Coccidiosis in Large and Small Ruminants

Sarah Tammy Nicole Keeton, PhD, MS\textsuperscript{a,*}, Christine B. Navarre, DVM, MS\textsuperscript{b}

INTRODUCTION: NATURE OF THE PROBLEM
Coccidiosis is a parasitic disease of vertebrate animals, including domestic ruminants.\textsuperscript{1} It is economically significant, with losses from both clinical and subclinical disease.

Coccidiosis is caused by the protozoan parasite of the genus \textit{Eimeria}. \textit{Eimeria} are host specific, meaning that an \textit{Eimeria} species that infect goats does not infect sheep or cattle and vice versa. Certain species of \textit{Eimeria} are nonpathogenic and do not cause disease. The pathogenic species and sites of infection are listed in Table 1. Mixed infections with multiple pathogenic and nonpathogenic species is common.

LIFE CYCLE
Proper treatment and control of coccidiosis requires an understanding of the complex life cycle and transmission of \textit{Eimeria} spp (Fig. 1). The life cycle can be divided into

KEYWORDS

- Coccidia
- Coccidiosis
- Diarrhea
- Ruminants
- Cattle
- Sheep
- Goats
- Ionophores

KEY POINTS

- Coccidiosis is an important parasitic disease of ruminant livestock caused by the protozoan parasite of the genus \textit{Eimeria}.
- Calves between 6 and 12 months of age and lambs and kids between 1 and 6 months of age are most susceptible.
- Subclinical disease is characterized by poor growth.
- Clinical disease is most commonly characterized by diarrhea.
- Control of coccidiosis is based on sound management, the use of preventive medications, and treatment of clinical cases as necessary.

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\textsuperscript{a} Department of Veterinary Clinical Sciences, School of Veterinary Medicine, Louisiana State University, Skip Bertman Drive, Baton Rouge, LA 70803, USA; \textsuperscript{b} LSU AgCenter, School of Animal Sciences, Louisiana State University, 111 Dalrymple Bldg, 110 LSU Union Square, Baton Rouge, LA 70803-0106, USA

* Corresponding author. 909 Durnin Drive, Denham Springs, LA 70726.

E-mail address: Sorlik1@lsu.edu

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2 phases: an exogenous phase (free living in the environment) and an endogenous phase (parasitic phase within host). The life cycle takes between 2 and 4 weeks to complete depending on the species of *Eimeria* and environmental conditions.

In the exogenous phase of sporogony, unsporulated oocysts are excreted in feces and undergo sporulation under ideal environmental conditions of oxygen, temperature, and moisture.

<table>
<thead>
<tr>
<th>Species of <em>Eimeria</em></th>
<th>Site of Infestation</th>
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</thead>
<tbody>
<tr>
<td><em>Eimeria zuernii</em></td>
<td>Small and large intestine</td>
</tr>
<tr>
<td><em>Eimeria bovis</em></td>
<td>Small and large intestine</td>
</tr>
<tr>
<td><em>Eimeria alabamensis</em></td>
<td>Small and large intestine</td>
</tr>
<tr>
<td><em>Eimeria ovinoidalis</em></td>
<td>Cecum and colon</td>
</tr>
<tr>
<td><em>Eimeria crandalis</em></td>
<td>Small and large intestine</td>
</tr>
<tr>
<td><em>Eimeria arloingi</em></td>
<td>Small intestine</td>
</tr>
<tr>
<td><em>Eimeria christensenii</em></td>
<td>Small intestine</td>
</tr>
<tr>
<td><em>Eimeria ninakohlyakimovae</em></td>
<td>Small and large intestine</td>
</tr>
</tbody>
</table>


**Fig. 1.** *Eimeria* life cycle. *(From Javier Garza, PhD, USDA-NIFA Fellow, Parasite Immunology, Division of Animal and Nutritional Sciences, West Virginia University, with permission.)*
moderate temperatures, and high moisture. Sporulation takes 1 to 4 days if environmental conditions are ideal but can take several weeks in less favorable conditions.3

The endogenous phase begins with the animal ingesting sporulated oocysts. Once ingested, the oocysts undergo excystation, in which the sporozoites are released and subsequently invade the intestinal cells. The sporozoites then transform into schizonts and multiply asexually to generate merozoites (merogony). Merozoites may then penetrate additional intestinal epithelial cells and multiply further or progress to macrogametes or microgametes. During the sexual phase (gametogony), microgametes (sperm) fertilize macrogametes (ova), producing oocysts. When the oocysts are mature, they rupture the host cell, are released into the lumen of the intestine, and are passed in the feces as unsporulated oocysts.4–7 The damage to the gut caused by this phase is what contributes most to the clinical signs.

**EPIDEMIOLOGY**

Coccidia are highly prolific because each sporulated oocyst has the potential to produce 23 million oocysts during the endogenous phase after just 21 days.6 This ability leads to high levels of environmental contamination. Sporulated oocysts are resistant in the environment and can survive for weeks to months, especially in favorable conditions of moderate heat and moisture.7

Buildup of high levels of contamination are most common in areas where animals congregate or are crowded and feces are more concentrated in the environment. Feedlots, drylots, and barns are common types of housing associated with coccidiosis. It can also be a problem in heavily stocked pastures, especially around watering and feeding areas.

Healthy ruminants are generally immune to disease by 1 year of age but serve as a reservoir to younger animals. The magnitude of infection, clinical signs, and oocyte shedding are affected by the species of *Eimeria* involved, level of environmental exposure, and animal immunity. Age, other stressors (weaning, weather, transportation, other diseases, and so forth), nutrition, and genetic susceptibility all contribute to animal immunity and susceptibility to coccidiosis.7,8

**HISTORY AND PHYSICAL EXAMINATION**

Calves are most susceptible to infection between 6 and 12 months of age. Lambs and kids are susceptible from 1 and 6 months of age, but most clinical disease is seen in lambs and kids between 4 and 8 weeks of age.9,10

There are subclinical and clinical forms coccidiosis. Subclinical infection can cause depressed appetite as well as decreased feed efficiency from gut damage, which leads to poor growth rates and weight gains.10,11

The following clinical signs may be associated with clinical coccidiosis:

- Diarrhea
- Anorexia
- Depression
- Weakness
- Abdominal pain
- Dehydration
- Pale mucous membranes
- Acute weight loss
- Straining to defecate and subsequent rectal prolapse
Diarrhea is the most common clinical sign, and it may be bloody or mucoid. The severity of disease varies from self-limiting, in which animals recover without treatment, to severe cases, in which animals quickly succumb to the infection and die.\(^8,12\)

Speed and degree of recovery depend on the severity of infection and area of the gut involved. Animals that recover from more severe infection may become chronic so-called poor-doers because of permanent scarring of the gut.

Nervous coccidiosis is a condition that occurs in calves after heavy infections with *Eimeria zuernii*. Clinical signs include muscle tremors, convulsions, nystagmus, and other central nervous system signs. Animals may fall to the ground, show neurologic signs, then recover and have periods of normality. Mortality associated with nervous coccidiosis can be 80% to 90%. The pathophysiology of this condition is not known.\(^7,13\)

**DIAGNOSIS**

A tentative ante mortem diagnosis of clinical coccidiosis is usually based on flock/herd history and clinical signs along with observation of coccidia oocysts in feces. A definitive diagnosis is complicated by the difficulty in interpreting results of fecal examination for oocysts. Quantitative fecal analysis by sugar or salt flotation techniques that give results in oocysts per gram of feces are superior to nonquantitative tests. Low numbers of oocysts are commonly shed in normal animals. Counts of 5000 oocysts per gram or higher in combination with a typical clinical picture are highly suggestive of coccidiosis. Speciation of the oocysts is important because high numbers of nonpathogenic species in animals with other diarrheal diseases is possible. It is also possible to have clinical signs develop in the early stages of the disease when fecal shedding is low or in animals that are in the chronic stages of the disease and have intestinal scarring. Fecal examinations on multiple animals during a suspected outbreak and over time in the herd or flock are helpful in interpreting results.\(^7,10,14–17\)

Necropsy may also help confirm coccidiosis in a herd or flock. Intestinal hemorrhage and white/gray patches or lines on the mucosa on gross examination are suspicious of coccidiosis. Histopathology can help confirm the diagnosis.

**PHARMACOLOGIC TREATMENT OPTIONS**

Prevention of coccidiosis is superior to treatment because subclinical production losses and potential permanent damage unresponsive to treatment are costly and have animal welfare implications. Some exposure to the organism is necessary to develop immunity, but it should be limited. Minimizing stress and other diseases, and optimizing nutrition are important, as is minimizing environmental contamination. Prevention of overcrowding, feeding off the ground, and sanitation of feeding and watering equipment are important. Exposure to sunlight and desiccation are effective means of decreasing of oocysts in the environment.

Where environmental control is not adequate, the use of anticoccidial drugs can be helpful for both treatment and prevention. Anticoccidial drugs work by impeding the growth and reproduction of coccidian parasites. They have little impact on existing infection but should help limit both subclinical and clinical disease and environmental contamination.

There are several anticoccidial drugs available for treatment and prevention of coccidiosis in ruminants (Table 2). Species and class approval varies and extralabel use should only be undertaken following the Animal Medicinal Drug Use Clarification Act (AMDUCA) in the United States. These agents may also be restricted in organic
and natural programs. Anticoccidial agents used in other species, such as poultry, may be toxic to ruminants.\textsuperscript{15}

The most commonly used anticoccidial drugs from those listed in Table 2 are the ionophores (decoquinate, lasalocid, and monensin). They are feed additives classified as antibiotics. By altering the rumen bacteria, they also improve feed efficiency and control bloat and acidosis.\textsuperscript{18} Sulfa drugs are commonly used to treat coccidiosis in many species but the exact mechanism is not known. Their clinical effectiveness may be more related to control of secondary bacterial enteritis than to a direct effect on coccidia. Sulfaquinoxaline is the only sulfa drug approved for control of coccidiosis and only in cattle.

When using anticoccidial drugs for prevention or treatment of weaned young stock, all animals in the group should be medicated. Resistance to coccidiostats can occur, and is common in poultry.\textsuperscript{7} To minimize this potential, longer-term preventive uses should be limited to high risk-situations. Although resistance is possible, evidence that it occurs in ruminant \textit{Eimeria} spp is mostly circumstantial at this time. Treatment success of clinical coccidiosis is frequently unrewarding, and no drug has ever been documented to be highly efficacious for treatment.\textsuperscript{19} Once clinical signs appear, damage to the intestines has already occurred. What seems to be lack of efficacy of a treatment (continued diarrhea), is most likely caused by a damaged gut.\textsuperscript{20} Use of

<table>
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<tr>
<th>Agent</th>
<th>Treatment</th>
<th>Prevention</th>
<th>Comments</th>
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<tbody>
<tr>
<td>Amprolium\textsuperscript{a} (Corid)</td>
<td>10/mg/kg BW for 5 d (C)</td>
<td>5 mg/kg BW for 21 d (C)</td>
<td>Available in multiple forms: ● 9.6% oral solution ● 20% soluble powder ● 1.25% or 2.5% crumbles/pellets</td>
</tr>
<tr>
<td></td>
<td>25–40 mg/kg BW for 5 d (S, G, ELDU)</td>
<td>50 mg/kg BW for 21 d (S, ELDU)</td>
<td></td>
</tr>
<tr>
<td>Decoquinate (Deccox)</td>
<td>0.5 mg/kg BW for at least 28 d (C, S, G)</td>
<td>Feed additive For prepartum use in sheep and goats ● 1 kg of 13% premix in 22 kg of trace mineralized salt</td>
<td></td>
</tr>
<tr>
<td>Lasalocid (Bovatec)</td>
<td>1 mg/kg BW continuously (C, S) G = ELDU</td>
<td>Feed additive For prepartum use in sheep and goats ● 1 kg of 6% premix in 22 kg of trace mineralized salt</td>
<td></td>
</tr>
<tr>
<td>Monensin (Rumensin)</td>
<td>20 g/ton of feed (G) (S = ELDU) Cattle doses vary by class-see specific labels</td>
<td>Feed additive May be best choice for goats</td>
<td></td>
</tr>
<tr>
<td>Sulfaquinoxaline</td>
<td>10–20 mg/kg BW for 3–7 d (C) (S, G = ELDU)</td>
<td>As a 0.015% solution in water</td>
<td></td>
</tr>
</tbody>
</table>

\textit{Abbreviations:} BW, body weight; ELDU, extralabel drug use.
\textsuperscript{a} Amprolium is a thiamine analog and can cause polioencephalomalacia, especially at high doses.

\textit{Data from} Refs.\textsuperscript{15–17}
drugs such as amprolium and sulfas for treatment may help prevent worsening of clinical signs by limiting reinfection in animals that cannot be removed from a contaminated environment and for which addition of ionophores to feed is impractical.

As mentioned before, the degree of oocyst shedding is affected by many factors, including initial dose, stage of the infections, age of the animal, and individual susceptibility. Therefore, using oocyst counts to determine drug efficacy/resistance in 1 or a small number of animals is difficult. The use of products not approved for food animal species, such as ponazuril (Marquis), for clinical cases that seem to be refractory to approved treatments is not recommended. It is unlikely to be any more clinically effective once clinical signs appear, and the meat withdrawal time is more than 120 days (contact FARAD.org for exact withdrawal times). Use of ponazuril for convenience (1 dose compared with multiple doses of approved products) is illegal under AMDUCA.

Coccidiosis prevention is usually reserved for calves after weaning, when they are most susceptible, and in drylot or crowded condition. If problems occur in nursing calves, an anticoccidial drugs in creep feed may be necessary. Because lambs and kids are most at risk while still on the dam, coccidiostats can be provided to the dams for 30 days before lambing/kidding to reduce environmental contamination. An added benefit to the use of ionophores prepartum in sheep and goats is a potential decrease in the incidence pregnancy toxemia.

NONPHARMACOLOGIC TREATMENT OPTIONS

Coccidiosis vaccines are commercially available for poultry. Despite ongoing research, a commercially available product in ruminants has not been developed.

Sericea lespedeza, a leguminous plant containing condensed tannins with anti-parasitic properties, has been shown to be successful in preventing and controlling coccidiosis and gastrointestinal nematode infections in lambs. In a study conducted by the Louisiana State University Agricultural Center, sericea lespedeza was fed to experimentally infected lambs to evaluate efficacy. The increase, peak, and decline of fecal egg counts observed in the control lambs indicated a typical patent infection. The comparatively unchanged fecal egg count in the treatment lambs indicated that sericea lespedeza effectively controlled infection compared with the control lambs. In addition, fecal egg count remained lower than in control lambs, which is in agreement with other reports of reduced fecal egg count in sericea lespedeza–fed animals. Under the conditions of this study, sericea lespedeza effectively controlled *Eimeria* spp infection, as well as reducing nematode infections. The use of this plant could be beneficial in weaning management to control coccidiosis.

SUMMARY

Coccidiosis is an important parasitic disease of ruminant livestock. Control of coccidiosis in cattle, sheep, and goats is based on sound management, the use of preventive medications, and treatment of clinical cases as necessary.

REFERENCES


