

Zoonotic threats to Pets and people

Veterinarians must educate Pet owners about preventing potential zoonotic diseases.



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How do we define a public health veterinarian in 2007? In 2000, there were 455 diplomates of the American College of Veterinary Preventive Medicine (ACVPM), or 7 percent of veterinary specialists active in the United States during that year.¹ Currently there are 681 members of ACVPM.² Veterinary schools are offering more combined DVM/MPH (Master of Public Health) programs to take advantage of the comprehensive education of veterinarians in comparative medicine. The graduates of these programs play an important role in studying health and the epidemiology of disease in Pet populations.

Physicians and other human health care providers can be involved with human-animal issues and deal with zoonoses directly. Zoonotic specialists may also have an MPH or other advanced epidemiology training. Their responsibility is to protect and promote human health and well-being as well as to work with veterinarians in situations where Pets are an integral part of the family. This can create a dilemma if the

evidence shows that the Pet can be both a risk and benefit to human health.

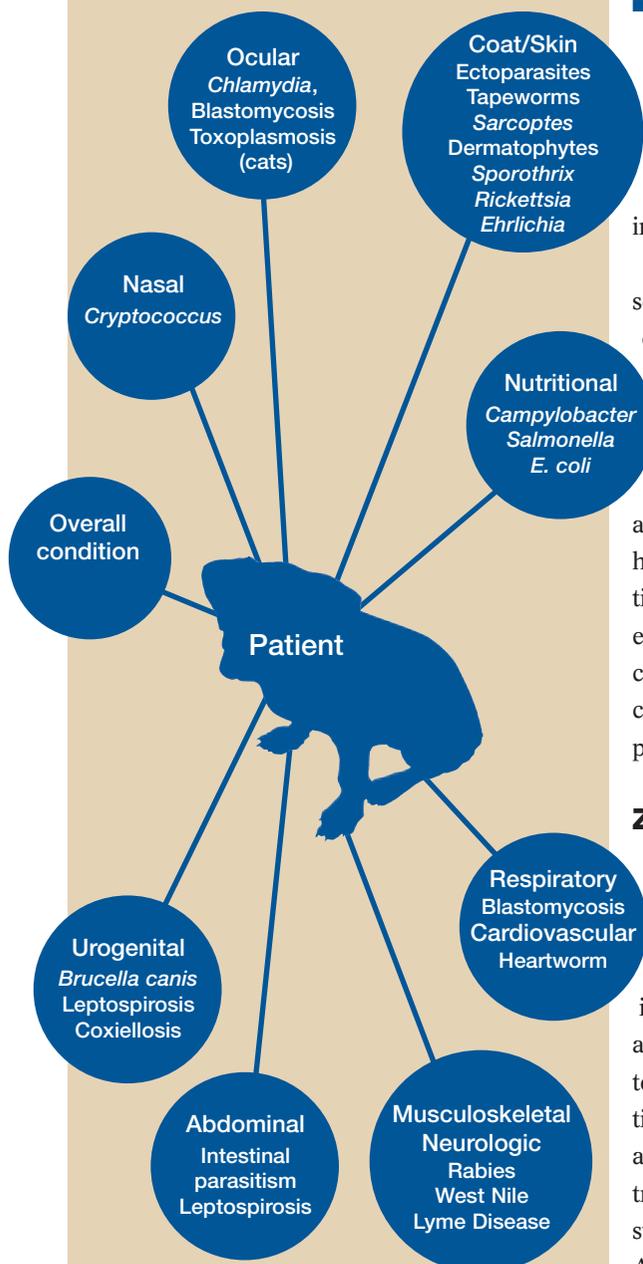
Is public health primarily the responsibility of specialists? Most opportunities to prevent and treat zoonotic diseases occur at the primary-care level. Whereas human physicians may or may not ask questions about the presence of Pets in the family, veterinary practitioners have the advantage of not needing to ask Pets if there are people in their families. This perspective makes us naturally more attuned to the interactions between Pets and their families.

Defining zoonosis

We often talk about zoonotic diseases and their potential risk to the health of people and their Pets. But as a clinician, it's important that you understand the different modes of transmission. A zoonotic disease is a disease common to, shared by or naturally transmitted between vertebrate animals, including Pets and people. Such diseases can spread by:

- Direct transmission: Contact with the infectious agent via contact with the infected animal or Pet
- Indirect transmission: Contact with the

Figure 1: The Value of the Physical Examination



Although many zoonotic diseases may be subclinical in household Pets, abnormal physical examination findings may clue the clinician into a potential zoonotic disease.

infectious agent via material from an infected animal or Pet, such as feces, urine or shed hair or feathers during infective intermediate stages

■ **Shared vector or source:** Pets and their families are both infected by the same vectors or environments.

It is important to distinguish public health issues related to veterinary medicine from true zoonotic diseases. For example, a dog attack is a public health concern but not a zoonotic threat. If the dog bite broke the skin and rabies virus was introduced into the bite victim, it is a zoonotic threat.

A complete discussion of all zoonotic agents is beyond the scope of this article; instead, the focus will be limited to discussing client-education opportunities available to Pet practitioners.

Practical preventive approaches to the most common zoonotic agents in private practice will also be addressed. Following a brief discussion of the more important agents of zoonotic disease, we will identify populations at risk including both people and Pets and avenues of cooperation between veterinary and human medical professionals. Current treatment recommendations for the zoonoses discussed can be found in many of the references noted. Because twice-yearly physical examinations are the cornerstone of modern veterinary medicine, we will discuss how clinicians can incorporate a preventive care program into their practice to decrease zoonotic risks (Figure 1).

Zoonotic threats

Roundworms. *Toxocara canis* and *T. cati* are common nematode (roundworm) parasites of dogs and cats, respectively, although they are not truly species-specific (Figure 2, page 40 and Figure 6, page 42). Most puppies are born with *T. canis* infections or are infected shortly after birth.³ Both transplacental and transmammary infections occur. The prepatent period is two to four weeks; therefore, puppies potentially have patent infections by 2 weeks of age. Thus, every puppy should be dewormed at 2, 4, 6 and 8 weeks of age. Kittens are only infected via the transmammary route, and common practice in the past was to start deworming at 6 weeks of age. However, the American Association of Feline Practitioners (AAFP) Guidelines recommend deworming kittens at 3, 5, 7 and 9 weeks of age⁴ and recent studies have confirmed infections in kittens younger than 4 weeks of age.^{5,6} Strategic deworming of bitches and queens is also critical to breaking the cycle of transmission. Shedding of the eggs into the environment passes the worms to other dogs as well as

people via the fecal-oral route, and there is evidence that direct contact with dogs having *Toxocara* eggs stuck in their fur is also a significant source of infection.⁷

In most parts of the country, 5 to 15 percent of 5 to 15-year-old children are seropositive for *Toxocara*, which indicates asymptomatic infection.⁸ There is wide variation in seroprevalence depending on geographic and socioeconomic factors.⁸ Very few of these infections cause overt clinical signs. However, damage can occur from migrating larvae, and the results can be devastating for the patient. The damage is caused by migration of the larvae through the internal organs (visceral larval migrans), eye or retina (ocular larval migrans) or nervous system (NLM). The raccoon roundworm, *Baylisascaris procyonis*, is more likely to cause debilitating or deadly NLM and is a serious concern since it has been shown to mature in domestic dogs.⁹

Environmental contamination is thought to be responsible for most human toxocarosis cases. The veterinary community has the responsibility to decrease the number of Pets carrying these parasites and shedding their eggs into the environment. Educating owners about reducing reinfection with monthly anthelmintics, such as ivermectin-pyrantel or milbemycin oxime, is also the veterinary team's responsibility.

Hookworms. *Ancylostoma caninum* and *Uncinaria stenocephala* cause blood-loss anemia in canine and feline hosts.⁸ They also cause "creeping eruptions" in people as larvae migrate through the skin, causing cutaneous larval migrans. Traditionally, human infections caused by hookworms were considered a nuisance more than a dangerous zoonotic disease. However, *A. caninum* has recently been associated with a form of human eosinophilic enteritis

caused by transiently patent infections in the gastrointestinal tract. Clinical signs are vague, manifesting in abdominal pain, distension, diarrhea and weight loss discomfort and are likely to be confused with those of other gastrointestinal diseases.^{8,10}

Tapeworms. Tapeworms of the family Taeniidae include *Echinococcus* and *Taenia* genera and are the most important zoonotic tapeworms. *Echinococcus granulosus* and *E. multilocularis* are the agents of hydatid disease. In the definitive host, the parasites are small, three-segment tapeworms 2 to 7 mm in length, but in the intermediate host the larvae transform into a fluid-filled, tumor-like metacestode called a hydatid cyst. The cysts can form anywhere in the body, but damage tends to be most severe when organ function is affected or the central nervous system is involved. *E. granulosus* has a thicker cyst wall than *E. multilocularis*, and the lesions tend to be less invasive, but damage can still occur from impingement on normal tissues or anaphylactic reactions to materials from leaking cysts.

E. multilocularis causes alveolar echinococcosis. The distribution of this parasite is currently expanding and has a large endemic focus in central North America. These cysts tend to be invasive, tumor-like and difficult to remove. Fatality rates in untreated people are greater than 90 percent.¹¹ *E. multilocularis* has been found in cats in North America, but not in dogs, even though dogs do show serologic evidence of infection.¹²

Three other North American taeniid species can also form intermediate stages of clinical significance in people. Most Taeniids form cysticercus larvae consisting of a single bladder and single invaginated scolex. However, *Taenia serialis* and *T. multiceps* form larger cysts with multiple scolices, and *T. crassiceps* forms large

Figure 2

**Transmission of *Toxocara canis*.**

Toxocara eggs are shed in the feces of an infected dog and can then be ingested by other hosts, including people. Pets may also become infected by eating other infected animals, such as rodents. Aside from the larvae that develop in the intestines, some larvae may migrate to other organs and encyst as arrested infective larvae, which can become reactivated. In pregnant dogs, the larvae can be transmitted across the placenta to a developing fetus or through the mammary glands to nursing puppies.

Figure 3



Life cycle of *Dipylidium caninum*. An infected human or animal sheds gravid proglottids containing egg sacs, which are then ingested by larval fleas. These egg sacs develop into infective cysticercooids in the adult flea. People, usually children, or Pets may become infected by ingesting the infected fleas.

Figure 4



***Giardia* cysts.** These are shed in the feces of an infected animal. Pets and people may ingest the cysts—which become infective shortly after being expelled—either from direct contact with the fecal material or from contaminated food or water.

Figure 5



Life cycle of *Toxoplasma gondii*. While cats are the only known definitive host for the parasite, people and other animals can contract the disease. Oocytes expelled in fecal matter can survive in the environment for months and after sporulation into tachyzoites can become infective. Any warm-blooded mammal that ingests tachyzoites in fecal material or eats undercooked meat containing *Toxoplasma* cysts may become infected. Cats can contract the disease by eating infected meat or by coming into contact with tachyzoites in the environment.

clusters of cysticerci in localized sites. The most significant feature of zoonotic taeniid infections is that the eggs are infective when shed from the definitive host.¹⁵

The flea tapeworm *Dipylidium caninum* (Figure 3, page 40 and Figure 7, page 42), the dwarf tapeworm, *Hymenolepis nana*, and the rodent tapeworm, *Hymenolepis diminuta*, can infect people.¹⁴ The first two are the more frequent and clinically significant and are reported as causing gastrointestinal distress in children with large worm burdens. *D. caninum* is maintained when cats and dogs ingest the larval stages in fleas; exposure to *H. nana* is from direct contact with eggs shed by infected Pet rodents or people.⁸

Heartworm. *Dirofilaria immitis* is a nematode parasite infecting the right side of the heart and associated pulmonary vessels. Transmission is via mosquitoes carrying the infective L3 stage obtained from patently infected hosts. In the new susceptible host, the L3 larvae then develop into the adult stage. Canids are considered the natural host for heartworm disease, but the infection has been found in more than 30 species of animals, including cats and people.

Clinical signs depend on the dog's size, age of infection and worm burden. Infections can primarily affect the heart and lungs or be more severe and affect the liver, kidneys and other important organs. Virtually 100 percent of dogs bitten by an infected mosquito will develop viable adult worms after six to seven months of larval development. In cats, the infection tends to be more limited with up to 12 worms, but more typically one or two. If present, microfilaremia in cats is only transient, and, therefore, they are not likely to be an important reservoir species. However, clinical infection in cats can be more devastating, and even a single worm can result in sudden death.

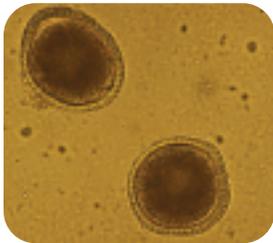
D. immitis has not traditionally been

thought of as a zoonotic agent but has been found in human pulmonary masses. Although people are not natural hosts for heartworms, a few are susceptible enough for larvae to grow and migrate to the arteries. The granulomatous reaction to living and dying larvae can cause pulmonary masses, which can resemble neoplasia on radiographs and cause respiratory signs. Diagnosis is usually made after surgical removal of the masses and histopathologic exam.^{15,16}

Protozoa. *Giardia* species are organisms whose infective cysts are ubiquitous in the environment and that infect both people and companion animals (Figure 4, page 40 and Figure 8, page 42). They are flagellate protozoa that cause significant gastrointestinal distress in many vertebrates. The most prevalent strain is *Giardia duodenalis*, of which there are several strains that may be more host-adapted but are still transferable. The diarrhea symptomatic of infection results from the attachment of the organism's trophozoite stage to the intestinal villi. Malabsorption is the clinical result, and the infection can wax and wane. It is recommended to treat asymptomatic dogs and cats because of the potential for transmission to family members. The *Giardia* vaccine has been shown to reduce shedding of cysts in vaccinated Pets, thus decreasing environmental contamination and disease transmission.^{17,18}

Toxoplasmosis is caused by the single-celled parasite *Toxoplasma gondii*, which affects both cats and people (Figure 5, page 40). Whereas cats are the definitive host for this parasite, most human infections originate from environmental contamination or consumption of undercooked meat containing infective cysts. It is a highly prevalent infection, with estimates that 30 to 40

Figure 6



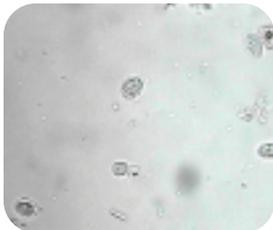
Roundworm egg—Large, round to slightly oval egg, with thick shell, containing a large unstructured center, surrounded by a thin colorless space.

Figure 7



Tapeworm—Oval-shaped egg packets containing five to 20 individual round eggs.

Figure 8



Giardia cyst—Small thin-shelled cyst with a sectioned center and refractile wall.

percent of adult humans in the world are seropositive—which would indicate previous or current infection.⁸ Of infected people and cats, very few have clinical signs because their immune systems usually keep the parasite from causing illness. In people, immunocompromised individuals and first-trimester fetuses are at the highest risk for illness due to infection. In cats, most infections occur in Pets less than one year of age since that population is most immunologically naïve, but seronegative cats of all ages that hunt or are fed raw meat are also at risk. Shedding occurs for two weeks after infection and has been experimentally reactivated by corticosteroid administration, although the doses used were well above typical therapeutic ranges. Feline leukemia virus and feline immunodeficiency virus infection have not been shown to reactivate shedding in seropositive cats.⁵ It is important to educate clients that this disease is preventable and transmission may occur outside of cat ownership. (Please see the CDC website for details.¹⁹)

Bacteria. Leptospirosis is a serious zoonotic disease and is often listed as a cause of acute liver or renal failure in dogs. *Leptospira* organisms can remain in the renal tubules of chronically infected dogs for up to four years, and dogs are considered an important reservoir species. Vaccination reduces the prevalence and severity of this disease but does not prevent the carrier state. This makes it important to reduce overall prevalence with aggressive vaccination programs and to be aware of the potential danger of urine from individuals of all carrier species, regardless of vaccination status. Feline infection has been serologically demonstrated but clinical disease is rare.⁵ The common causative agents of leptospirosis are *Leptospira bratislava*, *L. canicola*, *L.*

grippotyphosa, *L. hardjo*, *L. icterohaemorrhagiae* and *L. pomona*.

Most human infections occur in people involved in water sports or other outdoor recreational activities. Clinical signs range from mild flu-like illness to fulminant hepatic or renal failure.^{20,21} Leptospirosis is another example of a disease caused by an organism that primarily infects both people and Pets via a shared contaminated environment. Human encroachment upon previously wild areas where the primary hosts (opossums, skunks and raccoons) are found is implicated in the increased incidence of infections.²² Nonetheless, the members of the *Leptospira* genera are easily eliminated by ultraviolet light and most disinfectants.

Yersinia pestis and *Y. pseudotuberculosis* are the causative agents of plague. Most people are familiar with the bubonic form of the disease; rodents (primarily rats) are the definitive hosts, and fleas are the vector of transmission. In this case, the portal of entry is a flea bite. However, there is a pneumonic form that primarily affects people and cats, for which transmission may spread via aerosolization or hematogenously.²³ Veterinarians in endemic areas should be familiar with the clinical signs in cats.

Campylobacter jejuni and *C. coli* infect a variety of species. Although many canine and feline infections are asymptomatic, chronic or acute gastroenteritis may occur. Transmission from dogs and cats to people is most likely via fecal-oral contamination. Feeding cats and dogs cooked or irradiated food is the best way to avoid infection with this bacterium.

Fungal infections. Ringworm (dermatophytosis) is a common infection of dogs and cats that has a wide geographic distribution. The common causative species

affecting Pets and people are *Trichophyton mentagrophytes* and *Microsporium canis*. These organisms are ubiquitous in the environment, and it is more common to see clinical signs in immunocompromised animals.

Viral agents. Historically, the most notorious zoonotic virus was the rabies virus. It is a rhabdovirus with several substrains. Vaccination of wildlife populations via oral bait and required vaccinations of Pets have reduced the public health threat, but it has not been eliminated. Certain regions of the world are considered to be rabies-free, and animal import requirements for these areas can be extensive.

At-risk populations

Discussions regarding zoonotic diseases usually emphasize the risk posed by the Pet to susceptible people. It is now evident that veterinary practitioners play an integral role in reducing and protecting both Pet and human populations against zoonotic infections.

Most healthy people and Pets fight off diseases with a minimum of difficulty. Most veterinarians are aware of the factors that increase disease risk for people; however, we rarely think in terms of the factors that increase our Pets' risk for clinical or subclinical infection with zoonotic disease agents. A healthy Pet represents minimal risk for immunosuppressed people, whereas a Pet with a zoonotic disease—or a family environment infested with a vector for zoonotic disease—increases the risk for immunosuppressed and healthy people.

The infections or conditions that can render both Pets and people less resistant to disease are similar:

- Immunosuppressive viruses: human immunodeficiency virus (HIV), FIV, FeLV
- Immunosuppressive drug treatments for autoimmune disease, neoplasia and organ transplants

- Diabetes mellitus
- Cushing's disease
- Chronic disease of any major organ system and associated anxiety and depression.

If it seems awkward to ask questions about the immune status of family members, circumvent it by discussing zoonotic disease in general and letting the family know that your team members is happy to discreetly discuss issues related to immunosuppression. It is important that team members avoid attaching any stigma to an immunosuppressed state. Phrasing can put the client at ease—for example, a team member could ask if any family members are undergoing chemotherapy or are immunosuppressed for any other reason. A good resource is the online publication, “Preventing Infection from Pets: A Guide for People with HIV Infection.”²⁴

In the case of many infectious agents, infection of an animal occurs as a result of a shared vector or environmental exposure. Environments where there is crowding or stress increase the risk of disease. Most veterinarians have encountered persons with large, well-cared-for cat or dog populations, but they have also encountered collectors and have seen the catastrophic health consequences for the Pets. In addition, recent environmental disasters, such as Hurricane Katrina and tsunamis, have reminded us of what happens to the Pet population when an infrastructure is completely destroyed.

Veterinarian-physician roles

One role of the veterinarian is to be a purveyor of knowledge bridging Pet and human health concerns; accordingly, veterinary medicine has been described as being “indirectly, a human health care field, especially in dealing with the companion animal.”²¹ Veterinary medicine has

been referred to as comparative medicine. With our educational background, we are prepared to analyze diseases that affect all species. This is becoming more important as we try to understand the epidemiology of agents that jump from one species to another.

Part of the challenge comes from misunderstandings that occur because of differences in training and focus. It has been said that “most physicians other than infectious disease specialists profess ignorance about prevention and control of zoonoses,”²⁵ and some of us may have experienced resentment towards physicians when our patients are blamed for human pinworm, lice or strep throat. It is best in this circumstance to provide the correct information without irritation—it is our area of expertise, not theirs.

The value of physical examinations

The semiannual examination is the veterinarian’s opportunity to assess both the Pet and family situation. Are the Pets young, middle aged or older? Are there any behavior problems, such as coprophagia or jumping up and licking the faces of family members? Does the Pet eat wildlife or even bring prey into the home? The examination is also a great time to discuss the environment surrounding the home. Although many zoonotic diseases may be subclinical in the household Pet, abnormal physical examination findings may clue the clinician into a potential zoonotic disease. Clients are more likely to follow a doctor’s recommendations when they believe their Pet has received a thorough examination with solid communication. The veterinarian can practice taking this one step further and educate the client about zoonoses.

The value of preventive care

Even though many of the diseases of concern are common-source diseases, veterinarians still bear the responsibility (legal and otherwise) of educating clients about preventive care so the entire family is protected. The veterinary team can achieve this by implementing a preventive care program for Pets that includes strategic deworming, vaccination, nutrition and general sanitation.

As a profession, we do a better job educating clients about heartworm in dogs than heartworm in cats or ferrets. Although dogs are the natural host and the significant reservoir, transient microfilaremia has been induced in cats. Availability of palatable oral ivermectin-pyrantel preparations and topical preparations such as selamectin or moxidectin reduce the stress that many people experience when administering oral medications to cats.

Routine deworming of puppies and kittens is standard practice, but there is a false perception that adult Pets do not carry intestinal nematodes. The Companion Animal Parasite Council (CAPC) offers recommendations for juvenile and adult testing, treatment and prevention. Adult Pets should be on year-round, broad-spectrum heartworm preventives with activity against other zoonotic parasites and may need further testing and treatments, depending on geographic, seasonal and lifestyle factors.²⁶ Many clients are still used to testing and preventing heartworm starting in the spring and do not realize the value of year-round protection. We can most easily re-educate our clients by recommending testing first at 6 to 8 months of age and then every 12 months thereafter.

Routine heartworm preventives cover most nematode parasites, but as a profession

The prepatent period for *Echinococcus* ranges from 28 to 60 days and current recommendations are to use a deworming interval of 21 to 26 days to break the cycle of patent infection and environmental contamination.

we often miss the opportunity to address cestode infections until the owner reports that “Fluffy ate a rabbit” or has “wriggly rice” stuck to her tail. The adult *Echinococcus granulosus* are only 2 to 7 mm long and the *E. multilocularis* average only 2 mm in length, which reinforces the point that visual examination is not a good enough diagnostic test for potentially zoonotic tapeworm disease. The prepatent period for *Echinococcus* ranges from 28 to 60 days and current recommendations are to use a deworming interval of 21 to 26 days to break the cycle of patent infection and environmental contamination. We have yet to put our best foot forward as a profession in this area. Options are limited for affordable, broad-spectrum products that provide monthly treatment for both cestodes and nematodes (including heartworm). It is frustratingly common in my own practice for a client to agree to treatment for cestodes until they see how much the deworming medication costs.

Vaccinations

Using available vaccinations for zoonotic agents (rabies, giardiasis, leptospirosis) is a key part of preventing infection. Although many veterinarians hesitate to administer a leptospirosis vaccine for fear of a vaccine reaction, the reality is that the risk of clinical disease is increasing, and we are remiss to not protect our patients and their families from leptospirosis. The risk of disease is much higher than the risk of anaphylaxis, when comparing statistics.

Nutrition and exercise

Our patients and their families are better off in a multitude of ways with good nutrition. This decade has brought the unveiling of the first Pet foods proven to enhance a Pet's immune response to vaccination.²⁷ Higher-quality or prescription Pet foods can make a difference in the resistance of the household Pet to disease and enhance recovery when illnesses do occur. Fit Pets and people are also more resistant to disease and, therefore, tactfully addressing obesity is also part of our public health responsibility.

Proper grooming, sanitation and training

Even routine education on nail trimming and addressing dental disease would likely reduce the number of irritable cats prone to scratching. Tapeworm segments stuck to perineal fur are more likely to be noticed if the hair around the rectum is not excessively long or matted. Ectoparasites may be more easily seen, and topical ectoparasitides will likely be more effective if a Pet is well groomed.

We need to emphasize sanitation to our clients in addition to strategic deworming to break the life cycle of the parasites. Roundworm eggs are notoriously sticky. Dogs or cats rolling in the yard can pick them up on their fur and reinfect themselves through normal self-grooming activities or transfer them to young children who pet them. Economic realities may prevent families from testing an ill bird, kitten or puppy

for all modes of diseases—fecal cultures and leptospirosis titers are expensive. Basic sanitation and preventive measures will help. In addition to thorough hand washing, sanitation also includes destroying any wildlife nests in or near the home (especially raccoon nests), removing fecal material from the yard and changing litter frequently. It is important that Pets not be allowed to lick people's plates or faces. Also, Pets that are trained to come when called are less likely to ignore a command to stop chasing wildlife or refrain from examining a raccoon latrine.

Conclusion

Veterinary practitioners play an integral role in keeping both Pets and people safe from potential zoonotic diseases. Pet own-

ers expect veterinarians to preserve the human-Pet bond by ensuring that their Pet is healthy. Our knowledge of potential obstacles to this goal, such as zoonotic disease, is critical to overcoming those obstacles. Our biggest opportunities for controlling zoonotic diseases are strategic deworming, vaccination and sanitation, but we can impact the health of Pets and people in other areas. We bear the legal responsibility to educate all of our clients about potential zoonotic diseases without creating unnecessary concern. Taking the time to educate clients about potential zoonotic health risks will only strengthen the bond with their Pet and the veterinary team. The physical examination creates the ideal opportunity to provide this type of education. 

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Suggested reading

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