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EPIDEMIOLOGY

DEFINITION

Epidemiology is the study of frequency, distribution and determinants of health - related states and events and disease in human population.

Scope of epidemiology

The three components of epidemiology are **frequency, distribution** and **determinants.** Each of these components conveys an important message.

Disease frequency: The frequency of a disease is measured as ***rate or ratio*** e.g. death rate, incidence rate. These rates are required for comparing the frequency in different population or sub - groups. Epidemiology involves also measurement of health related events like height, weight, blood pressure etc.

Distribution of disease: The distribution of disease is not uniform but it occurs in certain ***patterns.*** The pattern varies in relation to person, population, place and time. The incidence of disease may be high in one area and less in another. It may be high at one time and less at a different time. An analysis of these data helps in identifying risk factors.

Determinants of disease: The unique feature of epidemiology is to test aetiological hypothesis and to identify the causes (risk factors). This aspect of epidemiology is known as ***'analytical epidemiology'.*** It helps in formulating health programmes, interventions and policies.

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Aims of epidemiology

1. To describe the distribution and size of disease in population.
2. To identify aetiological factors in the causation of disease.
3. To provide the data required for the planning, implementation and evaluation of health programmes.

Uses of epidemiology

1. To study the health history of population and their disease trends. This helps in identifying health problems.
2. To arrive at community diagnosis. This is necessary for initiating preventive and control measures.
3. To plan and evaluate health services.
4. Evaluation of risk and chances of a single individual e.g: risk of bearing a mongol child.
5. Searching for causes and risk factors e.g. smoking as a cause of lung cancer.
6. Identification of disease syndromes e.g association of iron deficiency anemia and Patterson. -Kelley syndrome.

METHODS OF EPIDEMIOLOGY

Types of methods

Four different types of methods (studies) are followed in epidemiology. They are:

1. Quantitative studies.
2. Descriptive studies.
3. Analytical studies
4. Experimental (or intervention) studies

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QUANTITATIVE STUDIES

The basic measurements used in epidemiology are:

1. Rate 2. Ratio 3. Proportion.

Rate

Rate measures the occurrence of a particular event (like occurrence of disease or death) in a population during a given time period. Death rate is the frequently used rate. It is expressed by the formula:

$$\text{Death rate} = \frac{\textit{Number of deaths in one year}}{\textit{Mid-year population}} \times 1000$$

Ratio

It is another measure of disease frequency. It expresses a relation in size between two random quantities. Broadly it is the result of dividing one quantity by another. It is expressed in the form of:

$$x : y \quad \text{or} \quad \frac{x}{y}$$

For example the ratio of WBC to RBC is 1:600 or 1/600. It means that for each WBC there are 600 RBCs. Other examples are male - female ratio, doctor - population ratio etc.

Proportion

It is the relation in magnitude of a part of the whole. The numerator is always included in the denominator. Proportion is usually expressed as percentage.

Example:

$$\frac{\text{Number of pregnant women at a certain time (NUMERATOR)}}{\text{Total number of women in the village at the same time (DENOMINATOR)}} \times 100$$

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MEASUREMENT OF MORBIDITY AND MORTALITY

Mortality

Mortality is death. The frequency of death and the number of people who die is a measure of health of a community. Rates and ratios are frequently used for measuring mortality. Example are:

1. Crude death rate $= \frac{\text{Number of deaths during the year}}{\text{Mid -year population}} \times 1000$

2. Specific death rate for disease $\times$

$$= \frac{\text{Number of deaths due to disease } \times \text{ during a calender year}}{\text{mid - year population}} \times 1000$$

3. Case fatality rate (ratio)

$$= \frac{\text{Total number of deaths due to a particular disease}}{\text{Total number of cases due to the same disease}} \times 100$$

Morbidity

It is defined as 'any departure or deviation, from a state of physiological well - being'. Morbidity may be a sickness, illness or disability. Morbidity is also measured in terms of rates and ratios. The two important measurements of disease frequency (i.e the rate at which disease occurs) are **incidence** and **prevalence.**

Incidence

Incidence rate is defined as ' the number of NEW cases of a specific disease occuring in a defined population during a specified period of time. It is given by the formula:

$$\frac{\text{Number of NEW cases of specific diseases during a given time period}}{\text{Population at risk}} \times 1000$$

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For example: The population of a particular year is 20,000. The number of new cases of a disease is 500. The incidence will be $\frac{500}{20000} \times 1000 = 25$ per 1000 per year.

Incidence rate refers 1. only the new cases. 2. during a particular period (usually one year) 3. a specified population (population at risk).

Uses of incidence rate: 1. to control the disease 2. for research in aetiology, pathogenesis and distribution of diseases.

Prevalence

The term disease prevalence refers to all **current cases (old and new)** in a given population at a particular point of time or over a period of time. The term incidence refers only to new cases, but prevalence refers to both new and old cases. Prevalence is classified into two types:

1. ***Point prevalence:*** It refers to the number of all current cases (old and new) at a particular **point of time** (e.g. particular day or particular week.)
2. ***Period prevalence:*** It refers to the number of all current cases (old and new) during a particular **period of time** (e.g. period of one year)

Relationship between prevalence and incidence

Prevalence depends on 2 factors: the incidence and duration of illness. This relationship is expressed as:

$$\text{Prevalence} = \text{incidence} \times \text{duration}$$

$$P = I \times D$$

Example:

Incidence (new cases) = 20 cases per year per 1000 population
Duration of the disease = 5 years
Prevalence = 20×5 = 100 per 1000 population

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Incidence and prevalence can be examplified with a tub provided with an inlet tap and outlet. The amount of water pouring through the inlet tap is the incidence (new cases). Prevalence is the amount of water in the tub at any point of time or period of time. (old and new cases). The outlet is the cases died due to the disease or recovered from the disease.

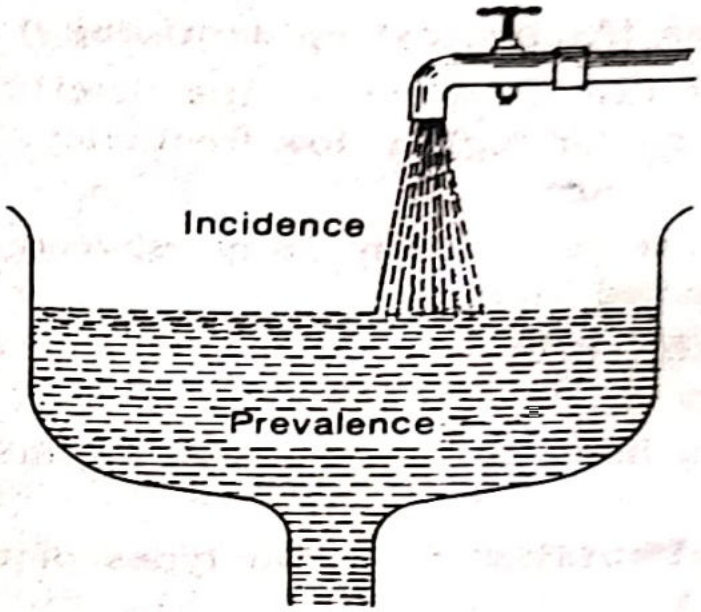

Fig. 39. Relationship between incidence and prevalence

Descriptive Studies (Descriptive epidemiology)

It is a broad description of the distribution of disease in terms of person, place and time. It involves observation of the disease or health related problems. In descriptive studies three questions are asked: **Who, Where, When.**

a) Who is getting the disease? - Person distribution

b) Where the disease occurs? - Place distribution

c) When the disease occurs? - Time distribution.

Aims of descriptive studies:

1. Evaluation of health status

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2. To make comparison between different population or countries.
3. To provide a basis for planning and evaluation of health services.
4. To identify problems that can be solved by analytical methods.

Analytical studies (Analytical epidemiology)

These studies are focussed on the determinants of disease i.e., reasons for high or low frequency. The aims of analytical studies are:

1. To find out the association if any between a disease and a suspected factor.
2. To study the problems identified in descriptive epidemiology.
3. To provide a basis for health planning and disease prevention.

Types of analytical studies: The two types of analytical studies are:

1. Case control study
2. Cohort study

CASE CONTROL STUDY

It is also called as **retrospective study**. The three features of case control study are:

1. The study is done ***after the disease has occured*** and produced its effect.
2. From the effect produced, the cause of the disease is analysed **backwards.**
3. It makes use of controls (persons without disease) and cases (persons with disease) for comparison.

Steps of case control study

1. ***Selection:*** Identical cases and controls are selected.

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2. ***Matching:*** Cases and controls are matched in relation to factors such as age, sex etc.
3. ***Data:*** Information about exposure to risk factors is obtained both in cases and controls.
4. ***Analysis:*** The association if any of the risk factor with a specific disease is analysed.

An example of case control study is the study of association between smoking and lung cancer. Here, the cases are those who have lung caner. Controls are those do not have lung cancer.

COHORT STUDY

It is also called as **prospective study.** The features of cohort study are:

1. The individuals involved in the study are selected **before** the appearance of the disease.
2. These individuals are observed over a period of time for the appearance of the disease.
3. The study proceeds forwards from the cause of the disease (e.g smoking) to the effect (e.g. lung cancer).

Steps of cohort study

1. ***Selection of study subjects:*** The subjects for cohort study are selected from
   a) general population of specified areas
   b) from people who can be easily followed like doctors, nurses, teachers etc.
2. ***Collection data:*** Information about exposure to risk factors is obtained through interviews or mailed questionnaires.
3. ***Comparison groups:*** They may be selected from the same area or from people with similar profession.

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EXPERIMENTAL STUDIES

(Experimental epidemiology): It is the study of disease among colonies of experimental animals such as rats and mice. Experimental studies may be conducted in humans also.

Aim of experimental studies:

1. To obtain scientific proof of risk factors.
2. To measure the effectiveness of health services in the control and prevention of diseases.

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Types of experimental studies: The two types of experimental studies are:

1. Randomized control trials
2. Non - randomized trials.

DYNAMICS OF DISEASE TRANSMISSION

Chain of Transmission

Communicable diseases are transmitted from the source of infection (reservoir) to the host. The three links in the chain of transmission are:

1. Source or Reservoir.
2. Mode of transmission
3. Susceptible host.

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MODES OF TRANSMISSION

From the source or reservoir, the infectious agent can be transmitted to the host either **directly** or **indirectely.**

Direct transmission: It can occur by:

1. ***Direct contact:*** This can occur from skin to skin, skin to mucosa or mucosa to skin of the same or different person.
2. ***Droplet infection:*** The infectious agent is sprayed as droplets of saliva or other secretions. This can occur while coughing, sneezing or talking.

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3. ***Contact with soil:*** Infections like tetanus are contacted from soil.

4. ***Inoculation to skin or mucosa:*** AIDS is transmitted through contaminated needles and syringes.

5. ***Transplacental (or vertical) transmission:*** Diseases like syphilis and AIDS are transmitted through placenta.

Indirect transmission: It occurs through the five traditional **F**'s

1. **F**luid and **F**ood - vehicles borne
2. **F**lies - vector borne
3. **F**omites - Fomite borne
4. **F**ingers and hands - Finger borne.

1. ***Vehicle borne*** transmission occurs through water and food. e.g. typhoid fever, cholera and polio are transmitted through water and food.
2. ***Vector borne*** transmission occurs through insects like flies and mosquitoes. e.g. malaria is transmitted through mosquitoes. Vector is defined as an arthropod or a living carrier which transports the infectious agent to a host.
3. ***Fomite borne*** transmission occurs through inanimate articles like clothes, towel, pencil, books, toys etc. e.g. diphtheria and typhoid fever can be transmitted through fomites.
4. ***Finger borne*** transmission includes those transmitted through contaminated fingers and hands. e.g. dysentery and hepatits A.

To the above group (indirect transmission) **air borne** infections must also be included.

Air borne transmission may occur through *droplet nuclei* and *dust.*

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Droplet nuclei are tiny particles (1 to 10 micron size) which contain dried residue of droplets. Droplet nuclei are formed by the evaporation of droplets coughed or sneezed into the air.

Dust: The droplets expelled during coughing or sneezing may settle on the floor and become part of the dust. Infection can occur when the dust is propogated through wind or through the act of sweeping, dusting etc. Examples of diseases transmitted through dust are tuberculosis and pneumonia.

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IMMUNITY AND IMMUNISATION

Immunity

Immunity is defined as the resistance against an infecting organism. The immune mechanism of the body is capable of recognising, destroying and eliminating infectious micro organisms. The immune mechanism is due to antibodies produced in the body.

Antigen

An antigen is a foreign protein. When an antigen is introduced into the body, it stimulates the production of specific antibody.

Antibody

It is a protein substance produced in the body in response to an antigen. The antibody recognises the disease producing organism and destroys it. Thus antibodies protect the body against disease. The protection is specific . Antibodies against small pox give protection only against small pox and not any other disease. Antibodies are produced by spleen, lymph nodes and plasma cells (small lymphocytes).

TYPES OF IMMUNITY

Immunity can be classified into: 1. Natural immunity 2. Artificial immunity.

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Natural immunity

This type of immunity is inherited from birth itself. This type of immunity provides natural resistance against diseases. For example, man is naturally resistant to a virus which produces a disease called rinderpest in cattle.

Artificial immunity

It is produced by the administration of vaccines or suitable substances. Artificial immunity is classified into 1. active immunity 2. Passive immunity.

Active immunity

It involves the stimulation of the body to produce its own antibodies. The stimulation of antibody production is achieved by the administration of vaccines, toxoids etc. Active immunity takes sometime to develop, but it is of long duration.

Passive immunity

It involves the administration of an antibody produced in one body (man or animal) to another i.e. ready-made antibodies are administered. Passive immunity develops rapidly, but it is of short duration. Passive immunity is produced by the administration of antisera and gamma globulin.

Immunisation

Immunisation is defined as 'production of immunity or resistance in the body by means of immunological agents'. Immunisation is classified as:

1. ***Passive immunisation*** which makes use of antisera and gamma globulin.
2. ***Active immunisation*** which makes use of vaccines and toxoids. Active immunisation may be primary or secondary.

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Primary immunisation

It is commonly carried out in infants and children to induce primary immunity. It consists of administering two or more doses of the vaccine or toxoid at suitable intervals. A mixture of two or more vaccines (e.g. T.A. B with cholera vaccine) or toxin - toxoid mixture (e.g diphtheria and tetanus toxoid with whooping cough vaccine) may be used for primary immunisation. This procedure is called as **combined immunisation.**

Secondary immunisation

It is carried out to reinforce primary immunity. It is achieved by giving a single 'booster dose' of the antigen. It is done as a routine procedure in a planned immunisation programme in children. It is also carried out during an epidemic or before undertaking journey to endemic zones.

Immunological products

Immunological products (immunizing agents) are those which are used to produce immunity. They are classified as

1. vaccines 2. immunoglobulins 3. antisera.

VACCINES

Vaccine is a preparation containing an antigen which stimulates the production of specific antibody. Vaccines can be classified into: 1. live vaccines 2. killed vaccines 3. toxoids 4. mixed vaccines.

Live vaccines

Live vaccines are prepared from live attenuated organisms. Examples of live vaccines are BCG, small pox, oral polio, measles, mumps and yellow fever. Except polio vaccine, others are administered in single dose.

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Killed vaccines

They contain organisms which are killed by heat or chemicals. Examples are vaccines used for the prevention of cholera, typhoid, rabies, influenza etc. The killed vaccines are administered in larger doses since they are weak compared to live vaccines.

Toxoids

They are obtained by detoxicating the exotoxins produced by microorganisms e.g., tetanus toxoid.

Mixed vaccines

These vaccines contain more than one type of immunising agent e.g. DPT (triple vaccine). The mixed vaccines simplify administration, reduce the cost and decrease the number of vaccinations.

IMMUNOGLOBULINS

There are five classes of immunoglobulins (Ig G, Ig M, Ig A, Ig D and Ig E) in the human system. Also there are subclasses within them. All antibodies are immunoglobulins. Two types of immunoglobulin preparations are available. They are: 1. Normal human immunoglobulin 2. Specific human immunoglobulin.

Uses of immunoglobulins

1. Prophylaxis of viral and bacterial infections.
2. For replacement of antibodies in immunodeficient patients.

Administration

Immunoglobulins ae administered by intramuscular injection. Recently intravenous preparations have been developed.

Advantages of immunoglobulins

1. They are free from hepatitis B.

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2. They can be concentrated in small volume for intramuscular injection.
3. They are stable, if properly stored.

Antisera (or Antitoxins)

The term *antiserum* is applied to materials prepared in animals e.g. horses. They are used for passive immunisation against diseases like tetanus, diphtheria, botulism etc.

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COLD CHAIN

It is a system of transport and storage of vaccines at low temperature from the manufacturer to the point of use.

Importance of cold chain

Vaccines are sensitive to heat. If they ae exposed to heat, they will loose their potency. When potency is lost, the protective effect is also lost. So vaccines must be stored and transported at low temperature.

Cold chain equipments

At the state and regional stores: Cold rooms and walk in coolers are available.

At the district stores: Freezers, refrigerators, cold boxes and vaccine carriers are available

A the Primary Health center: Refrigerator, ice - lined refrigerator (ILR), cold boxes and vaccine carriers are available.

At the subcentre: Cold boxes, vaccine carriers, thermocole boxes and thermos flasks are available.

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Storage of vaccines: Of all the vaccines, polio is most sensitive to heat. It must be stored at minus 20° C. Vaccines which should be stored in the **freezer compartment** of the refrigerator are polio, measles and BCG. Vaccines which must be stored in the **cold part** of the refrigerator but never allowed to freeze are typhoid, DPT and tetanus toxoid.

PRINCIPLES OF DISEASE CONTROL AND PREVENTION

Communicable diseases can be controlled and prevented by adequate measures which involve:

1. Diagnosis 2. Notificaiton 3. Isolation 4. Treatment 5. Quarantine 6. Investigation 7. Disinfection 8. Blocking of transmission 9. Immunisation 10. Health education.

1. **DIAGNOSIS:** It is first step in the control of a disease. The disease should be diagnosed and treated immediately and effectively. This will prevent the spread of an infection.
2. **NOTIFICATION:** As soon as a disease is detected, it should be notified immediately to the local health authority. This helps in taking immediate preventive measures to control the spread of the disease.
3. **ISOLATION:** The infected patient must be isolated in hospital or at, home, if hospitalisation is not possible. The period of isolation depends on the period of communicability of the disease. Isolation of the infected cted cted cted cted cted patient prevents the spread of infection.
4. **TREATMENT:**Treatment should be given to the infected patient and also to the carrier of the infection. Sometimes all the people in the community are treated, even if they do not have the

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disease. These measures effectively prevent the spread of infection.

5. **QUARANTINE:** It means isolation of healthy and normal persons till the incubation period of a disease is over. These healthy persons might have come in contact with the disease without actually suffering from it. So quarantine is necessary to prevent the spread of infection from these persons to others who have not been exposed to the disease. Quarantine is necessary for international travellers who have the possibility of carrying infections.

6. **INVESTIGATION:** The health authorities should conduct field investigation of infected person and also infected areas. Suspected and also infected cases must be confirmed by laboratory tests.

7. **DISINFECTION:** Disinfection of the excreta and articles used by the patient will prevent the spread of infection. Disinfection must be done both when the patient is suffering from the disease and after recovery or death.

8. **BLOCKING OF TRANSMISSION:** Most of the diseases spread through water, air and insect. So adequate measures should be taken to prevent the spread of infection through these channels.

   i) Water borne infections can be prevented by boiling water and also milk.

   ii) Air bone infections can be prevented by wearing masks, isolating the patient in a separate room, dust control and disinfection of air.

   iii) Insect born diseases can be prevented by using suitable insecticides.

9. **IMMUNISATION:** It is a very effective and easy method by which communicable diseases can be prevented. The diseases which can be effectively

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controlled by immunisation are small pox, poliomyelitis, diphtheria, wooping cough, tetanus, tuberculosis and measles.

10. **HEALTH EDUCATION:** The public should be taught about the importance of maintaining a clean environment, immunisation etc. It involves the responsibility of paramedical persons and the co-operation of the public.

HOSPITAL ACQUIRED INFECTIONS

Hospital infections (Hospital - acquired infections or nosocomial infections): These are infections developing in hospitalised patients which were not present at the time of their admission. These infections produce their symptoms either during hospital stay or after discharge. These infections may occur during diagnostic or treatment procedures.

Factors predisposing for hospital infections:

1. Impaired defence mechanism of the patient due to diseases.
2. Contaminated hospital environment.
3. Asepsis in hospital procedures.
4. Resistance of hospital infections to drugs and antibiotics.
5. Increased risk of infection from other patients

Types of hospital infections:

1. *Wound infections* like those of post-operative wound infections and infections caused by injections.
2. *Urinary tract infections* which may occur due to catheterisation.
3. *Respiratory infections* which occur due to aspiration, pulmonary ventilation or instrumentation.

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4. *Bacteremia and septicemia* which are caused by infected intravenous canulae.

Prevention and control

1. Diagnosis by routine bacteriological methods like smear, culture and sensitivity testing.
2. When an outbreak occurs, the source is identified and eliminated. The sources may be hospital staff, water, air or food.
3. Sterilisation techniques must be tested. A defective autoclave or steriliser must be repaired or replaced.
4. *Infection control teams* may be established in hospitals. These teams should consist of microbiologists, doctors, nurses and hospital administrators. This team should investigate outbreaks. Also it should monitor admission, treatments, sterilisation, disinfection etc.

DISINFECTION

Definitions

Disinfection is defined as the destruction of all pathogenic organisms or organisms capable of giving rise to infection.

Disinfectant or germicide is a substance which destroys harmful microbes (not usually spores) and thus prevent the transmission of disease.

Antiseptic is a substance which destroys or inhibits the growth of microorganisms. A disinfectant in low concentrations act as an antiseptic. Antiseptics can be safely applied on living tissues.

Detergent is a cleaning agent which acts by lowering the surface tension e.g. soap.

Deodorant is a substance which suppresses bad odour e.g. bleaching powder.

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TYPES OF DISINFECTION

Disinfection can be classified as: 1. concurrent disinfection 2. terminal disinfection 3. precurrent disinfection.

1. **Concurrent disinfection:** It is the disinfection of the infectious agent as soon as it is discharged from an infected person. It also applies to disinfection of articles soiled with such discharge. Concurrent disinfection is done for urine, feces, clothes, dressings etc. throughout the course of illness.
2. **Terminal disinfection:** It is done when the patient has died or has been discharged from the hospital. It is rarely practiced at present. Terminal cleaning is sufficient.
3. **Precurrent (prophylactic) disinfection:** It is prevention of an infection by chlorination of water, pasteurisation of milk, handwashing etc.

CLASSIFICATION OF DISINFECTANTS

1. Natural disinfectants : Air and sunlight.
2. Physical disinfectants : Heat and radiation.
3. Chemical disinfectants : Lime, Potassium permanganate, Bleaching powder, Formalin, Phenol

1. **Air:** Air kills microorgnisms by drying them.
2. **Sunlight:** The ultraviolet rays of sunlight kill microorganisms.
3. **Heat:** It can be produced by: 1. burning 2. hot air 3. boiling 4. steam.
   i) Burning can disinfect dressings and swabs.
   ii) Hot air can disinfect dressings, swabs and glasswares.

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iii) Boiling kills microoganisms including spores. Linon, utensils, instruments and glasswares can be sterilised by boiling.

iv) Steam destroys microorganisms and spores. Streilisation of instruments and dressings is done by steam.

4. **Radiation:** It can be done by inonising radiations and ultraviolet light.

i) *Ionising radiations:* They have a great penetrating power. Also they do not produce a heating effect on the object to be sterilised. Ionising radiations can be utilised for sterilising catgut, dressing and surgical instruments.

ii) *Ultraviolet rays:* They have a poor penetrating power. Also they take a long time to produce complete sterilisation. Ultraviolet rays can be used for sterilising hospitals and operation theaters.

5. **Lime:** It is used in the form of i) quick lime ii) milk of lime (which is an aqueous suspension). Lime is used for disinfecting feces and also for white washing.

6. **Bleaching powder:** It is used for disinfecting feces, urine, sputum, pus and water.

7. **Potassium permanganate:** It is used in the form of a weak solution. It disinfects contaminated vegetables and fruits.

8. **Formalin:** It is used in the form of a liquid or gas. It is used for disinfecting rooms, walls and furnitures.

9. **Phenol:** Pure phenol occurs in the form of crystals. It is highly corrosive. However, crude phenol (which contains some cresol) can be used for disinfecting feces.

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