The latest research on vector-borne diseases in dogs
A roundtable discussion
Recent research reinforces the importance of repelling ticks and fleas in reducing transmission of canine vector-borne diseases. In this roundtable, leading experts discuss the latest research and how to work with your clients to dramatically reduce a dog’s chances of infection.

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Common canine vector-borne diseases

Dr. Joe Hostetler: Dr. Breitschwerdt, would you please briefly review the more common and most important canine vector-borne diseases (CVBDs) transmitted by ticks in North America?

Dr. Edward Breitschwerdt: Lyme disease is important in the northeastern, north central, and western United States, as well as in other areas where *Borrelia burgdorferi* is transmitted to both dogs and people by various *Ixodes* tick species. In some areas, the prevalence of exposure to this particular organism can be as high as 80% to 90% in unprotected animals.

Rocky Mountain spotted fever is also notable because dogs can die from infection with *Rickettsia rickettsii*. The ticks that transmit Rocky Mountain spotted fever are widely distributed, and we are finding an increasing number of tick species that are vector-competent for the *Rickettsia* species.

Next are infections with *Ehrlichia* species. *Ehrlichia canis*, *Ehrlichia ewingii*, and *Ehrlichia chaffeensis* are transmitted to dogs by different tick species, with a distribution that covers nearly the entire United States and southern Canada.

Two important species of *Anaplasma* are transmitted by ticks in the United States: *Anaplasma phagocytophilum* and *Anaplasma platys*. Canine anaplasmosis, caused by *A. phagocytophilum*, is important because it mimics Rocky Mountain spotted fever, but it’s not as severe.

Another group of organisms that have become increasingly important throughout the United States are the *Babesia* species. *Babesia canis* is most likely a tick-transmitted species, whereas *Babesia gibsoni* is most often transmitted by biting during dog fights.

The last pathogenic organisms to mention are the *Bartonella* species. The literature in regard to tick-transmission of *Bartonella* species remains somewhat controversial; however, more recent information supports vector competence for some *Ixodes* species.

Common tick species

Dr. Hostetler: Dr. Dryden, what are the more common tick species in North America?

Dr. Michael W. Dryden: Overall there are nine to 10 different tick species that dogs might encounter in various places throughout North America. At least seven of those are well-characterized as transmitting CVBDs.

There are very few places in North America where you will not encounter some very important ticks and tick-transmitted diseases. — Dr. Michael W. Dryden

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of organisms the brown dog tick can transmit to dogs is extensive and includes *Ehrlichia canis*, *Babesia canis*, and *Anaplasma platys*. And recently in the southwestern United States, *Rhipicephalus sanguineus* was identified as a vector for *Rickettsia rickettsii*.

In addition we have the various *Ixodes* species. The two that are most important are *Ixodes scapularis* in the eastern half of the United States and *Ixodes pacificus* in the western half. Both these ticks are important because they can transmit *Borrelia burgdorferi* and *Anaplasma phagocytophilum*.

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**Dr. Hostetler:** Dr. Little, would you briefly go over the transmission of CVBDs from ticks to dogs?

**Dr. Susan E. Little:** Transmission of CVBDs is incredibly common throughout the world. Wherever ticks infest, dogs become infected with the tick-borne disease agents passed by the ticks during feeding. What has been shown repeatedly is that the longer a tick feeds, the more efficient transmission is. A tick has to be attached from 24 to 48 hours for Lyme disease to be transmitted and as briefly as six hours for Rocky Mountain spotted fever. This means that we need to make sure that ticks are repelled, that they don’t attach to the host.

**Dr. Breitschwerdt:** As clinicians, we are not only concerned about diagnosing CVBDs when they occur, but also about keeping ticks off dogs and keeping ticks from transmitting organisms.

**2010 efficacy study**

**Dr. Hostetler:** Dr. Breitschwerdt, you recently coauthored a study with Dr. Domenico Otranto (see boxed text) that looked at the efficacy of the combination of imidacloprid and permethrin in preventing the...
In October 2009, samples were collected from the remaining 83 dogs (44 from group A and 39 from group B), all untreated over the previous summer season, to investigate the annual incidence of CVBDs in the same dog population. A high year incidence for tick-borne diseases (78.1%) and for *L. infantum* (13.6%) was detected in dogs from group A seven months after the treatment had been withdrawn. The results demonstrate that ImPer preventive treatment against arthropods protects autochthonous and naïve beagle dogs against CVBD-causing pathogens.

This research suggests that in endemic areas animals should be treated with repellents throughout the year since ticks and fleas are present year-round in the Mediterranean area. This is also important from a public health standpoint since many of these CVBDs, such as leishmaniasis and Mediterranean spotted fever, are endemic zoonoses in Mediterranean countries. About 4,000 cases of human leishmaniasis caused by *L. infantum* are reported each year in the Mediterranean region. It is also notable that in this study, the percentage of dogs initially positive for CVBDs that remained positive at the third follow-up was significantly lower in treated than in untreated, control dogs. This indicates that dogs infected by single or multiple CVBD-causing pathogens should be treated to prevent further transmission of infectious agents. This also suggests the potential for a natural pathogen clearance if repellent compounds can effectively prevent new transmissions by ticks.

Dr. Breitschwerdt: It turned out to be an absolutely amazing study. The study was conducted in southern Italy at a large soccer stadium that was being used as the local shelter facility for dogs. The dogs had the opportunity to be inside, out of the heat and sun, but they also had the opportunity to be outside on grass and rocks where *Rhipicephalus sanguineus* can live and proliferate.

The study looked at the efficacy of an imidacloprid-permethrin combination product (Advantix®—Bayer HealthCare) in preventing the transmission of various pathogens, including *Ehrlichia*, *Babesia*, *Bartonella*, *Anaplasma*, *Hepatozoon*, and *Leishmania* species, from arthropods to dogs over a one-year period under field conditions and challenges. After the one-year application period, when product was no longer administered, the study also looked at which dogs then became infected with one or more tick-borne diseases.

One of the advantages of this study was that there were extremely large populations of fleas and brown dog ticks to which these dogs were being exposed on a constant basis. However, in southern Italy they only have one tick, whereas in the United States a dog could be exposed to up to five different tick species at once or at different times, and each tick species can carry different pathogens.

Dr. Little: What I found really exciting about the study is that dogs were heavily exposed to CVBDs, but the 10 beagles that were receiving the acaricide, Advantix®, were negative at the final follow-up, whereas eight out of 10 beagles from group B were positive for one or more CVBDs. During that year of exposure, these beagles were treated every three weeks with the imidacloprid-permethrin combination product.

That speaks to the importance of routinely using repellent acaricides on dogs. Even in dogs that were already infected, the ones that were treated acquired fewer new infections. We know that acquiring multiple co-infections over time will lead to accumulation of different pathogens or different strains of the same pathogen in a dog, which appears to lead to more severe disease. Using repellent acaricides on dogs, thereby reducing exposure to the vectors of CVBD, will hopefully protect them from developing disease due to these infections.

**Dr. Dryden:** It is important to kill ticks as rapidly as possible because the duration of attachment and feeding is significant. We also need to reduce the overall number of ticks that dogs are exposed to. By administering a highly effective acaricide, particularly one that has some repellency activity such as permethrin, we reduce the number of ticks the dog is exposed to and the duration of time that ticks are allowed to feed. A combination of factors is addressed together: speed of kill, repellency, and reduction of overall exposure rate.

In the Italian study, they were able to protect dogs in a hyperendemic area with large numbers of brown dog ticks and a very high infectivity rate. The study suggests that if our clients apply these products appropriately, we can dramatically reduce the chances that their dogs are going to get a vector-borne disease.

**Dr. Little:** A number of CVBD transmission studies have looked at the ability of acaricide use to interrupt transmission from ticks to dogs. This Italian study is the culmination of a series of papers that have shown that routine acaricide use decreases transmission of infection.

**Application**

**Dr. Hostetler:** What is known about the frequency of the application of spot-on treatments for optimum efficacy?

**Dr. Dryden:** In the Italian study, there was an 80% infection rate in the untreated dogs versus only 10% in the treated dogs. That’s fairly dramatic. The Advantix formulation was being applied once every three weeks. I think we need to recognize that for EPA-registered pesticides it’s a violation of federal law to use it in a manner inconsistent with the labeling. Veterinarians might think, “Well, isn’t that product labeled for once a month?” That is what a lot of these topical spot-on acaricides are labeled for. However, with the K9 Advantix II formulation (imidacloprid/permethrin/pyriproxyfen) you can legally apply the product more frequently than once every 30 days, and certainly once every three weeks is within the legal application range for the product.

With any acaricide used for tick or flea control we occasionally have issues with the decay curve of the molecules, and we know that over time the level of insecticide tends to decrease. Therefore, the speed of kill tends to decrease for both flea and tick products. Once-a-month application is more than adequate during typical exposure periods. However, when you have heavy parasite exposure, as was described in the study, practitioners may need to recommend applying a product sooner than 30 days. Legally being able to do that with K9 Advantix II is a benefit to practitioners, to clients, and obviously to the dogs we’re protecting.

**Hostetler:** Going back to a comment about K9 Advantix. In Italy, its label is a three-week application for Leishmania species. That’s why the study’s protocol called for application every three weeks because leishmaniasis was one of the CVBDs they were looking at.

**Frequency studies**

**Dr. Dryden:** In what we call the tub study, we treated dogs with various acaricides and placed them in stainless steel tubs. We then placed ticks on the dogs to see how the ticks would respond. What we found was quite surprising, especially with the permethrin-based formulations such as K9 Advantix. In the most dramatic cases, ticks would literally run off the dogs.
because of exposure to that product. The ticks that went through the haircoat were ultimately killed. We know that if ticks are kept off dogs and ticks are killed rapidly, exposure to CVBDs is reduced.

It is important to recognize that not every tick is going to be carrying a pathogen. Reducing the number of ticks a dog is exposed to will lessen a dog’s likelihood of acquiring a vector-borne disease.

**Dr. Hostetler:** You also did a natural exposure study.⁵

**Dr. Dryden:** Yes, we conducted a study where we walked nontreated dogs and dogs treated with K9 Advantix® daily for one month through a hyperendemic area for the lone star tick. The control dogs would come back with up to 60 ticks on them at a time, but the treated dogs were remarkably protected, in the mid to high 90% range throughout the entire month. Even under heavy exposure periods, a product like K9 Advantix® can provide a very high level of protection.

**Dr. Little:** The tick pressure that dogs are up against in some areas of the country at certain times of the year is considerable, and they are likely to acquire a few ticks even with acaricide use. What’s exciting about K9 Advantix® II is that it can be applied more frequently than once a month. Once a month is adequate for most dogs in most areas of the country most of the year, but when an area is experiencing a tick bloom and the numbers are just so high that control becomes difficult, this product can be applied more frequently.

Clients usually don’t come to us until the tick problem is already well under way. They often don’t see the need to apply a tick control product until they already have a tick infestation. We wish they would apply it to every dog, every month, all year long, but we know that in practice, that’s not how many of our clients respond. In cases where a tick infestation is already under way, more frequent application can result in more rapid control.

**External parasite control**

**Dr. Hostetler:** What additional benefits are there to dogs when veterinarians recommend comprehensive external parasite control for their patients?

**Dr. Dryden:** It’s critical to put animals on broad-spectrum parasite prevention. With the various products or combinations of products we have available to us today, we can prevent an array of parasitic diseases. We have the ability to treat and prevent ticks, fleas, heartworm, roundworms, hookworms, or whipworms in dogs, and to prevent an array of CVBDs that dogs can encounter. Fleas are a constant issue with many pet owners in the United States. Through recent data presented at the North American Veterinary Conference by Dr. Byron Blagburn and his nationwide parasite survey of dogs and cats, we recognize that a large array of animals are still infested with parasites. A large number of animals are exposed to parasites that are highly detrimental to their health. With highly effective, easily administered, and very safe products, we have the ability to prevent our dogs and cats from getting many of these parasitic diseases. It’s up to us to make the correct recommendations to pet owners.

**Dr. Breitschwerdt:** In the Otranto study, during the spring and fall follow-up periods when the intensity of tick activity was less, protection approached 100%.¹ At no point during the study, did the investigators find any fleas on any of the treated dogs. In regard to sandfly transmission of *Leishmania* species, the protection was 100%.

**Dr. Little:** In addition to preventing CVBDs, an important aspect of routine acaricide insecticide use on dogs is that it keeps them comfortable. We focus a lot on preventing transmission of diseases through use of a repellency, but many of us know that tick bites hurt. They are uncomfortable, they itch, and they are certainly uncomfortable for our pets as well. Keeping ticks off dogs, keeping biting flies away, ensuring that dogs are flea-free, and making sure there is some mosquito repellency achieved will keep dogs more comfortable and improve their quality of life.

**Dr. Breitschwerdt:** Currently, my laboratory is as interested in what fleas are transmitting to dogs, cats, and humans as we once were in regard to tick-transmitted infectious diseases. One flea-associated pathogen is *Rickettsia felis*. Like other rickettsial infections, it causes an acute, severe febrile illness in people. This is
a flea-transmitted *Rickettsia* species that has induced disease in human patients throughout many countries worldwide; therefore, we should pay more attention to the possibility that *R. felis* may contribute to febrile illness in cats and dogs.

Another flea-transmitted genus that's critically important is *Bartonella*. We now know that *Bartonella hensalae*, *Bartonella claridgeiae*, and *Bartonella koehlerae* are transmitted by fleas to cats and potentially dogs throughout the world. Other *Bartonella* species that have been cultured from the blood of cats and that may be transmitted by fleas include *Bartonella bovis* and *Bartonella quintana*. The importance of flea- and potentially tick-transmitted *Bartonella* species in the context of public health cannot be underestimated. Clearly, reducing transmission of *Bartonella* species is an advantage of killing fleas with K9 Advantix®, as seen in the Otranto study, which found that transmission of *Bartonella* species was extremely infrequent.

**Client education**

**Dr. Hostetler:** As we conclude this roundtable, what parting statement or conclusion would you like to see the practicing veterinarian come away with?

**Dr. Little:** We have the ability to prevent infection with CVBDs. It requires dedication and constant attention to educating clients about the importance of monthly, year-round use of acaricides on their dogs. Tick control products have to be on the dog before it encounters ticks in order to be effective, so we have to remind clients that we're not just controlling ticks, we're also trying to prevent infection in their pets. It is advantageous for clients and the general public to be aware of tick-borne diseases. People know that ticks present a risk of infection for their families, and they are certainly in favor of killing ticks. So we have to give clients the tools they need to make sure tick populations are controlled and acaricides are used routinely.

**Dr. Dryden:** There is no other area of parasitology that's changing as rapidly. Tick species are occurring in places they never did before. Vector-borne diseases are occurring in places we never had them before. While there are peak tick seasons, we can often find different species of ticks parasitizing our pets throughout the year. The easiest recommendation to make is year-round prevention of ticks and tick-transmitted diseases.

**Dr. Breitschwerdt:** Our profession needs to assume a primary role in understanding vector-borne diseases, especially those that are of zoonotic importance. Every veterinary hospital should have a team approach to the prevention of vector-borne infectious diseases. But when it comes to zoonoses, it is the responsibility of the veterinarian to educate clients as to specific risks to their pets and preventive strategies to keep pets free of pests that might be vectors for these diseases. Also, there has to be balanced expectations on the part of the veterinary profession and our clients, whether it's a vaccine, a therapeutic drug, or an acaricide product. Efficacy is rarely 100%. Finally, annual screening for exposure to these vector-borne organisms is not only medically sound, but is central to our understanding of when a pathogenic organism has been transmitted to our patients, and what potentially zoonotic agents might be transmitted by ticks in our respective practice areas.

**References**

4. Dryden MW, Payne PA, Smith V, et al. Evaluation of an imidacloprid (8.8% w/w)-permethrin (44.0% w/w) topical spot-on and a fipronil (9.8% w/w) - (S)-methoprene (8.8% w/w) topical spot-on to repel, prevent attachment, and kill adult *Rhipicephalus sanguineus* and *Dermacentor variabilis* ticks on dogs. *Vet Ther* 2006;7(3):187-189.