



GIARDIA: DRINKING WATER FACT SHEET

What is *Giardia*?

Giardia (je-ar' de-ah) are protozoan parasites which occur in a trophozoite and an oval-shaped cyst form. Cysts excreted in the feces of an infected host move passively through the environment. If cysts are ingested, infection may be transmitted to another vertebrate host. The trophozoite causes infection. Excystation to the trophozoite form is initiated in the stomach and completed in the small intestine. The trophozoites divide, attach to the small intestine, and then detach for unknown reasons. During the encystment process, they become rounded and elaborate a cyst wall that protects the cyst as it is excreted and carried through water and other media.

Numerous species of *Giardia* have been found in a variety of mammals, birds, reptiles, amphibians, and fishes. *Giardia* has also been detected in beaver, muskrats, wading birds, voles, mice, shrews, gerbils, rats, deer, native marsupials, Australian brush-tail possums, ringed seals, and llamas. There is no general agreement on the criteria to define species; host specificity, body size and shape, internal structures, and biochemical, molecular, and genetic techniques have all been used. Scientists and physicians describe the specie(s) responsible for human infections as *G. lamblia*, *G. duodenalis*, or *G. intestinalis*.

Where has *Giardia* been found?

The wide occurrence of cysts in humans and animals suggests that soil can be contaminated with *Giardia* through fecal deposition and sewage disposal practices. Municipal waste waters likely always contain *Giardia* cysts. *Giardia* is distributed worldwide in lakes, ponds, rivers, and streams. It is even found in high quality water sources with no municipal wastewater discharges. All surface waters probably contain *Giardia*, and whether cysts are detected depends largely on the methods used to collect and analyze water samples.

In North America, higher levels in water are often reported in the late summer, fall and early winter. Generally, there is no correlation of cyst levels in water with coliform bacteria. When *Giardia* cysts are detected in environmental samples, information about viability, infectivity, or species is not usually available.

Reported *Giardia* levels have ranged from 10,000 to 100,000 cysts/L in untreated sewage, 10 to 100 cysts/L in treated sewage, and 10 or few cysts/L in surface water sources and tap water. Cysts have also been detected in cisterns and in wells contaminated by surface water or sewage. Levels are generally higher in water sources influenced by agriculture (e.g., cattle or dairy farming) or municipal and residential wastewater discharges. Contamination levels may

fluctuate due to storms, agricultural practices, and the operation of wastewater facilities.

Giardia has been detected on stainless steel and Formica® surfaces in day care centers. Limited information is available on the levels of cysts in foods; improvements are needed in both sampling and analytical methods. There are no published reports on the occurrence of *Giardia* in air.

How long can *Giardia* cysts survive in the environment?

The survival of *Giardia* cysts in the environment is significantly affected by temperature; survivability decreases as the temperature increases. A small fraction of cysts can withstand a single freeze-thaw cycle. Cysts can survive for 2 to 3 months in water temperatures of less than 10 °C, and at 21 °C, cysts have remained viable for almost one month. Cysts are killed in 10 minutes at a water temperature of 54 °C. Raising the water temperature to boiling immediately kills cysts.

How infective are *Giardia* cysts?

Giardia cysts are highly infective. As few as ten human-source *Giardia* cysts produced infection in a clinical study of male volunteers. The incubation period (time interval between ingestion and the first appearance of symptoms) can range from 3 to 25 days.

Can *Giardia* be transmitted between animal species?

Giardia from some animals exhibit an apparent high degree of host specificity, but other isolates may infect more than one host. The role of animals in causing human infection is not clear, but evidence suggests that the beaver and possibly the muskrat is a source of infection for humans.

How prevalent is *Giardia* infection in humans?

Giardiasis is the most commonly reported intestinal protozoan infection worldwide; an estimated 200 million people are infected each year. In the United States, *G. lamblia* is the most frequently identified parasite in stool specimens submitted for parasitological evaluation.

Giardia infection tends to be more common in children than adults. Depending on the geographical area, studies have found from 1-68% of children to be infected. In many developing countries, most children under five years of age have been infected at least once. In two studies in the United States, 7% of children aged 1 to 3 years and 11% of infants and toddlers tested for admission to day-care centers were found to be infected.

How prevalent is *Giardia* infection in domestic and wild animals?

Giardia is a common protozoan parasite of farm animals, especially calves and lambs. Dogs are frequently found infected; cats less frequently. In different areas of the United States, 7-16% of beavers were found to be infected; 95% of muskrats were found to be infected.

What are the health effects of *Giardia* infection?

Giardia infection may be acquired without producing any symptoms, and this is often the case for children. In symptomatic patients, acute diarrhea is the predominate feature. In some instances, diarrhea may be transient and mild, passing without notice; in others diarrhea can be chronic. Other symptoms may include abdominal cramps,

bloating, flatulence, steatorrhea (daily losses of fat in feces greater than 7 grams), weight loss, and occasionally vomiting. Stools may be pale, greasy, and malodorous. Weight loss may be significant. In some patients, symptoms last for only 3 or 4 days, while in others symptoms can last for months or years.

Rarely does *Giardia* infection cause death, but each year 4,600 persons with giardiasis are estimated to be hospitalized in the United States. Hospitalized cases are primarily children under five years of age, and dehydration is the most frequent co-diagnosis.

A potentially serious consequence is nutritional insufficiency which may result in impaired growth and development of infants and children. Other reported associations with giardiasis in children include malabsorption of iron, allergic reactions, inflammation of the synovial membranes of major joints, and non-progressive retinal changes; these all require additional study.

Is treatment available for giardiasis?

As with all diarrheas, fluid replacement is important. Anti-giardial agents can be important in the management of individual cases but may not prevent reinfection of children in day-care centers or areas where exposures are frequent. Drugs have different effectiveness in their ability to clear *Giardia*, and side-effects should be considered, especially for pregnant women.

Who is at risk?

Giardia is frequently spread directly from person to person, especially among young children in day-care centers, nurseries, or institutions and among persons living in

areas with poor sanitation and hygiene. Although 7-54% of children attending day-care centers in the United States may be infected, infections are primarily without symptoms and do not result in adverse growth effects. An estimated 5-20% of household contacts and 9-35% of care-center staff also may be infected.

Studies have not found that pets are an importance source of infection. Several small foodborne outbreaks have been associated with ice and foods contaminated by food service workers, but restaurant-associated transmission of *Giardia* does not appear to be a significant problem. High attack rates have been reported in travelers to endemic areas. Giardiasis can also be transmitted by some sexual activities, particularly among male homosexuals who practice oral-anal sex.

Giardia can be an important cause of endemic and epidemic waterborne illness. In the United States, increased risks have been found in populations where surface water sources are not filtered, persons who use shallow well water systems, persons who drink contaminated water while picnicking, camping, and hiking, and persons who accidentally ingest water during swimming and other water recreational activities. Poorly maintained wading and swimming pools and heavily used swimming areas at lakes and ponds pose an increased risk, especially if they are used by diaper-age toddlers or other persons prone to fecal accidents.

What causes waterborne outbreaks?

Since 1971, *Giardia* has been the most commonly identified pathogen in waterborne outbreaks reported in the United States. More than 130 waterborne outbreaks have been

reported in 27 states; both residents and travelers have been affected. Outbreak statistics emphasize the need for filtration of surface water, optimization of the filtration process, frequent monitoring of treatment effectiveness, and better protection and treatment for ground water.

How effective is water treatment?

When operated under appropriate conditions, commonly used filtration technologies can effectively remove *Giardia* cysts from water. The highest removal by granular filters is achieved when coagulation is optimized. Care must be exercised when selecting membranes; those that can remove *Giardia* cysts may not be effective for other protozoa, like *Cryptosporidium*, that are smaller in size. Commonly used water disinfectants can effectively inactivate *Giardia* cysts depending on the disinfectant concentration and contact time. Cysts are relatively more resistant to disinfectants than bacteria and viruses, and high doses and lengthy contact times may be needed. This may result in high levels of disinfection by-products which are regulated by the EPA.

What is being done to reduce waterborne risks?

EPA's Surface Water Treatment Rule (SWTR) requires that public water systems filter, except in rare circumstances, and disinfect surface water and groundwater that is directly impacted by surface water; 99.9% of *Giardia* must be removed or killed.

How important is waterborne transmission of giardiasis?

A risk assessment has estimated that in the United States as many as 250 infections per 10,000 people may occur each year from

exposures to *Giardia* in drinking water. Although the limitations of this risk assessment are recognized, this estimate suggests that more stringent water treatment requirements may be needed. The EPA is currently collecting occurrence information about *Giardia* in water systems throughout the country. When this information becomes available, waterborne risks can be estimated again using this and other newly developed risk assessment models.

Whom should I contact if I suspect an outbreak is occurring?

If you or members of your family are diagnosed with giardiasis and suspect that your neighbors, fellow travelers, or children's friends may also be infected, you should discuss this with your physician or a public health worker in your local or state health department. Most health departments require that physicians and laboratories report giardiasis cases to them. Health department epidemiologists investigate disease clusters and increased reports of disease to determine if they are caused by contaminated water or food or other sources. Health departments may ask the Centers for Disease Control and Prevention (CDC) in Atlanta to assist in an outbreak investigation. The EPA can assist the CDC in the investigation of suspected waterborne outbreaks.

Whom should I contact if I am concerned about my drinking water?

If you suspect your water system is contaminated, you should contact your water utility and ask about the effectiveness of their treatment. State agencies can also provide information about public water systems and their water quality. In some states, the health

department will have regulatory jurisdiction; in others, a department of environmental quality or natural resources will have this responsibility. Your health department or county agriculture extension office can provide assistance and advice about the contamination and water treatment of non-public or individual water systems.

Home and personal water treatment systems should be carefully selected. If your home water supply is subject to contamination with *Giardia*, you should select a system that can remove or kill 99.9% of *Giardia* and *Cryptosporidium* and 99.99% of waterborne enteric viruses and bacteria. Independent testing groups, like NSF International, evaluate the effectiveness of water treatment devices. Heating water to at least 70° C for 10 minutes or boiling water for one minute at sea level (three minutes at high altitudes) is also acceptable.