CANINE HEARTWORM

START

VECTOR BORNE DISEASE

MSD Animal Health

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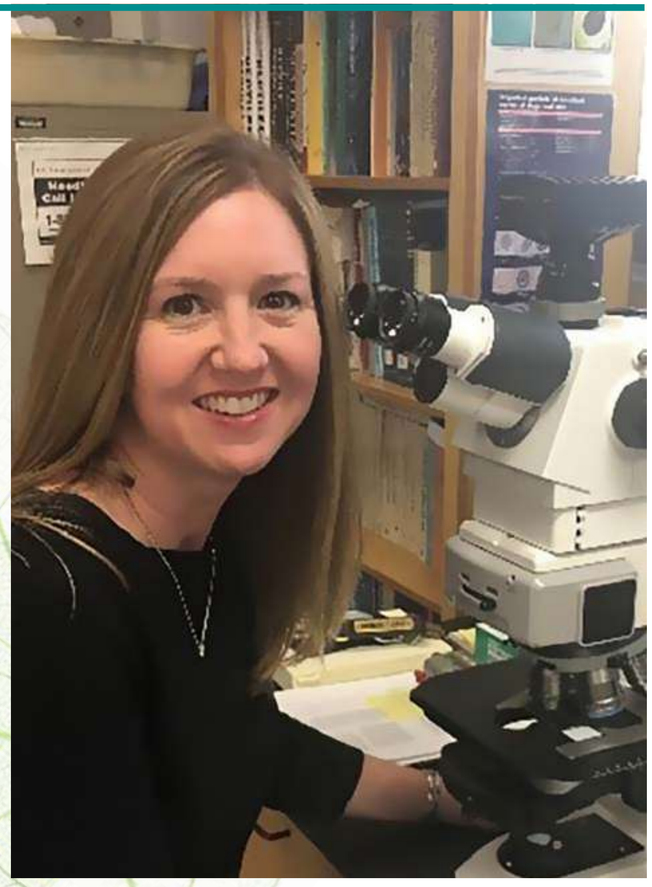
Dr. Heather Walden's research interests focus on zoonotic parasitic disease, diagnosis and classical parasite biology including modes of transmission and pathogenicity in the definitive host. Most of her research and collaborations span several parasite species and involve human and veterinary parasitic infections throughout the United States, Mexico, Ecuador, the Galapagos Islands, and Zambia and Senegal, Africa. These endeavors seek to gain a better understanding of relationships between parasites and their human and non-human hosts interacting in the same environment, and the influence of parasitic infections on population livelihoods. Her parasitology laboratory regularly works with parasites of exotic and domestic hosts, as her classical and molecular training allows inclusion of internal and external parasites of all taxonomic groups ranging from fish, amphibians, reptiles and birds to mammals, including marine mammals and nonhuman primates. She also teaches and mentors veterinary and graduate students at the University of Florida College of Veterinary Medicine and is a parasitologist board member of the Companion Animal Parasite Council (CAPC).



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WHERE IS THE DISEASE
MOST LIKELY TO BE FOUND?

Dirofilaria immitis, the nematode that causes heartworm, has been diagnosed in a variety of hosts **around the world.**

Heartworm relies on a **mosquito** as its intermediate host, or vector, to continue its life cycle and for transmission into the next definitive host.

Development of *D. immitis* microfilariae to a third stage infective larva (L3) will depend on the development of the mosquitoes which are **conditioned** by relative humidity and temperature.

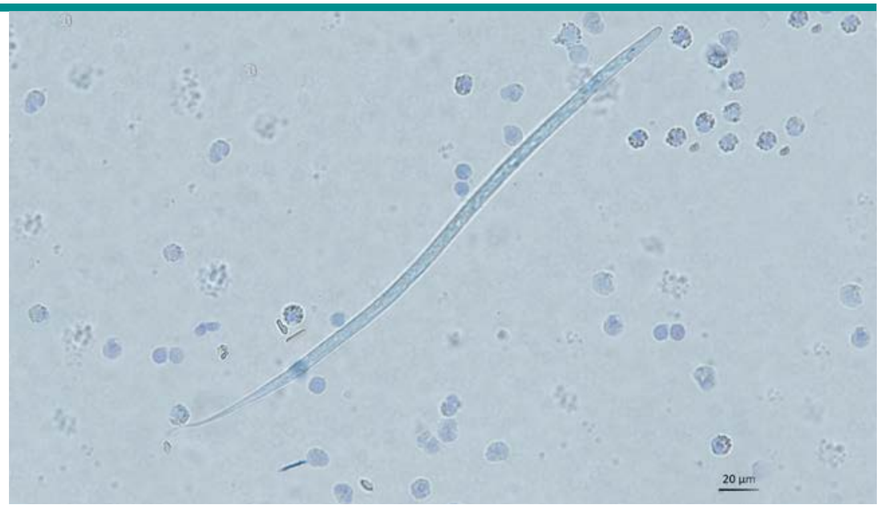
Heartworm is found throughout the world, from tropical areas to climates with long winters. **Infection and spread** are partially driven by the mosquito intermediate host, and the ability of many mosquito vectors to hibernate, or aestivate, extends their breeding cycle and the period of transmission risk.

HOW DOES A DOG **BECOME INFECTED?**

An introduction to the causative agent

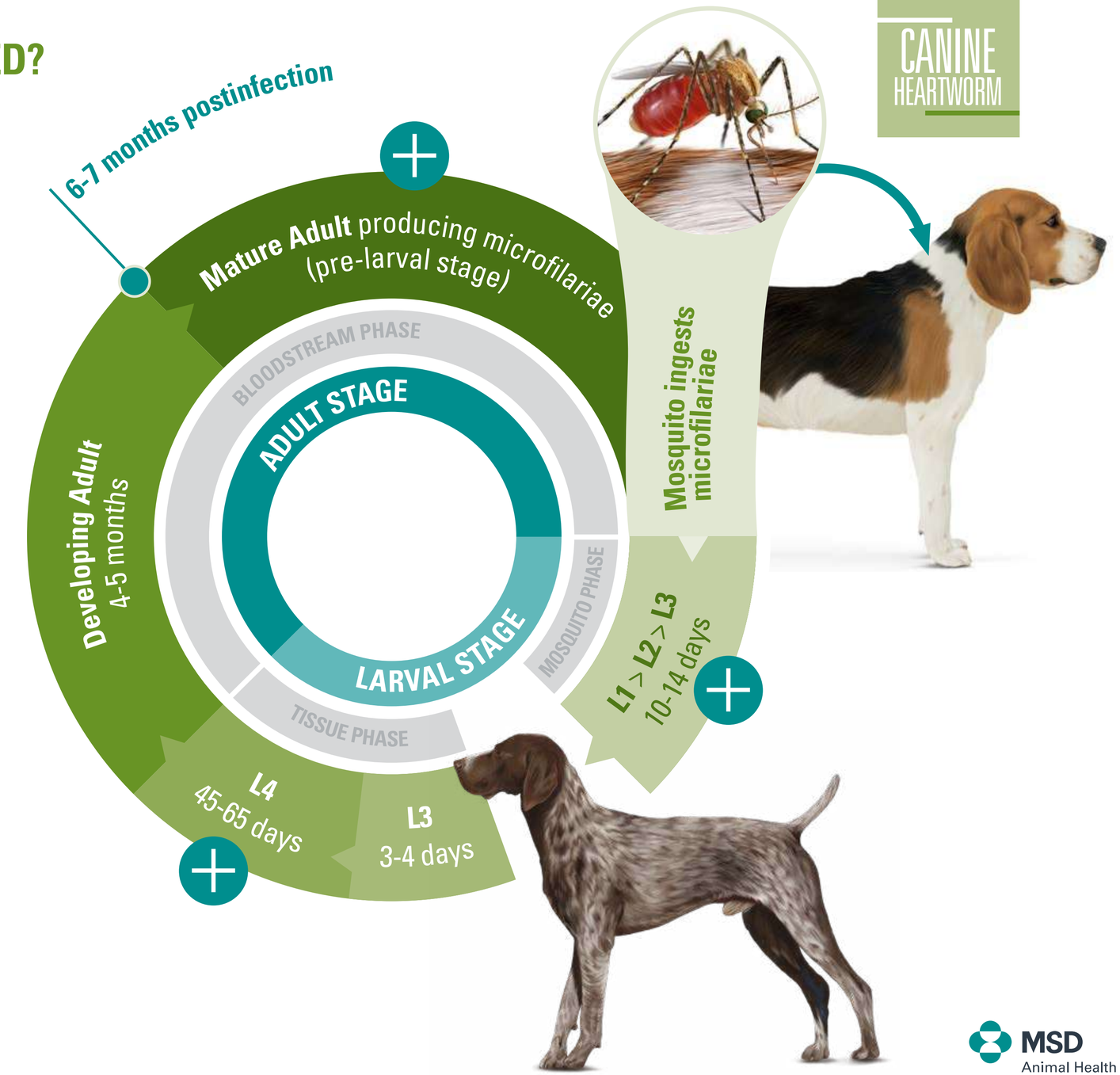
Dirofilaria immitis is a filariid nematode, and the causative agent of Dirofilariasis. These are long, thin worms, with **males** up to 20 cm and mature adult **females** nearing 30 cm in length.

Dirofilaria immitis microfilaria in a modified Knott's technique preparation of whole blood as seen at 400x total magnification.



HOW DOES A DOG **BECOME INFECTED?**

Dirofilaria immitis lifecycle



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Vector

Mosquitoes are the intermediate host, and vector, for *D. immitis*. Several species worldwide have been reported to harbor infective L3s, and can transmit heartworm. Most of these mosquitoes are *Aedes*, *Anopheles* and *Culex* species.

Aedes aegypti

Proportion of vectors infected

The proportion of mosquito vectors carrying heartworm infective stages varies depending on the mosquito population and the proximity of microfilaremic definitive hosts.

In endemic areas…

Dogs can have a heartworm prevalence that approaches 50%, especially after natural disasters.	The chance that a feeding mosquito will acquire the parasite increases.
Heartworm prevalence in mosquitoes can be about 20%.	However, mosquitoes sampled near known positive dogs had an increased prevalence.

Reservoirs

Additional factors that can contribute to increased heartworm prevalence in both dogs and mosquitoes include the presence of microfilaremic **reservoir hosts.**

HOW DOES A DOG **BECOME INFECTED?**

Probability of transmission

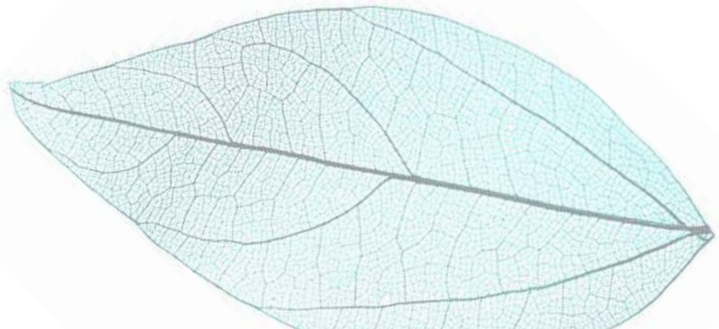
Heartworm transmission depends on a variety of factors.

- **Population of competent vectors or intermediate hosts** +
- **Population of definitive hosts or reservoirs** +
- **Natural disasters** +

Click on + for more information

Transmission mechanics

Transmission can occur at any time of day as some important heartworm vector mosquitoes are nocturnal, some are diurnal and others are crepuscular feeders. Additionally, **mosquito habitat** choices vary. Some mosquitoes also readily enter shelters or houses to feed while others do not.



WHAT BEHAVIORS
PUT A DOG AT RISK FOR THE DISEASE?

Activities/dwellings

Outdoor activities increase the risk of a dog getting a mosquito bite and subsequent heartworm infection. However, some mosquitoes may enter dwellings to feed; therefore, installing screens, closing doors and risk awareness are important.

CAN A DOG BE INFECTED AND **NOT SHOW SIGNS?**

Infection *vs* disease

Heartworm infections are found in dogs throughout the world. These infections occur in dogs in areas that support the development and maintenance of the mosquito vector and heartworm prevalence can reach 50% in dogs in endemic areas. There are many levels of disease severity associated with heartworm infections, and clinical signs can range from none to the most severe form of the disease known as Caval Syndrome.

Subclinical disease

Prevalence

The prevalence of subclinical disease in dogs around the world is unknown.

- Is there a risk? +
- Size of the risk +
- Tests that reveal a subclinically infected dog +

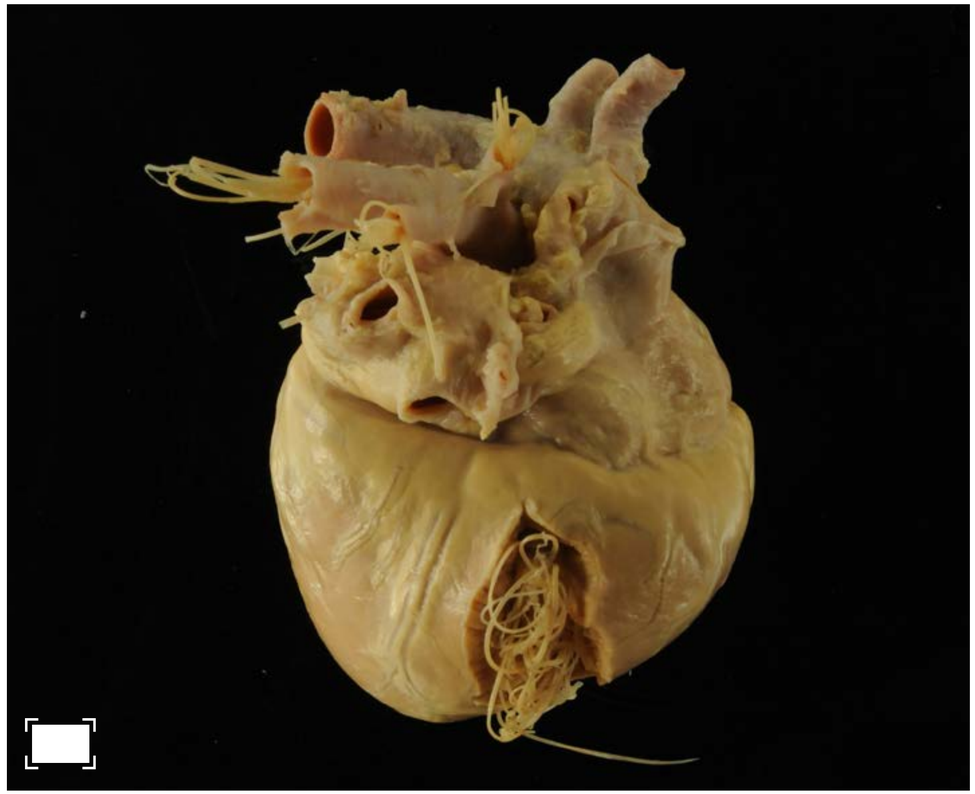
Click on + for more information

WHAT CLINICAL SIGNS
DOES A SICK DOG SHOW AND WHY?

Pathogenesis

Dogs infected with heartworms may show a wide range of clinical signs. **Worms** in the heart and pulmonary arteries damage the pulmonary endothelium.

Heartworm disease stages include mild, moderate, severe and Caval syndrome, and are commonly listed as **Class 1-4.**



Preserved canine heart with the right ventricle cut open showing a heavy *Dirofilaria immitis* infection with worms also visible in the transected major pulmonary vessels.

Progression

Class 1

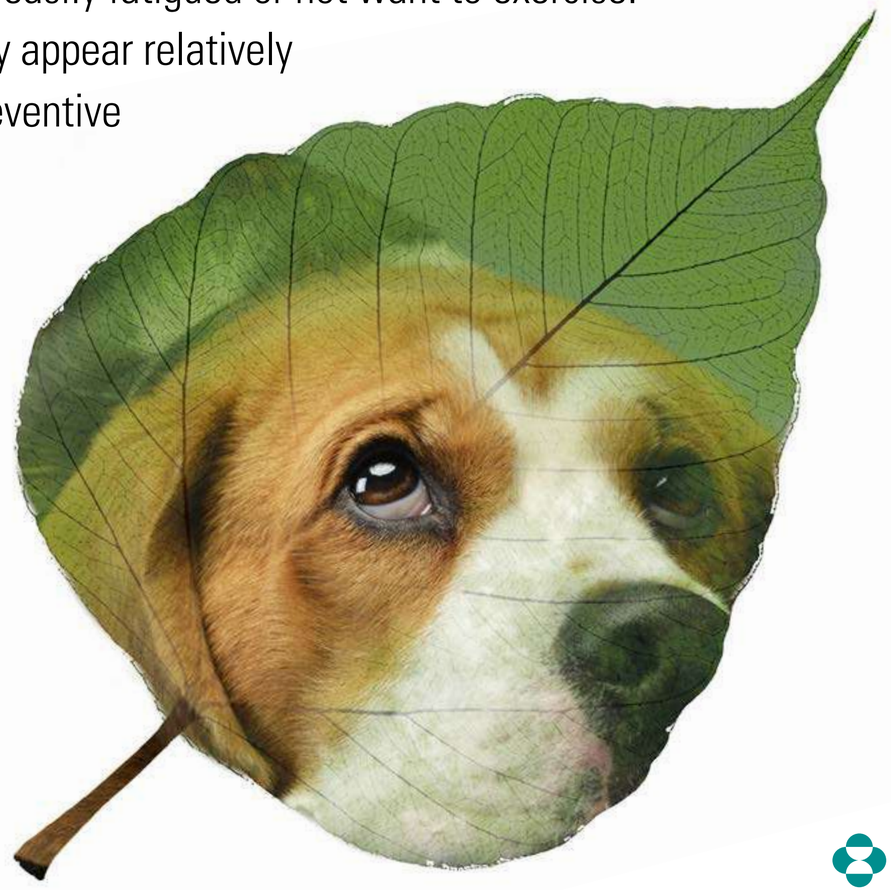
Dogs in Class 1 may have no signs or the occurrence of signs may be rare, with possibly a slight cough. Some infected dogs exhibit exercise intolerance at the early stages of infection.

Prognostic factors

Dogs infected with heartworms may have a persistent cough, may be easily fatigued or not want to exercise. They may have a decreased appetite and lose weight. Some dogs may appear relatively healthy. In these instances, travel and life style history, along with preventive history is important.

Recovery indications

Recovery from heartworm infections is possible with appropriate treatment, however, it can take several months to a year or more for full recovery. In some severe infections, where cardiopulmonary damage has been extensive, full recovery may not be possible.



WHAT DIAGNOSTIC TESTS SHOULD BE RUN
IN A DOG THAT IS SUSPECTED TO HAVE THE INFECTION/DISEASE?

Rapid, table-side

Heartworm **antigen tests,** along with blood microfilariae tests, are the first and most practical diagnostic tests to detect initial heartworm infections.

In hospital using microscope or similar equipment

Blood microfilariae tests can include a direct smear of whole blood to observe moving microfilariae, or a concentration test using the **modified Knott's technique** to identify microfilariae species and a count of microfilariae/mL of blood. **Radiography and echocardiography** can also confirm heartworm infection and should be used in combination with other diagnostic tests.

Diagnostic laboratories

PCR detection of DNA extracted from whole blood may be useful, especially if the dog is suspected to have infection with multiple filariid or *Dirofilaria* species.

Reference laboratories can also process **antigen tests and blood microfilariae tests.**

WHAT DIAGNOSTIC TESTS SHOULD BE RUN
IN A DOG THAT IS SUSPECTED TO HAVE THE INFECTION/DISEASE?

Test interpretation

Antigen and microfilariae tests allow heartworm detection in both early and chronic cases. Antigen detection relies on adult worm, mainly female but also male, presence.

A positive antigen test may not coincide with presence of microfilariae in the blood.

Reasons +

It can also occur that with **no antigen detected,** microfilariae are present on a direct smear or modified Knott's technique.

Reasons +

WHAT GENERAL TREATMENT STRATEGY IS RECOMMENDED FOR SICK DOGS?

Classes of drugs to use

Drugs available to treat heartworm infections in dogs include **melarsomine dihydrochloride,** an organo-arsenical agent used to treat adult worms (adulticides), and **macrocyclic lactones** to treat microfilariae **(microfilariacides).**

Mono or combination therapy

Treatment of heartworm in dogs is a combination therapy.
The approved adulticide drug is **melarsomine dihydrochloride** (2.5 mg/kg).

Doxycycline treatment is recommended for 4 weeks prior to melarsomine start in order to treat the *Wolbachia* bacterial symbiont present in all developmental stages of *D. immitis*. *Wolbachia* can play an important role in inflammation and disease. Killing these bacteria may lessen the severity of disease and weaken the heartworms, improving the efficacy of the adulticides and microfilariacides.

WHAT GENERAL TREATMENT STRATEGY
IS RECOMMENDED FOR SICK DOGS?

Label guidelines
for melarsomine dyhydrochloride recommended:

- Administration of 2 deep intramuscular injections 24 hours apart.
- An **alternative dosing strategy** of a single intramuscular injection, followed by the 2-dose injection protocol one month later, has been used to treat dogs in any disease stage.

Treating microfilariae in an infected dog is also an important part of therapy and involves the use of **macrocyclic lactones**. Moxidectin is approved for this use in the USA, however, other macrocyclic lactones may also have microfilaricidal properties.

Removing microfilariae is important because…

Macrocyclic lactone administration for **longer periods of time,** in some instances 2 years or more, is not recommended for heartworm treatment.

WHAT GENERAL TREATMENT STRATEGY
IS RECOMMENDED FOR SICK DOGS?

Supportive treatment strategies

- Glucocorticosteroids or antihistimines may help reduce reactions if large numbers of circulating microfilariae are present.
- Fluid therapy, diuretics, and vasodilators may also be indicated to stabilize dogs with clinical heartworm disease.

Management of co-infections

Dogs may be infected with other parasites, including other filariids.
Annual diagnostic exams, including heartworm tests and fecal exams for other internal parasites, are important to assess the **overall health of the dog.**

WHAT GENERAL TREATMENT STRATEGY
IS RECOMMENDED FOR SICK DOGS?

Monitoring for response to treatment

Dogs treated for heartworm with melarsomine should be closely monitored by a veterinarian and observe 'cage rest' or restricted activity during treatment, with the restricted activity continued for at least 2 months following **treatment completion.**

Monitor dogs for adverse reactions to treatment and for signs of pulmonary thromboembolism once adulticide therapy is complete and supportive care may be necessary.

Retest the dog...

Throughout the entire treatment process and beyond,...

ARE OTHER PETS OR PEOPLE IN THE HOUSE AT RISK?

The risks to people from an infected/sick dog

Human heartworm infections are rare, and any infection that occurs is from the bite of an infected mosquito and is not transmitted directly from the dog.

Other public health considerations

In humans, *D. immitis* does not normally develop to the adult stage, rather dying immature worms in the lung result in an immune response and local nodule formation.

- Immature worms have also been found in aberrant sites such as eye or skin.
- In heartworm endemic areas, protection from mosquito bites is the best means of reducing potential infection, as well as treatment of infected dogs for both adult worms and microfilariae.

Can cats get this infection/disease?

Cats can serve as hosts for *D. immitis*, although infection and disease are much different in a cat than a dog.

If dogs in an area are at risk for heartworm infection and disease, then cats are too.

Infection dynamics differ in cats in several ways.

Feline heartworm infections are more common han once thought and may be more common than feline leukemia in endemic areas.

WHAT ARE SOME RECOMMENDATIONS AROUND PREVENTION STRATEGIES?

How to avoid the vector

Avoiding the heartworm vector, the mosquito, is an important part of preventing infection, and should be tried even if difficult.

- **Stay indoors** during peak mosquito feeding times.
- **Stay away from mosquito breeding sites** and eliminating sites where possible will help with vector avoidance and control.

General thoughts on preventive treatments

Administering **macrocyclic lactone heartworm preventives** year-round, regardless of geographic location, with either a monthly dose (oral or topical) or a once or twice-yearly injection, is essential to preventing heartworm infections.

WHAT ARE SOME RECOMMENDATIONS AROUND PREVENTION STRATEGIES?

Is there a vaccine?

There is no vaccine available for the prevention of heartworm infection.

Is routine testing recommended?

Annual routine heartworm testing of every dog using a heartworm antigen test and a microfilariae test is recommended.

Adult dogs should be tested…

Puppies should start heartworm preventive at 8 weeks old, and can be tested 6 months later, and then yearly.

WHAT DOES THE FUTURE LOOK LIKE?

What are the changes being seen with the disease?

More is being learned about the disease and the potential long-term effects associated with chronic heartworm infections, even after the worms are gone, including the role of microfilariae and *Wolbachia*.

Diagnostic capabilities are improving, and heat treatment of canine and feline serum before diagnostic testing is shedding light on false negative test results after suboptimal adult worm treatment. Heat treatment is also useful where few worms are present, or in the rare instances where many worms are present but antigen is not detectable under normal conditions.

FURTHER READING

Websites

Companion Animal Parasite Council (CAPC): Heartworm Guidelines. https://capcvet.org/guidelines/heartworm/

American Heartworm Society (AHS): Canine Guidelines. https://www.heartwormsociety.org/veterinary-resources/american-heartworm-society-guidelines

European Scientific Counsel Companion Animal Parasites (ESCCAP): GL5 Control of Vector-Borne Diseases in Dogs and Cats.https://www.esccap.org/page/GL5+Control+of+VectorBorne+Diseases+in+Dogs+and+Cats/29/

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