Heartworm (Dirofilaria immitis) Infection & Prevention in Dogs

Drs. Foster & Smith Educational Staff

Heartworms were first identified in the United States in 1847 and occurred most frequently on the seacoast in the southeastern United States. In recent years, heartworm disease has been found in all 50 states in the USA. The movement of infected animals that could serve as sources of infection for others is probably a significant contributing factor to heartworms spreading across North America. The actual number of infected dogs and cats in the United States is unknown.

What are heartworms?

Heartworms, *Dirofilaria immitis*, belong to the same class of worms as roundworms. In fact, they look a bit like roundworms, but that is where the similarity ends. Heartworms spend their adult life in the right side of the heart and the large blood vessels connecting the heart to the lungs.

Heartworms are found in dogs, cats, and ferrets. They also occur in wild animals such as California sea lions, foxes and wolves. They have rarely been found in people.

How do dogs become infected with heartworms?

Adult heartworms in the heart lay very tiny larvae called microfilariae, which then live in the bloodstream. These microfilariae enter a mosquito when it sucks blood from an infected animal. In 2-3 weeks, the microfilariae develop into larger larvae in the mosquito and migrate to the mosquito's mouth.

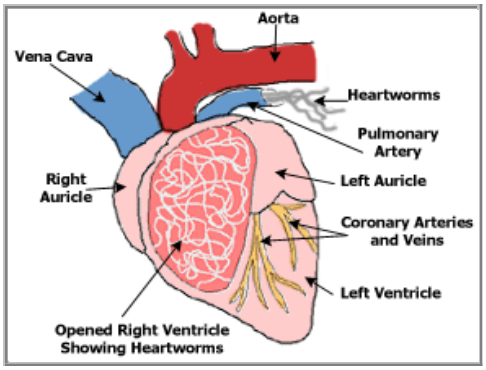
When the mosquito bites another animal, the larvae enter the animal's skin. The larvae grow and after about three months finish their migration to the heart, where they grow into adults, sometimes reaching a length of 14 inches. The time from when an animal was bitten by an infected mosquito until adult heartworms develop, mate, and lay microfilariae is about 6-7 months in dogs and 8 months in cats. (Remember this – it is important when we talk about diagnosis.)

Severely infected dogs can have up to several hundred heartworms in their hearts and vessels. Adult worms in dogs usually live up to 5-7 years. Thirty to eighty percent of infected dogs have microfilariae, and the microfilariae can live up to 2 years. Microfilariae cannot mature into adult heartworms unless they pass through a mosquito.

> There are more than 60 different species of mosquitoes that can transmit heartworms.

What damage do heartworms cause?

In dogs, the adult worms can obstruct the various large blood vessels leading from the heart to the lungs. Worms may also enter smaller vessels in the lung and obstruct those vessels, as well. In severe cases, called "caval syndrome" worms start to fill the right ventricle of the heart.



What are the signs of heartworm infection and how is it diagnosed?

Most dogs with heartworm infection do not show signs of disease. Some dogs may show decreased appetite, loss of weight, and listlessness. Often, the first sign of the disease is a cough. Animals with severe heartworm disease will start to show lack of endurance during exercise. Some will accumulate fluid in their abdomen (ascites) that makes them look pot-bellied. In rare situations in which animals have many adult worms, the animals may die of sudden heart failure.

Blood testing is performed to identify dogs infected with *D. immitis*. Because blood tests are not always accurate, we need to interpret test results in relation to the history and the symptoms the animal is showing. Radiographs (x-rays) and ultrasound (echocardiography) are often performed to look for typical changes in the heart and lungs caused by *D. immitis*, and determine the severity of the infection. Changes include enlargement of the pulmonary artery and the right ventricle. Certain types of cells (eosinophils) may increase in the blood or secretions from the lungs in heartworm infections. These additional findings can all help support the diagnosis.

What tests are available to detect *D. immitis* infection in animals?

There are several blood tests used to detect heartworm infection. In the 1960's, before more sophisticated tests were available, heartworm testing involved looking for the microfilariae in a drop of blood on a microscope slide. A better test, the Knott's test, was developed to concentrate the microfilariae from a larger portion of blood through centrifuging it. This gave veterinarians a better chance of finding the microfilariae.

Later, filter tests became available. In these tests, the blood cells in the blood were lysed (broken) by a special agent that did not affect the microfilariae. The resulting liquid was then put through a very fine filter. The microfilariae were concentrated on the filter. The filter was stained and examined under the microscope for microfilariae.

Veterinarians soon recognized that some animals could have heartworm infections without having microfilariae in the blood. This occurs if only male worms are present or if the females are not laying microfilariae at the time of the test. It was obvious that better tests were needed.

Antigen testing

Serologic tests were developed to identify antigens (small protein and carbohydrate components) of heartworms in the bloodstream. There are different varieties of this test. One of the most common types is called an ELISA test. Some test kits run one sample at a time and can be done right in your veterinarian's office. Others are designed to test multiple samples in large batches. This batch-type of test is generally performed by outside laboratories to which your veterinarian sends your dog's blood.

Although the antigen tests were much better than the filter test, we still could not identify all cases of heartworm infection because antigen tests will only be positive if adult female worms are present, since the antigen detected is from the worm's uterus. If the heartworms were not fully mature, or there were only male worms present, the antigen test result in infected animals would be falsely negative. This means the test result is negative when the animal is really infected.

Antibody testing

Serologic tests have now been developed to detect antibodies (proteins made by the animal's body to fight off the 'invaders') against heartworms. This is the test most commonly used in cats. This test will be positive even if only one male worm is present. But this test has a downfall, too. Although it is very good at giving positive results when an infection is present, false positive tests are more common with this test than the antigen test. A false positive result means the test result is positive when no infection is present.

What is included in a good heartworm prevention program?

The best program for prevention of heartworm infection includes using preventives, performing routine heartworm testing, and reducing exposure to mosquitoes.

Heartworm preventives

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Medications used to prevent heartworm infections are called preventives. The first thing to remember is that preventives are NOT used to kill the adult worms. Special drugs called adulticides must be used to kill the adults. These drugs will be discussed in the treatment sections. Some preventives can cause severe problems if given to animals with adult heartworms or microfilariae. Follow the recommendations of your veterinarian and the manufacturer of your preventive in regard to testing prior to giving the preventive.

Every dog, whether indoor or outdoor, should be on a heartworm preventive.

A number of monthly heartworm preventives for dogs are on the market. Some heartworm preventives, or drugs that are combined with them, will control other parasites. Preventive products should be used year-round, even in areas where mosquitoes only occur seasonally. Even if doses are accidentally skipped, preventive products are still beneficial to the pet. If given consistently over a 12-month period, it's possible to actually stop worms from developing into adults. Also, monthly heartworm preventives have activity against intestinal parasites, which inadvertently infect millions of people every year. These preventives protect pets and people.

The daily preventive, diethylcarbamazine is available with a prescription through compounding pharmacies. Two main disadvantages are that it can produce severe reactions if given to a dog with a heartworm infection, and that missing even two or three days of administration could result in a lapse of protection.

The most commonly used heartworm preventives for dogs in the United States are shown in the table below.

Active Ingredient	Example(s)	Dose Given	Mode of Action	Minimum age at which preventive can be given	Additional Ingredients	Additional Effects	Comments
Ivermectin	Heartgard®	M; oral	LA	6 weeks	None	N/A	* See below
Ivermectin	Heartgard® Plus, Iverhart Plus®, Tri-Heart® Plus	M; oral	LA	6 weeks	Pyrantel	Controls roundworms and hookworms	* See below
Ivermectin	Iverhart Max®	M; oral	LA	8 weeks	Pyrantel Praziquantel	Controls roundworms, hookworms, and tapeworms	* See below
Milbemycin oxime	Interceptor®	M; oral	LA	4 weeks, but puppies or dogs must weigh 2 pounds or more	None	Controls hookworms, roundworms, and whipworms	
Milbemycin oxime	Sentinel®	M; oral	LA	4 weeks, but puppies or dogs must weigh 2 pounds or more	Lufenuron	Controls hookworms, roundworms, and whipworms; prevents flea eggs from developing	
Selamectin	Revolution®	M; topical	LA	6 weeks	None	In dogs, controls fleas and ear mites; treats sarcoptic mange, and controls the	* See below

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						American Dog Tick.	
Moxidectin	Advantage MultiTM for Dogs	M; topical	LA	3 pounds and 8 weeks of age	Imidacloprid	Kills adult fleas. Does not kill ticks. Treats infestations with ear mites, roundworms, hookworms, whipworms, sarcoptic mange, and demodectic mange.	* See below
Moxidectin	ProHeart® 6	6 M; Inj	LA	6 months of age	None	Treats hookworm infections	* See below
Diethylcarbamazine		D; oral	LI	None	None	Treats roundworm infections	
D = Daily; M = Monthly; 6 M = Every 6 months; Inj = Injectable LA = Kills larvae accumulating in host during preceding month; LI = Kills larvae as they are introduced *Collies and related breeds are known to have a sensitivity to ivermectin and similar medications. Consult your veterinarian before using these products in a collie or herding breed.							

A preventive should be given to all dogs. Remember that mosquitoes can get indoors, so even though your dog may not go outside, the dog is still susceptible.

Testing

When and how often pets should be tested for heartworm infection is a matter of debate. In making a decision on when to test, we must consider how common heartworm disease is where the pet lives, what heartworm preventive the pet is receiving, and how long the mosquito season lasts.

The American Heartworm Society (AHS) advises all adult dogs being started on a heartworm preventive for the first time should be tested. In addition, all dogs should be tested annually for heartworm infection. In the past, if a dog had been on preventive methods routinely, it was not considered necessary to test every year, perhaps only every two to three years. Because of reports of animals on preventives that still contracted heartworms, the AHS recommends a more conservative testing routine. It may be too difficult to document when an animal hasn't been checked in three years, and therefore, annual testing will ensure that an infection is caught in plenty of time to effectively manage it.

Switching Prevention Methods Requires Additional Testing - Dogs should be tested for heartworm if they are going to be switched from one preventive product to another. Pet owners sometimes switch between prevention medications, for any number of reasons. In these instances, there are specific time periods at which the pet should be retested to ensure the pet is protected.

Testing puppies: In areas where heartworm preventives are given seasonally, a puppy that was not alive during the previous mosquito season would not have to be tested. For instance, in northern Wisconsin, puppies born in January do not need to be tested prior to starting them on heartworm preventive in the spring. Remember, any puppy less than 6.5 months old is probably going to have a negative antigen test, since any larvae the pup was exposed to would not have had time to mature and be detected by the antigen test.

Mosquito control

Reducing the exposure of a pet to mosquitoes can help prevent them from even being exposed to heartworm larvae. For detailed information on mosquito control, see Mosquito Control and Preventing Diseases They Transmit.

How is heartworm infection treated?

The first adulticide (drug to kill the adult heartworms) for dogs that was developed was thiacetarsamide sodium (Caparsolate®), which contained arsenic. It was given in the vein through a catheter. If any drug got outside of the vein, severe tissue damage was possible. Some animals became quite ill from this drug, and therapy sometimes had to be stopped. Almost all animals had to be hospitalized for the several days of treatment.

Melarsomine (Immiticide®), the medication currently used to treat heartworm infection, also contains arsenic. It is given by injection deep in the muscles of the back instead of intravenously. It is less likely to cause side effects than thiacetarsamide and is more effective.

The treatment protocol depends on the severity of infection. In less severe cases, the dog may be treated for four months with a heartworm preventive to kill any migrating heartworm larvae and to decrease the size of the female worms. Then an injection of melarsomine is given to kill the adult heartworms. Five weeks later, the dog is treated with two more injections

In August 2011, a shortage of Immiticide was announced by the manufacturer. The American Heartworm Society developed guidelines to use for the treatment of heartworm

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of the adulticide. Four months after the treatment, the dog should be tested for heartworms using the antigen test. Some animals may need to undergo a second round of injections if repeat antigen tests remain positive. It is recommended that dogs remain on a monthly heartworm preventive during the treatment. In severe cases, it may be necessary to use the adulticide before the four months of heartworm preventive are given.

Regardless of which drug is used, when the adult heartworms die, they can obstruct blood vessels to the lungs (these are called pulmonary embolisms). If only a small part of the lung is involved, there may be no clinical signs. However, if the vessels to a large portion of the lung, or a small area of an already diseased lung are blocked, severe signs may result. These include fever, cough, coughing up blood, and even heart failure. Because of the risk of these embolisms, any dog being treated with an adulticide must be kept very quiet during treatment and for at least 4 weeks thereafter.

In very severe infestations, adult worms are removed from the heart surgically.

Can humans be infected with heartworms?

Yes, there have been instances of heartworm infection in people. Instead of migrating to the heart, the larvae migrate to the lungs in humans. There the larvae can block vessels causing an infarction. At the site of the infarction, a nodule develops which can be seen on radiographs. Usually, the person has few, if any signs of infection. Surgical removal of the nodule is sometimes necessary.

treatment of heartworm infection if Immiticide is unavailable. The treatment includes regular use of a heartworm preventive (other than diethylcarbamazine) combined with doxycycline. If the dog has microfilariae in his blood, corticosteroids and an antihistamine should be given prior to treatment with the preventive and doxycylcine. The doxycycline/preventive treatment is not as effective as Immiticide. It will, however, shorten the lifespan of the worm, lessen the damage the worms cause, and help to disrupt heartworm transmission.

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