EESA10 - Final Notes

Human Health and Environment (University of Toronto)

Lecture 7 – Biological Hazards and Human Health

Infectious Disease

- Infectious disease is host-centered concept
  - Human body is a habitat and host to many organisms
- Associations that harm or bother use are infectious diseases, agents are pathogens
- Zoonosis – infectious disease transmissible to humans from other animals

Types of Pathogens

Worms – multicellular and parasitic

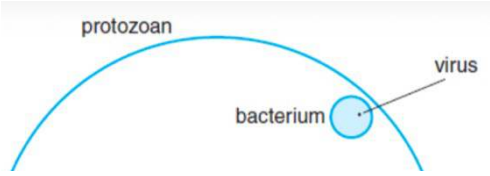
Protozoa – unicellular and parasitic

Bacteria – unicellular and mostly not parasitic

- Aerobic vs. anaerobic; or tolerate either
- Some form spores depending on the habitat (pH balance etc.)

Viruses – strand of DNA or RNA and parasitic

Figure 1 - Protozoan is the biggest, then bacterium then virus



The Body's Defence Against Pathogens

- Immune system distinguishes "self" from "foreign"
  - Active immunity – on first exposure to antigen, body produces antibodies
- Vaccination
  - Antigen preparation → active immunity (prepares antibodies, weak infection agents)
  - Antibody preparation → passive immunity
- Herd immunity – practical protection
  - If enough members of a group are immune, hard to maintain chain of infection

Evolution of Strategies for Managing Transmission of Disease

1. Segregation of sick or exposed persons
   - Isolation: the separation of persons who have infectious illness
   - Quarantine: the separation of persons who have been exposed to an infectious agent
2. Sanitation: misguided but beneficial
3. Vaccination to prevent illness
4. Antibiotics to treat illness
   - Populations of pathogens become resistant over time
   - Methicillin-resistant staphylococcus aureus (MRSA)
   - High reproductive rate allows them to become genetically resistant quickly
   - Overuse of antibiotics (antibiotics in food additives to boost livestock)
5. Pesticides to control vectors

Transmission of Infectious Disease

1. Transmission through closeness/contact
   - Droplet transmission: coughing, sneezing
     - Diphtheria, TB, pertussis; influenza and MMR
   - Direct oral contact
     - Strep, herpes simplex-1, infectious mononucleosis
   - Transmission by fomite (object or substance capable of carrying infectious organisms)
     - Skin cells, hair, clothing and bedding
2. Airborne transmission in aerosols (distinct from droplet transmission)
3. Fecal-Oral transmission of diarrheal disease
   - Fecal-oral pathway: one person's infectious diarrheal disease become next person's disease of fecal origin
   - If sewage is not well controlled, waterborne transmission dominates
   - Fecal-oral transmission also via soil and by hand-to- mouth transmission

- Cholera, typhoid fever, dysentery; giardiasis, cryptosporidium (zoonoses); hepatitis A, Norwalk virus and polio

4. Non-fecal organisms also transmitted in water or soil
    - Guinea worm disease, tetanus and via food (foodborne transmission) like housefly as mechanical vector

Global Patterns of Infectious Disease Mortality

- Fast global spreading (traveling)
- Total ~12.3 million deaths in 2008
    - Respiratory infections (29%), diarrheal disease (20%), and HIV/AIDS (14%) are leading infectious causes of death
- Worldwide, 22% of all deaths in 2008
    - Highest in Africa (53%), Southeast Asia (27%), and Eastern Mediterranean (25%)

Infectious Disease as a Cause of Cancer

- Infection can increase cancer risk (ex. Chronic irritation → cell proliferation)
- Known infections causes of cancer account for 18% of cancer worldwide
    - Liver (hep B and hep C viruses, liver fluke)
    - Cervix (HPV)
    - Stomach (Heliobacter Pylori bacterium)
- Higher percentage in lower income countries

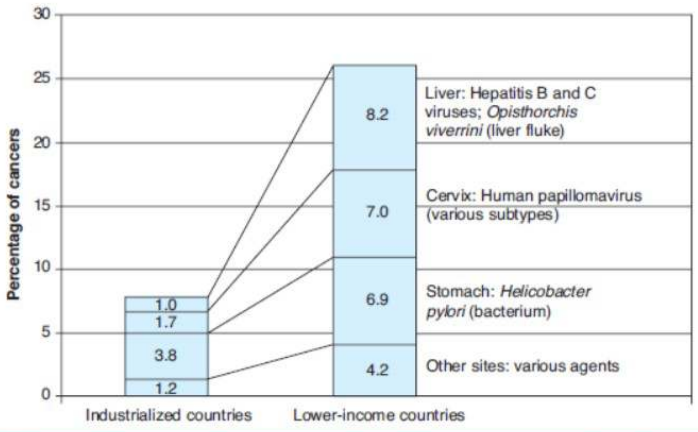


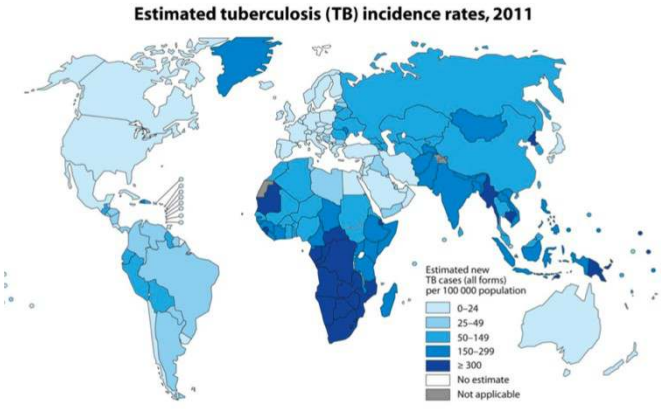
FIGURE 3.15 Percentage of cancers caused by infectious agents in industrialized and lower-income countries.

Some Important Types of Pathogens

- Bacteria (TB, Anthrax and Plague)
- Viruses (Yellow fever, HIV, bird flu and west nile virus)
- Protozoa (Malaria)

Bacterial Diseases

1. Tuberculosis is one of the wold's deadliest diseases



    - 1/3 of the world's population is infected with TB
    - In 2011, nearly 9 million people around the world became sick with TB
    - There were around 1.4 million TB-related deaths worldwide
    - TB Is a leading killer of people who are infected with HIV
    - Differences in health care systems
    - Most commonly attacks the lungs
    - Symptoms include; chest pain, coughing up blood, and a productive, prolonged cough for more than three weeks, fever, chills, night sweats, appetite loss, weight loss, paleness, and often a tendency to fatigue very easily
    - Transmissions – cough, sneeze, speak, kiss or spit of ill person
2. Anthrax
    - Bacillus anthracis (large, spore forming bacteria producing toxins)
    - All forms may lead to septicemia and death
    - Bioterrorism related; no smell or taste, too small to be seen by the naked eye

- Cannot be transmitted from person to person
- 3 major clinical forms; cutaneous (skin), inhalation or gastrointestinal

Cutaneous Anthrax

- The most common naturally occurring type (>95% of the time)
- After skin contact with contaminated meat, wool or leather from infected animals
- The incubation period ranges from 1 - 12 days
- Begins as a small raising bump, progresses into vesicle and then a painless ulcer
- Fever, headache, and lymph glands swell
- 20 % of untreated cases results in death

Inhalation Anthrax

- The most lethal form, inhalation of spores of anthrax
- Incubation period of 1 – 60 days
- Starts as viral respiratory illness: sore throat, mild fever, and muscle aches
- Many progress to respiratory failure and shock with developing meningitis
- 75% of cases result in death even with all possible interventions

Gastrointestinal Anthrax

- Consumption of raw/undercooked contaminated meat
- Incubation period of 1 – 7 days
- Nauseas, loss of appetite, vomiting and fever followed by abdominal pain, vomiting of blood and bloody diarrhea
- 25-60% of cases result in death
- Effect of early treatment is not defined

Bioterrorism Related Anthrax

- Mixed with powder to transport the bacteria
- Suspicious mail, if you get a suspicious letter/parcel; send for environmental testing, diagnosis and cure with antibiotics and vaccine

3. Plague
   - Caused by a bacterium called Yersinia pestis, can be used as a bioweapon, you need antibiotics, no vaccine

Bubonic Plague

- Most common form
- When a person is bitten by a flea that had been infected by biting an infected rodent
- Also, through a break in a person's skin
- Swollen, tender lymph glands (called buboes), fever, headache, chills and weakness
- Does not spread from person to person

Pneumonic Plague

- Infection of lungs
- From person (or animal) to person through the air
- Complication of bubonic plague

Septicemic Plague

- When plague bacteria multiply in the blood
- Complications of pneumonic or bubonic plague or it can occur by itself
- Some symptoms as bubonic but not buboes
- Does not spread from person to person

Viral Diseases

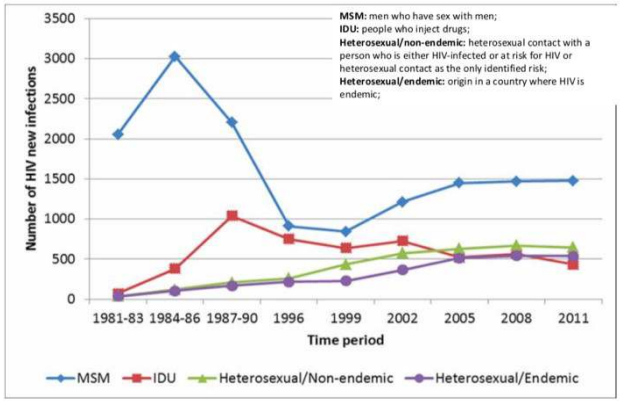
1. Yellow Fever
   - Caused by a virus, mosquitoes transmit yellow fever to humans

- Incubation period of 3-6 days
- First phase of symptoms: fever, muscle pain, backache, headache and vomiting
- 85% of victims recover after the first phase
- **aedes aegypti, the mosquito vector for yellow fever**
- Other unfortunate victims develop the toxic phase with; jaundice, internal bleeding and kidney failure (hepatomegaly)
- 50% of victims who develop toxic phase recover
- Those victims who do not recover and left untreated die after 10-14 days
- Yellow fever is native to West Africa, from Cameroon to Mauritania
- Areas with tropical and subtropical climates are more vulnerable that temperate climates
- Spread to Americas during European exploration

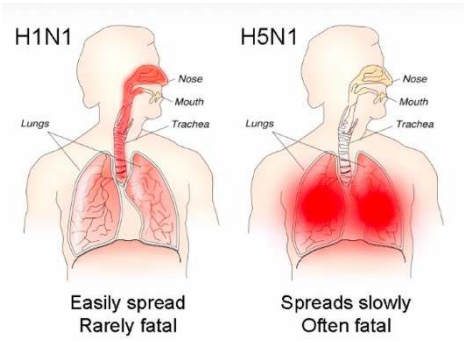
epidemic in Philadelphia during the summer of 1793 killing 4044 people. Haiti 1801 epidemic killed 90% of Napoleon's force that were sent to Haiti to crush a revolt against the French colonial authorities. Failure to recognize the spread of disease with mosquitoes, so efforts were concentrated on quarantining victim and sanitization, 19th century homes were designed to encourage air circulation, but that just let more mosquitoes in.

- Yellow fever was eradicated from North America by the mid-1900s through a combination of vaccinations, drainage of swamplands, and insecticide control of mosquitoes
- Yellow fever is still present in nine South American countries, and some of Caribbean islands.
- 33 African countries suffer from Yellow fever epidemics

2. Human Immunodeficiency Virus (HIV)
   - Infection with HIV occurs by the transfer of blood, semen, vaginal fluid, or breast milk
   - The immune system begins to fail, leading to life threatening infections
   - It was first recognized on Dec, 1st, 1981
   - HIV infection in humans is now pandemic
   - It's one of the most destructive pandemics in recorded history
   - Claimed more than 36 million lives so far
   - At the end of 2012, 35.3 million people were living with HIV
   - There is no cure for HIV infection, if untreated, eventually most HIV infected individuals develop AIDS and die. Most prevalent in Africa
   - About one in ten remains healthy for many years, with no noticeable symptoms
   - Treatment with antiretroviral drugs, where available, increases the life expectancy of people infected with HIV



3. Bird Flu



   - Physical contact with infected birds
   - H5N1 may mutate onto strain capable of efficient human-to- human transmission
   - Major world threat to possibly millions of lives

4. West Nile Virus
   - The main route of human infection is through the bite of a mosquito, peak szn is July and August
   - Mainly infects birds, but is known to infect humans, horses, dogs, cats, bats, chipmunks, skunks, squirrels and domestic rabbits

- <1% of infected will become seriously ill
- Originated in the area from Egypt to Iran, most cases in Canada are in Ottawa and Montreal
- Described in Africa, Europe, the Middle East, West and Central Asia and North America
- First detected in the united states & control is achieved through mosquito control

West Nile Virus Effects on Humans

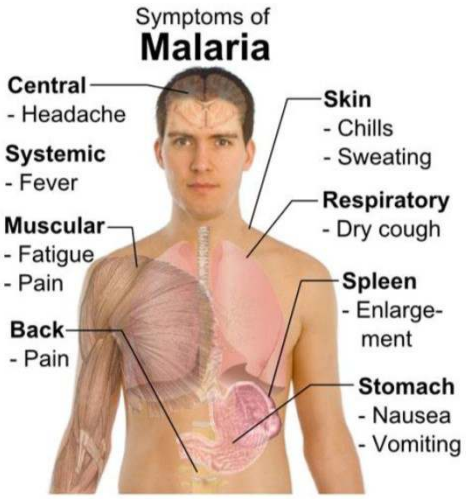
a) Asymptomatic infection – similar as flu
b) West Nile Fever – fever, headaches, chills, weakness, excessive sweating, rash, can take up to 2 months to resolve
c) West Nile Meningitis / Encephalitis – decreased level of consciousness, sometimes approaching near-coma, death

Protozoan Diseases

1. Malaria
   - Malaria is causes by the 4 species of the protozoa Plasmodium which lives as a parasite in the gut of the female mosquito
   - Malaria is spread by several species of mosquitoes

     Transmission Cycle

     Plasmodium sporozoites → 1st vector (mosquito) → initial human host → in utero transmission (female) and liver infection → blood infection → 2nd vector (2nd mosquito) → next human host then back from the liver infection and so on
   - The plasmodium transferred from mosquito to human will then reproduce in the human's liver and bloodstream causing malaria to develop
   - An infected person bitten by another mosquito can pass the mature Plasmodium on, thus creating a transmission cycle
   - Kills between 1 to 3 million people annually
   - Highest transmission is in Africa and South America



Lecture 8 – Foodborne Hazards and Human Health

Foodborne Illnesses

1. Food production (use of chemicals like fertilizers and pesticides)
2. Transmissible Diseases
   - Bacteria
     - Escherichia coli
     - Clostridium botulinum (botulism)
     - Salmonella
     - Listeria monocytogenes (listeriosis)
   - Viruses
   - Parasites
3. Non-Transmissible Diseases
   - Shellfish-associated toxins
   - Color additives
   - Obesity and diabeses
4. Organic Food
5. Genetically Modified food

Use of Chemical Fertilizers

- Extensive use of nitrate fertilizers – nitrites in groundwater
- Direct human health effect
  - Nitrites in water change hemoglobin to form that cannot carry oxygen
  - Causes methemoglobinemia (blue baby syndrome) in young infants

Use of chemical pesticides

- Pesticide = chemical used to kill pests
  - Active ingredient is the one intended to kill the pest

Types of Chemical Pesticides

1. Insecticides
    - Inorganic compunds
    - Pyrethrum (from the chrysanthemum plant)
    - Organochlorine inescticides
        - DDT, chlordane, aldrin, dieldrin, heptachlor
        - Neurotoxin; low acute human toxicity
        - Persistent and bioaccumulative
        - Many banned in more developed countries; Stockholm Convention

2. Organophosphate Insecticides

- Neurotoxins; not persistent in environment –Acute toxicity to people varies widely
- Carbamate insecticides
- Chemical action similar to organophosphates –Low acute toxicity to people
- Pyrethroid (pyrethrum-like) insecticides –Low acute toxicity to people & used in some consumer products

3. Herbicides

- Selective herbicides
    - Kill broad-leaved plants; do not kill plants in grass family (e.g., grain crops, turfgrass)
    - In military context, used to kill large plants that provide cover to enemy combatants
    - Non Selective herbicides—kill all plants –Example: Monsanto's Roundup
    - Roundup Ready - genetically engineered soybeans

4. Fungicides: used in agriculture
5. Rodenticides: often anticoagulant bait

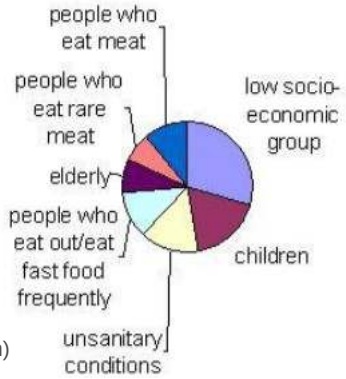
Limitations of Pesticides

- Resistance
    - Some pests are resistant (genetic makeup)
    - Resistant individuals survive and breed
- Human health effects of pesticides
    - Difficult to study chronic effects because of;
        - Difficult to assess exposure accurately
        - Changing mix of chemicals
        - Workers lack information
        - Variation in practices, protective gear
        - Hard to separate acute & chronic effects
    - Neurologic and reproductive effects, cancer
- Disparities in exposures and impacts
    - Pesticide production workers
    - Farmers and their families
    - Hired farmworkers
        - In U.S., mostly men, about half are Hispanic and half are foreign-born
        - Often inadequate protections, facilities, warning
    - In lower income countries; more hazardous pesticides may still be in use

Transmissible Foodborne Illnesses

Types of Food

Figure 2: Who is more likely to be sickened by food?



- Meat, dairy products, unpasteurised fruit and vegetable juices, raw or undercooked eggs, chicken, tuna, potato and macaroni salads, cream filled pastries, fresh produce, spices, chocolate, and seafood
- Careless food handling
    - food standing too long at room temperature
    - improper cooking
    - contaminated cutting boards and kitchen tools

Symptoms of Foodborne Illness

- Diarrhea, abdominal cramping, fever, vomiting, headache, sometimes blood in the stool
- Usually lasts only a day or two sometimes 7-10 days
- For most people it is not life threatening
- Severe for young children, the very old and people with certain diseases and conditions such as liver disease, iron disorder, diabetes, and cancer

Prevention of Foodborne Illness

- Starts in super market
- Safe storage
- Safe food preparation
- Keep everything clean
- Keep hot food hot and cold food cold
- Cook properly
- Proper storage of leftovers
- Wash your hands

<u>Bacteria: Escherichia Coli</u>

- Food poisoning usually associated with eating unwashed vegetables and meat contaminated post-slaughter
- Grounded beef
- Diarrhea, abdominal cramps
- Complications Hemolytic Uremic Syndrome in which the red blood cells are destroyed and kidneys fail (2-7% of cases)

<u>Bacteria: Clostridium Botulinum</u> (botulism)

- Rare but serious illness (fatal)
- Nerve toxin of bacterium Clostridium botulinum
- Caused by the toxin, not the bacterium itself
- Commercially canned foods should undergo “botulinum cook” in a pressure cooker at 121 º C for 3 minutes
- Home-canned foods
- Unusual sources;
    - Garlic or herbs stored covered in oil, improperly handled baked potatoes wrapped in aluminum oil and home-canned or fermented fish

<u>Main kinds of botulism</u>

a. Foodborne botulism
b. Wound botulism
c. Infant botulism

<u>Symptoms of Foodborne Botulism</u>

- Occurs between 12-36 hours after consuming the botulinum toxin
- Double and or blurred vision
- Difficulty swallowing, severe constipation
- Muscle weakness, lead to body paralysis
- Respiratory failure

<u>Bacteria: Salmonella</u>

- Salmonella bacteria are found naturally in the intestines of animals, (especially poultry and swine), birds, reptiles, some pets and some humans
- The bacteria can be found in the environment
- People who eat food contaminated by Salmonella can become ill with salmonellosis

- Small turtles are common source of the illness
- The symptoms often mimic the flu, usually no need for treatment
- Infants, the elderly and people who are immunocompromised may require hospitalization
- Long-term complications may include severe arthritis

Food Recalls in Canada

- 09/23/2013: certain Frisco's, Queen Victoria and metro brands spinach may contain salmonella bacteria
- 02/26/2014: Aquafuchsia brand Salad plus Alfalfa sprout with a touch of radish recalled due to Salmonella
- 01/25/2018, Ontario: Certain sesame seeds recalled due to Salmonella
- 01/29/2018: Prince Edward Island, Quebec → Coconut Tree brand Shredded Young Coconut recalled due to Salmonella
- 01/29/2018, Ontario: Bhugga sold at Rajdhani Sweets & Restaurant recalled due to Salmonella

<u>Listeria Monocytogenes (Listeriosis)</u>

- Found in soil, vegetation, water, sewage, silage, and in the feces of humans and animals
- Hard to identify, it doesn't change the colour or the smell of meat
- Animals and humans can carry the bacterium without knowing it
- Listeria can survive and sometimes grow on foods being stored in the refrigerator
- Listeria can be killed with proper cooking and procedures
- Serious disease called listeriosis, especially among pregnant women, the elderly or individuals immunocompromised
- In serious cases it can lead to brain infection (meningitis or encephalitis) and even death

<u>Maple Leaf Listeria Outbreak</u>

- August 2008, maple leaf foods announced a massive recall of 243 types of ready-to-eat meat products supplied to stores, restaurants and cafeterias
- Test results indicate a maple leaf food plant in Toronto is the source of a listeria outbreak that has killed 4 people

Food Recalls in Canada

- 12/28/2017, National: various brands of sandwich products recalled due to Listeria monocytogenes
- 01/31/2018, some parts of Canada: Sawler brands Turnip Sticks recalled due to Listeria monocytogenes

The Transmission of Infectious Disease (number of deaths/number of cases) x 100

Parasites and Foodborne Illnesses

- Live and reproduce within the tissues and organs of the infected human and animal host
- May be transmitted; animals to humans, humans to humans and finally humans to animals
- Some are very small, some are visible with the naked eye (worms)
- Often excreted in feces, if food comes in contact with excrements, raw/undercooked wild game

Non-Transmissible Foodborne Illnesses

Shellfish-Associated Toxins

- Caused by group of toxins from planktonic algae upon which the shellfish feed
- Toxins are accumulated and sometimes metabolized by the shellfish
- Symptoms include; type of the toxin, concentration in the shellfish amount of the shellfish consumed
- Shellfish harvested along the Florida coast and the Gulf of Mexico (mussels, clams, scallops, oysters)
- Not very frequent disease