Giardiasis and Cryptosporidiosis

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Take Home Message

*Giardia duodenalis* and *Cryptosporidium parvum* are parasitic protozoans and infections are common in domestic ruminants. Infections can lead to moderate to severe diarrhea with occasion mortalities. Clinical disease with *Cryptosporidium parvum* occurs in calves between 1 and 3 weeks of age lasting 1-2 weeks in duration. Giardiasis is observed in calves older than 3 weeks of age and is chronic. These diseases have tremendous ability to be transmitted from animal to animal and from animal to humans. These infections have led to a significant environmental and public health concern. *Cryptosporidium muris* infects older calves and may impair rate of gain in feedlot cattle and milk production in dairy cattle. *Giardia* infections can be treated with benzimidazoles but there are currently no effective treatments for cryptosporidiosis. Clearly, effective methods need to be employed to treat, prevent or control these diseases.

*Giardia* and *Cryptosporidium* Species

Giardiasis (giardiosis) is the infection caused by the flagellate intestinal protozoan, *Giardia duodenalis*, which is also known as *Giardia lamblia* or *Giardia intestinalis*. *Giardia* is a non-invasive parasite and it colonizes the mucosal surface of the small intestine. It is one of the most commonly identified intestinal pathogens in humans and animals throughout the world. There are some well defined species: *Giardia duodenalis* (Infects humans and most domestic and wild mammals), *Giardia muris* (infects rodents), *Giardia psittaci* (infects birds), *Giardia ardeae* (infects birds), and *Giardia agilis* (infects amphibians). These species are based upon morphology, biochemical characteristics, and host specificity. Presently the range of animals that each *Giardia* species may infect has not been clearly established. Cryptosporidiosis is also caused by a protozoan parasite, *Cryptosporidium spp*. It is associated with severe diarrhea in calves and immuno-suppressed humans. There have been numerous waterborne outbreaks of both giardiasis and cryptosporidiosis in humans. Beef and dairy cattle are infected with at least two distinct species.
(Cryptosporidium parvum and Cryptosporidium muris). Cryptosporidium parvum colonize the small intestine while Cryptosporidium muris infect the abomasum. Based upon molecular analysis and infection studies, there are numerous subspecies of Cryptosporidium. For example, cattle strains of Cryptosporidium parvum are infective to humans; however, human strains are not infective to cattle.

**Life Cycle and Transmission**

The infection is obtained after the microscopic infective cysts (Giardia) or oocysts (Cryptosporidium) are ingested. These cysts and oocysts are resistant to the environment and remain infective for months in cold water or damp, cool environments. After the cysts/oocysts are passed through the stomach, they develop, multiply and colonize the entire small intestine. The cysts and oocysts have a protective carbohydrate wall which makes them resistant to environmental destruction. They are only destroyed by desiccation, heat, UV radiation and high concentrations of biocides (e.g. Sodium hypochlorite). The cysts and oocysts can survive for months in water.

Ingestion of as few as 10 cysts/oocysts has led to infections in humans and animals (1). The most common method of transmission in animals and humans is the fecal-oral route (2). Disease outbreaks have most often been attributed to the waterborne method of transmission (3). It is believed that human effluent is the major source of water contamination, but certainly contamination of water with infected animal feces can lead to widespread infections in human and animals (3). Water mammals, like beavers, have been implicated with many waterborne infections of Giardia. However, certainly other animals may be more likely candidates to contaminate water supplies. Foodborne infections have been associated with poor hygiene in food handlers and washing food with contaminated water (1). This is a particular concern as water is important in the processing of many foods.

**Epidemiology**

Giardia lamblia is one of the most commonly identified intestinal pathogens in humans and animals in the world (1, 2). It should be noted that prevalence rates are underestimated, because of the sensitivity of parasite detection and the intermittent nature of cyst excretion. In the past, humans, dogs, cats, and certain species of wildlife are described as the principal hosts of this parasite (1). Recent studies have identified domestic livestock (e.g., cattle, sheep, pigs, horses) as major hosts for this parasite (2, 4). Cryptosporidium is most
commonly associated with intestinal disease in calves less than 4 weeks of age (4, 5). Table 1 describes the prevalence of *Giardia* and *Cryptosporidium spp* in Canadian farm animals (4). Table 2 summarizes studies which examined the prevalence of these organisms in BC and Alberta calves. It should be noted that *Giardia* infections have been shown to be highly prevalent in all provinces of Canada and throughout the world (2, 4).

In calves, *Giardia* and *Cryptosporidium* infection patterns differ significantly. Calves less than 4 weeks of age become infected with *Cryptosporidium*, and the duration of infection is short, lasting about 2 weeks (5). Calves become infected with *Giardia* around 4 weeks of age and infections persist for over 120 days (5). *Cryptosporidium muris* infects calves greater than 3 months of age and this infection can persist for years. Virtually all dairy calves develop cryptosporidiosis and giardiasis, but only some animals develop diarrhea. Cryptosporidiosis is less frequent in beef calves, but giardiasis was observed in 100% of animals (5, 6). Infection and clinical signs may be associated with immune status and stress.

### Table 1. Prevalence of *Giardia* and *Cryptosporidium* in Canadian Farm Livestock (4).

<table>
<thead>
<tr>
<th>Animal</th>
<th>Number Sampled</th>
<th><em>Giardia</em> No. Positive (% Positive)</th>
<th><em>Cryptosporidium</em> No. Positive (% Positive)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cattle</td>
<td>104</td>
<td>30 (29)</td>
<td>21 (20)</td>
</tr>
<tr>
<td>Sheep</td>
<td>89</td>
<td>34 (38)</td>
<td>21 (24)</td>
</tr>
<tr>
<td>Pigs</td>
<td>21</td>
<td>9 (9)</td>
<td>9 (11)</td>
</tr>
<tr>
<td>Horses</td>
<td>35</td>
<td>7 (20)</td>
<td>6 (17)</td>
</tr>
</tbody>
</table>

Sample locations: Vancouver, British Columbia; Strathmore, Alberta; Swift Current, Saskatchewan; Brandon, Manitoba; Lennoxville, Quebec; Fredericton, New Brunswick; Airdrie, Alberta; Saskatoon, Saskatchewan; Nappan, Nova Scotia; Truro, Nova Scotia; Whitehorse, Yukon; Calgary, Alberta; Edmonton, Alberta; Guelph, Ontario; Innisville, Alberta.

### Table 2. Prevalence of *Giardia* spp and *Cryptosporidium* spp in Alberta and British Columbia Dairy and Beef Calves (4, 5, 6).

<table>
<thead>
<tr>
<th>Location</th>
<th>Number</th>
<th>% with Diarrhea</th>
<th><em>Giardia</em></th>
<th><em>Cryptosporidium parvum</em></th>
<th><em>Cryptosporidium muris</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef Calves</td>
<td>BC 192</td>
<td>30%</td>
<td>37%</td>
<td>11%</td>
<td>0%</td>
</tr>
<tr>
<td>Range Cattle</td>
<td>BC 33</td>
<td>-</td>
<td>36%</td>
<td>6%</td>
<td>33%</td>
</tr>
<tr>
<td>Diary Calves</td>
<td>BC 386</td>
<td>7%</td>
<td>73%</td>
<td>15%</td>
<td>2%</td>
</tr>
<tr>
<td>Beef Calves¹</td>
<td>Alberta 20</td>
<td>56%</td>
<td>100%</td>
<td>5%</td>
<td>0%</td>
</tr>
<tr>
<td>Dairy Calves¹</td>
<td>Alberta 20</td>
<td>56%</td>
<td>100%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Feed lot Cattle</td>
<td>Alberta 60</td>
<td>-</td>
<td>82%</td>
<td>25%</td>
<td>82%</td>
</tr>
<tr>
<td>Range Cattle</td>
<td>Alberta 280</td>
<td>-</td>
<td>32%</td>
<td>9%</td>
<td>18%</td>
</tr>
</tbody>
</table>

¹Longitudinal study following calves from birth until 120 days of age.
Giardiasis is considered to be an important zoonotic disease and animal reservoirs are believed to be cats, dogs, ruminants, and a variety of wild animals. Infections in domestic ruminants are of special concern because of the potential contamination of surface and ground waters through pasture run-offs and use of manure as a spray on fields. Outbreaks from waterborne giardiasis and cryptosporidiosis in humans have been attributed to pasture runoff leading to drinking water contamination. Morphological, protein, and DNA similarities among *Giardia* isolated from animals and humans have been demonstrated. The number of clinical reports and transmission studies suggest the possible zoonotic transmission of the *Giardia* parasite (1). Similarly, *Cryptosporidium* from cattle have been clearly demonstrated to be transmissible to humans, but isolates from other animals may not be infective to humans (3). *Cryptosporidium* infections are infrequent, but waterborne outbreaks can lead to large numbers of human infections as occurred in Milwaukee where 400,000 humans were believed to have contacted the disease (3, 4).

**Clinical Signs and Effect on Animal Performance**

Clinical giardiasis and cryptosporidiosis are frequently not diagnosed, yet they may be the most common cause of diarrhea in calves on some farms. In humans and some animals, clinical signs of giardiasis and cryptosporidiosis include acute or chronic diarrhea, abdominal pain, dehydration, weight loss, and reduction in weight gain. Giardiasis has been associated with growth retardation and disease susceptibility in children from endemic areas (1). There have been reports of clinical signs in cattle and sheep, which include diarrhea and weight loss. Most infections in ruminants have been described as asymptomatic (2). Recently, experimentally infected SPF lambs showed an increase in abnormal stools compared to control lambs and a decrease in body weight gain (7). *Cryptosporidium parvum* may cause severe watery diarrhea in calves under 3 weeks of age. Older calves infrequently have clinical signs of cryptosporidiosis. *Cryptosporidium muris* infections in can cause moderate to severe impairment of weight gain and decreased feed efficiency in feedlot cattle (8).

In growing ruminants giardiasis has a negative effect on production leading to a reduced rate of gain without a reduction in feed intake suggesting malabsorptive and/or maldigestive disease. Infected animals may also have lower
carcass weight and an increase time to slaughter (7). Cryptosporidium parvum infection in young calves has been associated with moderate to severe diarrhea and occasionally death (4). It is believed to have a significant impact on the growth of calves (4). Cryptosporidium muris infection has recently been shown to reduce milk production in dairy cows and to reduce the rate of gain of feeder calves (8, 9).

Pathogenesis

The pathophysiology of intestinal disease is similar for both of these parasites. Both parasites cause diffuse damage to the small intestinal mucosal surface. Giardia and Cryptosporidium infection cause a reduction in the height of the villus and microvillus, and therefore, a loss of the absorptive surface area throughout the small intestine. There is impaired glucose, water, and sodium absorption in the small intestine, and disaccharidase activities are reduced, resulting in impaired digestion. An increase in intestinal motility has been shown in experimentally infected animals. Diarrhea is therefore attributed to malabsorption and maldigestion.

Diagnosis

Giardia and Cryptosporidium are diagnosed by examination of fresh or formalin fixed fecal samples. Cyst concentrations using zinc sulphate or sucrose gradient (SG 1.13) concentrations are usually performed to enhance the diagnosis. Cysts and oocysts are best demonstrated using fluorescent monoclonal antibody (4, 5). Giardia cysts can be stained with Lugol's iodine and Cryptosporidium oocysts with a Ziel-Nelson stain. Diagnosis requires high quality microscopic equipment and training in recognizing these parasites.

Treatment and Control

There is no current approved treatment for giardiasis and cryptosporidiosis in cattle. There is a limited number of drugs available for the treatment of giardiasis in domestic animals. Metronidazole, tinidazole, quinacrine and furazolidone are effective, but they should be avoided in food animals because they are carcinogenic and mutagenic. Benzimidazoles (fenbendazole, mebendazole, albendazole) have recently been shown to be effective in elimination of Giardia lamblia in cattle (10). Fenbendazole at doses of 5 mg/kg daily for 3 days
or 0.7 mg/kg daily for 6 days is highly effective in controlling ruminant giardiasis (10). A Giardia vaccine (GiardiaVax®, Fort Dodge Animal Health) is commercially available for dogs and cats but has not been evaluated in cattle.

Cryptosporidiosis is frequently a self limiting disease in young calves lasting for 2 weeks. The severity of clinical disease may be associated with the animals immune and nutritional status. Recently problem herds have been shown to be deficient in selenium (Olson, unpublished results). There is currently no satisfactory chemotherapeutic agent available for the treatment of cryptosporidiosis. Many agents have been tested in vitro and in vivo, but few agents have shown promise. Drugs such as paromomycin, halfluinone, and lasalocid have shown promise in calves (10). Paramomycin is expensive and halfluinone and lasalocid are highly toxic at effective doses. Cryptosporidiosis in calves should be treated with fluid therapy and correction of acid-base disturbances. Antibiotics can be used to control secondary bacterial infections. Colostrum, which contains anti-cryptosporidium antibodies, may also be beneficial. Experimental vaccines have been produced and these vaccine may provide an optimal method for controlling cryptosporidiosis in calves.

Currently there have no studies which have investigated the treatment of Cryptosporidium muris in the abomasum of feedlot or dairy cattle. Certainly, the impact of this infection on performance and production would warrant such studies.

References

