



Epidemiology

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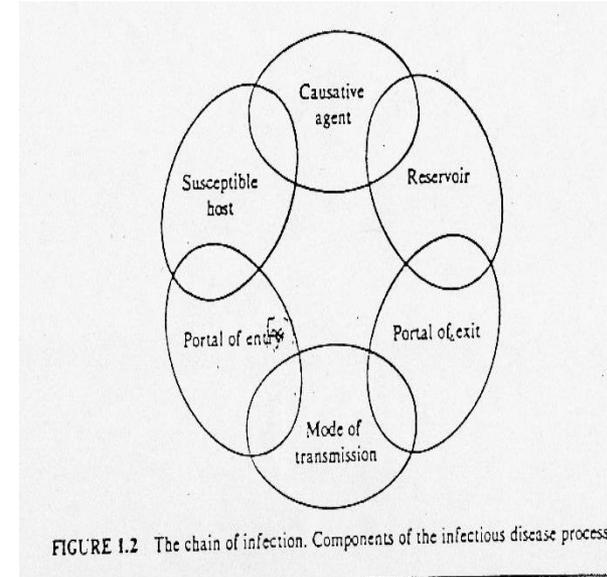
السلام عليكم ورحمة الله وبركاته

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Infectious process III



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Requisites for Perpetuation of Communicable Diseases (The Cycle Of Infection)

- ~~1. Presence of the **microbiologic agent**.~~
- ~~2. Presence of a **reservoir and source**.~~
- ~~3. An **outlet (portal of exit)** from reservoir.~~
4. A suitable **mode of transmission**.
5. An **inlet (portal of entry)**.
6. A **susceptible host**.

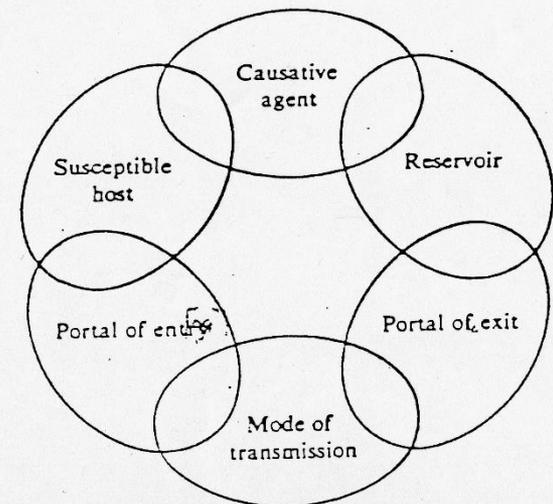


FIGURE 1.2 The chain of infection. Components of the infectious disease process.

The mode of transmission of infectious diseases may be classified as

A Direct Transmission

1. Direct contact
2. Droplet infection
4. Inoculation into skin or mucosa
5. Transplacental (vertical).

B Indirect Transmission

1. Vehicle-borne
2. Vector-borne
 - a. Mechanical
 - b. Biological
3. Air-borne
 - a. Droplet nuclei
 - b. Dust
4. Fomite-borne
5. Unclean hands & fingers

B *Indirect Transmission*

- This embraces a variety of mechanisms including the traditional
- 5 F's - "flies, fingers, fomites, food and fluid".
- ❖ **An essential requirement** for indirect transmission is that
 - the infectious agent must be **capable of surviving outside**
 - the human host in the external environment **and**
 - **retain its basic properties of pathogenesis and virulence**
 - **till it finds a new host. This depends upon the :**
 - 1) **characteristics of the agent,**
 - 2) **inanimate object and**
 - 3) **influence of environmental factors** such as temperature & humidity.
 - 4) If the disease agent **acquires drug resistance**, it will further facilitate its spread.
- **Indirect transmission can occur in a variety of settings :**



Indirect transmission

1 Vehicle-borne

1. Vehicle-borne
2. Vector-borne
 - a. Mechanical
 - b. Biological
3. Air-borne
 - a. Droplet nuclei
 - b. Dust
4. Fomite-borne
5. Insect, animal & fingers

- ❖ It implies transmission of the infectious agent through the agency of **water, food** (including raw vegetables, fruits, milk and milk products), ice, **blood, serum, plasma** or **other biological** products such as tissues and **organs**.
- ❑ of these **Water & Food** are the **most frequent** vehicles of transmission, because they are used by everyone.
- ❑ **The infectious agent**
 - ❖ **may have** multiplied **or** developed in the vehicle (e.g., *S. aureus* in food) before being transmitted; or
 - ❖ **only** passively transmitted in the vehicle (e.g., HAV in water).



Cont. ..Vehicle-borne

- ❖ Diseases **transmitted by water and food** include chiefly infections of the alimentary tract, *e.g., acute diarrhoeas, typhoid fever, cholera, polio, hepatitis A, food poisoning and intestinal parasites.*
- ❖ Those transmitted **by blood include** *hepatitis B,C, malaria, syphilis, brucellosis, infectious mononucleosis and cytomegalovirus infection .*
- ❖ **Organ transplantation** may result in the introduction of the disease agent such as cytomegalovirus, *hepatitis B,C*, in association with kidney transplants.



Epidemiological Features of Vehicle Transmission are :

- 1) **if the dose of** contamination **is heavy**, the outbreak may be **explosive** as in the case of cholera and hepatitis A epidemics
- 2) **cases are initially** confined to those who are **exposed** to the contaminated vehicle, in some infections
- 3) **when secondary** cases occur, the primary case may be obscured
- 4) **the distance travelled** by the infectious agent may be great, e.g., outbreaks of food poisoning
- 5) it is **not** always possible to **isolate the infectious** agent in the incriminated vehicle, e.g., typhoid bacilli in contaminated water
- 6) **when** the vehicle is **controlled** or withdrawn, the epidemic subsides, e.g., epidemics of cholera, and
- 7) the **common source** of infection is often **traceable**.

2. Vector-borne

□ In infectious disease epidemiology,

□ **vector is defined** as

❖ an **arthropod** or **any living carrier** (e.g., snail) that

❖ **transports an infectious agent to a susceptible individual.**

□ **Transmission by a vector may be**

❖ **Mechanical or**

❖ **Biological.**

❖ In the **Biological** case, the **disease agent** passes through a **developmental** cycle or **multiplication** in the vector.



Propagative,



Cyclo-propagative,



Cyclo-developmental



(a) Mechanical transmission :

The infectious agent is mechanically transported

- ❖ by a crawling or flying arthropod
- through **soiling of its feet** or proboscis; or
- by passage of organisms through its **gastrointestinal tract** and **passively excreted**.
- ❖ There is **no development or multiplication** of the infectious agent on or within the vector.

(b) Biological transmission :

- ❖ The infectious **agent undergoing replication or development or both in vector and**
- ❖ **requires an incubation period** before vector can transmit. **(extrinsic incubation period)**

□ Biological transmission is **of three types :**



Biological transmission is of three types :

Con. ...Vector-borne

(i) Propagative :

The agent **merely multiplies** in vector, but **no change** in form, e.g., plague bacilli in rat fleas.

(ii) Cyclo-propagative :

The **agent changes in form and number**, e.g., malaria parasites in mosquito.

(iii) Cyclo-developmental :

The disease agent undergoes **only development but no multiplication**, e.g., microfilaria in mosquito.

Trans ovarian transmission

when the infectious agent is **transmitted vertically** from the infected female to her progeny(offspring) in the vector, .

Factors influencing the ability of vectors to transmit disease are :

- (a) host feeding preferences
- (b) infectivity, that is ability to transmit the disease agent
- (c) susceptibility, that is ability to become infected
- (d) survival rate of vectors in the environment
- (e) domesticity, that is degree of association with man, and
- (f) suitable environmental factors.

Seasonal occurrence of some diseases (e.g., malaria) may be related to **intense breeding** and thereby greater **density** of the insect vector during certain periods of the year.

3. Airborne

Droplet nuclei :

- ❖ "Droplet nuclei" are a **type of particles** implicated (**related**) in the spread of **airborne infection**.
- ❖ They are tiny particles (**1-10 microns range**) that represent the **dried residue of droplets** .
- ❖ They may be formed by **evaporation of droplets** coughed or sneezed into the air or
- ❖ Droplet nuclei **may remain airborne** for **long periods** of time, **some retaining** and others **losing infectivity or virulence**.
- ❖ They **not only keep floating** in the air but may be **disseminated by air** currents from the point of their origin.
- ❖ Particles in **the 1-5 micron** range are **liable to be easily drawn** into the **alveoli of the lungs**& may be **retained** there.
- ❖ Diseases spread by droplet nuclei include TB, *influenza, measles, Q fever and many respiratory infections.*

(2) Dust :

Some of **the larger droplets** which are expelled during talking, coughing or sneezing, **settle down by** their sheer weight on the **floor, carpets, furniture, clothes, bedding, linen and other objects** in the immediate environment **and become part of the dust.**

Some of them (e.g., tubercle bacilli) **may survive in the** dust for **considerable periods under** optimum conditions of temperature and moisture.

. Airborne dust is primarily **inhaled**, but may **settle on uncovered food and milk.**

This type of transmission is most common in hospital acquired (nosocomial) infection

4. Fomite-borne

- **Fomites** (singular; fomes) are inanimate articles or substances other than water or food **contaminated** by the infectious **discharges** from a patient and
- **Capable of harbouring and transferring the infectious agent to a healthy person.**

Fomites include

soiled clothes, towels, linen, handkerchiefs, cups, spoons, pencils, books, toys, drinking glasses, door handles, taps, lavatory chains, syringes, instruments and surgical dressings.

❑ The fomites play an important role in indirect infection.

Diseases transmitted by *fomites* include diphtheria, typhoid fever, bacillary dysentery, hepatitis A, eye and skin infections

.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.
- ❖ **The transmission takes place both**
- ❖ **directly (hand-to-mouth) and**
- ❖ **indirectly.**
- ❖ *Examples include staphylococcal and streptococcal infections, typhoid fever, dysentery, hepatitis A and intestinal parasites.*
- ❖ Unclean hands and fingers **imply lack of personal hygiene.**
- ❖ **Lack of personal hygiene coupled with poor sanitation**

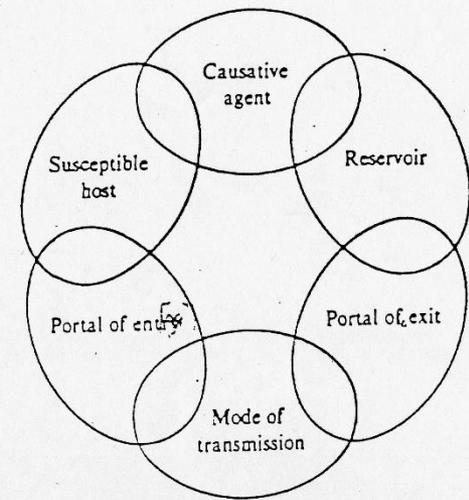


FIGURE 1.2 The chain of infection. Components of the infectious disease process.

(5) PORTALS OF ENTRY TO NEW HOST

THE CYCLE OF INFECTION)

(5) PORTALS OF ENTRY TO NEW HOST

- ❖ Respiratory tract
- ❖ Gastro-intestinal tract
- ❖ Genito-urinary tract
- ❖ Skin and mucous membranes through:
 - Affecting its layers
 - Affecting its layers then passing to
 - **cause systemic infection**
- ❖ Piercing skin through inoculation by:
 - Insects
 - During blood letting
- ❖ Trans-placental



Note

Some pathogens have:

- **One portal** of entry to new host.
- **Two or more portals** of exit from reservoir.

Examples:

Poliomyelitis viruses.

Salmonella typhi.

Time between entrance and start of manifestations is called incubation period

Definition of incubation period:

Interval between time of contact and entry of agent and onset of illness

❑ **Intrinsic incubation period**

Interval between **infection** of a susceptible person or animal and **appearance of symptoms** or signs of disease caused by infecting pathogen

❑ **Extrinsic incubation period:**

Period between that time when **vector gets infected** and time vector **becomes infective**

❑ **Variation in range and duration of incubation period depends on:**

- **Resistance of host**
- **Dosage and virulence of agent**
- **Type of agent with regard to toxin production**
- **Route of infection inside body**

SUSCEPTIBLE HOST

The Host

is a person or other living animal including birds and arthropods that **afford maintenance, (survival)** or **lodgment** to an infectious agent under natural conditions

Successful parasitism

Four stages have been described in **successful parasitism** :

- a) First, the infectious agent must find a **PORTAL OF ENTRY** by which it may **enter the host**.

There are many portals of entry, e.g., *respiratory tract, alimentary tract, genitourinary tract, skin, etc.*

- **Some organisms may have more than one portal of entry, e.g., hepatitis B, Q fever, brucellosis.**

- b) On gaining entry into the host, the organisms **must reach the appropriate tissue** or "**SITE OF ELECTION**" in the body of the host where it may find optimum conditions for its **multiplication and survival.**



Successful parasitism Cont. ..

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

❖ If there is no portal of exit, the infection **becomes a dead-end** infection as in *rabies, bubonic plague, tetanus and trichinosis*.

(d) After leaving the human body, the **organism must survive** in the **external environment** for sufficient period till a new host is found.

□ In addition, a **successful disease agent should not cause the death of the host** but produce only a **low-grade immunity** so that the **host is vulnerable again and again** to the same infection.

The best example is common cold virus.

Incubation period

defined as:

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

- ❖ During the incubation period, the infectious **agent undergoes**
- ❖ **multiplication** in the host. When a **sufficient density** of the disease agent is **built up** in the host,
- ❖ the **health equilibrium** is **disturbed** and
- ❖ the **disease** becomes **overt**.

❑ **Factors which determine the incubation period include**

- **the generation time** (time that it takes for bacteria to divide ,usually in hours or days). **of the particular pathogen,**
- **infective dose,**
- **portal of entry and**
- **individual susceptibility.**



- In some, the incubation period is of
- **median length** ranging from
- **10 days to 3 weeks**; in this category, *there are many examples: **typhoid infections**, virus diseases such as chickenpox, **measles and mumps**.*
- Then there are infections with
- **longer incubation** periods (ranging **from weeks to months or years**) and
- whose **incubation time is difficult to measure precisely**, e.g., hepatitis A and B, rabies, leprosy and slow virus diseases.



Serial interval

□ In actual practice we seldom know precisely the incubation period of a disease.

But we know, when an outbreak of disease occurs, say in a family which is the smallest group and also a closed group, there is an initial primary case.

The primary case is followed by 2 or 3 secondary cases within a short time.

❖ The gap in time between the onset of the primary case and the secondary case is called the "serial interval".

❖ By collecting information about a whole series of such onsets, we get a distribution of secondary cases from

❖ which we can guess the incubation period of disease

Communicable period

The communicable period is defined as

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

❑ Communicability varies in different diseases.

➤ **Some diseases are more communicable during the incubation period than during actual illness.**

❑ Communicability of some diseases can be reduced by early diagnosis and treatment.

An important measure of communicability is

Secondary attack rate.

Secondary attack rate (SAR) is defined as "the number of exposed persons developing the disease within the range of the incubation period, following exposure to the primary case"

HOST DEFENCES

Host defences against infection are at once

- local and systemic,
- non-specific and specific, and
- humeral and cellular.

It is difficult to identify any infectious agent that fails to stimulate multiple host defence mechanisms

Resistance:

It is the total body mechanisms which act as **barriers** to **invasion** or **multiplication** of infectious agents or their damaging effects of their toxins

- 1) **Natural barriers** (Inherent resistance or innate immunity).
- 2) **Acquired resistance** (immunity).

1) **Inherent resistance (Natural barriers (innate immunity):**

- ✓ **Non-specific** resistance of the body against the invading organisms which
- ✓ **doesn't depend** on the presence of **specific antibodies or antitoxin**
- ✓ for protection, but
- ✓ **depends on the anatomical or physiological characteristics** of the host.

1) **Inherent resistance (innate immunity):**

Natural defensive mechanisms:

- **The body surface**
- **Phagocytic cells lying in tissues**
- **Blood**

2) Acquired resistance (immunity).

i. Passive immunity:

- Natural
- Artificial

1) **Natural barriers** (Inherent innate immunity)
2) **Acquired resistance** (immunity).

ii. Active immunity

- Natural
- Artificial

i. Passive immunity:

Type of resistance in which **ready made antibodies** are gained

1. **Natural passive:** antibodies from the mother.
2. **Artificial passive:** by injecting immune serum or immunoglobulin

cont. .. Passive immunity :

Natural passive immunity: (Infant immunity)

Infant resistance due to antibodies passed to the fetus through the placenta.

The **mother should have** acquired the **infection** and/or **vaccine & developed specific antibodies** against the disease.

They are **at highest level at birth** and decline gradually till **disappearance by the 6th month**.

Can be induced by immunizing the mother during **pregnancy by** *tetanus toxoid to protect the infant against tetanus neonatorum.*

- ❖ **Breast milk**, specially the **colostrums** contains
 - **plenty of antibodies** (about 95% of colostrums' proteins)
 - Antibodies are continuously secreted in breast milk but at lower levels than the colostrums.

cont. .. Passive immunity :

Acquired resistance (immunity).
Passive immunity:
Natural
Artificial
Active immunity
Natural
Artificial

2. Artificial passive immunity:

(passive immunization or Immuno-prophylaxis)

- Immunity induced by **injecting immune serum or immunoglobulin.**
- Characterized by short duration (**for about 3 weeks**) during which the **antibodies are gradually eliminated**

A. Sera of artificially immunized animals

used either for prophylaxis or treatment as *anti-tetanic or antidiphtheritic sera.*

B. Immunoglobulin:

This is the plasma protein fraction that carries most of antibodies and used as **prophylaxis** as in hepatitis A.

Acquired(immunity).
Passive immunity:
Natural
Artificial
Active immunity
Natural
Artificial

ii. Active immunity:

Type of resistance in which the **person makes** or develops his own **antibodies**.

1. Natural active:

- ❖ **post infection** immunity.
- ❖ may be **solid**, long [mumps or measles],
- ❖ **moderate** [meningitis] or
- ❖ **short duration** [common cold])

2. Artificial active:

- **post vaccination immunity**,
- where the specific antigen when introduced in the
- body provoke the **formation of antibodies**

IDEAL IMMUNIZING AGENT:

- ✓ **Minimal side effects**
- ✓ **Antigenic stability**
- ✓ **Durable immunity**
- ✓ **Easy administration**
- ✓ **Few injections**
- ✓ **Reasonable cost**
- ✓ **Availability**
- ✓ **Good keeping quality (long shelf life)**
- ✓ **Easy storage**

Herd immunity

- It's the state of immunity **within the community**.
- It's the factor that decides **the epidemiological pattern** of any infectious disease among that community.
- Herd immunity theory proposes that in diseases passed from individual to individual, **it is difficult to maintain** a chain of infection when **large numbers of** a population are **immune**.
- The **higher the number** of immune individuals, the **lower the** likelihood that a susceptible person will come **in contact with an infectious agent**
- Herd immunity provides an **immunological barrier** 

Cont.Herd immunity

- ❑ Herd immunity provides an **immunological barrier** to the spread of disease in the human herd
- ❑ **population** with a **very low or no** immunity, the **attack and case fatality rates** tend to be **very high** involving practically all susceptible
- ❑ The epidemic wave **declined with a build-up** of herd immunity following natural infection.

The disease incidence rises at times when the number of **susceptible** in the **population is highest** and the **herd immunity is lowest**.

Herd immunity results from

- either an epidemic or
- after obligatory immunization schedules

Herd immunity may be determined by serological surveys (serological epidemiology).

Herd immunity Cont. ..

Community protection is governed by:

1. The extent of **coverage of the immunization** program.
2. The **degree of resistance** to infection afforded by the vaccine.
3. **Duration and degree of infectivity** of the organism.
4. **Past experience** with different infections.
5. Overcrowding and environmental sanitation

Thank You

Thank You