



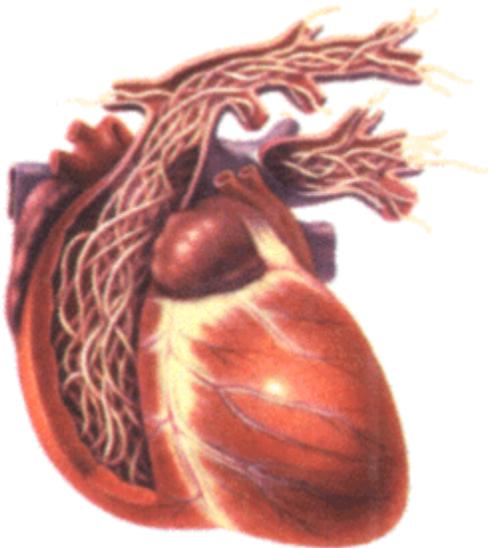
A GUIDE TO CARING FOR A HEARTWORM POSITIVE DOG
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What is heartworm?

Heartworm disease is caused by a nematode parasite *Dirofilaria immitis*. This parasite is transmitted by mosquitoes, and makes its home in the pulmonary artery (blood vessel going from the heart to the lungs) and the right atrium (chamber of the heart).

What Does Heartworm do to the body?

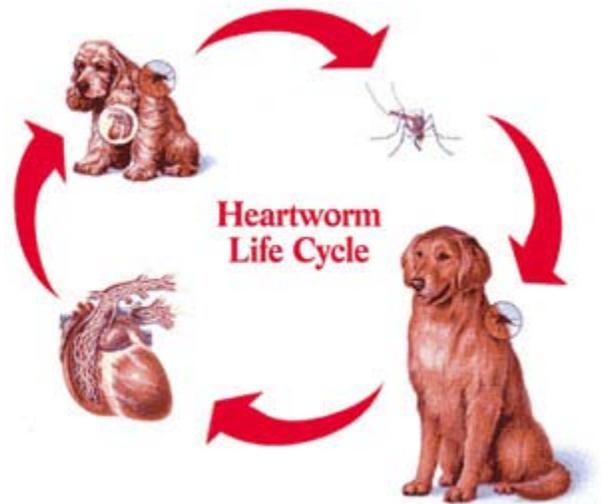
1. Damage to the Pulmonary Arteries (the vessels going from the heart to the lungs):



Arteries do not do well having worms living inside them. The lining of the artery becomes damaged within days of the worm's arrival. Cells of the immune system are called into the area but the worm is far too big for these tiny cells to destroy. The resulting inflammation; however, continues to damage the artery. The arteries dilate and become tortuous (which may be visible on a radiograph). Aneurysms (ruptured vessels) and abnormal blood clotting (embolism) can result. Blood is shunted to other arteries that are not plugged up by worms and fluid begins to accumulate in the lung around the worm-filled arteries. Blood being sent to the lung is not efficiently oxygenated and areas of lung become consolidated and unable to participate in providing oxygen to the blood.

- Coughing and exercise intolerance result as areas of the lung are unable to participate in the blood oxygenation process.
- Nose bleeds may occur due to abnormal blood clotting in the lung.
- A form of non-infectious pneumonia (pulmonary eosinophilic granulomatosis) can result from excessive infiltration of inflammatory cells into the lung in response to the parasite.

2. Heart Failure



Blood normally is pumped with ease through the arteries of the lung. With the arteries plugged with worms, the heart must pump harder against the pressure of the plugged arteries. This condition is called *pulmonary hypertension* and the right side of the heart must drastically increase its ability to work. It may be strong enough and it may not.

If worms begin backing up into the heart, there will be less space in the pumping chamber for blood to be pumped. The heart must pump through the high pressure system of the plugged arteries using less blood than normal. In order to meet the body's oxygen demand, the heart must pump faster and stronger still. There may come a point when the heart simply is not strong enough.

- When the heart muscle begins to thicken (as any over-worked muscle will), it may not conduct electrical impulses normally. This means that the pumping/filling rhythm can be disrupted and an *arrhythmia* may result.

In any heart disease, arrhythmia is a possibility; when arrhythmia is a possibility, so is sudden death.

- If the right side of the heart becomes too weak to keep up, fluid may accumulate in the chest cavity and abdominal cavity, leading to a pot-bellied appearance and/or difficulty breathing.

3. Chronic Immune System Stimulation

When a dog goes without treatment for heartworm disease, their immune system becomes chronically stimulated. Antibodies, which are not only important tools of the immune system but are inflammatory proteins, are produced in high amounts all the time. These antibodies can cause a lot of trouble by precipitating in the delicate membranes of the eye, kidney, blood vessels, and joints. Antibodies can get stuck in these areas and damage these delicate membranes thus setting up tremendous tissue damage and pain.

4. Caval Syndrome

Caval syndrome represents an especially disastrous form of heartworm disease. Here, there are so many worms (around 100) that the entire right side of the heart is filled with worms and they are backing out into the large veins that feed the right side of the heart. Usually there have been no signs of heart disease prior to the collapse, shock, and red blood cell destruction associated with this syndrome. Death usually occurs within 1 to 2 days and the only effective treatment is to open the dog's jugular vein and physically remove the worms with a special clamp. If enough worms can be removed to re-establish blood flow, the dog may survive.

Heartworm disease is a highly significant problem and must be managed both by dealing with the worms and by dealing with the heart disease.

Heartworm Treatment

Prior to therapy, the heartworm patient is assessed and rated for risk into one of four categories. Important factors include: how many worms are thought to be present based upon the tests performed, the size of the dog; the age of the dog; concurrent health factors; severity of the heart disease; and the degree to which exercise can be restricted in the recovery period.

- **Class I: Lowest Risk.** Young healthy dogs with minimal disease evident on x-ray, normal blood work, and no symptoms of illness. They may cough only occasionally if ever, they only fatigue with exercise, and their chest x-rays are normal.
- **Class II: Moderately Affected.** Healthy dogs with minimal signs as above, occasional coughing, fatigue only with exercise but with chest x-rays that show definite evidence of heart disease. Lab testing may show mild anemia, urine tests show some protein, but not severe urine protein loss.
- **Class III: Severely Affected.** Dog is suffering from weight loss, cough, difficulty breathing, blatant damage to the vasculature is apparent on chest x-rays, laboratory work reveals a more severe anemia and marked urinary protein loss.
- **Class IV: Caval Syndrome.** Dog is collapsing in shock and dark brown urine is evident. Heartworms visible by ultrasound in the right side of the heart, and blood work is abnormal. These dogs are dying and can only be saved by the physical removal of adult heartworms via an incision through the jugular vein. If such a dog can be saved from this crisis, further heartworm infection treatment cannot be contemplated until the dog is stable enough to fit into one of the other categories above.

After knowing what class the patient fits in, treatment can be determined. Dogs have three groups of heartworms in their body:

- The microfilaria (early larval stages – L1), which are the newborn children of the adult worms living in the heart and pulmonary arteries. The microfilariae are swimming freely in the bloodstream, possibly in large numbers, and it is the microfilaria that can spread to other dogs through a mosquito. The microfilarias are killed so as to keep the dog from spreading the infection.
- The new arrival heartworm larvae, delivered from mosquito bites in the last 6 to 7 months. These are L3 and L4 larvae stages. These will continue their maturation and repopulate the heart and pulmonary arteries if they are not killed before the adult worms.
- The L5 larvae and adult worms living inside the heart and pulmonary arteries. This group requires the arsenic compounds for destruction while the other two groups can be killed with less toxic products.

The first step in treatment is clearing the migrating immature worms. If we were to jump directly to killing the adult worms first, the adult worms we remove could be readily replaced shortly afterwards by those that were in the process of migration at the time of treatment. By addressing the migrating immature worms first, we minimize the number of adult worms we must kill in the second step. Fewer adult worms dying at once also means less risk.

The L3, and L4 larvae can all be killed by monthly ivermectin-based heartworm preventive products (i.e. Heartgard, Tri-Heart, etc.). There are other products that can kill these stages, but often much faster, which can create circulatory shock if there are large numbers of microfilariae dying all at one time. The American Heartworm Society recommends 1 to 3 months of a preventive prior to treating the adult worms.

The only product currently available for the treatment of adult heartworms is melarsomine dihydrochloride (Immiticide® by Merial). If you follow the manufacturer's recommendations, treatment

can be done in two doses or three doses depending on the class of infection. Most universities and The American Heartworm Society, however, opt to treat all patients with the three-dose protocol as it creates a more gradual kill of the adult worms, which is safer as it reduces the risk of embolism and shock.

The patient receives an intramuscular injection deep in the lower back muscles. This can be painful and these dogs are sent home with anti-inflammatory pain medications. Approximately 10-30% of dogs experience some sort of reaction at the injection (soreness, swelling, etc...) site that resolves in 1 to 4 weeks. Some dogs develop a permanent firm lump at the site of injection.

In the two-dose protocol, the dog receives a second injection the next day on the opposite side of the lower back. In the three-dose protocol, the dog comes back one month later for two doses 24 hours apart (the first dose represents an introductory treatment to kill some of the more sensitive worms.)

If the dog is stable (Class I), one option is to simply leave the dog on an ivermectin-based preventive. This option has led to a great deal of misconception about the ability of ivermectin to kill adult heartworms. Let us lay the rumors to rest now:

- **Ivermectin does not kill adult heartworms.**
- Ivermectin does shorten the lifespan of adult heartworms.
- Ivermectin does sterilize adult heartworms.
- Ivermectin does kill microfilaria (keeping the dog from being a source of contagion)
- Ivermectin does kill L3 and L4 larvae (preventing new infections).

This means that if you opt to treat a heartworm positive dog with an ivermectin-based heartworm preventive only, you can expect the dog to remain heartworm positive for as long as two to three years and the heartworm disease will be progressing during those two years. This is not good for the dog but certainly beats getting no treatment of any kind. This approach should only be considered for patients who are Class I and may be able to withstand prolonged heartworm infection.

Management of a Dog Before & After Adult Heartworm Treatment

From the time of diagnosis to adult heartworm treatment, it is important to start to implement exercise restrictions. This is for two reasons:

1. These dogs have compromised heart and lungs...they are at increased risk of developing inflammation of the lungs, throwing blood clots, etc...
2. They will need to be STRICTLY exercised restricted/crate confined for 1 full month after treatment – have them get used to it now.

After treatment, the patient must be strictly confined for one month following the final treatment. No walks greater than 5 minutes, no running around, no jumping or playing. Ideally these dogs are crate confined, they go out on leash to urinate and defecate, and that's it. The reason for this is that embolism (clots to the lungs) is to some degree an inevitable consequence of successful adult heartworm treatment and may be severe if infection is heavy and pulmonary arterial disease is extensive. It is important to minimize embolism-related problems: exercise increases heart rate and oxygen demand; we need the heart to rest during this recovery period. If signs of embolism (low grade fever, cough,

bloody nose, exacerbation of right heart failure) develop, they are usually evident within 7 to 10 days, but occasionally as late as 4 weeks after completion of adult heartworm treatment. Mild embolism in relatively healthy areas of lung may be clinically inapparent. **A pivotal factor in reducing the risk of complications is STRICT exercise restriction.**

Watch for:

- Coughing
- Inappetence
- Lethargy
- Fever
- Nose bleeds

If any of these occur, report them to the vet as soon as possible. The most critical time period is 7 to 10 days following a melarsomine treatment, but these signs can occur anytime in the month following treatment.