Are most *Giardia* spp. infections shared between animals and humans? The genus *Giardia* contains multiple species of flagellated protozoans that are indistinguishable morphologically. Host specificity was thought to be minimal for *Giardia* spp., but not all small animal isolates cause disease in human beings. There have been varying results concerning cross-infection potential of *Giardia* spp. Human *Giardia* isolates usually grow in cell culture; animal isolates often do not. Recent genetic analysis has revealed 2 major genotypes in people. Assemblage A (G. *duodenalis*) has been found in infected humans and many other mammals, including dogs and cats. Assemblage B (G. *enterica*) has been found in infected humans and dogs, but not cats. It appears that there are specific genotypes of *Giardia* that infect dogs (G. *canis*; Assemblages C and D) and cats (G. *felis*; Assemblage F) but not people. Accordingly, healthy pets are not considered significant human health risks for HIV-infected people by the Centers for Disease Control (www.cdc.gov/hiv/pubs/brochure/oi_pets.htm). The majority of dogs and cats with *Giardia* spp. infections are infected with animal-specific genotypes. However, Assemblage A is occasionally found in pets, especially cats.

What are the optimal diagnostic tests? The primary diagnostic tests that are available include direct smear of feces, direct saline preparation, fecal flotation, fecal antigen testing, and fecal PCR assay. These tests can be used alone or in combination.

How should I evaluate fresh feces from animals with diarrhea? Fresh, liquid feces or feces that contain large quantities of mucus should be microscopically examined immediately in the clinic for the presence of protozoal trophozoites of *Giardia* spp. (small bowel diarrhea), *Tritrichomonas foetus* (large bowel diarrhea), and *Pentatrichomonas hominis* (large bowel diarrhea). A direct saline smear can be made to potentiate observation of these motile organisms. A 2mm X 2mm X 2mm quantity of fresh feces is mixed thoroughly with one drop of 0.9% NaCl or water. The surface of the feces or mucus coating the feces should be used, as the trophozoites are most common in these areas. After application of a coverslip, the smear is evaluated for motile organisms by examining it under 100 magnification. Culture (*T. foetus*), antigen testing (*Giardia*), or PCR (*T. foetus* or *Giardia*) can be used to distinguish between specific organisms.

What are my options for fecal flotation? Fecal flotation with zinc sulfate centrifugal flotation technique (specific gravity 1.18–1.20) is one of the optimal techniques for the demonstration of cysts (www.capcvet.org) and is more sensitive for detection of *Giardia* spp. cysts than cup flotation. Sugar and other salt solutions lead to distortion of cysts but are also sensitive tests. Cysts are shed intermittently, and their presence does not correlate to clinical signs of disease. Evaluation of a single fecal flotation has a sensitivity of approximately 70%. Sensitivity increases to > 90% if at least 3 stool specimens are examined.

Do currently available antigen ELISAs detect dog and cat strains of *Giardia*? Multiple ELISAs for detection of *Giardia* antigens in stool are available. In experiments performed in our laboratory, all human and veterinary assays assessed to date have detected *G. canis* and *G. felis*.

What is the sensitivity and specificity of currently available *Giardia* spp. antigen assays? There is approximately a 5% false positive and 5% false negative rate for the assays. It is currently unknown how long *Giardia* antigens will persist in feces after successful treatment (resolution of diarrhea).

Does the IFA produced for human feces detect *Cryptosporidium* spp. and *Giardia* spp. in dog and cat feces? The IFA for simultaneous detection of *Giardia* spp. cysts and *Cryptosporidium* oocysts is currently available in most commercial veterinary laboratories and has been shown in our laboratory to identify *C. felis*, *C. canis*, *G. felis*, and *G. canis*. I use this assay as a first “wave” diagnostic test in dogs and cats with diarrhea (combined with a fecal float, a wet mount examination, and a rectal or fecal cytology) instead of *Giardia* antigen tests because it detects two important agents with zoonotic potential, and because *Cryptosporidium* spp. are usually not detected on fecal flotation in small animals.

When should I use PCR for amplification of *Giardia* spp. DNA from feces? The sensitivity of the currently available PCR assays is low and should not be used in lieu of fecal flotation or other tests. These assays should only be
used if genotyping of the previously detected *Giardia* spp. is desired. Genotyping is available in my laboratory at Colorado State University (call 970 297 0367 concerning sample submission).

**Which dogs and cats should be screened for *Giardia* spp. infections, and what tests should I use?** In healthy dogs and cats, a fecal flotation should be performed at least once or twice yearly. In dogs and cats with diarrhea, the combination of the direct saline preparation with fecal flotation should be used as the minimum initial screening tests for *Giardia* infection. Antigen tests or IFA test can be used to increase sensitivity but should not be used in lieu of the other assays.

**What are the best drugs for *Giardia* spp. infection?** *Giardia* spp. have specific antimicrobial sensitivity patterns like bacteria, so it is currently impossible to predict which anti-*Giardia* drug will be effective. *G. canis* and *G. felis* can be difficult to cultivate, and there are few *in vitro* susceptibility test results available. While there have been multiple drugs used for the treatment of giardiasis in dogs and cats, there are few studies that utilized dose titrations and evaluation of drugs in experimentally infected animals. In most studies, fecal samples were only assessed for short periods of time after treatment, and immune suppression was not induced to evaluate whether infection was eliminated or merely suppressed. Infection with *Giardia* does not appear to cause permanent immunity, so reinfection can occur, a finding that also hampers assessment of treatment studies. Treatment options currently available or used historically include metronidazole, tinidazole, ipronidazole, ronidazole, fenbendazole, albendazole, pyrantel/praziquantel/febantel, quinacrine, and furozolidone (Table 1). Newer drugs being studied include paromomycin and nitazoxanide.

**How do I choose which of these drugs to use?** If spore-forming rods, morphologically consistent with *Clostridium perfringens*, are concurrently detected with *Giardia*, use of metronidazole is indicated, as this drug is an antibiotic. If there is clinical evidence to suggest concurrent infection with a nematode, like eosinophilia or eosinophils, on fecal cytology, fenbendazole or febantel is indicated. Some clinicians currently recommend the combination of metronidazole and fenbendazole.

**What are the goals of *Giardia* spp. treatment?** The primary goal of treatment is to stop diarrhea. Because healthy pets are not considered human health risks, elimination of infection (which is difficult) is a secondary goal.

**What do I do if diarrhea continues and *Giardia* infection is still detected?** *Giardia* spp. can have resistant patterns, so if the first drug fails to clear the infection (cysts or antigen) or resolve the diarrhea, a second drug from an alternate class is indicated. The addition of fiber to the diet may help control clinical signs of giardiasis in some animals by helping with bacterial overgrowth or by inhibiting organism attachment to the microvillus. Immunotherapy with the *Giardia* vaccine has aided in the elimination of cyst shedding and diarrhea in some infected dogs. However, in a controlled study in 16 experimentally infected cats, vaccination as immunotherapy was ineffective with one strain of *Giardia*. Probiotic administration may also be beneficial in some animals. In one study, bathing the dog was a beneficial adjunct therapy. In dogs and cats with persistent diarrhea and *Giardia* spp. infection, a more extensive workup to attempt to diagnose other underlying diseases is indicated if several therapeutic trials fail. Common underlying disorders include cryptosporidiosis, inflammatory bowel disease, bacterial overgrowth, exocrine pancreatic insufficiency, and immunodeficiencies.

**Should healthy dogs and cats with *Giardia* infection be treated?** Healthy pets are not considered significant human health risks by the Centers for Disease Control (www.cdc.gov/hiv/pubs/brochure/oi_pets.htm). However, because clinical signs induced by *Giardia* spp. can be intermittent, and since some *Giardia* spp. may be zoonotic, treatment of healthy infected animals should be considered with each owner. Treatment of healthy animals is controversial because all of the drugs have side-effects, animals with normal stools are not considered human health risks, treatment is unlikely to eliminate infection, and re-infection can occur within days. For example, in a recent study of naturally infected healthy dogs, we induced clinical side-effects in 50% of the dogs treated with nitazoxanide or fenbendazole, and of the dogs with which the treatment protocol was completed successfully, 62.5% were still infected on recheck evaluation.

**Should healthy housemates of *Giardia* infected dogs and cats be tested?** Whether to test all housemates of infected dogs and cats is controversial, because all *Giardia* tests can give false negative results. It may be more financially viable to treat all animals in lieu of testing.
Should healthy housemates of *Giardia* infected dogs and cats be treated? Whether to treat all healthy housemates of infected dogs or cats is controversial, because all of the drugs have side-effects, animals with normal stools are not considered human health risks, treatment is unlikely to eliminate infection, and re-infection can occur within days. However, the safety margin of fenbendazole is very wide, so if treatment is chosen, this drug seems to be a reasonable choice.

Should I follow *Giardia* test results after treatment? The AAFP Advisory Panel on Zoonoses recommends attempting to remove the source of infection during the treatment period and performing a fecal flotation after *Giardia* treatment one time, within 2-4 weeks after the end of the treatment period (www.aafponline.org). If the animal is healthy and negative for cysts, retesting is not indicated again until the next scheduled fecal flotation.

What should I do with dogs or cats that have normal stool and are *Giardia* antigen positive, *Giardia* cyst negative? These animals have either a low-grade infection or false positive antigen test results. To further evaluate the case, the veterinarian can perform an IFA test, 2 additional fecal flotations, or an antigen test from a different manufacturer; if these other test results are negative, the antigen test was likely falsely positive.

What can I do to prevent re-infection with *Giardia* spp.? Prevention involves boiling or filtering of water collected from the environment prior to drinking and disinfection of premises contaminated with infected feces with quaternary ammonium compounds (1 minute contact time). Transport hosts should be controlled, and treatment of all animals in the environment could be considered. To date, no study has shown the *Giardia* spp. vaccines licensed for dogs and cats to have lessened *Giardia* spp. infections in the field, so both vaccines have been classified by AAHA and AAFP as generally not recommended as preventatives. The feline *Giardia* spp. vaccine was recently discontinued by the manufacturer.

Suggested Reading


Table 1. Drugs used for the treatment of *Giardia* spp. infections

<table>
<thead>
<tr>
<th>Drug</th>
<th>Species</th>
<th>Dose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metronidazole</td>
<td>B</td>
<td>15–25 mg/kg, PO, q12-24 hr, for 5–7 days</td>
</tr>
<tr>
<td>Ronidazole</td>
<td>F</td>
<td>20 mg/kg, PO, q12hr, for 14 days (primarily used for <em>T. foetus</em>; neurotoxicity common)</td>
</tr>
<tr>
<td>Tinidazole</td>
<td>C</td>
<td>44 mg/kg, PO, q24hr for 3 days</td>
</tr>
<tr>
<td>Ipronidazole</td>
<td>C</td>
<td>126 mg/liter of water, PO, ad libitum for 7 days</td>
</tr>
<tr>
<td>Fenbendazole</td>
<td>B</td>
<td>50 mg/kg, PO, daily for 3-5 days</td>
</tr>
<tr>
<td>Albendazole</td>
<td>B</td>
<td>15 mg/kg, PO, q12hr for 2 days (less commonly used because of bone marrow toxicity)</td>
</tr>
<tr>
<td>Pyrantel, praziquantel, febantel</td>
<td>C</td>
<td>Label dose for 3 days</td>
</tr>
<tr>
<td>Furazolidone:</td>
<td>F</td>
<td>Feline dose-56 mg/kg (based on the febantel component), PO, daily for 5 days</td>
</tr>
<tr>
<td>Quinacrine:</td>
<td>C</td>
<td>9 mg/kg, PO, q24hr for 6 days</td>
</tr>
<tr>
<td>Furoxidone:</td>
<td>F</td>
<td>11 mg/kg, PO, q24hr for 12 days.</td>
</tr>
</tbody>
</table>

*C = canine; F = feline; B = canine and feline*