Sharing is Caring…Or Is It? An Update on Canine Zoonotic Parasite Risks.

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Overview: Parasites – A shared risk

Many parasites that affect our canine companions are zoonotic and pose a risk to human health as well and underscore the importance of consistent parasite control practices. In general, parasites that infect or infest our dogs are common, omnipresent, under-recognized, and pose important medical concerns. Parasite infestations also significantly threaten the human-animal bond. Canine zoonotic parasites that will be discussed include ectoparasites (fleas and ticks) and endoparasites (hookworms, roundworms, tapeworms, and heartworms).

Ticks

We care about ticks for a variety of reasons, including because they: i) are nuisance pests, ii) can cause direct injury (e.g. anemia, paralysis), iii) can initiate allergic responses (e.g. alpha-gal syndrome), and iv) can transmit pathogens. A list of ticks commonly found infesting dogs (and people) and their general geographic distributions in the U.S. is provided in **Table 1**.

In the U.S., ticks are the most common arthropod vectors of disease for people and pets, capable of transmitting a variety of bacterial, protozoal, and viral pathogens. **Table 2** includes a list of the most common tick-borne pathogens reported in pets and people in the U.S. and the tick species associated with their transmission. For most of the listed pathogens, the tick initially acquires the pathogen from an infected wildlife host reservoir and then maintains that pathogen through the remainder of its individual life span, capable of transmitting the pathogen when it feeds on its next host. Few of the listed pathogens are vertically transmitted passed from the female tick to her progeny (notable exceptions include many of the viral pathogens, and some *Rickettsia* species). An excellent resource of monitoring where pets and people are at greatest risk for three major tick-borne diseases (Lyme disease, anaplasmosis, ehrlichiosis) is the Companion Animal Parasite Council[2]. The CDC also has excellent information on the clinical signs and case incidence of tick-borne diseases of concern for people[4]. It's important to remember that people and pets often share similar risk factors for encountering ticks and being infected with a tick-borne pathogen (most of which are zoonotic – the pathogen can infect people and animals)[7]. Because of these shared risk factors, a pet that tests positive for a tick-borne pathogen means that pet has been in an area with infected ticks, which means that the pet owner was also likely in an area with infected ticks. Direct transmission of tick-borne pathogens between pets and people is exceedingly rare.

Table 1. Ticks commonly in U.S.[5]

Common name	Scientific name	Geographic distribution in the U.S.
Black-legged tick (aka: deer tick)	*Ixodes scapularis*	Widely distributed in throughout eastern half of the U.S.

Western black-legged tick	*Ixodes pacificus*	Pacific coast
Lone star tick	*Amblyomma americanum*	Widely distributed in eastern, southeastern, and southcentral U.S.
American dog tick	*Dermacentor variabilis*	Widely distributed in east of Rocky Mountains
American dog tick	*Dermacentor similis*	West of Rocky Mountains, Pacific coast
Rocky Mountain wood tick	*Dermacentor andersoni*	Rocky Mountain states
Brown dog tick	*Rhipicephalus sanguineus*	Distributed throughout U.S. Prefers to infest dwellings.
Gulf coast tick	*Amblyomma maculatum*	Coasts areas of east coast, Gulf Coast, and south-central U.S.
Asian longhorned tick	*Haemaphysalis longicornis*	Eastern U.S., eastern central U.S.

Table 2. Tick-borne diseases most commonly reported from dogs and cats in the U.S.

Tick-borne disease	Pathogen name	Tick vector[Ω]	Zoonotic potential*
BACTERIAL			
Anaplasmosis	*Anaplasma phagocytophilum*	Black-legged tick	Yes
	Anaplasma platys	Brown dog tick	Unclear
Ehrlichiosis	*Ehrlichia canis*	Brown dog tick	Rare
	Ehrlichia ewingii	Lone star tick	Yes
	Ehrlichia chaffensis	Lone star tick	Yes
Lyme disease	*Borrelia burgdorferi*	Black-legged tick	Yes
Rocky Mountain spotted fever	*Rickettsia rickettsia*	American dog tick, Rocky Mountain wood tick, Brown dog tick	Yes
Spotted-fever rickettsiosis	Other spotted fever group Rickettsia species	American dog tick, Rocky Mountain wood tick, Brown dog tick, Lone star tick	Yes
Southern tick-associated rash illness (STARI)	*Borrelia lonestari* (?)	Lone star tick	Yes
Tick-borne relapsing fever	*Borrelia hermsii*	*Ornithodoros* species (soft tick)	Yes
	Borrelia turicatae	*Ornithodoros* species (soft tick)	Yes
Tularemia	*Francisella tularensis*	American dog tick, Rocky Mountain wood tick, Lone star tick	Yes
PROTOZOAL			
Babesiosis[€]	*Babesia gibsoni*	Brown dog tick	No (canids only)
	Babesia canis	Brown dog tick	No (canids only)
	Babesia conradae	Brown dog tick	No (canids only)
Cytauxzoonosis	*Cytauxzoon felis*	Lone star tick, American dog tick, Rocky Mountain wood tick	No (felids only)
Canine hepatazoonosis	*Hepatazoon americanum*[¥]	Gulf coast tick	No (canids only)
	Hepatazoon canis	Brown dog tick	No (canids only)
VIRAL			
Bourbon virus disease	Bourbon virus	Lone star tick	Yes
Colorado tick fever	Colorado tick fever virus	Rocky Mountain wood tick	Yes

Heartland virus fever	Heartland virus	Lone star tick	Yes
Powassan virus disease	Powassan virus	Black-legged tick	Yes

[Ω]Unless otherwise noted, tick-transmission of the pathogen occurs during the tick feeding process via tick saliva
*Can infect people and other animals
[€]Transmission of canine babesiosis can also occur via direct blood-to-blood transmission or dog bites between dogs. Human babesiosis in the U.S. is caused by *Babesia microti* (not infectious to dogs or cats).
[¥]Dog must eat an infected tick to become infected

To survive, ticks require hosts and environments with suitable temperature and humidity. The ticks that most commonly bite pets and people can be found in areas with tall grass, tree canopy, or other vegetative ground cover. These types of environments help regulate temperature extremes and improve humidity in addition to providing habitat for the wildlife species that ticks most commonly use as hosts. Places where wildlife species are active are places where ticks are more likely to be found. A notable exception is the brown dog tick, *Rhipicephalus sanguineus*, which preferentially utilize dogs as hosts for all life stages.

Fleas

Even though over 2,200 species/subspecies of fleas exist worldwide, the most common flea found on dogs (and cats) globally is the cat flea (*Ctenocephalides felis*). The cat flea is a voracious blood-feeding parasite that infests a wide range of mammalian and avian species. In urban areas, opossums are the primary wildlife host. A great resource for regional flea activity is the Flea Forecast[8].

- Source of flea: Pets get fleas from eggs deposited from flea-infested feral dogs, cats, and urban wildlife. Newly emerged adult fleas jump on pets and may be transported into the home.
- Flea life cycle on pets in the home:
    - Cat fleas begin feeding almost immediately once they acquire a host.
    - Within 24 hours, female fleas begin laying eggs and produce an average of 27 eggs/day and can produce eggs for >100 days.
    - Larvae hatch from the eggs, feed on adult flea feces and transform into pupae within 2-10 days.
    - Pupae are protected in sticky cocoons from which adults emerge 2-50 weeks later in response to host stimuli. On average, 85-95% of fleas emerge within 3-8 weeks.
    - Newly emerged adults seek out a host and they cycle continues. Adult fleas can live off-host 1-2 weeks but can live on-host >100 days.
- Flea-associated health concerns:
    - Flea-allergy dermatitis
    - Anemia
    - ***Flea-borne pathogens*** *(if you control fleas, you largely control transmission of these pathogens)*
        - *Yersinia pestis* – Plague (more commonly transmitted by rat and squirrel flea species)
        - *Bartonella* spp. – Cat scratch disease
        - *Rickettsia* spp. – Murine typhus, spotted fever rickettsiosis

- *Mycoplasma haemofelis* – Hemotropic mycoplasmas)
- *Dipylidium caninum* – Flea tapeworm

GI Nematodes

The primary gastrointestinal (GI) nematodes of concern for dogs are roundworms, hookworms, and whipworms. The Companion Animal Parasite Council[2] maps the prevalence of these parasites in dogs based on diagnostic lab test results from IDEXX and Antech. Of these GI nematodes, hookworms are most commonly detected from dogs, followed by roundworms and whipworms, although regional differences do occur.

A recent study examined GI parasites from dogs that visited dog parks in the U.S.[9] In this study, samples from 3,006 dogs from 288 parks, from 30 metropolitan areas were examined using coproantigen immunoassays and zinc sulfate centrifugal flotation. Of the tested samples, 20.7% of samples were positive for at least 1 intestinal parasite, the most common of which were hookworms (7.1%), followed by whipworms (1.9%) and roundworms (0.6%).

- Roundworms
  - *Life cycle:* i) eggs passed in feces; ii) larvae undergo somatic and/or tracheal migration (definitive host only); iiia) dogs (definitive host) infected through ingestion of infective larvated eggs or an infected parentenic host, iiib) migrating larvae encyst in intermediate and parentenic hosts (e.g. rodents, birds, humans)

  - *Major canine roundworm species in U.S.*
    - *Toxocara canis* (dog ascarid)
    - *Toxascaris leonina* (dog, cat ascarid)

  - *Prevalence of roundworms by dog age and region* (Blagburn et al. 1996)[10]
    - Age: *Toxocara canis* can infect dogs of all ages, but is most common in puppies (~30% of puppies <6 months infected; ~10% of dogs 6 months to 7 years old infected)
    - Region: Found throughout the continental U.S., but slightly more common in dogs in the southeast and Midwest. By comparison, *Toxascaris leonina* infection occurs about 10-fold less frequently.

  - *Human disease risk:* toxocariasis

- Hookworms
  - *Life cycle:* i) eggs passed in feces; ii) eggs hatch and rapidly develop into infectious L3 larvae in the environment; iiia) dogs (definitive host) are infected through ingestion of infective larvae, percutaneously, transmammary, and/or larval leak-back from somatic tissue stages; iiib) intermediate and parentenic hosts (e.g. rodents, birds, humans) are infected through ingestion of infectious L3 larvae and/or percutaneous routes.

- *Major canine hookworm species in U.S.*
  - *Ancylostoma caninum* (dog hookworm)
  - *Ancylostoma braziliense* (dog, cat hookworm)
  - *Uncinaria stenocephala* (dog, cat hookworm)

- *Prevalence of hookworms by dog age and region* (Blagburn et al. 1996)[10]
  - Age: Can infect dogs of all ages, no strong age association
  - Region: Found throughout the continental U.S., but more common in dogs in the southeast
- *Human disease risk:* cutaneous larva migrans

GI Cestodes (Tapeworms)

Tapeworms are parasitic flatworms in the class Cestoda. They cycle between definitive and intermediate hosts. They are hermaphrodites and are capable of self-fertilization and cross-fertilization. The adults attach to the gut wall of the definitive host using hooks and suckers. They have no digestive tract and instead absorb nutrients directly from host contents through their outer tegument. Segments containing egg packets are shed with host feces into the environment. The canine tapeworms of greatest public health concern are *Dipliydium caninum* (flea tapeworm), *Echinococcus granulosus* (cystic echinococcosis), and *Echinococcus multilocularis* (alveolar echinococcocus).

Heartworm

In the U.S., canine heartworm is caused by Dirofilaria immitis. This vector-borne parasite can be transmitted by >70 mosquito species. Although most common in the southeast U.S., infection and disease prevalence is rapidly expanding as a result of warming climate temperatures that facilitate mosquito activity and movement of infected dogs into areas not traditionally considered heartworm-endemic.

- Disease in humans: On rare occasions, humans may be infected with *D. immitis* and develop dirofilariasis. Disease occurs when migrating larvae die on their somatic migration to the pulmonary vessels. Migrating larvae may be encysted in various tissues. Dying larvae elicit significant inflammatory response and can lead to respiratory distress.

Parasite prevention, testing and control

- Evaluate risk: Utilize regional and timely resources to evaluate risk of encountering parasites (e.g. CAPC maps, published data). Risk assessment should include local and travel-associated risks.
- Limit exposure:
  - Avoid parasites (may not be easy or feasible)
  - Environmental management (e.g. pick up poop, reduce parasite habitat)
  - Good hand hygiene (wash hands often)
  - Limit pet scavenging (prevent pets from eating intermediate hosts, poop, etc)
- Test annually:

- *Who:* ALL pets
- *When:* EVERY year
- *How:* Depending on the parasite, a variety of diagnostic assay are available and may include serologic assays (e.g. detection of parasite antigen or generation of specific host antibody response to parasite antigen), molecular assays (e.g. detection of parasite DNA or RNA)d, or direct assays (e.g. fecal float)

- Treat pets with parasite control products
  - *Who:* ALL pets
  - *When:* ALL year
  - *With what:*
    - Ectoparasiticides (e.g. isoxazolines, permethrin, flumethrin)
    - Endoparasiticides (e.g. macrocytic lactones, pyrantel)
    - Endectocides (combination of ectoparasitide and endoparasiticide drugs/chemicals)
    - Vaccination (e.g. Lyme vaccine for dogs)
  - *Why:*
    - Maintain pet health
    - Reduce human risk of exposure to zoonotic parasites
    - Preserve human-animal bond

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