UNIT 4 INTRODUCTION TO EPIDEMIOLOGY-EPIDEMIOLOGICAL APPROACHES AND PROCESSES

Structure

4.0 INTRODUCTION

In the previous units of this block, you must have read about community health, health care planning and organisation of health care at various levels, also environmental health and sanitation in details. Epidemiology not only helps in understanding the health concepts, and disease causation, it also helps in planning, implementing and evaluating health care services.

The present unit gives an overview of epidemiology in terms of its concept, aims, uses, modes of disease transmission and fluctuations in disease occurrence. Let us learn these aspects of epidemiology.

4.1 OBJECTIVES

After completing this unit, you should be able to:

- define the term epidemiology and explain its aims and uses;
- describe the concept of epidemiology and comprehend the various modes of disease transmission;
- discuss epidemiological approaches and methods;
- explain the levels of prevention of diseases;
- describe epidemic, endemic and pandemic; and
- familiar the time trends or the fluctuations of disease occurrence;

4.2 EPIDEMIOLOGY-CONCEPT, DEFINITION, DISTRIBUTION AND FREQUENCY OF DISEASE

We shall focus on various aspects of epidemiology as given below.

4.2.1 Concept and Definition

The science of epidemiology deals with the study of occurrence of health related states and events in a population – who gets the disease where and why ?

You might be wondering why oral cancer is more common among males as compared to females, Japanese encephalitis keeps on occurring in eastern Uttar Pradesh, trachoma is found more commonly in western parts of India such as Punjab, Rajasthan as compared to other parts of India. If you try to analyse carefully you will find that there are certain factors responsible for the variations in the occurrence of diseases by person, by place and according to the time of the year. Sometimes there is a large scale occurrence of a particular disease in a specific area affecting specific population. Why this happens? How can this be controlled? It is necessary to understand the characteristics of disease occurrence and find out the responsible factors for disease prevention and control. There is a scientific approach to study the disease in the context of its occurrence, its distribution across geographical regions, populations, and factors responsible for its occurrence. The approach generally comes under epidemiology.

The term epidemiology is derived from the Greek 'epi' means 'on, upon, befall', 'demo' means 'people, population', and 'logos' means 'the study of'.

Definition

There are several definitions of epidemiology.

According to Greenwood (1934) "Epidemiology is the study of disease as a mass phenomenon." This concept is merely concerned with the occurrence of disease in a large population. This definition has the limitation of being having a narrow outlook. If epidemiology deals with disease outbreaks in the population, what about the distribution, and factors responsible for disease occurrence?

The epidemiology is define as "The study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems".

Hence, Lilienfeld (1957) came with another definition which states "Epidemiology may be defined as the study of the distribution of a disease or condition in a

population and of the factors that influence this distribution". On similar concept, MacMahon (1960) also gave the definition of epidemiology as "The study of the distribution and determinants of disease frequency in man".

This definition widens the scope of epidemiology. It gives an idea about the distribution of a disease in the population. Let us look at the following example. A low lying village near the river Brahmaputra gets inundated by floods every year during monsoon season. During monsoon season, a large number people suffer from diarrhoea in the village, much more than the usual frequency of diarrhoea occurring among the people during other seasons of the year.

In this example, diarrhoea is affecting a large number of people in a village near the river during a particular season. Hence, the disease occurrence has been distributed in the particular village (place of occurrence). Diarrhoea has occurred out of proportion during monsoon season (time of occurrence). The factor responsible for the diarrhoea occurrence during monsoon season can be related to consumption of contaminated water by the people in the village due to floods. Thus, factor responsible for diarrhoea has also been determined. All these aspects are covered under the definition given by Lilienfeld.

Let us go beyond these aspects of epidemiology. Think about 'what is the use of describing a disease in terms of distribution by place, person and time?' Is it merely for discussion by the health care providers? Or is it related for actions to control and prevent the disease? The ultimate aim of studying a disease lies in the control and prevention of the disease so as that people are healthy. Hence, a broader definition which includes aspects of disease control and prevention is more comprehensive and acceptable. Such a definition was given by John M. Last in 1988.

This definition goes beyond disease and includes health related states or events such as accidents, mental health, quality of health services etc. Hence, this is the most acceptable definition of epidemiology. Let us try to understand some of the terms used in this definition.

4.2.2 Distribution and Frequency of Disease

You can look around and try to find out whether everyone is healthy. It may not be so, some one may be suffering from infectious disease such as typhoid fever, malaria, tuberculosis etc. whereas some person may be suffering from chronic diseases such as diabetes, hypertension, asthma, heart attack, so on. Thus, a variety of diseases may be prevalent in the population. Epidemiology helps in mapping out such diseases or health related events in various subgroups of the population by time, place and person.

Not only mapping, we also need to know the magnitude of the health problems to identify the most frequent diseases or health related events. This is measured in form of rates or proportion (e.g. prevalence rate, attack rate, proportion of cataract among causes of blindness etc.) Such measurements help in comparison of the health problems between different populations or subgroups of the population such as between males and females, between rural and urban areas etc. Measuring frequency of health problems in the same population over a period of time can give us a picture about the changing trend of the occurrence of the health problem. This is important from the point of assessing the effectiveness of efforts in trying to control or prevent the health problems by the Government or local health agencies.

Determinants of disease: You might have heard that smoking causes lung cancer, alcohol consumption leads to liver failure, consumption of high salt intake is a risk

factor for hypertension (high blood pressure) and so on. You might be wondering how these factors are related to the occurrence of the diseases. Epidemiological studies are helpful in identifying such risk factors related to diseases.

4.2.3 Aims and Uses of Epidemiology

Let us now read about aims of Epidemiology and followed by uses in details.

According to the International Epidemiological Association, aims of epidemiology are:

1) To describe the distribution and magnitude of health and disease problems in human populations
2) To identify aetiological factors (risk factors) in the pathogenesis of disease, and
3) To provide the data essential to the planning, implementation and evaluation of services for the prevention, control and treatment of disease and to the setting up of priorities among those services.

Descriptive epidemiology involving cross sectional studies help us in describing distribution and magnitude of disease or health problems in the population.

Hence, epidemiology aims at reduction of human suffering from diseases or health problems by helping in understanding the risk factors, aetiological agent, and also the natural history of diseases.

Uses of epidemiology

By now, you might have learnt about the concept of epidemiology and the aims. You might have got some idea about its uses as well. Now, let us discuss the uses in detail. Epidemiology is the basis for improving public health status globally and it has got many uses. According to J M Morris, the uses of epidemiology are summarised as below.

1) **To study the natural history of disease, disability, injury and death**

You have gone through natural history of disease in Unit 1 of this block.

It helps to study the rise and fall of diseases and changes in their character. Remember that the occurrence of disease in the community is never static. It keeps on changing over a period of time affecting new susceptible population. Sometimes, the disease may fade gradually and may disappear until favourable conditions help it to appear in the population. As an example, small pox has been eradicated from the globe, but newer diseases such as HIV, Lassa fever etc. have been identified. Epidemiology has played a major role in the understanding of the occurrence of such newer diseases and in the control of other diseases.

2) **To make a community diagnosis**

Community diagnosis refers to the identification of health problems, related factors and their quantification in the population. The health problems could be in terms of understanding the diseases, conditions, injuries, disorders, disabilities, defects causing illness, or death in a community or region. This is done by measuring the present dimensions and distribution of ill health in terms of incidence, prevalence, and mortality. Epidemiological method such as survey is employed in understanding the magnitude of the health problems in the community. In addition to profiling diseases, epidemiology also helps in understanding the factors such as social, cultural and environmental conditions contributing to the distribution and occurrence of health problems. This information is useful in designing intervention programmes for controlling the diseases in the population.

3) **To assess risk factors of diseases in the population**

You may recall that agents are responsible for causation of infectious diseases. In addition to the causal agents, there are several contributing factors for occurrence of diseases. Sometimes, it may be difficult to identify the causal agent and we may only come across factors associated with the diseases in the community. Such factors are considered to be risk factors. As an example, the risk factors for hypertension are obesity, family history of hypertension, sedentary life style, smoking, alcoholism, high salt intake, high intake of saturated fat etc.

Risk factors are assessed in the population groups for various diseases, health conditions, injury, disabilities, defect etc. Epidemiological approaches such as health risk appraisal, health screening, medical examination, disease assessments by rapid surveys etc. are used for this.

4) **To assess, evaluate and conduct research on the health programmes**

You may know that there are several health programmes launched by the Government with the aim of controlling, preventing or giving treatment to the affected persons in the population. It is necessary to understand the progress and effectiveness of these health programmes for further modifications in the programme, if needed, and also to understand how well do public health and health services meet the problems and needs of the population. Epidemiological methods are applied in assessing and evaluating the outcome, effectiveness of health programmes in the population. Studies using epidemiological approaches are also used for converting research on the health problems and bringing out appropriate solutions to tackle the problems.

5) **To complete a clinical picture**

Understanding of the clinical spectrum of diseases is often the result of reports of diseases which are presented in the hospitals or clinics. While it is easier for the physician to study details of the disease in hospital set up, it is limited by a large number of diseases which go unreported to the doctor in the hospital. Many of them might have died even without reaching the hospital. Under such circumstances, we are unable to study clinical details of those who have not visited a doctor in the hospital. Thus, the reports based on hospital cases do not represent the whole clinical spectrum of diseases occurring in the community level. Epidemiological approaches in the community help in overcoming this gap to get a complete clinical picture of the disease.

Let us look at this example. Usually minor or atypical ischaemic heart disease does not report to the physician in the health centre or hospital. And many of such atypical ischaemic heart disease cases die suddenly, unattended by a physician. Missing information on such sudden death cases leads to incomplete clinical picture about ischaemic heart diseases. However, epidemiological methods can help in understanding the clinical picture, prognosis and thus, help in modifying treatment. In short, the natural history of disease will be more complete if the information is obtained from all cases using standardised criteria for diagnosis in the community.

6) **To identify syndromes**

Syndromes are a group of clinical features, characteristically related to a particular disease.

Syndrome identification is done by describing the distribution, association, and dissociation of clinical phenomena in the population using appropriate epidemiologic methods. A common observation in clinical practice is the clubbing

of cases of coronary heart disease and cerebrovascular lesions as "Atherosclerosis" cases. This is not justified since the two conditions may not behave similarly in terms of clinical presentation and prognosis. Similarly, in earlier times until 1920, little was known about two main groups of peptic ulcers i.e. gastric and duodenal ulcers. Better understanding of differentiation of these cases came with observational studies leading to refining syndromes. Thus, epidemiology contributes in defining and redefining clinical syndromes.

7) **To search for causes of health and disease by studying the incidence in different population groups, in terms of inheritance, behaviour and environment**

You might wonder how causes or aetiological agents of diseases could have been identified. Initial observation of the physicians, correlation of factors, comparison of the observations across different geographical areas as reported by various researchers, and supplemented by positive laboratory investigations leads to identify the causal factors. These are components of epidemiological approaches. Several examples can be cited in this regard, viz. use of thalidomide drug during pregnancy for pain relief and teratogenic outcomes in the newborns, cigarette smoking in British doctors and occurrence of lung cancer, rubella infection during early pregnancy and observation of congenital malformations in the newborn child etc. Our understanding of the causal factors in various chronic non communicable diseases such as cataract, cancers, cardiovascular diseases etc. is limited. Every day we find some newer factors or refuting older factors even in the chronic diseases based on epidemiological studies. Thus, the search for "risk factors" will remain elusive and it will continue in future as well.

In brief, to accomplish all the above mentioned uses, various epidemiologic methods are employed viz. (1) investigation of disease outbreaks or epidemics, (2) studies based on surveys to obtain occurrence of new cases of disease (incidence) and the prevailing disease at the time of survey or within a specified period of time (prevalence), assess risks, etc. (3) clinical trials to determine effectiveness of drugs, vaccines, or therapeutic regimes etc., (4) maintaining registries of diseases such as cancer registry, blindness registry, birth defect registry etc., (5) early detection or screening for diseases, (6) surveillance of a community for disease occurrence, (7) monitoring and evaluating the impact of health care systems.

4.2.4 Epidemiological Models of Causation of Disease

When we talk about the occurrence of a disease, we need to understand that it involves certain causative factors, affected person and the circumstances under which the disease occurs. In an outbreak of disease, several factors often play a role. As an example, when cholera outbreak occurs, there is a causative factor i.e. a type of microorganism (bacteria) called as Vibrio cholerae; transmitting medium which is usually contaminated water or food items, and an occasion where a large number of people gather together, take foods or drinks from a common source which may be contaminated by the microorganism (bacteria), the quantum of bacteria ingested, and the condition of immune system of the persons affected. These factors can be interrelated to each other and absence of one or more factors may not lead to the occurrence of cholera. When we talk about these factors, we try to categorise these factors into three broad groups viz. agent, host and environment. In this example, agent is Vibrio cholerae, host is human being and environment factors are water supply, sanitation etc.

Let us try to understand the interrelationship of agent, host and environment in a more elaborate manner.

Agent

Agent is usually considered to be the causal factor. A single factor must be present for an infectious disease to occur. It may be the microbes which may be bacteria, fungi, rickettsiae, virus. As an example, the spirochete is the agent of syphilis, a bacterium is the agent of cholera, a virus is the agent of measles. In occupation related diseases, lead is the agent for lead poisoning, asbestos for asbestosis etc. In other disease conditions, disability, injury, or death situations, the agent may be a chemical such as a poison, physical factor such as cold, heat, radiation, nutritional deficiency, animal poison such as that of a snake etc.

In epidemiology, we try to understand the interaction of various elements and factors in the environment in the context of disease outcome. The relationship between the organisms with the environment is closely observed and studied. However, all disease conditions cannot be attributed to a single causal agent, such as myocardial infarction (heart attack), which has several factors i.e. family history, sedentary lifestyle, smoking, alcohol consumption, obesity, high blood pressure, and high fatty diet consisting of saturated fats. When more than a single cause is present for occurrence of a disease, this is called multiple causation. Even in infectious disease also, a bacterium cannot solely cause the disease outbreak. We need to consider other factors such as the environment in which the organism grows, mode of transmission, the level of sanitation within the community, medium conducive to propagation, communicability of the organism, level of immunity in the population, population density and proximity of the cases to one another.

Host

By now you might have noticed that presence of an agent alone does not lead to disease condition. The agent should enter the body of another living being such as a human or an animal to cause the disease or harbour the agent. Thus, a host harbours the disease. The host may or may not get the disease. It again depends upon several factors such as immunity level, genetic make up, exposure level, and the state of health. Other factors such as gender susceptibility, social class, economic status, age, educational level also contribute to the etiology and distribution of disease. Illness caused by environmental factors such as heat, cold, radiations, noise, pollution etc are amenable to preventive and control.

Environment

The external conditions or surroundings of the human or animal favouring transmission of the disease agent are considered to be environmental factors. In the case of cholera, it may include a poor sanitation leading to contamination of the water supply with disease causing microbes, in case of dengue fever-stagnant clear water for mosquito breeding and so on. The environment includes three components: biological environment consisting of animals, plants, and living organisms external to the host and also within the host; social environment consisting of the economic, political, social and cultural practices prevalent in the society; the physical environment consisting of water, air, soil, radiations, sound, radiations, altitude, chemicals to which the host is exposed.

Historically, in 1500s, when small pox was introduced in Jamaica, the entire native population of the country lost their lives. The attributing factors included lack of exposure, immunity against small pox in the people, lack of sanitation, lack of knowledge about prevention and environmental conditions.

The relationship between the agent, host and environment is shown in the form of a triangle (Fig. 4.1).

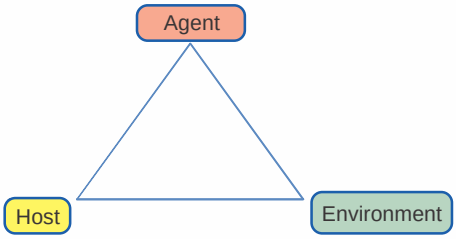


Fig. 4.1: Epidemiology Triangle

4.2.5 Concepts of Disease Transmission

Before discussing the modes of disease transmission we need to know some concepts related to disease transmission viz. fomite, vector, reservoir and carrier. Let us try to understand some of these one by one.

Fomites

Fomites (in singular, fomes) are inanimate objects which play a role in disease transmission. These could be towel, drinking glasses, pen, pencil, door handles, clothing's, or any other inanimate object which can help in transmission of infection by being contaminated with infectious agents and then touched or came in close contact with another person.

Vector

A vector is an arthropod such as mosquito, fly, flea, or rodents such as rat, mouse which is living non human carrier of disease that transports or serves the process of disease transmission. The vector carries the agent from an infected person or animals through bite, body fluids, waste products, or by contaminating foods and spreads to another person.

Reservoir

A reservoir is human, animal, plant, soil or inanimate organic matter (food or faeces) in which the infectious organisms live and multiply. Human being can serve both as a reservoir or a host.

Carrier

A carrier harbours, contains or spreads an infectious organism. A person or animal may appear to be normal despite harbouring the infectious organism but he or it can transmit the infectious agent to another person or animal through contact, or a transmission media such as water, food etc. and cause disease. The transmission of the infectious agent can occur during illness or even during or after recovery of the illness. Depending on the stage of disease state, carriers can be classified as: (a) incubatory carrier, (b) convalescent carrier, (c) healthy carrier.

a) **Incubatory carrier:** A person who sheds the infectious agent during early phase of the disease when the infectious agent has entered the body and the body has not started showing symptoms and signs of the disease (also called as incubation period). Such a person can transmit the infectious agent to another person and cause infection. Some examples of diseases having this type of carrier state are measles, mumps, polio, pertussis, diphtheria, and hepatitis B.

b) **Convalescent carrier:** An individual who has been exposed to and harbours a disease causing organism during the recovery phase of the course of the illness, but is still infectious is considered to be convalescent carrier. One of the best examples in this type of carrier is that of Typhoid Mary, who carried the salmonella typhi (causative organism for typhoid fever) for a long time and infected a large number of persons. It is known that typhoid fever patient can excrete the bacilli for 6 to 8 weeks. Such a carrier can pose a serious threat to the unprotected contacts and household members. Examples of some other diseases showing this type of carrier state are cholera, diphtheria, pertussis.

c) **Healthy carrier:** An individual who has been exposed to and harbours a disease causing organism, but has not become ill or has not shown any symptoms and signs of the illness at any point of time is called as a healthy carrier. Such type of carrier is also considered to be having a subclinical state of the disease. They are also called as "Passive carriers". Some examples of diseases showing this type of carrier state are cholera, meningococcal meningitis, polio, diphtheria and salmonellosis.

Based on the duration, carriers can be categorised as (a) temporary carrier, and (b) chronic carrier.

a) **Temporary carrier:** In this type, an individual harbouring the infectious organism excretes the organism for a short period of time. This category can include incubatory, convalescent and healthy carriers.

b) **Chronic carrier:** Here, an individual harbouring the infectious organism excretes the organisms for an infectious disease over a prolonged period of time. Some examples of diseases showing chronic carrier state are typhoid fever, dysentery, malaria, hepatitis B etc. Chronic carriers are a major source of transmission of infectious disease in the community. Some of them can excrete the organisms intermittently while some excrete the organisms continuously. Such carriers are the source of introducing an infectious disease in a virgin area or otherwise free of infection.

Check Your Progress 1

1) What is the definition of epidemiology to be used in the course?

.....

.....

.....

.....

2) Enumerate the uses of epidemiology.

.....

.....

.....

.....

3) What are the components of an epidemiology triangle?

.....

.....

.....

.....

4) What is the role of vector in disease transmission?

.....

.....

.....

.....

4.3 MODES OF DISEASE TRANSMISSION

After understanding some of the above mentioned concepts of disease transmission, let us now discuss details of modes of disease transmission. There are several methods of transmission of the agent to the host, from one host to the next host or exit from the host to infect another susceptible host which may be an animal or human being. It is dependent upon the infectious agent, portal of entry or the local prevailing environmental conditions. Broadly, the modes of disease transmission can be either direct or indirect.

4.3.1 Direct Transmission

It is also referred to as person-to-person transmission. In this, there is direct and immediate transfer of the microorganism or the agent from a host or reservoir to a susceptible host. Direct transfer can happen through (a) direct contact, (b) droplets, (c) contact with soil, (d) inoculation through skin or mucosa, and (e) transplacental (through placenta from the mother to the foetus).

a) **Direct contact:** Here, transmission of the infectious agent occurs through skin to skin contact as in the case of scabies, or mucosa to mucosa, or mucosa to skin of the same or another person. There is no involvement of any intermediate agency for the transmission of the agent. Skin to skin contact may be through touching by the contaminated hand or close continuous contact, kissing, or sexual intercourse. Examples of some diseases transmitted by this mode are leprosy, HIV/AIDS, skin infections etc.

b) **Droplets:** The nasal or nasopharyngeal secretions or saliva are released into a spray of droplets during coughing, sneezing, talking or spitting. Such droplets from an infected person, usually of the respiratory tract can be expelled to the surrounding environment. The droplets containing infectious agent can be transmitted upto a distance of about 30–60 cms from the source. On inhalation by other persons, small droplets (5 mm or less) can go deeply and reach the alveoli and can spread the disease. Examples of diseases which can spread through droplets are tuberculosis, respiratory infections, whooping cough, meningococcal meningitis etc.

c) **Contact with soil:** Soil including compost or decaying organic matter is the source of infectious agents for diseases such as tetanus, hookworm, mycosis etc. Direct exposure to soil can lead to transmission of these infectious agents.

d) **Inoculation into skin or mucosa:** Infectious agents such as hepatitis B, HIV, can be transmitted directly by inoculation into the skin by injection or through dog bite for rabies virus.

e) **Transplacental:** Also called as vertical transmission, some infectious disease agents such as HIV, hepatitis C, syphilis etc. can be transmitted from the mother to the foetus through placenta.

4.3.2 Indirect Transmission

This is a condition when the disease causing agents are transferred or carried by some intermediate items, means, processes, or organisms to the susceptible host resulting in disease. Indirect transmission can occur through several means: (a) airborne, (b) waterborne, (c) vehicle-borne, (d) foodborne, and (e) vectorborne.

a) **Airborne transmission:** As discussed above, airborne transmission can occur through droplets or dust particle infected with organisms or disease agents. It can remain floated in air for a long time and are carried by wind stream to long distances away from the source.

b) **Waterborne transmission:** This is one of the common ways of transmission of infectious disease agents. Drinking water sources include river, lakes, ponds, wells etc. which may be contaminated by sewage, effluents from industrial waste, and other toxins. Contaminated swimming pool can also lead to transmission of skin and eye infections. There are a large number of waterborne diseases some of which are cholera, shigellosis, typhoid, amoebiasis, giardiasis etc.

c) **Vehicle borne transmission:** In this mode of disease transmission, there are intermediate items such as fomites, eating utensils, comb, clothings, shared drinking bottles etc. transmit the agents. For example, sharing of common kajal applicator can lead to transmission of microbial agent causing trachoma from one person to another.

d) **Food borne transmission:** Food items can act as a medium for transmission of disease agents such as contaminated and improperly washed vegetables used for salad can transmit microbial agent, salmonella which can cause typhoid fever, canned seafood can lead to food poisoning and so on.

e) **Vector borne:** As mentioned earlier, vectors are arthropods or living carrier other than human being which transports infectious agents to susceptible individuals. Vectors could be invertebrates such as flies, mosquitoes, fleas, cockroaches, lice, bugs, ticks, mites and svertebrates such as mice, rat, bat. There are broadly two ways in which vectors transmit infectious agents viz. (1) mechanical and (2) biologic transmission.

   1) **Mechanical transmission:** The mode of transmission can be by a simple mechanical process, when the vector carries or transports the infectious agent such as a fly carrying bacilli causing diarrhoeal disease. This is known as mechanical transmission.

   2) **Biologic transmission:** On the other hand, some infectious agent multiplies or develops inside the host/vector a part of its lifecycle, than it is termed as

biologic transmission. For example, the malarial parasite Plasmodium develops inside the female Anopheles mosquitoes a part of its sexual development.

4.3.3 Chain of Infection

You might be wondering why we have been discussing the issues related to epidemiology triangle, concepts is epidemiology and modes of disease transmission. Understanding these concepts is essential before we proceed for knowing the dynamics of disease transmission. Communicable disease transmission follows a medical model shown in Fig. 4.2. This is termed as chain of infection. Transmission of disease occurs when the infectious disease agent leaves the reservoir through a portal of exit, and is spread by one or more modes of transmission to the susceptible host. The infectious agent enters the host through a portal of entry.

The etiological agent/ infectious agent can be microbes such as bacteria, virus, worms, or chemicals, other plant or animal related substances having the potential to cause disease, disability, or death. The source is the person, animal, object or substance from which an infectious agent passes or is disseminated to the host. The reservoirs are mostly human, animal, or non-living things such as soil, food, faeces, decaying organic matter or substance wherein the infectious agent lives, multiplies, or reproduce. In hookworm infestation, the source of infection is the soil, contaminated with infective larvae and man is the reservoir of infection.

Human reservoirs could be differentiated into three groups: (1) clinical cases – those who are ill and exhibit signs and symptoms of the disease, (2) subclinical case – those who are infected with the infectious agent which multiplies in the host but does not exhibit signs and symptoms of the disease, and (3) latent infection – in which the infectious agent lies dormant within the host without signs and symptoms, and without demonstrable presence in body fluids, blood, tissues, secretions of the host. Subclinical cases play an important role in the transmission of infection from one person to another. Subclinical case may be detected by laboratory tests e.g. by estimating antibody response, biochemical tests etc. Many subclinical cases may be seen in rubella, polio, mumps, influenza etc. Some infections such as herpes simplex, slow viruses, etc. show latent infection.

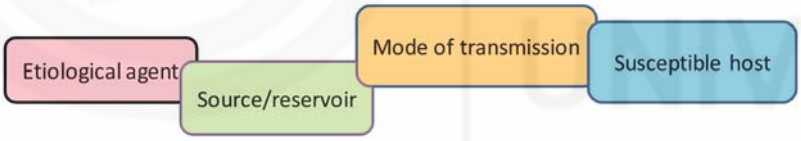


Fig. 4.2: Chain of infection

Once the etiological agent leaves the reservoir, it is passed on to the host by mode of transmission either by direct (person to person) or indirect transmission (airborne, droplets, fomites, food, vectors etc.). The final link in the chain of infection is the susceptible host (human or animal). Several factors play a role in the host before the disease sets in the host. The host has defensive mechanism against infectious agent in the form of protection by intact skin, mucous membrane, ciliary action of the respiratory tract, cough, acidity of the stomach, body's immune response. If the infectious agent overcomes these protective mechanisms and enters the body of the host, it is likely that the host will fall ill.

Check Your Progress 2

1) What are the direct modes of transmission of diseases?

.....

.....

.....

2) Enumerate the indirect modes of disease transmission.

.....

.....

.....

3) What constitutes the chain of infection?

.....

.....

.....

4.4 TIME TRENDS OR FLUCTUATIONS IN DISEASE OCCURRENCE

Before discussing the time trends or fluctuations in disease occurrence, let us try to understand some definitions used in disease epidemiology. Some of these are as follows:

4.4.1 Definitions used in Disease Epidemiology

Endemic: (en = in, demos = people). The constant presence of a disease or infection within a specified geographical area or population group is considered to be endemic for that particular area. Endemic can also be referred to as "usual" or expected frequency of the disease within a specified area or population. When the amount of diseases present in the population remains stable for long periods of time, it is considered to be endemic in that particular population. For example, upper respiratory infection, diarrhoeal diseases are endemic in India.

Epidemic: (epi= upon, demos= people). When a large number of persons are affected out of proportions to the routine occurrence of diseases in a specified population, then it is termed as epidemic. In other words, epidemic is "occurrence of an unusual frequency of disease above the endemic or expected frequency of occurrence" in a specified population, place and time. Some use the term "outbreak" for a small localised epidemic. For example, epidemics of infections such as measles, hepatitis, chicken pox, cholera etc. keeps on occurring off and on in specified populations in India.

There is ambiguity in what constitutes 'excess of expected frequency' for labelling epidemic. In places where the disease is eradicated or eliminated, occurrence of a single case would constitute as epidemic. For example, once polio is eradicated, even a single of polio would be considered as epidemic. For other commonly endemic diseases, when the frequency is more than two standard errors of the usual presence of the disease, usually calculated for a period of at least previous three years is considered to be epidemic.

Sporadic: When the disease occurs in scattered populations, irregularly, haphazardly from time to time and generally infrequently, then it is considered to be sporadic. There is no specific pattern of the occurrence of the disease in the

population with respect to time and place. The cases are usually few in number, not amounting to large epidemic proportions. In addition, there is no common source of outbreak that can be identified. As an example, some zoonotic diseases are seen to be sporadic in man.

Pandemic: (pan=all, demos=people) An epidemic affecting large population groups, extending to a wide geographical areas such as a nation, continent or the world is considered to be pandemic, e.g H1N1 influenza pandemic in 2009.

4.4.2 Types of Fluctuations in Disease Occurrence

Short-term, periodic, long-term

By now you might have come to know that disease occurrence keeps on changing over a period of time in different geographical areas. There are fluctuations in the disease occurrence and these can be (1) short term, (2) periodic, and (3) long term or secular.

1) **Short-term Fluctuations: Epidemics, Types**

Short-term fluctuations in the occurrence of disease can lead to an epidemic. As discussed earlier, you may recall that epidemic is considered when the disease occurs clearly in excess of expected normal distribution in a specified population and time. There are broadly three different types of short term fluctuation of diseases or epidemics.

A) Common source epidemics

B) Propagated epidemics

C) Mixed epidemics

A) **Common source epidemics**

When a large number of cases occur following exposure to a particular source, it is considered to be common source epidemic. It can be subdivided into (a) a single or point source exposure, (b) intermittent and (c) continuous/ repeated exposure.

a) **Common source, single exposure epidemic**

As an example, let us suppose that drinking of contaminated water supplied by a water plant led to the occurrence of large number of cholera cases (300) in East Delhi area supplied by the water plant over a period from July to September in 2013. Available data shows that only few cases ranging from 9 in 2012 to 10 in 2010 and 2011 occurred during the same months (Table 4.1). This shows clearly a great number of cases during 2013 as compared to the previous years in the same months. The occurrence of cholera in 2013 is considered to be an epidemic.

Table 4.1: Year and month wise distribution of Cholera cases in East Delhi from 2010 to 2013

Year	July	August	September	Total
2010	4	5	1	10
2011	3	5	2	10
2012	5	3	1	9
2013	50	240	10	300

If the cholera cases in 2013are shown in the form of a bar diagram, it shows a peak in August 2013 as shown in Fig. 4.3.

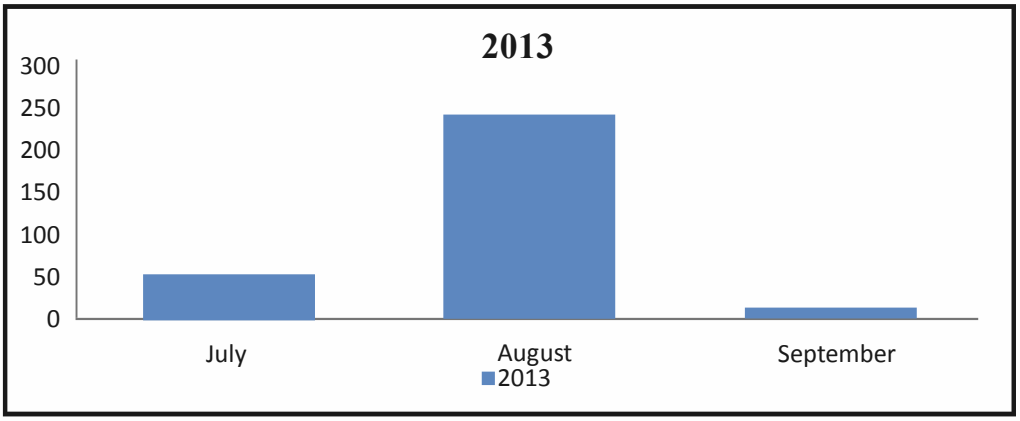
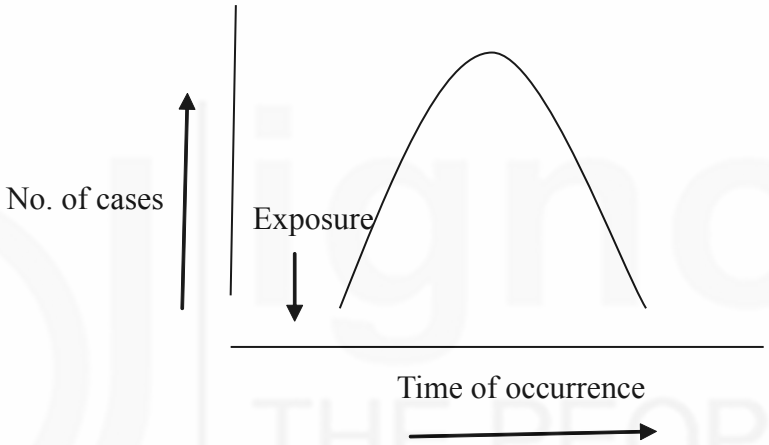


Fig. 4.3: Bar diagram showing number of cholera cases during July to September 2013.

Thus, when the occurrence of disease is shown as a curve it shows a peak with downward slope on both sides indicating an increasing and decreasing number of cases after the peak as shown in Fig. 4.4. This is known as epidemic curve.



The characteristics of a point source epidemic are (a) the curve rises and falls rapidly, (b) the peak shows maximum clustering of cases and within a short time interval, and (c) the cases develop during one incubation period (period from entry of the organism in the host to showing signs and symptoms of the disease).

b) **Common source, intermittent exposure epidemic**

In some disease outbreaks, persons are exposed to the disease off and on over a period of time i.e. days, weeks or even months together. In tuberculosis, the infected person coughs and transmits the disease through air droplets to close contacts. The infected person moves around and transmits to other people who come in close contact with him. Thus, there is no constant transmission of tuberculosis, but intermittently depending upon the movement and closeness of the infected person with other susceptible persons. This is clearly a case of intermittent exposure from a common infected person.

c) **Common source, continuous or repeated exposure epidemic**

Sometimes after the onset of an epidemic, the number of infected persons does not decrease over a long period of time. It keeps on sustaining at that level until it gradually comes down after affecting majority of the susceptible people in the particular or specific population. Such a situation emerges because of the spread of infection to the population through the untreated common source. As an

example, contaminated well water serves as a source of gastroenteritis in a particular village. Persons using this well water for drinking will keep on having the disease until it is chlorinated. Thus, there will be sustenance of the number of gastroenteritis casesin the village until well water is treated with chlorination. In common source, continuous exposure epidemic the occurrence of the disease outbreak continues beyond the range of one incubation period.

B) **Propagated epidemic**

In some disease outbreaks it may be difficult to identify the single common source. However, once the outbreak has been initiated, the disease transmission continues because of person to person transmission depending upon the contacts. Thus, the new infected person transmits another person, who in turn will transmit to another person and so on. This will lead to a situation in which the cases will continue until the immunity of the affected population is built up and or no more susceptible persons remain to be infected. Propagated epidemic usually exhibits an exponential growth pattern of the disease and fall off gradually. As in the case of common source continuous epidemic, the cases keep on appearing beyond one incubation period. The epidemic curve shows a series of successive peaks, indicating fresh number of cases cropping up in a large number, transmitted from newly infected persons. An example of this type of epidemic is the spread of HIV or hepatitis B infection through sharing of needles by intravenous drug users infected with HIV and or hepatitis B. New drug users using the infected shared needle keep on getting the infection and the epidemic can continue till no more new drug users are available to be infected. The epidemic declines once the affected population is treated, or immunised against the infection (if vaccine is available) or there is death of the affected persons. Propagated epidemics can be through direct contact, person to person, fomite borne, vehicle borne and or vector borne transmission. Mosquitoes spreading malaria is an example of vector borne transmission.

C) **Mixed epidemic**

The disease outbreaks can be a combination of common source epidemic which has started the epidemic and propagated epidemic maintained by person to person transmission. Both the situations may exist at the same time. This is called as mixed epidemic.

In addition to the abovementioned epidemics, another variant of epidemics commonly termed as “slow epidemic” or modern epidemic is also in vogue. This denotes the ever increasing number of cases of non-communicable disease such as diabetes, coronary heart diseases, depression etc. leading to public health alert. Such an epidemic may not be considered as a short-term fluctuation of disease since slow epidemics appear over a long period of time, years to decades. Steps of investigation of an epidemic outbreak is discussed in details in Practical Course 3 Block 1, Unit 3 management is also discussed in Course 1 Block 3.

2) **Periodic Fluctuations: Seasonal Trend, Cyclic Trend**

Occurrence of diseases may show fluctuations throughout the year and even year after year also. Such fluctuations may show (a) seasonal and (b) cyclic trend.

a) **Seasonal trend**

Many communicable diseases show a seasonal trend of disease occurrence. During winter season, cases of rota virus diarrhoea cases in children shoots up; whereas at the arrival of spring season the number of measles cases increases and during rainy season gastroenteritis cases increases while after the rains, dengue fever

cases come up in large numbers. Such observations are considered to be linked with the seasons and hence, epidemics may show a seasonal trend. The seasonal variation in the disease occurrence is related to the environmental conditions favouring disease transmission. It may be humidity, temperature, rainfall, overcrowding, or conducive conditions leading to breeding of the vectors which transmits the infections.

b) **Cyclic trend**

There are some communicable diseases which appear in the form of epidemics in a cyclical or periodic manner. It may be spread over days, weeks, months or even years. One of the examples is measles. During pre-vaccination times, it occurred cyclically after every two to three years when the number of susceptible individuals gradually built up and led to epidemics. Similarly, in rubella, epidemics can occur at every 6–9 years intervals of time. Cyclical nature of epidemics in infectious diseases is related to the immune status of the community, occurring more when there are a large number of people without immunity to the disease.

3) **Long-term or Secular Trends**

Some diseases tend to occur in large numbers over a long period of time, more than a year or so. It may be even in decades. Chronic diseases such as lung cancer, coronary artery disease, diabetes etc. tend to show this type of time trend. In all these conditions, the disease rates are tracked over time and secular trends emerge after years and decades. This information is useful for identifying diseases of public health importance, to formulate policy, programmes and the effectiveness of any intervention programme done to reduce morbidity and mortality from the disease in the population.

Check Your Progress 3

1) Define the terms endemic, epidemic.

.....

.....

.....

2) What is propagated epidemic?

.....

.....

.....

3) What is cyclic trend of diseases?

.....

.....

.....

4) List three levels of prevention of disease.

.....

.....

.....

4.5 EPIDEMIOLOGICAL APPROACHES

Epidemiological study requires systematic collection of health data, its analysis, description of health needs and health problems, identification of factors associated with the problems and stating the hypothesis which are: (i) Descriptive method, (ii) Analytical method, (iii) Experimental method. Descriptive and analytical methods or studies are also known as observational studies because the investigator does not intervene; he or she makes an observation of the frequency and distribution of the disease by person, place and time.

4.5.1 Descriptive Epidemiology

Descriptive epidemiology is concerned with the study of frequency and distribution of disease and health related events in population in terms of person, place and time. Its purpose is to provide and overview of the extent of health problems and to give a clue to possible etiological factors involved. This method gives information about who all are affected by a particular disease or health related problems, where the cases occur and when they occur. The data is collected about:

1) Personal characteristics such as age, sex, marital status, occupation, education, income, social class, dietary pattern habits.
2) Place distribution of cases i.e., areas of high concentration, low concentration and spotting of cases in the map.
3) Time distribution/trends such as year, season, month, weak, day and hour of onest of the disease.

Such information gives clues to possible associated factors such as age with specific disease e.g., measles, diphtheria, pertussis, in early childhood, cancer, dietary pattern with obesity; seasonal variation, periodic fluctuation, etc.

The data collected are analysed and presented in terms of percentage, rates and ratios. This refers to statistical information of a problem and are given in the table for you to learn to compute.

Thus, descriptive epidemiology provides information for:

1) Making community diagnosis i.e., describing the nature of diseases or problems and measuring their extent in terms of incidence/prevalence rate, ratios, mortality rates, etc., by age, sex, occupation, social class, etc.
2) Providing clues to etiology of disease for further rigorous investigation and confrontation of the causes.
3) Planning, organising and implementation of health care services to deal with these problems.

4.5.2 Analytical Epidemiology

You have learnt that descriptive studies yield etiological clues for various disease which helps in making a guess or formulation of hypothesis for further vigorous study or testing e.g. "cigarette smoking (10 to 20) in a day causes lung cancer in 10 to 15 per cent of smokers after 20 years of exposure". These type of hypothesis are further studied and tested by analytical studies to determine the association of cause with the effect.

Thus, analytical epidemiology goes beyond the descriptive epidemiology. It consists of two type of observational studies: (i) Case Control Study, and (ii) Cohort Study.

1) **Case Control Study:** In this method a group of people who have been diagnosed as having a particular problem (cases) are compared with a group of people who are similar in characteristics to that of cases but they are free from the problem under study (controls). Here the approach used is retrospective i.e., the disease has already occurred and the epidemiologist goes back in time. He reviews the records, interviews the cases and their family members. The data thus collected about the suspected factor/factors is analysed statistically to determine the extent of its association with the disease. This method, therefore, is called as retrospective method. This approach has helped in identification of causative factors of many diseases/problems, etc. e.g. Rubella in mothers during early pregnancy in the cause of congenital deformities in children, smoking associated with lung cancer, iodine deficiency associated with hyperthyroidism. These conclusions are based on repeated case control studies. Case control studies are easy to organise and are less expensive.

2) **Cohort Study:** A cohort is a specific group of people, at a certain time, sharing common characteristics or experience e.g., people born on the same day or the same year (birth cohort), couple married in the same year (marriage cohort), a class of nursing students (experience cohort), people with same occupations (occupational cohort) etc.

Cohort study is prospective in nature because the group under study is free from the disease but exposed to risk factor. In this method of study the epidemiology selects a cohort i.e., a group of people say in the same age group and who are exposed to a certain risk factor say cigarette smoking (study group) and who are not exposed to the risk factors (control group). Both the groups are followed up for several years and observations are made with reference to frequency and distribution of the suspected disease (in this example lung cancer) over a period of time. The data is statistically analysed and comparisons are done between the incidence among smokers and non-smokers to determine the association of risk factors to the disease.

The prospective study is expensive and time consuming but it has its advantages over retrospective method. This method can help in studying the natural history of disease, estimating incidence rates, risk factor under study to other diseases or problems e.g., cigarette smoking and high blood pressure, cardiovascular problems etc.

4.5.3 Experimental Epidemiology

Experimental studies are similar in approach to cohort studies expect that conditions are under the careful control of the investigator. Experimental studies are done to confirm the cause and effect association of the efficacy of preventive or therapeutic agent or procedure. In these studies, the investigator administers and does investigation/gives treatment to the experimental group which is either exposure to causative agent or preventive/therapeutic agent, but not to the control group which is similar to the experimental in all its aspects. He then observes and analyse the outcomes using statistical methods and confirm the cause of diseases, and establishes the efficacy or preventive measures and drugs under study. Usually these experiments are done in the laboratory animals. But clinical and community trials are done to determine efficacy of preventive or therapeutic laboratory animals. These trials do involve medical, ethical and moral issues.

4.6 PRINCIPAL OF CONTROL MEASURES/ LEVELS OF PREVENTION OF DISEASE

We are all familiar with a very popular phrase “Prevention is better than cure”. It is because of the fact that prevention helps to promote and preserve health and minimises

the sufferings and distress. It is also economical because preventive measures can be followed and practiced by all at the village and home level. It does not require sophisticated infrastructure, equipment and material. Above all it is a positive approach to healthful living. Epidemiologically, the concept of prevention is broad based. According to natural history of disease, three levels of prevention have been identified. They are : (i) Primary Prevention, (ii) Secondary Prevention, (iii) Tertiary Prevention.

1) **Primary Level of Prevention:** It refers to preventive measures taken before the occurrence of a disease i.e., during the prepathogenesis phase of disease. Preventive measures during this period of a disease process prevent the occurrence of disease and promote health. These measures are classified as:

   - **Health Promotion:** Health promotive factors include wholesome nutritious food, safe environment to live, healthful life-style and adequate resources. All these aspects are directly related to social-economic and cultural status of the family which must be improved. Much of the morbidity and mortality due to communicable diseases such as typhoid, cholera, dysentery, tuberculosis. Plague, leprosy etc., have been reduced due to these preventive measures. Health promotive measures are equally applicable to the prevention of chronic and non-communicable diseases such as cardiovascular, diabetes, accidents, etc.
   - **Specific Protection:** It refers to actions to protect from a particular disease or group of disease, like B.C.G immunisation for tuberculosis, D.P.T for diphtheria, pertussis and tetanus, increase or decrease of specific nutrient in diet and or supplementing it e.g., iron rich diet and supplementing with iron tablets in case of prevention of anaemia.

     Primary prevention is given major emphasis in health care and it is identified with health education because it is considered as the responsibility of the individual, family and community.

2) **Secondary Level of Prevention:** Secondary level of prevention refers to measures taken during pathogenesis period to control the progress of disease in man to stop or control the spread of disease in the community. Secondary preventive measures prevent disability or defects, and restore health. It includes early identification of cases an their contacts and giving them timely treatment and follow-up e.g., early diagnosis and treatment of all cases of tuberculosis and their contacts. These actions help in early recovery prevent cavitation and consolidation of the affected part of the lungs and also prevent further spread of the tuberculosis in community. Similarly, early diagnosis and treatment of high blood pressure will help in the prevention of possible cardiovascular emergencies. Thus secondary level of prevention reduces prevalence rate of disease i.e., prevents the occurrence of new cases and controls old cases.

3) **Tertiary Level of Prevention:** The purpose of tertiary level prevention is to limit the disability and help the individual adjust to permanent impairment and disabilities so as to lead a useful life. The measures included are physical, vocational and psychosocial rehabilitation e.g., deep breathing exercise, meditation, etc., for efficient lung expansion; guidance and training to learn new vocation and guidance and counselling for restoration of family and social relations, etc., in case of patients with pulmonary tuberculosis.

4.7 LET US SUM UP

In this unit you have learnt that epidemiology is the science of community health. Epidemiology deals with the study of distribution and determinants of health

related events and it is used for understanding rise and fall of diseases, community diagnosis, syndrome identification, completing clinical spectrum of diseases, searching of risks and causes, planning, evaluation and control of health problems. Diseases occur by interaction of agent, host and environmental factors (epidemiology triangle). Diseases can be transmitted by direct and indirect modes of transmission. The chain of infection includes eiological agent, source or reservoir of infection, mode of transmission and host. When disease occurs in outbreaks more than the expected frequency of disease in a population, it is also called as epidemic. Epidemics can occur through common source, it can be intermittent, continuous, propagated and mixed epidemic. Some diseases can occur seasonally, cyclically, and follows a secular trend. There are three levels of prevention of disease, primary which includes health promotion and specific protection, measures taken during pathogenic phase to stop or control the spread of disease by early detection and treatment in secondary level and in tertiary to limit viability and help individual to adjust the permanent impairment by physical, vocational and psychological rehabilitation.

4.8 MODEL ANSWERS

Check Your Progress 1

1) The most comprehensive definition of epidemiology was given by John M. Last in 1988 that states "The study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the control of health problems".

2) The uses of epidemiology are:
   a) To study the natural history of disease,
   b) To make a community diagnosis,
   c) To assess risk factors of diseases in the population,
   d) To assess, evaluate and conduct research on the health programmes,
   e) To complete a clinical picture,
   f) To identify syndromes,
   g) To search for causes of health and disease by studying the incidence in different population groups, in terms of inheritance, behaviour and environment

3) The components of epidemiology triangle are agent, host and environment.

4) A vector is an arthropod such as mosquito, fly, flea, or rodents such as rat, mouse which is living non human carrier of disease. It plays an important role in disease transmission. The vector carries the agent from an infected person or animals through bite, body fluids, waste products, or by contaminating foods and spreads to another person.

Check Your Progress 2

1) The direct modes of transmission of diseases are (a) direct contact, (b) droplets, (c) contact with soil, (d) inoculation through skin or mucosa, and (e) transplacental (through placenta from the mother to the foetus).

2) Enumerate the indirect modes of disease transmission?

   Indirect transmission can occur through several means: (a) air-borne, (b) water-borne, (c) vehicle-borne, (d) food-borne, and (e) vector-borne.

3) What constitutes the chain of infection?

The chain if infection includes etiological agent, source/ reservoir, modes of transmission and host.

Check Your Progress 3

1) Endemic: The constant presence of a disease or infection within a specified geographical area or population group is considered to be endemic for that particular area. Endemic can also be referred to as "usual" or expected frequency of the disease within a specified area or population.

2) Epidemic: Epidemic is "occurrence of an unusual frequency of disease above the endemic or expected frequency of occurrence" in a specified population, place and time.

3) Propagated epidemic:

Once the outbreak has been initiated from a source, the disease transmission continues because of person-to-person transmission depending upon the contacts. This type of sustained epidemic is termed as propagated epidemic.

4) What is cyclic trend of diseases?

Some communicable diseases appear in the form of epidemics in a cyclical or periodic manner. It may be spread over days, weeks, months or even years. For example, measles epidemic occurs at every 2–3 yearly intervals.

5) Three levels of prevention of disease are:

a) Primary which includes health promotion and specific protection,

b) Secondary level includes measures taken during pathogenic phase to stop or control the spread of disease by early detection and treatment,

c) Tertiary to limit viability and help individual to adjust the permanent impairment by physical, vocational and psychological rehabilitation.

4.9 KEY WORDS

Agent : Causative factor invading a susceptible host through a favourable environment to produce disease, which may be biological, chemical or physical in nature.

Clustering : Grouping or /colony of/ crowding of.

Communicable : Able to be transmitted from one host to another.

Ecology : A branch of biological science concerned with the study of interrelationship of organism and their environment.

Endemic : Habitual or usual presence of disease or infectious agent within a defined geographical area.

Environment : The aggregated of all external conditions that may enhance or inhibit the interaction between host and agent; they may be physical, biological, social, cultural and economical.

Epidemic : The occurrence in a community or region of an illness or a group of illness of similar nature clearly in excess or normal expectation.

Etiology	:	Cause of disease condition.
Host	:	A vertebrate or invertebrate species (human, animals, etc.) capable of being infected or affected by an agent.
Hypothesis	:	Statement showing relationship of one factor with the other.
Immunity	:	Insusceptibility to disease or condition, may be natural or acquired.
Incidence	:	A measurement of the number of new cases of a disease or other event occurring in a population during a given period.
Infection	:	The entry and development or multiplication of an infectious agents in the body of host; not synonymous to disease.
Morbidity	:	Illness or some other conditions, not including death.
Mortality	:	Death
Pandemic	:	An epidemic over a wide geographical area, or even worldwide.
Prevalence	:	Measurement of all cases (old or new) of disease or other conditions present in a population at a given time.
Scrutiny	:	Close or detailed examination, critical gaze.
Susceptible Host	:	Sensitive host i.e., the host who does not have immunity.

4.10 REFERENCES

1) Timmreck TC. An introduction to epidemiology. Jones and Bartlett Publishers, Sudbury, Massachusetts, 2002.

2) Park K. Park's textbook of preventive and social medicine. BanarasidasBhanot Publishers, Jabalpur, 23rd edition, 2015.