OVERVIEW

VECTOR BORNE DISEASE

MSD Animal Health

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INTRODUCTION

Vector-borne diseases (VBD) of dogs are increasing in range and are now found in new areas, leading to changes in the health risks for dogs and suggesting that veterinarians are likely to encounter VBD they may not have seen before. Therefore, this guide is written to provide veterinarians with a reference that will help them to recognize, diagnose, understand and manage five key canine VBD and to be prepared should a dog with one of these diseases present in the practice.

This introduction to the diseases includes a review of the main factors affecting the distribution of the big five VBD of dogs; briefly introduces each VBD and addresses the general topic of vector control. Subsequent chapters provide a consistent detailed look at each disease.

The "Big Five" are the most recognized wild animals that every traveler visiting Africa is seeking while on a wildlife photo-safari.

Similarly, the "Big Five" canine VBD in this guide stand out for their highly significant impact on canine health.

This guide will help veterinarians know where to look and what to look for and to be prepared for the time when one of these diseases is seen in the practice.

INTRODUCTION

The "Big Five" canine VBD are a diverse group of protozoal, bacterial and helminth parasitic diseases:

Heartworm

Caused by parasitic helminths: *Dirofilaria* spp.

Multiple mosquito species spread heartworm in dogs or subcutaneous dirofilariasis (*D. repens*)

Leishmaniosis

Babesiosis

Caused by protozoan parasites

- *Leishmania* spp.
- *Babesia* spp.

- *Leishmania:* sand flies
- *Babesia:* ticks

Lyme disease

Rickettsial diseases

(ehrlichiosis, rickettsiosis and anaplasmosis)

Caused by bacterial pathogens

- *Borrelia*
- *Ehrlichia, Rickettsia* and *Anaplasma* spp.

Ticks

The vectors for the big five canine VBD are all arthropods including ticks, mosquitoes, and sand flies. These arthropods act as living shuttles, carrying disease-causing organisms between animals as a result of their lifecycles and feeding behaviors.

INTRODUCTION

Dogs may have multiple concurrent infections from different VBD, and one vector may carry and transmit more than one pathogen. In some cases, these vectors may transmit these pathogens to people, in which case the disease is known as zoonotic.

The deadly and efficient beauty of the front view of an *Ixodes* tick under scanning electron microscopy.

There are two main factors that contribute to the apparent increase in the incidence of vector-borne diseases in dogs:

1 Changes in the **geographic distribution of vector populations**

- The climate in a region determines the ability of vectors, including mosquitoes, ticks and sand flies, to survive there. If ecological changes, and these may be human-caused, alter the local climate then the geographic range where vectors can survive also changes.
- In addition, human activities are changing, and often increasing, the local abundance of wildlife reservoir hosts that act as a source of the pathogens carried by the vectors.

2 Changes in the **geographic distribution of dogs**

The precise impacts of climate change and habitat change on vector distribution and subsequent VBD risks are challenging to quantify.
However, the increased worldwide movement of companion animals and the observation of unexpected diseases in new areas are facts.

There are insufficient data regarding the relative significance of canine VBD in most countries, primarily because there is no formal VBD case reporting requirement. Active surveillance systems are valuable tools for VBD to allow a detailed risk analysis, including the evaluation of potential spread of vectors into new areas or the introduction of exotic species or vector-borne diseases.

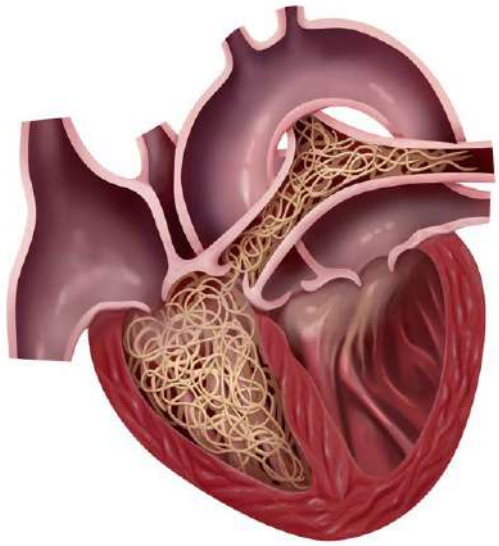
Questing *Dermacentor* ticks clustered at the tip of low vegetation waiting to grab a passing host.

MOSQUITO BORNE DISEASES

Dirofilariasis

In dogs, the mosquito-borne filarial nematode *Dirofilaria immitis* causes cardiopulmonary dirofilariasis (heartworm disease). Heartworm is a potentially fatal disease initiated by the bite of a mosquito infected with larval parasites. In dogs, the larvae mature into adult worms in the heart and nearby blood vessels leading to heart and lung failure.

Dirofilaria repens is another filarial nematode that causes subcutaneous dirofilariasis.



Both filarial helminth species may cause zoonotic disease.

The expansion of mosquito populations has had an impact on the distribution of both filarial nematodes. Heartworm has expanded its geographic distribution in the recent past, and ***D. immitis*** is now endemic globally in subtropical and tropical regions.

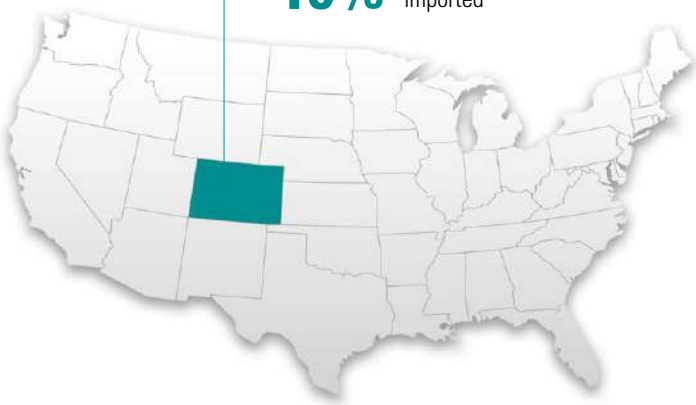
D. repens is restricted to Europe but has increased its prevalence over the past decades in areas where it was previously reported and has also expanded its distribution range. There is also evidence that *D. repens* has spread faster than *D. immitis* in Europe. However, the lack of rapid and reliable diagnostic tools and low awareness of *D. repens* in non-endemic areas are possible factors explaining why *D. repens* receives less attention than *D. immitis*.

MOSQUITO BORNE DISEASES

Animal welfare organizations in the United States are involved in the **translocation of large numbers of dogs between states.** Only a minority of these dogs are tested for heartworm infection before transport. The impact may be seen in the relationship between dog importation into **Colorado** and the prevalence of heartworm in the state which increased 67.5% between 2013 and 2017. During the same period nearly 10% of the total dog population of almost 1.2 million dogs was imported and the majority of imported dogs originated from states with a higher heartworm prevalence. Therefore, there is some evidence that dog movement from endemic areas can increase the risk of local transmission.

67.5% increased prevalence between 2013 and 2017

10% of the total dog population imported



TICK BORNE DISEASES

Global tick distribution

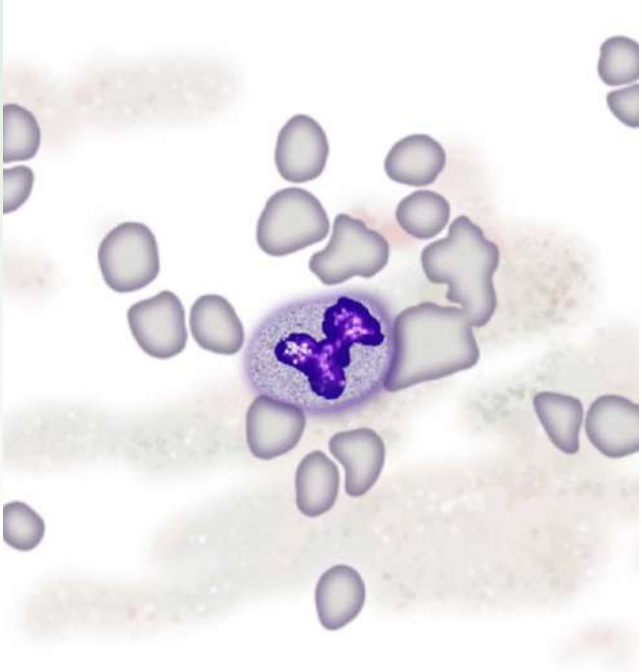
There are many examples illustrating the ongoing dynamic changes in the geographic distribution of vector tick populations. For instance, the dog tick, *Rhipicephalus sanguineus* is tending to move north in Europe from its previously Mediterranean distribution.

Also, *Dermacentor reticulatus*, the ornate dog tick, is now recorded in most European countries, whereas formerly this tick was relatively rare in the colder climates of central and northern Europe. Spread of this tick in these areas is enabling the local establishment of canine babesiosis.

A striking example of changes in the global tick distribution is the discovery of the Asian longhorned tick, *Haemaphysalis longicornis*, in the United States in 2017. *H. longicornis* is native to East Asia, where this tick is a major livestock pest. It was recently found in New Jersey on a sheep with no history of travel outside the country. Rapid geographic expansion of this tick, with detection in more than ten different states, is facilitated by its ability to reproduce through parthenogenesis, a rare form of asexual reproduction whereby female ticks can produce progeny without male ticks. *H. longicornis* also infests dogs, and the tick is a vector of *Babesia gibsoni.*

Hypothetically, the Asian longhorned tick may have gone unnoticed during transport while feeding in the external ear canal of dogs. Although the *H. longicornis* population in the United States is apparently not carrying *B. gibsoni*, the potential vector capacity for babesiosis in dogs in the USA is now significantly broader. Fortunately, *H. longicornis* is apparently not a vector for Lyme disease spirochetes.

Lyme borreliosis caused by *Borrelia burgdorferi* is, at present, the most frequent human tick-borne disease transmitted by *Ixodes* ticks. Dogs can also be infected and develop clinical disease. Lyme disease diagnosis remains as challenging in dogs as it is in humans and canine *Borreliosis* is more broadly recognized in the United States than in Europe.



Field research at the forest edge to collect and identify ticks in the area.

Tick bites expose both dogs and people to a broad range of Rickettsiales bacterial pathogens:

- *Ehrlichia canis*
- *Ehrlichia chaffeensis*
- *Ehrlichia ewingii*
- *Anaplasma phagocytophilum*
- *Anaplasma platys*
- *Rickettsia rickettsia*
- *Rickettsia conorii*
- Other spotted fever group rickettsiae

Ehrlichia canis

Monocytic ehrlichiosis, caused by *E. canis*, is a significant disease of dogs and occurs globally in association with the widespread distribution of the vector, the "brown dog tick" *Rhipicephalus sanguineus*. These ticks can experimentally acquire infections from dogs and then transmit these to non-infected dogs.

TICK BORNE DISEASES

Screening dogs for vector-borne diseases is more common in veterinary clinics in the United States than in Europe. There is still a lot to learn around how soon after transmission antibodies can be detected using point-of-care tests and when to expect clinical signs, or even if they will occur.

There are also apparent variations in the **speed of transmission** of different pathogens following the attachment of a tick.

Antibody test results do not appear to be affected by antimicrobial treatments such as doxycycline. Finally, the duration of antibody-positive status after infection can be years in the case of ehrlichiosis, which may further complicate test interpretation.

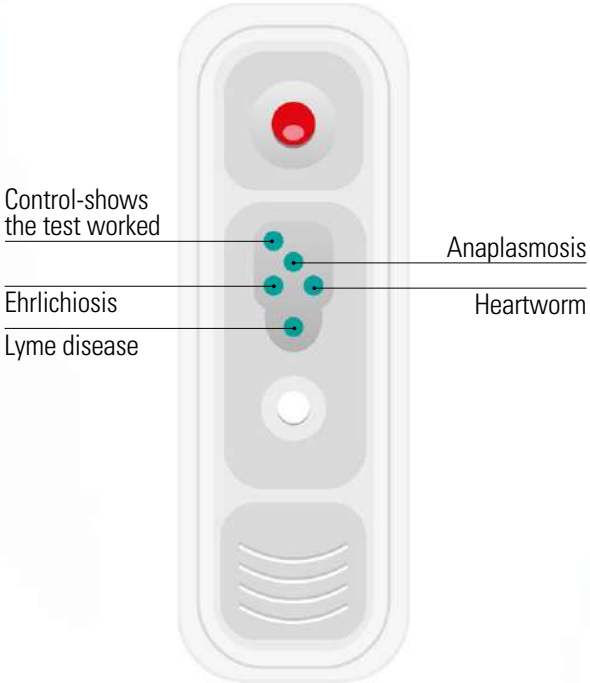
- *Anaplasma* and *Ehrlichia* species are transmitted within 24 hours of tick attachment.
- *B. burgdorferi* is transmitted from about 36-48 hours after tick attachment.
- *Babesia* parasites require development of sporozoites in the tick salivary glands and it is several days after tick attachment before they are transmitted.

The subsequent time that must elapse before infected dogs become antibody-positive also depends on the pathogen:

Anaplasma spp.	*Ehrlichia* species	*B. burgdorferi*
2-3 weeks	3-4 weeks	4-6 weeks

Snap® 4Dx Test (IDEXX, Portland Maine USA)

This test screens for ehrlichiosis, anaplasmosis, Lyme disease and heartworm.



An understanding of tick-borne pathogen transmission times and how antibody screening test results relate to the onset of clinical signs are valuable case management tools. Not all VBD infections produce clinical signs, however, **signs may be observed as early as one to three weeks after tick attachment.** If clinical signs suggest the possibility of tick-borne disease, then presumptive treatment with doxycycline and follow up with further antibody tests two weeks later is a common practical approach.

SAND FLY BORNE DISEASES

Leishmaniosis is a critical and frequent vector-borne disease of dogs caused by the protozoa *Leishmania infantum* and transmitted by several phlebotomine sand fly vectors.

- It is present in the Mediterranean Basin, the Middle East, Central Asia, South and Central America.
- It also infects humans and in the past the human disease occurred particularly in children (hence the name infantum).
- Vaccines now available are hoped to reduce the need for treatment and diminish the importance of this disease.

Clear guidelines are needed to increase protection against importing diseases that pose a risk to animal and human health.

A primary reason for the increased distribution of sand fly-borne diseases is the mobility of dogs. For instance, in Germany where canine VBD have increased in frequency in veterinary clinics, twelve per cent of dogs that either travelled to or relocated from endemic areas were positive for *Leishmania infantum* infection. Therefore, importing dogs to northwestern Europe from endemic regions could carry the significant risk of bringing this infection along. Another example was observed in the UK, where nearly fifteen per cent of imported dogs tested positive for *Leishmania*.

Dogs are the main reservoir of *Leishmania infantum*, therefore, they may be culled in some countries as part of a government policy to control the risk of visceral leishmaniosis transmission to humans. However, culling dogs, whether healthy or sick, is not likely an effective measure to control the domestic reservoir of *L. infantum*. Other preventative measures, such as sand fly anti-feeding treatments in combination with vaccination, are much more effective.

VECTOR CONTROL

There are multiple, highly effective treatment options available to protect dogs against the feeding of ticks and flying insect vectors.

- The recently launched **isoxazolines** offer systemic protection against both ticks and insects, although they are not repellent.
- **Synthetic pyrethroids** have a potent anti-feeding effect that is protective against flying insects including **mosquitoes and sand flies.**
- The **avermectins** and related compounds provide systemic protection against infection with **juvenile heartworm stages.**

When selecting a particular product or combination of products for effective vector protection, look at the product label recommendations in order to determine the correct retreatment intervals.

Also, when making a prevention recommendation, consider the duration throughout the year that a dog is at potential risk of vector attack based on your local climate and the travel plans of the dog's family. In general, dog owners tend to underestimate the risk duration during the year.

An important factor, often overlooked, in recommending a vector control program for the dog owner is the owner's compliance with the proposed program. Repeated evaluation of owner compliance behaviors suggests that administration of products with a longer period of action is more likely to lead to increased owner compliance with the control program. The most common reason for treatment failure is not vector resistance but rather it is failure to use products with proven efficacy against the vector and to follow the recommended administration method and schedule.

CONCLUSION

Big Five importance

Changes in the geographic distribution of vector populations and movement of dogs are the main drivers behind the increased impact and spread of vector-borne diseases on the health and welfare of dogs.

Moreover, changing climates are affecting the geographic range and survival of vectors including ticks, sand flies and mosquitoes and these are happening along with ecological changes increasing wildlife reservoir populations.

This dynamic global panorama is having an impact on the spread of canine VBD and the practicing veterinarian should be prepared to see any of the Big 5 VBD at any time.

A close-up view on scanning electron microscopy of *Rhipicephalus*, a potentially deadly vector tick.

An engorged female and a male *Ixodes* tick showing the size disparity.

FURTHER READING

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