<table>
<thead>
<tr>
<th>Animal Group(s) Affected</th>
<th>Transmission</th>
<th>Clinical Signs</th>
<th>Severity</th>
<th>Treatment</th>
<th>Prevention and Control</th>
<th>Zoonotic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Many mammal species:</td>
<td>Female mosquito vector: &gt;70 out of 3000 mosquito species worldwide; 16 species east of the Mississippi, three on the California coast, including <em>Aedes, Anopheles, Culex, Mansonia,</em> and <em>Psorophora</em> spp.</td>
<td>Tricuspid regurgitation murmur, right heart failure, pulmonary hypertension, pulmonary thromboembolism, jugular pulses, allergic pneumonitis, ascites, hemoglobinemia, and hemoglobinuria (caval syndrome).</td>
<td>Asymptomatic or mild, may progress to fatal</td>
<td>Melarsomine dihydrochloride</td>
<td>Macrolytic lactones—monthly oral ivermectin, milbemycin oxime, or moxidectin; or monthly topical moxidectin or selamectin; or parenteral moxidectin every 6 months. Mosquito control, keep animals indoors</td>
<td>Yes, but rare</td>
</tr>
<tr>
<td>Dogs</td>
<td>Dogs</td>
<td>Pulmonary granulomas, dyspnea, chylothorax, blindness, tachycardia, syncope.</td>
<td>Asymptomatic to fatal; possible spontaneous cure with no treatment</td>
<td>Symptomatic treatment or surgical extraction only</td>
<td>Same as dogs</td>
<td></td>
</tr>
<tr>
<td>Cats</td>
<td>Cats</td>
<td>Anorexia, cough, weakness, dyspnea, bilirubinuria</td>
<td>Potentially severe, &gt;4 worms can be fatal</td>
<td>Injectable moxidectin, if available</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ferrets</td>
<td>Ferrets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**DIROFILARIA IMMITIS**

**Fact Sheet compiled by:** Eleanor C. Newcomb; updated by Andrew Moorhead

**Sheet completed on:** 1 April 2011; updated 17 September 2013

**Fact Sheet Reviewed by:** Dwight D. Bowman; Richa Sachdev

**Susceptible animal groups:** Mammals. Dogs 100% susceptible. Cats 61-90% susceptible. Domestic dog and wild canids (wolf, coyote, fox), and possibly Eurasian otter, are definitive hosts. Raccoons, wolverines, coyotes, deer, and bears are wildlife reservoirs. Documented in the rabbit, ferret, river otter, muskrat, harbor seal, sea lion, red panda, Japanese raccoon dog, wild cat, black-footed cat, golden cat, bobcat, ocelot, clouded leopard, snow leopard, African leopard, tiger, African lion, American black bear, polar bear, horse.

**Causative organism:** *Dirofilaria immitis*, a nematode intravascular parasite, that lives in bloodstream of host, normally pulmonary vessels.

**Zoonotic potential:** Occasionally occurs and usually causes pulmonary dirofilariasis; in Florida, 100 cases were documented in the last 40 years.

**Distribution:** Diagnosed in 48 contiguous states plus Hawaii and US territories and worldwide.

**Incubation period:** Prepatent period at least 6-7 months in definitive host, 7-8 months in cat. Temperature dependent maturation of organism in mosquito occurs >57°F. In mosquito: ingested L1 (microfilariae) molt into L2 in 8-10 days post-infection, molt to L3 in 2-3 days after second molt, then migrate to mouth parts in 1-2 more days. Total development time can be as short as14-15 days. In dog: L3 injected into host by mosquito molt to L4 in 3-12 days in skin, molt to juvenile adult heartworm in subcutaneous tissue and muscle in 50-70 days, migrate to heart via vascular system by day 70-120. L1 (microfilariae) discharged by mature nematodes 6-9 months post infection and can survive up to 2-3 years in the bloodstream. Worm longevity: 5-7 years in dog, 2-3 years in cat. Clinical signs may not appear for one year after infection.

**Clinical signs:** Lethargy, weakness, fatigue, exercise intolerance, dyspnea, cough, anorexia, weight loss, vomiting, diarrhea, collapse, seizures, sudden death. Humans: aberrant host—worms do not reach adult stage—no microfilariaemia.

**Post mortem, gross, or histologic findings:** Female nematodes <12”, males <7”, microfilariae <1/800”. Worms found in lobar arteries and main pulmonary artery when mild (e.g., 10 worms); right atrium and caudal vena cava, and rarely the right ventricle when severe (e.g., >40 worms). Dogs: 1-250 worms. Cats: 1-3 worms. Rabbits: aberrant host—granulomatous lung nodule reported. Humans: “coin lesion” in lungs, can be confused radiographically with carcinoma.

**Diagnosis:** In dogs and exotic species, antigen test (most sensitive, nearly 100% specific) detects adult female *D. immitis* protein >5-7 months post-infection. Cats: Both antigen and antibody tests preferred. Ancillary tests: Modified Knott or filtration test for microfilariae to differentiate *D. immitis* from *Acanthocheilonema reconditum*, thoracic radiography, ultrasonographic visualization of worms.

**Material required for laboratory analysis:** In-house antigen blood testing simple and inexpensive for dogs. Blood tubes for both antigen and antibody testing for cats.

**Relevant diagnostic laboratories:** Any veterinary diagnostic laboratory that performs the diagnostic testing.

**Treatment:** Dogs--arsenical compound: melarsomine dihydrochloride—only effective on worms >120 days old. Maximum 98% efficacy on adult worms. Adjunct therapy: Pretreatment with macrocyclic lactone 8-12 weeks to eliminate migrating larvae <60 days old and allow larvae 60-120 days old to reach melarsomine-susceptible age. Doxycycline 10 mg/kg bid for 4 weeks to reduce inflammation from filarial-associated Wolbachia. Surgical extraction of adult heartworms in acute caval syndrome. Cats: adulticide treatment not recommended. Symptomatic: prednisolone, bronchodilators. Surgical removal via right jugular venotomy or right ventriculotomy. Caution must be exercised with melarsomine in exotic carnivores due to narrow margin of safety.

**Prevention and control:** Dogs and cats-- macrocyclic lactones: ivermectin/pyrantel (Heartgard Plus—Merial, dog and cat; Iverhart Plus—Virbac; Tri-Heart—Merck); milbemycin oxime/lufenuron (Sentinel--
**DIROFILARIA IMMITIS**

Novartis); moxidectin (Advantage Multi—Bayer, dog and cat; ProHeart 6;—Zoetis, dogs only); selamectin (Revolution—Zoetis)—all against L3, early L4; microfilariae—milbemycin oxime (off-label at preventive dose). Preventives have some efficacy against adult heartworms, but studies have mostly been performed with ivermectin/pyrantel compounds. Efficacy declines in late stages of L4. As of this writing, resistance to heartworm preventives has been proven; however, it does not appear to be a concern except in the Mississippi Delta region.

| Suggested disinfectant for housing facilities: | Not applicable |
| Measures required under the Animal Disease Surveillance Plan: | None |
| Measures required for introducing animals to infected animal: | None, although presence of mosquitoes will increase risk to non-infected individuals. |

**Conditions for restoring disease-free status after an outbreak:**
Treat affected individuals, eliminate microfilariae pre-treatment (milbemycin oxime 500 ug/kg or ivermectin at 50 ug/ kg most rapid rate of clearance), mosquito control

**Experts who may be consulted:**
American Heartworm Society
P.O. Box 8266
Wilmington, DE 19803-8266
info@heartwormsociety.org
http://www.heartwormsociety.org/

**References:**
4.  http://cp.vetlearn.com/Media/PublicationsArticle/PV_30_03_133.pdf access date