

MIWOA CONTINUING EDUCATION SEMINAR

**WATERBORNE DISEASES:
AGENTS, TRANSMISSION AND
SURVIVAL IN THE ENVIRONMENT**

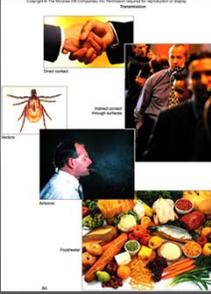
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Principles of Epidemiology

Infections - disease caused by microorganisms and transmitted from one host to another

In order for disease to spread:

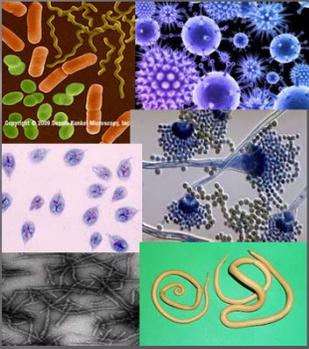
1. Reservoirs of infection: humans, animals, environment
2. Portals of exit: feces, saliva, dead skin cells
3. Transmission: susceptible host



Principles of Epidemiology

Disease causing agents or pathogens:

1. Bacteria
2. Viruses
3. Fungi
4. Protozoa
5. Helminths
6. Prions



Principles of Epidemiology

Pathogens causing infections:

1. Frank pathogen- causing infection in people with normal immunity and immunocompromised (through environment, water, food, fomites) e.g. Shigella sp.
2. Opportunistic pathogen- causing infection in immunocompromised people. E. g. Pseudomonas sp.

Principles of Epidemiology

Factors that influence epidemiology of disease

1. Dose
Minimum number of bacteria required to establish disease
2. Incubation period
Disease with long incubation period can spread extensively before first case appears
3. Population characteristics
Certain populations are more susceptible than others to certain pathogens (immunity, age, general health)

Principles of Epidemiology

Anthroponoses - diseases transmissible from humans to humans. Rubella, small pox, diphtheria.

Zoonoses - transmitted from animals to humans. Rabies, Lime disease, influenza, HIV, Ebola.

Sapronoses - from organic matter decaying in environment to humans. Legionnaires disease, aspergillosis, amebic encephalitis.

Principles of Epidemiology

Reservoir of infection is a place where a pathogen naturally lives and multiplies. It can be:

1. Humans - sick or carriers
2. Animals - wild or domestic
3. Environment - water or soil.

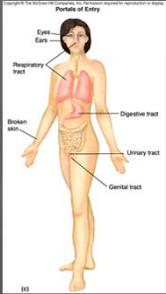
These pathogens difficult or impossible eliminate



Principles of Epidemiology

Transmission:

1. Pathogen must enter and colonize new host
2. Route by which pathogen enters body is termed portal of entry
3. Major portals of entry include
 - Eyes
 - Ears
 - Respiratory tract
 - Broken skin
 - Digestive tract
 - Genitourinary tract



Principles of Epidemiology

Contact with pathogen could be:

- Direct contact - one person physically touches another.
- Indirect contact - via inanimate objects (fomites)
- Droplet transmission - within three feet of release
- Foodborne- via contaminated food
- Waterborne - via contaminated water
- Airborne - via air

Waterborne Infections

Infections from water include:

1. Waterborne - through ingestion of contaminated water (cholera, typhoid fever)
2. Water washed - through poor hygiene (shigellosis)
3. Water based - through aquatic organism (Legionnaire disease)
4. Water related - through insects breed in water (malaria, dengue, yellow fever)

Escherichia coli

Bacteria, generally not a pathogen, because it naturally inhabits the gastrointestinal tract of humans. There are several pathogenic strains of Escherichia coli.

One of them is O157:H7 it causes diarrheal illness, and is classified as an enterohemorrhagic E. coli.

The reservoir for this bacteria are cattle, deer, goats, sheep and humans. It is typically associated with contaminated food and water.

Dose: 10 to 10bn

Survival: 1 day in water, 1.5 days in sediment, and 3 days in soil. Some sources 1.5 hr-16 months. In tropical climate, can live indefinitely



Outbreak: E. coli O157:H7. 243 cases, 32 hospitalizations, and four deaths. 1989. Cabool, Missouri. Case of no disinfection of the city's water supply during heavy rains. Storm runoff washed through cattle manure and into production well.

Salmonella spp.

bacteria that cause diarrheal illness. Not-typhoid type causes food poisoning, typhoid type causes typhoid fever.

Humans are the reservoir for typhoid type pathogen, can be asymptomatic carriers

Turtles, iguanas, chicks are reservoir for not-typhoid type.

Salmonella may be found in water sources such as private wells that have been contaminated with the feces of infected humans and animals.

Dose: not-typhoid 1000bac, typhoid 100,000 bac.

Survival: can survive in soil for 231 days, and water for up to 152 days. Flies have been shown to excrete certain serotypes for 8 days and bed bugs can excrete bacilli for up to 21 days. Certain serotypes have been shown to survive on fingertips for up to 80 minutes, depending on the inoculum size



"Typhoid Mary" notorious carrier. Caused at least 53 cases and 3 deaths over 15 years

1,000 individuals were infected. 1885. in Plymouth, Pennsylvania. A result of contaminated water pumped into the city's water supply.

Shigella spp

Cause diarrheal illness known as shigellosis.
Humans and primates are the reservoir for this pathogen.
Shigella infections can then be acquired by drinking, swimming in, or playing with the contaminated water.
Shigella are still present in the stools of persons while they are sick and for up to a week or two afterwards.

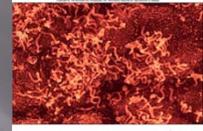


Dose-10-100bac
Survival: Months on dry surfaces, up to 10 days in soft drinks, several days on contaminated vegetables, over 9 hours on fingers, in feces for 12 days at 25°C, and water for under 3 days.
Flies can carry *Shigella* for up to 20 - 24 days.

Worldwide distribution. 5 - 15% of all diarrhea cases can be linked to *Shigella* spp. infection, where two-thirds of all cases and deaths occur in children younger than 5 years ()

Vibrio Cholerae

Bacteria that causes classic example of severe diarrhea. Loss of fluid per day can be 20 liters.
Associated with aquatic environments, shell stocks, and human.

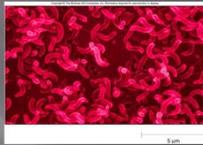


Dose: 1mn-100bn bac . Depends on gastric acidity.
Survival: in well water for 5-10days and up to 2-3 weeks, in a wide variety of foods and drinks for 1-14 days at room temperature and 1-35 days in an ice box. It has also been found on fomites at room temperature for 1-7 days.

1854 Soho, England. Outbreak resulted in greater than 10,000 fatalities. Poor sanitary conditions of city water system. This was the result of contamination of the city's water supply from cesspits.

Campylobacter spp.

Causes diarrheal illness. Primarily associated with poultry, animals, and humans.
Numerous foodborne and waterborne outbreaks have been reported
Dose: less than 500bac

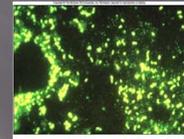


Survival: several months in frozen poultry, minced meat, and other cold food products. *Campylobacter* can survive for many weeks in water at 4°C, but only a few days in water above 15°C

Estimated 2.4 million cases annually
Outbreaks caused by the distribution of water or milk, which have infected 3,000 people at a time.

Legionella pneumophila

Opportunistic bacteria, causes a respiratory illness legionellosis. That has two forms: Legionnaire's disease and Pontiac fever, *Legionella* is naturally found in water, both natural and artificial water sources, dead ends in distribution systems and in recreational water systems.



Dose: unknown
Survival: up to 139 days in distilled water and 415 days in tap water. Can persist outside of the host in biofilms > 98 days.
Outbreaks: there were two fatalities in January 1999 on cargo vessel under repair. Mechanics were exposed to *Legionella* in a ship's fresh water pump.



Pseudomonas

Bacteria, opportunistic pathogen. Can cause dermatitis or otitis in healthy hosts and severe infections in immunocompromized. *Pseudomonas* is typically associated with soil and water, especially hot tubs, whirl pools and spa.

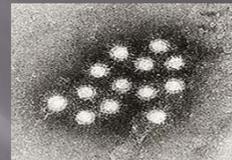


Dose: unknown
Survival: months on dry surfaces and inanimate objects, humidity can improve persistence. Growth observed in distilled water can survive up to months with minimal nutrients

Outbreak: 19 individuals in February of 1999 in Colorado. *Pseudomonas* in a hot tub due to inadequate chlorine levels.
9 Cases in February of 2000 in Maine. *Pseudomonas* was growing in a hot tub due to inadequate chlorine levels.

Hepatitis A

It is virus. It causes inflammation of the liver. The reservoir for Hepatitis A virus is humans. Transmission from ingestion of contaminated food or water. Many outbreaks originated from restaurants due to infected food handler



Raw shellfish frequent source of infection

Dose: unknown

Survival: HAV is exceptionally stable at ambient temperature and at low pH, survive in the environment, i.e. in water and sewage for long periods.

Outbreak in the 2003 United States hepatitis afflicted at least 640 people (killing four) in north-eastern Ohio and south-western Pennsylvania in late 2003. In 1988, more than 300,000 people in Shanghai, China were infected with HAV after eating clams from a contaminated river.

Norwalk virus

'Cruise ship virus' causes diarrheal illness. Humans are the reservoir for this virus. Norovirus transmission is usually person to person and through the environment, contaminated surfaces, food, water, fomites, and aerosols.

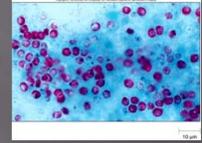
Dose: less than 10 particles
Survival: A protein capsid helps to survive in seawater, groundwater, fresh water, soil, and inanimate surfaces for an unknown period of time.



Noroviruses are responsible for 60-95% of outbreaks of nonbacterial acute infectious diarrhea. Outbreaks can last a long time and have been reported to last over 3 months. Caribbean Princess Explorer of the sea

Cryptosporidium spp.

A protozoan parasite that causes diarrheal illness known as cryptosporidiosis. Associated with animals and humans, and it can be acquired through consuming fecally contaminated food and water, including during swimming. Found in 97% of surface water in the U.S



Dose: 132 oocysts for healthy, 1-5 oocysts generally
Survival: as oocyst 6 months at 20°C
Can remain alive in salty water for several days.

370,000 cases per 800,000 population with over 4,400 hospitalizations and more than 100 deaths in 1993, Milwaukee, Wisconsin. During heavy rains, the city's filtration system was overwhelmed, and the Cryptosporidium oocysts passed through that system and infected the water supply throughout the city.

Giardia lamblia

Protozoan parasite that causes diarrheal illness known as giardiasis. It is typically associated with water. It can also be found in soil and food. Humans and animals are the reservoir for this pathogen. Giardia may be passed person-to-person or animal-to-person. Chronic asymptomatic infections can last from months to years

Dose: 10 cysts
Survival: At 4 °C Giardia lamblia cysts can survive 11 weeks in water, seven weeks in soil, and one week in cattle feces. They remain infective for a significantly shorter period at warmer temperatures - i.e. 25 °C.

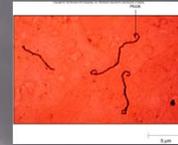


Giardiasis is a global disease. It infects nearly 2% of adults and 6% to 8% of children in developed countries worldwide. In the United States, Giardia infection is the most common intestinal parasitic disease affecting humans

Leptospira interrogans

Slender spiral bacteria causes infection with damage of kidneys, liver and nervous system, was known as "the illness of the wastewater worker"

Transmitted through contact of the damaged skin or mucous membranes with contaminated water, soil or vegetation; direct contact with urine or tissues of infected animals; ingestion of contaminated food or by inhalation of droplet aerosols of contaminated fluids



Dose: Unknown
Survival: Soil contaminated with infected urine - many weeks; in water passed through infected soil - up to 19 days; surface water of lakes up to 10 days; sludge - 5 days.

It is estimated that seven to ten million peoples are infected by leptospirosis annually. Annual rates of infection vary from 0.02 per 100,000 in temperate climates to 10 to 100 per 100,000 in tropical climates.

Cyclospora cayentanensis

Protozoan parasite causing diarrheal illness. Found in intestines of mammals and birds.

Transmitted through consumption of untreated water or contaminated with mature oocysts food. Maturations require 7-15 days in the environment.

Dose: 10-100 oocysts
Survival: Oocysts have been noted to survive in water for 2 months at 4°C and 7 days at 37°C.



As of August 2, 2013, an outbreak of the disease in the U.S. has sickened 425 people across 16 states. The source has been identified as a bagged salad mixture

Naegleria fowleri

Protozoan parasite 'brain eating amoeba' that causes primary amoebic meningoencephalitis, acute, fulminating, rapidly fatal disease that is often observed after exposure to fresh water.

Transmission through contaminated water, enters the nasal passage during swimming or diving in freshwater, then penetrates through the mucosal layer and travels along the olfactory nerve to the brain.

Dose: unknown.
Survival: in water at temperature up to 45°C and at pH 4.6 - 9.5.



there have been 132 PAM infections from 1962 through 2013 with only three survivors. The reason why some people affected and others not, are unknown.

Ascaris spp

The largest and most common intestinal roundworm parasites found in humans and animals.

Transmitted by ingestion of fecally contaminated water, food, fomites. Eggs must incubate in soil, may become airborne and be inhaled or swallowed .

Dose: unknown
Survival: Eggs may remain viable up to 6 years in mild climate.

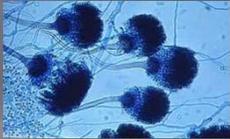


Roughly 0.8-1.3 billion individuals are infected with this intestinal worm, primarily in Africa and Asia. One study indicated that the prevalence of ascariasis in the United States is around 4 million (2%)

Aspergillus spp.

Fungi that causing aspergillosis. Diseases caused by *Aspergillus* spp. include clinical allergies, superficial and local infections. In immunocompromised people it causes severe pulmonary infections. Reservoir of infection is water and soil. Transmitted through air and contaminated water.

Dose: unknown
Survival: in soil and decomposing vegetation



Aspergillus spp. are found worldwide, and widely distributed in the environment. *Aspergillus* spp. occur primarily in immunocompromised individuals

Infectious Disease Surveillance

National Disease Surveillance Network
Depends heavily on network of agencies across the country Centers for Disease Control and Prevention (CDC) and Public Health Departments

Infectious diseases remains a threat
750 million cases each year in United States
Resulting in 200,000 deaths
Tens of billions of dollars spent on health care

Waste water

Wastewater personnel have a higher incidence of potential exposure to pathogens than the general public.
Newly employed wastewater workers may be more prone to illness than more experienced workers.
Collection system, treatment plant, laboratory personnel are in risk group.

Waste water

Routes of infection

Ingestion	Eating, drinking, smoking, 'chewing' or accidentally swallowing a pathogenic organism (e.g., hepatitis A)
Inhalation	Breathing spray or mist containing pathogenic organisms (e.g., common cold)
Direct contact	Entry of pathogenic organism to body via cut or break in the skin (e.g., tetanus)

Diseases associated with wastewater-contaminated environments.

Disease	Organism	Transmission
Bacillary dysentery	<i>Shigella</i> spp.	Ingestion
Asiatic cholera	<i>Vibrio cholerae</i>	Ingestion
Typhoid fever	<i>Salmonella typhi</i>	Ingestion
Tuberculosis	<i>Mycobacterium tuberculosis</i>	Inhalation
Tetanus	<i>Clostridium tetani</i>	Wound contact
Infectious hepatitis	Hepatitis A virus	Ingestion
Poliomyelitis	Poliovirus	Ingestion
Common cold	Echovirus	Inhalation
Hookworm disease	<i>Necator americanus/Ancylostoma duodenale</i>	Skin contact
Histoplasmosis	<i>Histoplasma capsulatum</i>	Inhalation
Leptospirosis	<i>Leptospira</i>	Wound contact/inhalation

Summary of biological health risks to wastewater workers

Type of hazard	Effect observed
Hepatitis A,E	Evidence of increased risk when working with raw wastewater and primary sludge.
Other viral infections	May indicate infection in the most exposed workers. Other factors contributing to infection should not be overlooked.
Leptospirosis	Formerly considered a problem; risks now appear minimal.
Gastrointestinal illness	Increased rates, especially among new workers. Other factors contributing to infection should not be overlooked
Compost-related factors	Excess nasal, ear, and skin abnormalities and eye irritation.

Waste water and HIV

The is concern with the possible transmission of AIDS from human wastes such as urine, excrement, and blood that are discharged to sewer.

CDC and Prevention has stated that there is no scientific evidence that HIV is spread in wastewater or its aerosols. The virus has never been recovered from wastewater. It is believed that the pH, temperature, and other conditions of the collection system are unsuitable for its survival.

Waste water and Ebola virus

The World Health Organization recommends that human wastes, including waste from Ebola patients such as vomitus and feces, be either disposed of through a sanitary sewer or be buried in a pit toilet or latrine with no additional contact or treatment.

There has been no evidence to date that Ebola can be transmitted via exposure to sewage.

Researchers believe Ebola survives in water for only a matter of minutes. Once in water, the host cell will take in water in an attempt to equalize the osmotic pressure, causing the cells to swell and burst, thus killing the virus.

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