
Water Treatment

NOTES

USDA Water Quality Program, Cornell Cooperative Extension

Cryptosporidium; a Waterborne Pathogen

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Fact Sheet 15, July 1996, updated August 2004

What is *Cryptosporidium*?

Cryptosporidium (crip-toe-spor-ID-ee-um) is a protozoan, a single-celled parasite that lives in the intestines of animals and people. This microscopic pathogen causes a disease called cryptosporidiosis (crip-toe-spor-id-ee-O-sis).

The dormant (inactive) form of *Cryptosporidium*, called an oocyst (O-o-sist), is excreted in the feces (stool) of infected humans and animals. The tough-walled oocysts survive under a wide range of environmental conditions.

What are the symptoms of cryptosporidiosis?

The most common symptom of the disease is watery diarrhea. There may also be abdominal cramps, nausea, low-grade fever, dehydration, and weight loss. Symptoms usually develop 4 to 6 days after infection but may appear any time from 2 to 10 days after infection.

People with healthy immune systems are usually ill with cryptosporidiosis for several days but rarely more than two weeks. Some infected individuals may not even get sick. Some people with cryptosporidiosis seem to recover, then get worse again. Those who are infected may shed oocysts in their stools for months, even after they no longer appear to be ill.

Cryptosporidiosis may cause complications for those with illnesses or conditions such as diabetes, alcoholism, or pregnancy. The effects of prolonged diarrhea and dehydration can be dangerous, especially for the very young, the elderly, and the frail.

Cryptosporidiosis is most severe and long-lasting in immunocompromised individuals (those whose immune systems are weak), such as people infected with HIV (the virus that causes AIDS), cancer patients on chemotherapy, transplant patients, or others taking medications that suppress the immune system.

How is this disease diagnosed and treated?

Cryptosporidiosis cannot be diagnosed by symptoms alone. Watery diarrhea is a symptom of many intestinal diseases caused by bacteria, viruses, or parasites. If *Cryptosporidium* is the suspected cause of an intestinal illness, the doctor should request a specific diagnostic test.

There is currently no drug that can cure cryptosporidiosis. People with competent immune systems will recover on their own and appear to develop some immunity to subsequent infections. Anti-diarrheal medicines may ease some of the symptoms. Anyone with diarrhea should drink plenty of fluids to prevent dehydration.

How is the pathogen spread?

You can get infected with *Cryptosporidium* when you put anything in your mouth that has been in contact with feces from an infected animal or person. When large numbers of people get cryptosporidiosis, the source of infection can sometimes be tracked down, but it is impossible to determine the origin of many individual cases of this disease.

Your hands may be contaminated with *Cryptosporidium* through person-to-person contact, perhaps while changing a child's diaper, caring for someone with diarrhea, or engaging in any activity that involves touching areas of the body contaminated with feces.

Cryptosporidiosis can be easily spread among people in close social groups such as families, day care centers, and nursing homes. People who work with animals, especially young animals or animals with diarrhea, have a greater chance of exposure to the parasite. You may pick up oocysts while handling a litter box, soil, or any object contaminated with even a small amount of feces.

You can also get cryptosporidiosis by drinking water or eating food that has been contaminated with oocysts. Drinking untreated surface water (such as streams, rivers, and lakes) or swallowing a small amount of water when swimming, even in a chlorinated pool, can cause cryptosporidiosis. The parasite may also be spread in uncooked foods, beverages, or ice prepared with contaminated water. Unwashed fresh fruits or vegetables may carry oocysts if manure was used or animals grazed where the crop was grown.

People who are infected (or whose hands become contaminated) with *Cryptosporidium* can spread the disease to other people or pets if they are not careful about their hygiene. Frequent hand washing is the single most important thing people can do to avoid spreading cryptosporidiosis and other illnesses. It is especially important to wash thoroughly before preparing food, as well as after using the toilet.

Oocysts are not killed by typical household disinfectants, including bleach, but are killed at temperatures over 160 °F (hotter than most domestic hot tap water). Thorough drying in a clothes dryer will kill oocysts by desiccating them.

Is cryptosporidiosis a new disease?

Cryptosporidiosis has long been a veterinary problem, predominantly in young farm animals such as calves. *Cryptosporidium* was first recognized as a cause of human disease in 1976 but was rarely reported in humans until 1982. The number of detected cases began to rise rapidly along with the AIDS epidemic and the development of methods to identify the parasite in stool samples. The earliest cases of human cryptosporidiosis were diagnosed in animal handlers. An outbreak at a day care center was first documented in 1983.

In 1987, 13,000 people in Carrollton, Georgia, became ill with cryptosporidiosis. This was the first report of its spread through a municipal water system that met all state and federal drinking water standards. In the spring of 1993 in Milwaukee, Wisconsin, municipal drinking water, again within standards, was contaminated with *Cryptosporidium*. An estimated 400,000 people became ill, and the disease contributed to the deaths of some AIDS patients. These outbreaks focused attention on the risk of waterborne cryptosporidiosis and the possible need for stricter drinking water standards.

How many people get cryptosporidiosis?

We do not know exactly how many cases of cryptosporidiosis actually occur. Many people do not seek medical attention or are not tested for this parasite and so *Cryptosporidium* often goes undetected as the cause of an intestinal illness.

Health professionals in some states are on the lookout for cases of cryptosporidiosis through surveillance programs at hospitals, clinics, and labs. The Centers for Disease Control and Prevention (CDC) in Atlanta, Georgia, keep track of many disease-causing organisms and send out warnings and advice on controlling outbreaks to every health department in the United States. warnings and advice on controlling outbreaks to every health department in the United States.

How prevalent is *Cryptosporidium* in surface water?

Oocysts are present in most surface bodies of water (e.g., lakes, rivers) across the United States, many of which supply public drinking water. Oocysts are more prevalent in surface waters when heavy rains increase runoff of wild and domestic animal wastes from the land or when sewage treatment plants are overloaded or break down.

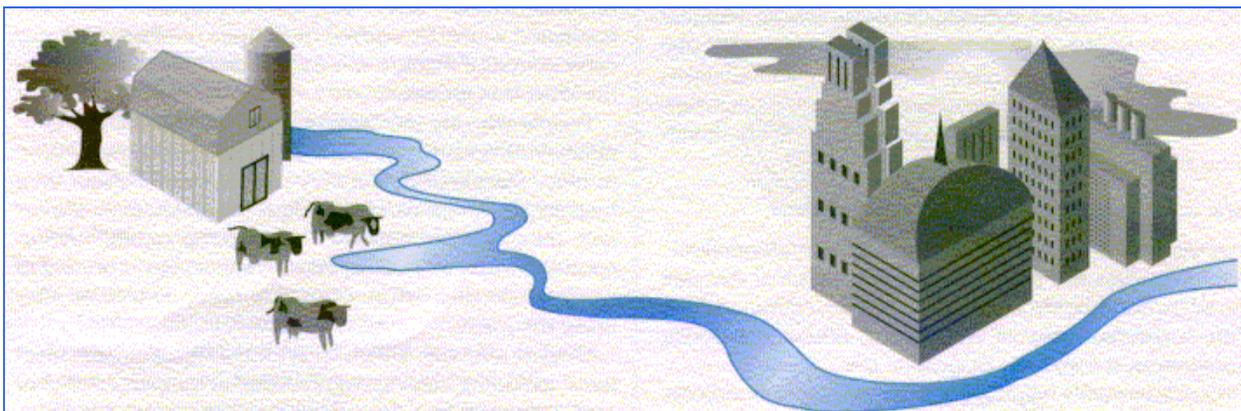


Figure 1: Cryptosporidium contamination originates from animal waste that enters the city drinking water intake facility.

Only laboratories with specialized capabilities can detect the presence of *Cryptosporidium* oocysts in water. Unfortunately, current sampling and detection methods are unreliable. It is difficult to recover oocysts trapped on the material used to filter water samples. Looking at a sample under a microscope, it is not easy to determine whether an oocyst is alive or whether it is the species *Cryptosporidium parvum* that can infect humans.

The number of oocysts detected in raw (untreated) water varies with location, sampling time, and laboratory methods. Water treatment plants remove most but not always all oocysts from municipal drinking water. It is not known exactly how many oocysts are sufficient to cause cryptosporidiosis, but the low numbers of oocysts sometimes present in drinking water are not considered cause for alarm in the general public.

How can we protect our water supplies from *Cryptosporidium*?

Multiple barriers are needed to protect our water supplies from *Cryptosporidium*. Water treatment methods alone cannot solve the problem; watershed protection and monitoring of water quality are critical.

Water treatment

Cryptosporidium oocysts have tough walls that can withstand many environmental stresses and are resistant to the chemical disinfectants such as chlorine that are traditionally used in municipal drinking water systems and swimming pools.

Physical removal of particles, including oocysts, from water by filtration is an important step in the municipal water treatment process. Typically, water pumped from rivers or lakes into a treatment plant is mixed with coagulants that help settle out particles suspended in the water. If sand filtration is used, even more particles are removed. Finally, the clarified water is disinfected and piped to customers.

Ultraviolet (UV) light can be used to inactivate *Cryptosporidium* and another parasite, *Giardia lamblia*. Ozone is a strong disinfectant that kills protozoa if sufficient doses and contact times are used. Both UV and ozone leave no residual for killing microorganisms in the distribution system, as does chlorine. The high costs of new filtration, UV light, or ozone treatment plants have to be weighed against the benefits of additional treatment. Even well operated water treatment plants cannot ensure that drinking water will be completely free of *Cryptosporidium* oocysts.

Watershed protection

Watershed protection is another barrier to *Cryptosporidium* in drinking water. Land use controls such as septic system regulations and best management practices to control runoff can help keep human and animal wastes out of the water.

Water treatment regulations

The U.S. Environmental Protection Agency (EPA) has set a standard of 99% removal of *Cryptosporidium* for public water systems "...using surface water or groundwater under the direct influence of surface water...[and] serving > 10,000..." people. This standard applies to smaller systems that provide water for less than 10,000 people.

How can you tell if the tap water is safe?

Properly drilled and maintained wells that tap into groundwater are unlikely to contain pathogens because of the natural filtration that takes place as water percolates down through the soil. But contaminants may flow into groundwater aquifers that lie beneath coarse soils or fractured bedrock. Very shallow or poorly constructed wells and springs can be contaminated with surface water runoff that carries disease-causing microbes. It is important that the well be protected from surface contamination by an intact well casing, proper seals, and a cap above ground.

The risk of waterborne cryptosporidiosis from public drinking water varies depending on the quality of the source water and type of water treatment. HIV-infected persons should follow the guidelines issued by the CDC and talk with their health care providers about safe drinking water. When routine testing of public drinking water indicates potential danger, the health department or water utility will issue a "boil water" notice.

How can you make sure your own drinking water is safe?

There are four measures you may wish to take to ensure that your drinking water is safe: boil your water to kill pathogens, remove oocysts from your water with certain types of filters, treat water with a UV light system, or drink certain types of bottled water. Boiling water is the best method of killing *Cryptosporidium* and other waterborne pathogens; water should be brought to a *rolling boil* for at least one minute. It should be stored in the refrigerator in a clean bottle or pitcher with a lid. To prevent recontamination, be careful not to touch the inside of the water bottle or lid.

Water can be filtered to remove *Cryptosporidium* and *Giardia* cysts. Point-of-use filters may be used to treat the water for drinking or preparing foods. They may be either attached to a faucet or have a pour-through design. Only filters with an "absolute" (not "nominal") pore size of one micron (1 μ) or smaller will remove all the oocysts (viruses, however, can pass through a 1 μ filter). The pores of reverse osmosis (RO) membranes are too small for oocysts to pass through. NSF International, an independent, nonprofit testing agency, publishes lists of filters and RO units certified for "cyst reduction." Follow the manufacturer's instructions that are supplied with water treatment equipment to prevent clogging and ensure proper filtration. The filter cartridge(s) and membrane will need to be replaced periodically. Improper maintenance can actually increase health risks.

UV light water treatment systems can inactivate *Cryptosporidium* and *Giardia* cysts. NSF International has developed standards for these systems, and certified systems can be found on the NSF website at www.nsf.org. For more information on these systems, see our fact sheet entitled "Ultraviolet Radiation for Disinfecting Household Drinking Water".

Isn't all bottled water safe to drink?

Under current standards, bottled water is not necessarily any safer than tap water. Bottled water from deep wells (groundwater sources) has a very low likelihood of containing oocysts, but bottled water from a surface water source has the same risk of containing oocysts as tap water from that source unless it is treated before bottling.

Read the label on bottled water for information about the water source and treatment. Water can be distilled or pasteurized to kill all pathogens before bottling. Oocysts can be inactivated by UV or ozonation. Oocysts can also be removed by reverse osmosis or a filter with an absolute one-micron rating. Other micro filtration or ion-exchange methods or treatment with chlorine or carbon dioxide *cannot* promise crypto-free water.

The heat of pasteurization will kill all pathogens in dairy products. Bottled and canned bubbly drinks such as sodas and beer are usually heated or filtered enough to kill or remove *Cryptosporidium*.

How can you avoid getting cryptosporidiosis?

You can minimize the chances of getting infected with *Cryptosporidium* (and numerous other pathogens) by always practicing good hygiene, especially after possible exposure to sources of infection. People with compromised immune systems must consistently take precautions *to avoid* exposure to *Cryptosporidium*.

- Wash your hands thoroughly with soap and water (and supervise children's hand washing)
- after using the toilet or changing diapers.
- after handling animals or cleaning up feces.
- after working in dirt or touching any objects such as shoes that may have been contaminated with fecal matter.
- before preparing, serving, or eating food.
- Avoid drinking untreated water from lakes, streams, and other surface water bodies.
- Because of possible contamination with manure, peel or rinse fruits or vegetables to be eaten raw.
- Take extra care in selecting food and drink when traveling to places with poor sanitation.
- Follow any water advisories issued by local health departments, state authorities, or the national Centers for Disease Control and Prevention.
- To treat contaminated water before drinking it, bring it to a rolling boil for at least one minute to kill oocysts or remove them with a filter with an absolute pore size of one micron or smaller.

For more information

- Contact your state or local health department.
 - Call the water utility serving your area.
 - Contact the Cooperative Extension office in your county.
 - Call the U.S. Environmental Protection Agency Safe Drinking Water Hotline at 1-800-426-4791.
 - Call the CDC AIDS Hotline at 1-800-342-AIDS.
- For a listing of drinking water treatment units that meet NSF standards, go to the NSF website at www.nsf.org.

Selected Reference

U.S. Environmental Protection Agency. 2002.
List of Contaminants and their MCLs.
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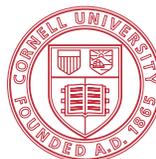
Center for Disease Control
Factsheet Cryptosporidium Infection
http://www.cdc.gov/ncidod/dpd/parasites/cryptosporidiosis/factsht_cryptosporidiosis.htm
(December 2004)

Center for Food Safety and Drug Administration
The bad bug book: *Cryptosporidium parvum*
<http://vm.cfsan.fda.gov/~mow/chap24.html>
(December 2004)

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The information in this fact sheet is not intended as medical advice for individual problems. Illustration by Margaret Nelson.

This publication is issued to further Cooperative Extension work mandated by acts of Congress of May 8 and June 30, 1914. It was produced with the cooperation of the U.S. Department of Agriculture; Cornell Cooperative Extension; and the College of Agriculture and Life Sciences, the College of Human Ecology, and the College of Veterinary Medicine at Cornell University. Cornell Cooperative Extension provides equal program and employment opportunities. Helene R. Dillard, Director
329WQFS6 9/100 5/96 5C CUPS MS50490



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