 °C. It can survive exposure to some antiseptics and to 70% ethanol.

By contrast, HIV is much less resistant. It survives for no more than 15 minutes when exposed to 70% ethanol and only three to seven days at ambient temperature. It is inactivated at 56 °C.

b. Contact with pathological/anatomical wastes and soiled wastes

With the exception of waste containing pathogenic cultures or excreta from infected patients, the microbial load of health care waste is generally not very high. Furthermore, health care wastes do not seem to provide favourable media for the survival of pathogens, perhaps because they frequently contain antiseptics. Results from several studies have shown that the concentration

Did you know ?

The risk of infection with hepatitis B is more than 10 times greater than for hepatitis C, and up to 100 times greater than for human immunodeficiency virus (HIV).

of indicator microorganisms in health care waste is generally no higher than in domestic waste and that survival rates are low.

c. Infections caused due to exposure to microbiological or laboratory waste

Cultures and stocks from the clinical laboratory contain high concentrations of many infectious agents, e.g. Mycobacterium tuberculosis, which can be transmitted to the health care workers while handling the infectious wastes.

d. Infections from wastewater

Wastewater can contain a high content of infection causing organisms. The load depends upon the type of patients and activities in the hospital. The load of infection becomes especially high during outbreaks and epidemics. The common organisms that can be found in the wastewater include hepatitis A, Hepatitis E, Cholera, Typhoid etc. Improper management, collection, treatment and disposal of wastewater and sludge will result in the pollution of surface water, and ground water. Consumption of contaminated water can result in diseases. Stagnant water may serve as breeding sites for vectors. This can cause numerous waterborne and vector-borne diseases (e.g. malaria and filariasis) and soil transmitted helminthic infections (e.g. Roundworms or Ascaris lumbricoides).

e. Infections from treatment facilities

Most exposures to biological hazards from health care wastes occur at waste treatment facilities or other locations where workers manually handle untreated waste. Workers may be exposed to blood and body fluids from leaking containers as well as airborne pathogens as the waste enters the treatment process.

Think and reflect
Why do you think the microbiological culture plates are a good source of infection?

Box 2.4: Type of infections as per nature of waste and exposure

Antibiotic and chemical resistant bacteria may develop as a result of improper disposal of health care waste to the environment - *E.Coli*, MDR-TB, MRSA.

2.2.6 Historical Incidents of Hazards Due to Infectious Waste

An overview of historical incident of hazards due to infectious waste is shown in Fig. 2.1.

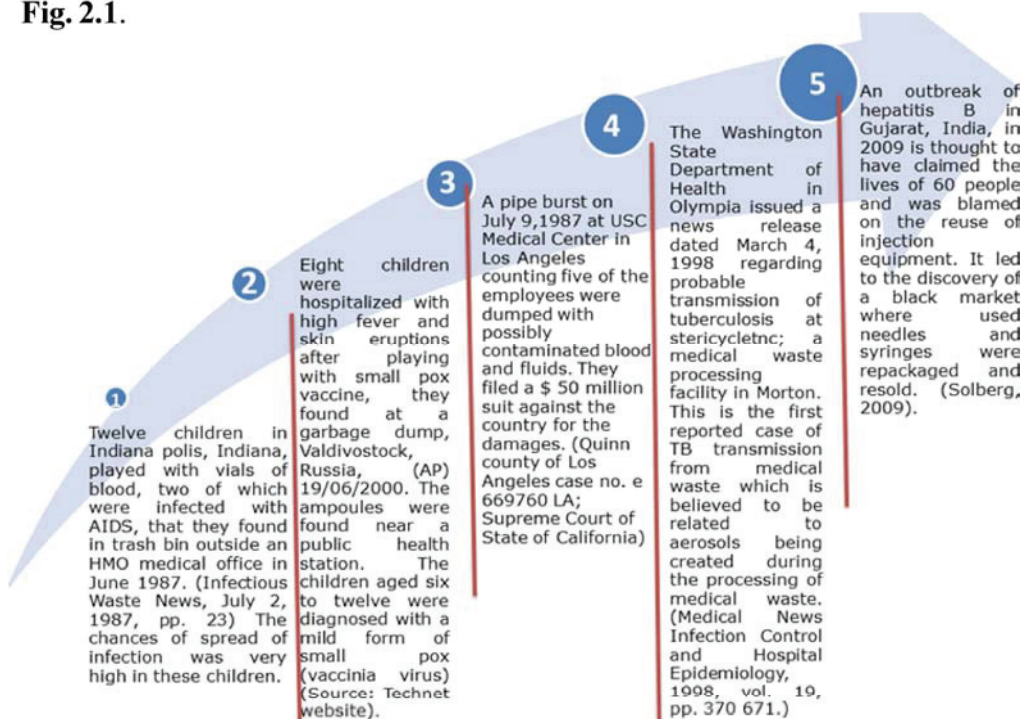


Fig. 2.1: An overview of historical incident of hazards due to infectious waste

Source: Solberg KE (2009). Trade in medical waste causes deaths in India. Lancet, 373(9669):1067.

Check Your Progress 2

1. Name the organism that can with stand high temperature and dessication that which does not.

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2.3 IMPACT OF PHYSICAL AGENTS IN HEALTH CARE WASTE

Before we discuss the effects of physical agents, let us list the sources for these (Box 2.5).

Think and reflect

Assess which type of risks you could be exposed to in your working environment.

The main sources of physical agents in health care are:

- a. Sharps like needles, broken glass syringes, vials, razors, blades etc, shredders and other equipment used in health care waste management which have the potential for causing injuries. In addition to the injury caused, they may be infected with body fluids or blood containing pathogens, from hospital solid or liquid waste, and therefore can transmit diseases in human beings after the physical injury.
- b. Disposal products which remain unresolved from incinerators namely fly ash and residual ash, particulate matter, emissions of acid gases, chlorine and toxic metal vapours.
- c. High temperature and steam generated by different treatment technologies.

Box 2.5: Sources of physical pollutants

The next question which comes to our mind is who is at Risk ?

All the health care staff are at a risk. The health professionals, paraprofessionals as well as health workers are exposed to the risks of injuries from sharps. Patient, cleaning staff, health workers, sanitary inspectors, and the environment are exposed to the risks from the disposal products and emissions. They are also at risk of burns and scalds from the equipment using steam for disinfection or sterilisation.

Let us discuss the impact of the physical agents/pollutants in the following sub-sections.

2.3.1 Risks from Effects of Treatment Technologies and Disposal Methods

In the Unit 21 to 24, Block 2, BHM-102, we have already discussed the effects of incineration by-products and heavy metals on health and environment. In this sub-section we will briefly understand the hazards of the various treatment technologies used for the treatment of waste.

Health Effects of different treatment technologies

- A. Incinerator emissions have serious adverse consequences on health workers, local communities near and far and the environment. The health risk is most serious where an incinerator is improperly operated or poorly maintained. The risks from the different treatment technologies are enumerated in the **Box 2.6**.

- a. If poorly controlled, emissions from waste incinerators may cause health concern from particulates including persistent organic pollutants (POPs) such as dioxins and furans which are specially dangerous because they undergo bio-accumulation and bio-magnification, resist decomposition and are capable of being transported over great distances, threatening public health and eco-systems around the world.
- b. Burnt-out needles and glass may have been disinfected but can still cause physical injury.
- c. A large amount of gaseous emissions are released by incinerators. The acid gases can cause eye and respiratory irritation and can contribute to acid rains with corrosive action on the skin and enhance the toxic effects of heavy metals like mercury and cadmium. Impact of these chemicals have been elaborated in the subsequent sections.
- d. Ash from the incineration of hazardous health care waste provides ideal conditions for production of dioxins and furans, because it is often exposed for a long time to a temperature range of 200-450.
- e. Incinerator ash may contain high concentrations of heavy metals and other toxic metals like mercury, cadmium gases released from incineration are neurotoxic, damage immune system, lungs and probably carcinogenic as discussed earlier.

- B. Autoclave and steam disinfection treatment methods can also pose potential hazards that needs to be managed. In particular, good maintenance and operation should be undertaken to avoid physical injuries from high operating temperatures and steam generation.
- C. Post-waste treatment water contains organic and inorganic contaminants. The concentrations should be monitored to ensure that discharges to sewerage systems are within regulated limits.
- D. Health care waste treatment mechanical equipment, such as shredding devices and waste compactors, can cause physical injury when improperly operated or inadequately maintained.

Box 2.6: Risks from the different treatment technologies

Impact of disposal methods

Burial of health care waste in landfill sites can pose hazards to workers and public. The risk increases especially when the waste is not segregated and is disposed of indiscriminately. Direct contact with sharp items in the waste could expose the workers to injuries with potentially contaminated items. The leachate from the waste could pollute the soil, surface and the ground water. It is thus important to segregate the waste and dispose of as recommended (**Fig.2.2**).

Fires and subsurface burning is another threat, especially in sites where the waste may have been disposed of indiscriminately or in open dumping of wastes. This exposes the workers as well as the general public to smoke, particulate matter and poisonous gases. Scavenging resulting in exposure to the chemical and biological agents also increases the risk not only to the person affected, but may also enter the food chain. You have already read in detail regarding this in the Unit 3 of Block 1, BHM-101. Injuries from the sharps indiscriminately thrown in the waste are added threat at the disposal sites.

Think and reflect

Among the various categories of health care personnel, who do you think is most exposed to the risk of infection? Which do you think is the single most effective method to prevent infection?

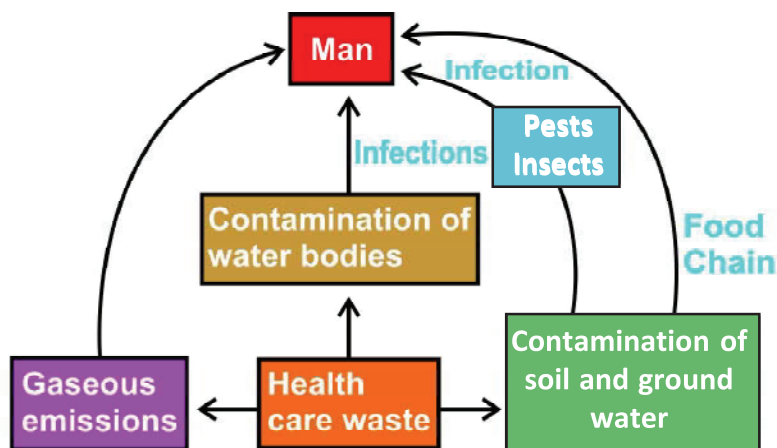


Fig. 2.2: Hazards of open dumping

Source: Safe management of wastes from health-care activities, WHO, 2014.

2.3.2 Physical Injuries

Physical injuries can occur due to improper handling of various categories of waste but sharps comprise the most dangerous category of waste. Sharps can cut or pierce into the skin and get in direct contact with the body fluids and thus are directly capable of transmitting diseases. The various procedures by which the needlestick injuries can occur are drawing of blood, recapping of needles, needle disposal, garbage disposal.

Table 2.3 lists the common medical and waste management procedures that led to a sharps injury, in selected countries.

Table 2.3: Frequency of procedure that health care workers were using at the moment of percutaneous injury, selected countries; Procedure involved in the accident (%)

Country (reference)	Recapping	Stuck by colleague	Disassembling device	During disposal	Unattended needle	Movement of patient
New Zealand (Lum et al., 1997)	15.0	NR	NR	21.0	NR	Nr
Nigeria (Adegboye et al., 1994)	18.0	18.0	10.0	NR	NR	29.0
South Africa (Karstaedit & Pantanowitz, 2001)	17.4	7.2	3.0	9.6	4.8	23.4
Taiwan (Guo et al., 1999)	32.1	3.1	2.6	6.1	NR	NR
USA (Mangione et al., 1991)	12.0	NR	NR	13.0	8.0	NR

NR, not reported; USA, United States of America

a The percentages do not sum to 100% because individual studies reported different categories of procedures from those in this table

Source: Safe management of wastes from health-care activities, WHO, 2014

The information provided in this table is only for your understanding and not for recall.

Injuries can also be caused by the equipments like shredders, impactors, grinders. Shredders should also always be used in closed system to avoid exposure to pathogens in aerosols released into the environment by mechanical destruction of untreated waste bags.

In any health care facility, nurses and housekeeping personnel are the main groups at risk of injury, with annual injury rates in the USA at 10-20 per 1000 workers. The highest rates of occupational injury among all workers exposed to health care waste are reported by cleaning personnel and waste handlers. In the USA, the annual rate is 180 per 1000 workers.

Did you know ?

The most numerous work-related injuries among health care workers and waste collectors are sprains and strains caused by lifting and over exertion, and not from the hazardous components of health care waste. (*Source* : Safe management of wastes from health-care activities WHO, 2014).

Check Your Progress 3

1. Describe the physical pollutants.

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2. Enumerate procedures which can cause needlestick injuries and group of health care providers who are more prone to needlestick injuries.

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2.4 IMPACT OF CHEMICALS IN HEALTH CARE WASTE

Sources of Chemical waste in health care settings are waste from laboratories, chemicals containing heavy metals and others used in health care as disinfectants, film developers, solvents, chemotherapeutic or anticancer drugs, expired medicines and emissions from incinerators and leachates.

Hazardous Chemical Waste Risks

Largely ignored, this class of hospital waste, which consists mainly of chemicals and discarded cytotoxic drugs, poses risks to hospital workers.

WHO consultant Professor Shiro Shiraqto, who is the chairman of the Japanese Society for Research on Medical Waste has recorded more than 500 cases of injury or poisoning with chemical waste from hospitals and more than 400 cases of bio-hazards from cytotoxic drugs improperly disposed. (*Source:* Ravi Agarwal, “Medical Waste, Issues, Practices and Policy: An Indian and International Perspective”, Srishti, 1998, 12).

Some common hazardous chemicals, some of which are probable carcinogens or pose other health risks are mentioned in **Fig. 2.3**.

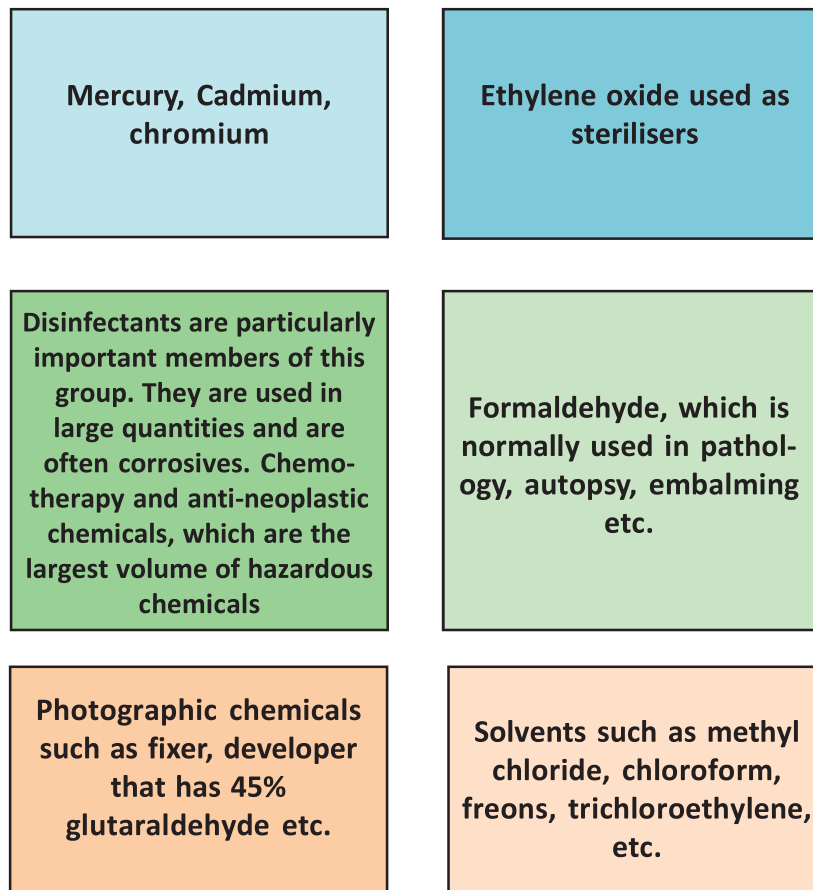


Fig. 2.3: Common hazardous chemicals in health care

Let us learn more about these chemicals in the waste.

2.4.1 Mercury

A potent human neurotoxin, mercury has traditionally been used in a range of medical devices such as thermometers and sphygmomanometers (blood pressure measurement devices). Exposures can occur when devices are broken or disposed. You have already read about the sources of mercury in health care facilities in Unit 10, Block 3, BHM-101. Just to recapitulate the sources are summarised in th **Fig 2.4**.

Health effects of mercury exposure

The health effects of mercury may vary depending on the form of mercury, type of exposure (acute or chronic), route of exposure.

Think and reflect

Observe in your working environment. What are the sources of mercury? How can you replace these with more safe alternatives?

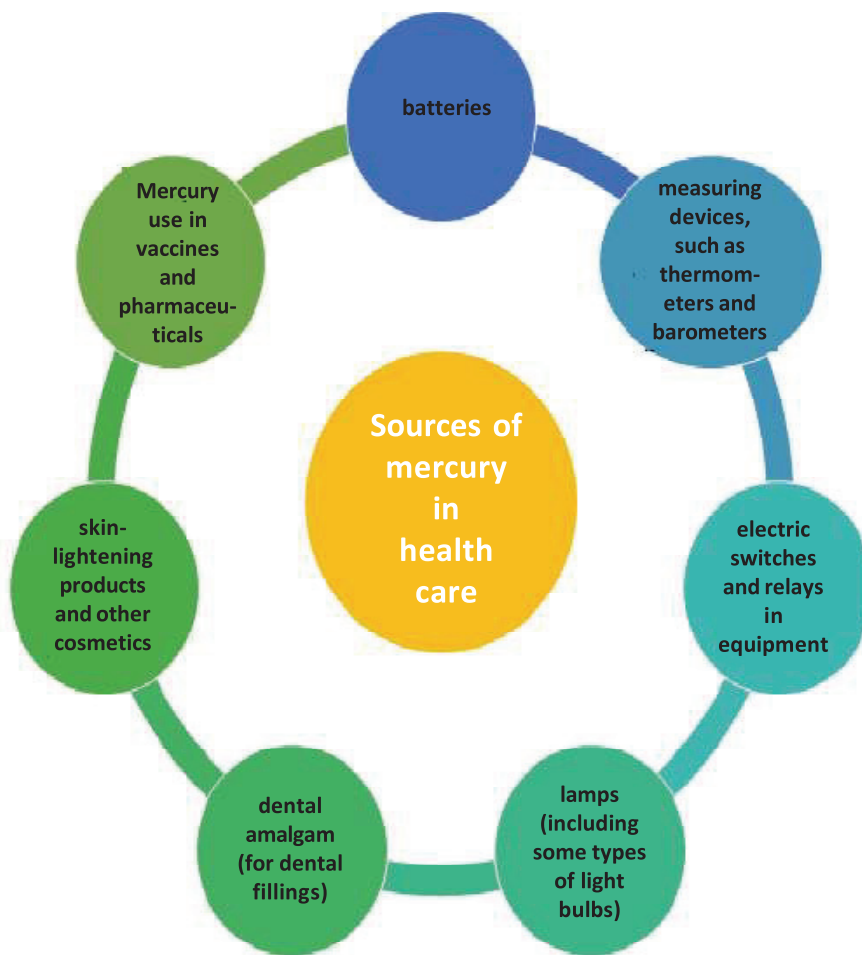


Fig. 2.4: Sources of mercury in health care

A. Effects depending on the form of mercury and route of exposure

Effects depending on the form of mercury and route of exposure is explained in Fig. 2.5.

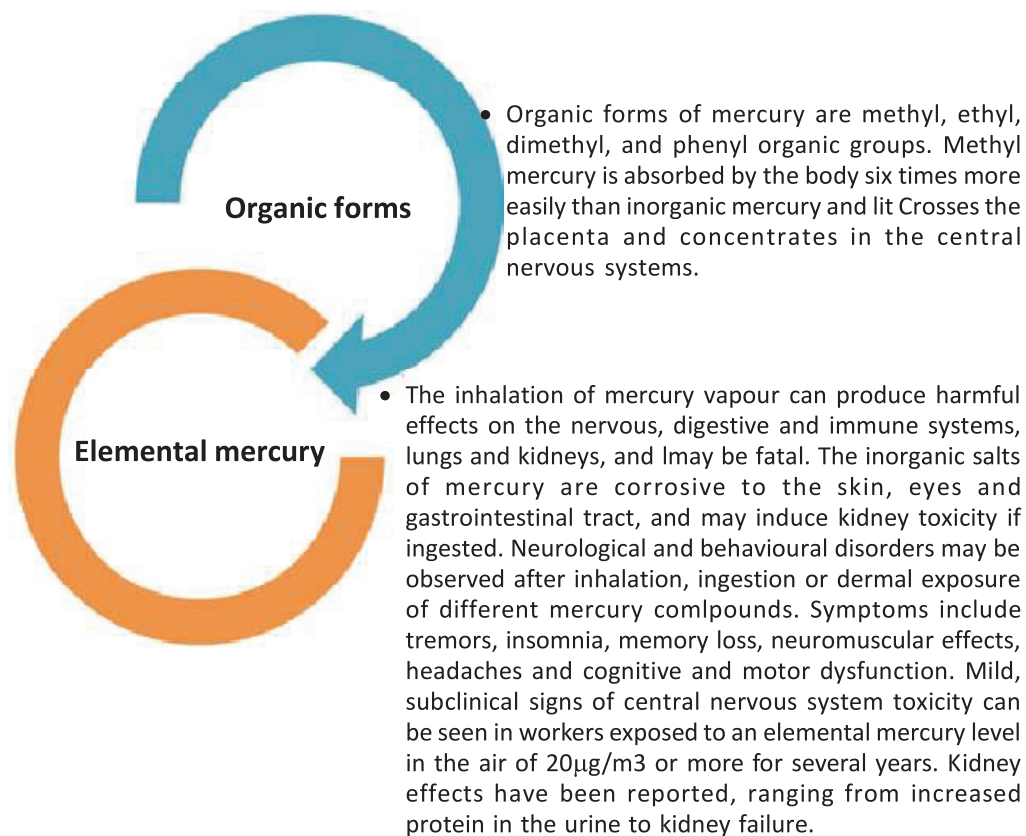


Fig. 2.5: Effects depending on the form of mercury and route of exposure

Did you know ?

1. Minamata disease - This is a neurological syndrome caused by severe mercury poisoning. **Prevention of exposure to mercury**

It's important symptoms include ataxia, numbness in the hands and feet, general muscle weakness, loss of peripheral vision, and damage to hearing and speech. In extreme cases, insanity, paralysis, coma, and death follow within weeks of the onset of symptoms. A congenital form of the disease can also affect foetuses in the womb. You can learn more about this disease from the following link http://www.who.int/water_sanitation_health/facilities/waste/module19.pdf?ua=1



B. Effects depending upon the type of exposure

Effects depending upon the type of exposure are explained in Fig.2.6.

The two most important actions for preventing the impact of mercury in the waste are:

- a. Phase out use of non-essential mercury-containing products
- b. Implement safe handling, use and disposal of remaining mercury-containing products

A range of actions are being taken to reduce mercury levels in products, or to phase out mercury-containing products. In health care, mercury-containing thermometers and sphygmomanometers are being replaced by alternative devices. You have also read about this in your Unit 10, Block 3, BHM-101.

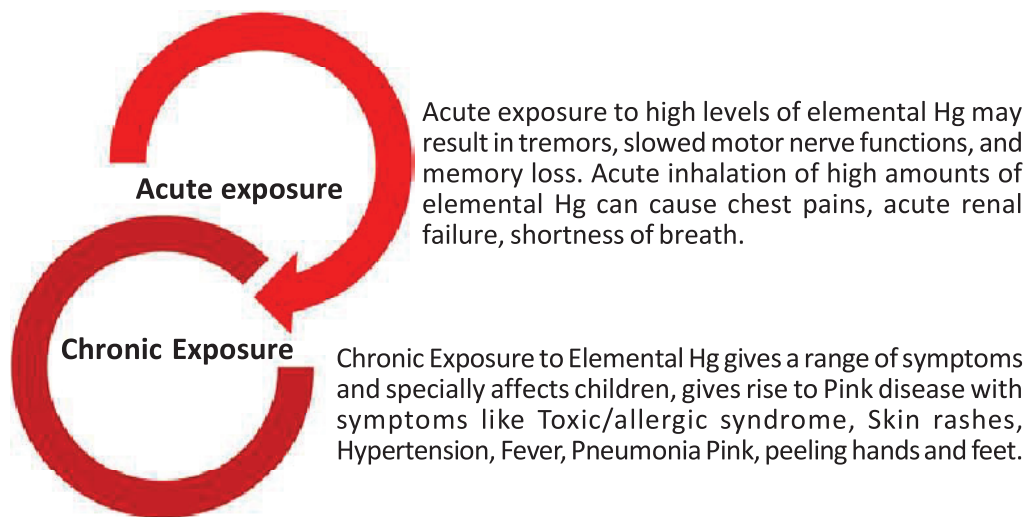


Fig.2.6: Effects depending upon the type of exposure

Dental amalgam is used in nearly all countries. A 2009 WHO expert consultation concluded that a global near-term ban on amalgam would be problematic for public health and the dental health sector, but a phase down should be tracked by encouraging disease prevention and alternatives to amalgam; research and development of cost-effective alternatives; education of dental professionals and the raising of public awareness.

2.4.2 Cadmium

Let us first learn about the sources of Cadmium (Table 2.4).

Table: 2.4: Sources of Cadmium in health care

Sl. No.	Hospital Products
a.	Batteries - Lead-Acid Nickel-Cadmium Silver-Cadmium
b.	Electronics - Leaded Glass Printed Circuit Boards
c.	Glass and Ceramics-Enameled - Glass/Ceramics Glassware Containers Laboratory Glassware Optical Glass
d.	Plastics - Infectious Waste Bags, Surgical Gloves, PVC Products, Stabilisers and pigments in non-food packaging, misc. durables, appliances, misc. nondurables, furniture, and toys
e.	Pigments - Paints Printing Ink
f.	Pharmaceutical and Personal Uses - Antiseptics Dental Fillings Diuretics Skin Preparations
g.	Medical Equipment - CAT Scan Film Fever Thermometers

h.	Electrical & Electronic Devices radio chassis Plate television and Pigments Printing inks, textile dyes and paints
i.	Others - Fluorescent Light Bulbs Lead Foils Phosphor Lights Rubber Products Used Oil X-ray Films Lead X-ray Shield/Aprons, blocks used for radiation therapy

Prevention of exposure from Cadmium in health care waste is explained in **Box 2.7**.

- a. Inhalation of cadmium fumes should be avoided by properly preventing the air pollution by the fumes generated during the incineration of health care waste.
- b. The health care facilities should shift to environmentally safe non-cadmium products.
- c. Educate personnel and have a proper policy for disposal of nickel-cadmium batteries. One could also advise promoting replacement with lithium or other type of batteries and to go in for rechargeable batteries.
- d. Store bio-medical waste in non-cadmium “red bags”; never throw them in the garbage. should be printed on the bag.
- e. Educate staff to ensure sharps containers are used solely for sharps-not batteries to protect the sharps from cadmium contamination.

Box 2.7: Prevention of exposure from Cadmium in health care waste

2. The classical Mad Hatters disease or syndrome - This was an occupational disease among hatmakers, caused by chronic mercury poisoning. It affected those whose felting work involved prolonged exposure to mercury vapours. The classic symptoms of the “Mad Hatter” syndrome – Erethism – Tremors – Gingivitis, Renal impairment.

2.4.3 Chromium

Stainless steel needles, rubber materials and syringes used in health care facilities contain chromium. The chromium is used in the form of sodium dichromate and chromic acid for cleaning of glasswares in laboratories in health care establishments. It is also produced as pollutant during incineration of hospital waste, along with other toxic metals and can produce environmental pollution.

Prevention and management of risk from Chromium waste

Measures for prevention of skin exposure-safety precautions for handling of sodium dichromate and chromic acid should be followed. The dichromate solution should be diluted and should be disposed after reducing it to harmless concentration by keeping it for more than three months and then pouring it into sewers.

2.4.4 Risks from Toxic Chemical Laboratory Waste

Toxic laboratory chemicals like Glutaraldehyde is a severe skin irritant (dermatitis). Formaldehyde is an irritant and possible carcinogen. Others toxic chemicals include: xylene, toluene, methanol, ethylene oxide, quaternary ammonium compounds, chloroform, phenols, barium compounds, herbicides, and pesticides. Hydrochloric acid, concentrated acetic acid, sodium hydroxide and ammonium hydroxide are corrosive acids and bases.

Flammable chemicals include ethyl alcohol, isopropyl alcohol, ether, toluene while certain chemicals are reactive chemicals e.g. lithium metal, concentrated hydrogen peroxide, dry picric acid, ethylene oxide disinfectants are corrosive and reactive. Chlorine bleach may result in burns and respiratory effects, and may react with strong acids to release chlorine gas. We will learn more about some chemicals which are used more commonly in health care. Let us read about formaldehyde (**Box 2.8**).

A. Formaldehyde

Details related to Formaldehyde

- a. Acute exposure may occur in eyes, nose or throat through air and through inhalation causing cough and wheezing. Accidental ingestion can lead to corrosion in the oral cavity and GI Tract
- b. Chronic exposure to formaldehyde by inhalation may be associated with nose, throat, or respiratory symptoms
- c. It may be a probable carcinogen
- d. Minimise the volume of waste generated by eliminating any unnecessary dilution
- e. Do not mix with any other waste streams

Precautions and Safe work practices

- a. The health care staff should be trained on safe work practices
- b. Protective gears must be wore while handling formaldehyde
- c. The product should be labelled and stored properly with adequate ventilation preferably in a fume hood and away from sources of ignition
- d. Mouth pipette should not be used for transferring formaldehyde
- e. Non-hazardous/less hazardous substitutes to formalin and formaldehyde should be used wherever possible

Alternatives for formalin and formaldehyde solutions should be used

a. As fixatives

- i. Ethyl alcohol, phenoxyethanol or polyethylene glycol are safer alternatives as fixatives. Glyo-fixx® (Thermo Scientific) can also be used

b. As disinfectants

- i. Chemicals like Hydrogen peroxide-based solutions can be used as disinfectants

c. Substitute formaldehyde with less hazardous solvents

- i. Benzene with xylene or hexane (many solvent uses)
- ii. Carbon tetrachloride with cyclohexane (qualitative test for halides)
- iii. Halogenated solvents with non-halogenated solvents (extractions and other uses)

d. For storage

1. Ethanol should be used for storage of biological specimens

Box 2.8: Details related to Formaldehyde and health

B. Glutaraldehyde

Details of Glutraldehyde and health are mentioned in **Box. 2.9**. Its effects are listed in (**Box 2.10**) and precaution in (**Box 2.11**).

Glutaraldehyde is a fixative particularly with nitrogen, ammonia, amines and proteins. It attacks proteins in the nucleus of microorganisms, DNA and protein

sacks of viruses, so that microorganism cannot develop resistance to it. It acts optimally at neutral to alkaline pH. If surfactants are used with glutaraldehyde, it kills the efficiency, increases stability while its volatility is reduced. The exposure limit for glutaraldehyde has been set at 0.20 ppm, which must never be exceeded.

Box 2.9: Details of Glutaraldehyde

- a. Throat and lung irritation
- b. Asthma and difficulty breathing
- c. Contact and/or allergic dermatitis
- d. Nasal irritation
- e. Sneezing
- f. Wheezing
- g. Burning eyes and conjunctivitis

Box 2.10: Effects of Glutaraldehyde

The main health hazards of glutaraldehyde are mostly associated with its strong irritant action. Vapour levels below 0.2 ppm (0.8 mg/m^3) cause nose, eyes and throat irritation, nausea and headache, chest discomfort, tightness and difficulty in breathing may also occur. Cases of allergic asthma are also reported with its exposure.

Precautions, Safety and Action Plan

To eliminate glutaraldehyde overexposure, take the following steps:

- a. Identify all exposure locations and minimise the number of personnel, which are involved in handling of glutaraldehyde.
- b. The rooms in which glutaraldehyde is used should have a minimum of 10 air exchange rates per hour. A local exhaust fume hood should be used in any room, which does not have a minimum of 10 air exchange rates per hour. The fume hood should have glutaraldehyde soaking bins, which will eliminate all exposure problems with it. To ensure proper performance the fume hood should have a minimum velocity of 80 feet per minute.
- c. Use of proper personnel equipment, e.g. protective splash goggles, shield protection with facemasks, gloves, masks and clothing. Protective gloves should be 11 to 13 inches long extending up to the arms, and made of polyethylene or “nitrile” or rubber which are most impervious to glutaraldehyde. All protective clothing must be made of a material i.e. impervious to glutaraldehyde i.e. liquid resistant or liquid impervious, like polyethylene coated polypropylene.
- d. Monitor the exposure levels by use of passive diffusion monitors (monitoring badges), sample pump and with cassettes which require sophisticated laboratory analysis (OSHA method) and hand held direct reading meters (glutameters or glutaraldehyde meters) which provide a discrete instantaneous measurement.
- e. Training in safety precaution and handling of hazardous chemical should be undertaken, including safe working habits, use of proper protective gear or clothing and safe spill clean up procedures.

Source: [www.http://www.osha.gov/SLTC/formaldehyde/](http://www.osha.gov/SLTC/formaldehyde/)



- f. Proper Disposal should be followed.
- g. The health care setting can shift to non-glutaraldehyde and formaldehyde free fixative composed of aldehydes.

Box 2.11: Precautions related to Glutaraldehyde exposure

Effects of exposure to glutaraldehyde can be reduced by neutralising the spent solution. The time required for complete neutralisation ranges from 10 minutes to 8-12 hours or even longer. The glutaraldehyde concentration of the solution at the end should be 10 ppm or less. Above this concentration glutaraldehyde retains its anti-microbial activity and thus can affect adversely the operation of sewage treatment facility. Properly disposed glutaraldehyde will have little or no effect on bacterial ecology.

C. Sodium Hypochlorite

Details of sodium hypochlorite and health are mentioned in **Box. 2.12.**

The effectivity of sodium hypochlorite depends mainly on its concentration and contact period. Studies indicate that it is effective to kill AIDS virus with as low as 0.5 per cent for a minimum contact period of ½ hr. The effectivity of hypochlorite also depends on the kind of waste. Highly organic waste like blood is required to be treated with greater concentration and longer contact period with the disinfectant for killing the germs.

Effects

Depending upon the concentration used, it can be an irritant or corrosive. The potential health hazards are similar to glutaraldehyde and involve eye, respiratory tract and skin. On ingestion it causes nausea and vomiting. However, it does not produce any substantial ecological disturbance.

Precautions

They are similar to glutaraldehyde. Use of protective gear and clothing, training in safe use and spill clean ups should be given to the employees handling sodium hypochlorite disinfectants.

Box 2.12: Sodium hypochlorite and health

2.4.5 Common Disinfectants

Some of the other disinfectants that are used are given in the **Box 2.13**. The amounts of these disinfectants used on individual patients is not substantial to produce any ecological disturbance. Also as their use is very limited in operation theatre and injection rooms or other areas, there are very less chances of small discharges of these drugs to have cumulative adverse effects on environment in the places of their use, unless large quantities of these disinfectants are routinely disposed of in sewers or health care waste after their use.

- a. The phenolic disinfectants - These are used as 2 per cent solution for disinfection of spillage of body fluids and substances on carpets, soft furnishing etc.
- b. Chlorhexidine - Used as 0.5 per cent in 70 per cent alcohol for preoperative and preprocedural skin preparation for disinfection of clean hand dressing, nursing procedures, and for cleaning of infected wounds and genitalia prior to urinary catheterisation and in concentration of 4 per cent in 70 per cent alcohol for hand washing prior to clinical and surgical procedures.

- c. Chlorhexidine and cetrimide in 0.015 per cent to 1.15 per cent concentration are used for cleaning of dirty operation theatres for emergency and preoperative preparation of sensitive areas e.g. face, scrotum and for obstetric examination.
- d. Povidone iodine 1 per cent solution, spray etc. is used for care of skeletal pin sites, infected pressure sores, ulcers and for surgical scrub and preoperative and preprocedural skin preparations.
- e. Alcohol 70 per cent used for skin preparation prior to injection, cleaning of thermometers etc.

Box 2.13: Common disinfectants used in health care

Protective measures for the exposure to common disinfectants is given in **Box 2.14**.

1. Gloves and protective eyeglasses should be worn during handling of chemical disinfectants to protect skin and eyes.
2. In case of skin contact, the affected area should be rinsed abundantly with water.
3. In case of eye contact, the eyes should be rinsed abundantly with water for at least 15 minutes followed by medical examination and treatment, if necessary.

Box 2.14 : Preventive measures for exposure to disinfectants

2.4.6 Gaseous Pollutants

Many types of gases are used in health care and are often stored in portable pressurised cylinders, cartridges and aerosol cans. Many of these are reusable, once empty or of no further use (although they may still contain residues). However, certain types – notably aerosol cans – are single-use containers that require disposal. Whether inert or potentially harmful, gases in pressurised containers should always be handled with care; containers may explode if incinerated or accidentally punctured .

Anaesthetic gases are chemicals which produce general anaesthesia when inhaled. They are used in hospitals and dental clinics for producing a stage of unconsciousness, (Anaesthesia), loss of pain (Analgesia) and adequate muscle relaxation to carry out any surgical procedures or operations on the patients.

The patients who are treated with anaesthetics will be exposed to anaesthetic gases briefly but those who work regularly or near anaesthetics may be at risk. Surgeons, anaesthetists, dentists, operation theatre nurses and operation theatre staff and many other workers like orderlies, technicians are included in this category who may be exposed to these anaesthetic gases during and after operations.

Faulty seals in equipment account for majority of gas leaks. Other cases include poor administration techniques and exhalation by patients. It is estimated that about 10 per cent of workers in health sector are exposed to anaesthetic gases used in operating theatres.

Did you know ?

The main source of gaseous pollution in health care institution is use of anaesthetic gases for surgical procedures, formaldehyde gas for disinfection and also those evolved during the disposal of health care waste in low temperature incinerators and open kiln burning which can produce air, water and soil pollution through toxic emissions.

2.4.7 Exposure to Chemicals from Emissions

In addition to the above, chemicals associated with waste-treatment processes flue gases from waste, ash from the incineration of hazardous health care waste may continue to pose a risk. Furthermore, incinerator ash may contain elevated

concentrations of heavy metals and other toxic items, and the ash provides ideal conditions for the synthesis of dioxins and furans, because it is often exposed for a long time to a temperature range of 200-450 °C.

2.4.8 Chemical Injuries

Chemical injuries occur due to hazardous toxic, corrosive, flammable, reactive, shock sensitive and genotoxic wastes which can produce chemical burns or accidental exposure or cause toxicity to cells, e.g., cytotoxic materials. The severity of the hazards of health care workers responsible for the handling or disposal of this waste depends on the severity of the toxicity of the substance itself and the extent of exposure as well as the duration of exposure to the genotoxic waste governed by a combination of the substance toxicity itself and the extent and duration of exposure.

Check Your Progress 4

1. What are the common hazardous chemicals?
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.....
.....
2. Enumerate the properties of these chemicals, which are hazardous to human health.
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.....
.....
.....

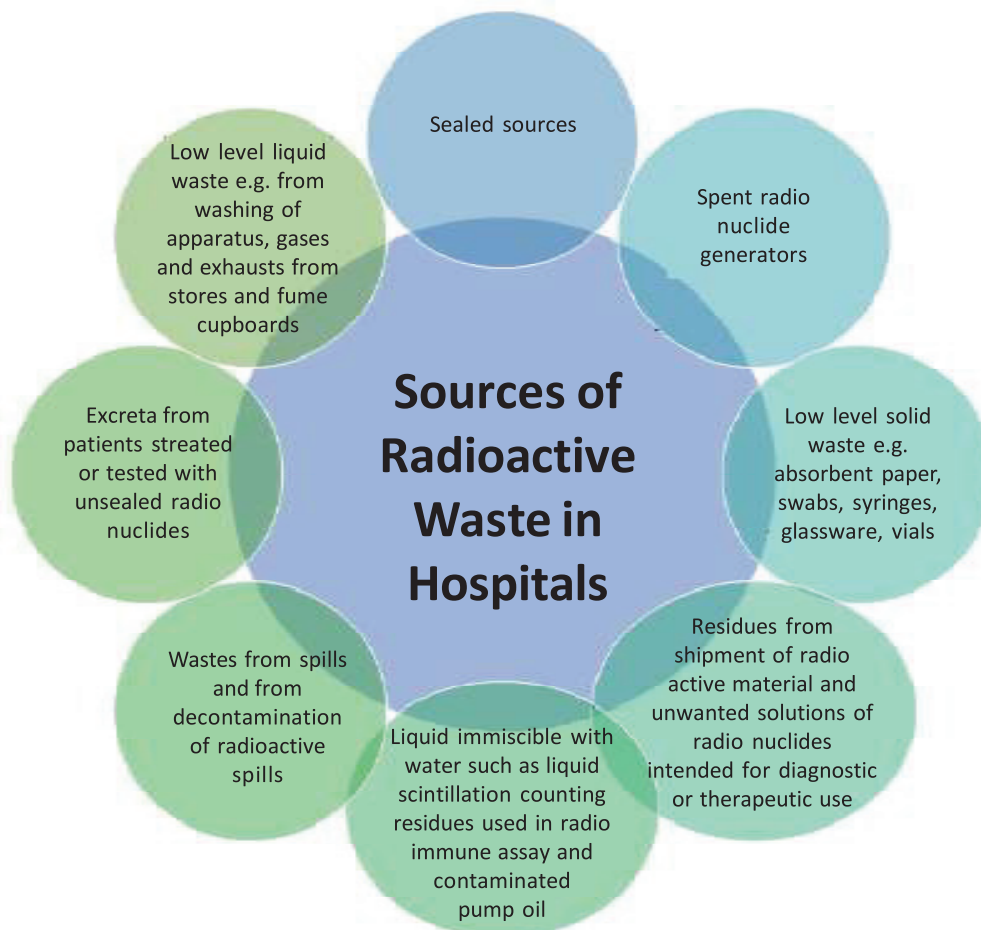
2.5 EFFECT OF RADIOLOGICAL POLLUTANTS

The radiological pollutants can cause radiation injuries which occur due to exposure to various radioactive wastes, e.g. vials and syringes, contaminated substances, radioactive spills, clothes or other accessories from isolation rooms in nuclear medicine department, exhaust from radium stores, sealed stores of radioactive materials, spent nuclide, etc.

Every year an estimated seven million health workers are exposed to radiation in excess of background levels. The use of radiological medical practices expands to developing countries, but without sufficiently stringent safety procedures, more workers will be at risk of exposure. Radiation produces both acute effects as well as delayed injuries with the cumulative effects of radiation. These effects include gene mutation and chromosomal alteration, delayed/improper cell division, interference with metabolic processes and various types of cancer (WHO)

2.5.1 Sources of Radioactive Waste in Hospitals

You have already read about radioactive waste in Unit 7, Block 2, BHM-101. The waste produced by health care and research activities involving radionuclides and related activities such as equipment maintenance, storage etc. can be classified as shown in **Fig. 2.7**.



Did you know ?

Radioactive waste is genotoxic, and a sufficiently high radiation dose may also affect genetic material.

Fig. 2.7: Sources of radioactive waste in hospitals

2.5.2 General Impact of Radioactive Waste on Human Health

It can range from headache, dizziness and vomiting to much more serious problems. Handling highly active sources, such as those used in diagnostic instruments (e.g. gallium sealed sources) may cause much more severe injuries, including tissue destruction and necessitating the amputation of body parts. Extreme cases can be fatal.

Hazards from Radioactive Waste

The type of disease, caused by radioactive waste is determined by the type and extent of exposure. It can range from headache, dizziness and vomiting to much more serious problems like causing mutations in the body cells. The radioactive waste, like certain pharmaceutical waste, is genotoxic. Handling of highly active sources, e.g. certain sealed sources from diagnostic instruments, may cause much more severe injuries (such as destruction of tissue, necessitating amputation of body parts) and should, therefore, be undertaken with the utmost care.

The hazards of low-activity waste may arise from contamination of external surfaces of containers or improper mode or duration of waste storage. Health care workers or wastehandlers or cleaning personnel exposed to this radioactivity are at risk.

Several accidents resulting from improper disposal of radioactive health care waste have been reported. One extreme case from Brazil demonstrated a carcinogenic impact on the general population from an unintended exposure to radioactive waste from a health care facility. While moving to a new site, a

radiotherapy institute left a sealed radioactive source in equipment at its old premises. An individual who gained access to these premises removed the sealed source, took it home and broke open the casing to reveal the radioactive material. As a consequence, 249 people were exposed, of whom several died or suffered severe health problems (IAEA, 1988).

You may also like to recall the case of the Mayapuri case that you read in the Unit 5, Block 2, BHM-101.

There are few reliable scientific data available on the impact from the routine generation and handling of radioactive health care waste.

The other recorded accidents involve exposure to ionising radiations in health care facilities as a result of unsafe operation of X-ray apparatuses, improper handling of radiotherapy solutions or inadequate control of dose of radiation during radiotherapy.

Check Your Progress 5

1. Enumerate the sources of radiological waste from hospitals.
.....
.....
.....

2. What are common hazards of radiological pollutants?
.....
.....
.....

2.6 EFFECTS OF GENOTOXIC WASTE

Genotoxicity is the property of a substance or its metabolite that is capable of interacting directly with DNA (genetic material), leading to DNA damage that can be assayed. It may include carcinogenic, mutagenic or teratogenic substances. Inhalation of dust or aerosols, absorption through the skin, ingestion of food accidentally contaminated with cytotoxic drugs, chemicals, or waste, and ingestion are the main pathways of exposure to genotoxic substances. The severity of the hazards also depends on the mode of exposure (inhalation, skin contact, etc.). Exposure to genotoxic substances may also occur during the preparation of treatment with particular drugs or chemicals or through contact with bodily fluids and secretions of patients undergoing chemotherapy.

There is very little data on the long-term health impacts of genotoxic health care waste. This is partly because of the difficulty of assessing human exposure to this type of compound.

2.7 IMPACT OF HEALTH CARE WASTE ON VISITORS AND COMMUNITY

In the previous sections we have stressed upon the impact of health care waste on the health care workers. However, health care waste also impacts visitors as well as the community. This impact could be direct to indirect. Direct impact is mainly through untreated waste findings its way to the community bins. Here the waste is picked up and the plastics specially the syringes are reprocessed. The syringes are many times reused, thus causing a serious health hazard with in-

stances of increased incidence of HIV, HBV, HCV and respiratory group of diseases in the community at large.

Other direct impact could be the concern risen by the community on the unhealthy sight of infectious waste and amputated body parts of bodies thrown in open. Open burning of waste is yet another area of concern as the smoke from the burning could cause respiratory disorders.

Indirect impact of hospital waste to the community

Through burning of waste either in open or in incinerators as this accounts for release of toxic air pollutants like dioxin furans and heavy metal contamination and toxic ash residues.

The air emissions affect the local environment and may affect communities hundreds or thousands of miles away. The ash residue is sent to landfills for disposal, where the pollutants have the potential to leach into ground water.

The general population, through ordinary dietary exposures, carries a current body burden of dioxin that is near or above the levels that cause adverse effects in animal tests. Breast milk contamination is such that the nursing infant, during vulnerable periods of development, is exposed to dietary levels of dioxin 35 to 65 times the amount considered safe with the pressure from the community.

2.8 LET US SUM UP

In this unit you have learnt about environmental pollution, physical, chemical, biological, and radiological agents and pollutants and their effects on human health. You have also learnt about infectious agents in health care waste, the various microorganisms present in it and how they grow in adverse climate conditions. Hospital Acquired Infection (HAI) also known as Nosocomial infections are an important cause of concern, for infections acquired due to visit or stay in the hospital must be avoided and prevented at all costs.

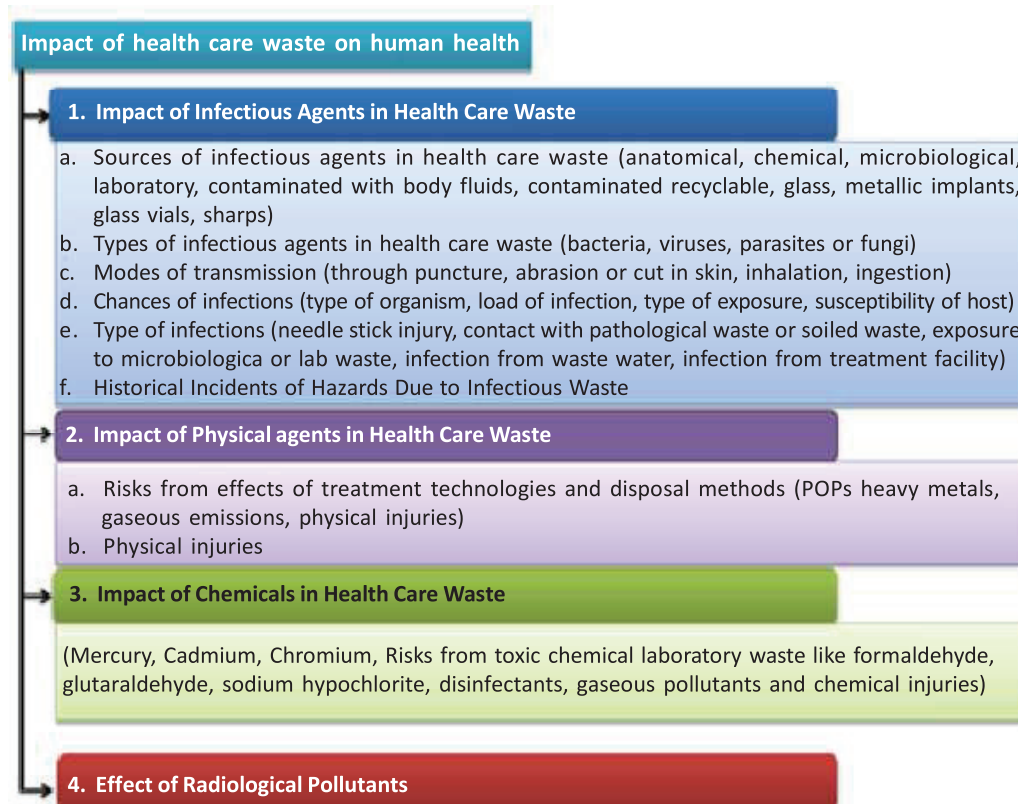


Fig. 2.8: Mind Map

2.9 GLOSSARY

- Antineoplastic** : Inhibiting or preventing the development of neoplasms.
- Cytotoxic** : Causing suppression of growth and multiplication of cells.
- Disinfectant** : Chemical agent i.e. able to reduce the viability of microorganisms.
- Genotoxic** : Descriptive of a substance that is capable of interacting directly with genetic material, causing DNA damage that can be assayed. The term refers to carcinogenic, mutagenic or teratogenic substances.
- Ground Water** : The water contained in porous underground strata as a result of infiltration from the surface.
- Hazard** : Intrinsic potential property or ability to cause harm.
- Impact** : Effect or influence.
- Incineration** : The controlled burning of solid, liquid or gaseous combustible wastes to produce gases and residues containing little or no combustible material.
- Microorganism** : Any microbial entity, cellular or non-cellular, capable of replication or transferring genetic material.
- Risk** : Probability that a hazard will cause harm and the severity of that harm.
- Susceptibility** : Being sensitive to hazard or being affected.

2.10 ANSWERS TO CHECK YOUR PROGRESS

Check Your Progress 1

1. a) True b) True c) False d) False
2. The infectious waste is suspected to contain pathogens, i.e. bacteria, viruses, parasites or fungi in sufficient concentration or quantity to cause disease in susceptible hosts.
3. The sources of infectious waste are:
 - a. Cultures and stocks of infectious agents for laboratory work.
 - b. Waste from autopsies, surgery on infected patients.
 - c. Tissue, materials, equipment which had been in contact with body fluids or blood of infected patients.
 - d. Waste from isolation wards, excreta, dressing materials, soiled linen.
 - e. Wastes from infected patients undergoing haemodialysis.
 - f. Instruments, sharps, IV Sets, needles used in infected patients.

Check Your Progress 2

1. The microorganisms that survive in dry air and high temperature, and do not get desiccated are Hepatitis B virus, Hepatitis C virus. While HIV/AIDS virus is less resistant and gets desiccated and inactivated at 56°C.

Check Your Progress 3

1. The physical pollutants consist of:
 - a. Incinerator fly and bottom ash.
 - b. Metals like, cadmium, lead, arsenic, mercury.
 - c. Acid gases, sulphur dioxide, hydrogen chloride, nitrous oxide, chlorine etc.
 - d. Particulate emissions.
 - e. Infected solid and liquid wastes.
 - f. Infected sharps.
 - g. Dioxins and furans.
2. The procedures which can cause needle stick injuries are:
 - a. Drawing of blood
 - b. Recapping of needles
 - c. Needle disposal
 - d. Garbage disposal

The health care personnel who are prone to get these injuries are:

- a) Hospital cleaners
- b) Laboratory technicians
- c) Nursing staff
- d) Medical staff
- e) Health attendants
- f) Rag pickers

Check Your Progress 4

1. The common hazardous chemicals are:
 - a. Chemotherapeutic and antineoplastic drugs.
 - b. Formaldehyde.
 - c. Photographic fixers, developers.
 - d. Solvents like chloroform, methyl chloride, trichlorethylene, freons.
 - e. Mercury, lead, arsenic.
 - f. Ethylene oxide.
2. The properties of these hazardous chemicals are:
 - a. Toxic to human cells or systems
 - b. Corrosive
 - c. Flammable
 - d. Reactive
 - e. Shock sensitive
 - f. Genotoxic-Cytotoxic

Check Your Progress 5

1. The radiological pollutants are usually:
 - a. Vials and syringes contaminated with radioactive substances.
 - b. Radioactive spills, clothes, accessories from isolation rooms in Nuclear Medicine Department.

- c. Exhaust from radium stores.
 - d. Sealed stores of radioactive materials.
 - e. Spent nucleotide generation.
2. The hazards due to radiological pollutants are exposure dependent:
 - a. Headache, dizziness and vomiting.
 - b. Destruction of tissues, fingers of radiologists.
 - c. Blood dyscrasias, Neoplasm

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