CHAPTER 3

Infectious Diseases
Infectious Diseases

- Over 160,000 people in the US die yearly from an infectious disease as the underlying cause of death
- According to a study done by University of Arizona- the kitchen sponge holds the greatest number of microorganisms of any objects in the home
Facts

- More than 200 diseases are transmitted through food
- When you sneeze, germs can travel at 80 mph across the room
- A kitchen cutting board harbors 400 times more bacteria than the avg toilet seat
- The avg desk harbors 400 times more bacteria than the avg toilet seat
- An avg of only 1 in 6 people wash hands after using the restroom
- After using the restroom, a single hand can have a population count of more than 200 million bacteria per square inch
Infectious Disease

- **Contagious or Communicable** – transmitted from human to human

- **Noncommunicable** – not transmitted directly from humans
Infectious Disease (cont.)

- **Epidemiology** is the study of the transmission, occurrence, distribution and control of disease.

  John Snow is the “father of epidemiology.

  The field of epidemiology began to flourish after World War II

- Comes from Greek words
  - **epi**, meaning “on or upon”
  - **demos**, meaning “people”
  - **logos**, meaning “the study of”
John Snow’s Famous Soho Map
Population or community health assessment

- What are the actual and potential health problems in the community?
- Where are they?
- Who is at risk?
- Which problems are declining over time?
- Which ones are increasing or have the potential to increase?
- How do these patterns relate to the level and distribution of services available?
When physicians diagnose a case of a reportable disease they send a report of the case to their local health department.

- Time - when the case occurred
- place - where the patient lived
- person - the age, race, and sex of the patient

*Health departments convert the case counts into rates, which relate the number of cases to the size of the population where they occurred*
Types of Epidemiology

- **Descriptive** - organize and summarize data according to time, place, and person
- **Acquired** - immunity and marital status
- **Person** - age, race, and sex
- **Activities** - occupation, leisure, use of med/drugs/tobacco
- **Conditions under which people live** - socioeconomic and access to medical care
- **Analytic** - used to search for causes and effects (why and how)
- **Experimental** - determine exposure status for each individual or community
- **Observational** - observe exposure and outcome status of each study participant (control group vs. exposed group)
Epidemic Disease Occurrence

- Level of Disease - amount of a particular disease that is usually present in a community

- Sporadic
- Endemic
- Epidemic
- Pandemic

Increasing amount of disease
Infectious Disease (cont.)

- **Incidence** is the number of new cases of a disease in a population.
- **Prevalence** is the number of existing cases.
- **Sporadic** - irregular pattern of occurrence, with occasional cases occurring at irregular intervals.
- A disease is **endemic** when it always occurs at low levels in a population.
- A disease is an **epidemic** if it occurs in unusually large numbers over a specific area.
- A **pandemic** is when an epidemic has spread to include large areas worldwide.
Transmission of Disease

- **Reservoir** is the source of an infectious agent. Examples include humans, animals, insects, soil, and water.

- **Horizontal transmission** happens when an infectious disease is transmitted directly from an infected person to a susceptible person.
Transmission of Disease (cont.)

- **Vertical transmission** occurs from one generation to the next.
- **The parenteral** route of transmission occurs through a port of entry.
- **Fomites** are inanimate objects that are contaminated by direct contact with the reservoir.
Chain of Infection

- Reservoir
- Mode of Transmission
- Susceptible Host
- Mode of Transmission
Chain of Infection

- **reservoir** of an agent is the habitat in which an infectious agent normally lives, grows, and multiplies.

- **Portal of exit** is the path by which an agent leaves the source host.
Chain of Infection

• Modes of transmission
  – Direct – immediate transfer of the agent from a reservoir to a susceptible host by direct contact or droplet spread
    ▪ Direct contact
    ▪ Droplet spread
  – Indirect – an agent is carried from a reservoir to a susceptible host by suspended air particles or by animate (vector) or inanimate (vehicle) intermediaries
    ▪ Airborne
    ▪ Vehicleborne
    ▪ Vectorborne
    ▪ Mechanical
  – Biologic
Chain of Infection

• Portal of entry – means by which an agent enters a susceptible host

• Host – individual infected with the agent
The Chain of Infection

- **Reservoir Host**
- **Susceptible Host**
- **Infectious Agent**
- **Portal of Entry**
- **Mode of Transmission**
- **Portal of Exit**

TIEX
Prions -

transmissible spongiform encephalopathies (TSEs)

- An infectious agent composed only of protein.
- All known prion diseases affect the structure of the brain or other neural tissue by inducing abnormal folding of normal cellular proteins in the brain.
- Usually progress rapidly and are currently untreated and fatal
- CJD disease
Prion Theory

The Prion Theory

It is widely (though not universally) accepted that mad cow and other wasting diseases of the brain—scrapie, kuru, Creutzfeldt-Jakob disease—are caused not by bacteria or viruses but by rogue proteins called prions.

Mad-cow disease starts when molecules in a nervous-system protein called PrP become abnormally folded. When an abnormal PrP touches normal PrPs, they refold to match the abnormal ones, forming new prions. Eventually, brain cells become clogged with abnormal proteins.

Prions can arise spontaneously, through mutation, but they can also be passed along when an animal or human eats infected nervous-system tissue. And unlike viruses or bacteria, prions can't be destroyed by cooking.

For championing this theory, often in the face of ridicule, Dr. Stanley Prusiner of the University of California, San Francisco, won the 1997 Nobel Prize.
Virus

- Core genetic material (RNA or DNA) enclosed in a capsid (protein coat)
- Does not independently grow, metabolize, or reproduce
- Carries out life processes by entering cells and directing energy, materials, and organelles or by causing cells to lyse (rupture) as in HIV
- Responsible for acute and latent infections as in herpes infections
Bacteria

- Small size, no nucleus or membranous organelles
- Cell wall
  - Cocci
  - Bacilli
  - Spirilla
  - Vibrios
- Gram-positive
- Gram-negative
Figure 3-1: Pathogenic organisms include bacteria (A), viruses (B), protozoa (C), and helminths, or worms (D).
Figure 3-2A: Gram-stained bacteria on a microscope slide. Red rod-shaped cells are Escherichia coli. (Courtesy of the CDC, 1979.)
Figure 3-2B: Blue-purple cocci are Staphylococcus aureus. (© SIU BioMed/Custom Medical Stock Photo.)
Bacterial Reproduction – Illness

- **Binary fission**
- **Endospores** – genetic material resistant to dessication
- **Endotoxin** – causes life-threatening shock
- Bacteria are able to adapt and survive in a number of different environments.
Protozoa

- Eukaryotic microorganisms
- Larger than bacteria with complex internal structures
- Classified as amoeboids, flagellates, ciliates, and sporozoans
Fungi

- Multicelled organisms
- Contain polysaccharide – chitin
- Reproductive structures – spores
- Cause disease by interfering with normal organ structure and function or by inflammation or allergy
Helminths

- Roundworms, flatworms
- Well developed reproductive systems
- Complex life cycle
- Infections are called infestations
Roundworms

• Round in cross section
• Include: filarial (infect lymphatics), large (infect the intestines)
• Examples: *Ascaris, Enterobius*
Figure 3-3: Ascaris. (Sinclair Stammers/Science Photo Library/Photo Researchers, Inc.)
Figure 3-4: Ascaris. Necator americanus. The cutting plates around the mouth are used to tear open blood vessels of the host. (David Scharf/Peter Arnold, Inc.)
Figure 3-5: Adult Enterobius vermicularis. (Newscom/Custom Medical Stock Photo.)
Flatworms

- Flattened bodies examples: *Schistosoma* *Taenia*
- Cause disease by using host nutrients or by feeding on host blood causing anemia and severe inflammatory responses
<table>
<thead>
<tr>
<th>Disease</th>
<th>Number of Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower respiratory infections</td>
<td>3.9 million</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>2.8 million</td>
</tr>
<tr>
<td>Diarrheal diseases</td>
<td>1.8 million</td>
</tr>
<tr>
<td>Tuberculosis</td>
<td>1.6 million</td>
</tr>
<tr>
<td>Malaria</td>
<td>1.2 million</td>
</tr>
<tr>
<td>Measles</td>
<td>0.6 million</td>
</tr>
</tbody>
</table>

Nosocomial Infections

• Also called hospital-acquired infections
• The principal routes of transmission are direct contact transmission from healthcare staff to patient and indirect contact transmission through fomites and the hospital’s ventilation system.
Reasons Nosocomial Infections are higher in developing countries

- Lack of supervision
- Poor infection practices
- Inappropriate use of limited resources
- Overcrowding in hospitals
What increases your risk?

- Burns
- Surgical wounds
- Injections
- Invasive procedures
- Ventilators
- IV therapy
Prevention of MRSA
Methicillin-resistant *Staphylococcus aureus*

- Correct usage of antibiotics
- Appropriate antibiotics used
- Take entire amount antibiotics
Antibiotics – Mechanism of Action

- Target bacterial cell wall
- Target cell membrane
- Inhibit protein synthesis targets in bacterial machinery
- Interfere with bacterial metabolism,
- DNA and/or RNA synthesis
Click [here](#) to view an animation showing penicillin.

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Antivirals

- Nucleic acid analogues mimic correct DNA or RNA bases.
- Interfere with assembly of new virus particles within the cell or interfere with the attachment of viruses to host cells

Reduces the number of viruses reproduced
Antibiotics- NOT used for virus

1. Virus does not have a cell wall
2. Virus uses a host cell to produce protein and synthesize RNA or DNA

<table>
<thead>
<tr>
<th>Illness</th>
<th>Usual Cause</th>
<th>Antibiotic Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold</td>
<td>✔️ Virus</td>
<td>No</td>
</tr>
<tr>
<td>Flu</td>
<td>✔️ Virus</td>
<td>No</td>
</tr>
<tr>
<td>Chest Cold (in otherwise healthy children and adults)</td>
<td>✔️ Virus</td>
<td>No</td>
</tr>
<tr>
<td>Sore Throats (except strep)</td>
<td>✔️ Virus</td>
<td>No</td>
</tr>
<tr>
<td>Bronchitis (in otherwise healthy children and adults)</td>
<td>✔️ Virus</td>
<td>No</td>
</tr>
<tr>
<td>Runny Nose (with green or yellow mucus)</td>
<td>✔️ Virus</td>
<td>No</td>
</tr>
<tr>
<td>Fluid in the Middle Ear (otitis media with effusion)</td>
<td>✔️ Virus</td>
<td>No</td>
</tr>
</tbody>
</table>
Antifungals

- Target cell walls and membranes
- Affect human cells, therefore may be toxic
- Topical agents are effective for skin infections and pose fewer risks
Antiprotozoals

- Interfere with protein synthesis and metabolism
- Sensitive to medications that paralyze protozoal muscles or interfere with carbohydrate metabolism
- Resistant microorganisms evolve, rendering existing treatments useless
Vaccination

- The presentation of antigens from a microorganism to provoke an immune response
- Contain dead bacteria, extracted antigens, deactivated toxins, viral particles, or genetically engineered proteins
- Have been used to eliminate disease
Emerging Infectious Disease

- Tuberculosis- (re-emerging)
- Antibiotic resistance
- Changes in climate, urbanization, crowding, increased incidence of chronic disease, fast world travel, disruption of social government structure; play a role in emerging, re-emerging and endemic disease
Common Childhood Vaccine-Preventable Infectious Diseases

- Mumps
- Rubella
- Diphtheria
- Tetanus
- Chickenpox
- Poliomyelitis
Figure 3-6: Measles rash. (© Lowell Georgia / Science Source / Photo Researchers, Inc.)
Figure 3-7: Chickenpox rash. (Ace Photo Agency / Phototake NYC)
Click [here](#) to view a video showing how to collect specimens.
Click [here](#) to view a video on the topic of sanitation, disinfection, and sterilization.

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<table>
<thead>
<tr>
<th>Microbe</th>
<th>Type</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotavirus</td>
<td>Bacterium</td>
<td>Infantile diarrhea</td>
</tr>
<tr>
<td>Ebola virus</td>
<td>Virus</td>
<td>Acute hemorrhagic fever</td>
</tr>
<tr>
<td><em>Legionella pneumophila</em></td>
<td>Bacterium</td>
<td>Legionnaires' disease</td>
</tr>
<tr>
<td>Human T-lymphotrophic virus I</td>
<td>Virus</td>
<td>T-cell lymphoma/leukemia</td>
</tr>
<tr>
<td>Toxin-producing <em>Staphylococcus aureus</em></td>
<td>Bacterium</td>
<td>Toxic shock syndrome</td>
</tr>
<tr>
<td><em>Escherichia coli</em> 0157:H7</td>
<td>Bacterium</td>
<td>Hemorrhagic colitis; hemolytic uremic syndrome</td>
</tr>
<tr>
<td><em>Borrelia burgdorferi</em></td>
<td>Bacterium</td>
<td>Lyme disease</td>
</tr>
<tr>
<td>Human immunodeficiency virus</td>
<td>Virus</td>
<td>Acquired immunodeficiency syndrome</td>
</tr>
<tr>
<td><em>Helicobacter pylori</em></td>
<td>Bacterium</td>
<td>Peptic ulcer disease</td>
</tr>
<tr>
<td>Hepatitis C</td>
<td>Virus</td>
<td>Hepatitis</td>
</tr>
<tr>
<td><em>Vibrio cholerae</em> 0139</td>
<td>Bacterium</td>
<td>Cholera</td>
</tr>
<tr>
<td>Hanatvirus</td>
<td>Virus</td>
<td>Respiratory distress syndrome</td>
</tr>
<tr>
<td>Cryptosporidium</td>
<td>Protozoa</td>
<td>Enteric disease</td>
</tr>
<tr>
<td>rvCJD</td>
<td>Prion</td>
<td>New variant Creutzfeldt-Jakob disease</td>
</tr>
<tr>
<td>HVN1</td>
<td>Virus</td>
<td>Influenza</td>
</tr>
<tr>
<td>Nipah</td>
<td>Virus</td>
<td>Severe encephalitis</td>
</tr>
<tr>
<td>SARS coronavirus</td>
<td>Virus</td>
<td>Severe acute respiratory syndrome</td>
</tr>
</tbody>
</table>

Table 3-2: Examples of Pathogenic Microbes Identified since 1973
<table>
<thead>
<tr>
<th>Microbe</th>
<th>Type</th>
<th>Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paramyxovirus</td>
<td>Virus</td>
<td>Mumps</td>
</tr>
<tr>
<td>Prion</td>
<td>Prion</td>
<td>Prion disease</td>
</tr>
<tr>
<td><em>Streptococcus, group A</em></td>
<td>Bacterium</td>
<td>Strep throat, impetigo</td>
</tr>
<tr>
<td><em>Staphylococcus aureus</em></td>
<td>Bacterium</td>
<td>Pneumonia, meningitis</td>
</tr>
<tr>
<td><em>Clostridium difficile</em></td>
<td>Bacterium</td>
<td>Colitis</td>
</tr>
<tr>
<td>Enterovirus 71</td>
<td>Virus</td>
<td>Hand, foot, mouth disease</td>
</tr>
<tr>
<td><em>Coccidioides immitis</em></td>
<td>Fungus</td>
<td>Valley fever</td>
</tr>
<tr>
<td><em>Mycobacterium tuberculosis</em></td>
<td>Bacterium</td>
<td>Tuberculosis</td>
</tr>
<tr>
<td><em>Vibrio cholerae</em></td>
<td>Bacterium</td>
<td>Cholera</td>
</tr>
<tr>
<td><em>Plasmodium</em></td>
<td>Protozoa</td>
<td>Malaria</td>
</tr>
<tr>
<td>Dengue virus</td>
<td>Virus</td>
<td>Dengue hemorrhagic fever</td>
</tr>
</tbody>
</table>

**Table 3-3: Re-emerging Pathogens**
Examples of Emerging and Re-Emerging Diseases

- Vancomycin-resistant Staphylococcus aureus
- Cryptosporidiosis
- Multidrug-resistant tuberculosis
- Drug-resistant malaria
- E. coli 0157:H7
- Cyclosporiasis
- Typhoid fever
- Diphtheria
- Rift Valley Fever
- H5N1 avian influenza
- E. coli 0157:H7
- v-CJD
- HIV
- Plague
- Human monkeypox
- Dengue hemorrhagic fever
- Cholera
- Lassa fever
- Ebola hemorrhagic fever
- Hantavirus pulmonary syndrome