

The Centers for Disease Control and Prevention's Vessel Sanitation Program is proud to bring to you the following session:

Waterborne Illness

While this presentation is primarily intended for cruise vessels under the jurisdiction of the Vessel Sanitation Program it may also be used by anyone who is interested in this topic.

This session should not be used as a replacement for existing interactive training but should be used as an adjunct to a comprehensive training program.



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Waterborne Illnesses

2007



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Learning Objectives

- List the pathogens associated with waterborne illness outbreaks
- List the routes of transmission for waterborne pathogens
- List the prevention methods for specific pathogens



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Waterborne Illnesses

- Potable Water Illnesses
- Recreational Water Illnesses



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Waterborne Outbreak Agents

- Bacterial
- Viral
- Parasitic
- Chemical



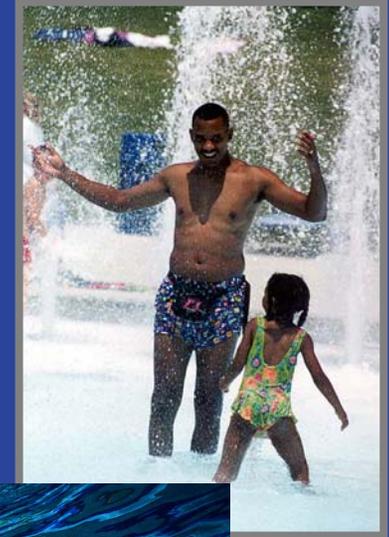
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Routes of Transmission

- **Ingestion**
 - Consuming water
- **Dermal**
 - Contact with skin/mucous membranes
- **Inhalation**
 - Breathing in mist



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Bacterial Pathogens

- *E. coli* 0157:H7
- *Salmonella*
- *Salmonella typhi*
- *Shigella*
- *Campylobacter*
- *Vibrio cholerae*
- *Pseudomonas*
- others



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Escherichia coli

- Enterovirulent *E. coli* (EEC)
 - Enterohemorrhagic (EHEC)
 - Enteroinvasive (EIEC)
 - Enterotoxigenic (ETEC)
 - Enteropathogenic (EPEC)
 - Enteroadgregative (EAaggEC)



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Escherichia coli 0157:H7: The Basics

- Bacteria
- Diarrheal illness (EHEC)
 - hemorrhagic colitis
- Cattle, deer, goats and sheep
- Humans
- Contaminated food and water



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E. coli 0157:H7: Prevention

- Source protection
- Halogenation
 - Chlorine
 - Bromine
- Boil 1 minute



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Salmonella spp.: The Basics

- Bacteria
- Diarrheal illness (salmonellosis)
- Humans and animals
- Contaminated food and water



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Salmonella spp.: Prevention

- Source protection
- Halogenation
 - Chlorine
 - Bromine
- Boil 1 minute



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Salmonella typhi: The Basics

- Bacteria
- Diarrheal illness (typhoid fever)
- Humans



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Salmonella typhi: Prevention

- Source protection
- Halogenation
 - Bromine
 - Chlorine
- Boil 1 minute



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Shigella spp.: The Basics

- Bacteria
- Diarrheal illness (shigellosis)
- Humans and primates
- *Shigella* species
 - sonnei (2/3 of shigellosis in US)
 - flexneri (the rest)
 - dysenteriae (developing countries)



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Shigella spp.: Prevention

- Source protection
- Halogenation
 - Chlorine
 - Bromine
- Boiling for 1 minute



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Campylobacter: The Basics

- Bacteria
- Diarrheal illness
- **Poultry**, animals and humans



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Campylobacter: Prevention

- Source protection
- Halogenation
 - Chlorine
 - Bromine
- Boil for 1 minute



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Vibrio cholerae: The Basics

- Bacteria
- Diarrheal illness (cholera)
- Aquatic environments, shellstock and humans
- Ship ballast water



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Vibrio cholerae: Prevention

- Source protection
- Halogenation
 - Chlorine
 - Bromine
- Boil for 1 minute



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Legionella: The Basics

- Bacteria
- Respiratory illness (legionellosis)
 - Legionnaire's disease
 - Severe pneumonia
 - Pontiac fever
 - Influenza-like illness
- Water (natural and artificial)



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Legionella: Prevention

- Maintain hot water systems at or above 50 C and cold water below 20 C
 - Hot water tank at 71-77 C
- Proper recreational water system maintenance and disinfection
- Prevent water stagnation
 - No dead ends in distribution systems or recreational water systems
- Prevent biofilm development



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Pseudomonas: The Basics

- Bacteria
- Dermal
 - Dermatitis
 - Otitis
- Soil and water



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Pseudomonas: Prevention

- Proper maintenance and disinfection of recreational water facilities



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Viral Pathogens

- Hepatitis A
- Norovirus
- others



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Hepatitis A: The Basics

- Virus
- Inflammation of the liver
- Humans



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Hepatitis A (HAV): Prevention

- Source protection
- Adequate disinfection
 - Fecal matter can protect HAV from chlorine
 - Resistant to combined chlorines



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Norovirus: The Basics

- Virus
- Diarrheal illness
- Humans



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Norovirus: Prevention

- Source protection



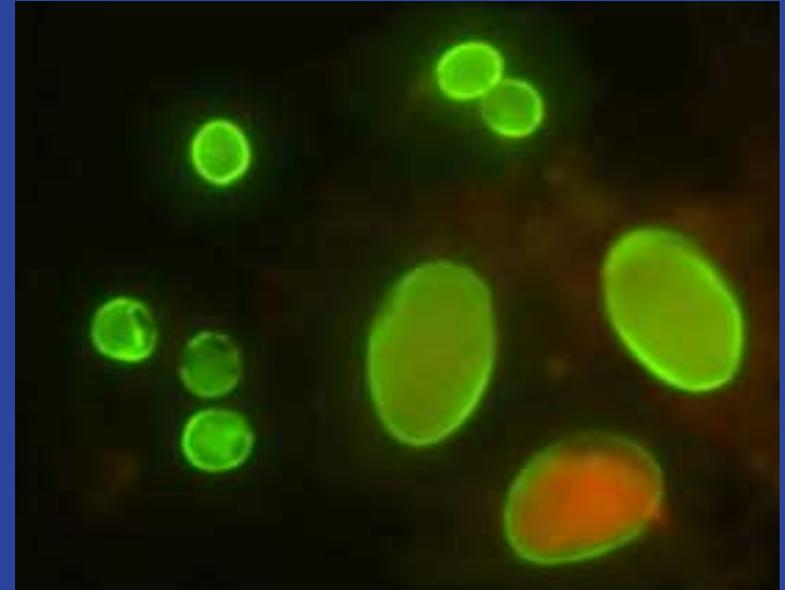
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Parasitic Pathogens

- *Cryptosporidium*
- *Giardia*
- *Schistosomatidae*
- others



Oocysts of *C. parvum* (L) and cysts of *Giardia intestinalis* (R) with immunofluorescent antibodies



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Cryptosporidium: The Basics

- Parasite
- Diarrheal illness (cryptosporidiosis)
- Animals and humans
- Fecally contaminated food, soil and water



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Cryptosporidium: Prevention

- Source protection
- CT=9600 (fecal accidents)
- Boil water 1 minute
- Filtration-"Absolute" pore size 1 micron or smaller
- Reverse osmosis



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Giardia: The Basics

- Parasite
- Diarrheal Illness (giardiasis)
- Water
 - Most common pathogen in waterborne outbreaks
- Soil and food
- Humans and animals



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Giardia: Prevention

- Source protection
- Filtration, coagulation and halogenation



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Schistosomatidae: The Basics

- Parasite
- Dermal (cercarial dermatitis)
 - Swimmer's itch
- Aquatic snails and birds



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Schistosomatidae: Prevention

- Eliminate snails with a molluscicide
- Interrupt the life cycle by treating birds with antihelminthic drugs



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Chemical Illnesses

- Too numerous to itemize
- Mainly cross-connections and run-off
- Some naturally occurring

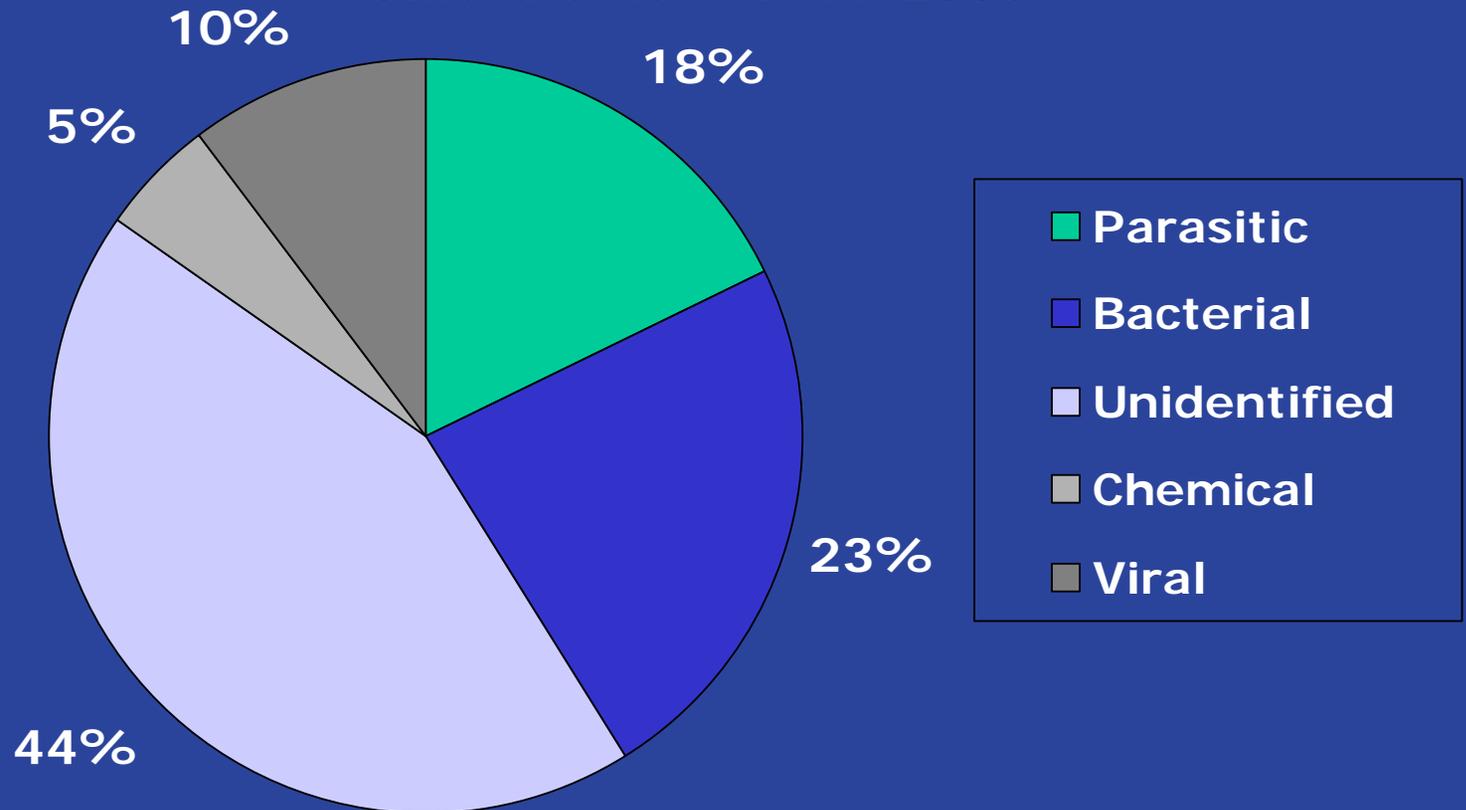


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Waterborne Illness Associated with Drinking Water by Etiologic Agent- United States 1999-2000



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Waterborne Outbreaks

Potable Water
Recreational Water



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Potable Water Outbreaks



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What: Cholera

- Who: >10,000 fatalities
- When: 1854
- Where: Soho, England
- Why: Poor sanitary conditions of city water system



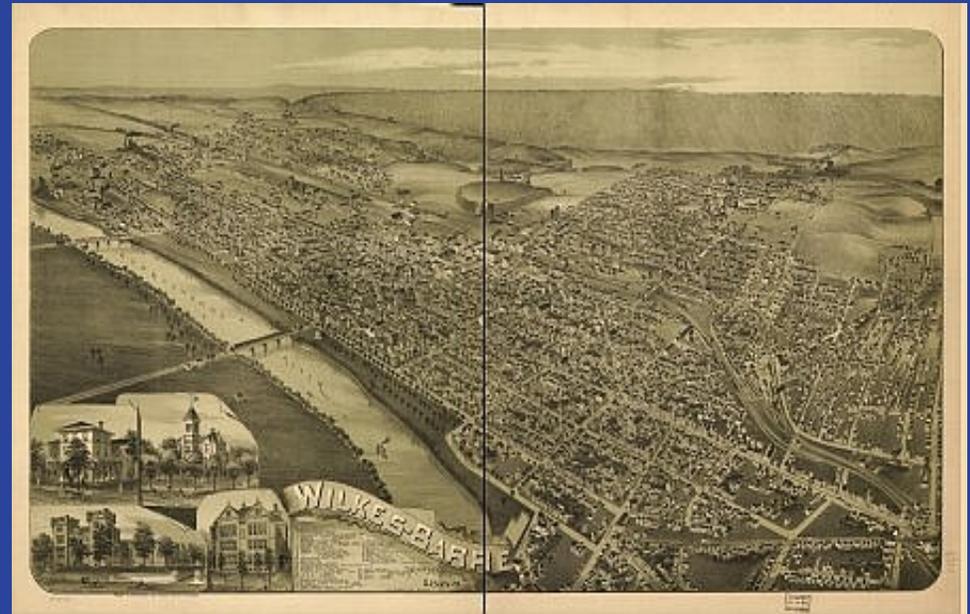
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What: Typhoid

- **Who:** 1000 cases
- **When:** 1885
- **Where:** Plymouth
- **Why:** Contaminated water pumped into water supply



Wilkes-Barre, Pennsylvania, as depicted on an 1889 panoramic map

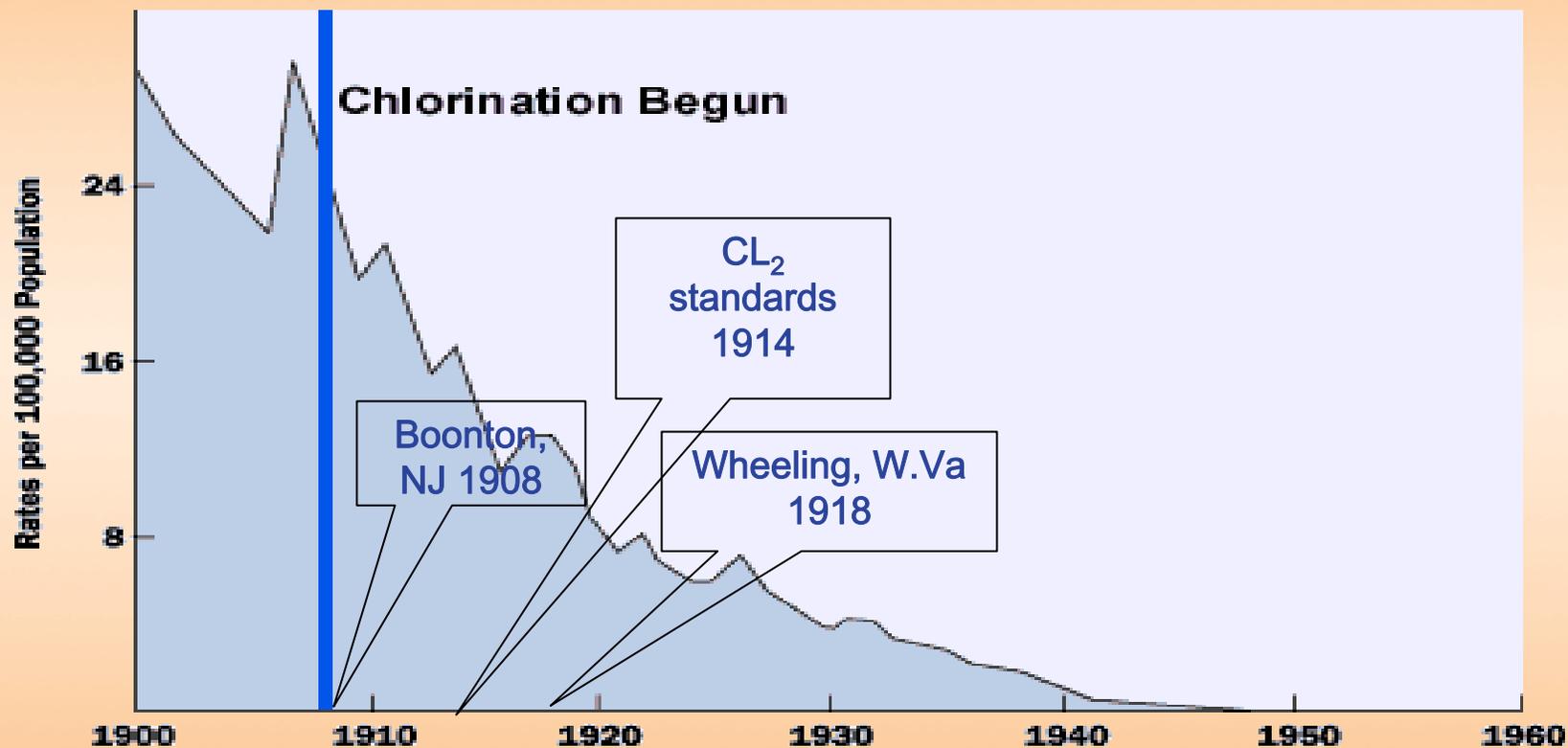


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Death Rate for Typhoid Fever United States, 1900-1960



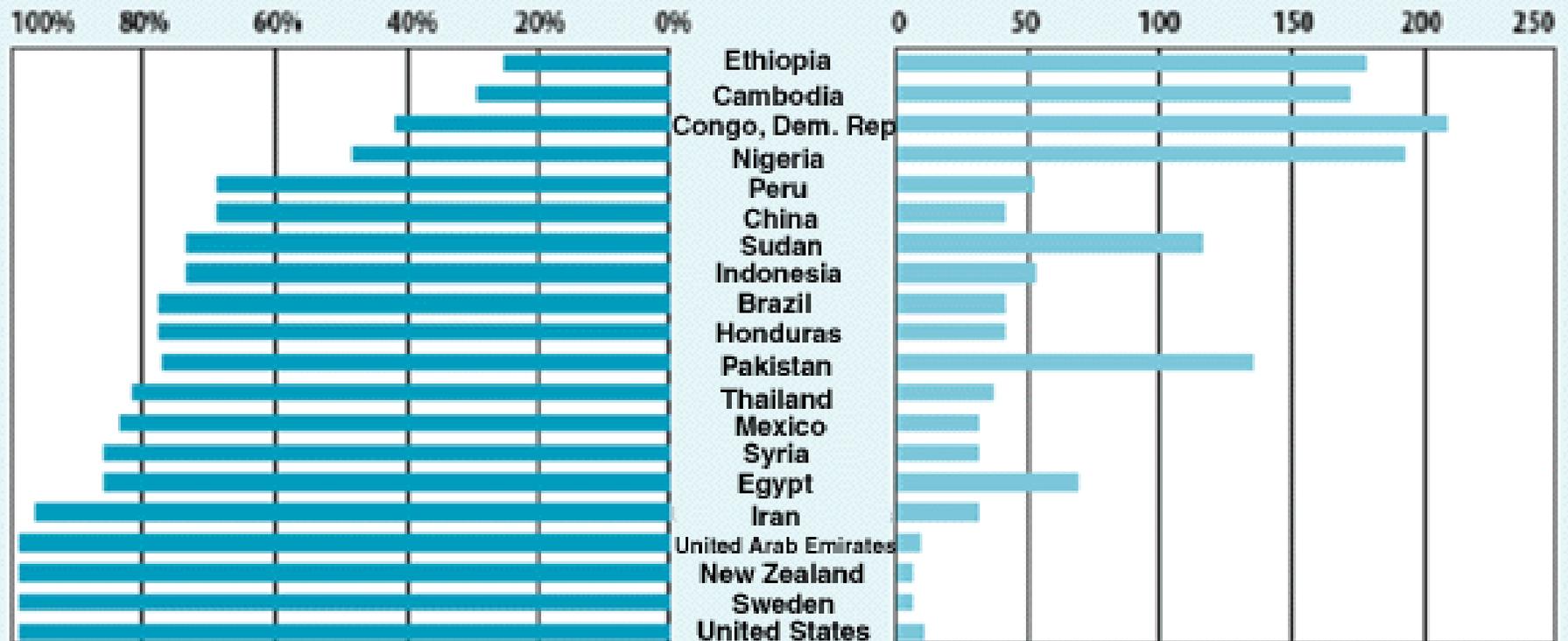
Source: U.S. Centers for Disease Control and Prevention, Summary of Notifiable Diseases, 1997.

In developing countries, 80 percent of all diseases are caused by consuming water contaminated with pathogens and pollutants.

Access to Safe Drinking Water Lives

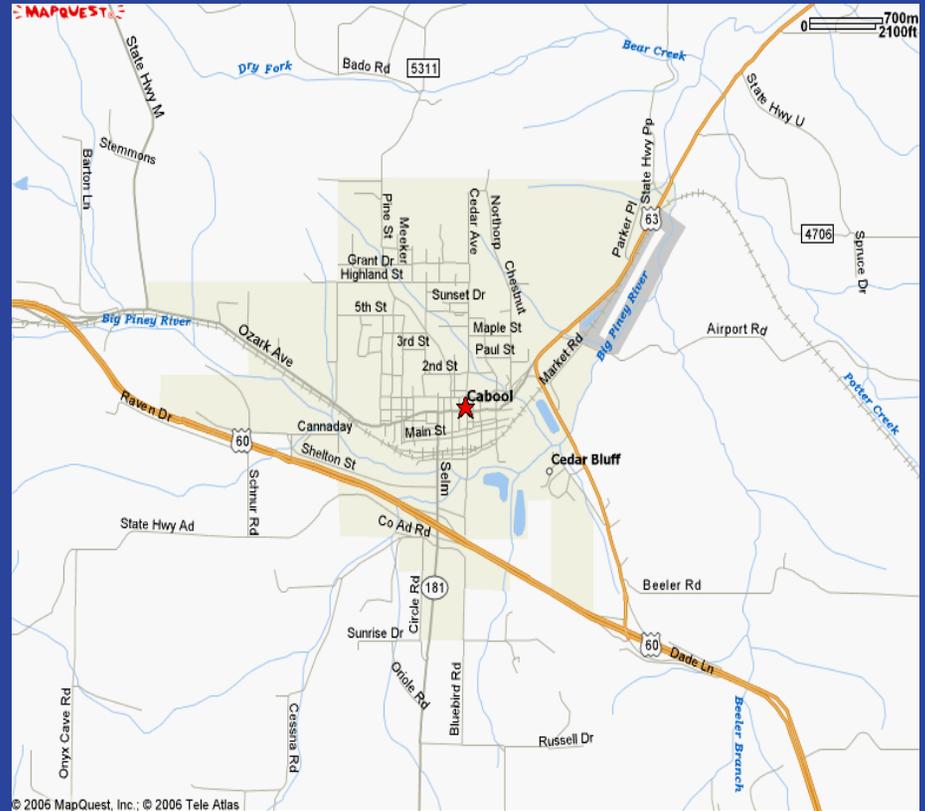
Populations with Access to Safe Drinking Water
(percent of population)

Deaths of Children Under 5 Years of Age
(deaths per thousand)



What: *E. Coli* 0157:H7

- **Who:** 243 cases
 - 32 hospitalized
 - 4 deaths
- **When:** 1989
- **Where:** Cabool, MO
- **Why:** No disinfection



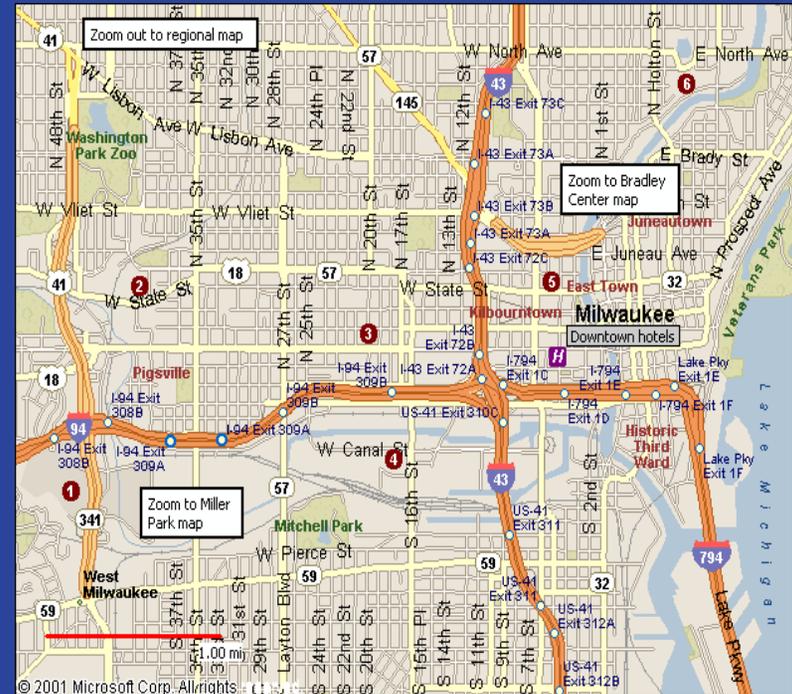
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What: *Cryptosporidium*

- **Who:** 370, 000 cases/800, 000 pop.
 - 4,400 Hospitalized
 - > 100 Deaths (?)
- **When:** 1993
- **Where:** Milwaukee
- **Why:** Oocysts passed through filtration system



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What: *Vibrio Cholera*

- Who: ?
- When: 1992
- Where: Alabama
- Why: Contaminated ballast water
- Corrective action: Change ballast water on high seas



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What: Photo Chemical



- Who: 544 ill
- When: 1978
- Where: Aircraft Carrier
- Why: Unprotected cross-connection



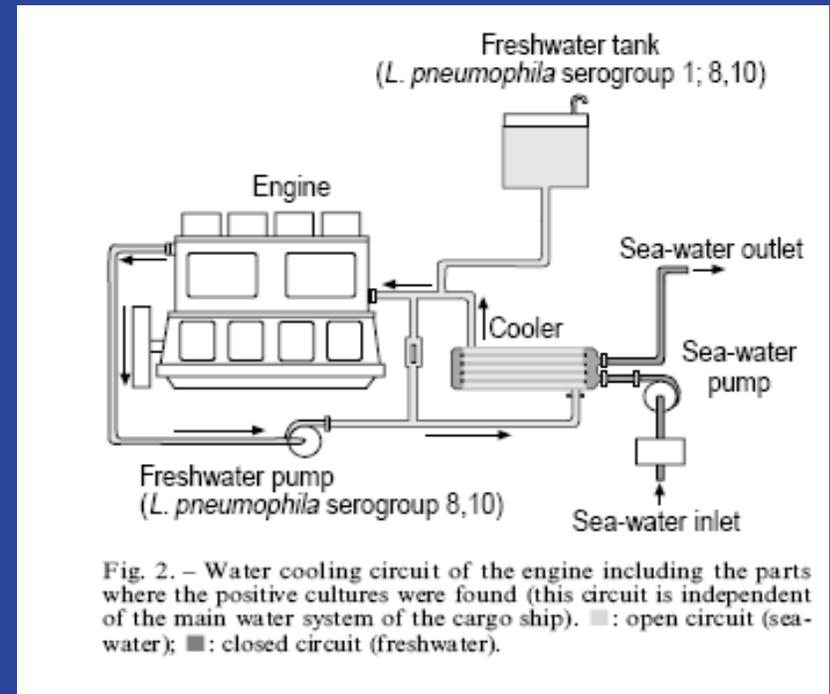
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What: *Legionella*

- **Who:** 2 fatalities
- **When:** January 1999
- **Where:** Cargo vessel under repair
- **Why:** Mechanics exposed to *Legionella pneumophila* in ship's fresh water pump



Eur Respir J 2001; 17: 1322-1327



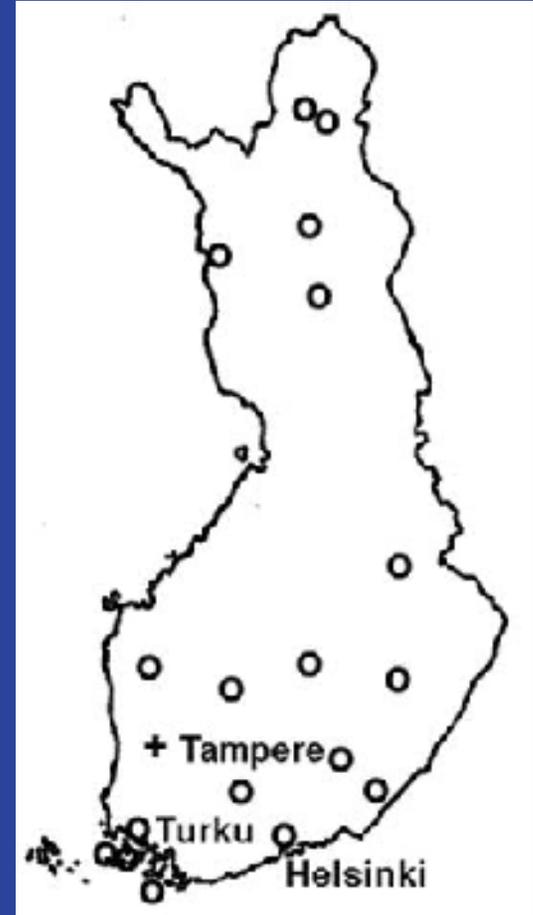
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What: Norovirus

- **Who:** 48 outbreaks (200-5500 cases)
 - Samples from 28 outbreaks available
 - Norovirus caused 18 outbreaks
- **When:** 1998-2003
- **Where:** Finland
- **Why:** Most likely caused by sewage contamination of surface water



Maunula L, Miettinen IT, von Bonsdorff C-H. Norovirus outbreaks from drinking water. *Emerg Infect Dis* [serial on the Internet]. 2005 Nov [date cited].



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Waterborne disease associated with ships 1970-2003

Organism/toxin	# of outbreaks	# of pax/crew affected
Enterotoxigenic <i>Escherichia coli</i>	7	2,917
Norovirus	3	788
<i>Salmonella typhi</i>	1	83
<i>Salmonella</i> spp	1	292
<i>Shigella</i> sp	1	690
<i>Cryptosporidium</i> sp	1	42
<i>Giardia lamblia</i>	1	200
Unknown Agent	5	849
Chemical water poisoning	21	6,402

Source: Public Health Reports/July-August 2004/Vol. 119



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Recreational Water Illness Outbreaks



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What: *Cryptosporidium*

- Who: 369 cases
- When: July 1997
- Where: Minnesota
- Why: Inadequately treated decorative/recreation fountain
- Corrective action: Back to decorative fountain



MMWR October 16, 1998/47 (40);856-860



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What: *Cryptosporidium*



- **Who:** 47 initial cases
 - Spread to 3000 ill with 711 crypto. (+)
- **When:** August 2005
- **Where:** Seneca, NY
- **Why:** Crypto. Oocysts in system
- **Corrective action:** Implementation of new guidelines for non-pool facilities such as spray pads



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What: *Cryptosporidium*

- Who: 1000 cases
- When: Summer 2000
- Where: Ohio and Nebraska
- Why: ?
 - Swallowing water
 - Fecal accidents (5 in Ohio)
 - Swimming while symptomatic (18% Nebraska)

MMWR May 25, 2001/50(20);406-410



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What: *Pseudomonas dermatitis*

- Who: 19 cases
 - When: February 1999
 - Where: Colorado
 - Why: Pseudomonas in hot tub due to inadequate chlorine levels
- Who: 9 cases
 - When: February 2000
 - Where: Maine
 - Why: Pseudomonas in hot tub due to inadequate chlorine levels

MMWR December 08, 2000/49(48);1087-1091



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What: *Legionella*

- **Who:** 15 cases
- **When:** October 1996
- **Where:** Virginia
- **Why:** Whirlpool spa display at a retail store positive for Legionella (Lp1)
- **Corrective action:** Whirlpool spas on display to be inspected and maintained

MMWR January 31, 1997/46(04);83-86



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Resources and References

- www.cdc.gov
- www.fda.gov
- **Waterborne Pathogens (AWWA M48)**
 - American Water Works Association
- Journal of Water and Health
 - 04 Supplement 2 2006



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