

CONTROL OF COCCIDIOSIS IN THE BARN AND ON THE PASTURE

Dr. Paula Menzies, Professor Emerita
Department of Population Medicine
Ontario Veterinary College, University of Guelph
Guelph, Ontario CANADA

Coccidia are microscopic, protozoal parasites of the intestine. There are 11 different species of coccidia in sheep and almost an equal number in goats but not all are considered to be pathogenic. There are subtle differences in the morphology and size of their oocysts which help to distinguish pathogenic from non-pathogenic. These parasites are host-specific and do not cross-infect.

Table 1. Pathogenic species of *Eimeria* in sheep and goats

Species	Coccidia Name	Pre-Patent Period	Pathogenicity
Sheep	<i>Eimeria crandallis</i>	15 to 20 days	++
Sheep	<i>Eimeria ovinoidalis</i>	12 to 15 days	+++
Goat	<i>Eimeria arloingi</i>	20 days	++
Goat	<i>Eimeria christensenii</i>	14 to 23 days	++
Goat	<i>Eimeria ninakohlyakimovae</i>	10 to 13 days	+++
Goat	<i>Eimeria caprina</i>	17 to 20 days	++

What makes a species more pathogenic is if it infects both the small and large intestine. The small intestine has an amazing ability to recover from damage but not so the large intestine. The life cycle of the coccidia is quite complicated as can be seen from Figure 1. One coccidial oocyst can result in up to 50 million intestinal cells being destroyed. The act of schizogony (asexual reproduction) and gametogony (sexual reproduction) causes the cells of the intestine to rupture and release the next stage of the life cycle. It is important to understand the basics of this life cycle in order to understand how to best control the infection.

COCCIDIOSIS – THE DISEASE

Most often affected are young stock – either nursing or weaned, with diarrhoea and poor growth. Adult sheep do not get disease and only very rarely adult goats. Coccidiosis as a herd/flock problem is often seen along with another disease, most often pneumonia and soremouth (orf). This may be because the kids or lambs are “run-down” from the other. We also more often find coccidiosis as a herd/flock problem when there are other stresses in the herd/flock, for example crowded conditions or weather stresses (e.g. cold, heat, high humidity). Coccidiosis is either acute and severe, or chronic.

Acute Severe Coccidiosis

Kids or lambs with this form of coccidiosis are notably ill and many may die without prompt and appropriate treatment. Signs may appear fairly suddenly and a kid/lamb only mildly ill the day

before, may be very sick the next day. Diarrhoea is an important feature and may be watery and brown or dysenteric (bloody). The kids or lambs may be dehydrated and anaemic. They will invariably be depressed but fever is not always present. Some animals may strain from the inflammation of the lower large intestine and pass only watery blood. Occasionally they may prolapse their rectum. In such an outbreak, it is common to have deaths.

Chronic Coccidiosis

Kids / lambs with chronic coccidiosis may have had acute severe coccidiosis earlier or may not ever have been noticed ill. The affected group will not appear thrifty and will be growing slowly. A common finding is that they are thin, pot-bellied and small – although their heads may continue to grow giving them a runty appearance. The hind end may be dirty due to the soft stools and intermittent diarrhea. Kids and lambs with chronic coccidiosis may never fully recover from the effects of the disease.

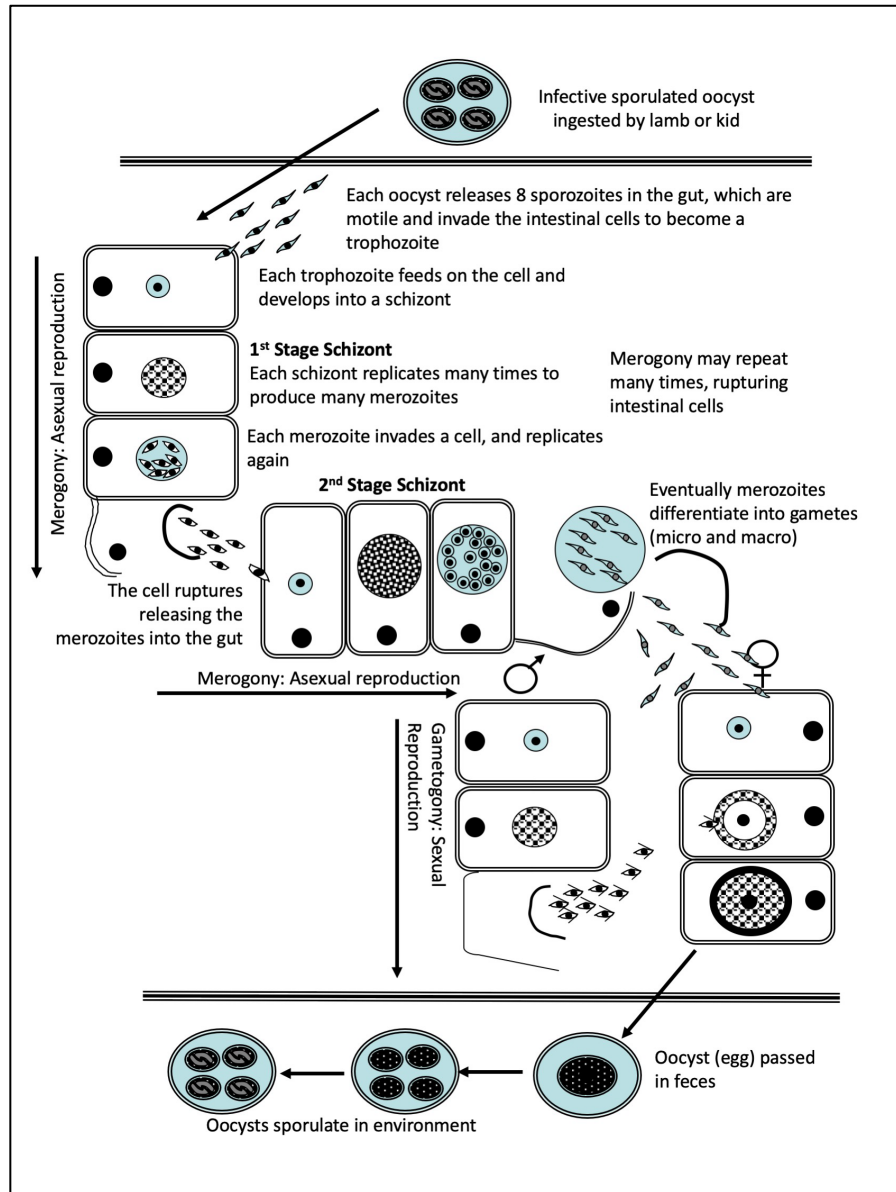
Age at Which Coccidiosis is Seen

Coccidiosis is a disease of young kids and lambs. The most common age to be affected is 4 weeks to 5 months. Nursing lambs/kids appear more at risk of acute severe coccidiosis. Occasionally, kids or lambs as young as 2 weeks may be affected and rarely 1 week – although diarrhea in this age group is more often due to agents of neonatal diarrhea (rotavirus, coronavirus and *Cryptosporidium*). Older animals can also be affected if not previously exposed as lambs/kids. However, if older animals appear to be suffering from chronic coccidiosis, it may be the lasting effects from an infection from when they were younger. Disease in adults is rare – again, because immunity develops within a month or two after exposure to the coccidia. It is important to remember that shedding of the coccidia eggs – oocysts – is not evidence of disease, but only evidence of infection. Adult goats and sheep often shed a small number of oocysts. It is also important to remember that severe disease can occur before infection is far enough advanced for the sheep/goat to be shedding oocysts, so absence of oocysts in the manure does not mean that the animal is not suffering from coccidiosis.

HOW THE DAMAGE IS DONE

A single oocyst once ingested – releases 8 sporozoites which swim through the contents of the intestine and then each penetrate a cell on the lining of the intestine (Figure 1). Inside the cell, the sporozoite changes to a schizont. This schizont divides many times within the cell to produce up to 1,000 structures called merozoites. The cell then ruptures releasing these merozoites which then again swim through the intestinal contents. Each merozoite penetrates another intestinal cell and goes through another cycle of developing into a schizont, dividing numerous times and then again releasing thousands of merozoites. This part of the cycle of the coccidia is called “schizogony” or asexual reproduction. Eventually, the merozoites that are released change into either microgametes (male merozoites) or macrogametes (female merozoites) (“gametogony”). These again infect intestinal cells, and male cells divide many times. The male cells fertilize the female cells (sexual reproduction) and in each infected intestinal cell, an oocyst or egg is formed. These oocysts burst out of the cell and are passed in the feces.

FIGURE 1. LIFECYCLE OF THE COCCIDIA



At each stage intestinal cells are invaded and then destroyed – causing repeated damage to the intestine. The intestinal damage can release blood and cause inflammation of the lining of the gut. If enough damage is done, it becomes extremely ill and may die.

DIAGNOSING COCCIDIOSIS

The best way to diagnose coccidiosis is based on the clinical signs shown in the group of animals and evidence of infection based on postmortem if any animals have died. Taking a fecal sample and having a quantitative count of the number of oocysts (fecal oocyst count or FOC) in the stool can also be helpful but there are many ways it can be misinterpreted so caution must be used. A low FOC does not rule out coccidiosis. As mentioned before, acute disease may be present before the prepatent

period is reached. A high FOC (even in the tens of thousands) can occur when the kid or lamb is infected with a low pathogenic species. While it is possible to differentiate the species of coccidia based on the microscopic appearance of the oocysts, it is difficult and must be done by a trained parasitology technician using special techniques. Additionally, a moderately high FOC will often be present even long after the animal develops immunity and may rise if the animal's immune system is stressed – all without it suffering from the disease.

FACTORS AFFECTING IF COCCIDIOSIS IS A PROBLEM IN THE HERD OR FLOCK

Why does one herd/flock have a problem with coccidiosis and another does not? Why are some years, or some times of the year worse than others? We need to consider that presence of the disease agent alone is often not sufficient for a coccidiosis problem to occur, but that different factors all play a role. It is easier to consider the factors in three categories:

The Parasite

What species of coccidia are present and how pathogenic are they? How many oocysts are present in the environment and where are the oocysts? Are they contaminating places that allow for easier transmission to the kids/lambs?

The Animal

How immune is the kid or lamb? Younger animals are more susceptible. Are the kids/lambs ill with another disease that could weaken their immune systems, e.g., soremouth or pneumonia? Have they been stressed by changes in the diet or a poor diet, by crowded conditions or bad weather? Have groups been mixed (e.g. younger moved in with older). Has there been fighting and competition at the feeders? Have they recently been weaned?

The Environment

The oocysts must sporulate before they are infective. Time to sporulation depends on moisture, oxygen (e.g. exposed to the air rather than buried in the bedding pack) and temperature. Exposure to sunlight will assist killing of the oocysts so pasture tends to be safer than indoor housing. Animals raised on dirty bedding are more at risk than those on slatted floors or clean bedding. Type of feeders and waters may have an effect if they are designed to prevent contamination with manure. High stocking densities, build-up over the kidding/lambing season – all increase the load of oocysts in the environment and thus increase risk of disease developing.

CONTROLLING COCCIDIOSIS

The information in the rest of these notes is not a recipe for what you should do but rather the building blocks that you can use to develop a herd health program.

Reducing the Load of Oocysts in the Environment

Reduce Stresses to the Kids/Lambs

Do this by optimizing housing. Keep stocking densities down. Make sure there is adequate space, not just for the dams but also the offspring. 2 meters² (2.4 sq yards) per animal is not unreasonable and 3 meters² (3.6 sq yards) is preferred. Make sure that ventilation is adequate to prevent build-up of humidity and ammonia levels in the barn. Avoid drafts and daily temperature fluctuations. If outdoors, make sure they have shelter from inclement weather (e.g., a run-in shed). Nutritional stresses may be from artificial rearing with poor quality or poorly managed milk replacer, nutritional deficiencies from a poor diet (e.g., poorly digestible forages, inadequate vitamin E and selenium, other mineral deficiencies). Other diseases such as soremouth and pneumonia may be worse under stressful conditions. In pastured kids and lambs, concurrent infection with gastrointestinal nematodes may increase the risk of disease from coccidia. Infections can be managed through the judicious and proper use of prophylactic anti-coccidial medications. This will be covered in depth later. Kids or lambs that are ill should be promptly treated to prevent more contamination of the environment.

Reduce Risks from the Environment

The biggest source of contamination of the environment is from kids or lambs with uncontrolled infection, so it is important to control infection as mentioned above. One oocyst eaten by a kid or lamb will result in 10,000 new oocysts produced and there can be thousands to millions of oocysts excreted per gram of feces (30 grams = 1 ounce). These oocysts can survive in the barn for many months. So, we can see outbreaks of coccidiosis late in the kidding/lambing season because of the build-up through the winter. For example, kidding out doelings in a pen that previously had nursing kids and dams, can be a risk if bedding was not cleaned out. Forage and grain feeders need to be designed so that manure contamination is minimized. This means not only preventing animals from defecating in the feeder but also preventing dirty feet from going in the feeder. Bedding should also be kept fresh and dry.

Oocysts are very hard to kill. They are resistant to desiccation and many disinfectants. Sunlight will help to kill oocysts on pasture but those in the barn are protected. Oocysts will sporulate in as little as 2-5 days at temperatures as low as 12° C so potential for environmental build-up is massive. To disinfect: remove all organic debris. If possible, steam-clean the entire pen and equipment. The extreme heat will help to kill the oocysts as well as physically remove them (they are sticky!). Ammonium based disinfectants (ammonium hydroxide) and hydrogen peroxide-based disinfectants may be most effective, but surfaces need to be initially cleaned. Check the label to determine if the disinfectant kills oocysts and use as directed including assuring sufficient contact time at the right concentration. Usually, these products are applied with no animals present in the barn as some give off harmful fumes.

Reducing Risks from the Dam

Although kids and lambs are the biggest source of contamination, some advocate preventing build-up in environment from adult animals. All adults will shed a few oocysts but in the period a few weeks before parturition and through lactation, the number of oocysts excreted may rise (peri-parturient oocysts rise). Yearlings have higher rises than adults. To control this, some give medicated feed to the adults during this period. This practice alone will likely not prevent coccidiosis in the offspring.

Use of Anti-Coccidial Drugs

Issues

The use of preventive anti-coccidial medications is a common method to control coccidiosis in sheep and goats. However, there are some issues that should be addressed.

- Drugs are an expense and to decide to use them, there should be a benefit to the animal higher than their cost.
- Some products are not licensed for that species necessitating the use of veterinary feed scripts. For example, while lasalocid, monensin, totrazuril and decoquinate are approved for use in sheep, only monensin is approved for use in goats.
- For those producers trying to raise animals in an organic or “natural” way, drugs should not be routinely used.
- Using drugs that are incorporated into the feed requires more exacting feeding management to make sure the kid/lamb gets the correct amount.
- It also requires getting the medication into the very young animal in sufficient quantities to prevent disease.
- Even the best drug cannot protect stressed animals or those in a heavy contaminated environment.
- The goal of using these medications is to control the level of infection so as to prevent the disease but to still allow enough infection so that the young animal develops immunity. To do that, usually the drug needs to be available from birth to 3 - 4 months of age, usually delivered in palatable creep feed.
- In Canada, it is legal to script medications not approved for that species into the feed. In the USA, scripts can be written if AMDUCA principles are adhered to and the medication is therapeutically necessary.

Lasalocid

Lasalocid (Bovatec® or Avatec®, Zoetis Canada), an ionophore antibiotic, is licensed for use in lambs but not kids. It kills the “free living” stages of the coccidia (sporozoites and merozoites) as they move from cell to cell in the intestine. Because it kills the coccidia, it may help control disease after the animal is infected. In lambs it is approved as a feed additive to be fed free choice, at a concentration of 36 ppm = 36 mg of drug per kg of feed (36 g/tonne). To be effective a kid/lamb needs to eat 1 mg lasalocid /kg body weight per day. Under-dosing is a big problem in animals that are nursing as they may not be eating enough creep to get that dose level. To determine if they are getting enough, weigh feed consumed daily, weigh the animals and calculate what they are eating. E.g. a 10 kg (22 lb) kid must eat 0.28 kg of creep daily (at 36 ppm of lasalocid) to receive a therapeutic dose. The CFIA Medicated Ingredients Brochure for lasalocid can be found at <https://inspection.canada.ca/animal-health/livestock-feeds/medicating-ingredients/lasalocid-sodium/eng/1331062251297/1331062327299#a6>

Monensin

Monensin (Rumensin™, Elanco Animal Health plus generics), another ionophore antibiotic, is licensed for sheep and goats in Canada (11 mg/kg ad lib complete diet; 22 mg/kg limit fed complete diet). The percentage complete diet (grain plus forage) is based on dry matter level and not as fed. It works the same as lasalocid. Monensin is more toxic than lasalocid. The LD 50 for sheep is 11.9

mg/kg bw/day (i.e. only slightly more than 10 times the therapeutic dose will kill 50% of the lambs!) and for goats is 26.4 mg/kg bw/day. “Decimal place” errors commonly kill lambs when the monensin is included at 110 ppm rather than 11 ppm. Feed refusal and stiffness, as well as death may occur if the levels are too high in the feed. Lambs and kids must be introduced to a ration slowly over 2-3 weeks to acclimatize the rumen organisms. The CFIA Medicated Ingredients Brochure for monensin in sheep and goats can be found at <https://inspection.canada.ca/animal-health/livestock-feeds/medicating-ingredients/monensin/eng/1331053867503/1331053926592#a8>

Monensin is commonly used in lactating dairy cattle in Canada to reduce the risk of metabolic disease in early lactation. It is not to be used in sheep and goats producing milk for human consumption.

Decoquinat

Decoquinat (Deccox 6%, Alpharma Animal Health) is not an antibiotic nor will it improve feed efficiency. It is licensed for use in sheep in Canada but not goats. The therapeutic dose is 0.5 mg/kg BW daily for sheep and goats although there is strong evidence that 1 mg/kg BW is much more effective in those species. The UK label for sheep is for 1.0 mg/kg bw daily. To determine the amount of premix to add to the feed, then it is critical that the amount of starter / creep being eaten daily be known. This can be done by knowing the number of lambs / kids in the pen, weighing a sample of them to get an average weight and range in the pen, dividing the amount of feed added daily to the pen and calculating the amount of feed eaten per kg of body weight daily.

Although this drug is not toxic it is more expensive than lasalocid or monensin. Decoquinat works very early in the life cycle, killing only the sporozoites as they first infect the kid or lamb, and so is not effective in animals that already have disease. Because it is so effective early in the cycle, for the kid or lamb to develop immunity, it should be treated for a minimum of 3 cycles (e.g. 70 days) and perhaps longer.

The CFIA Medicated Ingredients Brochure for decoquinat for sheep can be found at <https://inspection.canada.ca/animal-health/livestock-feeds/medicating-ingredients/decoquinat/eng/1331050592425/1331050751407#a4>

As with the ionophores, it is difficult to get nursing kids and lambs to eat enough decoquinat in the feed to be effective, particularly when they are very young and very susceptible to coccidiosis. This is because the milk intake as a portion of their body weight is high, so feed intake tends to be low. Winter kidding/lambing does in confinement increases this risk as does having heavily milking does and ewes (which is a good thing – but decreases the desire for the lambs / kids to eat solid feed containing the coccidiostat). You can increase the level of decoquinat in the creep ration to compensate for this if necessary; reducing it once the lambs / kids are weaned. Again, this needs to be calculated based on the measured daily intake of creep and the average weight of the kids in the pen.

Decoquinat is available in another form as an additive to milk or milk replacer for kids or lambs being raised artificially (Deccox M 0.8%) but is not licensed for either species. It contains 8 g decoquinat / kg premix, and it is mixed so that the kids/lambs receive 0.5 to 1 mg/kg BW/day. The amount added will depend on whether the milk is limit or free-choice fed. E.g. A 10 kg kid needs 10 mg/day. 1 g of premix contains 8 mg decoquinat, so each kid will need to consume 0.6 to 1.2 g/day. 1 level tsp. contains 3.5 g (28 mg decoquinat), so each kid will need ~ 1/3 of a tsp. per day at that body size. If consuming 10% of BW, then 1 tsp. per 3 litres of milk to 3 kids. However, it is important

to remember: the milk must be agitated for 5 minutes before feeding as well as during feeding to prevent settling out and under dosing, so only use to feed individuals (e.g. don't use with a kid bar).

Totrazuril

Totrazuril (Baycox 5% Bayer Animal Health) is licensed to control coccidiosis in lambs in Canada. It is not a feed additive but a drench to be given at a very specific time of the animal's life. The recommendation is 20 mg/kg BW *once* prior to the first expected onset of disease. It is very important to understand that this drug must have a very long withdrawal for meat and must NEVER be used in lactating dairy goats or dairy sheep. The meat withdrawal for lambs is 48 days. What is very different about totrazuril is that it kills coccidia in the intracellular stages. All the rest of the coccidiostat drugs only kill the "free-living" stages as they swim to the next cell to infect, but totrazuril kills the coccidia in the cell. This means that they effectively wipe out any infection in the animal when they are treated. Additionally, there is persistency of the drug reducing the need for retreatment.

Because of how it works, totrazuril must be used very differently from other anti-coccidial drugs. It is more suited for pasture-based systems when creep feeding is not used. But there are several factors that must be considered before deciding that this is the method to control coccidiosis:

- All individual lambs/kids must be treated. Even leaving one untreated animal can reinfect the remaining animals by increasing the environmental contamination.
- The animals must be at the correct age. Treatment is done around one week prior to the first time coccidiosis is seen in your lambs/kids. On most farms that is 4 to 5 weeks of age. This often means treating each animal when it reaches 3 to 4 weeks of age. This means you can't treat the group at one time but rather when the individual animal reaches that age. Waiting until everybody is old enough means that the older animals may be diseased and are shedding large numbers of oocysts, thus increasing the environmental contamination, which can overwhelm the drug.
- Some producers wish to treat lambs when they are very young, the same as the recommendation in piglets (3-4 days of age). The reason given by these producers is that a lower volume is needed and a cost saving is perceived. It may also require less labour. Keep in mind that the coccidia that affect piglets, *Isospora* spp have a much earlier infection period than *Eimeria* spp in lambs. While the drug has persistency, it is effective for 20 days at best. If totrazuril is given at 4 days of age, it will not be protective at 25 days of age, the time when most lambs are getting infected. If used at 3-4 days of age, it is very likely that a repeat dose will be required to control infection.
- To treat animals at the right age, you must have a very good identification system, excellent records and handling facilities – along with enough reliable help, so that it is easy to find, catch and treat the lambs/kids at the appropriate age.
- Because of the persistency of the drug, you can't use it for kids or lambs slaughtered at light weights. If a lamb is treated at 28 days of age + 48-day meat withdrawal, it cannot be marketed before 76 days of age. Kids should have a longer meat withdrawal (have your veterinarian contact CgFARAD).

- You must continue to monitor the animals for signs of coccidiosis. In situations where there is still a large environmental load of oocysts, it sometimes is necessary to retreat in 3 to 4 weeks.

Diclazuril

Diclazuril is not currently available in Canada for ruminants. Like toltrazuril, it works against the intracellular forms of coccidia. In the European Union it is available as a sheep drench (Vecoxan, MSD). The label indicates a single administration of 1 mg diclazuril per kg/bw most commonly at about 6-8 weeks of age, or two administrations beginning at 3 to 4 weeks of age and the second about 3 weeks later. Like toltrazuril, you need to give early in disease to prevent damage - it is not a treatment. Unlike toltrazuril, it is not persistent and meat withdrawals are shorter and so can be given at ages closer to slaughter. Again, as with Baycox – the client needs excellent handling facilities, records and animal identification to make sure are treated correctly.

Amprolium

Amprolium (Amprol 9.6%, Huvepharma AD) is not approved for sheep or goats in Canada. It is more effective as a treatment than a control. It acts on second generation schizonts and so kills the coccidia later in the life cycle, after the coccidia have already done some damage. However, it also interferes with thiamine uptake by the intestine, and so overdosing or chronic use can cause thiamine (vitamin B1) deficiency i.e. polioencephalomalacia. Resistance of coccidia to amprolium has been reported in goats.

There are many suggested doses for kids and lambs but the following has been reported as working well in kids as a treatment without causing problems: 50 mg/kg per day for 5 days; for lambs the dose is reported at 20 to 50 mg/kg bw/day for 3 to 5 days (higher doses at shorter intervals). Although the amprolium can be added to the water you are less sure of intakes, particularly in nursing animals, so it is highly recommended to drench individuals. Control dosages (not recommended) are 5-25 mg/kg bw/day in feed or water for 21 days.

Sulfonamides

This group of antimicrobials are to be used for treatment only. There are several types with efficacy against coccidia: sulfamethazine, sulfaquinoxaline, and sulfadimethoxine are usually given as a drench or in feed or water. Toxicity is a real risk from overdose or long-term treatment, and signs are depression and kidney failure. Chronic exposure to sulfa drugs will contribute to antimicrobial resistance. As with amprolium, resistance of coccidia to sulfa drugs has been reported in small ruminants.

SUMMARY

Coccidiosis is a common cause of disease in kids and lambs and a very important internal parasite. Although environmental control must be part of the herd health approach to this disease, judicious use of anti-coccidial drugs may be necessary to ensure adequate control. Any coccidiosis control program should be designed by the flock veterinarian as each farm and its challenges are unique.