Leptospirosis is caused by infection with serovars of *Leptospira interrogans sensu lato*. Organisms are transmitted by direct contact with infected urine, bite wounds or ingestion of infected tissues, or indirectly, through contact with infected water, soil, food or bedding. Survival of leptospires is promoted by stagnant warm water, a neutral or slightly alkaline pH, and temperatures between 0 and 25°C. In northern California, the incidence of leptospirosis is highest in the late fall and winter, but in other parts of North America, the incidence may be highest in the fall. In areas with year-round rainfall, the disease may occur throughout the year.

There are over 200 antigenically-distinct pathogenic serovars, which are grouped into serogroups. Serovars known to affect dogs include Canicola, Icterohaemorrhagiae, Grippotyphosa, Pomona, Ballum, Bratislava, Autumnalis, Bataviae, Australis, and Hardjo. Each serovar is adapted to one or more mammalian host species (maintenance hosts). Other hosts act as incidental hosts. Disease in incidental hosts tends to be more severe and the duration of shedding is generally shorter. Maintenance hosts include dogs (Canicola); rats (Icterohaemorrhagiae); raccoons, skunks, voles and opossums (Grippotyphosa); cattle and pigs (Pomona); pigs (Bratislava); cattle (Hardjo); and mice (Ballum). The prevalence of infection with a serovar in dogs depends on the degree of contact between the dog population and the maintenance host for that serovar.

The most common species thought to infect dogs before the introduction of the *Leptospira* vaccines were Icterohaemorrhagiae and Canicola. Vaccines containing only serovars Icterohaemorrhagiae and Canicola do not protect against infection by other serovars. Since introduction of the bivalent bacterins containing these two serovars, there have been decreasing reports of disease associated with seroconversion to Canicola and Icterohaemorrhagiae, and increasing reports of disease associated with seroconversion to serovars Pomona, Grippotyphosa, Autumnalis and Bratislava. Vaccine pressure, and increasing contact between dogs and skunks, raccoons and opossums, as well as increased testing, have been suggested as reasons for this change. In truth, the actual serovars causing disease in dogs in North America remain uncharacterized because the disease is diagnosed by serology, and serologic test results are not predictive of the infecting serovar.

Pathogenic leptospires penetrate abraded skin or mucus membranes and multiply rapidly in the bloodstream and tissues, causing hepatic and/or renal failure and vasculitis. Clinical manifestations may also depend on age, outbreak, and geographical location.

**Clinical Manifestations**

Most infections are subclinical. Younger, large breed, outdoor adult dogs are commonly affected, but the disease can occur in any dog breed and at any age; dogs that
live in cities may become infected as a result of exposure to rodent reservoir hosts. Younger animals tend to be more severely affected. Males may be predisposed.

Lethargy, anorexia, vomiting, pyrexia, dehydration, abdominal pain and increased thirst are common signs of acute leptospirosis. Reluctance to move due to myositis, icterus, uveitis, and petechial and ecchymotic hemorrhages may be noted. Respiratory difficulty may result from pulmonary hemorrhage (leptospiral pulmonary hemorrhage syndrome or LPHS), which is often associated with the development of moderate anemia.

**Laboratory findings**

Leukocytosis, thrombocytopenia, azotemia, hypoalbuminemia and mild to moderately elevated liver enzyme activities are common. Urinalysis may reveal isosthenuria, proteinuria, glucosuria and casts. Although it occurs with other causes of renal tubular damage, glucosuria in addition to azotemia can be a “red flag” for a diagnosis of leptospirosis. Thoracic radiography may reveal a focal or diffuse interstitial to bronchointerstitial pattern; alveolar patterns may represent pulmonary hemorrhage. Occasionally mild pleural effusion is evident. Hepatomegaly, splenomegaly, renomegaly and/or peritoneal effusion may be evident from abdominal radiography. Hyperechoic renal cortices and mild renal pelvis dilation are occasionally seen with abdominal ultrasound.

**Diagnosis**

Diagnosis of leptospirosis is generally based on serology using the microscopic agglutination test. Respective titers are provided for each of several different serovars in order to increase the chance of antibody detection. Traditionally, the organism with the highest titer has been interpreted as the infecting one; lower titers represent cross-reactions between serogroups. However, studies in humans and dogs have shown that the serovar with the highest titer can vary over time and so the MAT does not accurately predict the infecting serovar, and therefore should not be used for this purpose. Titers are usually negative in the first week of illness; positive titers early in the course of an illness may reflect residual vaccine titers or prior subclinical infection, and are not diagnostic for the disease. Demonstration of a fourfold rise in titer is required over a 1-2 week interval. Postvaccinal titers against Icterohaemorrhagiae, Canicola, Grippotyphosa and Pomona occasionally rise as high as 1:6400 for a few months after vaccination, and these can interfere with interpretation. The results can vary dramatically between laboratories (Miller et al, 2011). Use of a laboratory with a high level of quality control is recommended, or a laboratory that participates in the International Leptospirosis Society’s proficiency testing scheme.

Darkfield microscopy of the urine is not recommended as sole test for diagnosis because of the large number of false positives and false negatives. Silver staining and fluorescent antibody or immunoperoxidase staining of tissue specimens can also yield false negatives, and does not help identify the infecting serovar. Culture is difficult because of the fastidious growth requirements of leptospires, but is the only way to truly
identify an infecting serovar. Cultures must be incubated for several weeks. Multiple sampling may be required due to intermittent shedding. PCR assays are becoming more widely available, but their sensitivity is not well established, and they currently do not provide information about the infecting serovar. There is some anecdotal evidence that PCR may be very insensitive for diagnosis of canine leptospirosis, but the sensitivity and specificity may vary geographically depending on the serovars present and shedding patterns that occur for those serovars. PCR assays are best performed on blood AND urine concurrently because urinary shedding begins 10 days after the onset of infection. UC Davis now offers a multimodality approach to diagnostic testing for leptospirosis that includes serology with or without culture and PCR. For more information, readers are referred to http://www.vetmed.ucdavis.edu/foley_lab/leptospira/index.cfm.

Treatment

Specific treatment involves initial use of parenteral penicillin derivatives for leptospirosis. In our hospital, we generally use ampicillin (20 mg/kg IV q6-8h, adjusting dose down if severe azotemia is present) for 14 days. It is recommended that treatment then be changed to doxycycline (5 mg/kg PO q12h) for 2 weeks, in order to eliminate the carrier phase. Doxycycline can be substituted for penicillins if tolerated. Supportive therapy is also indicated for acute renal failure (eg. IV fluids, H2 blockers, antihypertensives, gastric protectants, antiemetics, phosphate binders, packed red cells and nutritional support). The use of hemodialysis can improve survival in dogs with severe renal failure, and early referral of these cases is recommended if client finances allow. Approximately 50% of our cases are dialyzed, and the average number of treatments required before polyuria and recovery occurs is 3. Euthanasia or death due to leptospirosis is recorded in 18% of our dogs.

Prevention

Vaccines are available for serovars Canicola, Icterohaemorrhagiae, Pomona and Grippotyphosa. The vaccines are generally safe and efficacious and studies suggest they provide a 1-year duration of immunity (Minke et al, 2009; Klaasen et al, 2003). Vaccine failure appears to be extremely rare with the current 4-serovar vaccines (Hennebelle et al, 2013). *Leptospira* bacterins have been associated with occasional acute, severe allergic reactions, but the incidence of these reactions has decreased dramatically in recent years. Vaccination against pathogenic leptospires is recommended for dogs living in endemic areas that are likely to be exposed. Minimizing access to rodents, farm animals and other wild animals also should help to prevent infection.

Public Health Risk

Leptospirosis remains an important zoonosis, although most documented human leptospirosis in the United States results from recreational activities that involve water, rather than contact with dogs. Because dogs are generally incidental hosts they may not shed for significant periods of time, although more studies are required to confirm this, and there are anecdotal reports of leptospirosis in staff that work in veterinary hospitals.
Human leptospirosis is typically a ‘flu-like illness’, but in some cases may be associated with vomiting, diarrhea, shock, jaundice, renal failure, pneumonia, meningitis, or abortion. Any animal with acute renal failure should be treated as a suspect. Warnings should be placed on cages, gloves should be worn while handling these dogs and bleach or iodine-based disinfectants should be used to clean areas soiled with urine. Owners should be warned that without specific treatment, leptospires may be shed in the urine for months despite clinical recovery. The ACVIM has published consensus guidelines for the diagnosis, treatment, and prevention of leptospirosis in dogs (Sykes et al, 2011).

Selected References: