Environmental Microbiology

Lecture-4:
Geographical distribution and Epidemiology of infectious diseases:

The infection does not arise in vacuum. It results from interaction of some factors . The predisposing factors that involved in the development of infections include mainly three factors:

1. Virulent microbe.
2. Susceptible host.
3. Environmental factors.

microbial factors:

1. Adaptation and resistance of pathogenic organisms to the adverse condition in new environment.
2. Vectors or any vehicles should be founded for transmission of pathogenic organisms from source of infection should and spread into environment and human population.
3. They must be capable of resisting the host defense.
4. Pathogenic organisms should be having virulence factors and cause damage the tissue of infected host.
5. Some virulent agents undergo changes in antigenic structures or they convert from nonpathogenic to pathogenic organism.

Host factors influencing susceptibility to infectious diseases:

1. Susceptible host is complaining from defect or suppress in immune system.
2. Disorder in physiologic state and hormones.
3. Age and race of host ; example the respiratory viral infections are more severe in adult , but more severe and more lethal in infants.
4. Stress ; increased susceptibility to infection due to steroid therapy.
5. Pregnancy ; hepatitis viruses during pregnancy result in more lethal outcome. UTI and pyelonephritis are more common in pregnant.
6. Malnutrition; lead to more severe and more lethal in some infection such as measles.

Environmental factors :

1. Lifestyle, social and behavior changes are important in occurrence of infection.
2. Economic and hygiene status.
3. Foreign bodies lead to necrotic tissues or necrotic bone fragments. Indwelling devices as in catheterization which facilitate infections.
4. Sources and vectors of microbes.

5. Seasonal climate: humidity and temperature; hot/cold climate, dry/wet climate .
6. Housing, crowding, little washing.

Epidemiologists identify the pathogen and investigate five links in infectious disease cycle ;

1. Characteristics of pathogen.
2. Source and reservoir of pathogen.
3. Mode of transmission.
4. Susceptibility of host.
5. Exit mechanisms.

More than 100 microbes commonly cause infection in human.

- Globally distribution, the infectious diseases cause more than 20% of all deaths and kill an increasing number in both the resource-rich and resource-poor world.
    1. Deaths from HIV peaked at 50 000 in 1995, but still exceed 12 000 each year.
    2. Influenza and pneumonia kill 61 000 people each year and affect many millions.
    3. Some 4 millions people carry HCV, and 15% develop life-threatening cirrhosis.
    4. MDR-TB is major cause of concern, as are food-borne infections and hospital-acquired infections.
- Emerging or re-emerging diseases continue to pose new microbiologic problems. Infectious diseases are major problem in resource-poor world , particularly in children. Tropical infections are now of much greater interest .
    New disease agents continue to be identified, and old diseases, previously thought to be under control, re-emerge as causes of concern. The emergency of new human infections such as a novel strain of influenza virus ,or a new infection of wildlife origin.
- There is an increasing prevalence of wide variety of opportunistic infections in patients who are hospitalized or immuno-compromised(immunocompromised therapies are now more common) .
- The economic cost of infectious diseases is enormous; US$ 550 billion was the estimated cumulative cost of AIDS epidemics by 2000 and the cost of malaria in Africa was estimated at US$ 12 billion in 2000. The successful eradication can therefore save very large sums, for example estimated US$20 billion from eradicating smallpox.
- Modern lifestyle and technical developments facilitate transmission of disease. New patterns of travel and trade, new agricultural

practice, altered sexual behavior, medical interventions and overuse of antibiotics.
- Density of people is increased numbers (more than 5 billion person in the world) with contrast in ethics and ideas which have role in occurrence and distribution of infection .

Diarrhea disease is major health problem in many part of world and cause high fatality rate . Most causes of diarrhea are *Vibrio cholerae* , Rota virus and *Giardia lamblia* . only Rota virus can be infect about 125 million person. 8 million persons are infected with cholera and 120,000 death. Generally, More than 3 millions death occur each year due to diarrhea in infants and children in developing countries .

Tuberculosis is still as big problem (as dread disease) and worldwide incidence . It is estimated that one-third of world population is latently infection with T.B, from this pool about 8-10 million person or more are infected annually as new active cases emerge . 2-3 millions person die per year, therefore the disease is called king of disease.
Size of population is increased, easy migration, development of medicine and transplantation, malnutrition, increased cases of AIDS are considered as predisposing factors for continued this disease .

AIDS ; global estimation of this disease among human population by WHO at end of the year 2000 there will reach 30 million person infected with HIV. The cumulative total since the beginning of epidemic being 30-40 million. About 90% of cases are in developing countries. Two million people dying of patient each year, but some references point to half of patient have death.
Distribution of HIV/AIDS in adults according to estimates by UN-AIDS program, 2007.
- North America   1.3 million
  Caribbean   230,000
  Latin America   1.7 million
- Western Europe,
  Eastern Europe , and
  Central Asia   1 million
- Eastern Asia and
  Southern Asia   8-9 million
- North Africa and   540,000
  Middle East
  Sub-Saharan Africa   25.4 million
- Oceania (Australia)   75,000

STD(prefer STI): WHO estimates that at least 333 million new cases of curable STD occur annually. These new cases comprise Trichomonas (170 million),Chamydia(89 million),Gonorrhoea(62 million) and Syphilis (12 million).

The STIs are determined by social and sexual activity. Recent changes in the size of human population and way of life have a dramatic effect on the epidemiology of STIs. People now have an increased number of sexual partners because of increasing population density, increased movement of people ,the decline of idea that sexual activity is sinful and knowledge that STIs are treatable and pregnancy is avoidable . In addition, the contraceptive pill has favored the spread of STIs by discouraging the use of mechanical barriers to conception. Condoms have been shown to reliably retain herpes simplex virus(HSV), HIV, Chlamydia, and gonococci in simulated coital tests of the syringe and plunger type. The absence of vaccine for almost all STIs.

Global distribution of syphilis among adults, 1999

- North America   100,000
  Latin America   3 million
- Western Europe   140,000
  Eastern Europe and   100,000
  Central Asia
- S.Asia and southeast Asia   4 million
- N. Africa and middle East   370,000
  Sub-Saharan Africa   4 million
- Australia and New Zealand   10,000

Malaria:

It is considered by many to be the most important infectious disease of human on a worldwide.

It is most common in tropical and subtropical regions of world but is established in some temperature climates as well.

During world war-II, at least 300 million persons were infected worldwide. About 1% of those persons died from infection that means between 2-3 million persons died each year from malaria. With development of second generation insecticides ,especially DDT, as well as good anti-malarial drugs the infection rate is reduced.

Screening tests for infectious disease

Screening tests that used for detection of infectious diseases must have highly sensitivity and specificity.

Sensitivity is ability of test to detect particular disease in individuals who have disease.

The number of individuals for whom screening test is positive, the individuals actually have disease(true positive), whereas number of individuals for whom screening test is positive ,but the individuals don't have the disease(false positive). The number of individuals for whom screening test is negative, and the individuals don't have disease(true negative) whereas no. of individuals for whom screening test is negative, but the individuals have disease(false negative).

$$\text{Sensitivity} = \frac{\text{No. of true +ve}}{\text{Total No.of +ve results(true positive + false negative)}} \times 100$$

Specificity is No. of individuals who do not have particular disease (true negative), or show (false negative) in person with disease.

$$\text{Specificity} = \frac{\text{No of true negative}}{\text{Total No. of -ve results (true negative + false positive)}} \times 100$$

Some disadvantages of these tests are cross-reaction may occur between Ab and non-target Ag, such cross-reaction can provide false positive or false negative result. This could occur if antigenic epitopes on target cell were damaged or genetically altered, thus preventing Ab recognition, binding and subsequent detection.

Epidemiology: medical science dealing with the occurrence and distribution of disease and the factors that influence or determine this distribution or that control on the disease in human populations.

Aim of epidemiology ;
- Describe the distribution and size of disease problems in human populations.
- Identify etiological factors in pathogenesis of disease .
- Provide the data essential for management evaluation and planning of services for prevention, control and treatment of disease.

In order to fulfill these aims, three types of epidemiologic studies using to identify the cause of disease :
- Descriptive studies(observational), concerned with observing the distribution and progression of disease in population. In which

describing the general characteristics of distribution of disease, particularly in relation to person (age, sex, race, marital status, occupation, life-style),place(rural and urban areas), and time(seasonal patterns in disease onset).

- Analytic studies, concerned with investigating by retrospective studies and follow-up(prospective) methods.
- Experimental or intervention studies(clinical trials), concerned with measuring the effect on population of manipulating environmental influences thought to be harmful and of introducing in controlled way preventive ,curative or a ameliorative services.

Epidemiology is needing the help and input of many disciplines as biostatistics, demography , sociology, biology, nutrition, occupational hygiene……etc.

Measurement of disease frequency used most frequently in epidemiology fall into two categories; prevalence(P) and incidence(I).

Prevalence of infectious disease is frequency of the disease in human population. The prevalence rate is No. of all persons(new and old cases) who are infected during defined time in defined population.

$$Prevalence = \frac{No.\ of\ persons(No.of\ all\ cases\ )\ who\ are\ risk\ at\ given\ time}{Average\ No.\ of\ persons\ exposed\ to\ risk(total\ population\ at\ risk)} \times 100$$

Incidence rate is percentage of newly reported cases of particular disease during defined time (usually for one year)in human population(per 1000 or 100,000).

$$Incidence = \frac{No.\ of\ new\ cases\ of\ disease\ in\ defined\ period}{Average\ No.\ of\ persons\ exposed\ to\ risk\ during\ this\ period} \times 100$$

Outbreak; is used and indicates the occurrence of disease in relatively large number of cases in limited area at a certain time.

The epidemiological terms are used to describe outbreak of infection (nomenclature of outbreak) :

- **Sporadic**; disease is occurring in irregular and affect only relatively few persons.

- **Endemic** infection; the term describes a disease that is constantly present but involves relatively few persons (that occur at low level) in certain geographic areas.

- **Epidemic** ; is usual occurrence of disease increase and involving large segments of population (occur at higher rate than usual in certain areas)for a limited period of time.

- **Pandemic**; is a series of epidemic affecting several countries or even major portions of world. The infection spread rapidly over large area of globe (worldwide distribution).

Analysis of outbreak (Measurement of disease frequency):

In order to study of diseases epidemiologically, the criteria of epidemiological study **6Q(5W and H);** which include**(what, where, when, who, why and how)** are involved in spread and distribution of disease in human populations.

What infectious disease is occurring? What pathogen caused the disease?

Who was attack by disease?

When did the disease occur?

Where did the cases a rise?

Why did infection occur? Why does a disease develop in some people and not in others?

How did those involved become infected? How the disease distributed in population? How pathogen transmitted? and how controlling the disease?

Mortality rate is number of death to particular disease per unit of population(usually 1000 person) within a given time period.

$$\text{Mortality rate} = \frac{\text{Deaths due to disease}}{\text{Total infected persons}}$$

Morbidity rate is number of person who infected within a given time. In other word, number of individual having disease per unit of population within a given time period. Usually 100,000 are taken as the unit of population for such calculation.

$$\text{Morbidity rate} = \frac{\text{New cases in a selected period}}{\text{Total population}}$$

Attack rate is number of people at risk in whom a certain illness develop

$$\text{Attack rate} = \frac{\text{No. of people at risk}}{\text{Total no. of people at risk}}$$