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Giardiasis


Giardia Enteritis
Lambliasis
Beaver Fever

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Overview

- Organism
- History
- Epidemiology
- Transmission
- Disease in Humans
- Disease in Animals
- Prevention and Control



In today's presentation we will cover information regarding the organism that causes giardiasis and its epidemiology. We will also talk about the history of the disease, how it is transmitted, species that it affects (including humans), and clinical and necropsy signs observed. Finally, we will address prevention and control measures, as well as actions to take if giardiasis is suspected.

[Photo: Scanning electron micrograph (SEM) of a flagellated *Giardia lamblia* protozoan parasite. Source: Janice Carr/CDC Public Health Image Library]

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ORGANISM

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Organism

- *Giardia intestinalis*
 - Protozoal parasite
- Also known as:
 - *Giardia lamblia*
 - *Lamblia intestinalis*
 - *Giardia duodenalis*
- Isolated from humans, domestic animals, and wild animals



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Giardiasis is caused by *Giardia intestinalis*, a protozoal parasite. This organism is also called *Giardia lamblia*, *Lamblia intestinalis* and *Giardia duodenalis*. The organisms isolated from humans, domestic animals and most wild animals appear to be identical; however, it is possible that *G. intestinalis* is actually a complex of several different species or subspecies.

[Photo: *Giardia intestinalis* trophozoites in a Giemsa stained mucosal imprint. Source: Centers for Disease Control and Prevention at http://www.cdc.gov/parasites/giardia/gen_info/faqs.html]

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Organism

- Human infections
 - Humans are main reservoir
- Interspecies/zoonotic transmission
 - Importance of animal reservoirs unclear
- Non-zoonotic *Giardia* spp. found in:
 - Rodents
 - Birds
 - Reptiles
 - Amphibians

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Humans are thought to be the main reservoir of infection for humans. Interspecies transmission of *G. intestinalis* has been demonstrated, and zoonotic transmission is thought to occur. However, the importance of animal reservoirs for human disease is controversial. Other species of *Giardia* are found in rodents, birds, reptiles and amphibians. These organisms are not known to be zoonotic. *Giardia muris* is seen in rodents, bird and reptiles. *Giardia agilis* occurs in amphibians.

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HISTORY

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History

- 1681
 - van Leeuwenhoek, the "Father of Microbiology," observes *Giardia* trophozoites in his own stool
- Doubt common regarding pathogenicity of *Giardia* organisms
- 1970s
 - Symptomatic travelers from Soviet Union increased awareness

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van Leeuwenhoek, known as the "Father of Microbiology" first observed a *Giardia* trophozoite obtained from his own stool in 1681. The pathogenicity of *Giardia* was doubted over the years; however, an outbreak in symptomatic travelers from the Soviet Union in the early 1970s increased awareness and recognition of the disease. Source: Wolfe M.S. Giardiasis. *Clin. Microbiol. Rev.* Jan 1992;5(1):93-100.

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EPIDEMIOLOGY

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Geographic Distribution

- *Giardia intestinalis*
 - Occurs worldwide
 - Most common in warm climates

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Giardia intestinalis occurs worldwide, and is particularly common in warm climates.

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**Morbidity and Mortality:
Humans**

- Populations affected
 - Children
 - Travelers, hikers
 - Swimmers
- Prevalence in developed countries
 - 2% of adults
 - 6-8% of children
 - Up to 15% in developing countries

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Giardiasis occurs most often in children and is common in day care centers. It is also prevalent in travelers, hikers and backpackers, and swimmers in contaminated water. In addition, cases are seen in homosexual men, probably due to sexual transmission. Giardiasis is seen in approximately 2% of adults and 6-8% of children in developed countries worldwide. In developing countries, the prevalence of infection may be greater than 15% in children. Many immunocompetent people seem to have good immunity to re-infection.

[Photo: (Top) Child. Source: CDC Public Health Image Library. (Bottom) Stream. Source: www.geograph.org.uk]

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**Morbidity and Mortality:
Humans**

- Naïve populations
 - Morbidity rate up to 20%
- Infections often resolve spontaneously
- Chronic infections occur
 - May contribute to decreased lifespan in immunodeficient individuals

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Epidemics can occur due to contaminated drinking water, food or recreational waters such as ponds. Community-wide outbreaks have occasionally been associated with municipal drinking water. During epidemics in naïve populations, the morbidity rate can reach 20%. Most infections are asymptomatic, and symptomatic cases in healthy people usually resolve spontaneously in 1 to 2 weeks. Chronic infections, lasting months or years, occur in less than 4% of patients. Chronic cases can be seen in both immunodeficient and immunocompetent individuals. In immunodeficient persons, chronic giardiasis can contribute to a decreased lifespan.

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**Morbidity and Mortality:
Animals**

- Young animals most affected
- Reported prevalence rates
 - Puppies: 20-35%
 - Kittens: 10-15%
 - Foals: 17-32%
 - Calves: 5-90%
 - Lambs: 6-80%
 - Pigs: 7-44%
- Usually not life threatening

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Both infection and disease occur more often in young animals. Reported prevalence rates are 20-35% in puppies, 10-15% in kittens, 17-32% in foals, 5-90% in calves, 6-80% in lambs and 7-44% in pigs. Approximately 2-10% of dogs and cats are subclinical carriers. Crowding increases the risk of transmission, and cases may be more common in kennels and catteries. Many infections are self-limiting, and giardiasis is not usually life-threatening.

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Giardiasis Incidence, 2011

* Per 100,000 population.
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Giardiasis is widespread geographically in the United States, with consistent increased reporting in certain states and regions. Whether this difference is of true biologic significance or reflects differences in giardiasis case detection and reporting among states is uncertain.

[Photo: This map depicts the incidence range (per 100,000 population) of *Giardia* cases in the United States and U.S. territories in 2011. Source: Summary of Notifiable Diseases – United States, 2011 at <http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6053a1.htm>]

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**Giardia Case Reports,
by Age, 2006-2008**

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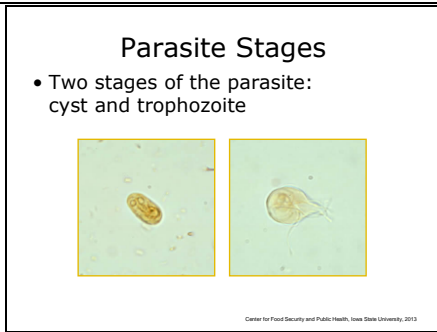
[Photo: This image depicts the number of giardiasis case reports, by age group and year, as reported by the National Notifiable Disease Surveillance System, United States, 2006—2008. Source: Centers for Disease Control and Prevention]

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TRANSMISSION

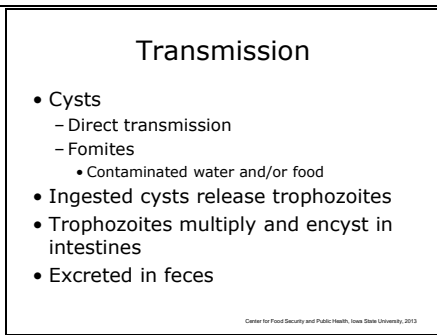
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There are two stages of the parasite: cysts and trophozoites.

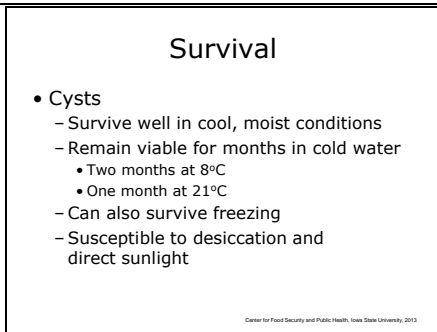
[Photos: (Left) *Giardia intestinalis* cysts in a wet mount stained with iodine; (Right) *Giardia intestinalis* trophozoite in a wet mount stained with iodine. Source: CDC Public Health Image Library]

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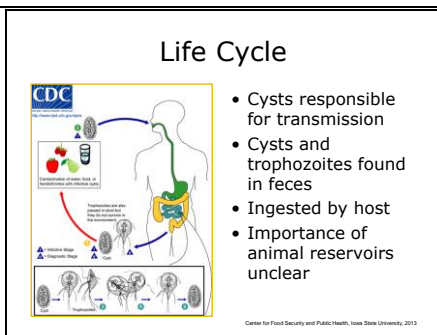
The cysts can be transmitted directly between hosts, or on fomites including contaminated water and occasionally food. Among humans, anal intercourse is a means of spread. Ingested cysts release one or two trophozoites in the small intestines, where the trophozoites multiply. Many of the dividing trophozoites are carried toward the colon, and encyst along the way. The cysts are infectious when they are excreted in the feces or shortly afterward. Trophozoites may also be found in the feces, particularly diarrheic feces.

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Giardia cysts can survive for long periods in the environment under cool, moist conditions, and remain viable for several months in cold water. They have been shown to survive in water for two months at 8°C and one month at 21°C. Some cysts can survive freezing at -13°C for two weeks. *Giardia* cysts are susceptible to desiccation and direct sunlight.

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This image from CDC reviews the life cycle of *Giardia*. As previously stated, cysts are resistant forms and are responsible for transmission of giardiasis. Both cysts and trophozoites can be found in the feces (diagnostic stages)(1). The cysts are hardy and can survive several months in cold water. Infection occurs by the ingestion of cysts in contaminated water, food, or by the fecal-oral route (hands or fomites)(2). In the small intestine, excystation releases trophozoites (each cyst produces two trophozoites)(3). Trophozoites multiply by longitudinal binary fission, remaining in the lumen of the proximal small bowel where they can be free or attached to the mucosa by a ventral sucking disk (4). Encystation occurs as the parasites transit toward the colon. The cyst is the stage found most commonly in nondiarrheal feces (5). Because the cysts are infectious when passed in the stool or shortly afterward, person-to-person transmission is possible. While animals are infected with *Giardia*, their importance as a reservoir is unclear.

[Photo: Life Cycle of *Giardia*. Source: Centers for Disease Control and Prevention]

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DISEASE IN HUMANS

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Disease in Humans

- Incubation period: 1-25 days
- Most infections asymptomatic
- Symptoms of clinical disease
 - Mild to severe gastrointestinal signs
 - Sudden onset diarrhea
 - Foul-smelling stools
 - Abdominal cramps
 - Bloating, flatulence
 - Nausea, fatigue
 - Weight loss

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The incubation period in humans is 1 to 25 days; most infections become clinically apparent after 7 to 10 days. Most human infections are asymptomatic, but some people develop mild to severe gastrointestinal signs. The usual presentation is a sudden onset of diarrhea with foul-smelling stools. The feces may have a greasy appearance, but blood is rarely seen. The diarrhea can be accompanied by abdominal cramps, bloating, flatulence, nausea and fatigue. Weight loss or dehydration can also occur. Vomiting and fever are uncommon.

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Disease in Humans

- Illness usually lasts for 1-2 weeks
- Chronic infections reported
 - May last months to years
 - Immunodeficient and immunocompetent individuals
 - May lead to malabsorption syndromes, vitamin deficiencies, severe weight loss, and debilitation
- Disaccharide intolerance

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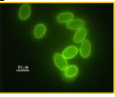
The illness usually lasts for 1 to 2 weeks, but chronic infections of months to years have been reported. Chronic infections have been reported. Chronic infections can be seen in both immunodeficient and immunocompetent individuals, and are characterized by recurrent symptoms that may lead to malabsorption syndromes, vitamin deficiencies, severe weight loss and debilitation. Urticaria has also been reported. In addition, approximately 20-40% of patients develop disaccharide intolerance, particularly lactose intolerance, during the infection and up to six months afterward.

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Diagnosis

- Direct observation in feces
 - Trophozoites
 - "Tear drop" shape
 - Two nuclei and tumbling mobility
 - Cysts
 - Approximately 13 microns long
 - Oval, with 2-4 nuclei
- Immunofluorescence
- ELISA, PCR

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Giardiasis is often diagnosed by direct observation of the trophozoites or cysts in the feces. Either stained preparations or unstained wet mounts can be used. Repeated sampling may be necessary in cases with low levels of organisms or intermittent shedding. The flagellated trophozoite has a "tear drop" shape, with two nuclei at the anterior end and tumbling motility. The cyst is approximately 13 µm long and oval, with two to four nuclei. Immunofluorescence can also be used to visualize the organism, and an ELISA can detect *Giardia* antigens. Serology has been used in epidemiologic investigations, and PCR may be available. Culture is used only in research.

[Photo: (Top) Wet mount of a *Giardia* cyst. Source: Centers for Disease Control and Prevention; (Bottom) Immunofluorescence image of *Giardia lamblia* cysts. Source: U.S. Environmental Protection Agency]

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Treatment

- Anti-protozoal drugs
 - Metronidazole
 - Tinidazole
 - Ornidazole
- Chronic cases
 - May be resistant
 - Prolonged therapy may be necessary

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Giardiasis can be treated with several drugs, including metronidazole, tinidazole and ornidazole. Other drugs may also be effective. Asymptomatic carriers may not need treatment. Chronic cases can be resistant to treatment, and prolonged treatment with a combination of drugs may be required.


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DISEASE IN ANIMALS

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Species Affected

- Domestic animals
 - Dogs, cats, ruminants
 - Horses, pigs (infrequently)
 - Others
- Wild animals
 - Beavers
 - Others



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G. intestinalis can be found in many domestic and wild animals, including dogs, cats and ruminants. Infections are infrequent in horses and pigs. Beavers may be a source of contamination in streams.

[Photo: Beaver. Source: USDA Forest Service]

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Disease in Animals

- Most infections asymptomatic
- Clinical signs may include:
 - Acute, chronic, or intermittent diarrhea
 - Poor hair coat
 - Flatulence
 - Weight loss/failure to gain
 - Light-colored mucoid stools
 - May contain undigested fat

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In animals, the incubation period is usually 5 to 14 days. Most infections, particularly in adult animals, are asymptomatic. Acute, chronic or intermittent diarrhea may be seen in some puppies and kittens. The clinical signs can include diarrhea or soft stools, a poor hair coat, flatulence, and weight loss or failure to gain weight. The stools are typically light-colored and mucoid, and may contain undigested fat. Blood is rarely seen. Similar enteric signs have also been reported in other species, including calves and lambs.

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Post Mortem Lesions

- No gross lesions usually found

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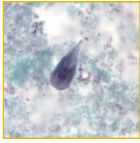
No gross lesions are usually found.

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Diagnosis

- Microscopic exam of feces
 - Stained preparations
 - Unstained wet mounts
- Cysts or trophozoites may be identified



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Giardiasis is usually diagnosed by microscopic examination of the feces, using either stained preparations or unstained wet mounts. Either cysts or trophozoites may be found.

[Photo: *G. intestinalis* trophozoites stained with trichrome. Source: CDC DPDx]

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Treatment

- Infections may be self-limiting
- Consider treatment due to zoonotic potential
 - Fenbendazole
 - Albendazole
 - Metronidazole
 - Tinidazole
 - Others

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Infections may be self-limiting but the potential for zoonotic transmission should be taken into consideration. Fenbendazole, albendazole, metronidazole, tinidazole, quinacrine and furazolidone have been used in dogs or cats.

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PREVENTION AND CONTROL

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Prevention and Control

- Water
 - Do not drink contaminated water
 - Untreated lakes, rivers, shallow wells
 - Treat potentially contaminated water
 - Heat (rolling boil for one minutes)
 - Filter (absolute pore size of one micron)
 - Chlorinate
- Food
 - Wash raw fruits and vegetables

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To prevent infection, untreated water from lakes, rivers, springs or shallow wells should not be drunk. In countries where the water supply may not be safe, untreated drinking water or ice should also be avoided. Methods that can be used to treat potentially contaminated water include heating the water to a rolling boil for at least one minute; filtering the water through a filter that has an absolute pore size of at least one micron (or has been NSF rated for cyst removal) Chlorination or iodination may also destroy the cysts, but these methods are less reliable and depend on the temperature, pH and turbidity of the water. All raw vegetables or fruits should be washed before eating, in water known to be uncontaminated.

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Prevention and Control

- Practice good hygiene
 - Hand washing
 - Don't swim in recreational waters for at least two weeks after symptoms end
 - Avoid fecal exposure



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Good hygiene, such as hand washing, can help prevent infection. It also prevents spreading giardiasis to other people. People with giardiasis should not swim in recreational water for at least two weeks after the symptoms end. Fecal exposure should be avoided during sexual activity.

[Photo: Hand washing. Source: CDC Public Health Image Library]

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Prevention and Control

- Limit environmental contamination
 - Clean and promptly remove feces from surfaces
- Keep pets indoors
- Vaccination
 - Dogs and cats
 - Use is controversial

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Cleaning and prompt removal of the feces can limit environmental contamination. Hard surfaces can be disinfected and should be left to dry, as the cysts are susceptible to desiccation. Pets and livestock can be infected from unsafe water sources such as lakes, streams, springs and shallow wells. Keeping pets indoors can decrease the risk of infection. Vaccines, available for dogs and cats, can prevent infections and the shedding of cysts. Their use is controversial.

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Additional Resources

- Center for Food Security and Public Health
 - www.cfsph.iastate.edu
- CDC: Giardiasis
 - <http://www.cdc.gov/parasites/giardia/>

<http://www.cfsph.iastate.edu>

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