

Unit 4th

**PRINCIPLES OF EPIDEMIOLOGY
AND EPIDEMIOLOGICAL
METHODS**

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• Introduction-

The concept of epidemiology is as old as medical science.

The word epidemiology is the combination of three Greek words.

Epi- among, upon

Demos- People

Logos- study of science.

Epidemiology is basic science of preventive and social medicine.

The roots of epidemiology can be traced back to Hippocrates (460-477 BC) who was sometimes referred to as the first epidemiologist.

They are the first person to associate disease with life style and environmental factors.

Epidemiology is the study of occurrence, distribution, and causes of disease in mankind. These include disease like cancer and heart diseases, hereditary disorder, nutritional deficiencies, mental illness, drug addiction, accidents, pregnancy, growth and development. (The scientific study of the spread and control of diseases).

- **Definition :-**

So many definitions of epidemiology are in vogue, but the main components of these definitions are almost same. These include:

- i) Study of the frequency of diseases.
- ii) Study of the distribution of diseases, and
- iii) Study of the causes of diseases.

Some common definitions of epidemiology are given below:

1. Epidemiology is the study of occurrence, causes and distribution of infectious diseases as it occurs in humans.
2. The study of the distribution and determinants of disease frequency in man.

Aims of epidemiology :-

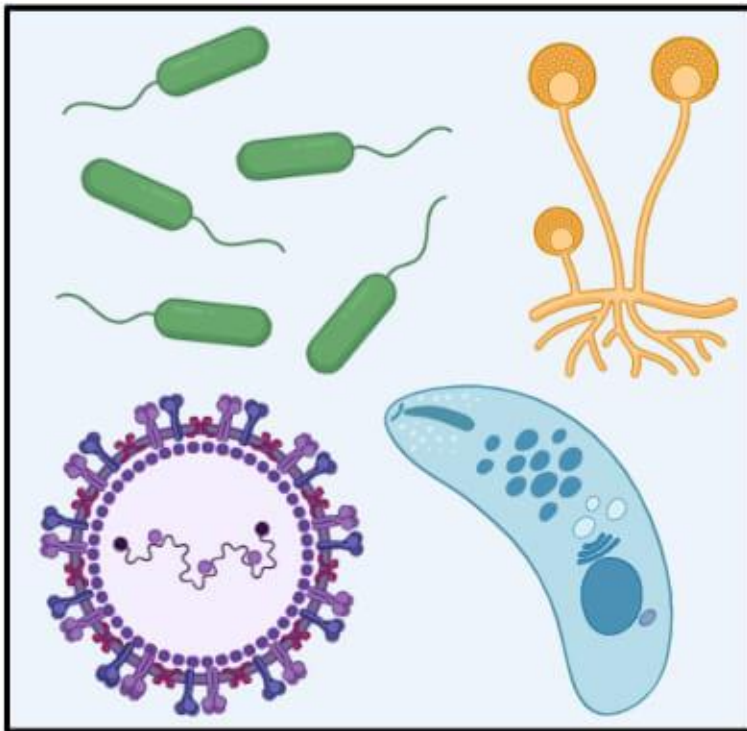
- The primary purpose of the epidemiology is the disease prevention and early intervention for the maintenance and promotion of health by which the ultimate aim; that is the well being of the society can be achieved.
- The main aims of the epidemiology as laid down by international epidemiological association are given here:

1. To describe the distribution and magnitude (degree of size) of health and disease problems among individuals and groups (human population).
2. To identify the etiological factors in the pathogenesis of disease.
3. To provide data for planning, implementation and evaluation of services for the prevention, control and treatment of disease and in setting up of priorities among those services.

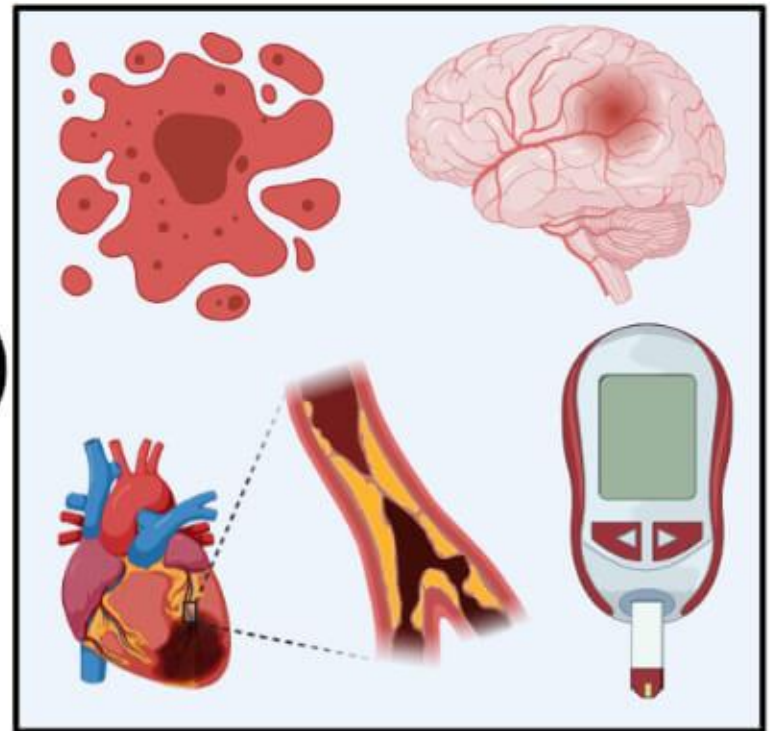
Different epidemiology tools and methods may be used to fulfil these objectives.

Communicable and non-communicable diseases-

Communicable and Non-Communicable Diseases



VS



● Introduction :-

Diseases are frequently referred to as communicable or non-communicable. Communicable diseases comprise infectious diseases such as tuberculosis and measles, while non-communicable diseases (NCDs) are mostly chronic diseases such as cardiovascular diseases, cancers, and diabetes.

Due to longer incubation period for non-infectious diseases such as coronary heart diseases and cancer, many environmental factors contribute to disease development overtime, creating a more complex situation for determining web of causation or cause –effect – relationship.

<u>COMMUNICABLE DISEASES</u>	<u>NON COMMUNICABLE DISEASES</u>
Communicable disease refers to diseases that can pass from one person to another.	Non-communicable diseases occur in one person and cannot be passed on to another person.
Communicable diseases are also known as infectious diseases	Non-communicable diseases are referred to as chronic
Communicable diseases are more likely to be acute, which means the disease develops quickly.	Non-communicable diseases tend to be chronic, which means they last a long time and progress slowly.
Generally involves the lower socioeconomic group	Involves generally affluent class
Vehicles of transmission and the vectors play a major role in the spread of disease.	Dietary habits, environment and lifestyle play a role in the causation of these diseases.
Ex. common cold, pneumonia and tuberculosis	Ex. Diabetes, Arthritis, High blood pressure, Scurvy

- **Epidemiological Investigation -**

Epidemiological investigation consists of following steps:

- i) Establishing the occurrence of a problem.
- ii) Verifying the diagnosis.
- iii) Collecting related data.
- iv) Formulating a hypothesis.
- v) Testing the hypothesis.

❑ **Epidemiological Methods :-**

For the purpose of community health nursing, one classification and its description is given here.

1) Descriptive Method –

- Person
- Place
- Time

The descriptive studies describe disease occurrence in relation to person, place and time.

The main objective of descriptive methods are as following :

- i) To provide a database for planning, providing and evaluating health services.
- ii) To evaluate the trends in health sector and provide a basis for comparisons among groups.
- iii) To identify problems for further analysis.

- **Person:-** Relationship between many personal characteristics of individuals and the occurrence of specific disease is well known.
- **Place:-** It is an established fact that nature and occurrence of disease are found in different ways in the developed, developing and undeveloped countries.
- **Time:-** The third important characteristics of descriptive study in relation to occurrence of disease is time.

2. Analytic Method –

Analytic method is carried out to test the hypothesis. Analytic method has mainly two approaches; experimental and observational.

i) **Experimental Approach:** This is used for testing the hypothesis in almost majority of scientific researches.

To determine the cause-effect relationship, investigator controls one factors; independent variable and measures the subsequent effect on dependent variable.

ii) **Observational Approach:** Due to human subjects, limited situations can be experimented, therefore observational methods are more commonly applied in epidemiology.

Observation approaches are of three types:

- a. Retrospective (case control)
- b. Prospective (cohort)
- c. Cross sectional

Basic Tools of Measurements

The most common basic tools of measurements, used in epidemiology are: i) Rates and ii) Distributions.

i) Rates–

The rates are widely used for the measurement of amount of disease or the number of those affected in a human population.

Rate may be defined as; measurement of a specific event, condition or disease in a given population within a specific time period. In formula it may be expressed as:

$$\text{Rate} = \frac{\text{Number affected in a time period}}{\text{Total population in a same area}}$$

Rates may be used for the comparison between groups. Rates present demographic data and morbidity data.


- **Demographic rates:** Some important rates, which represent the demographic data are mentioned below:
 - Crude birth rate (CBR)
 - Crude death rate (CDR)
 - Infant mortality rate (IMR)
 - Maternal mortality rate (MMR)
 - Neonatal mortality rate (NMR)

➤ Morbidity Rates (Disease rate):

Morbidity data are presented generally as incidence rate and prevalence rate. Morbidity indicates any department subjective or objective from a state of physiological well being along with the demographic rates. Morbidity rates also refers to index of health status of community.

➤ Incidence Rate-

No. of new cases of a disease during a
given time period

 100

Population at risk during that period

➤ Prevalence rate-

It indicates the number of existing cases of disease in the total population at a particular point of time.

number of existing cases of disease at a point of time

= -----

Total population at point of time.

ii) Distribution-

The term distribution used for the assessing and evaluating the community health needs.

❖ Disease Transmission –

- 1) **Direct Transmission**– Direct or immediate transmission of infectious agents in susceptible host.
- 2) **Indirect Transmission**– Infectious agent can survive outside the human host without losing his pathogenicity and can cause infection in the new host.

Direct transmission :-

A. Contact Transmission –

Types - Physical, soil, and droplet contacts.

- i) **Physical Contact** : It includes sexual contact, touch, continuous close contacts etc. and can cause skin, eye disorders etc.
- ii) **Soil contact** : Infectious agents present in soil can cause hookworm, tetanus etc.
- iii) **Droplet contact** : Droplet contact transmission occurs when infectious agents contained in most respiratory sections are speaked out, spitted or coughed or sneezed into environment.

B. Transplacental Transmission –

Transmission of infectious agent can occur transplacental. R-Rubella virus, H-Herpes virus.

C. Inoculator Transmission–

Transmission of infection can occur by injections syringes/needles as infection of hepatitis B or by direct bite on skin; as rabies infection after dog bite.

Indirect Transmission

A. Common source Transmission–

Infectious agents may be transmitted through a common source. It includes mainly vehicles, fomites and hands.

i. Vehicle: Food, water, ice, blood, its components and other biological products play the role of vehicle for the transmission of infection. (diarrhea, cholera, polio, food poison etc.)

ii. Fomites: Fomites are the major source of indirect transmission. Fomites include linen, books, dressings, utensils, stationary material, toys, furniture's, phone, computer, mobile causing the eye, ear, and skin infection).

iii. Hands: Unclean hands of the doctors, nurses, paramedical staff and patients are one of the main sources for transmission of infection. (GIT, intestinal parasite, hep. A, typhoid etc.)

- iv. Air borne infection- the air can carry droplet nuclei. These are small residue resulting from evaporated fluid from droplets coughed or sneezed by an infected person. These is major source of hospital acquired infection.
- v. Vector born- vector indicates an arthropod or any living matte, which carries in infection agent to any susceptible host, vector includes flies, mosquito, rodents, fleas.
- vi. Mechanical- it includes simple mechanical carriage by a crawling or flying insect through soiling of its feet.
- vii. Biological- multiplication cycle development or combination of both is required before the arthropod can transmit the infection from the agent to man. (saliva, bites, trauma etc.)

Levels of prevention of disease:-

The control of disease implies mainly the prevention of diseases; primary prevention or secondary prevention or combination of both.

- Reducing the occurrence of disease.
- Reducing the risk of transmission.
- Decreasing the mortality and morbidity.

For Example: we are controlling malaria and polio has been eliminated from various states of our country and smallpox has been eradicated from the world.

- **Primary prevention-** primary prevention can be defined as action taken prior to the onset of disease, which removes the possibility that a disease will even occur.

Eg. Health promotion- we can prevent no. of diseases such as cholera, typhoid, TB, nutritional disease by promoting the health of the individual and community.

specific protection- by specific protection we can preventing specific disease by specific measures. eg. Preventing TB, diphtheria, pertussis, TT, polio, measles by immunization.

- **Secondary prevention-** it may be defined as action taken which halt the progress of a disease at incipient stage and prevent complication.

Eg. Early diagnosis (testing, screening etc.)

Adequate treatment

- **Tertiary prevention-** when the disease process has advanced beyond its early stage. It is still possible to accomplish prevention by what may be called tertiary prevention. It may be defined as all measures available to reduce or limit impairment and disabilities minimize suffering caused by existing departures from good health and to promote the patient adjustment. Eg. Restoration of function, capacity to earn a living, restoration of family, social relationship, confidence.

Immunizing agent-

Immunizing agent means a vaccine, antitoxin or other substances used to increase an individual's immunity to a disease.

a. Vaccines- Over the last century, vaccination has been the most effective medical strategy to control infectious diseases. Smallpox has been eradicated world-wide and poliomyelitis has been almost eradicated. Most viral and bacterial diseases traditionally affecting children world-wide are now preventable by vaccines. Vaccination is estimated to save at least 2-3 million lives every year.

- Live vaccines- (e.g., BCG, measles, oral polio) are prepared from live or wild (generally attenuated) organisms. Live vaccines should not be administered to persons with immune deficiency diseases or to persons whose immune response. When two live vaccines are required they should be given either simultaneously at different sites or with an interval of at least 3 weeks.

- ~~Inactivated or killed vaccines-~~ Inactivated vaccines are produced by growing virus or bacteria in culture media and then inactivating them with heat or chemicals (usually formalin), when injected into the body they stimulate active immunity. Because the vaccine is inactivated, the infective agent cannot grow in the vaccinated individual and therefore, can not cause the disease, even in an immunodeficient person.
- Subunit vaccines- A vaccine can be made of single or multiple antigenic components of a microorganism that are capable of stimulating a specific immune response sufficient to protect from the relevant pathogen infection or from the clinical manifestation of the disease.
- Combined vaccines- If more than one kind of immunizing agent is included in the vaccine it is called a mixed or combined vaccine. Eg. DPT (Diphtheria-pertussis-tetanus) DT (Diphtheria-tetanus) DP (Diphtheria-pertussis) DPT and typhoid vaccine MMR (Measles, mumps and rubella) DPTP (DPT plus inactivated polio) Hepatitis A, and B Hepatitis A, and typhoid.

- **Incubation period-** “the time interval between invasion by an infectious agent and appearance of the first sign and symptoms of the disease.

During the incubation period the infectious agent undergoes multiplication in the host.

- **Portal of exit-** it is path by which a pathogen leaves its host. Eg. Nose and throat secretions, faeces, skin, urine etc.
- **Portal of entry-** the manner in which a pathogen enters a susceptible host. Eg. Sexual contact, saliva, genitourinary tract, skin, open wound etc.

TABLE 29

Vaccines currently in use

Live attenuated	Killed whole organism	Toxoid/Protein	Polysaccharide	Glycoconjugate	Recombinant
Tuberculosis (BCG)	Typhoid	Diphtheria	Pneumococcus	Hib	HBV
Yellow fever	Cholera	Tetanus	Meningococcus	Pneumococcus	Lyme disease
Polio (OPV)	Plague	Acellular Pertussis	Hib	MenACWY	Cholera toxin B
Measles	Pertussis	Anthrax	Typhoid (Vi)		HPV
Mumps	Influenza	Influenza subunit			
Rubella	Typhus				
Typhoid	Polio (IPV)				
Varicella	Rabies				
Rotavirus	JE				
Cholera	TBE				
Cold-adapted influenza	HAV				
Rotavirus reassortants					
Zoster					

BCG – Bacille Calmette-Guerin; HAV – hepatitis A virus; HBV – hepatitis B virus; Hib – Haemophilus influenzae type b; IPV – inactivated polio vaccine; JE – Japanese encephalitis; Men – meningococcus, OPV – oral polio vaccine; TBE – tick-borne encephalitis.

Source : (122)

Objectives of Immunization-

1. Reducing infant mortality rate : This objective can be achieved by giving vaccines against tetanus, polio, diphtheria, TB and measles.
2. Reducing maternal mortality rate : By immunizing the pregnant mothers, number of maternal deaths can be reduced to a large extent.
3. Controlling the infections of diseases and their carriers.
4. Increasing the health level and life expectancy of citizens by generating prophylaxis against diseases.
5. Developing sufficient capacity and technique to manufacture vaccines.

- BCG – Tuberculosis
- OPV – Polio
- Hep. B – Hep. B
- DPT – Diphtheria, Pertussis, Tetanus
- Hib – Pneumonia, Meningitis, Bacteremia
(Haemophilus influenzae Type B)

Measles – Measles

MMR – Measles, Mumps, Rubella

Typhoid – Typhoid

- TT – Tetanus
- PCV – Bacterial Diseases causing pneumonia, meningitis etc., (Pneumococcal Conjugate Vaccine)
- Varicella – Chicken pox
- Hep A – Hepatitis A
- HPV – Human Papilloma Virus causing cervical cancer
- Rotavirus - Diarrhoea

b. Immunoglobulins- Any of a class of proteins present in the serum and cells of the immune system. Which function as antibodies.

The human immunoglobulin system is composed of 5 major classes (IgG, IgM, IgA, IgD and IgE) and sub-classes within them.

IgG- Comprising about 80 per cent of the total serum immunoglobulins. Antibodies to gram-positive pyogenic bacteria, anti-viral and anti-toxic antibodies are found exclusively among IgG globulins. Its half life is about 21 days.

IgM- It accounts for about 6 per cent of normal serum immunoglobulins. Its half life is about 7 days.

IgA- Constitutes about 13 per cent of the total serum immunoglobulins. e.g., saliva, milk, colostrum, tears, bronchial secretions, nasal mucosa, prostatic fluid, vaginal secretions and mucus secretions of the small intestine;

IgE- Half-life is 2 days. Serum IgE is also typically increased during helminth infestations.

IgD- IgD acts as an antigen receptor when present on the surface of certain B lymphocytes. In serum it is present only in trace amount Its half-life is 2 days.

Concept of disease-

- The English word “disease” actually means dis-ease which implies uneasiness, distress, inconvenience and a state that is opposite to comfort.

Definition-

- Acc. To Oxford dictionary-

Disease is a state of body or its organ which either interferes with the functioning of the body or deranges its functions.

- Acc. to Ecology-

Disease is a condition of maladjustment between environment and organ of human body.

Epidemiological Triad

- The agent, host, environment is essential to develop a disease. Heart disease, cancer, degenerative disease and some chronic diseases are the only exceptions to this rule.
- When the host is weak, agent strong and environment is conducive to generate a reaction, disease develops.

Agent- biological, nutritional,
physical, chemical, mechanical.

Host- Age, sex, food, genetic,
profession, customs, habits,
human behaviour.

Environment- physical,
biological, social

1. Agent- agent is the foremost factor. It can be living or non living. There can be one or more agent responsible for a single disease.

- Biological- these are living agents (virus, bacteria, protozoa, fungi). (found in insects, man, soil, air)
- Nutritional- imbalance among the nutritional content of food. (proteins, carbohydrate, minerals, vit. Fats etc.)
- Mechanical- injures, fractures, wounds etc.
- Physical agent- heat cold, pressure, electricity and exposure to radiation.
- Chemical- gas, acid, allergic metals, dust, smoke etc.
- Social agent- poverty, illiteracy, prostitution, increase in population, smoking, drinking, drugs, addictions.

2. Host-

- Demographic factor- sex, age etc.
- Biological- some disease common in some specific individuals only. Eg. Congenital disease, genetic, mental disorders, blood disease, diabetes hypertension.
- Socioeconomic- social status, education, habitat, marital status, profession.
- Lifestyle factor- customs, rituals, moral values, habits, nutrition, consumption of alcohol, drugs, smoking behaviour and personality.

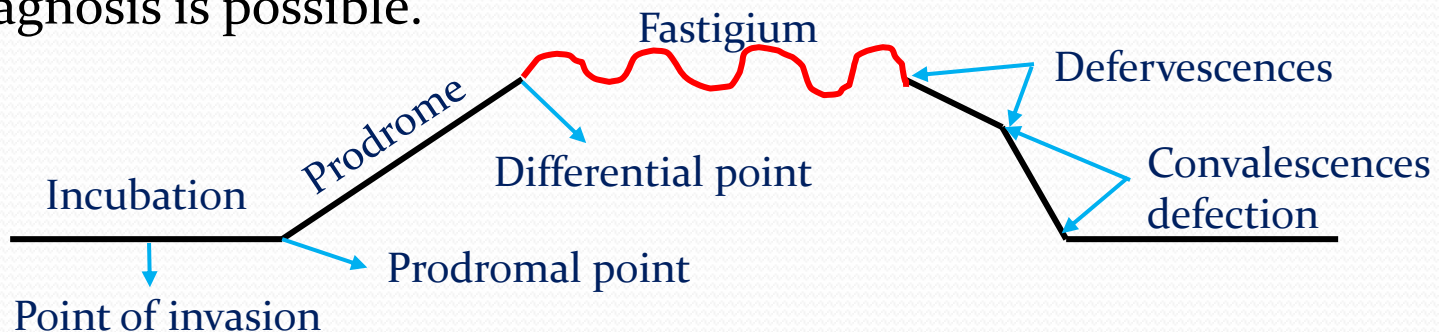
3. Environment-

- Physical- air, houses, season, water, land, temperature, light, noise, radiation, body waste, etc.
- Biological- animals, insects, rodents etc.
- Psychosocial env.- customs, faith, education, standard of living, culture, broken family etc.

Disease cycle-

The cause of most communicable disease is marked a certain stages.

1. Incubation period- this is the time interval between the disease agent in the body and manifestation of clinical signs and symptoms.
2. Prodromal period- this is short period ranging from 1 to 4 days and is marked by vague signs and symptoms. Clinical diagnosis is usually not possible.
3. Defervescences- the patient begins to feel better the body defences (immunity begins to respond)
4. Convalescence- the patient recovery is established. He is improving fast.
5. Defection- the patient recovers from illness.
6. Fastigium- this represents the height of the disease. Sign and symptoms are reluctant the patient is confirmed to bed clinical diagnosis is possible.



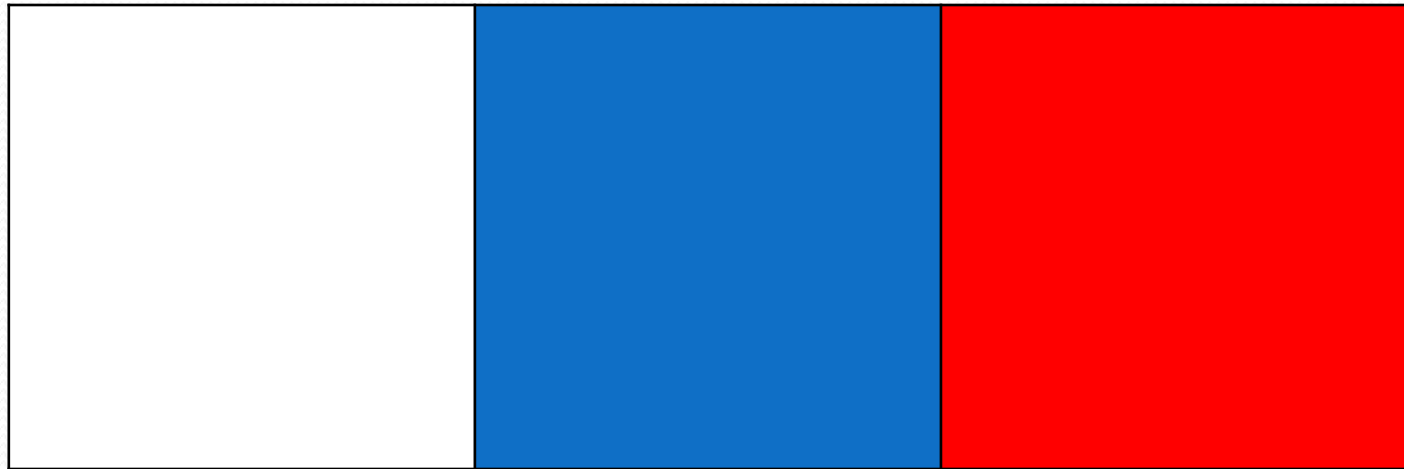
Uses of epidemiology

- To study the historical rise and fall of occurrence, distribution and trends of disease in a population.
- To identify the determinants of disease.
- To make community diagnosis by identifying health problems.
- To plan effective needs based health care services for prevention and control of health problems.
- To evaluate health care services that are implemented to assess their effectiveness dealing with the given health problem.
- Evaluation is done to determine the effectiveness and usefulness of new techniques preventive measures and programmes.
- To identify the syndrome by describing the distribution and association of clinical finding in the population eg. STD.
- To complete the clinical picture of disease and describe their natural history.
- Evaluation of individual risk and changes.
- Epidemiology makes statement about the degree of risk in a population by calculating relative risk and probability of occurrence.

Spectrum of disease-

- Disease can be acute, chronic, infectious, moderately severe or severe. But the clinical manifestation of the disease may be different.
- It may be hidden (latent), subclinical, clinical or in serious stage.
- The spectrum refers to image of a band of colours (as seen in rainbow) formed by a ray of light that has passed through a prism.
- The colours of the spectrum are usually described as VIBGYOR; violet, indigo, blue, green, yellow, orange and red. But it is difficult to find out the beginning, end or boundaries of colours.
- The spectrum, clinical manifestation of disease may be from subclinical to fatal conditions, in the middle it may be mild to severe. Thus, the clinical picture of disease shows the similar pattern as spectrum does. And this variation in the presentation of signs and symptoms of disease is called spectrum of disease.

- Spectrum of disease may be affected by various factors and generally represents the immunity and receptivity level of the individual to infection.



No Infection

Unrecognized
infection

Clinical
recognized cases

-Carrier-

-Missed cases-

-Mild-

-Moderate-

-Severe-

-Recovery or death.

❑ Control of Disease :-

The control of disease implies mainly the prevention of diseases.

- Decreasing the duration of illness.
- Decreasing the possible complication.
- Reducing the financial burden to the population.
- Reducing the occurrence of disease.
- Reducing the risk of transmission.
- Decreasing the mortality and morbidity.

● Disinfection:-

Disinfection is related to control of microbial growth.

the control of microbial growth can be achieved by two ways; killing or destroying the micro-organisms or inhibiting their growth.

1. **Cleaning**- Removing all visible dust, soils and other foreign materials.
2. **Disinfection**- Killing or destroying most infectious agents outside the body by physical, chemical.

Terminal disinfection implies the destruction of infectious material or cleaning the room furniture, bedding etc. after the discharge or release, transfer or death of the pt. from hospital.

3. **Sterilization**– Destroying all forms of micro-organisms. (destruction of all pathogenic, non-pathogenic micro-organisms and viruses or all visible organisms)

4. **Disinfectant**– A substance that destroys harmful micro-organisms.

Is not inactivated by dilution with fluids or contact with micro-organisms. Disinfectants are suitable to use only on inanimate objects.

5. **Antiseptic**- A substance that destroy microorganisms or inhibits their growth. Antiseptics are safe and less strong enough to be used on living tissues.
6. **Deodorant**- A substance that suppresses or neutralizes bad odors. eg. Body spray, creams.
7. **Detergent**- A surface cleaning substance that acts by lowering surface tension. e.g. detergent soap etc.

❖ **Methods / Agents for Disinfection:-**

There are so many methods/ agents which can be applied for disinfection or control on microbials.

1. Natural

- i) Sunlight ii) Air iii) Cold

2. Physical Agents –

i) Heat

A) Dry heat: Burning, Hot air

B) Moist heat: Boiling, Autoclaving

ii) Radiation

3. Chemical Agents – Alcohol, Halogens, phenol and related compounds

4. Miscellaneous - Acids, Gases, sound vibrations.

Cont

THANK
YOU