

Pet-Related Infections

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Physicians and veterinarians have many opportunities to partner in promoting the well-being of people and their pets, especially by addressing zoonotic diseases that may be transmitted between a pet and a human family member. Common cutaneous pet-acquired zoonoses are dermatophytosis (ringworm) and sarcoptic mange (scabies), which are both readily treated. Toxoplasmosis can be acquired from exposure to cat feces, but appropriate hygienic measures can minimize the risk to pregnant women. Persons who work with animals are at increased risk of acquiring bartonellosis (e.g., cat-scratch disease); control of cat fleas is essential to minimize the risk of these infections. People and their pets share a range of tick-borne diseases, and exposure risk can be minimized with use of tick repellent, prompt tick removal, and appropriate tick control measures for pets. Pets such as reptiles, amphibians, and backyard poultry pose a risk of transmitting *Salmonella* species and are becoming more popular. Personal hygiene after interacting with these pets is crucial to prevent *Salmonella* infections. Leptospirosis is more often acquired from wildlife than infected dogs, but at-risk dogs can be protected with vaccination. The clinical history in the primary care office should routinely include questions about pets and occupational or other exposure to pet animals. Control and prevention of zoonoses are best achieved by enhancing communication between physicians and veterinarians to ensure patients know the risks of and how to prevent zoonoses in themselves, their pets, and other people. (*Am Fam Physician*. 2016;94(10):794-802. Copyright © 2016 American Academy of Family Physicians.)



► See related editorial at <http://www.aafp.org/afp/2016/0301/p344.html>.

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Many households in the United States have one or more species of pet animal. The most popular pets are dogs and cats, but rabbits and backyard poultry are increasingly common in domestic settings, and a wide range of reptiles and other “exotic” species are entering our homes. Pets bring enormous social and health-related benefits to people,¹ but they can also transmit disease. Physicians and veterinarians have the opportunity to collaborate in their interactions with patients and pets to optimize health for all.

One area in which physicians and veterinarians are able to readily work together is in addressing infectious diseases that can be transmitted between animals and humans (zoonoses). These diseases can be spread directly, through contact with infected animals; indirectly, through contact with contamination in the animal’s environment; or via the vector-borne route (involving

transmission by arthropods such as ticks, fleas, flies, or mosquitoes). Often, the clinical disease affects both the person and the pet, but sometimes the pet may appear healthy only to have a subclinical infection or colonization that can lead to illness in a person. Testing of human or animal patients should not be delayed when clinical presentation suggests a zoonosis.

Zoonotic diseases have recently been reviewed² by the One Health Committee of the World Small Animal Veterinary Association (<http://www.wsava.org/educational/one-health-committee>), and further information on many of the diseases is available from the Centers for Disease Control and Prevention (<http://www.cdc.gov/nceid/>).

The term “One Health” has been used to describe a collaborative effort among veterinarians, physicians, other health care professionals, and scientists to address the well-being of humans, domestic and wild animals, and their shared environment.^{3,4} In

SORT: KEY RECOMMENDATIONS FOR PRACTICE

Clinical recommendation	Evidence rating	References
Pets bring enormous social and health-related benefits to their human families.	C	1
Physicians and veterinarians should take advantage of opportunities to collaborate to improve the health of people and their pets.	C	5
The clinical history should routinely include questions about whether the family keeps pets or has any other exposure to animals.	C	5
It is unnecessary for families to rehome pets diagnosed with dermatophytosis (ringworm), scabies, toxoplasmosis, bartonellosis, tick-borne infection, salmonellosis, or leptospirosis if infections are managed appropriately.	C, A for toxoplasmosis	6-13
Reptiles and amphibians are not recommended pets for children younger than five years because of increased risk of <i>Salmonella</i> infection.	C	29-31

A = consistent, good-quality patient-oriented evidence; B = inconsistent or limited-quality patient-oriented evidence; C = consensus, disease-oriented evidence, usual practice, expert opinion, or case series. For information about the SORT evidence rating system, go to <http://www.aafp.org/afpsort>.

a viable One Health partnership, physicians and veterinarians would be known to each other and communicate professionally for the benefit of the families they serve.⁵ For example, a veterinarian diagnosing zoonotic disease in the consultation room might inquire if any in-contact family members are unwell and suggest an appointment with their physician's health center, or the veterinarian might offer to make direct contact with the family physician. Similarly, physicians might ask their patients whether they have pets or pet contact, explore whether any presenting symptoms reflect a zoonotic disease, and evaluate the risks that keeping pets may pose for patients who are very young, very old, immunocompromised, or pregnant. The aim of this article is to provide examples of pet-related zoonotic diseases, correct misconceptions about whether some common human diseases are actually zoonotic, and outline the disease risks associated with popular pets. Pets diagnosed with the diseases described in this article do not need to be rehomed if infections are properly managed.⁶⁻¹³

Is My Patient's Infection Pet Related?

DERMATOPHYTOSIS

Dermatophytosis (ringworm) is caused by a number of skin fungi and can infect both humans and animals¹⁴ (Figure 1). Sources of infection include humans, domestic animals, wildlife (primarily rabbits and rodents), and soil. Dogs or cats may show clinical signs or be sub-clinical carriers of the most common zoonotic species, *Microsporum canis*, and act as a source of infection for other dogs, cats, or humans.^{6,15} Some people are more susceptible to dermatophytosis because of genetic factors, preexisting skin disease (e.g., allergic dermatitis), or an immunocompromised state.



Figure 1. (A) Dermatophytosis in a Jack Russell terrier showing erythema, alopecia, and crusting (circled). (B) Dermatophytosis lesion on the arm of a veterinary student.

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Table 1. Infections That Can Be Acquired by Direct Contact with Pets

Infection	Affected pets	Symptoms in humans	Clinical signs in animals
Dermatophytosis (ringworm [e.g., <i>Microsporum canis</i> , <i>Trichophyton mentagrophytes</i>])	Dogs, cats, rabbits, or rodents	Ring-like, red, scaly lesions	Well-demarcated hair loss with variable itchiness, redness, scale, and scabs
Scabies (sarcoptic mange; <i>Sarcoptes scabiei</i> var <i>canis</i>)	Dogs	Small, itchy papules that are often excoriated; papules more common in areas of contact (i.e., chest, abdomen, thighs, and forearms) Lesions are self-limited, usually persisting for no more than a few days after successful treatment of pets	Usually intensely itchy Hair loss, papules, inflammation, crusts, and excoriations High-incidence areas are the ventral abdomen and chest, ear pinnae (especially pinnal margins), face, elbows, hocks, and feet With chronicity, the problem can become generalized

Pets with dermatophytosis do not need to be rehomed,¹⁵ but physicians should refer pet owners to their veterinarian to develop the best management plan, particularly if any family member is immunocompromised (Table 1).

SCABIES

There is often anguish and some degree of disgust associated with having a dog that has received a scabies diagnosis (sarcoptic mange; *Sarcoptes scabiei* var *canis*¹⁶; Figure 2). The scabies mite is highly communicable among dogs and may infest humans, but cats are relatively resistant. Persons in contact with an infested dog may be variably affected, and they are only transient hosts for the mites unless there are repeated exposures.¹⁷ Mites may persist without a host for two to 21 days, but there is a lesser chance of contracting the infestation from the surrounding environment or fomites than from direct contact with an infested pet.¹⁸ If a dog has scabies, it does not need to be rehomed, and there are many effective treatments available from a veterinarian⁷ (Table 1). The related feline mite *Notoedres cati* may rarely spread to in-contact humans and cause a pruritic rash, but the infection is self-limited. Scabies in people is more commonly caused by the human itch mite (*S. scabiei* var *hominis*), which is transmitted by direct person-to-person contact. The human itch mite does not infect pets.

HEAD LICE

Lice from pets do not infest people, and human lice do not infest pets or other animals. Only humans can acquire



Figure 2. (A) Scabies in a dog showing hair loss, papules, excoriations, and inflammation of the lateral elbows and extremities. (B) Scabies on the arm of a veterinarian. The lesion developed after contact with an infected dog. Note the characteristic linear tract of mite migration.

Control measures when diagnosed

Lesions in humans generally respond to topical application of antifungal drugs; appropriate systemic medical therapy is required for the pet. Fungal culture of all resident dogs and cats should be performed to assess for carrier status and to separate infected from noninfected animals. Thorough cleaning of the environment and bedding with soap and water followed by application of appropriate disinfectants is recommended. Isolation of infected animals to areas with minimal carpeting and upholstery is ideal. Hands should be washed thoroughly after handling infected or carrier animals and contaminated bedding. Immunocompromised persons should avoid contact with infected dogs or cats and their bedding.

All in-contact dogs should be treated simultaneously, including dogs with no signs because subclinical carriers are possible; response to therapy is usually rapid, with significant improvement within one to two weeks and cures in four to six weeks.

Affected dogs should not be allowed access to other dogs (e.g., dog parks, dog day care centers, grooming parlors) until they are cured.

To minimize environmental sources of the mites, bedding should be discarded or washed and dried at the highest setting possible and areas frequented by the dog (or dogs) should be thoroughly vacuumed; environmental therapy (flea therapies suffice) is only occasionally warranted (i.e., with very large numbers of mites or mites on multiple dogs).

and spread human head lice (*Pediculus humanus capitis*), typically through head-to-head contact as occurs during play at school, home, sports activities, playgrounds, and camps. They are less commonly spread by contact with clothing (e.g., hats, scarves, coats) or other personal items (e.g., combs, brushes, towels).^{19,20}

PINWORM

Human pinworms (*Enterobius vermicularis*) do not come from pets or other animals, but are intestinal parasitic worms specific to human hosts.^{21,22} Human pinworm infection can affect persons of all ages and socioeconomic levels, but most commonly occurs in school-aged and preschool-aged children, persons who are institutionalized, and household members and caretakers of patients with pinworm infection. Dogs and cats do not get pinworm infestations, but rabbits may be affected by a species (*Passalurus ambiguus*) that is not transmissible to humans.²³

Which Diseases Could Pet Owners Acquire from Their Pets?**TOXOPLASMOSIS**

A common concern for pregnant women is the risk of toxoplasmosis. Because cats are the primary host of *Toxoplasma gondii*, pregnant women are often concerned about whether they can be infected by their pet cats.

T. gondii is a ubiquitous parasite that completes its life cycle in the intestine of cats. Oocysts that pass in cat feces can contaminate soil, drinking water, and foods such as vegetables, and can initiate infection of humans

and other animals if ingested.⁸ Eating undercooked meat is another common route of infection.²⁴

If *T. gondii* is acquired during pregnancy and transmitted to the fetus, damage to the fetal central nervous system and eyes can occur. Humans usually do not acquire toxoplasmosis from their pet cats because large numbers of oocysts are shed only once, for less than three weeks, and because most cats groom feces from fur before oocysts become infective.^{9,25}

The application of control measures discussed in Table 2 makes it unnecessary to rehome a pet cat during pregnancy.

BARTONELLOSIS

Although other infectious agents can be transmitted via cat scratch, a major concern is transmission of bacteria of one of the *Bartonella* species. Cat fleas (*Ctenocephalides felis*) have a role in the transmission of several *Bartonella* species among cats, dogs, and other small mammals.¹⁰ Cats can be chronically bacteremic for months to years after flea transmission, making flea-exposed cats a major reservoir for human infection.

The bacterium can remain viable in flea feces in the environment (i.e., the cat's fur) for at least 15 days. While grooming, flea-infested cats contaminate their claws and saliva with *Bartonella*-infected flea feces.

Bartonella henselae causes cat-scratch disease in humans (Figure 3). Veterinary workers and persons with occupational animal contact or arthropod exposure are at increased risk of acquiring *Bartonella* infections.²⁶ It is important for physicians to ask patients about

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Table 2. Pet-Related Infections

Infection	How can it be acquired from a pet?	What are the consequences of infection?
Toxoplasmosis (<i>Toxoplasma gondii</i>)	Exposure to cat feces containing oocysts that contaminate soil, water, or vegetables; eating undercooked meat may be more important route, depending on culture and country	Damage to the fetal central nervous system and eyes in pregnant women Risk of clinical toxoplasmosis is greater in immunocompromised persons
Bartonellosis (e.g., cat-scratch disease [<i>Bartonella henselae</i>]; other <i>Bartonella</i> species that occur in humans and pets include <i>B. quintana</i> , <i>B. vinsonii</i> subsp <i>berkhoffii</i> , and <i>B. koehlerae</i>)	Inoculation by cat claws contaminated by flea feces or contamination of a wound by flea feces	Fever and enlarged lymph nodes days to weeks after a cat scratch Rare, atypical, and more chronic manifestations suspected to be associated with <i>Bartonella</i> infection include tonsillitis, encephalitis, cerebral arteritis, transverse myelitis, granulomatous hepatitis/splenitis, osteomyelitis, pneumonia, pleural effusion, arthritis, and thrombocytopenic purpura
Tick-borne infections (e.g., anaplasmosis [<i>Anaplasma phagocytophilum</i>], ehrlichiosis [<i>Ehrlichia</i> species], Rocky Mountain spotted fever [<i>Rickettsia rickettsii</i>], bartonellosis [<i>Bartonella</i> species], borreliosis [<i>Borrelia</i> species; e.g., Lyme arthritis])	Via a tick feeding on an infected pet and subsequently on a human; pets act as reservoirs of infection For some infections (e.g., rickettsiosis, borreliosis) pets can act as sentinels for human disease	Wide range of clinical illnesses of varying severity; infections may be challenging to diagnose
Salmonellosis (<i>Salmonella</i> species)	Contact with reptiles and amphibians or their environment	Diarrhea (may be bloody), vomiting, fever, and abdominal cramps are possible Health care professionals should consider contact with reptiles, amphibians, poultry, and other animals to be a possible source of salmonellosis and should collect patient stool specimens for culture testing when appropriate
Salmonellosis (<i>Salmonella</i> species), <i>Campylobacter</i> species, chlamydiosis (<i>Chlamydia</i> species), mycobacteriosis (<i>Mycobacterium</i> species), influenza virus, equine encephalitis virus, West Nile virus, and others	Contact with backyard poultry or their environment	Wide range of clinical disease depending on the infectious agent (e.g., enteric, respiratory, or neurologic disease) For <i>Salmonella</i> and <i>Campylobacter</i> , diarrhea (may be bloody), vomiting, fever, and abdominal cramps are possible
Leptospirosis (<i>Leptospira</i> species)	Contact with urine from an infected animal (dogs and wildlife, especially rodents) or contaminated water	Fever, chills, muscle aches, headaches, nausea and vomiting, cough, loss of appetite Weil disease, a more severe form of leptospirosis that may involve the liver, kidney, heart, lungs, or brain, develops in approximately 10% of patients

How can this infection be avoided?

Have a nonpregnant family member clean the cat's litter box or use gloves when cleaning cat litter; litter boxes should be cleaned regularly
 Keep cats indoors and prevent them from hunting; feed them commercial diets or well-cooked meat
 Avoid eating inadequately processed or undercooked meat or cross-contaminating raw meat and ready-to-eat products
 Wash hands thoroughly after gardening; avoid drinking untreated water

Control of cat fleas on the cat and in the environment using appropriate flea-control products
 Avoid interacting with pets in a way that is likely to result in being scratched (may require education of family members in appropriate interaction to minimize the risk of bites or scratches)

Use of appropriate tick control products on dogs and cats prevents them from developing these infections and prevents transport of ticks into the home environment

Family members should avoid tick habitats (e.g., high grass, brush, woodlines), use a tick repellent, perform frequent tick checks, and promptly remove ticks using an appropriate tick remover; ticks should not be removed by hand because there is a risk of exposure to infected blood within the tick

Children younger than five years, immunocompromised persons, and older adults should not touch amphibians, reptiles, or their environment
 Hands should be washed thoroughly after handling reptiles, amphibians, and anything in the area where these animals live, including their food or equipment

Reptiles and amphibians and their equipment should be kept out of kitchens or anywhere food is prepared, served, or consumed

Food-preparation areas should never be used to clean reptile or amphibian habitats or anything in their habitats, and such items should be cleaned outside of the home when possible; if habitats are cleaned in the bathroom, it is important to thoroughly clean and disinfect the area after to prevent cross-contamination

Food for these pets, including frozen or live rodents, equipment, and materials (including tank water) can be contaminated with *Salmonella* and other microorganisms

Never kiss or snuggle with reptiles and amphibians because this increases the risk of *Salmonella* infection

Reptiles and amphibians are not recommended pets for children younger than five years, including in household or school settings

Isolating birds from wild species will reduce the potential for infection from organisms such as *Chlamydia*, avian influenza, and West Nile virus; appropriate hygiene, such as regular disinfection of food and water containers, systematic cleaning of the coop and pen, as well as good personal hygiene, will reduce the pathogen load; keeping the flock in ideal health through a regular program of parasite control, health monitoring, and rapid response to illness will reduce the potential for the transmission of disease to owners

Persons should wash hands thoroughly with soap and water right after touching live poultry or anything in the area where poultry live and roam; children younger than five years, immunocompromised persons, and older adults should not handle or touch chicks, ducklings, or other live poultry

Live poultry should not be kept in the house or in bathrooms, and especially not in areas where food or drink is prepared, served, or stored, such as kitchens and outdoor patios; any equipment or materials associated with raising or caring for live poultry, such as cages or feed or water containers, should not be cleaned inside the house

Persons, especially young children, should not snuggle or kiss live poultry, touch their own mouths after handling live poultry, or eat or drink around live poultry; live poultry are not recommended for children younger than five years, including in household or school settings

Avoid contact with urine of an infected pet, use routine household disinfectants to clean areas of urine contamination, and wash hands after handling an infected pet

Infected dogs should be walked to urinate in areas that are not close to bodies of water or frequented by family members until antibiotic treatment is completed

Repeat infection with *Leptospira* can occur; if the source of the primary infection is known, it should be avoided

Dogs that are vaccinated against the four most common *Leptospira* serovars are less likely to shed organisms if infected

Contact of dogs with standing water should be minimized when possible

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occupational and lifestyle exposure to fleas and cats and to consider the potential role of zoonotic infections in patients with chronic symptoms affecting the joints and the neurologic and vascular systems.²⁷ Prevention of flea infestation of pets is key to preventing these diseases (Table 2).

TICK-BORNE INFECTIONS

Ticks are one of the most important vectors for transmission of infectious agents to people and their pets. Ticks can transmit bacteria, protozoa, rickettsiae, and viruses to pets and humans within the same household.²⁸ In most cases, an infected pet is unlikely to transmit tick-borne infectious agents to humans because pets and humans are both accidental hosts. Transmission of tick-borne agents generally occurs when the tick obtains a blood meal from an animal or human.

Tick species vary in geographic distribution (<http://www.cpcvet.org/parasite-prevalence-maps/>), and different tick species preferentially transmit different pathogens. Pets and humans can be sequentially or simultaneously infested with more than one tick species, and a single tick can transmit more than one organism, leading to coinfection in the tick-infested host.

Pets can be persistently infected (for months to years) with tick-borne zoonotic pathogens and serve as reservoir hosts.¹¹ If a previously infected tick or a tick that acquires an infection from a pet detaches before ingesting a complete blood meal, the tick could subsequently transmit the agent after reattaching to a human. This is a rare event because most attached ticks feed to repletion before detaching, laying eggs, and dying. Pets can also serve as a transport host by carrying ticks from the outdoor environment into the house, where the tick could drop off of the pet and attach to a human. Environmental acquisition of tick-borne disease is more likely than acquisition from a pet. Control measures to prevent tick-borne infection, such as regular use of an ectoparasite control product for pets, are discussed in Table 2.

SALMONELLOSIS FROM REPTILES AND AMPHIBIANS

Reptiles (e.g., turtles, snakes, lizards) and amphibians (e.g., frogs, toads, salamanders) often carry *Salmonella* bacteria, and the areas where they live can also become contaminated with these bacteria. Contact with contaminated water can lead to illness in humans²⁹⁻³¹ (Table 2).

Children younger than five years, persons who are immunocompromised, and older adults are at a higher risk of illness from *Salmonella*. *Salmonella* may spread from the intestine to the bloodstream and then to other body sites, resulting in serious illness or death unless the



Figure 3. Cat-scratch disease in a human. (A) Papule at the site of cat scratch. (B) Axillary lymphadenopathy.

person is treated promptly with antibiotics. Young children are at increased risk of *Salmonella* infection because their immune systems are still developing and because they are more likely to put their fingers or other items into their mouths. Therefore, reptiles and amphibians are not recommended pets for children younger than five years.²⁹⁻³¹

Salmonellosis should be considered in the differential diagnosis for patients with diarrhea and fever who report a history of reptile or amphibian contact. Physicians and other clinicians should refer patients who own reptiles or amphibians to their veterinarian for advice on appropriate husbandry that will minimize the risk of salmonellosis.

DISEASE RISKS FROM BACKYARD POULTRY

An increasing number of persons keep poultry (e.g., chickens, ducks) as part of a greener, healthier lifestyle

or for economic or cultural reasons. Although they provide benefits, backyard poultry carry the risk of illness, especially for children. Disease can result from handling these birds or anything in the areas where they live and roam. Among the birds kept as pets, chickens pose one of the greatest risks of transmitting disease to their owners compared with other bird species, such as parakeets or canaries.^{32,33} Salmonellosis is the most common zoonotic disease associated with owning backyard chickens.³⁴ Live poultry infected with *Salmonella* typically appear healthy, but they shed the bacteria intermittently. Other zoonoses that may be spread between humans and poultry are listed in *Table 2*.

Appropriate preventive measures should be taken to minimize disease transmission to humans³⁵ (*Table 2*). Physicians should be alert to the possibility of zoonotic disease introduced by a flock of backyard chickens and educate patients on the risks when applicable.

LEPTOSPIROSIS

Multiple *Leptospira* species can infect dogs, cats, or humans.³⁶ Prevalence rates vary by geographic region, and numerous wildlife reservoirs exist for the bacteria. The organisms are shed in urine, and infection is initiated after exposure to contaminated water. Alternatively, *Leptospira* infections can occur by direct penetration of intact skin following contact with infected urine, blood, or tissue. Clinical manifestations vary depending on the bacterial strain and mammalian species infected (*Table 2*).

Infections in the owners of dogs that have been diagnosed with leptospirosis and are undergoing treatment are uncommon, and human leptospirosis is most often acquired from environmental or wildlife exposure.^{12,13} However, the owner should consult his or her physician and veterinarian for advice about minimizing the risk of infection, particularly if a family member is immunocompromised. Persons who work with animals have a greater risk of contracting leptospirosis.

This review updates a previous article on this topic by Rabinowitz, et al.³⁷

Data Sources: A literature search was conducted using the Thompson Reuters Web of Science and the search terms zoonosis and dog, zoonosis and cat, zoonosis and reptile, and zoonosis and poultry. Additionally, the individual disease-related sections of the manuscript were critically reviewed by eight internationally recognized specialists (named below) who also recommended relevant reference material. Search date: February 1, 2016.

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