

[Companion Animals and Human Health: Part II -- Zoonotic Diseases](#)

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CME/CE

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### Introduction: "One Medicine"

This is the second installment of a series of articles dealing with the risk to human health from companion animals (pets). This relationship between diseases of lower animals and mankind is most often described as zoonotic disease. "Zoonoses are diseases the agents of which are transmitted between vertebrate animals and people."<sup>[1]</sup> In excess of 100 diseases of humans have been classified as infectious to the great apes, including:

- Polio;
- Common cold;
- Influenza;
- Measles;
- Tuberculosis;
- Rubella; and
- Hepatitis A and B.

More than 800 diseases are transmissible from animals to humans, including:<sup>[2]</sup>

- Ebola;
- Leptospirosis;
- Brucellosis;
- Rabies;

- Monkeypox; and
- Anthrax.

It is at this interface of animal and human disease interchange that the concept of "One Medicine" comes to the forefront.<sup>[2]</sup> "One Medicine" is a term encompassing veterinarians, physicians, and other healthcare professionals who provide for the health of the human and the animal and often the economic well-being of the human. A perfect example of the need for "One Medicine" is the current outbreak of the highly pathogenic avian influenza (HPAI) virus in chickens in Asia and Africa.<sup>[3]</sup> When transmitted to humans, this disease has a high mortality rate, but it has an even higher mortality rate in domestic poultry. The estimated \$10 billion economic loss to the poultry industry impacts the economic well-being of the countries affected.

The "One Medicine" focus of this article is to discuss 6 of the 11 diseases listed in the following [Table 1](#) : *Salmonella*, *Campylobacter*, dermatophytes, mange, plague, and cat-scratch disease. Veterinarians, physicians, and other healthcare professionals should appreciate the zoonotic implications of these diseases and consider them in the treatment of their patients - - be they human or other animals.

### Salmonella

#### Epidemiology

There are almost 2000 serotypes of the *Salmonella* genus found in the environment, wild and domestic animals, and humans. Normally associated with contaminated food, the disease is often transmitted via hand-to-mouth contact from either ill or asymptomatic individuals or animals, their bedding, surfaces they have contaminated, or water they have contaminated. A number of species kept as pets have been associated with human *Salmonella* infections.<sup>[4]</sup>

**Turtle.** The frequency of salmonellosis associated with baby turtles sold as pets led the US Food and Drug Administration (FDA) to ban the sale of pet turtles with shells less than 4

inches long beginning in 1975. Recently, the FDA issued a press release re-emphasizing the risk presented by pet turtles to their owners after a 4-week-old Florida infant died of an infection caused by *Salmonella pomona*.<sup>[5]</sup> The organism was also found in a pet turtle in the infant's home. Other reptile pets and *Salmonella* organisms frequently associated with them are:<sup>[6]</sup>

- Iguanas -- *Salmonella marina*; and
- Turtles and lizards -- *Salmonella java* and *Salmonella poona*.

**Baby chicks.** A recent Centers for Disease Control and Prevention (CDC) publication cited the ongoing problem of human *Salmonella* outbreaks associated with the sale of baby chicks to the public in agricultural feed stores.<sup>[7]</sup> Purchasers are generally unaware of the potential for these chicks to be *Salmonella* carriers and do not take adequate hygiene precautions to prevent fecal-oral transmission. While these chicks are cute and are sometimes purchased as pets, they pose a significant risk for *Salmonella* infections.

**Rodents.** In 2004, hamsters, mice, and rats (sold both as pets and to feed snakes) were found to be infected with multidrug-resistant *Salmonella typhimurium* in a multistate outbreak associated with a number of pet rodent breeders.<sup>[8]</sup> It was determined that a number of the breeders were routinely providing antibiotics for nonspecific rodent enteritis either through feed or water. Cases occurred in 10 states and involved 17 humans.

**Dogs and cats.** Dogs and cats with clinical infection may exhibit:

- Gastroenteritis;
- Bacteremia; and
- Enterotoxemia.

They may serve as asymptomatic carriers and have contaminated:

- Fur;

- Fecal material; and
- Saliva.

Dogs and cats may become infected through contact with wild rodents or through contaminated diet or treats provided by humans.<sup>[9]</sup> The current trend for "natural diets" has led some owners to provide their dogs with a "bones and raw food diet (BARF)." The diet often consists of whole raw chicken mixed with vegetables. A recent study found that 80% of dogs fed this diet shed *Salmonella* in their stool.<sup>[10]</sup> Another source of *Salmonella* for dogs and, subsequently, human infections has been processed pig ear treats.<sup>[11]</sup>

## Incidence

The CDC estimates that there are 40,000 cases of salmonellosis in the United States every year, but there is major underreporting because many of the milder cases are not identified or reported.<sup>[12]</sup> They also estimate that 600 individuals die yearly.

## Pathology and Symptoms

Ingested *Salmonella* organisms enter the gastrointestinal tract, access the bloodstream via the lymphatic channels, and cause:

- Diarrhea;
- Fever; and
- Abdominal cramps.

## Diagnosis

Diagnosis is made from isolation of *Salmonella* organisms in cultures from:<sup>[13]</sup>

- Feces;
- Blood;
- Urine;
- Pus; and
- Vomitus.

## Treatment

*Salmonella* infections normally resolve without treatment in 5 to 7 days. Patients with severe diarrhea may require intravenous (IV) fluids. Antibiotics:

- Do not shorten the duration of symptoms;
- May prolong the duration of bacterial carriage; and
- Are not routinely used to treat uncomplicated nontyphoidal *Salmonella* gastroenteritis.

If the infection spreads from the intestines, it can be treated with.<sup>[14]</sup>

- Ampicillin;
- Gentamicin;
- Trimethoprim/sulfamethoxazole; or
- Ciprofloxacin.

## Prevention

Prevention of companion animal-associated *Salmonella* infections is based primarily on good hygiene practices. Good hand-washing is essential after handling the animal, its housing, and the bedding of cage-raised animals. A number of different Internet sites and publications are available to assist the pet owner in preventing *Salmonella*, *Campylobacter*, or other intestinal infections. The CDC Web site has excellent instructions on how to maintain a reptile pet in the home safely. These same instructions can be used for other cage-confined animals.<sup>[15]</sup>

## *Campylobacter*

### Epidemiology

A number of *Campylobacter* species have been associated with human illness, but *Campylobacter jejuni* is the most common cause of bacterial diarrhea worldwide. *Campylobacter*

*fetus*, *Campylobacter coli*, *Campylobacter sputorum*, *Campylobacter concisus*, *Campylobacter curvus*, and *Campylobacter retus* have also been linked to human diseases. Large outbreaks have been associated with contaminated foods, especially unpasteurized or underpasteurized milk.<sup>[16]</sup> However, most cases are sporadic in occurrence.

Studies have shown up to 21% of cats and 29% of dogs with diarrhea were positive for *Campylobacter*, while only 4% of healthy dogs and cats were positive.<sup>[9]</sup> Studies of puppies have reported the range of *Campylobacter* shedding to be from 5% to 90%. Most clinical cases are in animals less than 6 months of age. *Campylobacter* is found at higher rates in stray or shelter animals than those in households.

Most *Campylobacter* cases from pets to humans have been epidemiologically linked. In one instance, a 3-week-old infant became clinically ill 6 days after a new puppy was introduced into the household.<sup>[17]</sup> The infant's blood was culture positive for *C jejuni*. Cultures of the puppy and its littermates (in a separate household) were also positive for *C jejuni*. The isolates from the infant and puppies were genetically the same.

### Symptoms

Symptoms from *Campylobacter* include:

- Watery or bloody diarrhea;
- Fever;
- Abdominal cramps; and
- Nausea and vomiting.

Guillain-Barré syndrome is a rare complication developing approximately 2 weeks after the initial illness.<sup>[18]</sup>

### Diagnosis

Stool culture should be obtained along with blood cultures in patients with signs of focal infection or serious systemic illness. White blood cells are present in stained smears of stool.<sup>[19]</sup>

## Treatment

Most enteric infections resolve spontaneously. The use of antibiotics is controversial. Some studies have found that erythromycin rapidly eliminated *Campylobacter* from the stool without affecting the duration of illness, while others have shown children benefited from early treatment with erythromycin.

Antimotility antidiarrheals should not be used. They prolong the duration of symptoms and have been associated with fatalities.<sup>[20]</sup>

## Dermatophytes

### Epidemiology

The dermatophytes of animals are mostly parasitic on the hair and skin and are readily transmitted to people by direct contact. Dermatophytes that most often affect dogs and cats and can be transmitted to humans are:

- *Microsporum canis*;
- *Microsporum gypseum*; and
- *Trichophyton mentagrophytes*.

*M canis* is the most frequent fungal agent of cats and dogs and is also the most frequent agent of human tinea capitis and often the agent of tinea corporis. Infections in kittens and puppies often result in scaly lesions with hair loss around the face, paws, and body. Clinically, other dermatologic lesions are similar, and suspected dermatophyte infections in both animals and humans should be culture confirmed. Identification of the infecting fungus will provide clues to the source of infection.<sup>[21]</sup>

Dermatophyte infections in dogs and cats are infrequent with less than 4% of clinically suspected cases actually confirmed with a positive culture. Some strains of *M canis* do not fluoresce under a Wood's lamp. Generalized infections of dermatophytes are more likely in cats, especially long-haired cats who are predisposed to infection.

Humans in households with infected cats are likely to become infected. Cats may also be asymptomatic carriers. Increased risk of carrier state occurs with cats that:

- Go to shows;
- Are in catteries; and
- Spend a good deal of time in veterinary clinics.

Dogs may also be asymptomatic carriers. The veterinary diagnostic techniques and treatment regimens for animals are well discussed in *Muller and Kirk's Small Animal Dermatology*.<sup>[22]</sup>

### Pathology

The dermatophytes proliferate in the superficial cornified layers of the skin. They expand centrifugally with peripheral scaling and central clearing.<sup>[23]</sup>

### Diagnosis

Dermatophytes are diagnosed when fungal elements are found in a potassium hydroxide examination of skin scrapings. Cultures are often necessary to identify fungal infections in dogs, cats, or other pets, especially in asymptomatic animals.<sup>[24]</sup>

### Treatment

Smaller lesions will resolve with a cream, lotion, or gel of:

- Imidazole;
- Ciclopirox;
- Naftifine; or
- Terbinafine.

Effective therapy for extensive or resistant tinea corporis is oral itraconazole 200 mg once daily or terbinafine 250 mg once daily for 2 to 3 weeks.<sup>[25]</sup>

## Prevention

At this time, prevention of dermatophyte infection in companion animals and resultant transmission to humans focuses on treating individually affected animals or animal populations (catteries). The focus is on treating both the individual animals as well as their environments, which can remain infective with fungal spores for up to 18 months.<sup>[22]</sup>

## Mange

### Epidemiology

Mange is a general term to describe the infestation of the skin of dogs, cats, and other animals with microscopic mites. Three important mites of dogs are:

- *Demodex canis*;
- *Cheyletiella yasguri* and other *Cheyletiella* species; and
- *Sarcoptes scabiei* var. *canis*.

Cats may have infestations of:

- *Cheyletiella blakei* and other *Cheyletiella* species;
- *Demodex cati*; and
- *Notoedres cati*.

Rabbits may also have infestations of *Cheyletiella* species. Many of the pocket pets can be infested with either *Sarcoptes* or *Cheyletiella* mites.<sup>[22]</sup> (See Animal Protection Institute article for definition of pocket pets.<sup>[26]</sup>)

*D canis* and *D cati* are considered normal flora of the dog and cat and do not infect humans. *D canis* is noted for its ability to cause severe skin pathology in dogs. This mite can cause small lesions of scaly skin with alopecia covering large portions of the body and secondary bacterial infections. *Muller and Kirk's Small Animal Dermatology* contains an extensive discussion of the pathology of this disease and

its treatment. It is a condition that has flustered many veterinary clinicians and dog owners.<sup>[22]</sup>

*Cheyletiella* mites are large mites that live in the keratin layer of the skin and complete their life cycle on one host. Their large size and feeding habits in the upper layers of the skin result in their being called "walking dandruff." Clinical signs and symptoms on both dogs and cats are increasing scaly skin and pruritus. The female mite may survive free living for up to 10 days and is a risk to other animals and humans. Humans more frequently acquire this infection through contact with an infected animal.

*S scabiei* var. *canis* and *N cati* both have 17- to 21-day life cycles and are also similar because the adults copulate in skin pockets and the female mite burrows through the horny layer of the skin laying eggs behind her. Eggs hatch and larva burrow to the skin surface where they travel and feed, eventually resting in a molding pocket. Nymphs may also wander and feed. Sarcoptic mites prefer skin with little hair and are most common on the:

- Elbows;
- Abdomen; and
- Hocks (tarsal joint of the hind leg).

These locations are also best for diagnostic skin scrapings.

*N cati* may cause transient lesions on humans, but *S scabiei* mites can burrow into human skin after direct contact with infected animals, causing severe pruritus. The mites can live on humans for up to 6 days, and cases of mite multiplication on humans have been noted. At least 1 case of generalized *S scabiei* has been reported on a child. Generally, lesions last no more than 2 weeks beyond breaking contact with the infected animal.

Mites must be eliminated from infected animals via a number of licensed veterinary topical parasiticides.<sup>[22,27]</sup>

Scabies in humans is normally associated with *S scabiei* var *hominis*. While most frequently

found in children, the elderly are also at risk due to a number of reasons, including environmental factors of overcrowding in communal living and patient care issues. Mites are frequently found in long-term care facilities (nursing homes) even when cleanliness is maintained.<sup>[28]</sup> Direct physical contact with an infected person, rather than contact with infested clothing and furniture, is the cause.

### Signs, Symptoms, and Pathology

*Cheyletiella* mite infections in humans are characterized by erythematous macules on the limbs and body. These macules become pustular and excoriated due to the intensity of the pruritus. To maintain the infestation, continuous contact with the infected animal is necessary, otherwise lesions heal within about 3 weeks.<sup>[22]</sup>

The female mite, burrowing under the skin to lay her eggs, elicits a pruritic, inflammatory, allergic response. Scratching can lead to a secondary dermatitis and infection.<sup>[29]</sup>

### Diagnosis

Diagnostic scabies burrows appear as fine, wavy, and slightly scaly lines up to 1 cm long. A tiny mite may sometimes be seen at the end of the burrow. Diagnosis is confirmed by finding the mite or her eggs or her fecal pellets in scrapings of the burrow.<sup>[30]</sup>

### Treatment

A topical scabicide is usually effective when thoroughly applied to all skin surfaces from the neck down.<sup>[31]</sup>

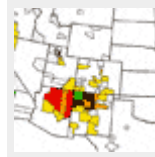
## Plague

### Epidemiology

Plague has long been a scourge of mankind. At various times in human history, plague has caused epidemics with high morbidity and mortality. During the 14th century, it is estimated that 25% of Europe's population died from plague.<sup>[21]</sup> The last pandemic of plague occurred in 1894, starting in China and

spreading around the world to include North America. In most countries, if a suitable reservoir host was not present in the environment, plague transmission ceased within a few years. In Western United States, an effective transmission cycle was established in fleas and wild rodents.

Since the last urban plague outbreak in Los Angeles in 1924-1925, plague cases have been scattered and limited to rural areas. Most cases have been due to peridomestic exposure to infected fleas originating on wild rodents but possibly introduced into the home by free-ranging pets. The CDC reports that 10 to 15 human cases occur each year in the United States. The following figure illustrates that the bulk of cases occur in Arizona and New Mexico.<sup>[32]</sup>



**Figure 1.** (click image to zoom) Reported human plague cases by county: United States, 1970-1997.

In 2006, 13 cases of human plague were reported in 4 states:

- New Mexico (7);
- Colorado (3);
- California (2); and
- Texas (1).

Two cases were fatal. In 6 of the 13 cases reported by the CDC, the following were risk factors for illness.<sup>[33]</sup>

- Skinning rabbit carcasses;
- Presence of a "die-off" of rodent species in the area;
- Infected fleas found on animals on the cases' property; and
- Pets with positive plague serology.

**Dogs.** Dogs and wild canines appear to be fairly resistant to the plague organism. Laboratory-infected dogs have a mild clinical illness with a mild fever. *Yersinia pestis* can be cultured from the mouth of some dogs occasionally for up to 10 days. At least 1 human case has occurred in an individual who skinned a dead coyote.<sup>[34]</sup> Other wild carnivores, with the exception of wild felines, appear to be resistant.

**Cats.** Cats are prone to severe infections acquired from consuming infected rodents. Experimentally, cats became ill within 1 to 2 days of oral inoculation and developed bacteremia and subsequently pneumonia. Nearly 40% of laboratory-infected cats die of plague.<sup>[35]</sup> Cats with pneumonia plague may serve as a source for human plague.

In 1984, a California small animal veterinarian developed bubonic plague with secondary plague pneumonia.<sup>[36]</sup> The veterinarian had not had contact with wild animals or traveled outside his local area. However, he had treated an afebrile cat (A) with an illness compatible with the signs and symptoms of pneumonia plague -- namely, difficulty breathing and hemoptysis. Cat A died. Another cat that had contact with cat A later became ill and, with treatment, lived and had a *Y pestis* titer of 1:512. A rodent die-off had been observed in the locale where cat A lived.

### Symptoms and Pathology

Symptoms of the plague include:

- Fever;
- Headache;
- General malaise;
- Painful swollen regional lymph nodes called "bubos"; and
- Bacteria invading the bloodstream causing septicemia and pneumonia.<sup>[37]</sup>

### Diagnosis

Diagnosis can be made from stain and culture of the organism from needle aspiration of a bubo. Blood and sputum cultures may also be positive. Other tests include immunofluorescent staining and serology. Polymerase chain reaction (PCR) testing, if available, is diagnostic.

Patients with pulmonary symptoms or signs should have a chest x-ray.<sup>[38]</sup>

Prior vaccination does not exclude plague.<sup>[38]</sup>

### Treatment

Streptomycin is the drug of choice for plague. Patients who are allergic to streptomycin may be given doxycycline.<sup>[39]</sup>

### Prevention

Individuals who live in enzootic plague areas can best protect themselves by:

- Removing all rodent harborages;
- Rodent proofing their homes;
- Eliminating food sources (such as feeding pets outdoors); and
- Maintaining year-round flea control of pets and keeping them indoors.

Individuals who participate in outdoor activities should wear clothing that will prevent contact with fleas and use insect repellents. Sick or dead animals should be avoided.

### Cat-Scratch Disease

#### Epidemiology

Cat-scratch disease was first clinically described in 1889 but was not linked to cats until 1939.<sup>[40]</sup> Almost 100 years after the first clinical description, *Rochalimaea henselae*, now *Bartonella henselae*, was identified in 1983 as the causative agent of cat-scratch disease. *Bartonella clarridgeiae* has occasionally been linked to cat-scratch disease.

*B henselae* infections in the cat have been characterized as a self-limiting febrile illness lasting 48 to 72 hours. Cats may exhibit some transient neurologic dysfunction with:

- Lethargy;
- Persistent staring; and
- Unresponsiveness to environmental stimuli.

Experimentally infected cats have shown:<sup>[9]</sup>

- Transient fever;
- Anorexia;
- Generalized peripheral lymphadenomegaly; and
- Inflammatory process in multiple organs.

Naturally infected cats do not exhibit clinical evidence of illness in spite of a persistent bacteremia.

*B henselae* is thought to be transmitted from cat to cat via fleas. Seroprevalence studies have indicated that the infection rate in cats in the United States varies by region. In the Midwest and Great Plains, 4% to 7% of the cats were seropositive, while 60% of cats were positive in the Southeast. Seropositivity increased with:

- Age of the cat;
- Warmer temperatures; and
- Higher humidity.

Feral cats and cats with fleas also had higher positivity rates.<sup>[9]</sup>

Most human cases occur in those who are less than 20 years of age, and males are infected more often than females.<sup>[41,42]</sup> Between 25% and 60% of patients have a history of a cat scratch or bite at the site of the initial lesion, a papule or pustule.

## Signs and Symptoms

A flu-like illness may accompany developing lymphadenopathy. Occasionally, encephalopathy may occur and last for an extended time.<sup>[41,42]</sup>

The main signs of cat-scratch disease are:<sup>[43]</sup>

- Erythematous, tender papules or pustules at the scratch site; and
- Tender unilateral lymphadenopathy.

## Diagnosis

Serologic testing provides confirmation of the diagnosis. The addition of PCR from a lymph node biopsy provides even more sensitive detection.<sup>[44]</sup>

## Treatment

Treatment consists of analgesics and local heat to lymph nodes.<sup>[45]</sup>

## Prevention

Cats should be kept free of fleas and confined indoors to prevent opportunities for infection. Bacteremic cats can be treated with high levels of antibiotics and should have blood cultures performed posttreatment to ensure treatment success. The following antibiotics have been shown to be effective:<sup>[9]</sup>

- Enrofloxacin (a fluoroquinolone used in veterinary medicine);
- Doxycycline; and
- Rifampin.

Cats owned by those who are immunocompromised should be screened by blood culture for *B henselae* and treated if positive.

## Conclusion

Potential health risks associated with owning a pet might make one question the advisability of

bringing an animal into the home. The associated positive effects of owning a pet, both mental and physical, to humans and their pets make it a positive experience for all. Hospitals and long-term care facilities recognize the benefits of pet therapy. Children need no explanation for the pleasure and education they receive from pets. Veterinarians can play a large role in human-animal interactions by providing preventive and curative medicine for the pet, educating the owner on zoonotic risks, and defining disease prevention steps.

Physicians and other human healthcare providers should be aware of zoonotic diseases and include pet ownership in the patient's social history when searching for clues to determine the cause or source of clinical illness. Being aware and reinforcing prevention steps when gathering social history supports the veterinarian's efforts. Provider involvement in "one medicine" (animal-environment-human) can make pet ownership a rewarding and positive health benefit for mankind.

## Tables

**Table 1. Companion Animal and Corresponding Zoonotic Diseases**

Companion Animal	Zoonotic Disease Related to the Animal
Dogs	<i>Salmonella</i> <i>Campylobacter</i> Visceral larval migrans Cutaneous larval migrans Ringworm Sarcoptic and <i>Cheyletiellidae</i> mange Tapeworm Leptospirosis Plague

Cats	<i>Salmonella</i> Ringworm <i>Campylobacter</i> Visceral larval migrans <i>Cheyletiellidae</i> mange Leptospirosis Toxoplasmosis Plague Cat-scratch disease
Pocket pets	<i>Salmonella</i> Lymphocytic choriomeningitis <i>Cheyletiellidae</i> mange
Birds	<i>Cheyletiellidae</i> mange Psittacosis
Reptiles	<i>Salmonella</i>
Fish	<i>Salmonella</i>