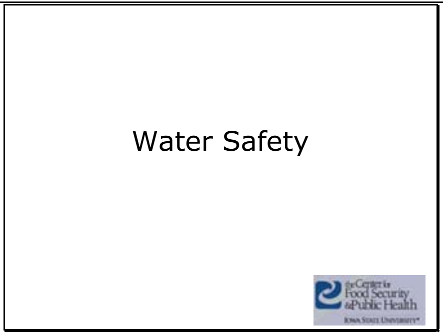
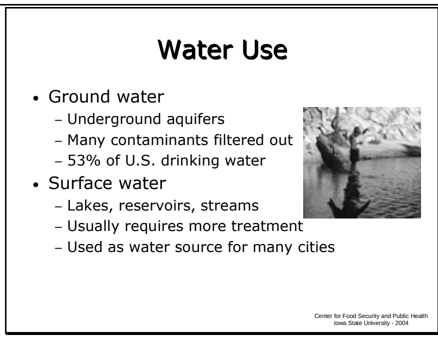
Slide 1

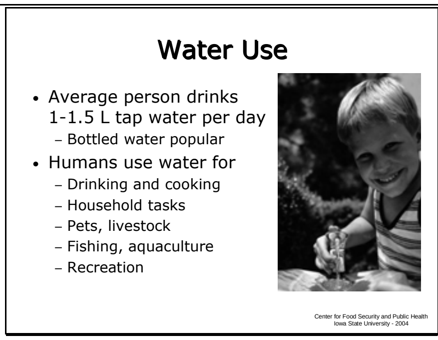


Slide 2



Fifty-three percent of U.S. drinking water comes from ground water, which is naturally filtered as it moves from the surface to underground aquifers. Surface waters such as lakes, reservoirs and streams are often used as city water sources, but they require more treatment.

Slide 3

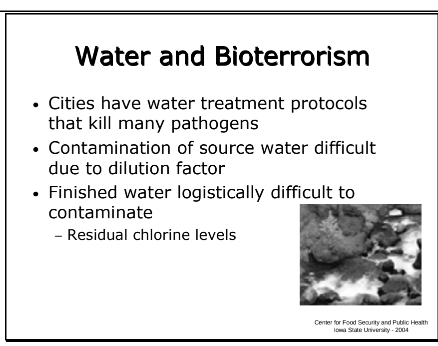


Many people drink bottled water, and on average people only drink 1-1.5 liters of tap water per day. Therefore, most water is used for showers, toilets, cleaning, etc. Humans use water for many things: drinking, cooking, household tasks (showers, toilets, cleaning, laundry), pets, livestock, fishing, aquaculture, recreation.

Slide 4

There are two governmental regulations that protect our water supply. The Safe Drinking Water Act protects surface water for drinking, recreation and aquatic food. The Clean Water Act regulates the potential contamination of finished drinking water and also protects source waters.

Slide 5



The risk of bioterrorism via the water supply is low for several reasons. Many cities have water treatment protocols that will inactivate many pathogens. Biological agents introduced into a body of water would be greatly diluted, thereby decreasing the threat. Finished water would be difficult to contaminate as it would require access to holding tanks, reservoir towers or distribution systems. Finished water has residual chlorine levels that would affect most pathogens.

Slide 6

Chlorine Resistant Agents

- Chlorination inactivates most agents
- Resistant agents include
  - *Clostridium perfringens*
  - *Bacillus anthracis* (Anthrax) spores
  - *Cryptosporidium*

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There are approximately 27 biological and chemical agents that could potentially be used to contaminate water sources. A few of the pathogens resistant to chlorine include *Clostridium perfringens, Cryptosporidium*, and Anthrax spores. Some water treatment facilities are now using ozone, which easily destroys most chorine-resistant microbes, in the treatment process.

Slide 7

Cryptosporidium parvum

- Coccidian protozoa
- Located worldwide
- Primarily infects small intestine
- Oocysts resistant to disinfection
- Transmission
  - Aerosol (rare)
  - Fecal-oral
    - Person-to-person
    - Animal-to-person
    - Waterborne
    - Foodborne
    - Mechanical (cockroaches, flies)

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Cryptosporidium parvum is a protozoan and is a obligate intracellular pathogen. *Cryptosporidium* has been isolated in 50 countries and six continents. The organism primarily infects the small intestine of humans and mammals. Sporulated thick-walled oocysts are infectious and are resistant to many chemical disinfectants. Ozone, which is sometimes used in the water treatment process, effectively kills oocysts. The organism is transmitted through aerosol (rarely) or fecal-orally through person-to-person, animal-to-person, waterborne and foodborne routes. Cockroaches may carry the agent on their feet/legs to food, serving as a mechanical source of infection.

Slide 8

Cryptosporidium: History

- 1912
  - Discovered by Tyzzer
    - American parasitologist
- Outbreaks associated with
  - Drinking water, food, swimming pools and lakes, unpasteurized apple cider, hospitals (nosocomial), HIV wards, pediatric hospitals

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In 1912, Earnest Edward Tyzzer reported discovery of *C. parvum*, which is now recognized as the parasite usually responsible for mammalian cryptosporidiosis. In the 1970's, it was not clear whether *C. parvum* was an opportunistic parasite or a pathogen. Image from: Illustrated history of tropical diseases, the Wellcome Trust. Edited by FEG Cox. Many outbreaks have occurred in recent years. Some have been associated with drinking water, food, swimming pools and lakes, unpasteurized apple cider and hospitals (nosocomial infections).

Slide 9

Cryptosporidium: History

- 1993: Milwaukee, WI
  - Largest water supply outbreak
  - 40,000 ill
- 1997: Minnesota Zoo
  - Decorative water fountain
  - 369 cases
    - Most <10 years old

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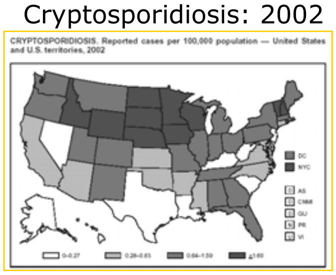
There have been two large outbreaks of *Cryptosporidium* in recent years. In 1993, there was an outbreak in the municipal water supply in Milwaukee, WI, causing about 40,000 illnesses. Another outbreak occurred at the Minnesota Zoo, associated with a large decorative water fountain where children were allowed to play. There were 369 cases of *Cryptosporidium* infection, most occurring in children under the age of 10 years.

Slide 10

Cryptosporidiosis: 2002



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This slide shows the reported cases of Cryptosporidiosis per 100,000 people in the U.S. in 2002. These data suggest that the disease is geographically widespread, with particularly high incidences in the northern midwestern states. However, due to differences in surveillance and data reporting, this may be difficult to properly interpret. There is usually a seasonal peak in incidence between late summer and fall (July and October). There were a total of 3,016 cases reported in the U.S. in 2002. Data from the Summary of Notifiable Diseases 2002, CDC website.

Slide 11

Cryptosporidium: Humans

- Incubation: 1-12 days
- Healthy people
  - Asymptomatic
  - Acute self-limiting gastroenteritis
    - 13 days in duration
    - 10% require rehydration therapy
- Immunosuppressed people
  - Severe, life-threatening
    - Pulmonary or tracheal cryptosporidiosis
    - Low-grade fever
    - Severe intestinal symptoms

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Incubation period in humans ranges from 1 to 12 days, with 7 days being most typical. In healthy people, the disease is usually a self-limiting gastroenteritis (characterized by vomiting, weight loss, fever, watery diarrhea, cramping, abdominal pains, flatulence, malaise, myalgia) of about 13 days in duration, and about 10% of these patients will require hospitalization for rehydration. In immunosuppressed patients (chemotherapy, HIV, elderly, etc.) the disease can be severe and debilitating. These infections can result in pulmonary or tracheal cryptosporidiosis, low-grade fever, or severe intestinal symptoms.

Slide 12

Cryptosporidium: Animals

- Mammals
  - Pigs, camelids, cats, dogs, deer, rodents, rabbits, primates, cattle, sheep, goats, horses, hamsters, guinea pigs
  - Severe disease in young and immunosuppressed
  - Treatment
    - Supportive therapy

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Cryptosporidium has been reported in many animals including: camelids, cats, dogs, deer, rodents, rabbits, hamsters, guinea pigs, primates, cattle, sheep, goats, horses, pigs. The disease can be severe in very young or immunocompromised animals, and treatment is supportive therapy.

Slide 13

Cryptosporidium: Animals

- Calves
  - 1-3 weeks of age
  - Incubation period
    - Average 4 days
  - Anorexia, profuse diarrhea, tenesmus, weight loss
- Horses, pigs, companion animals
  - Infection usually inapparent

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Calves one to three weeks old seem to be most susceptible. Mean incubation period is four days. Clinical signs include anorexia, diarrhea, tenesmus and weight loss. Infection is usually inapparent in horses, pigs, and companion animals.

Slide 14

Cholera

- *Vibrio cholerae*
- Humans only natural host for disease
- Transmission
  - Fecal-oral, contaminated water source
- Incubation: hours to 5 days
- Disease
  - Subclinical
  - Self-limiting
  - Severe (dehydration)

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Cholera is the result of infection by the Gram-negative bacteria *Vibrio cholerae*. Humans appear to be the only natural hosts, while rabbits, mice and chinchillas have been experimentally infected. Dogs may be susceptible if the dose of agent is very large. Cholera is fecal-orally transmitted (e.g. through contaminated water supply) and the incubation period ranges from hours to 5 days (most commonly 2 to 3 days). Infections can be subclinical, self-limiting (mild gastroenteritis), or severe. Severe disease can result in profuse watery diarrhea and vomiting, causing severe dehydration ("ricewater feces") and shock. Most deaths are due to dehydration. Without treatment, death can occur within hours.

Slide 15

Cholera

- Sources
  - Contaminated drinking water or food
  - Usually feces of infected person
    - International travel
  - Shellfish
    - Bacterium can live in brackish rivers and coastal waters

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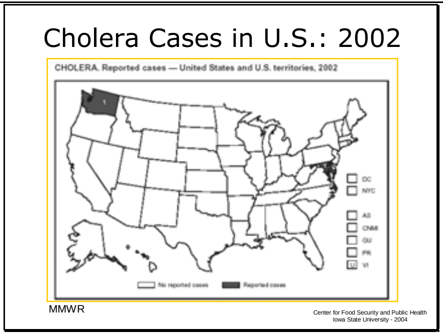
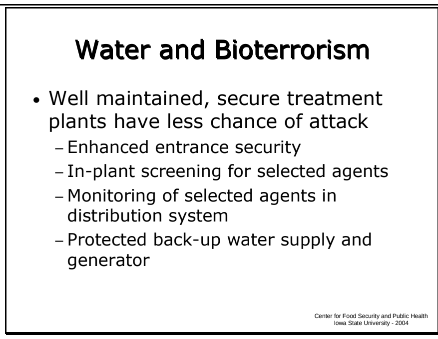
Sources of cholera infection could include: contaminated drinking water or food, other infected people or shellfish (bacterium can live in brackish rivers and coastal waters). While cholera has international implications if discovered in the U.S., its use as a bioterrorism agent is less than ideal since it is killed by the chlorine added to water in the treatment process. The U.S. has experienced cholera cases before as a result of global spread of the disease and from international travel.

Slide 16



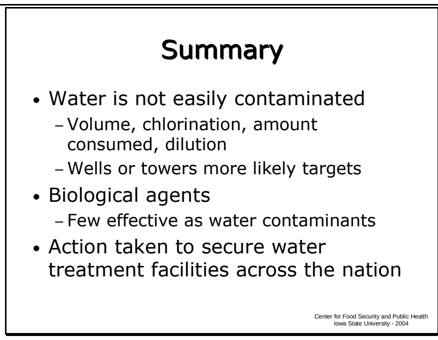
This map shows the reported cases of cholera in the U.S. (in Maryland and Washington state) in 2002. Infection is rare in the U.S. due to modern sewage and water treatment systems; most infections are acquired through travel to developing countries or through consumption of contaminated seafood. There is a vaccine for cholera, although it is no longer available in the United States and is not recommended for international travelers. There were a total of 2 cases reported in the U.S. in 2002. Data from the Summary of Notifiable Diseases 2002, CDC website.

Slide 17



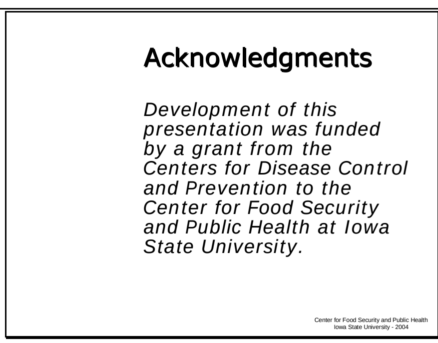
What can be done to protect water from bioterrorism? Well maintained, secure treatment plants, such as those with enhanced entrance security, in- plant screening for selected agents, monitoring of the distribution system for selected agents, and protected back-up water supply and generator have less chance of attack. Careful scrutiny of employees and security checks on new hires are also recommended.

Slide 18



Municipal treatment plants are unlikely targets for bioterrorism with biological agents due to the fact that most cities process large volumes of water and chlorinate it. Agents will not survive chlorination in all probability, with the exception of chlorine resistant organisms such as cryptosporidium. Even then, if ozone or nanofilters are used in the treatment process then the agent will be removed. Untreated water from wells that serve small communities or families, and possibly water towers, are more likely targets of terrorists. However, even in rural areas some water towers hold very large volumes (1 million gallons or more) and are not easy to break in to. There have been many biological agents considered to be used for water bioterrorism, but almost all of these would only be effective when used in untreated water systems or in large quantities put into small volumes. On June 12, 2002, the President signed the "Public Health Security and Bioterrorism Preparedness Response Act of 2002". Public Law 107-188 is designed to improve the ability of the United States to prevent, prepare for, and respond to bioterrorism and other public health emergencies. Included is the requirement that water treatment plants conduct evaluations of security and enact measures to make terrorism unlikely against the water they produce.

Slide 19



Slide 20

Acknowledgments

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