



# Introduction to the epidemiology of communicable diseases

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# Outline

- What is special about infectious diseases?
- General characteristics of infections
- Characteristics of host individuals and population
- Geographical distribution
- Time factor in infection



## Five common characteristics of infectious diseases

- They are very common.
- Some of them cause death and disability.
- Some of them cause epidemics.
- Most of them are preventable when using simple interventions.
- Many of them affect infants and children.



What is special about infectious diseases?

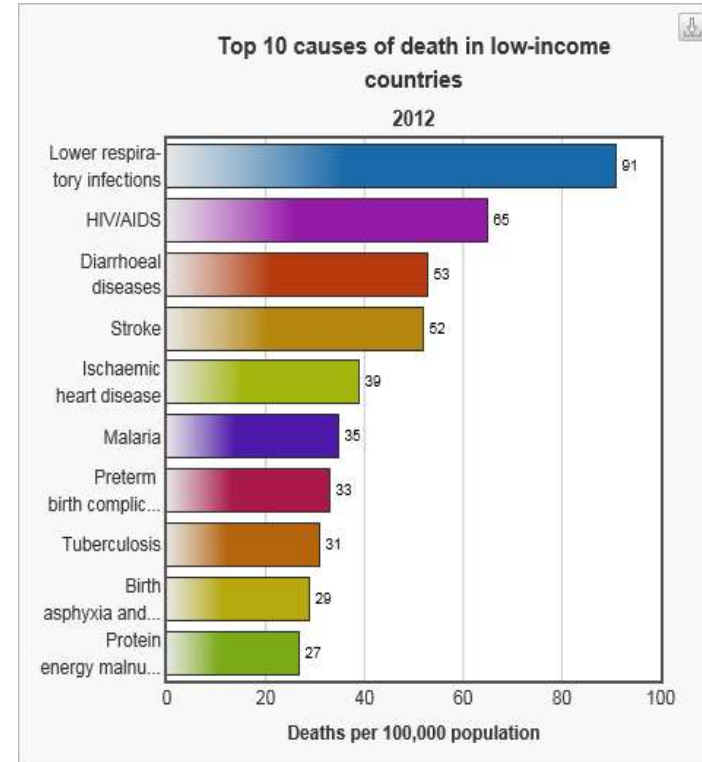
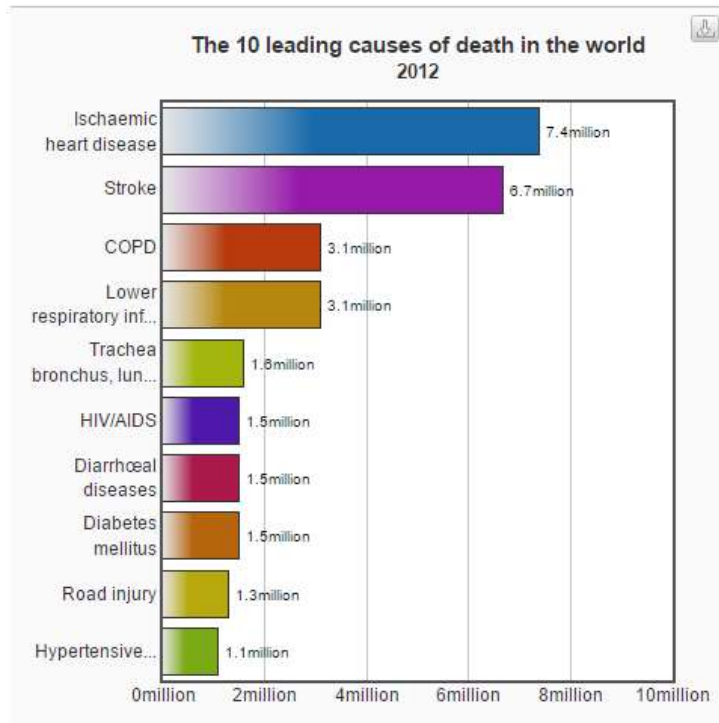
**1. Importance**

**2. Novelty**

# What is special about infectious diseases?

## 1. Importance

- Infectious diseases are responsible for much morbidity and mortality





# What is special about infectious diseases?

## 1. Importance

## 2. Novelty

- Recent years have seen the appearance or recognition (emergence) of several new infectious agents and diseases

### **Emerging infectious diseases:**

Covid-19, Helicobacter, HIV, SARS, H5N1 Influenza, Coronavirus, Ebola, Zika... etc



# General characteristics of infections

- The necessary aetiological factors of infectious diseases are **infectious agents** which live on or in a larger organism (a **host**).

E.g. of infectious agents:

pirons, viruses, mycoplasma, rickettsia, bacteria, fungi, protozoa, helminthes, arthropods



# Characteristics of host individuals

- **Naturally resistant:** Not able to become infected because of genetic constitution
- **Susceptible** (to infection): uninfected, but able to become infected, if exposed. Not immune.
- **Infected:** presence of infectious agent, in some form, within the host. Does not necessarily mean “diseased”.
- **Colonized:** presence of a microbial infectious agent on an epithelial surface of the host, but without tissue invasion.
- **Infested:** often used in preference to infected or colonized, for a host carrying arthropod ectoparasites, e.g. lice





# Characteristics of host individuals

## **Incubating:**

infected, but not yet manifesting clinical signs.

## **Latent infection (silent infection, subclinical infection):**

Presence of infectious agent but absence of clinical disease, and typically implies that a host is not infectious as well as not diseased.

## **Carrier:**

A protracted infected or colonized state with shedding of the infectious agent. Carriers may be diseased, convalescent or healthy.



# Characteristics of host individuals

## **Patent infection:**

Presence of sufficient infectious agents (in the blood, tissues, stools, etc of the host) for them to be demonstrable microscopically or by culture.

## **Infectious (infective):**

The infected individual is in a state to transmit the agent, either directly (by contagion), or indirectly (e.g. via an insect vector)

## **Contagious:**

- An infected individual can transmit the infectious agent, by actual contact or by aerosol, directly to a susceptible individual.
- All contagious individuals are infectious, but not all infectious individuals are contagious.



# Characteristics of host individuals

## **Diseased:**

Presence of clinical signs of pathology. Not synonymous with “infected”

## **Immune:**

Possessing some level of cell-mediated or humoral antibody protection against an infection.



# Characteristics of host individuals

## **Passive immunity:**

Due to transfer of maternal IgG across the placental, or to serum prophylaxis/therapy.

## **Active immunity:**

Due to a prior sensitization of the individual to antigens (or similar antigens) of the infectious agent.



# Characteristics of host individuals

## **Contact:**

An individual who has been exposed to a source of infection and who thus may be infected.

NB: Exposure (e.g. being near an infectious source) does not mean that infection has necessarily taken place.

## **Case:**

Typically restricted only to those manifesting clinical signs of the infection, i.e. diseased individuals.

# Characteristics of host population

## **Reservoir host (species):**

- A species, or population, which is capable of maintaining an infectious agent indefinitely.
- e.g. Rodents for Leishmaniasis.

## **Definitive host:**

- A host in which the infectious agents undergoes an obligatory sexual phase (reproduction) in their life cycle (many helminthes and protozoa).
- e.g. humans are definitive hosts for *Schistosoma haematobium*

## **Intermediate host:**

- Infections whose life cycle involves two different host species – the intermediate host being (formally) that in which asexual reproduction of agent occurs.
- e.g. snails are intermediate hosts of schistosomes



# Characteristics of host population

## **Vector host:**

An invertebrate species which serves to carry an infectious agent from one to another individual of a vertebrate host species. This may be:

### **1. Mechanical transmission by vectors**

- A purely mechanical transport function
- e.g. houseflies may be mechanical vectors of *Entamoeba histolytica*.

### **2. Biological transmission**

- The infectious agent may actually multiply and develop with the vector
- e.g. mosquitoes are biological vectors of malaria *Plasmodium* spp.



# Host population

## **Herd immunity:**

- Indirect protection of susceptible individuals brought about by the presence of immunes in a host population.
- The higher the proportion of immunes, then the smaller the potential number of infectious cases, and the smaller the risk of infection among remaining susceptibles (herd effect).

If the proportion immune is very high, eg as a consequence of an immunization campaign, the population of susceptibles may be:

- Insufficient to maintain the infectious agent
- or at least insufficient to support large epidemics





# Geographical distribution

- Like all living organisms, infectious agents have strict environmental requirements.  
eg malaria transmission depends on Anopheles mosquitoes which depend on climatic conditions
- Global warming may be leading to the spread of tropical infections into previous temperate zones of the world



# Time factor in infection

## 1. Time course of a single infection

### **Incubation period:**

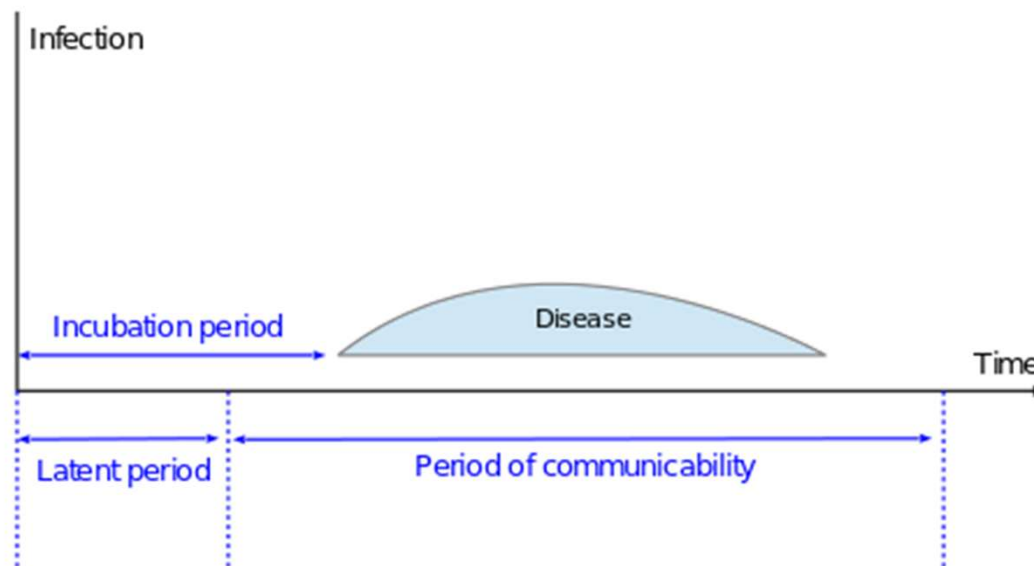
- The time from initial infection to the onset of clinical signs.
- Incubation periods are variable for any infection.

### **Latent period (pre-infectious period):**

- The time from initial infection to onset of infectiousness.
- For many infections, this pre-infectious period is slightly shorter than the incubation period.
- Important for contact tracing.

# Time factor in infection

- **Incubation period**
- **Latent period (pre-infectious period)**





# Time factor in infection

## 1. Time course of a single infection (cont.)

### **Duration of infectiousness, patency or communicability**

- Important for isolation of cases and assessing contact risk period.
- It varies greatly between infections
  - Few days (eg many acute respiratory viruses)
  - Years (eg leprosy)

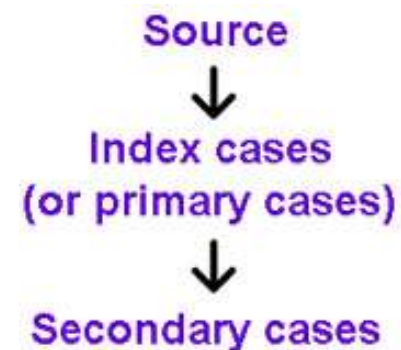
### **Relapse, recrudescence or reactivation of disease:**

- Recurrence of clinical signs after a period of silent (latent, subclinical) infection
- E.g. Plasmodium vivax malaria, Herpes simplex, Herpes varicella-zoster and Mycobacterium tuberculosis

# Time factor in infection

## 2. Time relationship between cases

- **Primary (index) case:** the first case in a defined outbreak or epidemic.
- **Secondary cases** (also tertiary, quaternary cases, etc). Secondary cases owe their infections to the primary cases... etc





# Time factor in infection

## 3. Middle-term time trend

### **Endemic:**

- The maintenance of relatively constant incidence and prevalence rate over a long period of time (years..).
- E.g. HBV has a low endemicity in Iraq (1.6%)

### **Epidemic:**

- A sharp and significant rise in incidence over the expected level for a given time period.
- E.g. epidemic of cholera in Kurdistan in 2007 – 7000 cases.



# Time factor in infection

## **Outbreak:**

- A sudden epidemic, usually of short duration.
- Used especially for point-source episodes for food-borne or zoonotic infections.
- E.g. Outbreak of anthrax in Akre in 2008 – 37 cases.

## **Pandemic:**

- A world-wide epidemic. Classical pandemic infections are plague, cholera and influenza.
- E.g. Influenza pandemic 1918-1919 – 50M deaths



# Summary

An introduction to the general terminology and language of infectious diseases and epidemiology of infectious diseases before going into the details of specific topics.





# References

- **Control of communicable diseases manual**, by Heymann DL, American Public Health Association, 19<sup>th</sup> edition, 2008.
- **Park's textbook of preventive and social medicine**, by Park K, Banarsidas Bhanot Publishers, 21<sup>st</sup> edition, 2011.