

Principles of Communicable Diseases Epidemiology

The background is a solid teal color. At the bottom right corner, there is a dark teal silhouette of a mountain range with jagged peaks.

Objectives

- ◆ **Definition of epidemiology**
- ◆ **The epidemiologic triad**
- ◆ **Definition of communicable diseases**
- ◆ **Importance of studying communicable diseases epidemiology**
- ◆ **Terminology**
- ◆ **Dynamics of disease transmission (chain of infection):**
 - **Human reservoir or source**
 - **Modes of transmission**
 - **Susceptible host**

Definition of Epidemiology

Epidemiology is the study of the distribution and determinants of health-related states and events in populations, and the application of this study to control health problems (Last, 1983).

Epidemiologic triad

- Demographic characteristics
- Biological characteristics
- Socioeconomic characteristics

Host

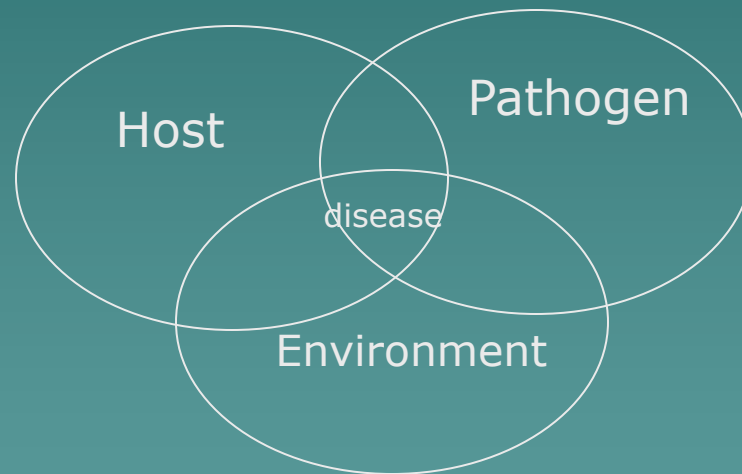
Agent

Environment

- Biological agents
- Physical agents
- Chemical agents
- Nutrient agents
- Mechanical agents
- Social agents

- Physical environment
- Biological environment
- Social environment

Infectious Disease Model



Definition of communicable diseases

- ◆ A communicable disease is an illness due to a specific infectious (biological) agent or its toxic products capable of being directly or indirectly transmitted from man to man, from animal to man, from animal to animal, or from the environment (through air, water, food, etc..) to man.

Importance of Studying Communicable Diseases Epidemiology

- ◆ Changes of the pattern of infectious diseases
- ◆ Discovery of new infections
- ◆ The possibility that some chronic diseases have an infective origin.

Terminology and Definitions

- ◆ Infection
- ◆ Contamination
- ◆ Infestation
- ◆ Contagious disease
- ◆ Incidence and prevalence of infectious diseases
- ◆ Epidemic
- ◆ Endemic
- ◆ Hyperendemic
- ◆ holoendemic
- ◆ Pandemic
- ◆ Exotic
- ◆ Sporadic
- ◆ Attack rate
- ◆ Primary/secondary cases
- ◆ Zoonosis, epizootic and enzootic
- ◆ Nosocomial infection
- ◆ Opportunistic infection
- ◆ Eradication
- ◆ Elimination

Terminology and Definitions (cont.)

- ◆ Virulence
- ◆ Reproductive rate of infection
- ◆ Host
- ◆ Vector (source)
- ◆ Reservoir
- ◆ Incubation period
- ◆ Infectivity period
- ◆ Serial interval
- ◆ Latent period
- ◆ Transmission Probability ratio

Infection

- ◆ Infection is the entry and development or multiplication of an infectious agent in the body of man or animals. An infection does not always cause illness.
- ◆ There are several levels of infection (Gradients of infection):
 - Colonization (*S. aureus* in skin and normal nasopharynx)
 - Subclinical or inapparent infection (polio)
 - Latent infection (virus of herpes simplex)
 - Manifest or clinical infection

contamination

- ◆ The presence of an infectious agent on a body surface, on or in clothes, beddings, toys, surgical instruments or dressings, or other articles or substances including water and food

Infestation

- ◆ It is the lodgment, development and reproduction of arthropods on the surface of the body or in the clothing, e.g. lice, itch mite. This term could be also used to describe the invasion of the gut by parasitic worms, e.g. ascariasis.

Contagious disease

- ◆ A contagious disease is the one that is transmitted through contact. Examples include scabies, trachoma, STD and leprosy.

Host

- ◆ A person or an animal that affords subsistence or lodgement to an infectious agent under natural conditions. Types include: an obligate host, definitive (primary) host, intermediate host and a transport host.

Vector of infection

- ◆ An insect or any living carrier that transports an infectious agent from an infected individual or its wastes to a susceptible individual or its food or immediate surroundings. Both biological and mechanical transmissions are encountered.

Reservoir

- ◆ Any person, animal, arthropod, plant, soil, or substance, or a combination of these, in which an infectious agent normally lives and multiplies, on which it depends primarily for survival, and where it reproduces itself in such a manner that it can be transmitted to a susceptible host. It is the natural habitat of the infectious agent.

Incidence and prevalence of infectious diseases

- ◆ Incidence of an infectious disease: number of new cases in a given time period expressed as percent infected per year (cumulative incidence) or number per person time of observation (incidence density).
- ◆ Prevalence of an infectious disease: number of cases at a given time expressed as a percent at a given time. Prevalence is a product of incidence x duration of disease, and is of little interest if an infectious disease is of short duration (i.e. measles), but may be of interest if an infectious disease is of long duration (i.e. chronic hepatitis B).

Epidemic

- ◆ “The unusual occurrence in a community of disease, specific health related behavior, or other health related events clearly **in excess of expected occurrence**”
- ◆ (epi= upon; demos= people)
- ◆ Epidemics can occur upon endemic states too.

Endemic

- ◆ It refers to the constant presence of a disease or infectious agent within a given geographic area or population group. It is **the usual or expected frequency of disease** within a population.
- ◆ (En = in; demos = people)

Hyperendemic and holoendemic

- ◆ The term “hyperendemic” expresses that the disease is constantly present at high incidence and/or prevalence rate and affects all age groups equally.
- ◆ The term “holoendemic” expresses a high level of infection beginning early in life and affecting most of the child population, leading to a state of equilibrium such that the adult population shows evidence of the disease much less commonly than do the children (e.g. malaria)

Pandemic and Exotic

- ◆ An epidemic usually affecting a large proportion of the population, occurring over a wide geographic area such as a section of a nation, the entire nation, a continent or the world, e.g. Influenza pandemics.
- ◆ Exotic diseases are those which are imported into a country in which they do not otherwise occur, as for example, rabies in the UK.

Sporadic

- ◆ The word sporadic means “scattered about”. The cases occur irregularly, haphazardly from time to time, and generally infrequently. The cases are few and separated widely in time and place that they show no or little connection with each other, nor a recognizable common source of infection e.g. polio, meningococcal meningitis, tetanus....
- ◆ However, a sporadic disease could be the starting point of an epidemic when the conditions are favorable for its spread.

Attack rates and primary/secondary cases

- ◆ Attack rate: proportion of non-immune exposed individuals who become clinically ill.
- ◆ Primary (index)/secondary cases: The person who comes into and infects a population is the primary case. Those who subsequently contract the infection are secondary cases. Further spread is described as "waves" or "generations".

Zoonosis, epizootic and enzootic

- ◆ Zoonosis is an infection that is transmissible under natural conditions from vertebrate animals to man, e.g. rabies, plague, bovine tuberculosis.....
- ◆ An epizootic is an outbreak (epidemic) of disease in an animal population, e.g. rift valley fever.
- ◆ An Enzootic is an endemic occurring in animals, e.g. bovine TB.

Nosocomial infections

- ◆ Nosocomial (hospital acquired) infection is an infection originating in a patient while in a hospital or another health care facility. It has to be a new disorder unrelated to the patient's primary condition. Examples include infection of surgical wounds, hepatitis B and urinary tract infections.

Opportunistic infection

- ◆ This is infection by organisms that take the opportunity provided by a defect in host defense (e.g. immunity) to infect the host and thus cause disease. For example, opportunistic infections are very common in AIDS. Organisms include Herpes simplex, cytomegalovirus,
- ◆ *M. tuberculosis*....

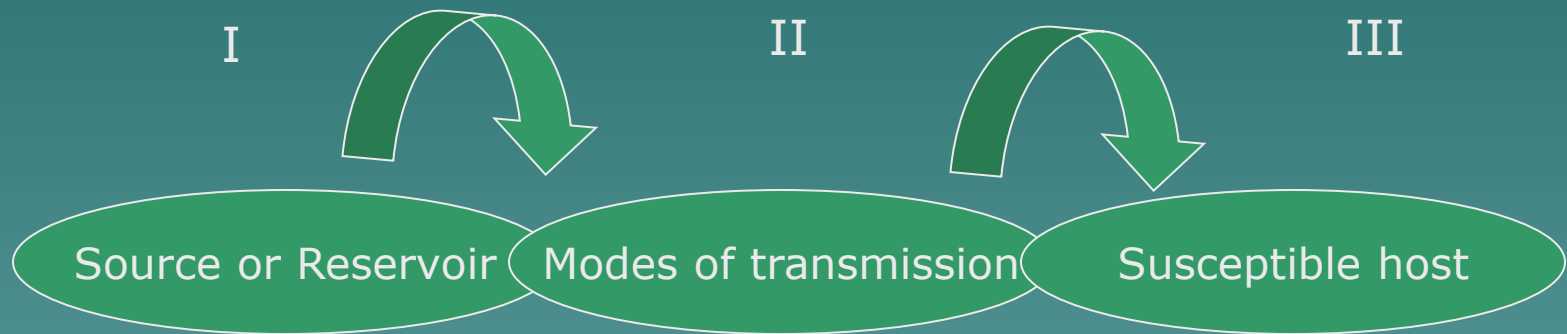
Eradication and Elimination

- ◆ Termination of all transmission of infection by the extermination of the **infectious agent** through surveillance and containment. Eradication is an absolute process, an “all or none” phenomenon, restricted to termination of infection from the whole world.
- ◆ The term elimination is sometimes used to describe eradication of a disease from a large geographic region. Disease which are amenable to elimination in the meantime are polio, measles and diphtheria.

Reproductive rate of infection:

- ◆ Reproductive rate of infection: potential for an infectious disease to spread. Influential factors include the probability of transmission between an infected and a susceptible individual; frequency of population contact; duration of infection; virulence of the organism and population immune proportion .

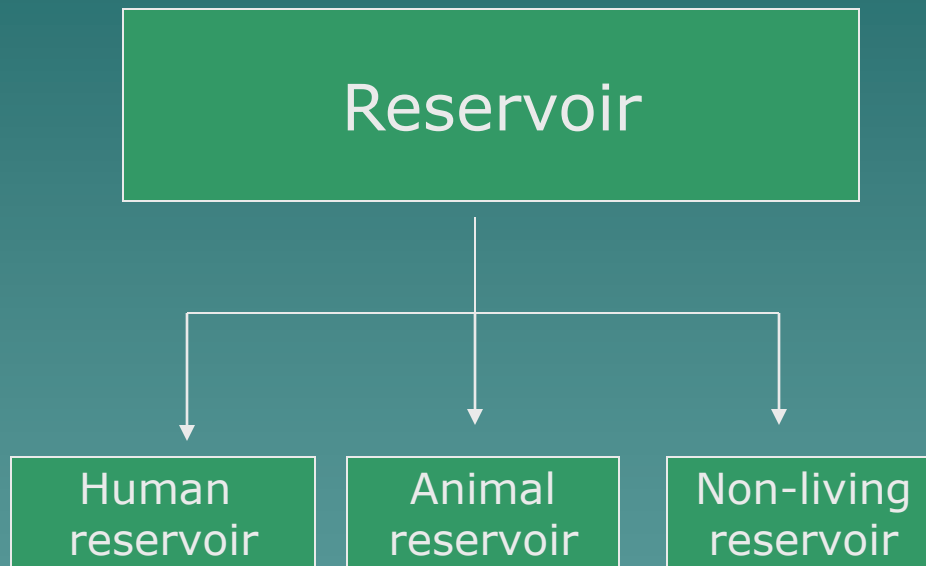
Dynamics of disease Transmission (Chain of Infection)



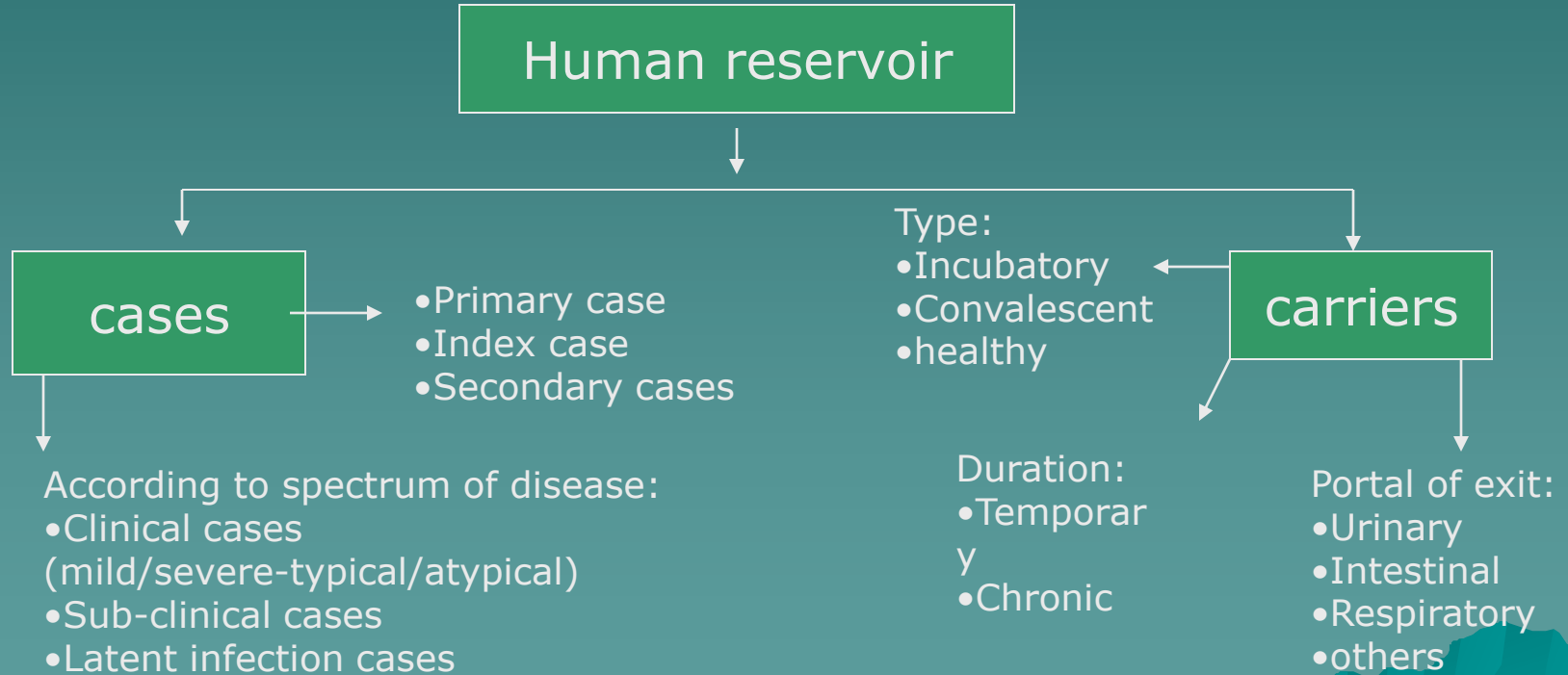
(I): Source or Reservoir

- ◆ The starting point for the occurrence of a communicable disease is the existence of a reservoir or source of infection.
- ◆ The source of infection is defined as “the person, animal, object or substance from which an infectious agent passes or is disseminated to the host (**immediate source**). The reservoir is “any person, animal, arthropod, plant, soil, or substance, or a combination of these, in which an infectious agent normally lives and multiplies, on which it depends primarily for survival, and where it reproduces itself in such a manner that it can be transmitted to a susceptible host. It is the natural habitat of the infectious agent.”

Types of reservoirs



Human reservoir



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”

Carriers

- ◆ It occurs either due to inadequate treatment or immune response, the disease agent is not completely eliminated, leading to a carrier state.
- ◆ It is “an infected person or animal that harbors a specific infectious agent in the absence of discernible (visible) clinical disease and serves as a potential source of infection to others.
- ◆ Three elements have to occur to form a carrier state:
 1. The presence in the body of the disease agent.
 2. The absence of recognizable symptoms and signs of disease.
 3. The shedding of disease agent in the discharge or excretions.

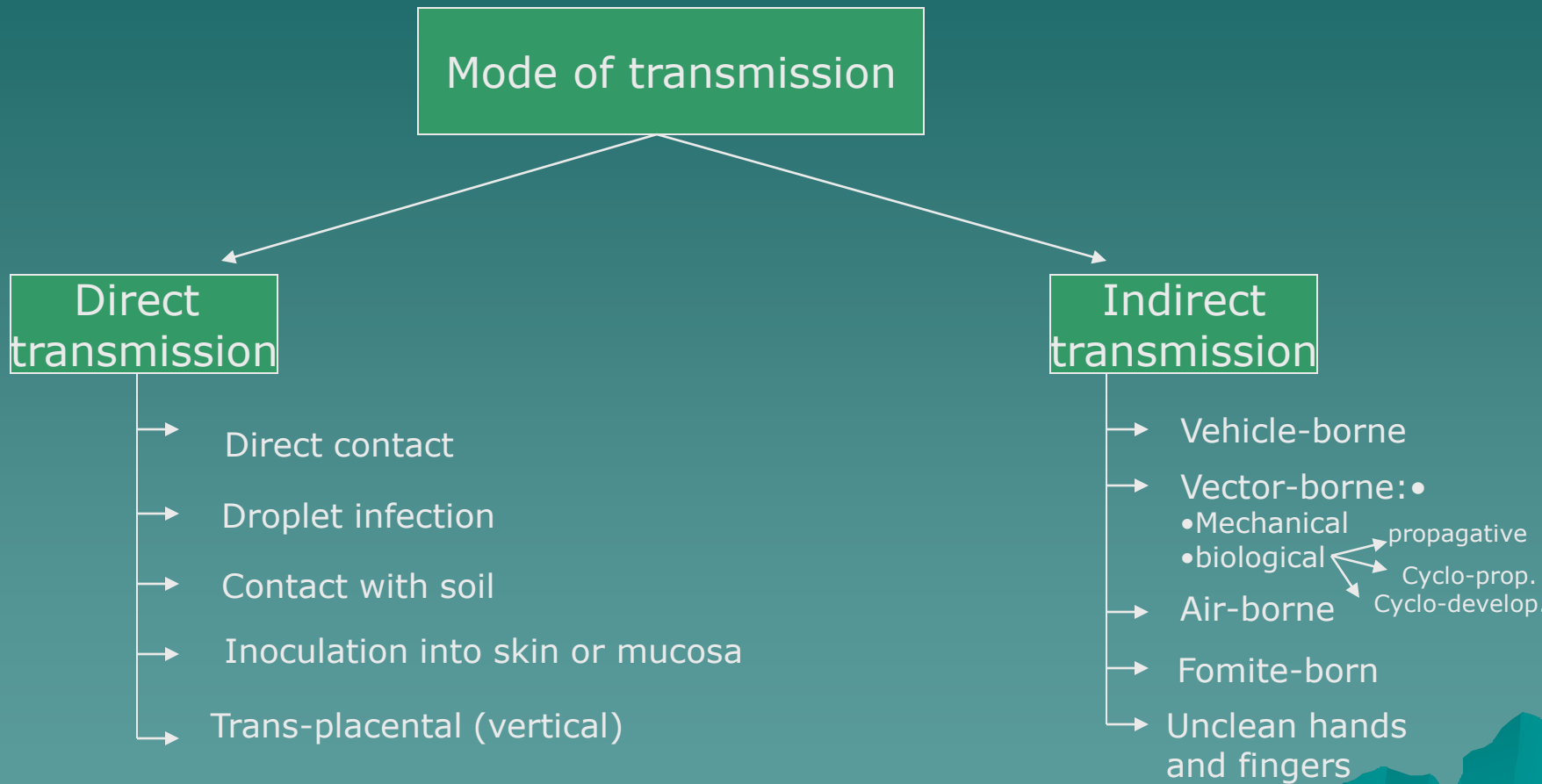
Animal reservoirs

- ◆ Zoonosis is an infection that is transmissible under natural conditions from vertebrate animals to man, e.g. rabies, plague, bovine tuberculosis.....
- ◆ There are over a 100 zoonotic diseases that can be conveyed from animal to man.

Reservoir in non-living things

- ◆ Soil and inanimate matter can also act as reservoir of infection.
- ◆ For example, soil may harbor agents that causes tetanus, anthrax and coccidioidomycosis.

(II): Modes of transmission



(III): Susceptible host

- ◆ An infectious agent seeks a susceptible host aiming “successful parasitism”.
- ◆ Four stages are required for successful parasitism:
 1. Portal of entry
 2. Site of election inside the body
 3. Portal of exit
 4. Survival in external environment

Virulence and Case Fatality Rate

- ◆ **Virulence:** is the degree of pathogenicity; the disease evoking power of a micro-organism in a given host. Numerically expressed as the ratio of the number of cases of overt infection to the total number infected, as determined by immunoassay. When death is the only criterion of severity, this is the case fatality rate.
- ◆ **Case fatality rate for infectious diseases:** is the proportion of infected individuals who die of the infection. This is a function of the severity of the infection and is heavily influenced by how many mild cases are not diagnosed.

Serial interval and Infectious period

- ◆ Serial interval: (the gap in time between the onset of the primary and the secondary cases) the interval between receipt of infection and maximal infectivity of the host (also called generation time).
- ◆ Infectious (communicable) period: length of time a person can transmit disease (sheds the infectious agent).

Incubation and Latent periods

- ◆ Incubation period: time from exposure to development of disease. In other words, the time interval between invasion by an infectious agent and the appearance of the first sign or symptom of the disease in question.
- ◆ Latent period: the period between exposure and the onset of infectiousness (this may be shorter or longer than the incubation period).

Transmission Probability Ratio (TPR)

TPR is a measure of risk transmission from infected to susceptible individuals during a contact.

TPR of differing types of contacts, infectious agents, infection routes and strains can be calculated.

There are 4 types of transmission probabilities.

TPR (cont.)

Transmission probabilities:

- ◆ p_{00} : tp from unvaccinated infective to unvaccinated susceptible
- ◆ p_{01} : tp from vaccinated infective to unvaccinated susceptible
- ◆ p_{10} : tp from unvaccinated infective to vaccinated susceptible
- ◆ p_{11} : tp from vaccinated infective to vaccinated susceptible

TPR (cont.)

- ◆ To estimate the effect of a vaccine in reducing susceptibility, compare the ratio of p_{10} to p_{00} .
- ◆ To estimate the effect of a vaccine in reducing infectiousness, compare the ratio of p_{01} to p_{00} .
- ◆ To estimate the combined effect of a vaccine, compare the ratio of p_{11} to p_{00} .



THANK YOU