

A Roundtable Discussion

FELINE



HEARTWORM

DISEASE



**Understanding the Role of Heartworm Infection
in Respiratory Disease in Cats**



If you're not seeing feline heartworm disease, you may be looking in the wrong place. Feline heartworm disease does exist and is a potentially life-threatening infection. It causes more problems than ever thought possible, presents numerous diagnostic challenges, and is very different from the canine disease. In light of recent research, emerging data, and the anticipated launch of the new SNAP® Feline Triple Test, several veterinary experts met to discuss the serious threat of heartworm-associated respiratory disease (HARD), the pros and cons of the various testing methods, and the importance of heartworm prevention in cats.

Feline Heartworm FAQ

Heartworm disease is rare in cats, so why should I be concerned about it?

Feline heartworm disease is more prevalent than we once thought. Studies have shown that feline heartworm infection rates likely meet or surpass infection rates for feline leukemia. Additionally, other data have suggested that the feline adult heartworm infection rate can be estimated to be 20% of the canine infection rate for the same geographic area. Although prevalence studies are ongoing, current research suggests that more cats are at risk than previously thought.

What is HARD?

Heartworm-associated respiratory disease, or HARD, refers to the presentation and clinical circumstances associated with the death of immature adult heartworms (so-called fifth-stage larvae) or the presence of adult worms in the pulmonary arteries of heartworm-infected cats.

Is feline heartworm disease really that dangerous?

Feline heartworm disease is potentially more dangerous than its canine counterpart

for two critical reasons. First, diagnosis is complicated and findings can be inconsistent. A heartworm-infected cat may present with severe respiratory signs but test negative on antigen and antibody tests. Ancillary tests such as thoracic radiography, serum chemistry analysis, and echocardiography can also be inconclusive. Cats can also die suddenly with no evidence of preexisting illness.

Second, there is no approved treatment for feline heartworm disease, so the only way to protect feline patients is to initiate year-round heartworm prevention early in life. All cats, even "indoor cats," should be on prevention.

What is the best way to diagnose heartworm disease in a cat?

Diagnosis of feline heartworm disease can be a complicated and costly procedure. Heartworm antigen and antibody tests have been recommended as the initial diagnostic steps. Refer to the algorithm and supporting text on pages 8 and 9 for a more detailed discussion of diagnostic options.

If heartworm test results are inconsistent, why recommend testing to clients?

Heartworm testing should be considered in many cats, including newly acquired cats, sick cats (especially those presenting with respiratory signs), and healthy cats that are going to receive heartworm preventive. Although test results in general can be inconclusive, the SNAP® Feline Triple Test will soon be available to screen feline patients for heartworm disease. Veterinarians and clients need to understand that heartworm disease poses a serious threat to cats. Testing will detect infection in a significant number of cats and therefore plays an important role in identifying at-risk patients and increasing veterinarians' and clients' understanding of local disease prevalence.

How can I convince clients to put cats, especially indoor cats, on heartworm preventive?

Feline heartworm disease is an incurable and potentially fatal disease. Outdoor cats are certainly at risk, but mosquitoes can get indoors and expose indoor cats to this threat as well. In a recent study, 27% of heartworm-infected cats were exclusively indoor pets according to their owners.¹ As veterinarians educate clients about protecting their indoor cats from fleas and intestinal parasites, heartworms need to be included among the parasites that continue to pose a danger to indoor cats. As mentioned, there is no approved treatment for feline heartworm disease, but it is readily preventable. ■

About the Participants

Lynn Buzhardt, DVM, Moderator, a 1980 graduate of Louisiana State University School of Veterinary Medicine, is a companion animal practitioner and partner in The Animal Center in Zachary, Louisiana. She serves on the East Baton Rouge Parish Animal Control Committee, is a board member of the American Heartworm Society, conducts FDA clinical trials, and is a spokesperson for several animal health companies. Her book, *Can We Have One?: A Parent's Guide to Raising Kids, Cats, and Dogs*, will be available in fall 2008.



Byron L. Blagburn, MS, PhD, holds the appointment of distinguished university professor at the Auburn University College of Veterinary Medicine. He is past president of the American Association of Veterinary Parasitologists, the Southern Conference on Animal Parasites, and the Southeastern Society of Parasitologists. Dr. Blagburn was the 2001 recipient of the American Association of Veterinary Parasitologists' Distinguished Veterinary Parasitologist Award and the 2003 recipient of the Auburn University Student Government Association Teacher of the Year award.



Mark Cousins, DVM, DABVP (Feline), graduated from Louisiana State University in 1980 and AAHA's Veterinary Management Institute at Purdue University in 1995. He started and owns New Orleans' first exclusively feline practice, The Cat Practice, in 1987 and is a partner in Chateau Veterinary Hospital in Kenner, Louisiana. The Cat Practice has won several awards, most notably the Hospital of Merit Award in the September 2005 issue of *Veterinary Economics* and the Innovation in Business Award from the New Orleans Chamber of Commerce.



Ray Dillon, DVM, MS, MBA, DACVIM, received his DVM from Texas A&M University in 1973. He was the first recipient and continues to hold the Jack O. Rash Chair in Medicine at Auburn University. Dr. Dillon is the recipient of numerous awards, including the Phi Kappa Phi Scholar for Auburn University, Exceptional Achievement in Auburn University Outreach, and the Beecham Award for Research Excellence, and was the founding president of the American College of Veterinary Internal Medicine Foundation.



Julie K. Levy, DVM, PhD, DACVIM, graduated from the School of Veterinary Medicine at the University of California, Davis, and earned her PhD in the immunopathogenesis of FIV infection at North Carolina State University. She is currently assigned to the small animal internal medicine service at the University of Florida. Her research and clinical interests center on feline infectious diseases, neonatal kitten health, and humane alternatives for feline population control.



Tom Nelson, DVM, is the immediate past president of the American Heartworm Society. He earned his degree at Texas A&M University and has been in private practice for 29 years. He is a partner, surgical director, and co-medical director at the Animal Medical Center of Northeast Alabama in Anniston. Dr. Nelson was awarded the 2002 Public Relations award by the Texas Veterinary Medical Association and is a board member of the Companion Animal Parasite Council.



Estimating the Prevalence of Feline Heartworm Infection

Dr. Lynn Buzhardt: Let's begin by illustrating the significance of feline heartworm disease. Dr. Levy, please review the information gathered from your work with shelter cats in Florida.

Dr. Julie Levy: My journey with feline heartworm disease started when an apparently healthy feral cat died under anesthesia for neutering. A



Levy: It appears that the risk for infection with adult heartworms is equivalent to the risk for the retroviral infections, but the risk for infection with immature heartworms, which we now know cause disease, is three times as high as the retroviral diseases.

necropsy revealed a single adult heartworm in the pulmonary artery, which led to a debate among my colleagues about whether we should be recommending heartworm preventives for all of our feline patients. Was this a freak finding or a significant threat to our patients?

To answer the question about the risk in our Gainesville, Florida, community, we necropsied hundreds of cats after they were euthanized at the local animal control facility. We were startled to find that 5% of cats had adult heartworms, which was similar to the rate of feline leukemia virus (FeLV) and feline immunodeficiency virus (FIV) infection in the same group of cats. We were even more surprised to find that about 15% of the cats were seropositive for heartworm antibodies and that these cats suffered substantial lung disease even if there were no adult worms.

Based on the new data, we now know that the risk for heartworm infection is even greater than the risk for these retroviral diseases we've been testing for and vaccinating against. We were beginning to feel like our traditional approach to diagnosis of heartworm disease in cats was detecting only the tip of the iceberg.

Buzhardt: Let's talk about actual prevalence in relation to antigenicity. Based on data from IDEXX Reference Laboratory submissions, 1%

of cats are antigen positive.² Realizing that not all cats with heartworms will have a positive antigen test, what is your estimate of the number of cats with adult heartworms?

Dr. Tom Nelson: During 1997, 25,277 serum or plasma samples from 46 states were submitted to Heska for feline heartworm testing.³ Of these samples, 15.9% were antibody positive. Miller and colleagues⁴ looked at cats from 21 areas across the country, primarily the Northeast and Midwest (areas not highly endemic for heartworm), and found that 12% of cats were antibody positive. So across the board, 12% to 16% of cats are antibody positive.

Dr. Levy and colleagues evaluated six antibody tests, and the sensitivity ranged from 32% to 89%.^{5,6} In my study, 50% of the cats with necropsy-confirmed adult heartworms were negative on an antibody test.⁷ Combine that with the number of infected cats that were antibody negative 8 months after infection, as indicated in the Auburn study,^{8,9} and that 16% rate is obviously an underestimate of the true incidence of heartworm infection.

A review of necropsy data as well as serology results has indicated that heartworms exist in cats wherever they are found in dogs. The infection rate for mature heartworms in cats ranges from 5% to 20% of the rate found in the local dog population.¹⁰ Since we now have sufficient evidence to indicate that disease in cats is caused by juvenile worms, antibody serology data can be used to indicate the percentage of cats infected at some point in their life and thus establish regional risks.

Levy: We performed necropsies on 630 cats and found that 5% of them had FeLV, 6% had FIV, 5% had adult heartworms, and 15% had heartworm antibodies.¹¹ When we compare this with the prevalence of other diseases that we consider to be important in our feline patients, it becomes apparent that heartworm infection is among the leaders. Diabetes comes in at about 1.1% of cats, renal disease at 1.2%, FeLV at 2.3%, and FIV at 2.5%.^{12,13} (See graph, left.)

Thus, it appears that the risk of infection with

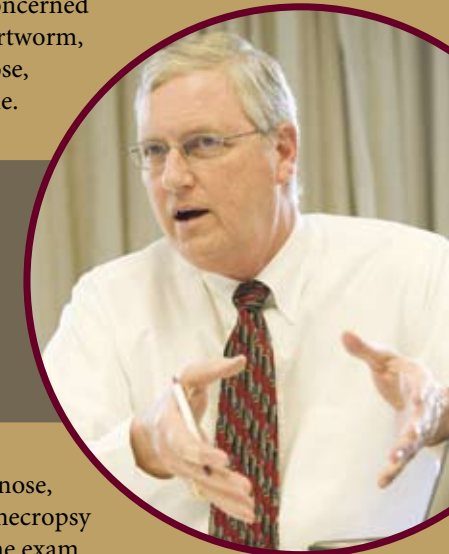
adult heartworms is equivalent to the risk of the retroviral infections, but the risk of infection with immature heartworms, which we now know cause disease, is three times as high as the retroviral diseases.



*Cousins: It makes sense, and prevalence rates confirm, that in areas where *Dirofilaria* is endemic in dogs, cats are going to be infected, too.*

Dr. Ray Dillon: As Dr. Levy's work has shown, heartworm disease is a bigger risk to cats than FeLV, yet the profession has gone crazy over FeLV. Heartworms are preventable but not easy to test for in cats.

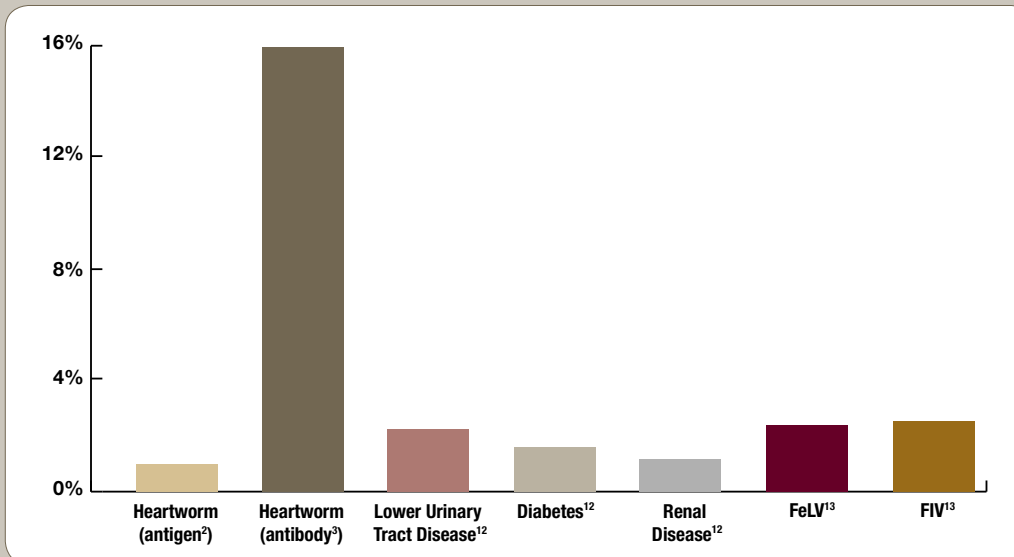
Levy: Necropsy studies are likely to underestimate the true prevalence of heartworm infection, because they often identify only cases in which adult worms are found. However, they do help us put the risk for heartworm infection in the perspective of other diseases that the public and veterinarians are concerned about, such as FeLV and FIV. Like heartworm, these diseases can be difficult to diagnose, are difficult to treat, and are preventable.



Dillon: Heartworm disease is a bigger risk to cats than FeLV, yet the profession has gone crazy over FeLV. Heartworms are preventable but not easy to test for in cats.

Heartworm may be the hardest to diagnose, but it's also the most preventable. The necropsy data offer a handy statistic to have in the exam room because it can be confusing to clients when we first start having these conversations. Having new data to share helps them understand why we are just now starting to discuss heartworm preventives for cats after years of talking about heartworms only in dogs. ■

Relative Risk of Various Feline Diseases



Based on recent findings, the risk for infection with immature heartworms is greater than the risk for many other diseases considered to be important in cats.



HARD: Defining the Syndrome

Buzhardt: Veterinarians have focused on adult heartworm infection. What is the impact of immature heartworms in the cat?

Dr. Byron Blagburn: Cats and heartworms share a unique relationship. In cats, many heartworms arrive in the heart and lungs as immature adults (or fifth-stage larvae [L5], although the term is technically incorrect because this stage of the worm does not undergo another molt) that usually do not survive to adulthood and do not betray their presence by inducing antigen-positive test results. Therefore, infected cats may or may not be antibody positive. These immature heartworms cause lesions in the lungs that may or may not be identified as heartworm induced. In the absence of other infectious agents or another disease process, the death of immature heartworms in the lungs induces respiratory disease that often cannot be distinguished

Dillon: If you're not seeing heartworm-positive cats in your clinic, rest assured that heartworm-positive cats are seeing you.

radiographically, and maybe even histologically, from other causes of respiratory disease. Thus we coined the term “heartworm-associated respiratory disease” or HARD, which encompasses vascular, airway, and interstitial lung lesions caused by the death of immature worms and which is virtually impossible to diagnose definitively.

Nelson: HARD encompasses both the clinical and subclinical manifestations of cats exposed to heartworms. Just because a cat is not displaying any signs, it doesn't mean it doesn't have disease. There is pathologic disease in the lungs, and even if it is subclinical, it can be quite dramatic later in life. It is important to realize that just because a cat doesn't exhibit signs of clinical disease at a given point in time, the pathology occurring in the lungs is significant.

Dillon: Although both dogs and cats will have immature heartworms 3 months after becoming infected, the difference is that in cats a lot of the immature heartworms don't survive much past 3 months. The cat experiences a unique reaction to the death of these worms; this is the initiation of HARD. This inflammatory response is minimal in dogs, but in cats it happens regardless of whether a mature heartworm infection develops.

Radiographically, I cannot tell the difference between a 4-month-old infection in a cat in which all the immature heartworms die versus a 4-month-old infection in a cat that goes on to have live adult heartworms. I have a thousand radiographs, and I defy anyone to look at the films and predict which cat will develop an adult infection.

In my view, the easiest concept to grasp is that heartworms arrive in the lungs of dogs and cats 3 months after infection. Dogs go on to have successful mature infections from the 3-month-old worms, while cats have a lot of unsuccessful immature worms that create clinical disease; oh, and by the way, some of those cats do go on to get mature heartworms as well.

Blagburn: We can actually translate this difference into numbers. If we administer 100 infective larvae to a dog, 75 will mature to adults in our model. In cats, only 3.5 will mature to adults. Furthermore, we have to presume that a high percentage of immature worms in cats make their way to the lungs. So while we may recover only three and a half adult worms, many more immature worms are in the inflamed lungs, and that's the explanation of HARD. In the laboratory, we can induce worm death when the worms are in the lungs and see the resulting vessel and airway lesions—and that's HARD.

Dillon: Even more important is that in our research control cats in which heartworms reached adulthood, the lung disease at day 110 was indistinguishable from that seen in cats that never developed mature worms.

I refer to the immature worms as “juvenile delinquents” and the damage they do in terms of a hit and run driver. They get into the cat, create significant lung damage, and leave no evidence that they were there. Yes, we can see the lung lesions, but we're not going to find any worms on necropsy, the antibody disappears very quickly, and these cats will not be antigen positive because they do not have adult worms.

We should also point out that HARD may be transient, lasting only 6 to 8 months, and it can recur the following year if the patient is not put on prevention. In many parts of the country, HARD is seasonal, peaking 4 to 6 months after the mosquito season in northern climates, and therefore should be suspected during that time frame.

If you're not seeing heartworm-positive cats in your clinic, rest assured that heartworm-positive cats are seeing you.

Buzhardt: In the examination room, practitioners can effectively discuss the significance of feline heartworm disease in terms the client can relate to. For example, pet owners relate to FIV when it is presented as AIDS. Clients are also familiar with canine heartworm disease, so we can take advantage of this knowledge when discussing feline heartworm disease. If we present the disease in familiar terms, we will get their attention, they will understand the significance of feline heartworm infection, especially HARD, and they will be more likely to comply with heartworm prevention recommendations. ■

Heartworm-Associated Respiratory Disease

The term “heartworm-associated respiratory disease”—HARD—was coined to encompass the vascular, airway, and interstitial lung lesions caused by the death of immature heartworms or the presence of adult worms in the pulmonary vasculature. HARD refers to both the clinical and subclinical manifestations of cats infected with heartworms and is used to describe the pathology that occurs regardless of whether affected cats are symptomatic.

Estimating the Prevalence of HARD

Buzhardt: Feline prevalence data can be difficult to pin down. What is the estimated number of cats with HARD?

Dillon: When you include cats with the immature forms of heartworm, with HARD, and with confirmed adult heartworm infections, the exposure and infection rates between dogs and cats are almost the same.

Nelson: We know that antibody-positive cats have been infected with heartworms at some point, and nationwide the antibody-positive

rate is 12% to 16%. Half the antibody-positive cats in Dr. Levy's necropsy study had vascular lesions we now associate with HARD.¹⁴ Based on that, we can estimate that 6% to 8% of of antibody-positive cats have HARD, but the true rate of HARD is even higher because of the vast number of antibody- and antigen-negative cats that will be infected with heartworms.

Blagburn: A crude estimate is that for every demonstrably antigen-positive cat, there are as many as 10 cats that have been infected. Even in an area that has a low rate of canine heartworm infection, where you're going to see even fewer antigen-positive cats, the ratio of antigen-positive cats to cats that are infected with heartworms we can't detect is likely to remain constant. The

significance is that the number of cats affected by HARD far exceeds the number that we can confirm to have heartworm infection. (See prevalence illustration on page 10.)

Buzhardt: How does the rate of infection in cats relate to the rate in dogs? Dr. Nelson, what do you tell practitioners about the relationship between the prevalence of heartworm disease in cats versus dogs?

Nelson: Based on necropsy studies in which researchers have compared the rate of adult heartworms in dogs and cats,¹⁰ the infection rate for mature adult heartworms in cats ranges from 5% to 20% of the rate found in the local dog population. For every 10 dogs with adult heartworms, there's one cat with adult heartworm. However, probably only 10% of heartworm-infected cats will have an adult worm.

Dillon: Which means that when you include cats with the immature forms of heartworm, with HARD, and with confirmed adult heartworm infections, the exposure and infection rates between dogs and cats are almost the same. ■

Nelson: Heartworms can cause serious illness in cats even if the worms never develop to adulthood.

Also see prevalence illustration on page 10

Diagnostic and Follow-Up Recommendations for Cats Based on Heartworm Antigen Test Status

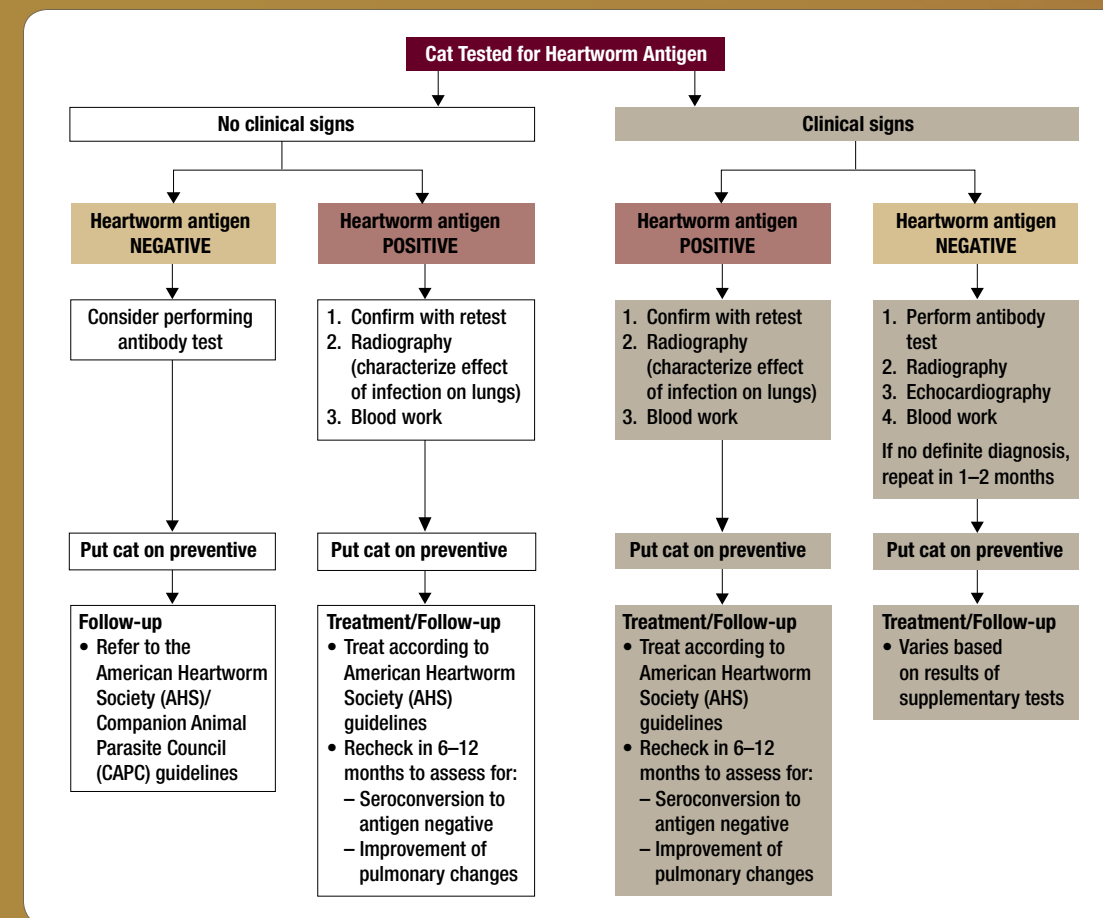
Any cat can be tested for heartworm antigen, as "at-risk" cats include any indoor or outdoor cats living in areas of the country where heartworm has been diagnosed in dogs. Newly acquired cats greater than 6 months old also benefit from being tested. Regardless of heartworm serologic testing results, all cats should be placed on preventive. Cats are rarely microfilaremic, and even when microfilariae are present, the numbers are low; therefore, it is safe to administer preventives to heartworm-positive cats.

Heartworm-infected cats frequently have the same radiographic lesions whether they are symptomatic or asymptomatic: peribronchial infiltrate with some pulmonary interstitial pattern, which is more prominent in the caudal lung lobes. The caudal pulmonary artery may or may not be demonstrably enlarged. These findings are indistinguishable from every other historically described bronchial disease.

Additional diagnostics are warranted in symptomatic cats to look for coexisting disease(s), which might actually kill the cat before the heartworms do. Echocardiography allows practitioners to estimate the worm burden and whether the cat also

has any primary cardiac disease, such as cardiomyopathy, that may be contributing to the respiratory signs. Bronchoalveolar lavage with cultures and cytology may be indicated. Lung worms should be considered in endemic areas. A complete blood count, chemistry panel, and urinalysis should also be performed.

Although a discussion of treatment recommendations is beyond the scope of this publication, it is important to realize that cats with immature or adult heartworm infections can experience a severe, acute reaction, including sudden death.^{15,16} Owners of cats diagnosed with heartworm infection need to be made aware of this risk and instructed to seek prompt medical attention at any sign of respiratory distress. It may be prudent to send such owners home with a syringe containing 10 mg of dexamethasone sodium phosphate and instructions to administer the shot (IM or SC) if the cat shows signs of respiratory distress and immediately take the cat to an emergency clinic. Some practitioners recommend dispensing two syringes, because anxious pet owners often "miss" with the first one.



Antibody versus Antigen Testing

Buzhardt: Testing methods can be confusing for both practitioners and pet owners. What is the difference between antibody and antigen testing in reference to feline heartworm disease?

Levy: Antigen tests are very good at detecting adult female worms in cats, with performance levels approaching those in dogs. In naturally infected cats, antigen testing detects approximately three-quarters of cats that are carrying adult worms. The only cats we've missed in our necropsy studies are ones with a single male worm. Antibody tests, on the other hand, identify cats that have produced some antibody in response to heartworm infection; a positive antibody test may indicate that the cat is currently infected with juvenile or adult worms or may indicate a previous heartworm infection. How long these antibodies persist after the parasite is eliminated is quite variable, as is the performance of the different brands of antibody tests. What is probably more important is that a substantial number of cats that are carrying immature or mature worms do not make antibodies that these tests can detect, and

such cats will always be falsely negative no matter how many times we test them. Furthermore, an individual cat can be antibody positive on one test and antibody negative on another brand of test at the same time, making it even more frustrating for practitioners who are trying to use these serologic tests to identify infected cats. (See illustration, right.)

Dillon: If a cat is antibody positive, it's been infected; we just don't know how old the worm is. It's our duty to figure out where the cat is along the 4-year course of potential disease. If we have cats on heartworm prevention, we don't need to determine each individual cat's risk for disease.

Buzhardt: Is it easier for practitioners to justify doing an antigen test because a positive result is definitive?

Blagburn: It's easier for me to convince clinicians that there is a reason to run an antigen test than an antibody test. A positive antibody test in an asymptomatic cat may not change

your approach at all, because cats on heartworm prevention may have a positive antibody test but will never be infected with worms in the heart or lungs. On the other hand, a positive antibody test may help practitioners convince pet owners to accept prevention because it indicates that heartworm-infected mosquitoes are in the area. A positive antigen test in an asymptomatic cat may well change your approach. It may affect your strategies for managing that case beyond putting the cat on a preventive.

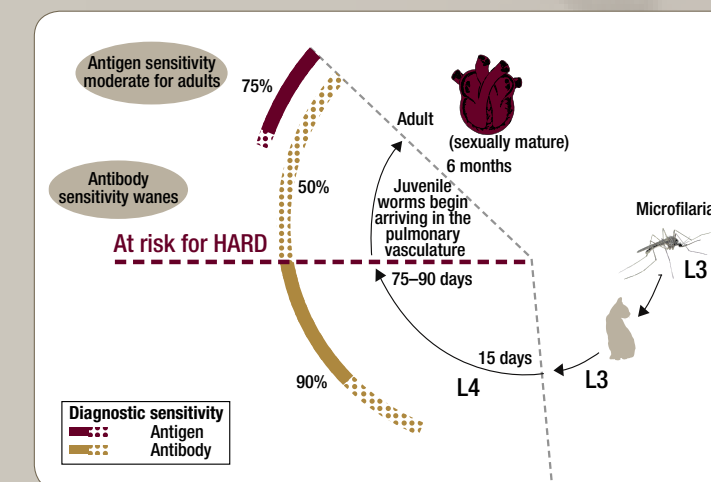
Buzhardt: If a practitioner runs antigen tests on several cats without seeing any positive results, will that instill a false sense of security that there is no heartworm disease in the area?

Dr. Mark Cousins: Absolutely. Those of us here today know that many cats get immature heartworms and develop HARD yet may never have an adult heartworm. The goal is to educate veterinarians about the significant disease that immature heartworms cause in cats, regardless of whether they ever host an adult worm. Veterinarians need to understand the extremely probable discordance between feline heartworm test results and the existence of clinical heartworm disease. Veterinarians try to correlate disease with some sort of positive test. I truly believe that this is one of the key issues in the reluctance of veterinarians to embrace the existence of heartworm disease in cats.

Blagburn: I believe that if enough cats around the country are antigen tested, we eventually would see a sufficient number of positive results and clinical cases to convince veterinarians that this really is a problem. That said, it is still important to remember that fewer heartworms mature to adults in cats than in dogs, that cats are more likely than dogs to have male-only infections, and that immature adults can cause disease (HARD). Also, when we test a suspect population of cats (i.e., cats with respiratory disease), the prevalence of heartworm infection is about what we see when screening healthy dogs.

Levy: The heartworm component of the soon-to-be-released SNAP® Feline Triple Test is an antigen test, so if you see the blue dot, you know the cat has adult heartworms. On the other hand, it will not detect the larval stages of the parasite that have been shown to play such a pivotal role in the development of HARD. This is why we say that antigen-positive cats represent only the tip of the iceberg. (See illustration, left.)

Heartworm Life Cycle in Cats

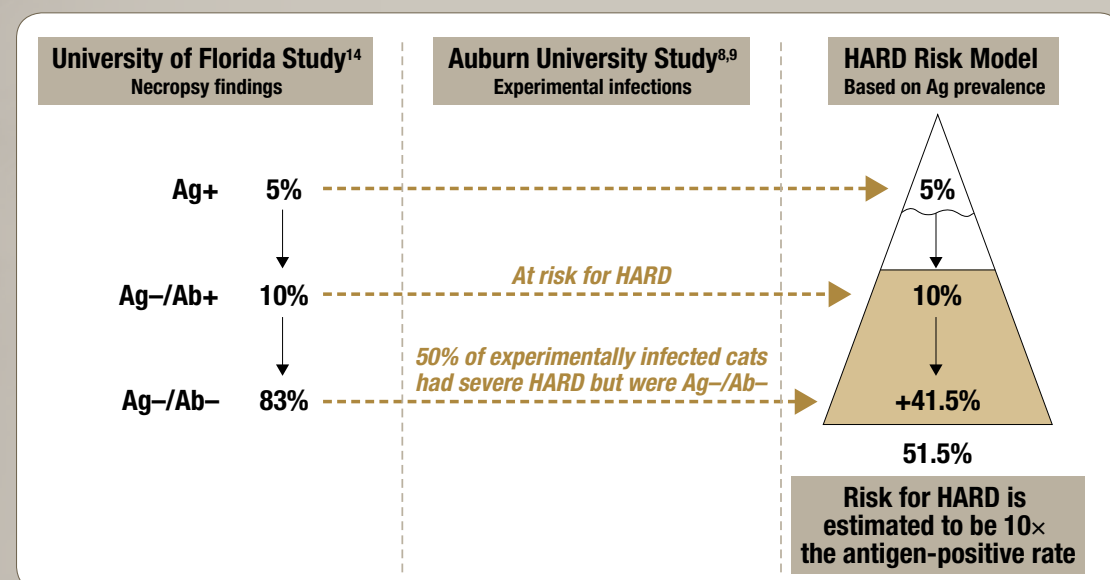


Most heartworm life cycle illustrations do not tell the entire story, particularly in cats. Female mosquitoes ingest circulating microfilariae when they feed on heartworm-positive dogs. The microfilariae then undergo a transformation and two molts within the mosquito to become infective third-stage larvae (L3). When that mosquito then bites a cat, the L3 are deposited on the skin in the saliva, enter through the bite wound into the subcutaneous tissue, and molt to L4 within a couple of days.

The L4 migrate in subcutaneous adipose tissue and muscle over the next 2 months, at which time the larvae undergo their final molt to a juvenile worm and enter a peripheral vein. It is at this point, about 60 days after infection, that we start to see an antibody response by the host, be it a dog or cat. This animal is now considered to be successfully infected because the parasite achieved its final molt. (Historically, the juvenile worm has been referred to as an L5, which denotes a fifth-stage larva. Since this stage does not undergo another molt, it should not be considered a larval stage. It is an immature or juvenile worm and matures into an adult over the next several months.)

After the immature adults enter a peripheral vein, the blood carries them to and through the heart and into the caudal pulmonary arteries, arriving 75 to 90 days after infection. By 100 days after a dog or cat is bitten by an infected mosquito, there are 2-inch juvenile worms in the pulmonary arteries. Up until this point, the pathway is the same in dogs and cats, but this is where things begin to change. In dogs, the majority of juvenile worms mature into adult worms and can live for 5 to 7 years. In cats, the vast majority of these juvenile worms die shortly after arriving in the pulmonary arteries, initiating an inflammatory response that clinically resembles allergic bronchitis or asthma and can cause significant pathologic changes in the pulmonary arterioles, bronchi, and alveoli. Antibodies begin to wane as the juvenile worms die; if the worms mature to adults, the adult worms suppress the immune system, which also causes antibodies to wane.

Antigen Prevalence Is Only the Tip of the Iceberg



The risk for HARD far exceeds the number of cats testing antigen positive (Ag+). In the University of Florida shelter study, 5% of cats were Ag+. Another 10% of cats were antigen negative (Ag-) and antibody positive (Ab+), indicating they had been infected with heartworms and were therefore at risk for HARD, and 83% were both Ag- and antibody negative (Ab-). In the Auburn study, 50% of experimentally infected cats had severe HARD but were serologically negative (Ag-/Ab-). If these findings are extrapolated, half of the 83% of Ag-/Ab- cats (41.5%) can be presumed to be at risk for HARD, suggesting that the risk for HARD is about 10 times the Ag+ rate.

Testing Guidelines—Which Cats Should Be Tested?

Buzhardt: Which population of cats should be tested with the SNAP® Feline Triple Test? If we use the SNAP® test only on sick cats or cats at risk for FeLV or FIV, we're potentially missing a large number of cats that could be positive for heartworm disease.

Cousins: Any cat that would normally be tested for retroviruses will now be tested for heartworm as well. In my practice, that includes new patients, new cats entering the household if they are older than 6 months of age, and sick cats with signs related to any disease assayed on the SNAP® Triple. This would include any cat with symptomatology referable to the retroviral diseases, as well as coughing cats and those with a history of chronic vomiting.

Buzhardt: Many veterinarians use the AAEP guidelines to determine which cats to test for retroviruses, which are the ASK cats: at-risk, sick, and kittens. In terms of retrovirus testing, the at-risk group encompasses cats that go outdoors, that live in multiple-cat households, and whose retroviral status is unknown. For heartworm disease, the at-risk group will have to be expanded to include indoor cats. Living indoors may decrease a cat's exposure to mosquitoes but does not preclude it entirely. Indoor cats are still at risk for heartworm infection and, in fact, many have been diagnosed with heartworms.



Blagburn: We used to believe that the antibody test was a screening test and the antigen test was a confirmatory test. That was before we discovered just how many infected cats could be antibody negative. We have to unlearn some of our previous approaches.

Levy: In terms of retrovirus testing, I also want to test every new cat coming into a household. I always offer diagnostic screening; a lot of my clients decline testing but will put their cat on prevention anyway. I'm already testing sick cats for retroviruses, so I'll be passively acquiring heartworm information on those patients. I

would also promote heartworm testing in cats that are at low risk for retroviruses but that have respiratory signs.

Buzhardt: How do you think practitioners will respond to the SNAP® Triple?

Blagburn: When I talk to veterinarians about the combination of heartworm antigen testing and retrovirus testing, I get an overwhelmingly positive response given the facts that the tests are going to be on the same platform and at no incremental cost to the veterinarian. I think the test will be welcomed and used a lot.

The trick is how to make sure veterinarians understand that they'll potentially be testing two different populations of animals and that the results have to be interpreted in the context of the population being tested. This raises two questions: How do we change the strategy of testing to encourage more heartworm testing, and how do we interpret the results in the context of the population being tested?

Nelson: A positive antigen test is easy to interpret: The cat has an adult female worm.

Buzhardt: What does an antigen-negative result tell us?

Cousins: The cat does not have adult females in the heart. It does not rule out the presence of immature worms or adult males.

Nelson: Antigen tests detect proteins and/or carbohydrates shed from mature worms, especially females. A positive antigen test confirms the presence of adult heartworms in the cat, but a negative antigen test does not rule out feline heartworm infection or a male-only infection. Antigen testing also will not detect the juvenile worm infections that make up the majority of HARD cases. Despite these limitations, antigen testing will provide us with a lot of information. Serologic data indicate that approximately 1% of the cats currently being tested for heartworm antigen are positive.² If this same percentage remains constant with a larger sample size, I estimate 25,000 to 30,000 cats with heartworm infections that previously would have gone undetected will be diagnosed with heartworms the first year.

What will this mean besides the fact that thousands of cat owners and veterinarians are going to be shocked to find out a pet or patient has heartworm disease? It will give us vital information on the numbers of cats at risk for the

much more prevalent form of feline heartworm disease, HARD. As we receive more data from cats being tested, we will have a better idea of the actual risk, which will be substantial. Hopefully this will lead to more cats being placed on heartworm preventives, because less than 5% of cats are currently being protected.

Buzhardt: If a practitioner sees a cat in which retrovirus testing isn't indicated, should he or she use the SNAP® Triple Test before prescribing heartworm prevention? The test will be in the hospital and it won't cost any more than the retrovirus combo test did. When should practitioners perform the triple test for the heartworm component alone?

Levy: I don't believe that heartworm testing should be used as a general health screening test. I think it has utility when it's being offered before starting a cat on prevention and that it is very useful in symptomatic cats, but I wouldn't test every cat for heartworm every year.

If I'm screening a healthy cat without an index of suspicion for infection, such as I might do before putting a cat on prevention, I suggest both an antigen and an antibody test. Using them in combination gives me the greatest sensitivity. If I'm testing sick cats that I suspect have heartworm infection, I'm going to run the antigen and antibody tests and add chest radiography and possibly ultrasonography.

Blagburn: This is an excellent example of the shift from our previous belief that the antibody test was a screening test and the antigen test was a confirmatory test. That was before we discovered just how many infected cats could be antibody negative. We have to unlearn some of our previous approaches.

Cousins: I would use the antigen test if I wanted to screen a cat for heartworm disease or in cats that cough or have other signs consistent with "feline bronchial asthma," cats with acute respiratory distress syndrome, cats with sudden, unexplained neurologic dysfunction that may be referable to aberrant worm migration, and cats with a history of chronic vomiting that live in highly endemic areas. I should point out that the SNAP® Triple might not be the only heartworm test I would run, nor would serology alone be the only work-up in these patients.

One reason practitioners don't test more is that they don't understand the prevalence rate of the disease in their area. Another is that they don't know what test to use. Including this

Cousins: The surprise positive antigen tests are going to highlight that heartworm disease is a problem in cats and will help practitioners to realize that feline heartworm disease is indeed present in their geographic area of practice and has been all along.



antigen test with the retroviral tests certainly simplifies the choice.

Buzhardt: How do you respond to long-term clients who ask why this is the first time you've mentioned heartworms in all the years you've cared for their cats? How do you respond to the question, "Why do you want to test my cat today?"

Nelson: I'm simply going to explain that heartworms are a major issue in our area and that as we've learned more about the disease, we've discovered that cats are much more susceptible than previously thought. Cats do get heartworms, and the infection causes serious illness. We therefore recommend that all cats go on prevention.

Cousins: I'd also tell them that I have seen cases in my practice.

Dillon: Do you tell your clients up front that you want to put the cat on a preventive regardless of the test results? If so, the question becomes, "So why are you taking my money to test?" No test result can establish a negative heartworm status.

Nelson: I explain that we need to know if your cat is currently infected so we know what to do next. I recommend antigen and antibody testing before initiating prevention in cats that have never been on a preventive even though we know that a negative test does not rule out heartworm infection. However, a positive result to either test is significant.

Cousins: I think the availability of the antigen test will increase awareness of the problem and therefore of the need for prevention. Heartworm disease is a bad disease that we can prevent. The surprise positive results that come up are going to highlight that heartworm disease is a problem in cats and it will help practitioners to realize that, yes, feline heartworm disease is indeed present in their geographic area of practice and has been all along. ■

Use of Preventives

Buzhardt: Which cats should be on heartworm prevention?

Levy: All cats need to receive prevention.

Blagburn: All cats. There's evidence of heartworm throughout the country. Plus, most of the available preventives also eliminate common endo- and ectoparasites at a reasonable price. We've talked about heartworms in the context of disease, diagnosis, and our ability to prevent it, but we haven't talked about the available products that do more than just prevent heartworm.



Cousins: Prevention is the only proactive measure we have.

Cousins: That's what makes it such an easy sell in the exam room.

Nelson: It's the second part of the sell: In addition to getting rid of heartworms, we can prevent a host of other parasites and the threat they pose to your pet and the rest of your family.

Cousins: Also, putting cats on heartworm prevention is good business. We know that people spend 30% less on their cats than on their dogs nationwide. If you want to close that gap and increase the feline franchise portion of your practice, it makes good sense to practice preventive medicine and put your feline patients on prevention. Prevention is the only proactive measure we have.

Blagburn: There are too many variables affecting test results—whether the cat in question produces antibody, whether the antibody persists or is even detectable by the test being used, the age of the cat, where it lives, the time of year the test is run, the prevalence of heartworm in the area, whether the cat has clinical signs, whether an antibody or antigen test is being used, and so forth. That's why we're all such strong proponents of prevention. There are too many variables to overcome, and it's too complicated a disease. It's too difficult to diagnose and the outcome is unpredictable. We have the products to prevent the disease, so let's do it.

Cousins: The difficulty in convincing the clinicians relates to the difficulty in diagnosing the problem in the first place. Most veterinarians say, "I never see feline heartworm disease." As Dr.

Dillon notes when he lectures, "It's not a blue-dot disease." I love that line and it's the truth. It's tough to diagnose, so practitioners say they never see it when, in fact, they see it all the time. How do you convince a pet owner or veterinary colleague that HARD is important and that cats should be on prophylaxis to protect them from it?

Nelson: If they see a cat with clinical signs consistent with HARD, they'll run one test, get a negative result, and never retest, but we have to remember that the utility of these tests in cats is not the same as in dogs. This is why prevention is key. We can recommend testing, but if the owners turn it down, we still put the cats on prevention.



Clinical Implications of Testing

Buzhardt: As we've discussed, feline heartworm disease is often misdiagnosed as other forms of respiratory disease, and even when heartworm disease is evident, some practitioners are still in denial. How do we change their minds and convince them that heartworm disease is a significant medical issue for cats?

Nelson: First, I'd confide that I didn't believe feline heartworm disease existed until I saw the results of my necropsy survey.⁷ Then, I'd share the data we have from their area. Any place that you look for heartworms, you'll find them.

Buzhardt: Testing cats for heartworms and putting them on prevention allows us to fulfill our primary objective of providing good health care for our patients. Veterinarians who test cats will reap a financial benefit as well. The entire staff needs to be educated and to believe in the heartworm protocol if we expect them to convince clients of the need for testing and prevention.

How can we convince our veterinary colleagues to test cats for heartworm infection using this antigen test?

Blagburn: More often than you might imagine, I hear veterinarians say, "Until I saw that case around here, I wasn't convinced." I think that even one positive antigen test—one blue dot—can be compelling. The recognition that one infection exists can compel our colleagues to change their minds.

Levy: I am concerned that on the local level, at a single practice, there won't be enough testing done for those positives to start coming up. The proportion of cats that are actually tested for FeLV and FIV is actually much lower than many people appreciate. If regional data are collected and reported back to the veterinarians in that region, it will be more compelling.

Buzhardt: IDEXX will be encouraging practitioners to submit their SNAP® Triple results to them and will also be testing cats through their reference laboratory. Practitioners can help generate both local and national feline heartworm prevalence data, which will be valuable information for all veterinarians. In this way, veterinarians will not only see their individual hospital results but will gain a broader view of the nationwide prevalence.

Blagburn: Another benefit of testing is to identify the antigen-positive cats that are not sick so that you can properly manage and follow them. From a parasitologist's perspective, there's everything to be gained and nothing to lose by gathering more information about positive cats, whether they are asymptomatic or symptomatic, and I think practitioners are more likely to believe a positive antigen test.

Buzhardt: Almost all laboratory tests require some degree of client education. Feline heartworm testing may just require a little more. We should explain the limitations of any test before we even draw the first blood sample, so I don't see the conversation about heartworm testing as being any different.

Nelson: The more testing that is done, the more positives there will be, and as the number of positives increases, more people will become convinced that feline heartworm disease exists. It will change their minds.

Blagburn: The potential for increased information about infected cats is tremendous. If those veterinarians who never even think about heartworm in a symptomatic cat in certain regions of the country start using the test and discover that there are heartworm antigen-positive cats in their area, they are more likely to promote a program of prevention with broad-spectrum agents. ■





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For More Information

American Association of Feline Practitioners

www.catvets.com

American Heartworm Society

www.heartwormsociety.org

Companion Animal Parasite Council

www.capcvet.org

Dr. Dillon's Feline Heartworm Disease website

www.vetmed.auburn.edu/distance/cardio

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