

# Principles of Disease and Epidemiology (Chapter 14)

Lecture Materials

for

Amy Warena Czura, Ph.D.

Suffolk County Community College

Eastern Campus

Primary Source for figures and content:

Tortora, G.J. Microbiology An Introduction 8th and 9th ed. San Francisco: Pearson Benjamin Cummings, 2004 and 2007.

# PRINCIPLES OF DISEASE & EPIDEMIOLOGY

Pathology = study of disease:  
cause, development, & effects on host

Etiology = study of the cause of a disease

Epidemiology = study of when and where  
diseases occur and how they are  
transmitted

Pathogenesis = manner in which a disease  
develops

Infection = invasion or colonization by  
pathogenic microbes

Disease = change from a state of health

## Normal Microbiota/Normal Flora

-in utero: sterile

-once born microbes colonize

Human body =  $1 \times 10^{13}$  cells

has  $1 \times 10^{14}$  microbes in or on it

Normal flora = permanent residents that do not usually cause disease

e.g. *Staphylococcus* on epidermis and mucus membranes; *Escherichia* in colon

Microbial antagonism = normal flora prevent over growth of harmful microorganisms

e.g. vagina flora (*Lactobacillus*) create pH4 which inhibits *C. albicans*:  
disruption of flora or pH can lead to yeast infection (e.g. antibiotics).

*E. coli* in intestines produce bacteriocins that inhibit other bacteria like *Salmonella* (typhoid) & *Shigella* (dysentery)

Normal flora may inhibit potential pathogens:

1. Competing for nutrients
2. Producing toxins
3. Altering pH
4. Affecting O<sub>2</sub> availability
5. Occupying space

Relationship between host and normal flora is symbiosis (“living together”)

Most microbes are commensals

(commensalisms): microbe benefits,  
human is unaffected

Some are mutualistic (mutualism): both  
human and microbe benefit

e.g. *E. coli* synthesize vitamin K.

Disease causing microbes are parasites:  
microbe benefits, human is injured

## Opportunistic Pathogens:

- ordinarily do not cause disease in their normal habitat (commensals)
- in new habitat or immune compromised host, can cause disease

e.g. *Candida albicans*:

- 80% of population has it in the gut as commensal
- in vagina: can cause vaginitis
- can kill AIDS patients: systemic infection

# Etiology of Infectious Disease

Koch 1877:

- first to link a microbe with a particular disease
- studying Anthrax, proved *Bacillus anthracis* to be causative agent
- later showed tuberculosis to be due to *Mycobacterium tuberculosis*

## Koch's Postulates

1. The same pathogen must be present in every case of the disease
2. The pathogen must be isolated from the diseased host and grown in pure culture
3. The pathogen from the pure culture must cause the same disease when it is inoculated into a new healthy animal host
4. The pathogen must be isolated from the inoculated sick animal and must be shown to be the same original pathogen

## Exceptions to Koch's Postulates:

1. Some microbes cannot be cultured on artificial media  
e.g. *Mycobacterium leprae* – leprosy  
*Treponema pallidum* – Syphilis  
-must use other methods such as growth in animals or eggs or direct testing of patients to prove all have the same pathogen
2. One infectious disease can have multiple causes/pathogens  
e.g. pneumonia, meningitis
3. One pathogen can cause several disease conditions  
e.g. *Streptococcus pyogenes* = sore throat, Scarlet fever, skin infections, osteomyelitis, etc.

## 4. Ethical considerations

- some human diseases have no animal host  
e.g. HIV
- Can not infect humans on purpose to  
prove the agent causes disease  
e.g. HIV → AIDS

# *Classifying Infectious Disease:*

## 1. Patient Appearance

- A. Symptoms = subjective changes in body function e.g. pain
- B. Signs = objective changes in body function that can be measured e.g. lesions, fever
- C. Syndrome = specific group of symptoms & signs that may accompany a particular disease

## 2. Spreadability

A. Communicable disease = spreads from one host to another

e.g. herpes

B. Contagious disease = spreads **easily** from one person to another

e.g. chicken pox

C. Non-communicable disease = not spread from one host to another:

-either resident flora that becomes an opportunistic pathogen e.g. UTI,

-or accidental inoculation from environment e.g. tetanus

-rate of spread of contagious/communicable disease is determined by susceptibility of population

-immunization/vaccination: attempt to prevent spread

Herd immunity = enough immune people in the population to prevent the spread of disease

### 3. Occurrence

Incidence = number of people who develop the disease in a particular time frame (indicates rate of spread)

Prevalence = number of people who have the disease at one specified time (indicates how seriously and how long the disease affects the population)

A. Sporadic disease = occurs only occasionally in population

B. Endemic disease = constantly present in a population

C. Epidemic disease = many people in a given area acquire the disease in a short amount of time

D. Pandemic disease = worldwide epidemic

## 4. Severity and Duration

- A. Acute disease = develops rapidly, but lasts only a short time  
e.g. influenza, cold
- B. Chronic disease = develops slowly, may have mild symptoms or signs, but is continual or recurrent for a long time  
e.g. tuberculosis, hepatitis
- C. Subacute disease = intermediate between acute and chronic  
e.g. endocarditis
- D. Latent disease = agent remains inactive for a period of time, but then activates to cause disease  
e.g. shingles, herpes

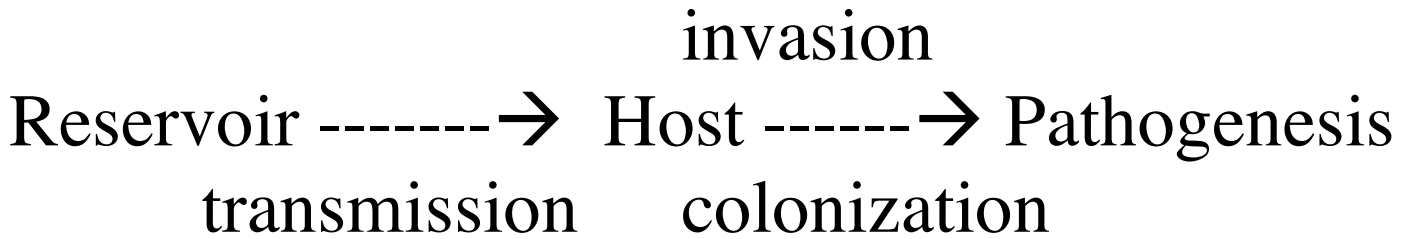
## 5. Extent of Host Involvement

- A. Local infection = microbe restricted to a particular location on the body  
e.g. abscesses
- B. Systemic infection = spread throughout the body by blood and/or lymph  
e.g. measles
  1. Bacteremia = bacteria in the blood
  2. Septicemia/sepsis = bacteria multiplying in the blood
  3. Toxemia = toxins in the blood
  4. Viremia = virus in the blood
- C. Focal infection = local infection that moves via blood or lymph to set up a new infection at another site  
e.g. tooth infection → rheumatoid arthritis

Primary infection = acute infection that causes initial illness

Secondary infection = caused by opportunistic pathogen as a result of primary infection  
(HIV) AIDS → *C. albicans* mycosis

# Patterns of Disease



## I. Development of disease

1. Incubation period = time between initial infection and appearance of signs or symptoms (might be contagious)
  - Time depends on the type of microbe, virulence, inoculum amount, and host resistance
2. Prodromal period = short, mild symptoms following incubation period
3. Period of illness = acute phase: overt signs and symptoms
  - Immune system either overcomes pathogen or person dies

4. Period of decline = signs and symptoms subside (feel better) but still prone to secondary infections

5. Period of convalescence = host returns to pre-disease state (might still be contagious)

-for some diseases, person is contagious from incubation to convalescence, for others only during illness

## II. Spread of Infection

1. Reservoir of infection = source of disease agent (microbe):

### A. Humans

1. Sick people = actively ill
2. Carriers = no symptoms/signs of disease
3. Latent infections = contagious during reactivation

### B. Animals

zoonoses = diseases that can be transmitted from animals to humans  
e.g. rabies, ringworm, spotted fevers

### C. Non-living

environmental: soil and water  
e.g. tetanus, cholera

## 2. Transmission

### A. Contact transmission

1. direct contact (person to person)  
e.g. STDs
2. indirect contact: reservoir to host via a fomite (a non-living object that transmits disease)  
e.g. syringe, surfaces
3. droplet transmission = mucus droplets from sneeze or cough

### B. Vehicle transmission = in a medium

1. water borne transmission
2. food borne transmission
3. airborne transmission  
(like droplet transmission but travels further than 1 meter, or on dust, or by spores)

C. Vectors = animals that carry pathogens from one host to another: mostly arthropods

1. mechanical transmission

-carry pathogens on body parts  
e.g. houseflies

2. biological transmission

-from bites: usually involves complex life cycle of pathogen cycling between vector and host

## Nosocomial Infections

- acquired as a result of hospital stay
- 4th leading cause of death in U.S.

Result from:

1. Microbes in hospital environment
    - reservoir of opportunistic pathogens & antibiotic resistant pathogens
  2. Compromised status of host
    - patients have reduced ability to resist disease
  3. Chain of transmission
    - fomites covered in microbes
    - health care workers: fail to wash between patients
- \*Aseptic technique and hand washing most important to stop spread of nosocomial infections!

# Epidemiology

- study of where and when diseases occur and how they are transmitted
- important for disease control in populations

Epidemiologists identify:

1. when the disease occurs
2. to whom (age, race, class etc.)
3. mode of transmission
4. reservoirs
5. effective methods of control
6. plans to prevent future outbreaks

# Centers for Disease Control and Prevention (CDC)

-Monitors U.S. population for disease and publishes weekly reports (MMWR) on notifiable diseases:

1. Morbidity = number of people in population affected/infected
2. Mortality = number of deaths

-trends are monitored and quarantines issued to prevent epidemics

Notifiable diseases = contagious, deadly, diseases doctors must report

e.g. Hepatitis, HIV, Lyme disease

complete list at <http://www.cdc.gov>