



Protozoan Parasites

Sarcocystis

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Sarcocystis

- There are about 130 recognised species in this genus reported from the striated muscles of mammals, birds, reptiles and humans. The parasites derive their name from the intramuscular cyst stage (sarcocyst) present in the intermediate host.
- **Sarcocystosis** is one of the most **zoonosis parasitic** disease of livestock and infects animals.
- Most *Sarcocystis* species, infecting human and domestic animals, are **species-specific** for their **intermediate hosts** and **family-specific for their final hosts**.
- *Sarcocystis* infections in the intermediate host are usually asymptomatic. Gastrointestinal disease is occasionally reported in humans.
- Sarcocysts are found in striated and heart muscles and may be either microscopic or visible to the naked eye and contain merozoites initially, and bradyzoites when mature.

Classification of *Sarcocystis*

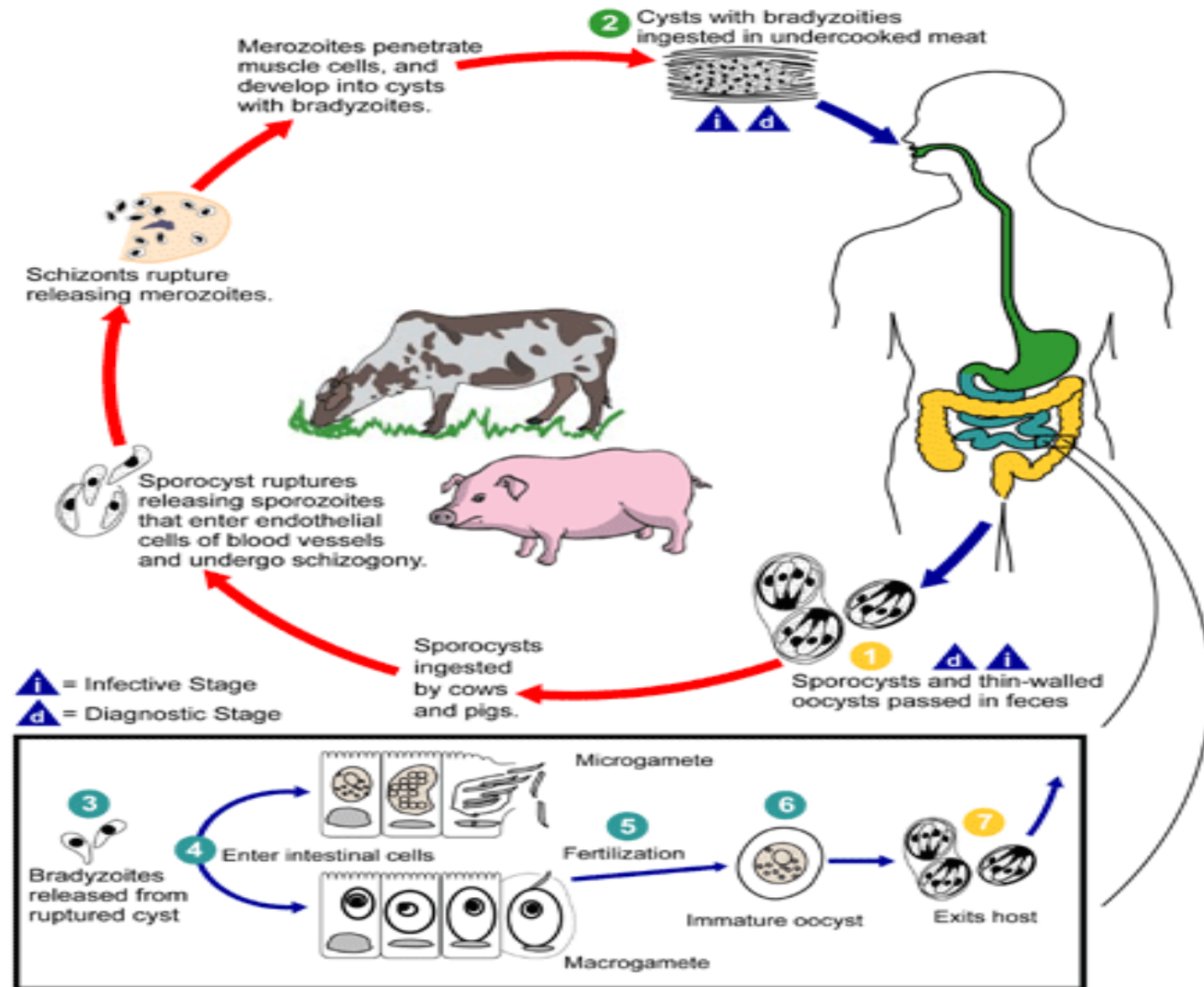
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|---------|--------------------------------|
| Phylum: | Apicomplexa |
| Class: | Conoidasida |
| Order: | Eucoccidiorida |
| Family: | Sarcocystidae |
| Genus: | <i>Sarcocystis</i> |

| Species | Final host | Intermediate host | Site |
|--|---------------------------|--------------------------------|--------|
| <i>Sarcocystis bovicanis</i> (syn. <i>Sarcocystis cruzi</i> , <i>Sarcocystis fusiformis</i>) | Dog, fox, wolf, coyote | Cattle | Muscle |
| <i>Sarcocystis bovifelis</i> | Cat | Cattle | Muscle |
| <i>Sarcocystis bovi hominis</i> | Human, primates | Cattle | Muscle |
| <i>Sarcocystis cameli</i> | Dog | Camel (Bactrian, dromedary) | Muscle |
| <i>Sarcocystis capracanis</i> | Dog | Goat | Muscle |
| <i>Sarcocystis cuniculi</i> | Cat | Rabbit | Muscle |
| <i>Sarcocystis sui hominis</i> | Human, primates | Pig | Muscle |

| | | | |
|--|---------|-------------------|---------------------------|
| <i>Sarcocystis cuniculi</i> | Cat | Rabbit | Muscle |
| <i>Sarcocystis equicanis</i> | Dog | Horse | Muscle |
| <i>Sarcocystis fayeri</i> | Dog | Horse | Muscle |
| <i>Sarcocystis hircicanis</i> | Dog | Goat | Muscle |
| <i>Sarcocystis hovarthi</i> (syn. <i>Sarcocystis gallinarum</i>) | Dog | Chicken | Muscle |
| <i>Sarcocystis ippeni</i> | Unknown | Camel (dromedary) | Muscle |
| <i>Sarcocystis lamacenis</i> | Unknown | Llama | Muscle |
| <i>Sarcocystis muris</i> | Cat | Mouse | Muscle |
| <i>Sarcocystis neurona</i> | Horse | Opossum | Brain, spinal cord |
| <i>Sarcocystis ovis</i> (syn. <i>Sarcocystis tenella</i>) | Dog | Sheep | Muscle |
| <i>Sarcocystis ovifelis</i> (syn. <i>Sarcocystis tenella</i> , | Cat | Sheep | Muscle |
| <i>Sarcocystis sinensis</i> | Unknown | Buffalo | Muscle |
| <i>Sarcocystis suicanis</i> | Dog | Pig | Muscle |

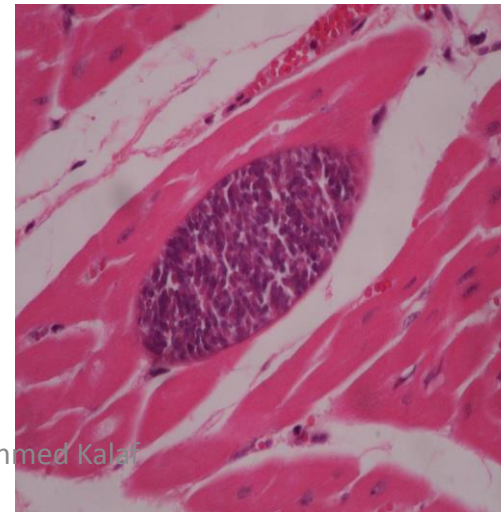
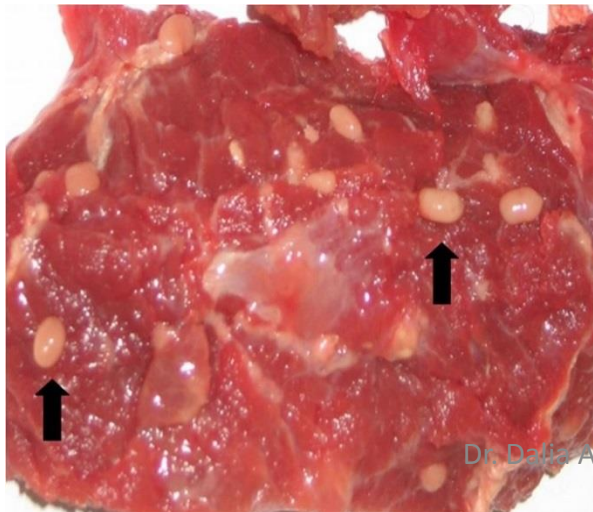
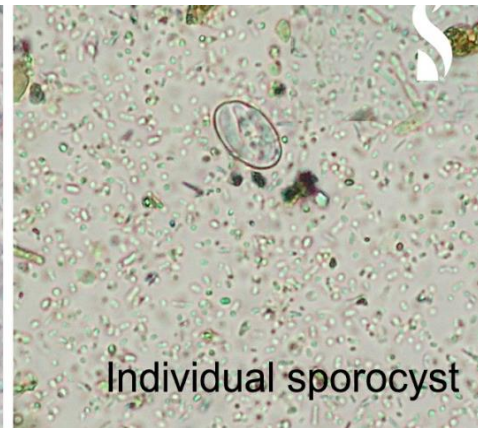
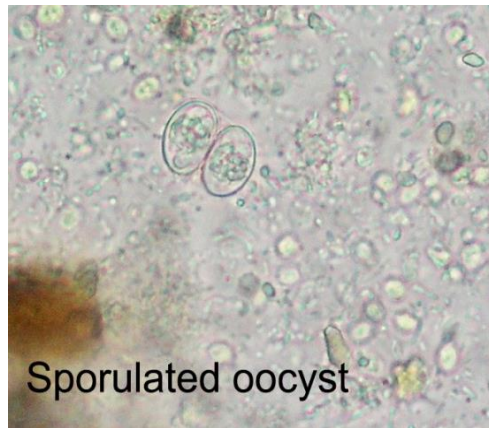
Life cycle of *Sarcocystis*

- The life cycle for all species is heteroxenous. **Sexual stages** occur in the final host and **oocysts sporulate within the body of final host** and are passed in the faeces.
- Once ingested, there are three asexual generations. In the first, **sporozoites**, released from the sporocysts, invade the intestinal wall and enter the capillaries where they locate in endothelial cells in many organs and undergo two **merogony cycles**.
- A third asexual cycle occurs in the circulating lymphocytes, when merozoites penetrating muscle cells. There they encyst and then divide by a process of budding or **endodyogeny**, giving rise to **broad banana-shaped bradyzoites contained within a cyst**. Cysts are found in skeletal and cardiac muscle.
- Infection in the dog and cat is by ingestion of bradyzoite cysts in the muscles of infected intermediate hosts.
- The bradyzoites are liberated in the intestine and the freed zoites pass to the subepithelial lamina propria and differentiate into micro and macrogametocytes. Following conjugation of gametes, thin-walled oocysts are formed which, unlike those of most other enteric sporozoans. Two sporocysts are formed, each containing four sporozoites. Usually the **fragile oocyst wall ruptures and free sporocysts are found in the faeces**.
- The prepatent period is about 12–14 days and the patent period lasts at least 18 days



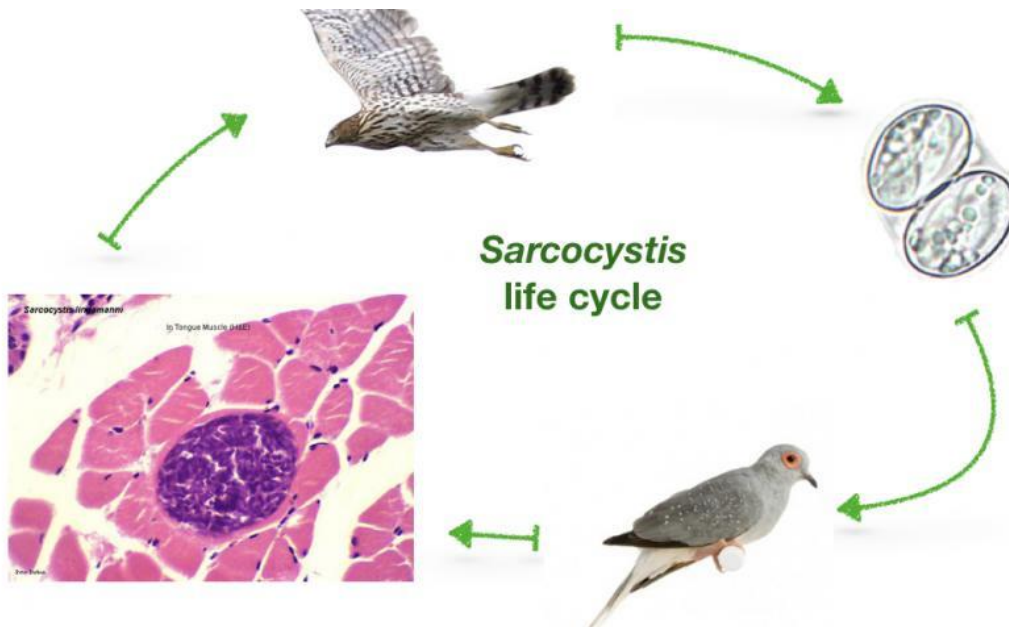
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Oocysts are **smooth, colourless**, 12–18 by 11–14 μm and contain two sporocysts each with four sporozoites, dumb-bell shape in appearance, and with no micropyle, polar granule/oocyst residuum. Sporocysts are ellipsoidal, 11–14 by 7–9 μm (mean $12.5 \times 7.8 \mu\text{m}$) **without a Stieda body** but with a residuum.



Sarcocystis in Birds

- sarcocysts were first reported in the muscles of birds by Kuhn in 1865, the first lifecycle involving a bird (*Gallus gallus*).
- These parasites can also infect birds, producing three different clinical forms: **an acute pulmonary disease, muscular disease, and neurological disease**. Symptoms include lethargy, shortness of breath, tail bobbing, yellow-tinted droppings, and sudden death. The presence of the cysts in the muscle of wild birds is known as "rice breast".



Epidemiology

- Human infection is considered rare with less than 100 published cases of invasive disease (about 46 cases reported by 1990). These figures represent a gross underestimate of the human burden of disease. The extremes of age reported to date are a 26-day-old infant and a 75-year-old man.
- The prevalence of intestinal Sarcocystis infection in humans has been estimated to be **between 1.1% and 10.4% in Europe, between 0.4% and 23.2% in Asia, 0.5% in Australia, and 0% in Argentina.**
- Virtually all cases appeared to be **asymptomatic**, which probably explains the **lack of recognition.**
- An outbreak affecting 93 persons was reported in 2012 in Malaysia revealed an infection rate of 21%. *Sarcocystis nesbitti* was confirmed to the cause in several cases.
- Infection occurs when undercooked meat is ingested. The incubation period is 9–39 days. Rats are a known carrier. Contaminated water may be able to cause infection, but this remains a theoretical possibility.
- The invasive forms of the intestinal form are *S. hominis* (from undercooked beef) or *S. suis* (from undercooked pork).

Clinical Signs and Pathology

- **In humans:** The pathology is of two types: a rare invasive form with vasculitis and myositis and an intestinal form that presents with **nausea, abdominal pain, and diarrhea**.
- While normally **mild and lasting under 48 hours**, the intestinal form may occasionally be severe or even life-threatening. The invasive form may involve a wide variety of tissues including lymph nodes, muscles, and the larynx.
- Clinical cases have been associated with acute fever, myalgias, bronchospasm, pruritic rashes, lymphadenopathy, subcutaneous nodules associated with eosinophilia, elevated erythrocyte sedimentation rate, and elevated creatinine kinase levels. Symptoms may last as long as five years.

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In cattle: Four recognised species infect cattle: *S. bovifelis*, *S. bovi hominis* (*S. hominis*), *S. cruzi* (*S. bovicanis*), and *S. hirsuta*. *S. cruzi* is the only species known to be pathogenic in cattle. Several clinical syndromes have been reported in connection with this parasite: eosinophilic myositis; **abortions, stillbirths, and deaths in pregnant cows**; two cases of necrotic encephalitis in heifers have also been reported. Typical clinical signs of **acute bovine sarcocystosis** are: **anorexia, pyrexia (42°C or more), anemia, cachexia, enlarged palpable lymph nodes, excessive salivation, and loss of hair at the tip of the tail.**

In sheep: Ovine protozoan **myeloencephalitis** is a recognised syndrome that may occur in outbreaks. The usual pathological findings in such cases are **multifocal spinal cord white matter oedema and necrosis**, glial nodules and mild to moderate encephalomyelitis.



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In horse: *S. neurona* causes equine protozoal myeloencephalitis. Exposure to this parasite appears to be common in the United States, with serological surveys indicating that **50–60% percent of all horses** in the Midwest United States have been exposed to it. Clinical signs include **gait abnormalities including ataxia, knuckling, and crossing over. Muscle atrophy, usually unilateral, may occur.** The lesions are typically focal. Brain stem involvement is common. **Depression, weakness, head tilt, and dysphagia also occur.** *S. fayeri* may cause myositis in horses.



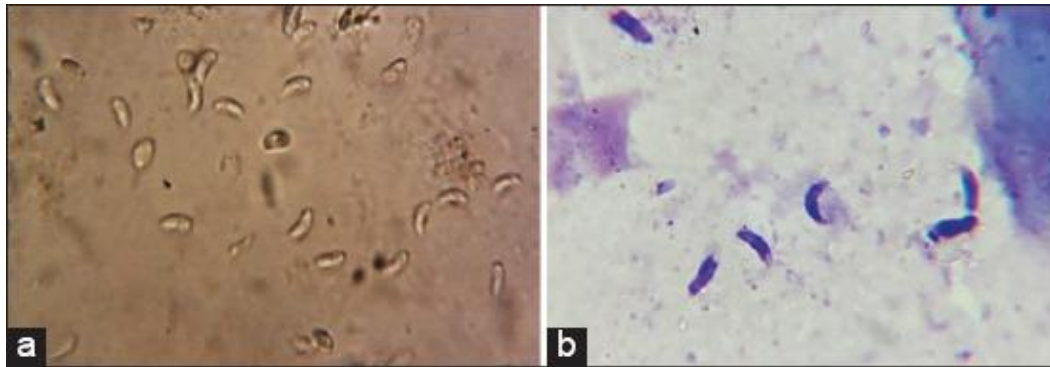
In camel: **Fatal infection** of an alpaca (*Lama pacos*) with an unnamed species has been reported. Findings included disseminated eosinophilic myositis, **abortion**, and haemoabdomen. The myositis was associated with hameorrhage, necrosis, and degeneration.

Diagnosis

1. Definitive diagnosis by biopsy of an infected muscle (muscle biopsy). Sarcocysts are identifiable with Hematoxylin and Eosin.



2. **Pepsin digestion** method was to test fresh muscle tissue samples for detecting microsarcocysts followed by microscopic examination cited from “**Investigation of *Sarcocystis* spp. in slaughtered cattle and sheep by peptic digestion and histological examination in Sulaimani Province, Iraq**” 2021, **Veterinary World journal**.



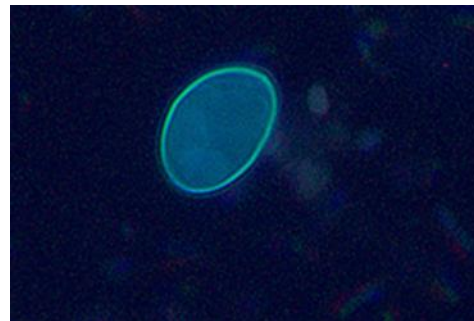
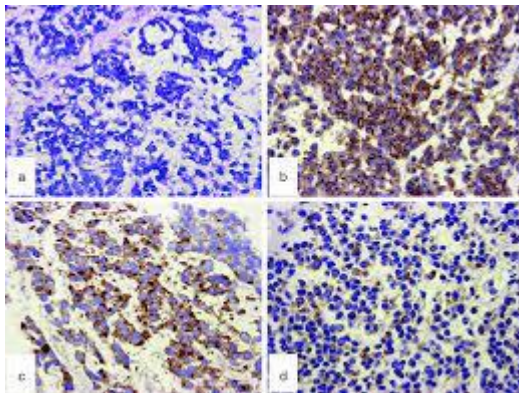
(a) Fresh smear preparation from microcyst, showing crescent-shaped bradyzoites (40×), (b) Giemsa stained from digested muscle samples showing *Sarcocystis* bradyzoites (100×).

3. Fecal examination: direct fecal smear, and fecal flotation using bright field microscope.



Sporulated oocyst contains 2 sporocysts each has 4 sporozoite.

4. The PAS (Preiodic Acid Schiff) stain: walls stain positive.



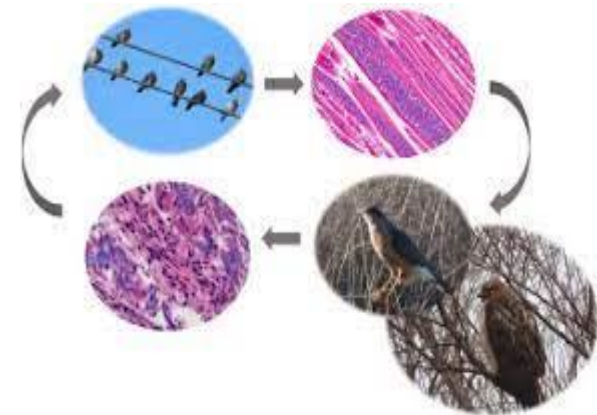
5. Along with the sarcocystis, inflammatory cells may be found (**eosinophilia**) and **increase in erythrocytes cells**.

6. PCR amplification of the rRNA may also be used.

7. dermal sensitivity testing or complement fixation tests

Differential Diagnosis

- Sarcocystidae family consists of species that infect a range of animals, including mammals, birds, and reptiles include: *Besnoitia*, *Caryospora*, *Cystoisospora*, *Frenkelia*, *Isospora*, *Hammondia*, *Hyaloklossia*, *Lankesterella*, *Neospora*, and *Toxoplasma*.
- *Frenkelia*, another genus within this family, appears to be very closely related to Sarcocystis. **Some molecular studies consider *Frenkelia* a species belong to Sarcocystis.** differs from in that its **last-generation meronts occur in the brain rather than in the muscles.**
- The protozoa in this genus infect the **gastrointestinal tract of birds (definitive hosts) and the tissues of small rodents (intermediate hosts).**



Treatment

- Because infection is rarely symptomatic, treatment is rarely required and spontaneously recovery. Agents that have been used include albendazole, metronidazole, and cotrimoxazole for myositis in lambs.
- These agents have **not been tried in humans** to date.
- Amprolium (100 mg/kg, daily for 30 days), fed prophylactically, reduced illness in **cattle** inoculated with *S. cruzi*. Prophylactic administration of amprolium or salinomycin also protected experimentally infected sheep.
- **In horses**, sulfonamides and pyrimethamine. Sulfadiazine (20 mg/kg orally) once or twice a day is a commonly used. Infected horses should also be placed on pyrimethamine

at the dose of 1.0 mg/kg given once a day orally for 120 days or longer.



Prevention and Control

1. Infection can be prevented by cooking the meat before eating to a temperature of 150-160°F (71° C) for 15 minutes should **destroy** the parasite.
2. Alternatively, freezing the meat at -5°C for several days before ingestion kills the sporocysts.
3. Do not swim in fresh water that may be contaminated.
4. Drink and use safe and clean water.

No vaccines are currently known. Experimental trails presented to develop a persistent immunity.



Is sarcocystosis be transmitted from person to person?

Additional references

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Thank You