Helminth parasites are regularly diagnosed in dogs in the U.S. Those in dogs typically fall into 1 of 2 categories: intestinal helminths or pulmonary helminths. Canine intestinal helminths were discussed in this column in the January/February 2014 issue, available at tvpjournal.com; this article will address canine pulmonary helminths.

PULMONARY HELMINTHS
A surprisingly wide variety of helminths damage the pulmonary system of dogs and, at times, can cause severe, life-threatening respiratory disease (Table 1).

- *Dirofilaria immitis* (heartworm) is by far the most important parasite of the canine pulmonary system, inducing severe morbidity and, in some cases, mortality.
- *Toxocara canis* and *Ancylostoma caninum* are intestinal nematodes that migrate through the lungs as larvae.
- *Paragonimus kellicotti* is a trematode that develops in cysts in the lung parenchyma.1
- *Angiostrongylus vasorum*, the French heartworm, and the lungworms *Crenosoma vulpis*, *Eucoleus aerophilus*, and *Filaroides* species also create pathology in canine lungs.

While less familiar than heartworm, infection with these other pulmonary helminths can be very important in some canine patients. This article outlines how dogs become infected and describes appropriate treatment courses to manage the infections.

### TABLE 1. Life Cycle Summary: Helminths Found in the Lungs of North American Dogs

<table>
<thead>
<tr>
<th>PARASITE</th>
<th>LOCATION OF ADULT HELMINTH IN DOG</th>
<th>INTERMEDIATE HOST</th>
<th>PARATENIC HOST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NEMATODES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Angiostrongylus vasorum</em></td>
<td>Pulmonary arteries</td>
<td>Snail or slug</td>
<td>Frog</td>
</tr>
<tr>
<td><em>Crenosoma vulpis</em></td>
<td>Lumen of bronchi</td>
<td>Snail or slug</td>
<td>None</td>
</tr>
<tr>
<td><em>Dirofilaria immitis</em></td>
<td>Pulmonary arteries</td>
<td>Mosquito</td>
<td>None</td>
</tr>
<tr>
<td><em>Eucoleus aerophilus</em></td>
<td>Tracheal and bronchial epithelium</td>
<td>None</td>
<td>Earthworm</td>
</tr>
<tr>
<td><em>Filaroides hirthi</em></td>
<td>Lung parenchyma</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><em>Filaroides osleri</em></td>
<td>Nodules in trachea</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td><strong>TREMATODES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>Paragonimus kellicotti</em></td>
<td>Cysts in lung parenchyma</td>
<td>Snail, crayfish</td>
<td>Mammals</td>
</tr>
</tbody>
</table>
develop in pulmonary capillaries. Larvae that hatch from the eggs move into an airspace; then are coughed up, swallowed, and passed in the feces. Snails and slugs feeding on the feces ingest the larvae and perpetuate the life cycle.3

Clinical Signs. Infection with *A. vasorum* produces disease similar to that caused by *D. immitis*: chronic cough, dyspnea, exercise intolerance, and anorexia.

- Gagging and weight loss are the most common clinical signs reported.
- Pulmonary hemorrhage can occur as larvae migrate into airspaces.
- Granulomas develop in response to eggs and larvae, and pulmonary fibrosis occurs.
- Pulmonary vascular lesions include thromboarteritis and intimal proliferation; pulmonary hypertension can lead to congestive right heart failure.4

Diagnosis. Larvae can be detected in feces using the Baermann technique or fecal flotation, and are identified by the characteristic kink at the tip of the tail (Figure 2)

Radiographic changes associated with *A. vasorum* infection include:

- Diffuse peribronchial, interstitial, and alveolar densities
- Enlargement of the right heart and pulmonary artery.

Treatment (Table 2, page 70). Infections have been treated with several different types of anthelmintics:

- Albendazole or fenbendazole
- Ivermectin
- Levamisole
- Moxidectin.

Severe dyspnea and ascites may be seen after treatment; bronchodilators, expectorants, and diuretics may be required to manage these post-treatment reactions.

Prevention. Routine administration of topical moxidectin has been shown to protect dogs from infection with this parasite.5 Dogs can also be protected by minimizing opportunities to consume snails, slugs, and frogs.

**Crenosoma vulpis**

Distribution. This lungworm of foxes and other wild canidae is most common in the northeastern U.S. and the eastern part of Canada.6

Life Cycle. Dogs become infected when, like foxes, they ingest the snail or slug intermediate host. The nematodes migrate to the lungs and develop into adults, moving from the smaller bronchioles to the larger bronchi as they mature.

Clinical Signs. Infections may be asymptomatic or can induce bronchitis and bronchiolitis, resulting in chronic cough.7

Diagnosis. Infection with *C. vulpis* is confirmed by identifying characteristic larvae with a conical head and conical, tapering tail (Figure 3) in the feces, or finding the worms in the bronchi at necropsy.

Treatment (Table 2). Successful treatments described in the literature include fenbendazole, ivermectin, and febantel. More recently, excellent results have been obtained using:

- Milbemycin oxime at 0.5 mg/kg PO single dose
- Topical application of 10% moxidectin, single dose.8

Prevention. Routine use of monthly parasite control products containing milbemycin oxime or moxidectin are expected to prevent establishment of future infections.

**Eucoleus aerophilus**

Distribution. Infection with *E. aerophilus* is seen wherever dogs and cats are found, although foxes are considered an important reservoir host.9

Life Cycle. Eggs are shed in the sputum or feces, and embryonate in 30 to 50 days. Larvae are released when eggs or earthworm paratenic hosts are ingested and migrate by the bloodstream to the lungs. The larvae then penetrate the alveoli and migrate up the air passages as they develop. They reach maturity in the epithelium of the bronchioles, bronchi, and trachea, threading their thin bodies through the epithelial surface.1

Clinical Signs. Most infections with *E. aerophilus* are clinically inapparent. If large numbers of nematodes are present, dogs may develop tracheitis, bronchitis and, sometimes, pneumonia,11 which can cause:

- Anorexia
- Cough
- Debilitation
- Dyspnea
- Nasal discharge.

Diagnosis. The eggs passed in sputum or feces are characteristic, with polar plugs that are slightly askew of the central axis (Figure 4) and a granular shell. The eggs in the feces of dogs must be differentiated from those of *Trichuris vulpis* (larger), *Eucoleus boehmi* (contain a partially developed embryo when passed), and *Pearsonema plica* (present in feces contaminated with urine).2

Treatment (Table 2) & Prevention. Extended courses of ivermectin or fenbendazole have been reportedly successful at eliminating infection, but anecdotal evidence suggests that routine preventives may not be protective against this nematode.
**Filaroides species**

**Distribution.** Infection with *Filaroides* species occurs sporadically, and periodically appears in some kennels or in individual dogs.12

**Life Cycle.** Larvae shed in the feces or in the respiratory secretions of infected dogs are immediately infective and may be transmitted to other dogs by ingestion; this direct life cycle facilitates rapid spread between co-housed dogs. Ingested larvae migrate to the trachea and develop into adults in nodules (*F osleri*) or the lung parenchyma (*F birthi*).

**Clinical Signs.** Infection with *F osleri* can cause a hard, dry cough triggered by exercise or exposure to cold air.12 Young dogs are most acutely affected and sometimes develop respiratory distress, anorexia, and emaciation. 

Infection with *F birthi* is usually asymptomatic, but fatal cases of hyperinfection have developed in severely stressed and immunodeficient animals.13

**Diagnosis.** Infection with *Filaroides* species is diagnosed by finding larva with fecal flotation using zinc-sulfate centrifugation.

- Larva of:11
  - *F osleri* have a constriction and a kink just posterior to the end of the tail (Figure 5).
  - *F birthi* come to a simple point at the tip of the tail (Figure 6).

Infection with *F osleri* may also be diagnosed at bronchoscopy by identifying the pathognomonic transparent submucosal nodules containing nematodes.

**Treatment (Table 2).** The treatment of choice for *F osleri* seems to be injectable doramectin; some veterinarians also remove as many nodules as possible with the aid of the bronchoscope. Dogs with both *F osleri* and *F birthi* have also been successfully treated with several days of fenbendazole or ivermectin.

**Prevention.** Because larvae of *Filaroides* species are immediately infective when shed in the feces, control can be difficult, particularly if other canine members of the household are infected.15

**Paragonimus kellicotti**

**Distribution.** Infection with *P kellicotti* occurs along the Mississippi, Missouri, Ohio, and St. Lawrence rivers and in areas of the southeastern U.S.16

**Life Cycle.** Eggs passed in the feces hatch to release a miracidium, which penetrates a snail. Cercariae are produced that leave the snail host and enter a crayfish to encyst as metacercariae. When the crayfish is eaten by a dog, cat, other wild carnivore, or a human, adult trematodes develop within cysts in the lung parenchyma. Paratenic hosts that ingest infected crayfish may also harbor infective metacercariae.1

**Clinical Signs.** Dogs infected with *P kellicotti* may be asymptomatic or can present with a variety of respiratory signs, including:

- Coughing
- Dyspnea
- Bronchiectasis
- Hemoptysis

Dogs may tolerate a low number of intact cysts, but in heavy infections, or when cysts rupture, severe disease may result due to:17

- Pulmonary hemorrhage
- Pneumothorax
- Granulomatous pneumonia.

**Diagnosis.** Eggs of *P kellicotti* can be recovered by sugar flotation, sedimentation of feces, or transtracheal wash, and are characterized by their size, seated operculum, and abopercular bump or flange on the end opposite the operculum (Figure 7). Pulmonary cysts may be evident on thoracic radiographs.

**Treatment (Table 2).** Infections may be treated with repeated courses of any of the following:18

- Albendazole
- Fenbendazole
- Praziquantel.

**RISK FOR ZOONOTIC INFECTION**

Several of the common canine pulmonary helminths are zoonotic, although infections are acquired from the environment or a vector, rather than direct contact with infected dogs.

- Toxocariasis upon ingestion of infective eggs of *T canis* from contaminated soil is well documented; as many as 1 in 7 adults in the U.S. harbor antibodies to *Toxocara* species.19
- Human infection with *D immitis* via mosquitoes also occurs, resulting in development of pulmonary granulomata.20
- Human infection with *P kellicotti* following ingestion of raw crayfish has also been reported in young men and is associated with alcohol consumption.16
TABLE 2. Canine Pulmonary Helminths: Recommended Treatment Dosages

<table>
<thead>
<tr>
<th>ANTHELMINTIC</th>
<th>EFFECTIVE AGAINST</th>
<th>DOSAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fenbendazole</td>
<td>Angiostrongylus vasorum</td>
<td>50 mg/kg PO Q 24 H for 10–14 days</td>
</tr>
<tr>
<td></td>
<td>Eucoleus aerophilus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Filaroides hirthi</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Filaroides osleri</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Paragonimus keliotti</td>
<td></td>
</tr>
<tr>
<td>Milbemycin oxime</td>
<td>Crenosoma vulpis</td>
<td>0.5 mg/kg PO single dose</td>
</tr>
<tr>
<td>Moxidectin</td>
<td>Angiostrongylus vasorum</td>
<td>10% moxidectin topical application, single dose</td>
</tr>
<tr>
<td></td>
<td>Crenosoma vulpis</td>
<td></td>
</tr>
<tr>
<td>Praziquantel</td>
<td>Paragonimus keliotti</td>
<td>23 mg/kg PO Q 8 H for 3 days</td>
</tr>
</tbody>
</table>

Protecting dogs from infection with pulmonary helminths limits environmental contamination, reducing risk of both canine and human disease.

GENERAL CONSIDERATIONS & CAPC RECOMMENDATIONS

- Administer broad-spectrum parasite control products that provide internal parasite control and prevent heartworm infection to all pet dogs year-round.
- Routinely deworm puppies beginning at 2 weeks of age, with deworming repeated every 2 weeks.
- Begin administering a monthly control product with efficacy against intestinal helminths when puppies reach 4 to 8 weeks of age.
- Other preventive measures that owners can implement include:
  - Keeping dogs on a leash or in a fenced yard to prevent predation and scavenging activities; this limits the opportunity for dogs to acquire infection via ingestion of vertebrate hosts (ascarids) or from a feces-contaminated environment.
  - Promptly removing feces from the yard to prevent eggs from decomposing with fecal material or dispersing into the environment.

Inform clients that routine parasite control typically results in negative fecal examinations, confirming the efficacy of routine parasite prevention. In the case of pulmonary helminths, even though those other than heartworm are not mentioned on product labels, it is very likely that administration of these drugs minimizes the ability of lungworms to develop if the dog is receiving monthly preventive therapy.

References


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