Highlights of the
Canine Guidelines for the

Prevention, Diagnosis, and Management of Heartworm Infection (*Dirofilaria immitis*) in Dogs

Revised 2024

These guidelines are a living document and are revised periodically based on information presented at the American Heartworm Society's Triennial Symposium, new research, and additional clinical experience. This summary of the guideline's highlights supersedes previous editions and has been peer reviewed by independent experts. The full Canine Guidelines can be found at the American Heartworm Society's website.

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SUMMARY OF HIGHLIGHTS

- **Diagnostics:** AHS recommends annual antigen and microfilaria testing. (As the interpretation of diagnostics has become more complex, please see the "Microfilaria and Antigen Testing" section for more complete information.)
- **Prevention:** AHS recommends veterinarians prescribe year-round administration of preventive drugs approved by the US Food and Drug Administration (FDA) to prevent heartworm infection and enhance compliance, the latter being particularly important in light of the documented presence of resistant subpopulations. Application of an Environmental Protection Agency (EPA) registered mosquito repellent/ ectoparasiticide has been shown to increase the overall efficacy of a heartworm prevention program in laboratory studies involving known resistant heartworm isolates by providing control of the arthropod vector of heartworm. Furthermore, use of an FDA-approved ectoparasiticide product can break the transmission cycle and could aid in reducing mosquito populations. AHS recommends reduction of exposure to mosquitoes through standard environmental control of mosquitoes and their breeding environments, and when possible, reducing outdoor exposure during key mosquito feeding periods.
- **Adulticide Therapy:** AHS recommends use of doxycycline and a macrocyclic lactone (ML) prior to the three-dose regimen of melarsomine (one injection of 2.5 mg/kg body weight followed at least one month later by two injections of the

same dose 24 hours apart) for treatment of heartworm disease in both symptomatic and asymptomatic dogs. Any method utilizing only MLs as a slow-kill adulticide is not recommended.

EPIDEMIOLOGY

- Heartworm infection has been diagnosed in all 50 states and around the globe.
- Environmental and climatic changes, both natural and those created by humans, relocation of microfilaremic dogs, and expansion of the territories of microfilaremic wild canids continue to be important factors contributing to further spread of the parasite.
- A pivotal prerequisite for heartworm transmission is a climate that provides adequate temperature and humidity to support a viable mosquito population, and can also sustain sufficient heat to allow maturation of ingested microfilariae into infective, third-stage larvae (L3) within the intermediate host.
- The length of the heartworm transmission season in the temperate latitudes also depends on factors such as the influence of microclimates, unique biological habits and adaptations of the mosquito vector, variations in time of larval development, mosquito life expectancy, and temperature fluctuations.
- Heartworm transmission does decrease in colder months, but the presence of microenvironments in urban areas suggests that the risk of heartworm transmission never reaches zero.

***For detailed information on heartworm epidemiology, please refer to the complete* AHS Current Canine Guidelines.**

BIOLOGY AND LIFE CYCLE

- The relatively long life cycle of *D. immitis* (7 to 9 months) requires a reservoir of infection, a vector capable of transmitting infection, and a susceptible host.
- The mosquito, the required vector for transmission of *D. immitis*, becomes infected as she takes a blood meal from a microfilaremic host.
- The *D. immitis* microfilariae mature within the malpighian tubules of the mosquito, developing into larval stage 1 (L1), then molting into larval stage 2 (L2), and finally molting into the infective third-stage larvae (L3), which are transmitted to the dog when bitten by the mosquito.
- Once the infective L3 enter the dog's body, they molt into fourth-stage larvae (L4). A final molt into juvenile/immature adults occurs between days 50 and 70, while they are migrating through the body; and they eventually reach the smallest pulmonary arteries as early as day 67 after transmission.
- Sexual maturity occurs about day 120 post infection with dogs developing patent infections (i.e., having circulating microfilariae) as early as 6 months but usually by 7 to 9 months after infection.

A clear understanding of heartworm transmission, development, prepatent period, and the susceptibility of the different life stages of the parasite to available pharmaceutical drugs is critical to be able to effectively select the most appropriate adulticidal treatment option and treatment time, and to convey realistic expectations to the client for the outcome of therapy.

- A clear understanding of heartworm transmission, development, prepatent period, and the susceptibility of the different life stages of the parasite to available pharmaceutical drugs is critical to the successful management of infected dogs.

***For detailed information on heartworm biology and life cycle, please refer to the complete* AHS Current Canine Guidelines.**

HEARTWORM PREVENTION

- The FDA-approved heartworm preventives currently marketed (ivermectin, milbemycin oxime, moxidectin, and selamectin) belong to the macrocyclic lactone (ML) class of drugs.
- Macrocyclic lactones, when given according to label instructions, are highly effective and are

among the safest medications used in veterinary medicine.

- It is possible for an animal to become infected while appropriately dosed or because of skipped or delayed administration of just one preventive dose.

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- While the vast majority of reported claims of lack of efficacy of MLs can be linked to poor compliance/adherence, ML-resistant heartworms have been documented.
- AHS and the FDA recommend year-round administration of FDA-approved preventive drugs to prevent heartworm infection and enhance compliance/adherence.
- Application of an EPA-approved mosquito repellent/ectoparasiticide has been shown to increase the overall efficacy of a heartworm prevention program by controlling the mosquito vector in laboratory studies. Furthermore, use of an FDA-approved ectoparasiticide product can break the transmission cycle and could aid in reducing mosquito populations.
- In addition, reduction of exposure to mosquitoes through standard environmental control of mosquitoes and their breeding environments, and when possible, reducing outdoor exposure during key mosquito feeding periods is recommended.

***For detailed information on heartworm prevention, please refer to the complete* AHS Current Canine Guidelines.**

PRIMARY DIAGNOSTIC SCREENING

- The American Heartworm Society recommends annual screening for all dogs over 7 months of age with both an antigen and a microfilaria test.
- The current generation of heartworm antigen tests identifies most infections consisting of at least one mature female worm and are nearly 100% specific. Differences in sensitivity exist especially in cases with low worm burdens and/or low antigenemia.
- All positive antigen tests should be confirmed through additional testing prior to the administration of any therapy. Confirmation is accomplished upon the identification of circulating microfilariae, or when another positive result is obtained utilizing a different type of antigen test.
- A no antigen detected (NAD) test result does not confirm that a dog is free of heartworm infection; it simply indicates that no antigen can be detected by that particular testing method.
- **ALL DOGS MUST BE TESTED FOR MICROFILARIAE ANNUALLY!** Microfilaremia validates serologic results, identifies the patient as a potential reservoir of infection, alerts the veterinarian to a high microfilariae burden, and may aid in detecting infected dogs that test falsely negative due to presence of immune complexes.

Adult heartworms are a grave risk to our canine patients. The longer they remain in an animal, the greater the damage to the cardiopulmonary system and the greater the risk of illness and death.

- Heat treatment of serum samples prior to heartworm antigen tests to release blocked antigen is currently available through reference laboratories. However, the routine heating of blood samples **IS NOT PRESENTLY RECOMMENDED** for heartworm screening in dogs.
- In cases of noncompliance or changing the brand or type of heartworm preventive, the dog must be antigen and microfilaria tested prior to starting or changing products.

***For detailed information on heartworm diagnostics, please refer to the complete* AHS Current Canine Guidelines.**

PRINCIPLES OF HEARTWORM TREATMENT

- The goals of any heartworm treatment are to improve the clinical condition of the animal and to eliminate all life stages of the heartworms (microfilariae, larval stages, juveniles, and adults) with minimal post-treatment complications.
- Dogs exhibiting significant clinical signs of heartworm disease must be stabilized before administering an adulticide. This may require administration of glucocorticosteroids, diuretics, vasodilators, positive inotropic agents, and fluid therapy.

Heartworm antigen testing is the most reliable method of confirming the efficacy of adulticidal therapy.

- Melarsomine, administered via deep intramuscular injection into the belly of the epaxial lumbar muscles between the 3rd and 5th lumbar vertebrae, is the only adulticidal drug approved by the FDA.
- Activity restriction during ANY treatment and the subsequent recovery period is ESSENTIAL for minimizing cardiopulmonary complications, regardless of treatment regimen used (i.e., melarsomine versus non-melarsomine). There is a distinct correlation between the activity level of the dog, the severity of disease, and increased risk of treatment-related complications.
- Adjunct therapy with doxycycline for 4 weeks prior to the administration of melarsomine eliminates *Wolbachia*, an endosymbiont bacteria harbored within *D. immitis*, and reduces pathology associated with dead heartworms and disrupts heartworm transmission.
- Administration of doxycycline to a microfilaremic dog does not kill the microfilariae directly, but rather renders the infective larvae later transmitted by infected mosquitoes to other dogs incapable of development to the adult stage, thus reducing the further spread of heartworm disease.
- A macrocyclic lactone preventive must be administered for 2 months prior to administering melarsomine to reduce new infections and eliminate existing susceptible larvae.
- The effectiveness of the macrocyclic lactone can also be potentiated with concurrent use of doxycycline for 4 weeks, as this will essentially eliminate all developing larvae during the first 60 days of treatment.
- Caval syndrome, which develops acutely in some heavily infected dogs when adult heartworms partially obstruct blood flow through the tricuspid valve, is usually fatal within 2 days if surgical extraction of the worms is not pursued promptly.
- The American Heartworm Society's recommended heartworm management protocol is outlined in detail in Table 1 on the following page.
- When the recommended three-injection protocol is not possible, there are a variety of options for treatment. It should be noted, however, that the long-term safety and side effects following completion of treatment with protocols other than the recommended three-injection protocol have not been evaluated.

***For detailed information on heartworm treatment, please refer to the complete* AHS Current Canine Guidelines.**

Table 1. AHS-Recommended Heartworm Management Protocol

Day	Treatment
0	**In a dog diagnosed and verified as heartworm positive, either by:** • Positive antigen (Ag) test verified with microfilaria (MF) test, OR if no MF are detected, • Confirm with a second Ag test with a new sample on a different type of testing platform 1. Administer appropriate heartworm preventive (monthly [topical or oral] or injectable) – If MF are detected, pre-treat with antihistamine and glucocorticosteroids, if not already on prednisone, to reduce risk of anaphylaxis – Observe for at least 8 hours for signs of reaction 2. Administer doxycycline 10 mg/kg BID for 28 consecutive days • Reduces pathology associated with dead heartworms • Disrupts heartworm transmission 3. Begin activity restriction—the more pronounced the signs, the more rigid the activity restriction 4. Administer an EPA- or FDA-approved ectoparasiticide product designed for use in dogs that has demonstrated mosquito-killing activity **If the dog is symptomatic in addition to the items above:** • Stabilize with appropriate therapy and nursing care • Prednisone prescribed at a tapering dose of 0.5 mg/kg BID 1st week, 0.5 mg/kg SID 2nd week, 0.5 mg/kg every other day (EOD) for the 3rd and 4th weeks
30	**Communicate with the client to ensure:** 1. Completion of the full course of doxycycline 2. Administration of heartworm preventive (unless injectable heartworm preventive was administered on day 0) 3. Administration of an EPA- or FDA-approved ectoparasiticide product designed for use in dogs that has demonstrated mosquito-killing activity
31–60	A one-month wait period after administration of doxycycline but before administration of melarsomine is currently recommended
61	1. Administer heartworm preventive (unless injectable heartworm preventive was administered on day 0) 2. Administer 1st (of 3) melarsomine injections, 2.5 mg/kg intramuscularly (IM) a. Monitor for post-injection anaphylaxis b. Prescribe appropriate pain control 3. Prescribe a tapering dose of prednisone of 0.5 mg/kg BID 1st week, 0.5 mg/kg SID 2nd week, 0.5 mg/kg EOD for the 3rd and 4th weeks 4. Start rigid activity restriction (or maintain if started on day 0): cage restriction, on-leash when taken outside to eliminate 5. Administer an EPA- or FDA-approved ectoparasiticide product designed for use in dogs that has demonstrated mosquito-killing activity
90	1. Administer heartworm preventive (unless injectable heartworm preventive was administered on day 0) 2. Administer 2nd (of 3) melarsomine injection, 2.5 mg/kg intramuscularly (IM) a. Monitor for post-injection anaphylaxis b. Prescribe appropriate pain control 3. Prescribe a tapering dose of prednisone of 0.5 mg/kg BID 1st week, 0.5 mg/kg SID 2nd week, 0.5 mg/kg every other day (EOD) for the 3rd and 4th weeks 4. Administer an EPA- or FDA-approved ectoparasiticide product designed for use in dogs that has demonstrated mosquito-killing activity

Table 2 continued on page 6

Table 1. AHS-Recommended Heartworm Management Protocol *(continued from previous page)*

Day	Treatment
91	1. Administer 3rd (of 3) melarsomine injection into the opposite epaxial muscle from the injection site on day 90, 2.5 mg/kg intramuscularly (IM) a. Monitor for post-injection anaphylaxis b. Prescribe appropriate pain control 2. Continue rigid activity restriction for the next 6–8 weeks: cage restriction, on-leash when taken outside to eliminate
120	1. Quantitatively test (e.g., Modified Knott Test) for presence of MF regardless of patient's MF-status on day 0 • If positive, treat with a microfilaricide and retest every 4 weeks until no MF detected. If MF persist, additional testing for resistance should be considered 2. Continue a year-round heartworm and mosquito prevention program as described under Prevention 3. Gradual return to normal activity over the next 4 weeks
365	Resume annual HW-screening protocol (9 months after last melarsomine injection) • Antigen test • Microfilaria test If still Ag-positive, re-treat with 28 days of doxycycline followed by 2 injections (2.5 mg/kg IM each) of melarsomine 24 hours apart • Monitor for post-injection anaphylaxis • Prescribe appropriate pain control • Prescribe a tapering dose of prednisone of 0.5 mg/kg BID 1st week, 0.5 mg/kg SID 2nd week, 0.5 mg/kg for the 3rd and 4th weeks • Institute and maintain strict activity restriction for 6–8 weeks: cage restriction, on-leash when using yard