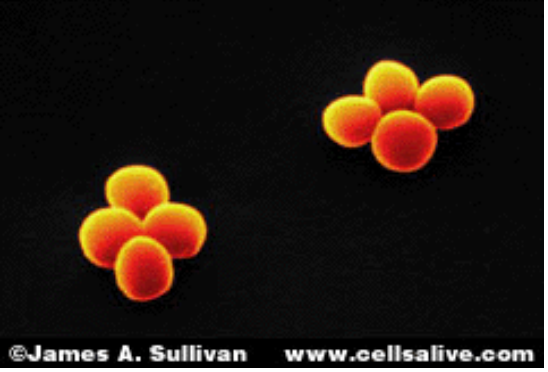
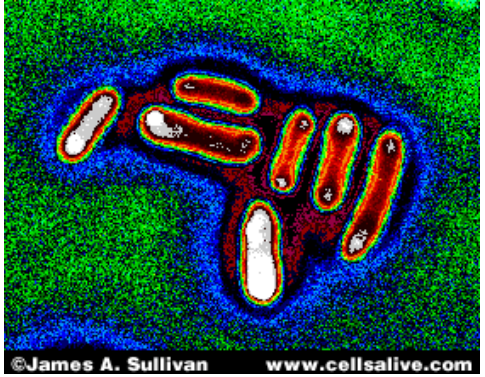
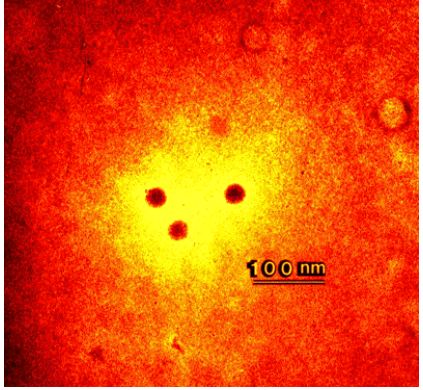
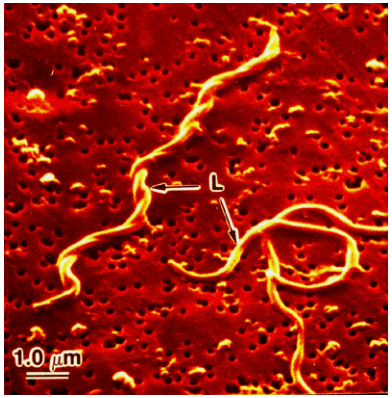






Infectious Disease Epidemiology



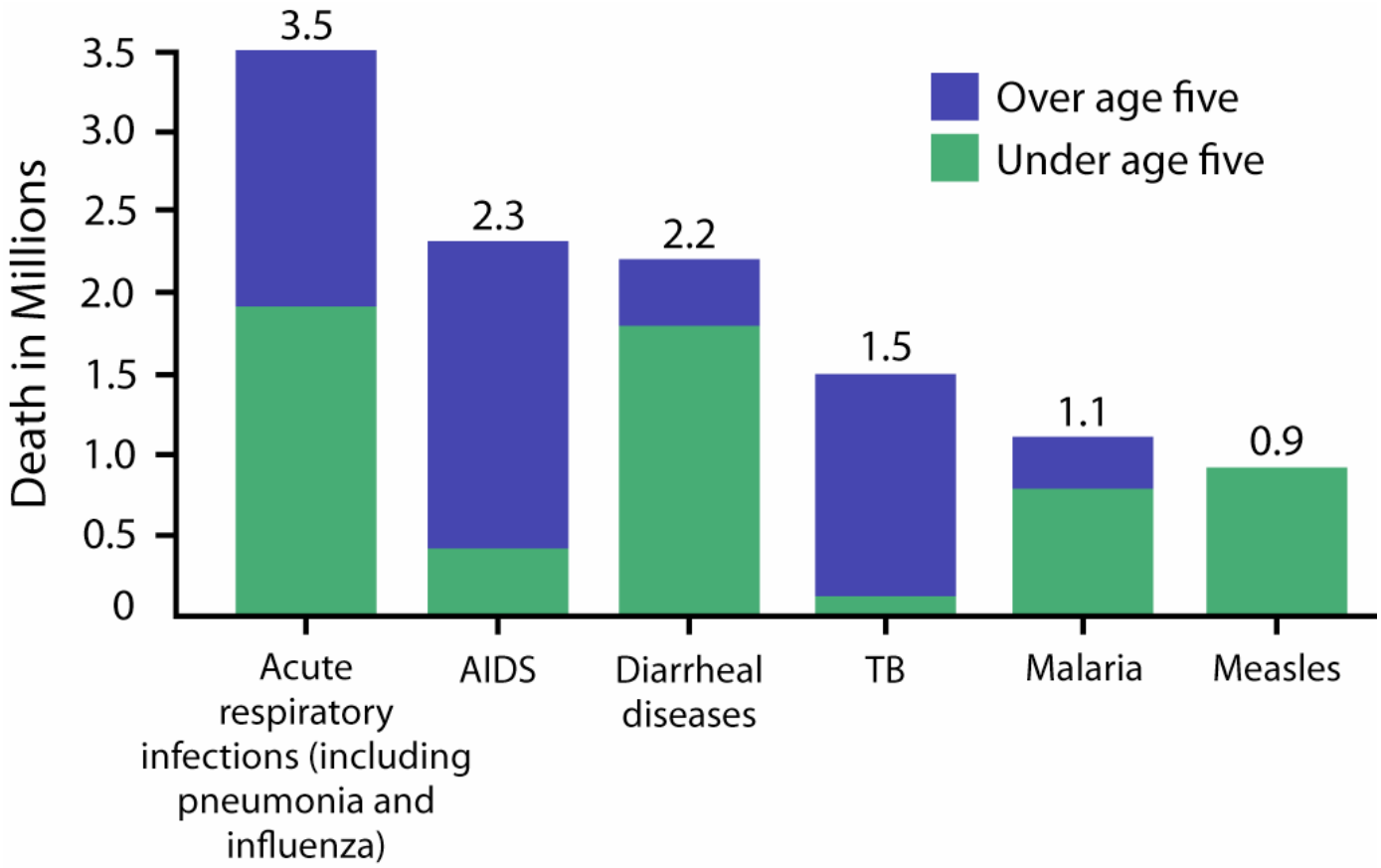
Dr Munir Abu-Helalah

Associate Professor of Epidemiology and Preventive Medicine

- Infectious diseases - History
- Why study Infectious diseases
- What is infectious disease epidemiology
- Concepts / definitions – IDE

- 14th century - Europe - plague kills 20-45 % of the world's population
- 1819- - 50 million deaths due to H1N1 spanish Flu
- 1831 - Cairo – 13 % of population developed cholera
- 1854-56 - Crimean war – deaths due to dysentery were 10 times higher than deaths due to casualties
- 1899-1902 - Boer War – deaths due to dysentery were 5 times higher than deaths due to casualties

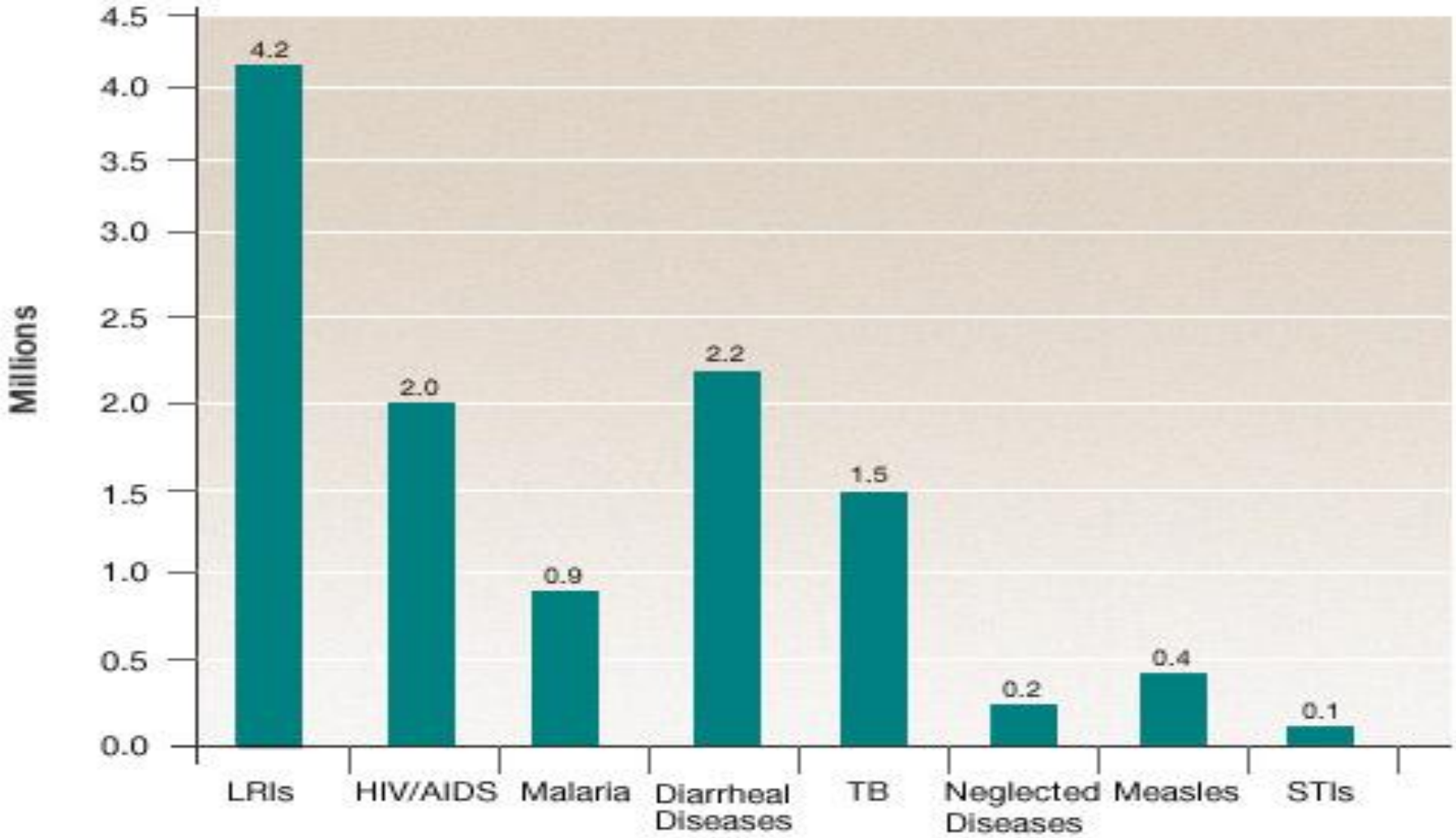
Millions of deaths, worldwide, all ages,



Adapted from WHO, 1999

CTLT

15 million deaths



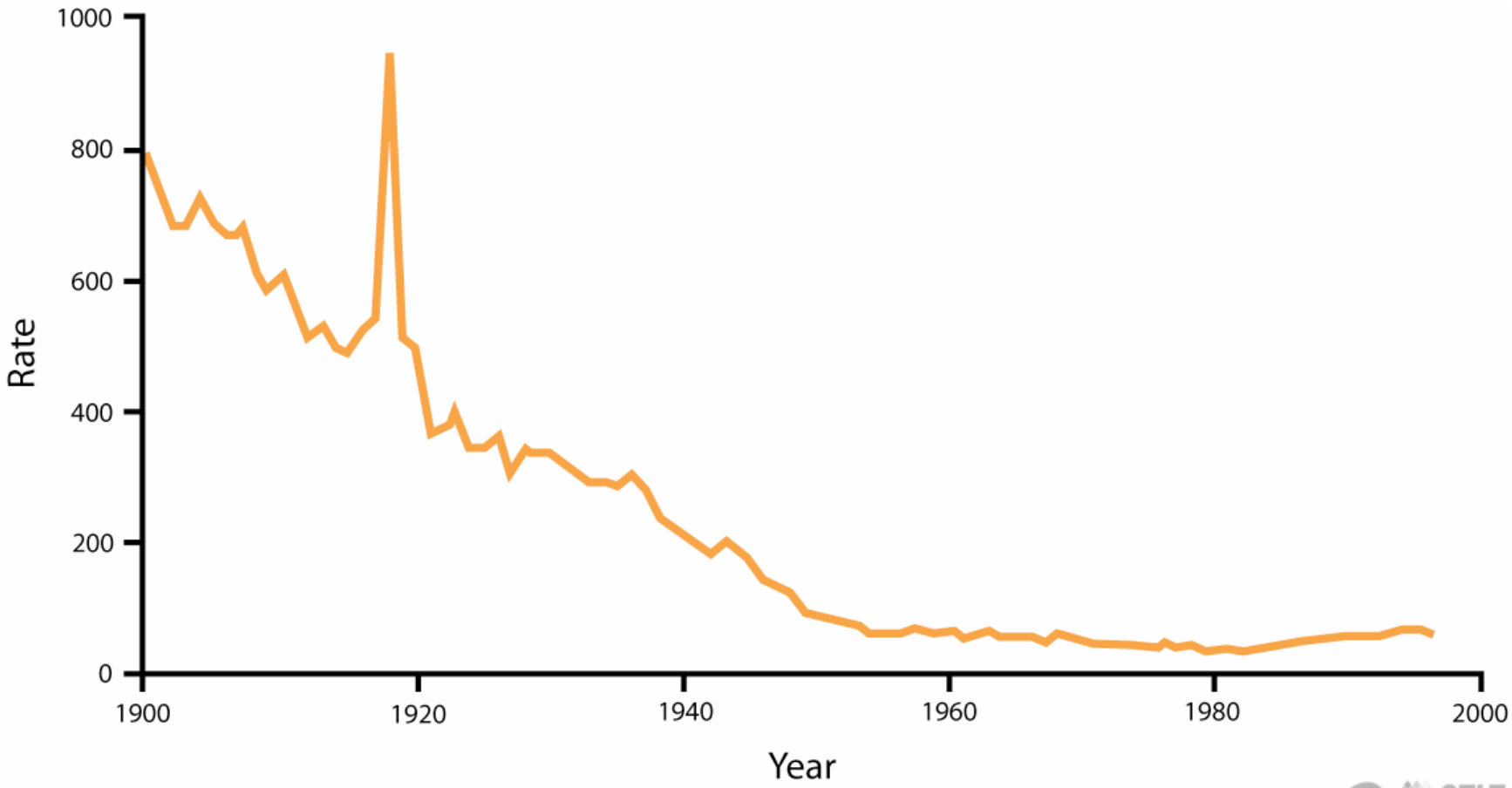
21st Century

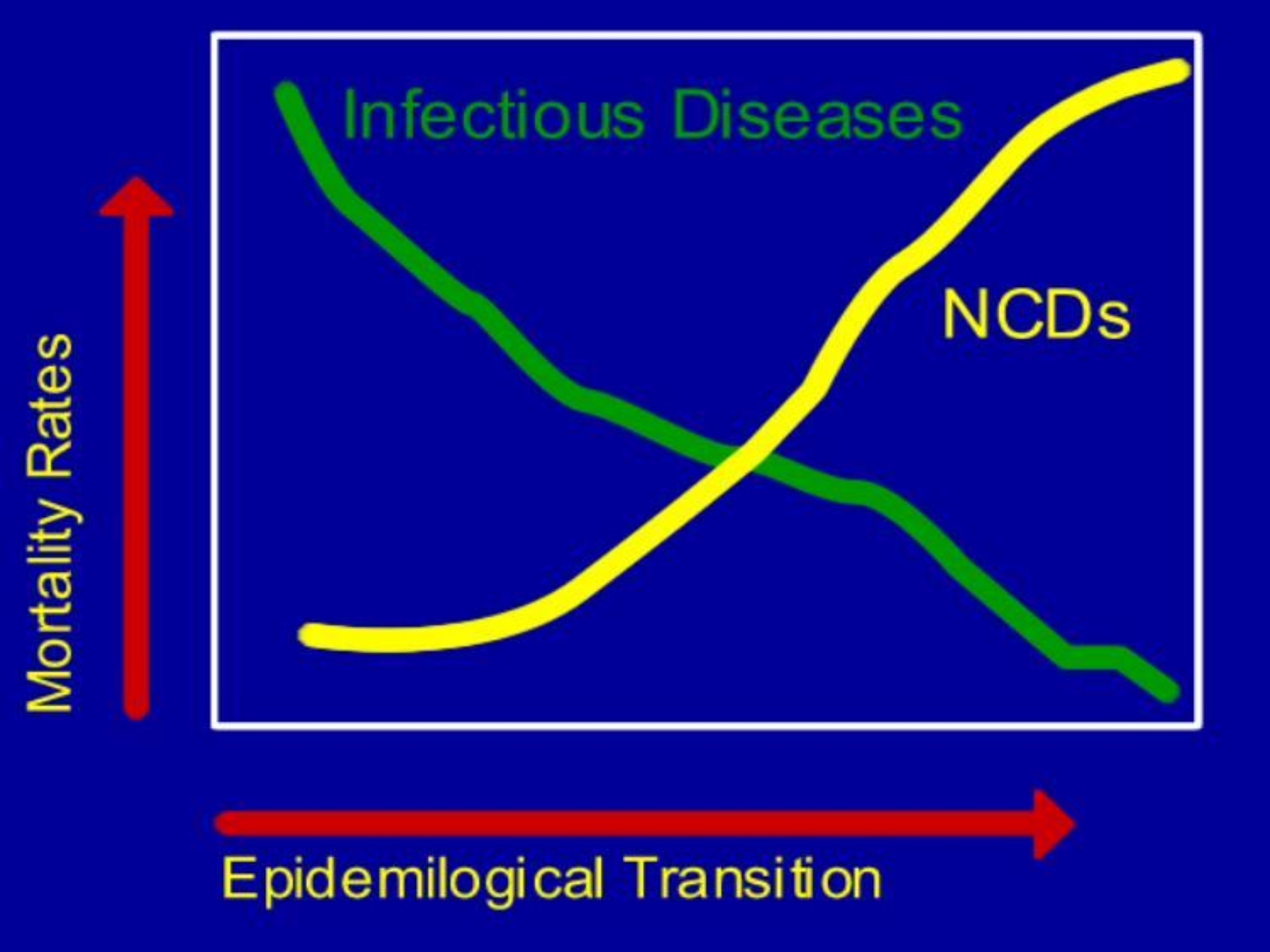
- Microbes are back in news particulary after COVID-19 pandemic
- Resistance
- Newer pathogens
- Changing environment – warming
- Bioterrorism

SUCCESSES

- Eradication of Smallpox in 1977
- Elimination of Poliomyelitis from the Western Hemisphere in 1994
- Potential elimination of global poliomyelitis in the next 5 to 10 years
- Potential elimination of measles in the next 10 to 20 years
- Vaccines in development for prevention of diarrheal diseases, cervical cancer (HPV)

Mortality due to infectious diseases




Infectious Diseases
NCDs
Mortality Rates
Epidemilogical Transition

CHALLENGES

- More pathogens have been identified than the drugs developed
- Many pathogens no longer respond to drugs
- Human activity has accelerated this imbalance
- HIV

Global Burden of infectious diseases

- **One death in three of the 54 million deaths** worldwide is from an infectious cause
- Virtually all of these deaths are in **developing areas** of the world – mainly India and sub-Saharan Africa
- Disproportionately affect **children**
- Many of the developing world deaths are due to **preventable** causes
  - Pneumonia and Diarrhea – account for 40% of these deaths
  - Tuberculosis
  - Measles
  - Malaria

Some Emerging Non- AIDS related Infectious Diseases

1. COVID-19
2. SARS
3. Variant CJD disease
4. Monkey pox
5. Ebola and Marburg viruses
6. Dengue
7. Influenza H5/N1 (?)
8. Hanta virus
9. *E. Coli O157 :H7*
10. Antibiotic-resistant
    - Pneumococci
    - *Staph-aureus*
    - Gonococci
    - Salmonella
11. Cryptosporidium
12. Anthrax
13. West Nile disease

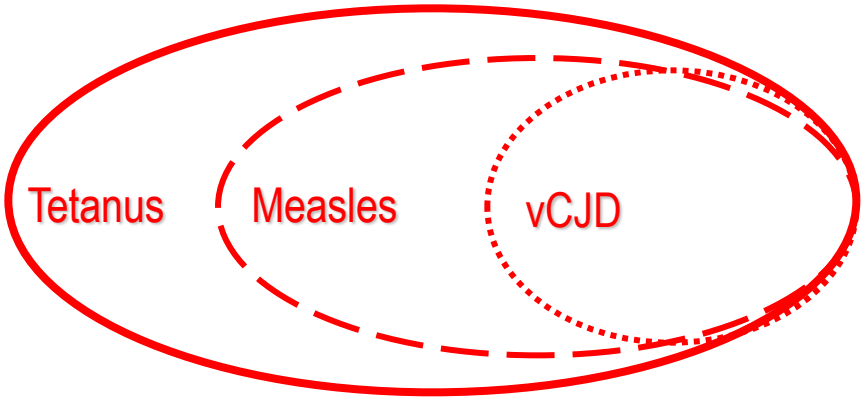
Factors Leading to Emergence of Infectious Diseases

- AIDS
- Population growth
- Speed and ease of travel
- Dam building
- Global climate change
- Increased antibiotic use for humans and animals
- Encroachment of human populations on forest
- Industrial commercial agriculture
- War and social disruption
- Relocation of animals
- Growth of daycare
- Aging of the population
- Human-animal contact

Epidemiology

- **Study of distribution & determinants of disease and health related events and its application in control and prevention.**

Infectious Disease



Definitions

- **Infectious diseases**
  - Caused by an infectious agent
- **Communicable diseases**
  - Transmission – directly or indirectly – from an infected person
- **Transmissible diseases**
  - Transmission – through unnatural routes – from an infected person

- from one patient to another through surgical instruments or tranplants.

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Table 14.12 Terms Used to Classify Infectious Diseases

Term	Definition
Acute disease	Disease in which symptoms develop rapidly and that runs its course quickly
Chronic disease	Disease with usually mild symptoms that develop slowly and last a long time
Subacute disease	Disease with time course and symptoms between acute and chronic
Asymptomatic disease	Disease without symptoms
Latent disease	Disease that appears a long time after infection
Communicable disease	Disease transmitted from one host to another
Contagious disease	Communicable disease that is easily spread.
Noncommunicable disease	Disease arising from outside of hosts or from opportunistic pathogen
Local infection	Infection confined to a small region of the body
Systemic infection	Widespread infection in many systems of the body; often travels in the blood or lymph
Focal infection	Infection that serves as a source of pathogens for infections at other sites in the body
Primary infection	Initial infection within a given patient
Secondary infection	Infections that follow a primary infection; often by opportunistic pathogens

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.

What is *infectious disease epidemiology?*

- **Two or more populations**
  - **Humans**
  - **Infectious agents**
    - **Helminths, bacteria, fungi, protozoa, viruses, prions**
  - **Vectors**
    - **Mosquito (protozoa-malaria), snails (helminths-schistosomiasis)**
    - **Blackfly (microfilaria-onchocerciasis) – bacteria?**
  - **Animals**
    - **Dogs and sheep/goats – *Echinococcus***
    - **Mice and ticks – *Borrelia***

What is *infectious disease epidemiology?*

- The cause often known
  - An infectious agent is a necessary cause

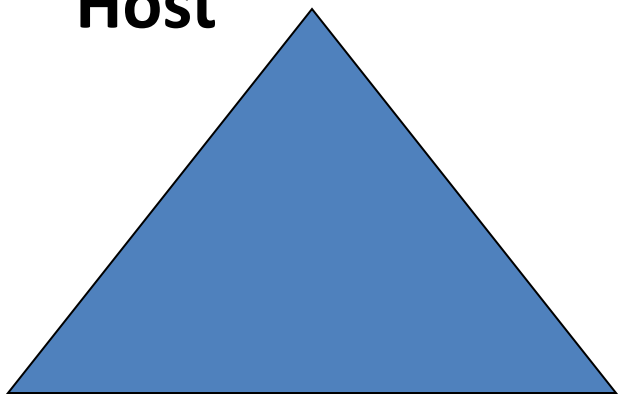
What is infectious disease epidemiology then used for?

- Identification of causes of new, emerging infections, e.g. HIV, vCJD, SARS
- Surveillence of infectious disease
- Identification of source of outbreaks
- Studies of routes of transmission and natural history of infections
- Identification of new interventions

Epidemiologic triad

Host

- **Demographic characteristics**
- **Biological characteristics**
- **Socioeconomic characteristics**



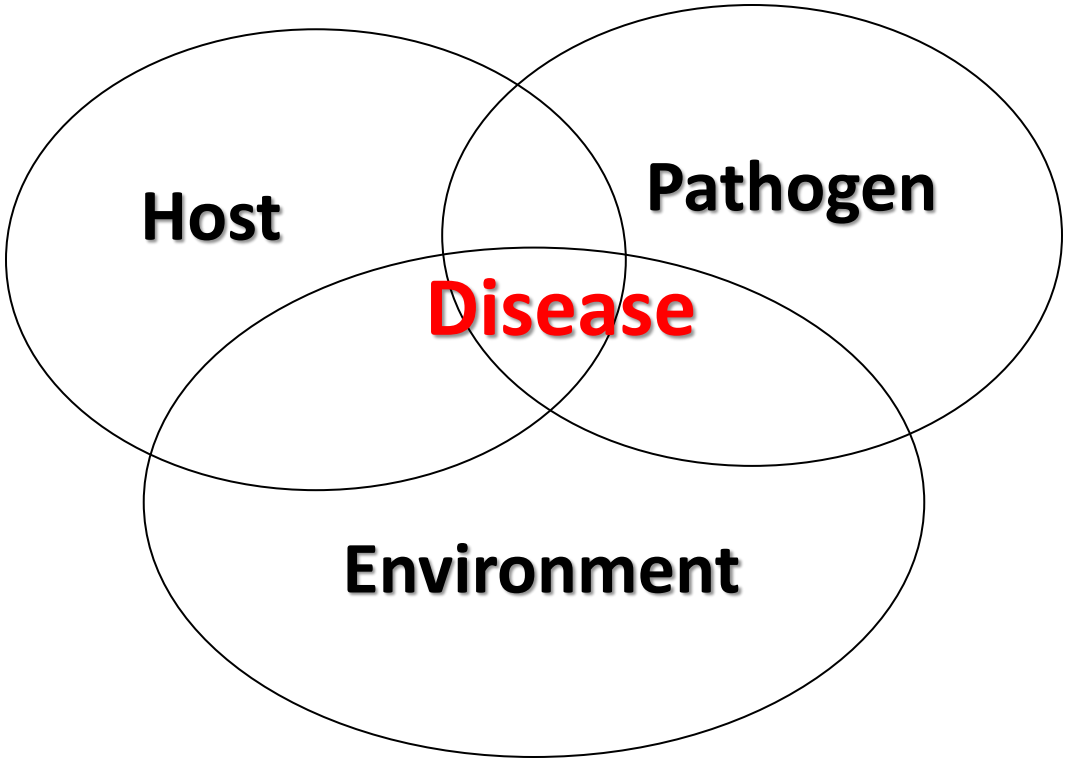
Agent

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

Environment

- **Physical environment**
- **Biological environment**
- **Social environment**

Infectious Disease Model



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.

Contagious disease

- A contagious disease is the one that is transmitted through contact.

Examples - scabies, trachoma, STD.

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)

Endemic - Epidemic - Pandemic

- Endemic
  - Transmission occur, but the number of cases remains constant
- Epidemic
  - The number of cases increases
- Pandemic
  - When epidemics occur at several continents – global epidemic

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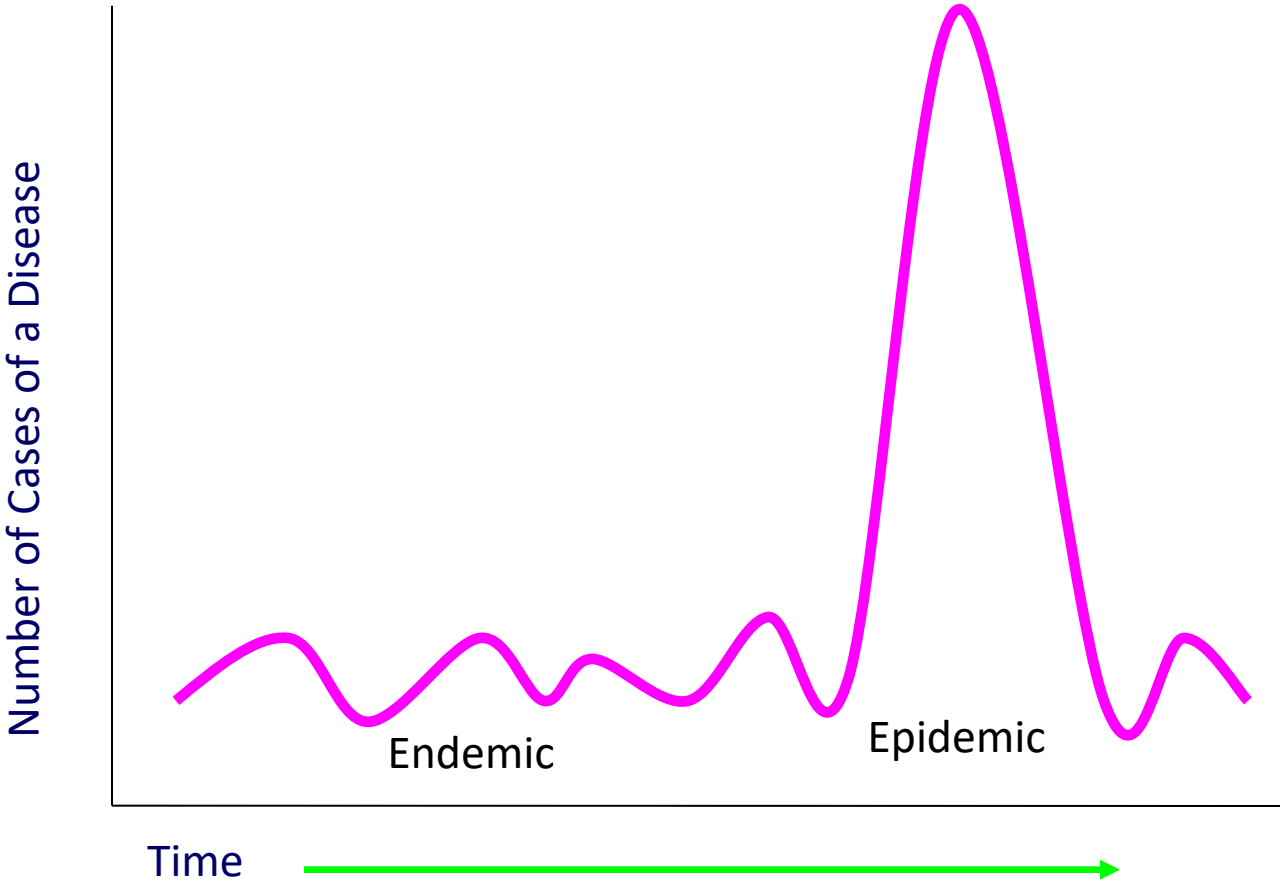
Endemic vs Epidemic



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)**

Sporadic

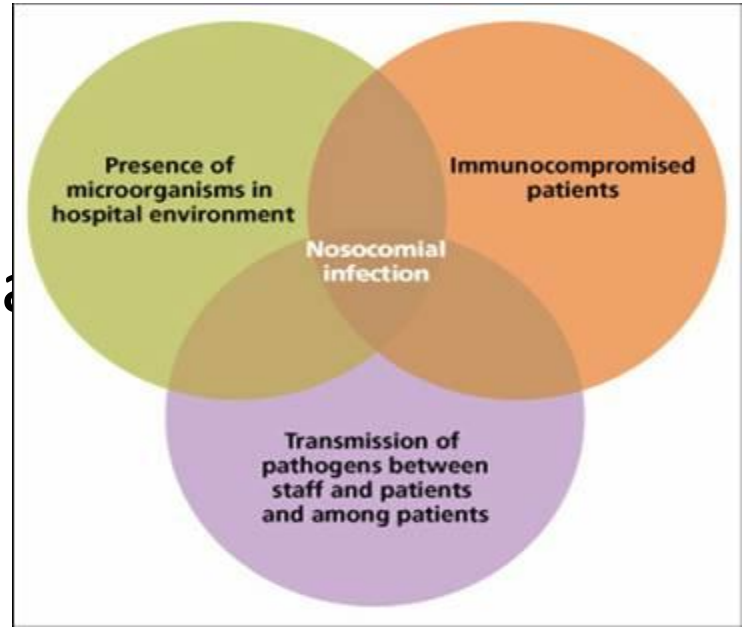
- The word sporadic means “scattered about”.
- Cases - irregularly, haphazardly and generally infrequently.
- Cases - few and separated widely in time and place e.g. polio, meningococcal meningitis, tetanus….
- May be starting point of an epidemic

Exotic

- **Exotic diseases** are those which are imported into a country in which they do not otherwise occur, as for e.g., rabies in the UK, Yellow fever in India

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. E.g. infection of surgical wounds, hepatitis B and urinary tract infections.

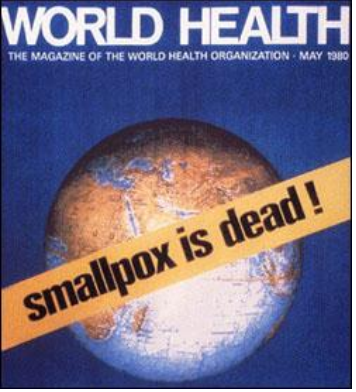


Opportunistic infection

- 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.
- E.g., opportunistic infections are very common in AIDS. Organisms include Herpes simplex, cytomegalovirus, M. tuberculosis etc.

Iatrogenic (Physician induced) Disease

- Any untoward or adverse consequence of a preventive, diagnostic or therapeutic regimen or procedure that causes impairment, handicap, disability or death resulting from a physician's professional activity or from professional activity of other health professionals.
- E.g., hepatitis B infection following blood transfusion.



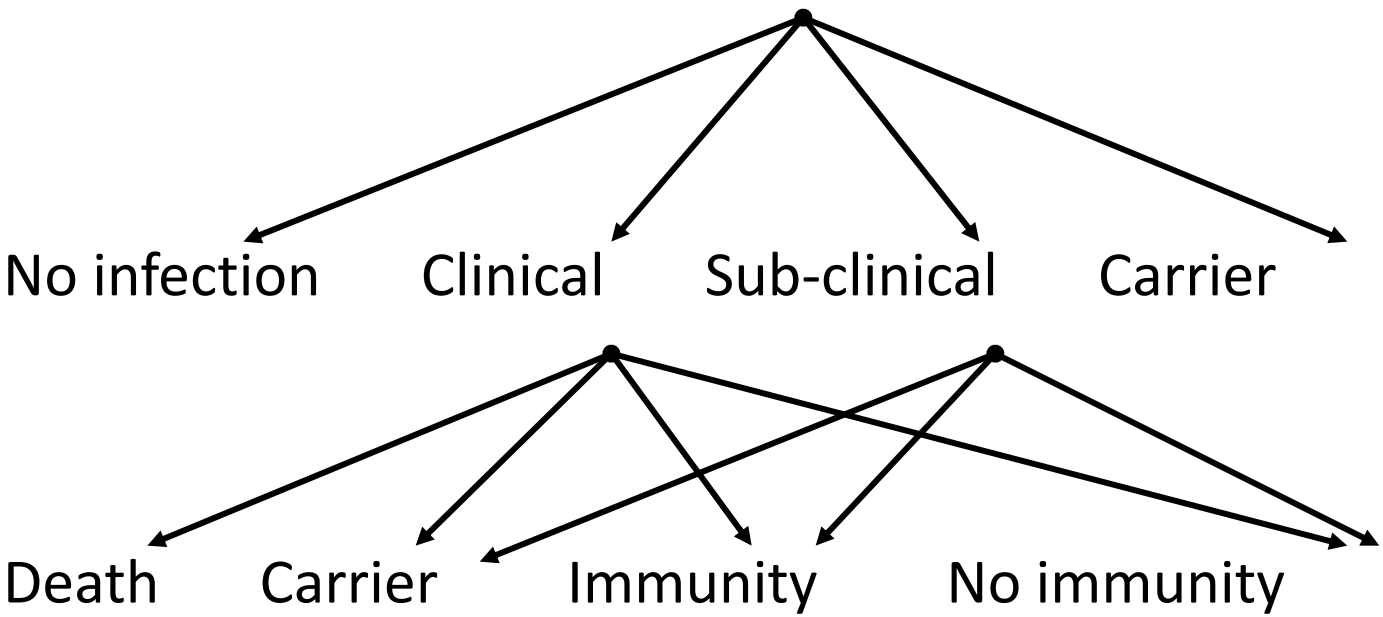
Eradication

- 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.

Elimination

- 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, leprosy and diphtheria.

Exposure to Infectious Agents



Outcome

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”

- **Index Case**
  - **Person that comes to the attention of public health authorities**
- **Primary Case**
  - **Person who acquires the disease from an exposure**
- **Secondary Case**
  - **Person who acquires the disease from an exposure to the primary case**
  - **Secondary attack rate**

Secondary attack rate

- The number of exposed persons developing the disease within the range of the incubation period, following exposure to the primary case.
- SAR = $\frac{\text{No. of exposed persons developing the disease within the range of incubation period}}{\text{Total no. of exposed / susceptible contacts}}$ **X 100**

Virulence and Case Fatality Rate

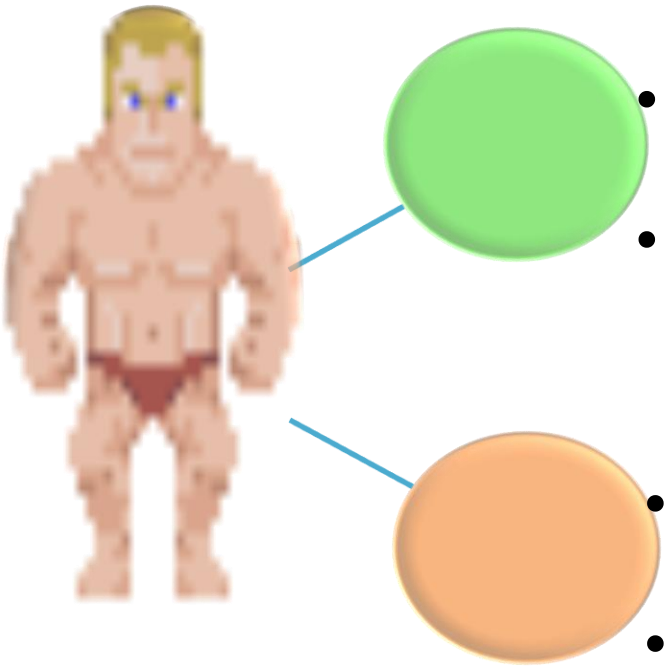
- **Virulence**
  - Degree of pathogenicity; the disease evoking power of a micro-organism in a given host.
  - Virulence can be measured experimentally by determining the number of bacteria required to cause death, illness, or lesions in a defined period after the bacteria are administered by a designated route.
  - Pathogenicity Numerically expressed as the ratio of the number of cases of overt infection to the total number infected.
  - When death is the only criterion of severity, this is the case fatality rate.

- **Case fatality rate**
  - Proportion of infected individuals who die of the infection. This is a function of the severity of the infection.

Case Fatality Rate

$$\text{Case fatality rate (\%)} = \frac{\text{Number of deaths due to disease}}{\text{Number of cases of disease}} \times 100$$

Host defences



- **Local**
- **Systemic**
- **Specific**
- **Non Specific**

Active Immunity
- Humoral
- Cellular
- Combination

Passive Immunity
- Normal human Ig
- Specific Human Ig
- Animal Antitoxins or Antisera

Epidemiologic Triad-Related Concepts

Infectivity (ability to infect)

(number infected / number susceptible) x 100

Pathogenicity (ability to cause disease)

(number with clinical disease / number infected) x 100

All are dependent on host factors

Predisposition to Infections
(Host Factors)

Gender

Genetics

Climate and Weather

Nutrition, Stress, Sleep

Smoking

Stomach Acidity

Hygiene

Community medicine S1

- Register your attendance with your university number
- Make sure that the settings of your phone allow tracking location

Go to settings > privacy> location> services> make sure that location services is ON

Community medicine S2

- Register your attendance with your university number
- Make sure that the settings of your phone allow tracking location

Go to settings > privacy> location> services> make sure that location services is ON

Community medicine S3

- Register your attendance with your university number
- Make sure that the settings of your phone allow tracking location

Go to settings > privacy> location> services> make sure that location services is ON

Community medicine S5

- Register your attendance with your university number
- Make sure that the settings of your phone allow tracking location

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Community medicine S6

- Register your attendance with your university number
- Make sure that the settings of your phone allow tracking location

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