DYNAMICS OF DISEASE TRANSMISSION

Communicable diseases are transmitted from the reservoir/ source of infection to susceptible host.

Basically there are 3 links in the chain of transmission of i.,e, Reservoir, mode of transmission and the susceptible host.

Sources and Reservoir

The **source of infection** is defined as "the person, animal, object or substance from which an infectious agent passes or disseminated to the host"

A **reservoir** is defined as "any person, animal, arthropod, plant, soil or substance in which infectious agent lives an multiplies, on which it depends primarily for survival, and where it reproduce itself in such manner that it can be transmitted to a susceptible host"

The reservoir of three types:

1. Human reservoir.
2. Animal reservoir.
3. Reservoir in non living things

HUMAN RESERVOIR

By far the most important source or reservoir of infection for humans is man himself. He may be a case or carrier.

CASES: A case is defined as" a person in the population or study group identified as having the particular disease, health disorder or condition under investigation"

1. The clinical illness may be mild or moderate, typical or atypical, severe or fatal depending upon the gradient of involvement.
2. The subclinical cases are variously referred to as in apparent, covert, missed or abortive cases. The disease agent may multiply in the host but does not manifest itself by signs and symptoms.

3. The term latent infection must be distinguished from subclinical infection.

A latent infection is a situation in which a virus is present in the body, but it remains dormant, not causing any overt symptoms

Primary case: refers to the first case of a communicable disease introduced into the population until being studied.

Index Case: refers to the first case to come to the attention of the investigator, it is not always the primary case.

Secondary Case: are those developing from contact with primary case.

A Suspect Case: is an individual who has all of the signs and symptoms of a disease or condition yet has not been diagnosed as having the disease or had the cause of the symptoms connected to the suspected pathogen

CARRIERS

Carriers may be classified as below:

A. Type

1. Incubatory
2. Convalescent
3. Healthy

B. Duration

1. Temporary
2. Chronic

C. Portal of exit

Urinary, intestinal, respiratory, others.

A. Type

1. **Incubatory:** are those who shed the infectious agent during the incubation period of disease.
2. **Convalescent:** those who continue to shed the disease agent during the period of convalscence.
3. **Healthy:** these emerge from subclinical cases.

B. Duration

1. **Temporary:** are those who shed the infectious agent for short periods of time.
2. **Chronic:** is one who excretes the infectious agent for indefinite periods.

C. By Portal of exit

Urinary, intestinal, respiratory, others. In typhoid fever urinary carrier is more dangerous than the intestinal carrier.

RESERVOIR

1. **Animal reservoir:** The disease and infections which are transmissible to man from vertebrates are called zoonoses.

2. **Reservoir in non living things:** Soil and inanimate matter can also act as reservoirs of infection. Ex: soil-tetanus, anthrax etc.

MODES OF TRANSMISSION

1. **Direct Transmission**
   - ✓ Direct contact
   - ✓ Droplet infection
   - ✓ Contact with soil
   - ✓ Inoculation into skin or mucosa
   - ✓ Transplacental

2. Indirect transmission

- Vehicle borne.
- Vector borne
- a. Mechanical, b. Biological

3. Air borne

- Droplet nuclei
- Dust

4. Fomite borne

5. Unclean hands and fingers

A. DIRECT TRANSMISSION

1. **Direct contact:** Skin to skin, mucosa to mucosa, or mucosa to skin of the same or other person. Ex: skin to skin contact as by touching, kissing, or sexual intercourse.
2. **Droplet infection:** Spray of droplets of saliva and nasopharyngeal infections. Ex; common cold, respiratory infections, TB.
3. **Contact with soil:** direct exposure of susceptible tissue to the disease agent in soil, compost or decaying vegetable matter. Ex: Tetanus, mycosis.
4. **Inoculation into skin or mucosa:** ex: rabies virus by dog bite, hepatitis B through contaminated needles and syringes.
5. **Transplacental (or vertical):** ex: syphilis, AIDS, hepatitis B.

B. INDIRECT TRANSMISSION

This embraces a variety of mechanisms including the traditional 5 F'S

- ✓ Flies
- ✓ Fingers
- ✓ Fomites
- ✓ Food
- ✓ Fluid.

1. VEHICLE BORNE

Transmission of infectious agent through the agency of water, food, raw vegetables, milk, milk products fruits, ice, blood, serum.

2. VECTOR BORNE

vector is defined as an arthropod or any living carrier that transports an infectious agent to a susceptible individual.

Epidemiological classification of vector borne diseases

I. By vector

a. Invertebrae type: Arthropod vectors fall into seven orders largely

- ➢ Diptheria- flies and mosquitoes
- ➢ Siphonaptera- fleas
- ➢ Orthoptera- Cockroaches
- ➢ Anoplura- Sucking lice
- ➢ Hemiptera- bugs, including kissing bugs
- ➢ Acarina- ticks and mites
- ➢ Copepoda Cyclops

b. Vertebrate type: mice, rodents, bats.

II. By transmission chain:

a) Man and a non-vertebrate host

- ➢ man-arthropod-man(malaria)

- Man- snail-man (schistosomiasis)

b) man, another vertebrae host, and a non-vertebrea host

- Man – arthropod – man (plague)
- Bird- arthropod- man(encephalitis)

c) Man and 2 intermediate hosts

- man-cyclops-fish-man(fish tapeworm)
- Man- snail-fish- man (clonorchis sinensis)
- Man-snail-crab-man (paragonimiasis)

III. By methods in which vectors transmit agent

- ✓ Biting
- ✓ Regurgitation
- ✓ Scratching
- ✓ Contamination of host with body fluids of vectors.

IV. By methods in which vectors are involved in the transmission and propagation of parasites.

a. Mechanical transmission: The infectious agent is mechanically transported by crawling or flying arthropod through soiling of its feet.

b. Biological transmission: The infectious agent undergoing replication or development or both in vector or requires an incubation period before vector can transmit. **1. propagative:** the agent merely multiplies in vector, but no change in form ex: palgue baccilli in rat fleas. **2. Cyclo propagative:** the agent changes in form and number. Ex: malaria parasites in mosquito.

3. Cyclo developemental: the disease agent undergoes only development but no multiplication ex: microfilaria in mosquito.

3. AIR BORNE

1. Droplet nuclei: They are tiny particles (1-10 microns in range) that represents the dried residue of droplets.

2. Dust: some of the larger droplets which are expelled during walking, coughing, sneezing, settle down by their sheer weight on floors, carpets, furniture's, clothes and bedding.

4. FOMITE BORNE

Fomites are inanimate articles or substances other than water or food contaminated by the infectious discharges from a patient and capable of harboring and transferring infectious agent to a healthy person.

It includes soiled clothes towels, linen, handkerchiefs, cups, spoons, pencils, books, toys, drinking glasses, door handles, taps, syringes.

5. UNCLEAN HANDS AND FINGERS

Hands are the most common medium by which pathogenic agents are transferred to food from the skin, nose, bowel etc, as well as from other foods. Ex; typhoid fever, heapatitis B, intestinal parasites.

SUSCEPTIBLE HOST

Successful parasitism

a) First, the infectious agent must be a find a **"PORTAL OF ENTRY"** by which it may enter the host. Ex: respiratory tract, ailmentary tract, skin

On gaining entry into the host,

b) the organisms must reach the appropriate tissue or **"SITE OF SELECTION"** in the body of the host where it may find optimum conditions for its multiplication and survival.

c) Thirdly, the disease agent must find a way out of the body **"PORTALS OF EXIT"** in order that it may reach a new host and propagate its species.

d) After leaving the body, the organism must live in external environment for sufficient period still new host is found.

INCUBATION PERIOD

the time interval between invasion by an infectious agent and appearance of the first sign or symptom of the disease in question.

LATENT PERIOD

the period from disease initiation to disease detection.

SERIAL SURVIVAL

The gap in time between the onset of the primary case and the secondary case.

GENERATION TIME

the interval of time between reciept of infection by a host and maximal infectivity of that host.

COMMUNICABLE PERIOD

the time during which an infectious agent may be transferred directly or indireclty form an infected person to another person, from an infected animal to man, or from an infected person to animal, including arthropods.

SECONDARY ATTACK RATE

the number of exposed persons developing the disease within the range of incubation period , following exposure to primary case.

HOST DEFENSES

Specific defenses

Specific protective antibodies or cellular immunity as a result of previous infection or immunization, or is so conditioned by such previous experience as to respond adequately to prevent infection and/or clinical illness following exposure to a specific infectious agent.

1. **Active immunity**

a. Humoral immunity
b. Cellular immunity
c. Combination of the above

2. **Passive immunity**

a. Normal human Ig
b. Specific human Ig
c. Animal anitoxins or antisera.

1. **Active immunity**

It is the immunity in which individual develops as a result of infection or specific immunization.

It may be acquired in 3 ways:

a. Following clinical infection. Ex: chicken pox, rubella.
b. Following subclinical or inapparent infection. Ex: polio, diptheria.
c. Following immunization with an antigen which may be killed vaccine. Ex: a live attenuated vaccine.

THE IMMUNE RESPONSE

1. **Primary Response**

When an antigen administered for the first time to an animal or human who has never been exposed to it, there is a latent period of induction 3 to 10 days before antibodies appear in the blood. The antibody that is elicited first time is entirely of IgM type. Igm increases steadily for 2 -3days or more and declines. Meanwhile if antigenic stimulus sufficient it rises IgG 7-10 days gradually declines for weeks to months.

2. **Secondary (Booster) Response**

The response of booster dose differs from primary response

1. Short latent period.
2. Production of antibody is rapid.

3. Antibody more abundent
4. Antibody response maintained at a higher levels for a longer period of time.
5. The antibody tends to have a greater capacity to bind to the antigen.

3. Humoral immunity

It comes form B-cells(bone marrow derived lymphocytes) which proliferate and manufacture specific antibodies after antigen presentation by macrophages.

4. Cellular Immunity

It plays a fundamental role in resistance to infection. It is mediated by the T-cells. The T-cells do not secrete the antibody, but are responsible for recognition of antigen. On contact with antigen, the T- cells initiate chain of responses.

5. Combination of the above

In addition to B and T lymphoid cells, they cooperate with one another and with certain accessory cells such as macrophages and human K (killer) cells.

2. PASSIVE IMMUNITY

When antibodies produced in one body (human or animal) are transferred to another to induce protection against disease , it is known as passive immunity.

3. HERD IMMUNITY

It is the resistance of a level of community or a group of people to a particular disease.

IMMUNIZING AGENTS

It may be classified as vaccines, immunoglobulins, and antisera**.**

VACCINES

It is an immunobiological substance designed to produce specific protection against a given disease.

It stimulates the production of protective antibody and other immune mechanisms.

Live vaccines

Live vaccines(ex: BCG, measles, oral polio) are prepared from live microroganisms.

These organisms have been passed repeatedly in the laboratory in tissue culture or chick embryos and have lost their capacity to induce full blown disease but retain their immunogenicity.

Inactivated or killed vaccines

Organisms killed by heat or chemicals, when infected into the body stimulate active immunity. They are usually safe but less efficacy than live vaccines.

Toxoids

Certain microorganisms produce exotoxins ex: diphtheria and tetanus bacilli. The toxins produced by these organisms detoxified and used in the preparation of vaccines.

Cellular fractions

Vaccines, in certain instances, are produced from extracted cellular fractions. Ex: meningococcal vaccine from the polysaccharide antigen of cell wall.

Combinations

If more than one kind of immunizing agent is included in the vaccine, it is called a mixed or combined vaccine. Ex: DPT, DP, DT, DPT and typhoid.

Future prospects

- Use of recombinant DNA techniques to insert the gene coding.
- Including in the vaccine only those sub viral components needed to stimulate protective antibody.
- Use of purified proteins isolated from purified virus or synthesized from cloned genes.
- Use of synthetic peptides.

IMMUNOGLOBULINS

The human immunoglbulins is composed of 5 major classes IgG, IgM, IgA, IgD and IgE) and subclasses within them.

IgG:

- is the major immunoglobulin of serum, comprising of total 80 percent of the total serum immunoglobulins.
- Because of small molecular weight easily diffuse into interstitial fluid. In other words, it is largely extravascular.
- IgG is the only class of IgGs which is transported across the placenta.
- Its half life about 21 days.

IgM

- It accounts for about 6 percent of normal serum immunoglobulins.
- Its presence may be indicative of recent infection.
- It has high agglunitaing and complement fixing ability.
- Its half life about 7 days.
- It can be produced by a foetus undergoing infection.

IgA

- It constitutes 13 percent of total serum immunoglobulins
- It is relatively present in large quantities in bodily secretions ex: saliva, milk, tears, colostrum, bronchial secretions, nasal mucosa.

- ❖ The half life is approximately 6-8 days.

IgE

- ❖ Its half life 2 days. It is concentrated in submucosa tissues.
- ❖ It is the major antibody responsible for immediate allergic anaphylactic reactions.

IgD

- ❖ It acts as an antigen receptor when present on the surface of certain B lymphocytes. Its half life is 2 days.

Normal human Ig

Is an antibody rich fraction (cohn fraction II) obtained from a at least 900 donors. It is used to prevent measles from in highly susceptible individuals and to provide temporary protection against hepatitis A infection.

Specific human Ig

The specific (hyper immune) human Ig should contain at least 5 times the antibody potential of the standard preparations per unit volume. These are made from plasma of patients who have recently recovered from an infection.

The advantages of immunoglobulins are

- ❑ Freedom from hepatitis B
- ❑ Concentration of antibodies into a small volume for intramuscular use.
- ❑ Stable antibody content if properly stored.

Antisera and antitoxins

- ❑ The term antiserum is applied to materials prepared in animals.
- ❑ Originally passive immunization was achieved by the administration of antisera or antitoxins prepared from non human sources such as horses.