American Association of Feline Practitioners 2003 Report on Feline Zoonoses

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American Association of Feline Practitioners 2003 Report on FELINE ZOONOSES*

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Zoonotic diseases are defined as being common to, shared by, or naturally transmitted between humans and other vertebrate animals.[1] Transmission of zoonotic agents from animals to humans can potentially occur by direct contact with an animal, indirect contact with secretions or excretions from an animal, and contact with vehicles such as water, food, or fomites that were contaminated by an animal. For many agents, infection of an animal or human occurs from a shared vector or environmental exposure.

Most zoonotic agents can infect anyone regardless of immune status. However, when immunosuppressed humans are infected, the clinical illness is often more severe. For example, primary *Toxoplasma gondii* infection of an immunocompetent person is usually inapparent, whereas infection in an immunosuppressed person can cause life-threatening disease. Examples of immunosuppressed individuals include those with AIDS; those on immunosuppressive drugs for immune-mediated disease, cancer, or organ transplantation; fetuses or other young humans without fully developed immune systems; and older individuals with decremental deterioration of the immune system.

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When immunodeficiency is detected or suspected in a family, it is often recommended that cat ownership be discontinued because of potential health risks.[2,3] Because many infectious agents infect both cats and humans, it is sometimes assumed that zoonotic diseases are commonly acquired from cat contact. In actuality, humans are unlikely to acquire infectious diseases from healthy, adult, parasite-free, indoor cats.[2,4–7] In many instances of cat-associated zoonoses, humans are more commonly infected than cats; thus it is more likely for a person to become infected from contact with another person or the contaminated environment (e.g., *Cryptosporidium* spp, *Giardia* spp, *Salmonella* spp). In the online publication, *Preventing Infections from Pets: A Guide for People with HIV Infection*, the Centers for Disease Control and Prevention in the United States state, "You do *not* have to give up your pet."[a]

Pet (including cat) ownership provides many health

[a]Centers for Disease Control and Prevention, Divisions of HIV/AIDS Prevention: *Preventing Infections from Pets: A Guide for People with HIV Infection*. Available at **http://www.cdc.gov/hiv/pubs/brochure/oi_pets.htm**; accessed November 2003.

benefits, including increased happiness and decreased depression.[5,8] All caregivers for humans or animals should provide accurate information to clients concerning the risks and benefits of pet ownership so that an informed decision about acquiring and keeping pets can be made. However, information provided to clients often varies among health care providers. For example, in a recent study, responses of veterinarians and physicians varied dramatically when queried about zoonoses.[9] Veterinarians were more likely than physicians to encounter or discuss zoonoses in their practices. Most physicians did not feel comfortable counseling clients about zoonoses and felt that veterinarians should provide information for patients and physicians. However, there was almost a total lack of communication about the issues between veterinarians and physicians.

Multiple infectious agents are capable of zoonotic transfer. The most common or important zoonoses associated with cats are listed by agent in Table 1. The following is a brief description of the most common cat-associated illnesses that are encountered in small animal practice grouped by route of transmission. Recommendations to minimize dangers associated with cat ownership and to those providing cat health care are included by section, and most are summarized in Tables 2 and 3. Many of the recommendations were adapted from those used by the Centers for Disease Control and Prevention.[a,b]

ENTERIC ZOONOTIC AGENTS

Multiple enteric agents are capable of infecting humans and cats (Table 1). Some of these infections are common in cats.[10–13] For example, enteric agents with zoonotic potential were detected in feces of 13.1% of cats tested in north-central Colorado[12] and in 40.7% of kittens tested in central New York State.[13] Some infectious agents (e.g., *Giardia* spp, *Cryptosporidium* spp, *Salmonella* spp, *Campylobacter* spp) are immediately infectious and could be acquired from contact with individual cats. Other infectious agents (e.g., *Ancylostoma braziliense, Toxocara cati, T. gondii*) require a period of time outside the host to become infectious. Humans are more likely to develop infection caused by feline enteric pathogens from contact with the environment than by direct contact with cats. General guidelines for prevention of enteric zoonoses are included in Tables 2 and 3. The morphologic characteristics of enteric parasites are listed in Table 4.

Cestodes

Cats and humans can be infected with adult *Dipylidium caninum* by ingesting fleas that harbor cysticercoids. *D. caninum* infection, although rare in humans, is usually seen in children. It can cause abdominal pain, diarrhea, and pruritus ani or be relatively asymptomatic and recognized only because proglottids are passed per rectum. Cats can bring infected fleas into the human environment. This organism can also be classified with shared vector zoonoses.

Enteric agents with zoonotic potential were detected in feces of 13.1% of cats tested in north-central Colorado and in 40.7% of kittens tested in central New York State.

Cats, dogs, and foxes are definitive hosts of *Echinococcus multilocularis*. These animals become infected by ingesting intermediate hosts (i.e., rodents). Definitive hosts of this cestode are subclinically infected but pass infective eggs (Table 4) into the environment.[14,15] Following human ingestion of eggs, *E. multilocularis* onchospheres enter the portal circulation and are distributed to the liver and other tissues. Larval or metacestode forms then develop in infected tissues as tumor-like masses. The liver, lung, and brain are most commonly infected. The larval tumors are multilocular and grow rapidly (alveolar echinococcosis). A combination of surgical excision and anthelmintic treatment is used to treat the syndrome in humans, but the disease often has a poor prognosis. *E. multilocularis* is most common in the northern and central parts of North America but seems to be spreading with the fox population (the most common definitive host). It is also present in parts of Europe and Asia. It is rare in humans in North America, but, to reduce the incidence further, cats in endemic areas should not be allowed to hunt. Taeniacides should be administered monthly to cats that live in endemic areas and are allowed to hunt (Table 5).

[b]Centers for Disease Control and Prevention, National Center for Infectious Diseases: *Infectious Disease Information.* Available at **http://www.cdc.gov/ncidod/diseases/index.htm**; accessed November 2003.

Table 1. Feline Zoonotic Agents

Organism	*Clinical Presentation*	*Source of Infection*	*Relative Human Risk from Cats*
BACTERIA			
Bacillus anthracis[a]	**Cat:** subacute to chronic; carbuncular lesions of jowl and tongue; swelling of lips, head, and throat **Human:** cutaneous ulcer with necrotic center, pneumonia, bloody diarrhea, hematemesis, meningitis	**Cat:** wounds, inhalation, ingestion **Human:** wounds, inhalation, ingestion	Not associated with cats to date
Bartonella spp	**Cat:** subclinical, uveitis, fever, neurologic signs, gingivitis **Human:** lymphadenopathy, fever, malaise, bacillary angiomatosis, bacillary peliosis, etc.	**Cat:** *Ctenocephalides felis*, bites, scratches **Human:** bites, scratches, *C. felis* and its excrement	Common human infection; mostly in areas with fleas; risk to humans primarily from fleas and their excrement (shared vector)
Bordetella bronchiseptica	**Cat:** subclinical, upper respiratory, pneumonia (rare) **Human:** pneumonia in immunosuppressed patients	**Cat:** aerosolization **Human:** aerosolization	Extremely rare
Borrelia burgdorferi	**Cat:** subclinical **Human:** rash, polyarthritis, myocarditis, neurologic disease	**Cat:** *Ixodes* spp **Human:** *Ixodes* spp	None, except as a shared vector zoonotic agent
Campylobacter jejuni	**Cat:** subclinical, gastroenteritis **Human:** subclinical, bacteremia, gastroenteritis, myalgia, arthralgia polyradiculoneuritis	**Cat:** fecal contamination, poultry products, carnivorism **Human:** fecal contamination, poultry products	Rare; occasionally associated with cat contact
Capnocytophaga canimorsus	**Cat:** subclinical **Human:** bacteremia, keratitis	**Cat:** normal oral flora **Human:** bite wounds, possibly scratches	Extremely rare; occasionally transmitted by cat bites
Corynebacterium diphtheriae	**Cat:** subclinical, membrane covering larynx, enlarged kidneys, paralysis **Human:** fever, pharyngitis, diphtheritic membrane, cervical lymphadenopathy, myocarditis	**Cat:** Inhalation, contact with secretions **Human:** Inhalation, contact with secretions	Not associated with cats to date
Francisella tularensis	**Cat:** septicemia, pneumonia **Human:** ulceroglandular, glandular, oculoglandular, pneumonic, or typhoidal (depending on route of infection)	**Cat:** bloodsucking arthropods, ingestion of contaminated meat (rabbits) **Human:** bloodsucking arthropods, contaminated meat or water, inhalation, cat bites	Rare; occasionally transmitted by cat bites
Helicobacter spp	**Cat:** subclinical, vomiting (rare) **Human:** subclinical, gastric ulcer	**Cat:** fecal or oral contamination? **Human:** fecal or oral contamination?	Rare, although common in humans; transmission from cats unlikely; reverse zoonosis possible

[a]For more information concerning this organism, see the *AAFP Newsletter*, December 2001.

Table 1. Feline Zoonotic Agents *(cont)*

Organism	*Clinical Presentation*	*Source of Infection*	*Relative Human Risk from Cats*
BACTERIA *(cont)*			
Leptospira spp	**Cat:** subclinical, fever, nephritis, hepatitis **Human:** fever, malaise, acute inflammatory renal or hepatic disease, uveitis, CNS disease	**Cat:** direct contact with urine, ingestion of contaminated meat **Human:** direct contact with urine, ingestion of contaminated meat, bite wounds	Regional variation in human endemicity; not associated with cat contact to date
Listeria monocytogenes	**Cat:** subclinical intestinal carrier **Human:** abortion, stillbirth, septicemia, neonatal death, meningoencephalitis, uveitis, aseptic meningitis	**Cat:** contaminated soil or water **Human:** human carriers, contaminated soil, water, vegetation, silage	Not associated with cat contact to date
Mycobacterium spp	**Cat:** cutaneous lesions predominant **Human:** respiratory disease	**Cat:** ingestion, contact, inhalation **Human:** inhalation primary	Cats are not a source of human infection
Mycoplasma felis	**Cat:** chronic draining tracts, polyarthritis **Human:** cellulitis, polyarthritis	**Cat:** normal flora **Human:** cat bite	Extremely rare; only two cat-associated cases reported
Salmonella spp	**Cat:** subclinical, mixed or large bowel diarrhea, bacteremia, abortion **Human:** subclinical, gastroenteritis, bacteremia, abscesses	**Cat:** fecal contamination, poultry products, carnivorism, "songbird fever" **Human:** fecal contamination, poultry products	Common human infection; rare from cat contact
Streptococcus group A	**Cat:** subclinical, transient carrier (if at all) **Human:** strep throat, septicemia, skin infections, otitis, toxic shock syndrome, glomerulonephritis, etc.	**Cat:** aerosol **Human:** aerosol	Extremely rare (if ever) from cat contact; reverse zoonosis theoretically possible
Yersinia enterocolitica	**Cat:** subclinical **Human:** gastroenteritis	**Cat:** fecal contamination **Human:** fecal contamination	Not associated with cats to date
Yersinia pestis	**Cat:** bubonic, bacteremic, or pneumonic **Human:** bubonic, bacteremic, or pneumonic	**Cat:** ingestion of bacteremic rodents, rodent fleas **Human:** rodent fleas, cat bites, aerosol, contact with exudates	Southwest region; occasionally associated with cat contact
Yersinia pseudotuberculosis	**Cat:** anorexia, gastroenteritis, abdominal pain, icterus **Human:** lymphadenopathy, ileitis, arthralgia, septicemia, cutaneous swellings	**Cat:** fecal contamination **Human:** ingestion, inhalation	Not associated with cats to date
CESTODES			
Dipylidium caninum	**Cat:** subclinical **Human:** subclinical, pruritus ani, abdominal pain	**Cat:** ingestion of fleas **Human:** ingestion of fleas	None, except as a shared vector zoonotic agent
Echinococcus multilocularis	**Cat:** subclinical **Human:** hepatic and pulmonary disease	**Cat:** ingestion of rodents **Human:** ingestion of eggs	Extremely rare; north-central United States and Canada; not definitively linked to cat contact

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Table 1. Feline Zoonotic Agents *(cont)*

Organism	*Clinical Presentation*	*Source of Infection*	*Relative Human Risk from Cats*
ECTOPARASITES			
Cheyletiella	**Cat:** pruritic skin disease **Human:** pruritic skin disease	**Cat:** direct contact **Human:** direct contact	Occasional
Sarcoptes scabiei	**Cat:** pruritic skin disease **Human:** pruritic skin disease	**Cat:** direct contact **Human:** direct contact	Rare
FUNGI			
Dermatophytes	**Cat:** subclinical, superficial dermatologic disease **Human:** superficial dermatologic disease	**Cat:** direct contact **Human:** direct contact	Common
Sporothrix schenckii	**Cat:** chronic draining of cutaneous tracts **Human:** chronic draining of cutaneous tracts	**Cat:** wound contamination from soil **Human:** wound contamination from soil; feline exudate contact	Rare; not geographically defined; cats have large numbers of organisms in exudates
NEMATODES			
Ancylostoma braziliense	**Cat:** subclinical, hemorrhagic diarrhea, blood loss anemia **Human:** pruritic skin disease (cutaneous larva migrans)	**Cat:** ingestion of transport host, transmammary, egg ingestion, skin penetration **Human:** skin penetration by larvae after >3 days in environment	Rare; exposure from contaminated environment
Ancylostoma tubaeforme	**Cat:** subclinical, hemorrhagic diarrhea, blood loss anemia **Human:** pruritic skin disease (cutaneous larva migrans)	**Cat:** ingestion of transport host, transmammary, egg ingestion, skin penetration **Human:** skin penetration by larvae after >3 days in environment	Rare; exposure from contaminated environment
Dirofilaria immitis	**Cat:** subclinical; rarely cough, vomiting, or sudden death **Human:** subclinical pulmonary mass	**Cat:** mosquito **Human:** mosquito	None, except as a shared vector zoonotic agent
Strongyloides stercoralis	**Cat:** subclinical, hemorrhagic diarrhea **Human:** pruritic skin disease, diarrhea, disseminated disease in immunosuppressed patients	**Cat:** fecal oral **Human:** skin penetration	Rare; exposure from contaminated environment
Toxocara cati	**Cat:** subclinical, vomiting, failure to thrive **Human:** subclinical, cough, ocular disease	**Cat:** ingestion of transport host, egg ingestion **Human:** ingestion of larvated eggs after 3 weeks in environment or ingestion of larvae and adults	Rare; exposure from contaminated environment
Uncinaria stenocephala	**Cat:** subclinical, hemorrhagic diarrhea, blood loss anemia **Human:** pruritic skin disease (cutaneous larva migrans)	**Cat:** ingestion of transport host, transmammary, egg ingestion, skin penetration **Human:** skin penetration by larvae after >3 days in environment	Rare; exposure from contaminated environment

Table 1. Feline Zoonotic Agents *(cont)*

Organism	*Clinical Presentation*	*Source of Infection*	*Relative Human Risk from Cats*
PROTOZOANS			
Cryptosporidium spp	**Cat:** subclinical or small bowel diarrhea **Human:** subclinical or small bowel diarrhea	**Cat:** fecal contamination, carnivorism **Human:** fecal contamination	Rare; common in humans, but rarely directly linked to cats; potential reverse zoonosis
Entamoeba histolytica	**Cat:** hemorrhagic diarrhea **Human:** hemorrhagic diarrhea	**Cat:** ingestion of cysts **Human:** ingestion of cysts	Extremely rare; immediately infectious and common in humans in some countries, but not definitively linked to cats; potential reverse zoonosis
Giardia spp	**Cat:** subclinical or small bowel diarrhea **Human:** subclinical or small bowel diarrhea	**Cat:** fecal contamination, carnivorism **Human:** fecal contamination	Extremely rare; immediately infectious and common in humans in some countries, but rarely directly linked to cats; potential reverse zoonosis
Toxoplasma gondii	**Cat:** subclinical, fever, uveitis, muscle pain, hepatic inflammation, pancreatitis **Human:** subclinical, lymphadenopathy, abortion, stillbirth, encephalitis	**Cat:** ingestion of transport host, ingestion of oocysts after 1–5 days of sporulation, transplacental **Human:** ingestion of undercooked meat, ingestion of oocysts after 1–5 days of sporulation, transplacental	Rare; common in humans, but not usually associated with individual cats because of the short-term oocyst shedding period and sporulation time
RICKETTSIAE AND CHLAMYDIAE			
Chlamydophila felis	**Cat:** conjunctivitis, mild upper respiratory **Human:** conjunctivitis, pneumonia, endocarditis, glomerulonephritis	**Cat:** direct contact, aerosol **Human:** direct contact, aerosol?	Extremely rare; direct contact with cats (occasionally)
Coxiella burnetii	**Cat:** subclinical, abortion, stillbirth **Human:** fever, pneumonitis, myalgia, lymphadenopathy, arthritis, hepatitis, endocarditis	**Cat:** bloodsucking arthropods, ingestion of contaminated tissues **Human:** bloodsucking arthropods, aerosol from infected tissues	Extremely rare; distribution unknown; multiple point-source outbreaks associated with cats
Rickettsia felis	**Cat:** subclinical **Human:** fever, lymphadenopathy	**Cat:** fleas **Human:** fleas	None, except as a shared vector zoonotic agent
VIRUSES			
Cowpox	**Cat:** circumscribed, ulcerative, pruritic skin lesions and mild conjunctivitis **Human:** papulovesicular skin disease	**Cat:** direct contact **Human:** direct contact	Extremely rare
Rabies	**Cat:** progressive CNS disease **Human:** progressive CNS disease	**Cat:** animal bites, ingestion, inhalation **Human:** animal bites, ingestion, inhalation	Regional; direct transmission from cats can occur
West Nile virus	**Cat:** CNS disease **Human:** CNS disease	**Cat:** mosquitoes **Human:** mosquitoes	None, except as a shared vector zoonotic agent

Table 2. Veterinarian Guidelines for Managing Zoonotic Diseases of Cats

- Familiarize yourself and your staff with zoonotic issues.
- Take an active role in discussing the health risks and benefits of cat ownership with clients so that they can make logical decisions concerning cat ownership and management.
- Make it clear to your clients that you and your staff understand conditions associated with human immune deficiency, are discreet, and are willing to help.
- Provide information concerning veterinary or public health aspects of zoonoses to cat owners, but do not diagnose, treat, or make recommendations about diseases in humans.
- Refer clinically ill cat owners to a physician for additional information and treatment.
- Veterinarians and physicians have different experiences concerning zoonoses; therefore, volunteer to speak to a cat owner's physician to clarify zoonotic issues when indicated.
- When public health–related advice is offered, document it in the medical record.
- When reportable zoonotic diseases are diagnosed, contact the appropriate public health officials.
- Vaccinate all cats for rabies.
- Routinely administer anthelmintics to kittens as early as 3, 5, 7, and 9 weeks of age to aid in controlling hookworms and roundworms.
- In *D. immitis*–endemic areas, use monthly heartworm preventatives that control hookworms and roundworms.
- Test all cats for GI parasites at least once yearly.
- Offer diagnostic plans to assess for presence of organisms with zoonotic potential, particularly if a cat is clinically ill.
- Consider the following minimal diagnostic plan for cats with diarrhea of >1–2 days duration and for all cats in homes with immunosuppressed humans:
  - —Zinc sulfate centrifugation and microscopic examination for oocysts, cysts, and eggs
  - —Fecal wet mount to evaluate for trophozoites of *Giardia* spp and *Tritrichomonas* spp
  - —Rectal cytology to look for white blood cells and spirochetes consistent with *Campylobacter* spp
  - —*Cryptosporidium* spp screening by IFA, antigen ELISA, or acid-fast stain
  - —Fecal culture for *Salmonella* spp and *Campylobacter* spp
- Periodically (monthly in *E. multilocularis*–endemic areas) administer taeniacides, particularly in cats allowed outdoors.
- Maintain flea and tick control at all times.
- Do not allow clients to restrain cats, and do not attempt to pull cats from their carriers.
- Train staff members on how to avoid bites and scratches.
- Provide rabies vaccinations for all staff members who handle animals.
- Every 2 years, reevaluate rabies antibody titers of staff members who handle animals.
- Follow biosecurity measures for small animal hospitals.

Nematodes

Cats and humans can be infected with *T. cati*. Visceral (including neural) larva migrans (VLM) and ocular larva migrans (OLM) are the syndromes associated with human toxocariasis. Most cases of VLM and OLM are thought to be caused by *Toxocara canis* infection, but the same syndromes can occur following infection with *T. cati*.[14,16,17] Human infection with *Toxascaris leonina* has not been reported. VLM is most common in children younger than 6 years of age, and OLM is most common in older children and young adults. Infected cats pass eggs into the human environment. In warm weather, after 3 to 4 weeks, the eggs larvate and are then infectious. Humans are infected by ingestion of larvated eggs that release infective larvae in the gastrointestinal (GI) tract. The larvae penetrate the mucosa of the small intestine and migrate to the liver, lungs, and other organs (VLM). The inflammatory reaction against the larvae can result in clinical signs of disease. Manifestations include eosinophilia, abdominal pain, anorexia, nausea, vomiting, fever, cough, hepatomegaly, myocarditis, and encephalitis. Larvae (usually only one) that migrate to the eye can cause severe intraocular inflammation.

Adult *T. cati* have been passed in the vomitus or per rectum in some infected children. Affected children generally have no evidence of VLM and probably ingested advanced larval stages or adult worms passed by infected cats.

Toxocara eggs are environmentally resistant, so when an area is contaminated, the potential for infection will persist for months or years. In the United States, the seroprevalence of antibodies against *Toxocara* is 2.8% in the general human population and from 4.6% to 7.3% in children 1 to 11 years of age.[14] Thus exposure to infective roundworms is still common.

Cats can be the definitive host for *A. braziliense, Ancylostoma tubaeforme, Uncinaria stenocephala,* and *Strongyloides stercoralis.* Eggs are passed into the

environment where they larvate after several days in warm, humid conditions. Infective larvae penetrate human skin by direct contact. Pruritic, serpiginous, erythematous tracts occur as the larvae migrate in the epidermis (cutaneous larva migrans). Although *Ancylostoma caninum* has been linked with eosinophilic enteritis in humans, this syndrome has not been described with hookworms that infect cats.[18]

The risk of hookworm and roundworm infections is lessened by reducing exposure to animal excrement and routinely administering anthelmintics to cats (Tables 2 and 3). Direct skin contact with moist, potentially infected soil should be avoided. Children's sandboxes should be covered when not in use, and fecal material should be removed immediately. Geophagia and ingesting untreated surface water should be discouraged. In areas where nematodes are common, three doses of an anthelmintic can be administered every 2 weeks to kittens beginning as early as 3 weeks of age to lessen potential clinical disease and environmental contamination with eggs[c] (Table 5). Queens should be treated concurrently because they often have patent infections while nursing. Fecal flotation tests should also be conducted once or twice yearly on feces from all cats and more frequently for cats that go outdoors. Ivermectin-containing heartworm preventatives aid in controlling hookworms, and both selamectin and milbemycin heartworm preventatives aid in controlling hookworms and roundworms.[19] However, fecal flotation is still indicated at least yearly for cats on heartworm preventatives because there are other important parasites that the drugs do not control.

Protozoans

Cats and humans can be infected with *Entamoeba histolytica, Cryptosporidium parvum, Cryptosporidium felis, T. gondii,* and *Giardia* spp (Table 1). *E. histolytica* infection

[c]Centers for Disease Control and Prevention, Division of Parasitic Diseases: *Prevention of Zoonotic Transmission of Ascarids and Hookworms of Dogs and Cats: Guidelines for Veterinarians.* Available at **http://www.cdc.gov/ncidod/dpd/parasites/ascaris/prevention.htm**; accessed November 2003.

Table 3. Cat Owner Guidelines for Avoiding Zoonotic Transfer of Disease

- If adopting a new cat, the cat least likely to be a zoonotic risk is a clinically normal, arthropod-free, adult animal from a private family.
- Once the cat to be adopted is identified, quarantine it from immunocompromised people until a thorough physical examination and zoonoses risk assessment are completed by a veterinarian.
- Seek immediate veterinary care for all unhealthy cats.
- Seek veterinary care at least once or twice yearly for a physical examination, fecal examination, deworming recommendations, and a vaccine needs assessment.
- Have all cats vaccinated for rabies at appropriate intervals.
- Avoid handling unhealthy cats, particularly those with GI, respiratory, skin, neurologic, or reproductive disease.
- Do not handle cats with which you are unfamiliar.
- Do not allow cats to drink from the toilet.
- Wash hands after handling cats.
- Remove fecal material from the home environment daily.
- If possible, do not have immunocompromised humans clean the litterbox. If immunocompromised humans must clean the litterbox, they should wear gloves and wash hands thoroughly when finished.
- Use litterbox liners and periodically clean the litterbox with scalding water and detergent.
- Wear gloves when gardening, and wash hands thoroughly when finished.
- Cover children's sandboxes to avoid fecal contamination by outdoor cats.
- Only feed cats cooked or commercially processed food.
- Control potential transport hosts, such as flies and cockroaches, that may bring zoonotic agents into the home.
- Filter or boil water from sources in the environment.
- Housing cats indoors may reduce their exposure to other animals that may carry zoonotic agents, to the excrement of other animals, and to fleas and ticks.
- Seek veterinary advice concerning flea and tick control.
- Do not share food utensils with cats.
- Avoid being licked on the face by cats.
- Have your cat's claws clipped frequently to reduce the risk of skin penetration; nail caps or declawing could be considered in some cases.
- Consider behavior modification for cats prone to biting or scratching.
- Do not tease cats or attempt to pull them from their carriers.
- If bitten or scratched by a cat, seek medical attention.
- Cook meat for human consumption to 176°F (80°C) for a minimum of 15 minutes (medium-well).
- Wear gloves when handling meat, and wash hands thoroughly with soap and water when finished.

Table 4. Morphologic Characteristics of Enteric Zoonotic Parasites of Cats

Organism	*Life Stage; Description*
Nematodes	
Toxocara cati	Egg; 65–75 µm
Ancylostoma cati	Egg; 55–65 × 34–45 µm
Ancylostoma braziliense	Egg; 55–76 × 35–45 µm
Uncinaria stenocephala	Egg; 60–75 × 33–50 µm
Strongyloides stercoralis	Egg; 55 × 30 µm; larvated
	Larvae; rhabditiform first-stage larva
	Egg; 30–33 × 45–55 µm; larvated
Cestodes	
Dipylidium caninum	Proglottid; double pored
	Egg packet; each egg is 25–40 × 30–45 µm
Echinococcus multilocularis	Egg; 37 × 32 µm
Coccidians	
Toxoplasma gondii	Oocyst; 10 × 12 µm
Cryptosporidium spp	Oocyst; 4–6 × 4–7 µm
Flagellates	
Giardia spp	Cyst; 7–10 × 8–12 µm
	Trophozoite; 10–12 × 15–18 µm
Tritrichomonas foetus[a]	Trophozoite: 4–6 × 7–14 µm

[a]Unlikely to be zoonotic.

is only rarely described in cats and thus is not likely to be a significant zoonosis.[20] *Balantidium coli* has not been isolated from cats.[21] Although trichomoniasis of cats may be common, *Tritrichomonas foetus*[22,23] transmission from a cat to a person has never been documented.

Cryptosporidiosis

C. parvum is a coccidian that commonly infects humans and can result in severe GI disease. The organism frequently causes diarrhea outbreaks in daycare centers[24]: approximately 300,000 humans in Milwaukee developed cryptosporidiosis when a water purification system malfunctioned,[25] and nearly 10% to 20% of AIDS patients are infected with *C. parvum* at some time during their lives.[26] Many individuals require hospitalization for IV fluid therapy. Infection of immunosuppressed individuals may be life-threatening. Humans coinfected with AIDS may never be cured.

Cryptosporidium spp oocysts or antigens have been documented in feces of many domestic cats with or without diarrhea in the United States, Japan, Scotland, Australia, and Spain.[12,13,27–36] Presence of serum antibodies can be used to estimate numbers of individuals exposed to *C. parvum*. An enzyme-linked immunosorbent assay for detecting *C. parvum* IgG was developed and applied to serum of cats.[35] Using this assay, the seroprevalences of *C. parvum* antibodies in serum of cats in Colorado and the United States are 15.3% and 8.3%, respectively.[35,37] Oocysts or antigens of *C. parvum* were detected in feces of 5.4% of cats tested in north-central Colorado[12] and in 3.8% of kittens tested in central New York State.[13]

Although the source of most *C. parvum* infections in humans is unknown, contaminated water is one likely source.[38] Cryptosporidiosis has been documented in humans and cats in the same environment, suggesting the possibility for interspecies transmission or acquisition from a common source.[39–42] Oocysts are passed sporulated and infectious; thus there is potential for direct zoonotic transfer (Figure 1). Limited cross-infection studies have been performed with *C. parvum* isolates from cats or humans. A feline isolate failed to cross-infect mice, rats, guinea pigs, or dogs,[43] but another isolate from a cat cross-infected lambs.[44] *Cryptosporidium hominis*, a human parasite, does not infect cats.[45] An alternative to cross-infection studies is comparison of isolates genetically. A feline genotype (*C. felis*) that varies considerably from human and cattle genotypes has been identified.[46] *C. felis* has been documented in infected humans and cows, suggesting the genotype can infect other mammals.[47–50] However, in a study of HIV-infected humans with cryptosporidiosis, there was no statistical association with cat ownership, suggesting that cat contact is an uncommon way to acquire cryptosporidiosis.[51] Although cats are commonly infected with *Cryptosporidium* spp[12,13] and can shed oocysts for extended periods of

Figure 1—*Cystoisospora felis* oocysts, sporulated *T. gondii* oocysts, and *C. parvum* oocysts in a feline fecal sample. (Bar = 10 µm)

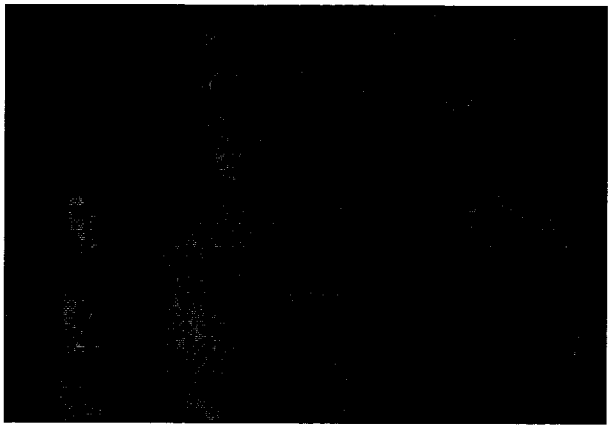

Figure 2—*C. parvum* oocysts stained with modified acid-fast stain. (Bar = 10 µm)

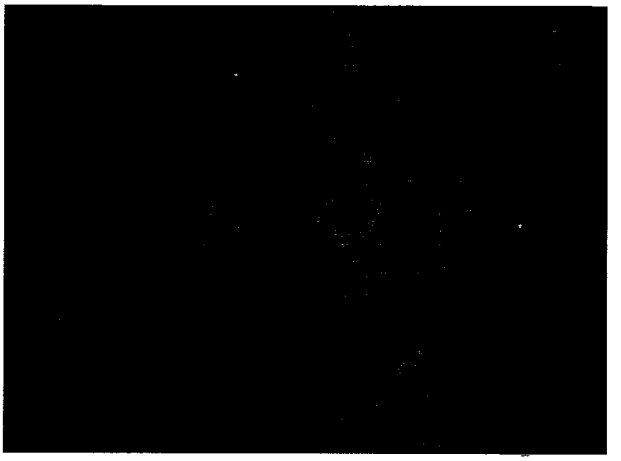

Figure 3—*Giardia* cysts. (Bar = 10 µm)

time,[43] only small numbers of oocysts per gram of feces are shed.[28] This may decrease the risk of transmission from cats to humans.

It is impossible to determine zoonotic strains of *Cryptosporidium* by microscopic examination. Thus it seems prudent to assume feces from all cats infected with *Cryptosporidium* spp are a potential human health risk. Techniques for detecting *Cryptosporidium* spp should be included in the diagnostic evaluation of all cats with diarrhea and all cats in the homes of immunosuppressed individuals. Only a few *Cryptosporidium* spp oocysts are generally shed by infected cats, and they are extremely small (approximately 5 µm); thus acid-fast or immunofluorescent antibody (IFA) staining of feces aids in their identification[52] (Figure 2). Fecal antigen ELISAs are also available; at this time, it is unknown whether IFA assays or fecal antigen ELISAs developed for detecting *C. parvum* will consistently detect *C. felis*. Recently, a polymerase chain reaction assay has been used to amplify *Cryptosporidium* DNA from feline feces and was more sensitive than an IFA assay.[53]

It is unknown where cats acquire cryptosporidiosis, but because rodents[54] are commonly infected, acquisition may be acquired by carnivorism. It is possible that administering paromomycin, tylosin, or azithromycin (Table 5) can lessen oocyst shedding from infected cats, but data are limited and it is unknown whether treated cats are cured.[33,34] Paromomycin should not be prescribed to cats with bloody diarrhea because absorption is enhanced, possibly resulting in acute renal failure in some cats.[55] Reinfection is also likely (see the Follow-Up Testing Recommendations section on p. 17). *Cryptosporidium* spp can be removed from contaminated surface water by boiling or filtration. Hands should be washed after handling fecally contaminated material (e.g., soil, even if gloves were worn [Table 2]).

Giardiasis

Giardia is a flagellate with worldwide distribution that causes significant GI disease in dogs, cats, and humans. The organism is thought to have a wide host range. Prevalence in cats varies by the region; 3.9% and 1.9% of client-owned cats with or without diarrhea, respectively, were infected in a study conducted in north-central Colorado.[12] In a study of kittens younger than 1 year of age in central New York State, the organism was identified in 6.1% and 8.1% of client-owned and shelter cats, respectively.[13]

Because the organism is immediately infectious when passed as cysts in stool, there is potential for direct zoonotic transfer. There have been varying results concerning cross-infection potential of *Giardia* spp. In one study, *Giardia* spp from humans were inoculated into cats, which were relatively resistant to infection.[56] In contrast, evaluation of human and feline *Giardia* spp isolates by isoenzyme electrophoresis suggests that cats could serve as a reservoir for human infection.[57]

Recent genetic analysis has revealed two major genotypes in humans. Assemblage A has been found in infected humans and many other mammals, including dogs and cats.[58] Assemblage B has been found in infected humans and dogs, but not cats.[58] It appears that there is also a specific genotype of *Giardia* that infects cats, but not humans.[58]

To date, there has not been a documented case of human giardiasis acquired from a cat in the literature. However, because potentially zoonotic strains have been detected in cats and it is impossible to determine zoonotic strains of *Giardia* spp by microscopic examination, it seems prudent to assume feces from all cats infected with *Giardia* spp are a potential human health risk.

Giardia is a common enteric pathogen and can be detected in feces of cats with and without diarrhea (Fig-

Table 5. Drugs Used in Managing Feline Zoonotic Diseases[a]

Drug	*Dosage*	*Organism(s)/Parasite(s)*
Amoxicillin	10–22 mg/kg PO q12h	*Streptococcus* group A
Amoxicillin–clavulanate	15 mg/kg PO q12h	*Bartonella* spp *Bordetella bronchiseptica* *Pasteurella multocida*
Ampicillin	22 mg/kg IV q8h	*Leptospira* spp
Azithromycin	7.5–10 mg/kg PO q12–72h	*Cryptosporidium* spp *Bartonella* spp
Clarithromycin	7.5 mg/kg PO q12–24h	*Helicobacter* spp
Clindamycin	10–12 mg/kg PO q12h	*Toxoplasma gondii*
Doxycycline	5–10 mg/kg PO q12–24h	*Anaplasma phagocytophilum* *B. bronchiseptica* *Bartonella spp* *Chlamydophila felis* *Ehrlichia* spp *Mycoplasma felis*
Enrofloxacin[b]	5 mg/kg/day PO	*Bartonella* spp *Campylobacter* spp *M. felis* *Yersinia pestis*
	5 mg/kg/day SC or IV	*Salmonella* spp bacteremia
Erythromycin	10 mg/kg PO q8h	*Bartonella* spp *Campylobacter* spp
Fenbendazole	50 mg/kg/day PO	*Ancylostoma* spp *Giardia* spp *Strongyloides stercoralis* *Toxocara cati*
Fipronil	7.5–15 mg/kg topical 0.25% spray and 10% spot-on	Ticks Fleas
Fipronil–methoprene	7.5–15 mg/kg topical spot-on	Ticks Fleas
Fluconazole	50 mg PO q12–24h	Dermatophytes *Sporothrix schenkii*
Griseofulvin (microsize)	25 mg/kg PO q12h	Dermatophytes
Griseofulvin (ultramicrosize)	5–10 mg/kg/day PO	Dermatophytes
Imidacloprid	10–20 mg/kg topical spot-on	Fleas
Itraconazole	5 mg/kg PO q12h for 4 days and then 5 mg/kg/day PO	Dermatophytes *S. schenkii*

[a]Although other drugs are available for treating zoonotic agents, this table lists those used most often by panel members.
[b]Other fluoroquinolones may also be effective.

Table 5. Drugs Used in Managing Feline Zoonotic Diseases *(cont)*

Drug	*Dosage*	*Organism(s)/Parasite(s)*
Ivermectin	24 µg/kg/mo PO	*Dirofilaria immitis* Hookworms
	200–300 µg/kg/wk PO	*Cheyletiella* *Sarcoptes scabiei*
Lime-sulfur	Dip every 5–7 days	Dermatophytes
Lufenuron	80–100 mg/kg PO every 2 wk 30 mg/kg PO every 30 days 10 mg/kg SC every 180 days	Dermatophytes Fleas Fleas
Metronidazole	25 mg/kg PO q12h	*Entamoeba histolytica* *Giardia* spp
Miconazole and 2% chlorhexidine	Dip every 3–4 days	Dermatophytes
Milbemycin	0.5–0.99 mg/kg/mo PO	*D. immitis* *Ancylostoma* spp *T. cati*
Paromomycin	150 mg/kg PO q12h for 5 days	*Cryptosporidium* spp
Praziquantel	5 mg/kg PO, SC, or IM once	*Dipylidium caninum* *Echinococcus multilocularis*
Pyrantel	20 mg/kg PO once, repeat in 3 weeks	*Ancylostoma* spp *S. stercoralis* *T. cati*
Pyrantel plus praziquantel	72.6 mg pyrantel and 18.2 mg praziquantel, 1 tablet/cat PO	*Ancylostoma* spp *T. cati* Cestodes
Selamectin	6 mg/kg/mo topically	*Ancylostoma* spp *T. cati*
Terbinafine	20 mg/kg PO q24–48h	Dermatophytes
Tylosin	10–15 mg/kg PO q12h	*Cryptosporidium* spp

ure 3). Fecal examination should be performed on all cats at least yearly, and treatment with anti-*Giardia* drugs (Table 5) should be administered if indicated. Zinc sulfate centrifugation is considered the optimal fecal flotation technique by most parasitologists (Table 6). If fresh stool is available from cats with diarrhea, examination of a wet mount to detect the motile trophozoites may improve sensitivity and can also be used to detect *T. foetus* infection. Although monoclonal antibody-based IFA tests and fecal antigen tests are available, limited studies of sensitivity and specificity for feline *Giardia* isolates have been conducted. These techniques should be used in addition to, not in lieu of, fecal flotation tests, which can reveal other parasites.

A *Giardia* vaccine was recently licensed but is not currently recommended for routine prophylactic use in cats.[59] Vaccination against *Giardia* could be considered in cats with recurrent infection and is being evaluated as a therapeutic agent.[60] In one experimental study however, administration of the vaccine three times to cats with giardiasis was ineffective as a treatment.[61] Prevention of zoonotic giardiasis includes boiling or filtering surface water for drinking. Hands should be washed after handling fecally contaminated material,

even if gloves were worn (Table 2). It is unknown whether treated cats are cured, and they are likely to be reinfected if re-exposed (see the Follow-Up Testing Recommendations section on p. 17).

Toxoplasmosis

T. gondii is one of the most common feline zoonoses; approximately 30% to 40% of adult humans in the world would test seropositive, suggesting previous or current infection.[62] Humans are usually infected congenitally, after ingesting sporulated oocysts, or after ingesting tissue cysts in undercooked meat. Clinical disease is generally mild following primary infection in immunocompetent humans. Self-limiting fever, malaise, and lymphadenomegaly are the most common clinical abnormalities, and most humans never realize when their acute *T. gondii* infection occurs. The disease can be confused with infectious mononucleosis. Clinical disease is usually more severe in immunodeficient humans, including those with AIDS and those being treated with immunosuppressive agents (e.g., chemotherapy). *T. gondii* is a common opportunistic central nervous system (CNS) infection in humans with AIDS; as T-helper cell counts decline, toxoplasmic encephalitis can result from activation of bradyzoites in tissue cysts. Stillbirth, CNS disease, and ocular disease are common clinical manifestations in a fetus if a woman contracts an acute *T. gondii* infection during pregnancy.[63]

Cats (wild and domestic) are the only known definitive hosts for *T. gondii*. They pass unsporulated (noninfectious) oocysts into the environment.[64] Once passed into the environment, sporulation occurs in 1 to 5 days; sporulated (infectious) oocysts survive for months to years. Although ingestion of tissue cysts in undercooked meat is a common way for humans to acquire *T. gondii* infection, it is likely that some humans acquire toxoplasmosis from ingesting sporulated oocysts in contaminated soil or drinking water. Clinical toxoplasmosis developed in a group of humans following a common exposure in a riding stable,[65] in a group of soldiers drinking contaminated water in Panama,[66] and from an oocyst-contaminated municipal water supply.[67]

Cats shed oocysts only for days (after tissue cyst ingestion) to several weeks (after sporulated oocyst ingestion). Thus an individual cat passes oocysts into the human environment for only a small fraction of its entire lifespan. Because oocysts are passed unsporulated and noninfectious, contact with fresh feline feces (<1 day old) is not a risk. Most cats are fastidious and do not leave feces on their fur long enough for sporulation to occur. For example, bioassay failed to detect oocysts on the fur of cats 7 days after they were shedding millions of oocysts in feces.[68] These findings suggest that touching individual cats is an unlikely way to acquire toxoplasmosis; this hypothesis is supported by epidemiologic studies as well. In general, veterinary health care providers are no more likely than the general population to test seropositive for *T. gondii* infection. In one case control study of pregnant women, there was no association between primary toxoplasmosis and having a cat or kitten at home, litterbox cleaning, or owning a cat that hunts.[69] Humans with HIV infection who owned cats were no more likely to acquire toxoplasmosis during their illness than those with HIV infection who did not have contact with cats.[70] When CNS toxoplasmosis occurs concurrently with AIDS, it is thought to be reactivation of chronic infection rather than a primary infection in most cases.

Following primary inoculation of cats, it is difficult to induce repeat oocyst shedding. Superinfection with *Isospora* spp led to oocyst shedding in some *T. gondii*–infected cats.[64] Prednisolone administered at 10 to 80 mg/kg PO or methylprednisolone administered at 10 to 80 mg/kg IM induces repeat oocyst shedding in some cats with toxoplasmosis, but the level and duration of shedding are much lower and shorter than with primary infection. However, these doses are greater than those used in clinical practice. Methylprednisolone acetate administered at 5 mg/kg weekly for 4 to 6 weeks to cats infected with *T. gondii* for 14 weeks or 14 months failed to induce oocyst shedding.[64] Cats infected with *T. gondii* were given FIV followed by FeLV and developed immunodeficiency-associated syndromes,[d] but repeat *T. gondii* oocyst shedding could not

Table 6. Zinc Sulfate Centrifugation

1. Place 1 g fecal material in a 15-ml conical centrifuge tube.
2. Add 8 drops of Lugol's iodine, and mix well.
3. Add 7–8 ml of zinc sulfate ($ZnSO_4$; 1.18 specific gravity)[a] solution, and mix well.
4. Add $ZnSO_4$ solution until there is a slight positive meniscus.
5. Cover the top of the tube with a coverslip.
6. Centrifuge at 1500–2000 rpm for 5 min.
7. Remove the coverslip, and place on a clean microscope slide for microscopic examination.
8. Examine the entire area under the coverslip for the presence of eggs, cysts, oocysts, or larvae at a magnification of 100×.

[a]Add 330 g $ZnSO_4$ (Fisher Scientific, Hanover Park, Illinois) to 670 ml of distilled water.

[d]Lappin MR: Unpublished data, Colorado State University, Fort Collins, 2003.

be demonstrated. Cats with FIV or FeLV infections have been inoculated with *T. gondii*; oocyst shedding periods and number of oocysts shed were similar to those for cats without FIV or FeLV infections.[64,71] It has been shown that gut immunity to *T. gondii* in cats is not permanent; four of nine cats inoculated 6 years after primary inoculation shed few to 1.25×10^6 oocysts for 6 to 10 days even though each had high serum antibody titers.[68] However, *T. gondii*–infected cats with and without FIV infection failed to repeat oocyst shedding when reinfected with *T. gondii* 16 months after primary inoculation.[71] Thus cats that are repeatedly exposed to *T. gondii* probably do not shed large numbers of oocysts after the first infection and are a minimal public health risk.

No serologic assay accurately indicates when a cat has shed *T. gondii* oocysts in the past. Most cats that are shedding oocysts test seronegative[72]; and most cats that test seropositive (IgM or IgG) have completed the oocyst shedding period, are unlikely to repeat shedding, and are unlikely to be a source of human infection.

Surface water collected directly from the environment should be boiled or filtered before drinking (Table 2). Gloves should be worn when handling fecally contaminated material (e.g., soil), and hands should be washed afterward. Produce from the garden should be washed carefully before ingestion. Children's sandboxes should be covered when not in use. Litterboxes should be cleaned daily; oocysts require 1 to 5 days to sporulate. Immunosuppressed or pregnant clients should not clean litterboxes, if possible. Sporulated oocysts are extremely resistant to most disinfectants; cleaning with scalding water or steam is most effective but can lead to burns. Use of disposable litter pans may be worth considering.

Oocysts measuring 10×12 µm in a cat's fecal sample could be *T. gondii*. *Hammondia hammondi* and *Besnoitia darlingi* are morphologically similar coccidians passed by cats, but they are not human pathogens.[64] Differentiation of these parasites from *T. gondii* can be made by laboratory animal inoculation. Alternately, if an infected cat develops *T. gondii* serum antibodies, it was likely infected with *T. gondii*. If a cat is found to be shedding oocysts morphologically consistent with *T. gondii*, the feces should be disposed of daily until the oocyst shedding period is complete; administering clindamycin, sulfonamides, or pyrimethamine can reduce levels of oocyst shedding[64] (Table 5).

The primary way to avoid contracting *T. gondii* infection is to avoid ingestion of the organism in undercooked meat.

Because most cats that test seronegative would shed the organism if infected, they should not be fed raw meat or allowed to hunt. Because humans are not commonly infected with *T. gondii* from contact with individual cats and because serologic test results cannot accurately predict the oocyst shedding status of cats, testing healthy cats for *T. gondii* antibodies has little public health application and is not recommended.[5,72] Although fecal examination can determine whether an individual cat is actively shedding oocysts, it is not very useful for public health purposes because the oocyst shedding period is so short. Finding oocysts has limited clinical relevance because most cats are subclinically infected at that time. If humans are concerned that they may have toxoplasmosis, they should see their doctor for serologic testing.

The primary way to avoid contracting *T. gondii* infection is to avoid ingestion of the organism in undercooked meat. Meats (particularly pork in the United States) should be cooked to medium-well (176°F [80°C]) to inactivate tissue cysts. Gloves should be worn when handling raw meats (including field dressing), and hands should be cleaned thoroughly afterward. Freezing meat at 10.4°F (–12°C) for several days kills most tissue cysts. Ingesting raw goat's milk can also result in human toxoplasmosis.

In summary, because humans are unlikely to contract *T. gondii* infection from direct contact with their own cats, patients need not be advised to part with their cats or to have them tested for toxoplasmosis.[73,a]

Bacterial Diseases

Salmonella spp, *Campylobacter* spp, *Escherichia coli*, *Helicobacter* spp, and *Yersinia enterocolitica* infect cats and can cause disease in humans. *Y. enterocolitica* is probably a commensal agent in cats but can induce fever, abdominal pain, bacteremia, and chronic polyarthritis in humans.

Campylobacteriosis

Campylobacter jejuni, *Campylobacter coli*, *Campylobacter helveticus*, and *Campylobacter upsalensis* infections can be subclinical or result in anorexia, vomiting, and large bowel diarrhea in humans and cats.[74–77] Disease in cats is uncommon.[74] Humans are usually infected by ingesting contaminated food or water. The organism is directly infectious in feces; infection of humans has been linked

to cats in several reports.[78–81] In previous studies, it was reported that up to 60% of pets from crowded environments were infected.[1,74] *Campylobacter* spp were cultured from the feces of 47 of 227 commercially reared cats.[75] However, the incidence in client-owned cats may be lower. In two recent studies in north-central Colorado[12] and central New York State,[13] *Campylobacter* spp were cultured from the stool of 0% and 1.8% of client-owned cats and 1.6% and 0% of shelter source cats, respectively. Diagnosis is based on culture. Several antibiotics, including erythromycin, chloramphenicol, quinolones, and second-generation cephalosporins, are effective for treatment (Table 5). At this time, optimal repeat testing intervals are unknown, but reinfection should be prevented by keeping cats indoors and feeding them cooked or commercially processed food (Table 2 and Follow-Up Testing Recommendations section on this page).

Because humans are unlikely to contract *T. gondii* infection from direct contact with their own cats, patients need not be advised to part with their cats or to have them tested for toxoplasmosis.

Helicobacteriosis

Cats are infected by *Helicobacter felis, Helicobacter pametensis, Helicobacter pylori,* and *"Helicobacter heilmanni."*[82–84] *H. pylori* causes ulcers in humans and has been isolated from a colony of research cats, but not stray cats. *H. pylori* is rarely found in naturally exposed cats, and human infection probably does not originate from cats.[85] However, an infected person and his cat were infected with a genetically identical *"H. heilmanni."*[86] In cats, the prevalence of *Helicobacter*-like organisms in gastric tissues ranges from 41% to 100% of healthy cats and 57% to 100% of vomiting cats.[83] In one study of farm workers with helicobacteriosis, an association was made with cat contact,[87] but in three other studies, including one of veterinarians, there was no epidemiologic association of cat contact with human helicobacteriosis.[88–90] Based on these reports, it appears that humans are unlikely to acquire *Helicobacter* spp infection from contact with cats. However, humans should avoid being licked on the face and should not share food utensils with cats (Table 1).

Salmonellosis

Salmonella enteritidis has more than 2,000 variants.[91] The organism is infectious when passed in feces and can be a direct zoonosis. However, it appears that most infections occur from indirect contact. *Salmonella* infection in cats is often subclinical. Approximately 50% of clinically affected cats have gastroenteritis; others are presented with abortion, stillbirth, neonatal death, or signs of bacteremia.[92–94] Neutropenia and neutrophils on rectal cytology are common findings in acute salmonellosis. Songbird fever is a clinical syndrome noted in some cats following ingestion of infected birds.[92] The incidence of salmonellosis varies by region and husbandry. It was reported that *Salmonella* spp were cultured from 1% to 18% of cats.[95] However, the incidence in client-owned cats may be lower. In two recent studies in north-central Colorado[12] and central New York State,[13] *Salmonella* was cultured from the stool of 0.8% and 0.9% of client-owned cats and 1.3% and 0.7% of shelter source cats, respectively.

Diagnosis of salmonellosis is made by culture of stool. Prevention of salmonellosis is based on sanitation and control of exposure to feces, including that of prey species. Insect control should be maintained as well; flies trapped in greyhound kennels were recently shown to carry *Salmonella* spp.[96] Antibiotic therapy with drugs such as quinolones can control clinical signs of disease but should not be administered to subclinical *Salmonella* carriers because of risk of developing antibiotic resistance. Several cats have been reported with multiple antibiotic-resistant *Salmonella* infections.[97–99] In bacteremic cats, parenterally administered quinolones (Table 5) are usually effective at controlling clinical signs of disease. At this time, optimal repeat testing intervals are unknown, but reinfection should be prevented by keeping cats indoors and feeding them cooked or commercially processed food (Table 2 and the following Follow-Up Testing Recommendations section).

Follow-Up Testing Recommendations and Maintenance of Cats with Enteric Zoonotic Infections

For most enteric zoonotic agents of cats, it is unknown whether treatment eliminates infection. Repeat infection and shedding can occur with most enteric zoonotic agents after treatment. Diagnostic test results can be false negative or transiently negative; thus it can be difficult to prove a cure. Therefore, with the information currently available, it is difficult to make

definitive recommendations concerning follow-up testing of cats known be infected with an agent with zoonotic potential. The following are general recommendations for long-term management of cats known to have harbored an enteric zoonotic agent.

If a cat tests positive, its feces should be removed from the litterbox daily and disposed of properly while treatment is administered (if indicated). The litterbox should be disinfected or cleaned with scalding water and detergent, preferably by someone other than an immunosuppressed person and with care to avoid burns. Probable sources of the primary infection should be removed, if possible. For example, the cat should be housed indoors to minimize exposure to transport hosts, contaminated food or water, and other cats, and only processed foods should be fed. If the source of reinfection is likely to have been removed, it is indicated to repeat the appropriate fecal test at least once within 2 to 4 weeks of discontinuing treatment. However, the client should be advised that a single negative test result does not confirm elimination of infection. For cats that become chronic carriers of an enteric zoonotic agent, clients should be advised of the public health risk. That risk may be unacceptable if very young children or immunocompromised humans will be exposed. If the clients choose to keep the cat, they should exercise meticulous hygiene and sanitation, with emphasis on frequent hand-washing, particularly before eating and after handling the cat and touching potentially contaminated surfaces or materials. Clients should be advised to seek medical care if they develop diarrhea or unexplained fever.

Repeat infection and shedding can occur with most enteric zoonotic agents after treatment.

BITES AND SCRATCHES

Several infectious agents (including *Bartonella* spp, *Capnocytophaga* spp, *Mycoplasma felis*, *Pasteurella* spp, *Fransicella tularensis*, rabies virus, *Yersinia pestis*) have been transmitted from cats to humans via bites or scratches. *Y. pestis* is discussed with the respiratory diseases (p. 21). Guidelines for prevention of zoonoses transmitted by bites and scratches are summarized in Table 2.

Bartonellosis

Cats can be infected with *Bartonella henselae*, *Bartonella clarridgeiae*, *Bartonella koehlerae*, and *Bartonella weissii*.[100–104] *B. henselae* and *B. clarridgeiae* have been associated with cat scratch disease in humans.[105,106] *B. henselae* causes bacillary angiomatosis and bacillary peliosis in immunosuppressed humans. There are two genetic variants of *B. henselae*: type I and type II. Both variants can be detected in infected cats and humans.[107–108] *Bartonella* spp infection is the most common direct zoonosis associated with cats. In Japan, 35 of 233 (15%) veterinary health care providers tested seropositive, which suggested previous or current infection.[109]

Humans with cat scratch disease develop a variety of clinical signs, such as lymphadenopathy, fever, malaise, weight loss, uveitis, myalgia, headache, conjunctivitis, skin eruptions, and arthralgia. The disease is self-limited but may take several months to completely resolve. The incubation period is approximately 3 weeks. Most cases are associated with kitten contact. Approximately 25,000 cases of cat scratch disease are diagnosed in the United States every year, resulting in at least $12.5 million in health care costs.

As many as 54.6% to 81% of cats in some geographic areas of the United States test seropositive for *Bartonella* spp and presumably were infected at one time.[110,111] *Bartonella* spp infection is more common in flea-infested cats from catteries.[112] *B. henselae* replicates in fleas and can survive in flea feces for days.[113,114] *B. henselae* has been cultured from the blood of many naturally exposed cats; cats infected with the organism by inoculation intradermally, subcutaneously, intravenously, or intramuscularly; and cats infected by fleas.[111,115–119] IV, IM, and intradermal inoculation have resulted in fever, lethargy, lymphadenopathy, and neurologic diseases in some cats.[118–121] In some naturally infected cats, uveitis and other clinical signs of disease, including stomatitis, fever, and lymphadenopathy, have been reported.[122–125]

Blood culture is the optimal test to prove the presence of current *Bartonella* spp infection. However, bacteremia can be intermittent, and false-negative results might occur. Polymerase chain reaction can be used to document the presence of *Bartonella* spp DNA, but there are occasional false-negative results, and positive results do not necessarily indicate that the organism is alive.[126] Serologic testing can be used to determine whether an individual cat has been exposed, but both cats that test seropositive and seronegative can be bacteremic, which limits the diagnostic utility of serologic testing.[127] Thus

testing healthy cats for *Bartonella* spp infection is not currently recommended.[128] Testing should be reserved for cats with suspected clinical bartonellosis.

Administering doxycycline, tetracycline, erythromycin, amoxicillin–clavulanate, or enrofloxacin (Table 5) limits bacteremia but does not cure infection in all cats.[115,116,118] Thus antibiotic treatment of healthy bacteremic cats is controversial and not currently recommended. Treatment should be reserved for cats with suspected clinical bartonellosis. Doxycycline was used successfully to manage *Bartonella* spp uveitis in a cat.[123]

Maintenance of flea control may lessen the risk of acquiring cat scratch disease.

Administering azithromycin decreased lymph node volume but did not change the final clinical outcome in humans with cat scratch disease.[129]

Several precautions can be taken to lessen the potential to develop bartonellosis (Table 2). These guidelines should be emphasized to immunosuppressed humans. If a new cat is to be adopted, an adult cat without a history of flea infestation is least likely to be infected. Flea control (Table 5) should be maintained continually and cats housed indoors to lessen the potential for exposure. Flea feces should be removed from the kitten and the environment. Immunosuppressed humans should avoid kittens.

Capnocytophaga spp, *Mycoplasma felis*, and *Pasteurella* spp

Approximately 300,000 emergency room visits per year are made by humans bitten by animals in the United States.[130] Most of the aerobic and anaerobic bacteria associated with bite or scratch wounds cause only local infection in immunocompetent individuals. However, 28% to 80% of cat bites become infected, and severe sequelae, including meningitis, endocarditis, septic arthritis, osteoarthritis, and septic shock, can occur.[130]

Immunocompromised humans or those exposed to *Pasteurella* spp or *Capnocytophaga canimorsus* (DF-2) are more likely to develop systemic clinical illness than when exposed to other bacteria associated with animal bites.[131,132] Local cellulitis is noted initially, followed by evidence of deeper tissue infection. Osteomyelitis underlying the bite wound is often associated with *Pasteurella multocida* infection. Bacteremia and the associated clinical signs of fever, malaise, and weakness are common, and death can occur from either of these two genera, particularly in splenectomized individuals. *P. multocida* from a cat was cultured from the lungs of a man with AIDS who had only passive contact with the cat.[133] Human *Mycoplasma* spp infections associated with cat bites (one with cellulitis and one with septic arthritis) have been reported.[134,135]

Diagnosis of bacterial infections is confirmed by culture. Treatment of infected bite wounds in humans includes local wound drainage and systemic antibiotic therapy. Penicillin derivatives are very effective against most *Pasteurella* infections. Penicillins and cephalosporins are effective against *Capnocytophaga* in vitro. Humans with bites and scratches should seek immediate medical attention. To avoid bites and scratches, humans should not tease cats and should use appropriate restraint techniques (Table 2).

Rabies

Cats are highly susceptible to rabies. They are usually infected with the enzootic strain that predominates in terrestrial animals locally. For example, along the Atlantic coast in the United States, cats are most likely to be infected with the raccoon strain of rabies; in the Midwest, they are most likely to be infected with a skunk strain. In Germany, cats became spillover hosts for the strain in foxes. There is no feline-adapted strain of rabies anywhere in the world among wild or domestic cats (i.e., felids usually get infected from other animal species but do not maintain the infection within their own species). Despite the prevalence of rabies in bats in the United States and the likelihood that a cat would be attracted to and would attack a bat floundering on the ground, rabies with a bat origin rarely occurs in cats. Perhaps this is because cats are adept at avoiding getting bitten when they attack a bat, and bats, with their tiny teeth, may have a hard time penetrating feline fur and skin.

Since 1980, more cases of rabies have been reported in cats than in dogs in the United States. In 2001, 270 cases of feline rabies were reported versus 89 cases of canine rabies.[136] Feline rabies is a major, potentially lethal, occupational health hazard for those commonly working with cats with unknown vaccination status, including veterinary staff as well as humane shelter and rescue group employees. Pre-exposure vaccination should be offered to veterinarians and others who work with cats in rabies enzootic areas.[137] In a recent survey, 85.1% of veterinary medical association members and

managers of animal shelters or wildlife rehabilitation centers had been vaccinated versus only 17.5% of staff members.[138] The pre-exposure series consists of three injections given on days 0, 7, and 21 or 28. Vaccinated individuals should have their titers checked every 2 years and a booster administered once the titer drops below an acceptable level.[137] Rabies vaccines are interchangeable. Properly immunized people exposed to rabies should get two booster doses IM 3 days apart.[137]

Cats should be administered their first rabies vaccine in accordance with the vaccine label, local ordinances, and published guidelines.[139] The second rabies vaccine should be administered 1 year later; thereafter, boosters are given annually or triannually as indicated for the specific vaccine product. Currently approved vaccines cannot induce rabies as occurred when modified-live vaccines were used. Although all approved vaccines have a very high level of efficacy, rabies has occurred in cats that were vaccinated. Some of those breakthrough cases could have occurred with the use of outdated, improperly stored, or improperly administered vaccine. Feline rabies vaccination should be mandatory as it is for dogs in most communities. This should include indoor cats because they occasionally get outdoors and because rabid animals, such as bats and raccoons, can enter houses. Although rabies vaccination results in soft tissue sarcomas in one of 1,000 to 10,000 cats, vaccination should be required in all cats because of public health risks.[139–143]

In 2001, 270 cases of feline rabies were reported versus 89 cases of canine rabies.

The clinical signs in cats have been extensively reviewed.[144] Rabid cats can present with classic furious or dumb rabies, but clinical signs can also be subtle, including hind leg lameness, increased vocalization with a change in pitch of voice, lethargy, anorexia, trembling, vomiting, and aggressiveness. It is possible that various strains of rabies could cause a different spectrum of illness. Rabies should always be considered in the differential diagnosis of a cat with these and other neurologic signs that are not otherwise explained or a cat that becomes ill following an injury compatible with a bite.

In theory, cats can transmit rabies by scratch as well as bite because they lick their paws. A cat that has bitten or scratched a human or another animal should be confined and observed daily for 10 days.[139] It should not receive rabies vaccine during that time. If it shows signs suggestive of rabies, it should be euthanized, the local health department should be notified, and the head submitted (refrigerated, not frozen) for rabies examination at an approved laboratory. If the cat remains healthy, there is no risk that rabies transmission occurred, and it can be vaccinated and released from the quarantine at the end of the 10-day period.

If a properly, currently vaccinated cat is bitten by a proven or suspected rabid animal, it should receive a booster immediately and be observed for 45 days. If it remains well through that time, it can be released from quarantine. If signs suggestive of rabies develop, it should be euthanized and examined for rabies at an approved laboratory.

If a cat that is not currently vaccinated is bitten by a proven or suspected rabid animal, it should be euthanized immediately. If the owner is not willing to have this done, the cat should be kept in strict isolation for 6 months and vaccinated 1 month before release from quarantine. If signs of rabies develop during the quarantine period, the cat should be euthanized and examined for rabies at an approved laboratory.

Cats that are rabies suspects should be strictly isolated, and access to them should be limited to personnel that are currently immunized. Appropriate measures should be taken to reduce any possibility of the staff being injured by these animals during the quarantine period. Public health officials should be notified immediately about possible exposures to rabies. Individuals exposed to potentially rabid animals should be urgently referred to a physician.

Feline Retroviruses

There has been concern that the feline retroviruses FeLV, FIV, and feline foamy virus can infect humans.[145] This has been a particular concern with FeLV because subtypes B and C can replicate in human cell lines.[146,147] Several studies have been conducted over the years to assess the risk. To date, humans have not been shown to be infected with feline retroviruses. In a recent study, 204 veterinarians and others potentially exposed to feline retroviruses were assessed for antibodies against FIV and feline foamy virus, FeLV p27 antigen, and FeLV provirus.[145] There was no serologic or molecular evidence of infection of any individual by any of the three retroviruses. At this time, there is no known risk

of human infection with feline retroviruses. Whether infection of a cat with a retrovirus increases human risk for other zoonoses is undetermined.

Tularemia

Tularemia is caused by *F. tularensis*, a gram-negative bacillus that is widely endemic in the continental United States and Europe. *Dermacenter variabilis, Dermacenter andersoni,* and *Amblyomma americanum* are vectors.[148,149] Tularemia can be transmitted to humans by ingestion; aerosol from water; soil or other fomites; tick bite; or contact with infected animals, including cats. Cats are infected most frequently by tick bites or by ingesting infected rabbits or rodents. Infected cats exhibit generalized lymphadenopathy and abscess formation in organs, such as the liver and spleen, which lead to fever, anorexia, icterus, and death.[150–152] Ulceroglandular, oculoglandular, glandular, oropharyngeal, pneumonic, and typhoidal forms occur in humans, depending on the route of exposure. Cat-associated tularemia in humans has occurred most frequently via bites but has also been associated with exposure to infected cat tissues.[149,153] Cultures and documentation of increasing antibody titers can be used to confirm the diagnosis in cats and humans. To lessen risk of exposure, ectoparasite control should be maintained and cats should not be allowed to hunt. This disease is an uncommon zoonosis.

RESPIRATORY EXPOSURE

A number of agents carried by cats can infect humans by exposure to respiratory secretions. These include *Y. pestis, Bordetella bronchiseptica, Staphylococcus* spp, and, potentially, *Chlamydophila felis. Coxiella burnetii* infects humans by inhalation, but it is discussed in the Genitourinary Exposure section (p. 23) because it is passed in parturient secretions. Humans can develop respiratory disease by inhaling *F. tularensis*, but this agent is discussed in the Bites and Scratches section (p. 18) because bites and scratches are more common routes of transmission from cats.

Bordetellosis

B. bronchiseptica is a common primary pathogen in dogs resulting in infectious tracheobronchitis. Many cats have serologic evidence of exposure or are culture positive, particularly in crowded environments.[154,155] Cats may acquire infection from contact with infected dogs.[156] In one study, *B. bronchiseptica* was isolated from 82 of 740 cats sampled.[155] Although exposure is common, the infection is usually subclinical in cats. Clinically affected cats have fever, mucopurulent nasal discharge, and cough.[157,158] By 1998, 39 cases of *B. bronchiseptica* infection in humans had been reported; many of the humans were immunodeficient.[159–162] Association with a cat has been reported only once (in an HIV and *B. bronchiseptica*–coinfected person).[162] Although cats are commonly exposed, humans are rarely infected; thus it appears that *B. bronchiseptica* infection in humans from contact with cats is uncommon. However, for households with immunosuppressed family members, a diagnostic workup and antimicrobial therapy should be considered for cats with respiratory disease. The organism is easily cultured. Tetracycline derivatives, amoxicillin–clavulanate, and quinolones are effective in controlling clinical signs of disease, but treated cats can culture positive for months (Table 5).

To date, humans have not been shown to be infected with feline retroviruses.

Chlamydiosis

Chlamydophila felis (formerly feline *Chlamydia psittaci*) commonly causes conjunctival disease and can cause rhinitis in cats.[163] The prevalence rates of antibodies against an isolate of *C. felis* in Japan were 51.1% in stray cats, 15% in pet cats, 3.1% in the general human population, and 5% in small animal clinic veterinarians, suggesting that transfer between cats and humans may occur.[164] This agent is thought to cause conjunctivitis in humans following direct contact with ocular discharges from cats.[165–168] Feline *Chlamydia* was indirectly associated with atypical pneumonia in an apparently immunocompetent 48-year-old man,[169] with malaise and cough in an immunosuppressed woman,[170] and with endocarditis and glomerulonephritis in a 40-year-old woman.[171] Care should be taken to avoid direct conjunctival contact with discharges from the respiratory or ocular secretions of cats, especially by immunosuppressed humans (Table 2). Topical or oral tetracycline derivatives are effective for treating infected cats.[163]

Group A *Streptococcus*

Humans are the natural hosts for group A *Streptococcus pyogenes*, the principal cause of "strep throat" in

humans. It is theoretically possible that cats in close contact with infected humans could develop colonization of pharyngeal tissues, which could lead to infection of humans.[172–175] However, this is poorly documented and is unlikely. Veterinarians may be consulted about treating the cats of a family with chronic or recurrent strep throat. Culture of the tonsillar crypts with Lancefield group serologic testing should be used to confirm carriage. Without serotyping, other β-hemolytic streptococci, not *S. pyogenes*, found in cats could be isolated and erroneously designated as the source of human infection. Penicillin derivatives should be effective at clearing any possible carrier state in cats.

Feline Plague

Feline plague is caused by *Y. pestis*, a gram-negative coccobacillus found most commonly in the United States in mid- and far-western states; it is also found in many Asian, African, and Latin American countries.[176,177] Rodents are the natural hosts for this bacterium; cats are most commonly infected by ingesting bacteremic rodents or lagomorphs or by being bitten by *Yersinia*-infected rodent fleas.[177] Humans are most commonly infected by rodent fleabites, but there have been many documented cases of transmission by exposure to wild animals and domestic cats. From 1977 to 1998, 23 cases of human plague (7.7% of the total cases) resulted from contact with infected cats.[178] Humans can be infected by inhalation of respiratory secretions of cats with pneumonic plague, by bite, or by contaminating mucous membranes or abraded skin with secretions or exudates. Bubonic, septicemic, and pneumonic plague can develop in cats and humans; each form has accompanying fever, headache, weakness, and malaise.[177] Suppurative lymphadenitis (buboes) of the cervical and submandibular lymph nodes is the most common clinical manifestation in cats. Exudates from cats with lymphadenomegaly should be examined cytologically for the characteristic bipolar rods. The diagnosis is confirmed by culture of exudates, the tonsillar area, and the saliva; by fluorescent antibody staining of exudates; and by documentation of increasing antibody titers. Cats in enzootic areas with suppurative lymphadenitis should be considered plague suspects, and extreme caution should be exercised when handling exudates or treating draining wounds. Humans that are exposed to infected cats should be urgently referred to physicians for antimicrobial therapy, and public health officials should be alerted. Aminoglycosides, chloramphenicol, enrofloxacin,[d] and tetracyclines can be used successfully for treating feline plague. Dogs are more resistant to *Yersinia* infection than are cats. Cats are not considered to be a zoonotic risk to humans after 4 days of antibiotic treatment. Guidelines for handling hospitalized plague suspects are listed in Table 7.

CUTANEOUS OR EXUDATE EXPOSURE

Dermatophytosis

Several dermatophytes are shared between cats and humans; *Microsporum canis* is thought to be the most common. Approximately 50% of exposed humans and most humans living in households with dermatophyte-infected cats become infected.[179] Cats can be subclinical carriers or develop superficial dermatologic disease characterized by broken-haired alopecia, crusts, and scales.[180,181] Infected humans develop characteristic red, raised, circular, pruritic lesions at infection sites. Invasive infection can occur in immunocompromised humans.[182] Microconidia may be noted within hair shafts on cytologic examination, and some cutaneous fungi fluoresce under black-light illumination. Definitive diagnosis can be made by culture of hair, but false-negative and false-positive results can occur. Risk to humans is greatest from kittens obtained from shelters with a known history of infection and from pet cats exposed to large numbers of other animals. The age of both the human and cat also influences risk; children and kittens are most likely to be infected.[183] To lessen the risk for zoonotic transmission, affected areas should be carefully shaved (which may worsen the lesion locally) and topical treatment combined with systemic treatment (Table 5). A vaccine is available that is not recommended by most as a preventative.[59] When used as a treatment, vaccination may result in the development of a subclinical carrier state. To be considered ringworm free, a previously infected cat should be shown to be culture negative three times, 3 weeks apart.[179]

Households with immunosuppressed family members should seek out veterinary care for clinically ill cats.

Ectoparasites

In addition to being the vector or reservoir of some zoonotic agents (see the Shared Vector Zoonoses section on p. 24), ectoparasites can induce disease prima-

Table 7. Plague Control Procedures

- In endemic areas from April through October, cats with clinical evidence of submandibular or retropharyngeal lymphadenopathy or abscessation, clinical signs of bacteremia, or coughing should be considered plague suspects.
- All plague suspects should be placed in strict isolation and the door clearly marked, indicating that a plague-infected animal is housed within.
- The number of staff exposures to the cat for treatments or cleaning should be minimized.
- Cats with submandibular abscessation should be handled with care; gloves, a surgical mask (preferably a N-95–type respirator), and a gown should be worn while aspirating the mass.
- Coughing cats with fever that require transoral tracheal aspiration should be handled as plague suspects; the procedures should be completed while wearing gloves, a gown, and a surgical mask.
- Specimens should be collected, bagged, clearly labeled, indicating they are from a plague suspect, and transported to the appropriate diagnostic laboratory.
  - —Antemortem samples should be submitted only from client-owned cats and should include abscess material smeared and dried on a slide for fluorescent antibody staining, abscess biopsy, lymph node biopsy, and tracheal wash fluid. Fresh tissues or fluids can be submitted for culture or mouse inoculation.
  - —Postmortem samples vary by the clinical signs; appropriate tissues include abscess material, spleen, liver, or lung.
- Surfaces contaminated by contact with fluids from infected cats should be cleaned with quaternary ammonium disinfectants.
- Bedding and waste should be incinerated.
- Affected cats, the home environment, and the veterinary hospital should be treated for fleas.
- Clients and all other individuals that have been in contact with an infected cat should be urgently advised to consult a physician for prophylactic antibiotic treatment.
- Animals that have been in contact with infected cats should be treated prophylactically with tetracyclines for 7 days.
- County and the state department of health officials should be notified.

rily. *Ctenocephalides felis, Cheyletiella* spp, *Sarcoptes scabei, Notedres cati,* and a variety of ticks parasitize both cats and humans. Pruritic skin disease is most common with ectoparasites other than ticks. Diagnosis is based on gross visualization of the organism (*C. felis,* ticks) or during microscopic examination of skin scrapings (*S. scabei, N. cati, Cheyletiella*) or material obtained from combing or a tape test (*Cheyletiella*). Topical and systemic treatments are available (Table 5).

Sporotrichosis

Sporothrix schenckii is a saprophytic fungus common to soils throughout the world. Multiple cases have been reported in cats.[184–186] Infection of cats and humans usually occurs after the organism contaminates broken skin. Cats are thought to be infected by scratches from contaminated claws of other cats; infection is most common in outdoor males.[185] Infection of both cats and humans is characterized by ulcerative cutaneous lesions, usually with a mucopurulent discharge. In cats, lesions are most common on the limbs, head, and tail base. Many cats develop systemic infection of lymph nodes and lymphatics. Humans often have nodular lymphadenitis advancing centripetally from the site of inoculation. In cats, the organism replicates readily and large numbers are passed in the exudates, potentially resulting in human infection.[186] The organism is round, oval, or cigar shaped and can be extracellular or intracellular after being engulfed by macrophages. The presumptive diagnosis is based on cytologic demonstration; definitive diagnosis is confirmed by culture. Long-term antifungal treatment is usually required. Direct skin contact with exudates should be avoided.

GENITOURINARY EXPOSURE

Coxiellosis

C. burnetii is the rickettsial agent found throughout the world, including North America, that causes Q fever in humans. Cats, cattle, sheep, and goats are usually subclinically infected and pass the organism into the environment in urine, feces, milk, and parturient discharges. Infection of cats most commonly occurs following tick exposure, ingestion of contaminated carcasses, or aerosolization from a contaminated environment. The true incidence of infection in cats has not been determined; 20% of the cats tested from a humane society in southern California and in maritime Canada tested seropositive, suggesting that exposure is common.[187,188] The organism was grown from the vagina of healthy cats in Japan.[189] Humans are infected by aerosol exposure to the organism passed by normally parturient or aborting cats. Acute clinical signs in humans include fever, malaise, headache, interstitial

pneumonitis, myalgia, and arthralgia.[190–194] In cat-associated infections, clinical signs develop 4 to 30 days after contact. In approximately 1% of human cases, chronic Q fever can develop years after primary infection and can manifest as hepatic inflammation or valvular endocarditis. Tetracyclines, chloramphenicol, and quinolones are usually effective therapeutic agents in humans. Gloves and masks should be worn when attending to parturient or aborting cats.

Leptospirosis

Cats can be infected with *Leptospira interrogans*, but the disease is usually subclinical even though organisms can be detected in urine, blood, and tissues.[195] Ascites resulting from infection may have occurred in one cat.[196] To our knowledge, infection of humans from cat contact has not been reported.

Approximately 50% of humans exposed to *M. canis* and most humans living in households with dermatophyte-infected cats become infected.

SHARED VECTOR ZOONOSES

Many zoonotic organisms are transmitted by vectors. Those transmitted by fleas and ticks potentially have the greatest significance because cats can bring those vectors into the human environment. Those transmitted by mosquitoes, such as *Dirofilaria immitis* and West Nile virus, are not directly related to cats in any fashion.

Anaplasma phagocytophilum

DNA of *A. phagocytophilum* (previously *Ehrlichia equi* and human granulocytic ehrlichial agent)[197] has been amplified from the blood of cats in the United States, Sweden, Ireland, Denmark, and Mexico.[198–202] Several of the cats were clinically ill and responded to administration of tetracycline therapy, suggesting that the organism was associated with the clinical disease.[198,199] Several of the cats were infested by *Ixodes* spp ticks that are known to be the vector in humans. Although unknown, it is unlikely that direct contact with infected cats would result in human infection. Fleas and/or ticks should be controlled if infestations are likely to occur.

Bartonella spp

B. henselae is transmitted between cats by fleas and lives for at least days in flea feces.[113,114,117] Thus it is possible that fleas or their excrement are associated with human infection. (See the Bites and Scratches section on p. 18 for further discussion of this organism.)

Borrelia burgdorferi

Ixodes spp ticks are the vectors for *B. burgdorferi*. The organism is endemic to the northeastern and north-central United States as well as northern California.[203] Significant clinical syndromes in some infected humans include rash, arthritis, cranial neuropathies, and myocardial disease. Although *B. burgdorferi* antibodies have been detected in the serum of cats and experimental infections have been produced, there is no compelling evidence to suggest that naturally infected cats are clinically affected.[204,205] There is no evidence that human borreliosis is associated with cat contact. It is unlikely that the organism reaches infectious levels in cat urine. However, because *Ixodes* spp feed on cats, it is possible for cats to bring infected ticks into the human environment (Table 2).

Ehrlichia spp

Based on the presence of morulae in mononuclear cells and the presence of antibodies that seroreact with *Ehrlichia canis* or *Neorickettsia risticii* (previously *Ehrlichia risticii*), ehrlichiosis has been suspected in multiple cats around the world.[206–213] To date, *E. canis*–like DNA has been amplified from EDTA blood from three cats in North America and two cats in France.[212,213] Whether these *Ehrlichia* organisms will also infect humans is unknown, and it is unlikely that direct zoonotic transfer occurs.

Rickettsia felis

In humans, louse-borne or epidemic typhus is caused by *Rickettsia prowazekii*. In southern Texas and California, opossums serve as a reservoir, and the organism is transmitted by *Ctenocephalides felis*. Using PCR and restriction fragment length polymorphism, *R. felis* was discovered in a human with clinical signs similar to those of typhus.[214–215] Subsequently, *R. felis* has been isolated from *C. felis* in multiple states, including California, Florida, Georgia, Louisiana, New York, North Carolina, Oklahoma, Texas, and Tennessee, as well as in France.[216] The organism is passed trans-stadially and

transovarially in fleas. Experimentally inoculated cats are subclinically infected but seroconvert. It is unknown whether cats are clinically affected.

SHARED-ENVIRONMENT ZOONOSES

A number of infectious agents infect humans and cats from the same environment but are not usually transmissible between species. Examples include *Histoplasma capsulatum, Blastomyces dermatitidis, Coccidioides immitis, Cryptococcus neoformans, Mycobacterium avium,* and *Aspergillus* spp. Cats infected with these organisms can be sentinels, warning of environmental risk to humans.

BIOTERRORISM

Y. pestis, F. tularensis, Bacillis anthracis, and *C. burnetii* are some of the potential agents of bioterrorism. Cats could be coincidental victims of such an attack and could be sentinels of human exposure. They could also maintain the infection in the environment for some period of time after the initial attack. Veterinarians should promptly report cases of these infections to their state departments of animal and public health and should do so with particular urgency if cases occur with unusual frequency or geographic distribution. Further discussion of bioterrorism is beyond the scope of this article. Links to important resources are available for review.[e]

RECOMMENDATIONS FOR VETERINARIANS

Veterinarians should familiarize themselves with zoonotic issues and take an active role in discussion of the health risks and benefits of pet ownership with clients so that logical decisions concerning ownership and management of individual animals can be made (Tables 2 and 3). Attempts should be made to show that the staff of the veterinary hospital understands immunodeficiency, is discreet, and is willing to help. Veterinarians should contact appropriate public health officials when reportable zoonotic diseases are diagnosed. Information concerning veterinary or public health aspects of zoonoses should be provided to clients as indicated or requested, but veterinarians should not diagnose or treat diseases in humans or make recommendations about those issues. The client should always be referred to a human health care provider for additional information and treatment. The veterinarian should always document in the medical record that public health–related advice was offered. Failure to provide information concerning zoonoses may have legal implications.[217] Biosecurity procedures should be followed to lessen the potential for infectious disease spread within a hospital (Table 8).

Information concerning veterinary or public health aspects of zoonoses should be provided to clients as indicated or requested, but veterinarians should not diagnose or treat diseases in humans or make recommendations about those issues.

BIOSECURITY PROCEDURES FOR SMALL ANIMAL HOSPITALS[f]

General Biosecurity Guidelines

Contaminated hands are the most common source of infectious disease transmission in the hospital environment. Fingernails of personnel having patient contact should be cut short. Hands should be washed before and after attending to each individual animal. Hands should be washed as follows:

- Collect clean paper towels, and use them to turn on the water faucet.
- Wash hands for 30 seconds with antiseptic soap; be sure to clean under the fingernails.
- Rinse hands thoroughly.
- Dry hands with clean paper towels.
- Turn off the water faucet with paper towels.

Antiseptic hand lotions should be made available. Personnel with soiled hands or gloves should not touch patients, clients, food, doorknobs, drawer or cabinet handles or contents, equipment, or medical records.

All employees should wear an outer garment, such as a smock or scrub suit, when attending to patients.

[e]American Veterinary Medical Association: *Resources Related to Terrorism and Emergency Preparedness.* **http://www.avma.org/pubhlth/biosecurity/resources.asp**; accessed November 2003.

[f]Adapted from Colorado State University: *Biosecurity Standard Operating Procedures.* Available at **http://www.vth.colostate.edu/vth/biosecurity/biosecurity.html**; accessed November 2003.

Footwear should be protective, clean, and cleanable, or disposable shoe covers should be used appropriately. A minimum of two sets of outer garments should always be available and should be changed immediately after contamination with feces, secretions, or exudates. Equipment (e.g., stethoscopes, pen lights, thermometers, bandage scissors, lead ropes, percussion hammers, clipper blades) can be a fomite and should be cleaned and disinfected with 0.5% chlorhexidine solution after each use. Disposable thermometer covers or disposable thermometers should be used.

To avoid zoonotic transfer of infectious diseases, food or drink should not be consumed in areas where cat care is provided. Food and beverages should not be kept in refrigerators used for storing laboratory specimens. All areas where cats are examined or treated should be cleaned and disinfected immediately after use, irrespective of infectious disease status of the individual animal.

Patient Evaluation

Recognition of zoonotic diseases starts with the front desk personnel. Staff should be trained to be alert for public health problems and to direct these issues to the appropriate individual. Cats with cutaneous, GI, or respiratory diseases are the most likely to be contagious. Infectious GI disease is possible in all cats with small or large bowel diarrhea, whether the signs are acute or chronic. The index of suspicion for infectious diseases is increased for cats with acute disease and fever, particularly if the animal is from a crowded environment such as a breeding facility, boarding facility, or humane society. Front desk personnel should indicate clearly on the hospital record that an animal has a GI or respiratory disease. If the presenting complaint is known before admission into the hospital, it is optimal to meet the client in the parking area to determine the infectious disease risk before entering the hospital. If infectious GI or respiratory disease is suspected, the cat should be transported (i.e., not allowed to walk on the premises) to an examination room or the isolation facility. If a cat with acute GI or respiratory disease is brought directly to the reception desk, the receptionist should contact the receiving clinician or technician immediately and coordinate placement of the animal in an examination room to minimize hospital contamination. If hospitalization is required, the cat should be transported to the appropriate housing area by the shortest route possible, preferably using a carrier to reduce hospital contamination.

Hospitalized Patients

If possible, all cats with suspected zoonotic diseases (e.g., infection with *Salmonella* spp, *Campylobacter* spp, rabies virus, or plague) should be housed in an isolated area of the hospital. The number of staff members entering the isolation area should be kept to a minimum. Upon entry into the isolation area, outerwear should be removed and surgical booties or other disposable shoe covers placed over the shoes. Alternately, a footbath filled with disinfectant should be placed by the exit and used when leaving the area. A disposable gown (or smock designated for the patient) and latex gloves should be worn. A surgical mask (preferably a type N-95 particulate respirator) should be worn when attending to cats with plague. Separate equipment and disinfectant supplies should be used in the isolation area.

All biologic materials submitted to the clinical pathology laboratories or diagnostic laboratories from animals with suspected or proven infectious diseases should be clearly marked as such. Fecal material should be placed in a plastic, screw-capped cup using a tongue depressor and while wearing gloves. The cup should be placed in a clean area and the lid put on with a clean-gloved hand. The used gloves should be removed and the cup placed in a second bag clearly marked with the name of the

Table 8. General Hospital Biosecurity Guidelines

- Wash hands before and after contact with each cat.
- Wear gloves when handling cats when zoonotic diseases are in the differential diagnosis.
- Minimize contact with hospital materials (e.g., instruments, records, door handles) while hands or gloves are contaminated.
- Always wear an outer garment, such as a smock or scrub shirt, when handling cats.
- Change outer garments when soiled by feces, secretions, or exudates.
- Clean and disinfect equipment (e.g., stethoscopes, thermometers, bandage scissors) with 0.5% chlorhexidine solution after each use.
- Do not consume fluid or drink in areas where cat care is provided.
- Clean and disinfect examination tables and cages after each use.
- Clean and disinfect litterboxes and dishes after each use.
- Immediately place cats with suspected infectious diseases into an examination room or isolation area on admission into the hospital.
- When possible, postpone (until the end of the day) any procedures using general hospital facilities, such as surgery and radiology.

zoonotic disease suspected. The outer surface of the bag should be disinfected before leaving the isolation area.

Disposable materials should be placed in plastic bags in the isolation area. The external surfaces of the bags should be sprayed with a disinfectant prior to being removed from the isolation area. After attending to the patient, contaminated equipment and surfaces should be cleaned and disinfected, and contaminated outer garments and shoe covers should be removed. Hands should be washed after discarding the contaminated outerwear. Disposable dishes and litter pans should be used, or dishes and litter pans should be cleaned thoroughly with detergent before returning them to the central supply area. Optimally, materials such as outerwear and equipment that will be returned to the central supply area should be placed in plastic bags and sprayed with a disinfectant before transport. Procedures requiring general hospital facilities, such as surgery and radiology, should be postponed to the end of the day, if possible, and contaminated areas should be disinfected before use with other animals. Cats should be discharged using the shortest possible route to the parking lot.

Basic Disinfection Protocols

Cats should not be moved from cage to cage, if possible. Cage papers and litter pans soiled by feces, urine, blood, exudates, or respiratory secretions should be removed and placed in trash receptacles. Bulk fecal material should also be placed in trash receptacles.

Many agents are resistant to disinfectants or require prolonged contact time to be inactivated.[218] Contaminated surfaces, including the cage or run floor, walls, ceiling, door, and door latch, should be wetted thoroughly with a disinfectant and then blotted with clean paper towels or mops. Surfaces should be in contact with the disinfectant for 10 minutes, if possible, particularly if known infectious agents are present. Soiled paper towels should be placed in trash receptacles. If zoonotic diseases are suspected, trash bags should be sealed, the surface of the bag sprayed with a disinfectant, and the trash bags discarded.

Contaminated surfaces in examination rooms should be cleaned to remove hair, blood, feces, and exudates. Examination tables, countertops, floors, canister lids, and water taps should be saturated with disinfectant for 10 minutes, if possible. Surfaces should be blotted dry with paper towels and the soiled towels placed in a trash receptacle. Urine or feces on the floor should be contained with paper towels, blotted, and placed in trash receptacles. The soiled area of the floor should be mopped with disinfectant.

Disinfectants are relatively effective for viral and bacterial agents but require high concentrations and long contact times to kill parasite eggs, cysts, and oocysts. Cleanliness is the key to lessening hospital-borne infections with these agents; detergent or steam cleaning inactivates most. Litter pans and dishes should be thoroughly cleaned with detergent and scalding water.

More frequent cleaning is suggested for areas where hospital-acquired infections are more common, such as surgical suites and critical care units. In these areas, periodic closure for extensive cleaning is indicated. If hospital-borne infections occur frequently, environmental cultures should be used to attempt to identify a source, and cleaning and disinfection protocols should be assessed.

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