Leptospirosis is a bacterial zoonosis that is common worldwide, especially in developing countries. Organisms are shed in the urine of infected animals, including rodents and domesticated animals, which may not show signs of disease. Humans usually become ill after contact with infected urine, or through contact with water, soil or food that has been contaminated. Outbreaks have been associated with floodwaters. In animals, the clinical signs of leptospirosis are often related to kidney disease, liver disease or reproductive dysfunction. In humans, many cases are mild or asymptomatic, and go unrecognized. In some patients, however, the illness may progress to kidney or liver failure, aseptic meningitis, life-threatening pulmonary hemorrhage and other syndromes.

Etiology
Leptospirosis is caused by various species of *Leptospira*, a spirochete in the family Leptospiraceae, order Spirochaetales. Some *Leptospira* are harmless saprophytes that reside in the environment, while others are pathogenic. The basic unit of *Leptospira* taxonomy is the serovar. Serovars consist of closely related isolates based on serological reactions to the organism’s lipopolysaccharide. More than 250 pathogenic serovars, and at least 50 nonpathogenic serovars, have been identified.

Species affected

**Maintenance hosts**
*Leptospira* serovars are generally adapted to one or more mammalian or marsupial maintenance hosts, which may or may not develop clinical signs. Dogs are reservoir hosts for serovar Canicola, and pigs for Bratislava and Pomona. Horses may also maintain Bratislava. Cattle are the primary reservoir hosts for Hardjo; however, this serovar is also maintained in farmed red deer (*Cervus elaphus*) and wapiti (*Cervus elaphus nelsoni*) in New Zealand, and sheep and goats may also have a role. Rodents and insectivores are reservoir hosts for a number of *Leptospira* serovars, including members of the serogroups Icterohaemorrhagiae, Grippotyphosa and Sejroe. In particular, rats are important hosts for serovars Icterohaemorrhagiae and Copenhageni in the serogroup Icterohaemorrhagiae. Other domesticated and wild animals (e.g., skunks, raccoons, wild boars) are also thought to maintain pathogenic *Leptospira*, but in many cases, there is less information about their roles.

**Clinicaly affected species**
Leptospirosis occurs in dogs, cattle, sheep, goats, horses, pigs, South American camelids and farmed cervids, but illness seems to be rare in cats. Disease also seems to be uncommon in camels, although this might result from nomadic husbandry rather than innate resistance. Leptospirosis has been reported occasionally in zoo animals or wildlife. Among marine mammals, clinical cases have occurred most often in California sea lions (*Zalophus californianus*) and northern fur seals (*Callorhinus ursinus*), but they have also been seen in captive harbor seals (*Phoca vitulina*) and northern elephant seals (*Mirounga angustirostris*). The most common *Leptospira* serovars in clinical cases vary with the host species and geographic region, and sometimes with selection pressures from vaccination. Icterohaemorrhagiae and Canicola were once the most common serovars in symptomatic dogs, but the introduction of Icterohaemorrhagiae/Canicola vaccines has resulted in the increasing prominence of other serovars.

**Zoonotic potential**
A variety of *Leptospira* species and serovars can cause disease in humans; however, members of *L. interrogans* and *L. borgpetersenii* are found most often. People are usually considered to be incidental hosts, which do not act as reservoirs for these organisms. One recent study suggested that people might maintain *Leptospira* in certain environments such as the Peruvian Amazon.

**Transmission**
Leptospirosis can be transmitted either directly between hosts or indirectly through the environment. *Leptospira* spp. can be ingested in contaminated food or water, spread in aerosolized urine or water, or transmitted by direct contact with the skin. The organisms usually enter the body through mucous membranes or abraded skin. They might also be able to penetrate intact skin that has been immersed for a long time in water, although this is controversial.

*Leptospira* spp. are excreted in the urine of both acutely and chronically infected animals. Chronic carriers may shed these organisms for months or years. Although humans can also shed *Leptospira* in the urine, prolonged shedding seems to be uncommon; most people excrete these bacteria for 60 days or less. In animals, *Leptospira* can be found in aborted or stillborn fetuses, as well as in normal fetuses or vaginal discharges after giving birth. They can be isolated from the male and female reproductive organs in some species, and these infections may persist for long periods. For example, serovar *Hardjo* may be found in the reproductive tract of both cows and bulls for more than a year. In rare instances, human cases have also been transmitted during sexual intercourse, or by breast feeding. Other uncommon routes of exposure in people include rodent bites and laboratory accidents.
Pathogenic *Leptospira* spp. do not multiply outside the host. In the environment, they require high humidity for survival and are killed by dehydration or temperatures greater than 50°C (122°F). These organisms may remain viable in the environment for several months under optimal conditions, e.g., in water or contaminated soil. They survive best in bodies of water that are slow-moving or stagnant.

**Disinfection**

*Leptospira* can be inactivated by 1% sodium hypochlorite, 70% ethanol, iodine-based disinfectants, quaternary ammonium disinfectants, accelerated hydrogen peroxide, glutaraldehyde, formaldehyde, detergents and acid. This organism is sensitive to moist heat (121°C [249.8°F] for a minimum of 15 min). It is also killed by pasteurization.

**Infections in animals incubation period**

The incubation period can be as short as a few days, with clinical signs appearing after 5 to 15 days in experimentally infected dogs. It may be longer when clinical signs are the result of chronic, low level damage to the kidneys or liver. Rare case reports in cats suggest the possibility of prolonged incubation periods in this species. Abortions usually occur 2 to 12 weeks after infection in cattle, and 1 to 4 weeks after infection in pigs.

**Clinical signs**

**Dogs**

The syndromes and disease severity are highly variable in dogs. The initial clinical signs are usually nonspecific, and may include fever, depression, anorexia, stiffness, myalgia, shivering and weakness. The mucus membranes are often injected. Later, there may be signs of kidney involvement, with polydipsia, polyuria, oliguria, or anuria, and hematuria or dehydration in some cases. Fever may or may not be apparent in dogs that present with kidney signs. Vomiting, diarrhea, abdominal pain, gray stools, weight loss, jaundice, conjunctivitis and abortions can also be seen. Hemorrhagic syndromes occur in some dogs: the mucus membranes may have petechial and ecchymotic hemorrhages, and in later stages of the disease, there may be other signs such as hemorrhagic gastroenteritis and epistaxis. Leptospiral pulmonary hemorrhage syndrome has been seen in dogs, and can cause coughing, tachypnea or dyspnea. Vasculitis may result in peripheral edema and mild pleural or peritoneal effusion. Evidence of pancreatitis or myocardial involvement (ECG alterations) has also been reported. Deaths can occur at any time, including the acute stage. Chronic kidney disease can be a sequela.

Chronic infections may be asymptomatic, or associated with fever of unknown origin. There may also be a link between leptospirosis and some cases of chronic hepatitis.

**Cats**

Clinical leptospirosis appears to be uncommon in cats, but rare cases with kidney signs, icterus, uveitis and/or lameness have been reported. Experimentally infected cats had only mild clinical signs (mild temperature elevation, polyuria/polydipsia), although some animals had histopathological evidence of inflammation in the kidneys and liver. The clinical signs included depression, dehydration, vomiting, polydipsia and fever, as well as abortions and neonatal deaths. Affected sea lions are typically reluctant to use their hind flippers, and assume a hunched position with the flippers held over the abdomen. A few case reports have documented leptospirosis in other species. The clinical signs in two black rhinoceroses (*Diceros bicornis michaeli*) included acute depression, anorexia, gastrointestinal discomfort with reduced fecal output, rear leg trembling, dysuria and glucosuria. One animal died rapidly, but the other survived with treatment. Illnesses that might have been caused by *Leptospira* were reported in a captive cougar (*Puma concolor*) with fatal interstitial nephritis, and a wild cougar that was concurrently infected with FeLV. Clinical cases, some severe, have also been reported uncommonly in nonhuman primates. Many infections in wildlife, particularly rodents, are thought to be asymptomatic.

**Diagnostic tests**

Leptospirosis can sometimes be diagnosed by detecting the organism, its antigens or nucleic acids in clinical samples such as blood (acute infections), urine and milk, or liver, kidney and other tissue samples collected at necropsy. Shedding of organisms in the urine may be either continuous or intermittent. *Leptospira* is usually identified in clinical samples by immunofluorescence or immunohistochemical staining, or polymerase chain reaction (PCR) techniques. These organisms stain poorly with the Gram stain, and are not observed by microscopy unless special stains or methods are employed. Silver staining or immunogold-silver staining is sometimes useful as an adjunct technique. Darkfield microscopy can also be used to detect *Leptospira*; however, this technique is non-specific and not very sensitive.

Culture is definitive, but the availability of this test is limited. *Leptospira* spp. can be isolated on a variety of media, but they are fastidious and grow slowly on primary isolation. Special transport media may be required for shipment to the laboratory. Depending on the serovar, culture can take up to 13 to 26 weeks. Identification to the species, serogroup and/or serovar level is done by reference laboratories, using genetic and immunological techniques.
Serology is often used to diagnose leptospirosis. Caution must be used in interpreting serological test results, as subclinical infections are common; the vaccination status of the animal must be considered; antibodies may not be present early in the illness; and antibody titers can become low or undetectable in some chronically infected animals. Paired acute and convalescent samples are preferred from most animals, and rising antibody titers are usually seen in acute cases. Single samples with high titers increase the suspicion of leptospirosis, although they are not definitive. However, a single positive sample from an aborted fetus is diagnostic. Herd tests are often used in ruminants. The most commonly used serological tests in animals are the microscopic agglutination test (MAT) and enzyme-linked immunosorbent assays (ELISAs). The MAT evaluates antibody responses to a selection of Leptospira serovars (often 5-7 in veterinary assays). This test is serogroup but not serovar specific, although it may suggest a likely serovar. False negatives are possible if the infecting serogroup was not included in the MAT panel. ELISAs, including a bovine milk ELISA, are available for some species of animals.

**Treatment**

Various antibiotics including tetracyclines (e.g., doxycycline), penicillins, dihydrostreptomycin and streptomycin may be used to treat leptospirosis. Fluid therapy, blood transfusions, respiratory support, and other supportive care may also be necessary.

The primary treatment for equine recurrent uveitis in horses is anti-inflammatory drugs and medications to decrease discomfort (e.g., mydriatic cycloplegics such as topical atropine). Surgery (pars plana vitrectomy) and other therapies may also be used.

**Prevention**

Leptospirosis vaccines are widely available for pigs, cattle, and dogs. In some countries, vaccines may also be licensed or used in other species such as sheep, goats or farmed deer. Vaccines are usually protective only against the included or closely related serovars, and their content may need to be changed periodically. Most bovine vaccines contain serovar Hardjo, and most porcine vaccines contain Pomona, although other serovars may be included depending on the region. Vaccines for dogs have traditionally contained Icterohaemorrhagiae and Canicola, but additional serovars are now included in some vaccines, particularly in North America. In addition to routine use, vaccines are sometimes used to help prevent further abortions in livestock herds in the face of an outbreak.

Isolation and treatment of infected animals reduces the risk that they may spread the infection to contacts. Prophylactic treatment with antibiotics can be used to prevent disease in exposed animals.

Environmental control measures and sanitation may also reduce the risk of infection, although their practicality varies with the host species and situation. Such measures include providing safe drinking water, and preventing contact with contaminated environments (e.g., lakes) or infected domesticated animals and wildlife, particularly rodents. Good sanitation can reduce the risk of infection in kennels, and in areas where livestock are bred or give birth. Quarantine and testing of newly acquired livestock, or new equine studs on a farm, can also help prevent the introduction of Leptospira.

Large-scale eradication programs have not been widely used for leptospirosis; however, a control program has virtually eliminated serovar Hardjo from cattle herds in the Netherlands. This program includes regular testing of bulk tank milk with a Hardjo-specific ELISA, antibiotic treatment of infected cattle, and certification of Hardjo-free farms. Its success depends, in part, on the absence of serovar Hardjo in wildlife hosts.

**Morbidity and mortality**

Leptospirosis is particularly prevalent in warm and humid climates, and marshy or wet areas. This disease is often seasonal: it is most common during the rainy season in the tropics, and in the summer and fall in temperate regions.

Morbidity and mortality vary with the species and age of the animal, the host specificity of the serovar, and other factors. Leptospirosis is often asymptomatic or mild in adult pigs and cattle, and reproductive signs are the main evidence of infection. In newly infected cattle herds, up to 40% or more of the cows may abort. In endemically infected herds, abortions are usually sporadic and occur mainly in younger animals. Young livestock may be more severely affected, and can develop acute disease. In dogs, the risk of infection can vary with lifestyle factors, such as exposure to lakes and ponds. With treatment, 80% of dogs are expected to survive even when the kidneys are involved. However, the prognosis is poorer in cases with severe pulmonary complications. Domesticated cats rarely seem to be affected, although serological surveys report that up to 35% of cats may be exposed in some populations.

There is little information about the impact of leptospirosis, if any, on most wildlife species. In some areas, major outbreaks occur periodically among wild California sea lions.
Internet resources
Centers for Disease Control and Prevention (CDC)
http://www.cdc.gov/leptospirosis/index.html


FAO Manual on Meat Inspection for Developing Countries http://www.fao.org/docrep/003/t0756e/t0756e00.htm


International Veterinary Information Service (IVIS)
http://www.ivis.org

Public Health Agency of Canada. Pathogen Safety Data Sheets

The Merck Manual
http://www.merckmanuals.com/professional/index.html

The Merck Veterinary Manual
http://www.merckmanuals.com/vet/index.html

World Health Organization (WHO), Leptospirosis
http://www.who.int/topics/leptospirosis/en/

WHO Leptospirosis fact sheet http://www.searo.who.int/about/administration_structure/cks/CDS_leptospirosis-Fact_Sheet.pdf

World Organization for Animal Health (OIE)
http://www.oie.int/


Disease and Infection Prevention Practices: Is Your Clinic Up to Snuff?
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This document is designed to provide a complete and readily accessible summary of infection prevention and control best practices for small animal veterinary clinics, and is intended to be understandable to all members of the veterinary practice team.

1. Infection prevention and control strategies are designed to **protect patients, owners, veterinary personnel and the community**. All veterinary personnel should play an active role in protecting every person and animal associated with the veterinary clinic.

2. **Every** veterinary clinic, regardless of type or size, should have a **formal infection control program**, a written infection control manual, and an infection control practitioner (ICP) to coordinate the program.

3. Some form of **surveillance** (either passive or active) should be practiced by all veterinary facilities. The keys to passive surveillance are to centralize the available data, and to have a designated ICP who compiles and evaluates the data on a regular basis.

4. **Routine Practices** that are critical to infectious disease prevention and control:
   a. Hand hygiene, including:
      i. Handwashing
      ii. Use of alcohol-based hand sanitizers
   b. Risk reduction strategies, particularly those related to:
      i. Use of personal protective equipment (PPE)
      ii. Cleaning and disinfection
      iii. Laundry
      iv. Waste management
   c. Risk assessment of animals and personnel with regard to:
      i. Disease transmission
      ii. Disease susceptibility
   d. Education
      i. Veterinary personnel
      ii. Animal owners
      iii. Public

5. All **surgical procedures** cause breaks in the normal defensive barriers of the skin or mucous membranes, and therefore carry an inherent risk of surgical site infection (SSI). Good general infection control practices (e.g. hand hygiene, cleaning and disinfection) are important for prevention of SSIs, but there are also specific infection control measures pertaining to surgery that should be considered.

6. Every veterinary clinic should have an **isolation area** for caring for and housing animals with potentially contagious infectious diseases.

7. Proper **wound care** is critical to preventing transmission of bacteria, particularly multidrug-resistant pathogens, between animals, personnel and the environment.

8. **Animals from shelters** and similar facilities should be considered high risk from an infectious disease standpoint and managed appropriately to prevent transmission of disease.

9. **Safety** of personnel and animal owners should always be a priority. Personnel should take all necessary precautions to prevent animal-related injuries (e.g. bites, scratches), and all bite wounds should be taken seriously. Proper sharps handling practices should be emphasized to reduce the risk of needle-stick injuries.

10. **Education** of personnel and clients about zoonotic and infectious disease risks and prevention is crucial.

Guiding principles
1. Infection prevention and control strategies are designed to protect patients, owners, veterinary personnel and the community.

2. A significant percentage of hospital-associated infections (HAIs) in veterinary clinics can likely be prevented with proper compliance to basic, practical infection control practices.
a. Although poorly quantified, HAIs occur in veterinary clinics and can have a significant impact on animal health. While the proportion of preventable HAIs in veterinary clinics is unknown, it has been estimated at 30-70% of HAIs in human hospitals are preventable (Haley et al. 1985).

3. A systematic approach to infection prevention and control requires all veterinary personnel to play an active role in protecting every person and animal associated with the veterinary clinic, patients or veterinary personnel.

4. Veterinary personnel need to follow infection prevention and control protocols at all times and use critical thinking and problem solving in managing clinical situations.

Basic principles of infection prevention and control

General concept

Every veterinary clinic, regardless of size and type, should have a documented infection control program. This may range from simply a written collection of basic infection control practices, to a formal infection control manual with specific training, monitoring, surveillance and compliance programs. Lack of a clearly defined infection control program may lead to unnecessary patient morbidity and mortality, and exposure of veterinarians, staff and owners to zoonotic pathogens. Improved infection control is a necessity as veterinary medicine evolves. Advances in veterinary medicine mean that animals are living longer, and owners are often expecting a higher level of care for their pets that is more comparable to what they themselves may receive. There are also more animals at higher risk for infection in general because of more invasive and immunosuppressive therapies. In addition to the desire to achieve “best practice” standards whenever possible, the increasingly litigious nature of society may be one of the driving forces toward improved infection control in veterinary clinics. While the potential liability associated with morbidity and mortality in individual pets is limited, the potential consequences of zoonotic diseases in owners and staff are significant and warrant careful consideration.

Infection prevention and control measures can be broadly divided into three main categories: those that decrease host exposure, decrease host susceptibility and increase host resistance to infectious pathogens.

1. Decreasing exposure is the most important aspect of disease control in most situations. If a pathogen does not encounter an individual, then disease cannot occur. The number of organisms to which a host is exposed is also an important factor in determining whether or not colonization or infection (disease) will ensue. Depending on the pathogen, decreasing or preventing exposure may be easy, difficult or impossible.

2. There are many factors that interact to determine whether or not infectious disease will develop in a particular host. In most cases, simple exposure of an animal to an infectious agent does not mean that disease will result. The susceptibility of the individual to a particular number of an infectious agent plays an important role. Although difficult to quantify, certain situations may result in increased susceptibility to infection and disease. Many factors causing increased susceptibility are not preventable, but some are, and efforts should be undertaken to address these issues. Factors to consider include judicious use of antimicrobials and other drugs, provision of proper nutrition, adequate pain control, and appropriate management of underlying disease.

3. Measures to actively increase resistance of a host are commonly used in veterinary medicine, but these should be considered only the third line of defense, after those meant to decrease exposure and susceptibility. Vaccination is currently the main technique used to increase resistance of animals or humans to infection. However, no vaccine is 100% effective. Therefore, while vaccination is an important part of infection prevention and control, it must not be the only component of an infection control program if the program is to be successful. In addition, many HAI-infections are caused by opportunistic microorganisms for which vaccines are unavailable.

Transmission

Microorganisms are transmitted in animal health care settings by four main routes: contact, droplet, air-borne and vector-borne transmission. The same microorganism may be transmitted by more than one route.

1. Contact transmission is the most important and frequent mode of transmission of health-care associated infections (HAIs). It can be divided into direct and indirect contact transmission.

   a. Direct contact transmission involves direct body surface-to-body surface contact resulting in physical transfer of microorganisms from an infected or colonized animal. For example, two dogs in a waiting room that come into direct contact when they sniff each other may transmit pathogens present in their noses or perineal areas; direct contact of a veterinarian’s hands with a wound on an animal may result in transmission of opportunistic pathogens from the normal microflora of the person’s hands, or infectious organisms present in the animal’s wound, to the patient or the veterinarian, respectively.

   b. Indirect contact transmission is the result of physical transfer of microorganisms from the original animal (or human) source to a new host, without direct contact between the two. This typically involves body surface contact with an inanimate object, environmental surface or the integument of another animal or person that has been transiently contaminated by the original animal (or human) source. For
example, handling one animal and then petting another animal without washing one’s hands constitutes indirect contact between the two animals.

2. **Droplet transmission** is theoretically a form of contact transmission. However, the mechanism of transfer of the pathogen from host to host is quite distinct from either direct or indirect contact transmission. Droplets are generated from the source animal primarily during coughing or sneezing, and during the performance of certain procedures such as suctioning. Transmission occurs when droplets containing microorganisms generated from the source animal are propelled a short distance through the air (usually less than one metre) and deposited on the new host’s conjunctiva (i.e. in the eye), nasal mucosa, mouth, or an open wound. For example, a cat with an upper respiratory tract infection can transmit viruses or bacteria to another cat in the waiting room by sneezing on it, particularly if they are face-to-face, even if the animals do not touch each other directly. Because droplets do not remain suspended in the air, special air handling and ventilation are not required to prevent droplet transmission; that is, droplet transmission must not be confused with air-borne transmission. Droplets can also contaminate the surrounding environment and lead to indirect contact transmission.

3. **Airborne transmission** occurs by dissemination of either airborne droplet nuclei (5 μm or smaller, about 2-3 times the size of most bacterial pathogens) from partly-evaporated droplets containing microorganisms, or dust particles containing the infectious agent. Microorganisms carried in this manner remain suspended in the air for long periods of time and can be dispersed widely by air currents. They may be inhaled by another host within the same room, or they may reach hosts over a longer distance from the source, depending on environmental factors. Airborne transmission of pathogens in veterinary clinics is very rare.

4. **Vector-borne transmission** occurs when vectors such as mosquitoes, flies, ticks, fleas, rats, and other vermin transmit microorganisms. Some act as simple mechanical vectors, comparable to indirect contact transmission, whereas others acquire and transmit microorganisms by biting. It is important to have control measures in place to reduce or eliminate the presence of such vectors in veterinary clinics.

**Routine practices**

Routine Practices are a way of thinking and of acting that forms the foundation for limiting the transmission of microorganisms in all health care settings. It is the standard of care for all patients/clients/residents.

– Rick Wray, Hospital for Sick Children, Toronto, Canada

Routine practices include:

- Hand hygiene
- Risk reduction strategies through use of personal protective equipment (PPE), cleaning and disinfection of the environment and equipment, laundry management, waste management, safe sharps handling, patient placement, and healthy workplace practices
- Risk assessment related to animal clinical signs, including screening for syndromes that might indicate the presence of infectious disease (e.g. fever, coughing/sneezing, diarrhea, abnormal excretions/secretions), and use of risk assessment to guide control practices

Personal protective equipment (PPE) is an important routine infection control tool. PPE use is designed to reduce the risk of contamination of personal clothing, reduce exposure of skin and mucous membranes of veterinary personnel to pathogens, and reduce transmission of pathogens between patients by veterinary personnel. Some form of PPE must be worn in all clinical situations, including any contact with animals and their environment.

These recommendations must always be tempered by professional judgment, while still bearing in mind the basic principles of infectious disease control, as every situation is unique in terms of the specific clinic, animal, personnel, procedures and suspected infectious disease.

Use of personal protective equipment does not eliminate the need for appropriate environmental engineering controls, such as hazard removal and separation of patient areas from staff rooms.

Personal protective outerwear is used to protect veterinary personnel and to reduce the risk of pathogen transmission by clothing to patients, owners, veterinary personnel and the public.

Parasite Prevalence in Off-Leash Dog Parks
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The objective of this summary is to review proper infection control measures for the treatment and management of dogs and cats with Giardia infections in shared animal facilities. Shared animal facilities include, but are not limited to, day-care, temporary housing, training facilities, parks, playgrounds and any other area animals congregate.

Despite your best efforts, Giardia can persist on items and in outdoor spaces. The risk of human infection and pet reinfection is possible, especially in shared animal facilities. [1]

Giardia survival in the environment
In cold temperatures, 4ºC (39.2ºF), Giardia survives about 7 weeks (49 days). At room temperature, 25ºC (77ºF), Giardia survives for 1 week. In a dry, warm environment in direct sunlight, Giardia survives a few days. [2, 3] In a moist, cool environment, Giardia survives up to several weeks. In water temperatures below 10ºC (50ºF), such as lake or puddle water in the winter and refrigerated water, Giardia survives 1–3 months. In water temperatures above 10ºC (50ºF) such as river water in the fall, tap water and puddles in the summer, Giardia survives less time, less than 4 days for water temperatures above 37ºC (98.6ºF).

Proposed solutions
Always wear gloves when handling feces and cleaning or disinfecting surfaces and items.

a. Frequency of cleaning and disinfecting
Clean and disinfect potentially contaminated items daily or when fecal accidents happen for as long as an animal is sick. If an animal is taking medication, clean and disinfect every day until three days after the last dose of medication is given.

b. Cleaning and disinfecting
For hard surfaces (i.e., cement or tile floors, crates, tables and trash cans) cleaning should include: removing feces and discarding in a plastic bag, scrubbing surfaces with soap and rinsing surfaces until no visible contamination is present. Disinfect surfaces according to manufacturer guidelines, ensuring contact with the surface for the recommended amount of time. Either quaternary ammonium compound products (QATS) [1], found in some household cleaning products (may be listed as alkyl dimethyl ammonium chloride), or bleach with water (3/4 cup of bleach to 1 gallon of water) may be used. [2] After disinfection, rinse the surface with clean water.

For carpets and upholstered furniture, remove feces with absorbent material (i.e., double layer paper towels) and discard in a plastic bag. Thoroughly clean the contaminated area with regular detergent or a carpet cleaning agent and allow the material to fully dry. To disinfect, either steam clean the area at 158ºF for 5 minutes (212ºF for 1 minute) or use a cleaning product with QATS. Read the label for specifications and instructions.

Household items, such as toys, clothing and pet bedding, should be cleaned and disinfected daily while a dog or cat is being treated for Giardia. Dishwasher-safe toys and water or food bowls can be disinfected in a dishwasher that has a dry cycle or a final rinse cycle that exceeds one of the following: 113ºF for 20 minutes, 122ºF for 5 minutes or 162ºF for 1 minute. If a dishwasher is not available, submerge dishwasher-safe items in boiling water for at least 1 minute (boil for 3 minutes at elevations >6,500 feet). Clothing, some pet items (i.e., bedding, cloth toys) and linens (i.e., sheets, towels) can be washed in a washing machine and then heat-dried on the highest heat setting for 30 minutes. If a dryer is unavailable, thoroughly air dry clothes in direct sunlight.

c. Reduction of giardia in outdoor environment
Remove feces promptly and place in a plastic bag, always while wearing gloves. [1] Limit access of animals with diarrhea or Giardia infections to common outdoor spaces. Eliminate all sources of standing water (i.e., puddles, containers with water, and fountains not in use) at your facility. Limit access of dogs to untreated surface water, such as creeks, ponds and lakes, to avoid infection and water contamination. Do not use bleach or QATS in your soil or grassy areas; they are ineffective. Keep new animals, especially young ones, from entering any shared outdoor spaces until advised by a veterinarian.

d. Reducing the risk of (re)infection during treatment
If an animal in your facility is diagnosed with Giardia, tell all facility pet owners to visit their veterinarians. Even animals without signs of illness can be infected and shedding Giardia into the environment and may need medication. Bathe all animals with pet shampoo, following medical treatment, to remove fecal residue in their coats. Clean your facility daily, as detailed above, making sure to wash your hands regularly with soap and water.

e. Treatment
No drugs are approved for the treatment of giardiasis in dogs and cats in the United States. Metronidazole is the most commonly used extra-label therapy, however efficacies as low as 50% to 60% are reported. Safety concerns for dogs and cats are also reported. Albendazole is effective against Giardia but is not safe in dogs and cats and should not be used.

Treatment of dogs
A combination of febantel, pyrantel pamoate, and praziquantel (DrontalPlus) is effective in treating Giardia in dogs when administered daily for 3 days using the dose bands indicated on the DrontalPlus label. Fenbendazole is effective in eliminating Giardia infections in dogs and has been approved for such use in Europe. Available experimental evidence suggests that it is actually more effective than metronidazole in treating Giardia infections in dogs. Fenbendazole should be administered (50 mg/kg SID) for 5 days. Alternatively, fenbendazole (50 mg/kg SID) may be administered in combination with metronidazole (25 mg/kg BID) for 5 days. This combination therapy, fenbendazole and metronidazole together, may result in better resolution of clinical disease and cyst shedding. [http://www.cdc.gov/parasites/giardia/giardia-and-pets.html - four]

Treatment of cats
Data on treatment of cats with Giardia are lacking. However, cats may be treated with either fenbendazole (50 mg/kg SID) for 5 days, metronidazole (25 mg/kg BID) for 5 days, or a combination of the two, as described above for dogs. There is anecdotal evidence that metronidazole benzoate is tolerated better in cats than metronidazole (USP).[8http://www.cdc.gov/parasites/giardia/giardia-and-pets.html - four]

f. Refractory treatment
Treatment failures may result from: reinfection, inadequate drug levels, immunosuppression, drug resistance and Giardia sequestration in the gallbladder or pancreatic ducts. The presence of immunosuppression, reinfection, or sequestration can usually be determined in a clinical setting.[9,10] Certain immunosuppressed patients are abnormally susceptible to giardiasis and their infections are often difficult to cure. Reinfection is common in endemic regions with high environmental contamination. [11]

g. Vaccine recommendation
Vaccines were previously available, but they are no longer being manufactured. Effectiveness of the vaccine was studied with variable results. While the Giardia vaccine was effective in treating dogs with chronic giardiasis, it was ineffective in asymptomatic canines. Many canines had persistent infections, even 6 months after vaccination. [12]

III. Conclusion
The risk of acquiring a Giardia infection from a dog or cat is small. However, there are some steps you can take to minimize your exposure and animal infection or reinfection. Promptly remove and properly dispose of feces, always while wearing gloves. Regularly clean and disinfect surfaces, areas and items in your facility that animals have access to, following appropriate guidelines and using appropriate products. Limit access of infected animals to common outdoor spaces and surface water.

IV. Recommendations
• All animals should be tested for parasites (by Elisa or PCR) every 3-6 months.
• All animals should be treated with parasiticides regularly. If parasiticide treatment is not routinely done, pets should be brought to a clinic every 3-6 months for treatment.
• Animals with any gastrointestinal condition should not attend shared facilities.
• Animals with fecal incontinence need to be diapered or should not attend facilities.

References