

A PRACTICAL APPROACH
Dogs affected by *Leptospira* species infection can experience illness that ranges from mild to severe. With appropriate medical care, the prognosis for most patients is favorable.

MANAGEMENT STRATEGIES

Diagnosis and Treatment of Leptospirosis in Dogs

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Leptospirosis is an emerging zoonotic disease found throughout most of the United States. Leptospirosis affects many organ systems and varies in severity; clinical signs range from none or mild and self-limiting to severe with acute kidney injury, hepatopathy, and/or vasculitis.

Dogs become infected when their mucus membranes or abraded skin comes into contact with *Leptospira*-infected urine or substrates contaminated with infected urine (e.g., water or soil) from a reservoir host. The most common reservoir hosts are wild animals such as rodents. *Leptospira* serovars have adapted to reservoir hosts, in which a carrier state is established and leptospires are intermittently shed in reservoir hosts' urine.

SIGNALMENT

Leptospirosis has conventionally been thought to most commonly affect young adult, male, large-breed or hunting dogs living in rural areas. Indeed, some studies have found intact male dogs and working dogs to be overrepresented among leptospirosis patients.^{1,2} However, other studies have found similar seroprevalence among dogs of large and small breeds, both sexes, and all age groups.^{3,4} In addition, living in an urban or suburban environment has been identified as a significant risk factor for the development of

leptospirosis, resulting from increased interactions between dogs and wildlife in periurban settings.⁵ Thus, leptospirosis should be suspected in any dog with consistent clinical signs, regardless of signalment or perceived exposure.

PRESENTATION

The clinical signs and examination findings for dogs with leptospirosis can vary considerably, depending on severity of illness, infecting serovar, and the dog's immune status.^{6,7} Leptospirosis is typically an acute disease; clinical signs become apparent in the first week after infection.⁶ Common clinical presentations can range from a mild febrile illness to acute kidney injury, hepatic injury, hemorrhagic disease, or some combination thereof (**BOX 1**). Other clinical findings include uveitis and reproductive failure.^{6,8-11}

DIAGNOSIS

Clinicopathologic Abnormalities

The most common clinicopathologic findings in dogs with leptospirosis are those associated with acute injury to the kidneys and liver. The most common abnormal biochemical abnormality is azotemia, found in 80% to 90% of dogs with leptospirosis.^{7,8,11} Elevated liver

enzymes (e.g., alanine aminotransferase, aspartate aminotransferase, alkaline phosphatase) and bilirubin are noted in 30% to 50% of leptospirosis patients and may be present in the absence of azotemia.^{7,9,11,12} Other findings can include electrolyte abnormalities (e.g., hyponatremia, hypokalemia, hypochloremia, and/or hyperphosphatemia).^{9-11,13} In dogs with oligoanuria, serum potassium may be paradoxically normal or low

BOX 1 Common Clinical Signs and Physical Examination Findings in Dogs with Leptospirosis

- Lethargy
- Arthralgia and myalgia
- Polydipsia and polyuria
- Oliguria or anuria
- Altered hydration status (overhydration with oliguria/anuria or dehydration with polyuria)
- Gastrointestinal abnormalities (decreased appetite, vomiting, diarrhea)
- Icterus
- Bleeding tendency (petechia, melena, hematochezia, epistaxis)
- Tachypnea
- Conjunctivitis



FIGURE 1. Thoracic radiographs of an 11-year-old spayed female Labrador retriever dog with leptospirosis. **(A)** Dorsoventral projection. **(B)** Right lateral projection. The pulmonary parenchyma is affected by a marked diffuse miliary pattern with an alveolar pattern in the cranioventral thorax consistent with leptospirosis-associated pulmonary hemorrhage syndrome. The dog had progressive respiratory distress with tachypnea and hypoxemia. Despite ventilator support, the dog's respiratory status declined and the client elected euthanasia.

because of alterations in the electrolyte transporters in the renal tubules.⁵ In dogs with myositis, creatine kinase levels can be elevated.⁷ Common hematologic abnormalities in dogs with leptospirosis include anemia, neutrophilia, and thrombocytopenia.^{8,9,11}

Urinalysis findings in dogs with leptospirosis are typically compatible with acute kidney injury and include isothermia, glucosuria, and proteinuria.⁷ Bilirubinuria may be noted in dogs with an associated hepatopathy. Leptospire cannot be visualized by routine light microscopy of urine sediment and do not readily grow on routine urine cultures.

Imaging Findings

In Europe, abnormalities have been found on up to 70% of thoracic radiographs of dogs with leptospirosis.^{14,15} Findings can range from a mild to moderate interstitial pattern to a nodular or alveolar pulmonary pattern in dogs with severe pulmonary hemorrhage (**FIGURE 1**).^{14,15} Common ultrasonographic changes include renomegaly, mild pyelectasia, medullary rim sign, or increased cortical echogenicity.^{16,17}

Leptospira-Specific Diagnostic Testing

Several diagnostic assays, serologic and molecular, are

available to aid in the diagnosis of leptospirosis. Often, a definitive diagnosis requires use of a combination of these assays.

Serologic Testing

The standard serologic reference for leptospirosis is the microscopic agglutination test (MAT), which provides a quantitative antibody titer. The results report titers to a panel of 6 to 8 *Leptospira* serovars, representing the common serogroups that infect dogs and that vary according to geographic location. Failure to include a member of the infecting serogroup in the panel could lead to false-negative results.

Testing of 2 serum samples, collected 7 to 14 days apart and representing acute- and convalescent-phase titers, is recommended.¹⁸ A 4-fold increase in titer indicates seroconversion and a diagnosis of leptospirosis.¹⁸ When paired samples are submitted, the sensitivity of the MAT is 100% and the specificity is 70% to 100%.^{19,20} A single acute serum sample is not as sensitive (50%) while antibodies are being produced and should not be relied on to rule out disease.^{19,20} Vaccination can result in positive MAT results; maximum titers can reach 1:6400. Titers of >1:1600 to vaccinal or nonvaccinal serovars can persist 1 year after vaccination.²¹⁻²³ Therefore, although a single positive MAT result may be suggestive of leptospirosis, convalescent-phase testing is still recommended.^{18,24}

Point-of-care assays have become commercially available and provide rapid diagnostic results. These assays are modified enzyme-linked immunosorbent assays and qualitatively detect *Leptospira* antibodies.²⁵⁻²⁸ As such, the limitations of these diagnostics are similar to those of the MAT. Results from these point-of-care diagnostic tests should be confirmed with paired MAT titers and/or polymerase chain reaction (PCR) results.^{18,24}

BOX 2 Antibiotic Therapy for Leptospirosis

- Ampicillin 20–30 mg/kg IV q6–8h
- Penicillin G 25,000–40,000 U/kg IV q6–8h
- Doxycycline 5 mg/kg PO q12h or 10 mg/kg PO q24h

Molecular Testing

Leptospira PCR detects bacterial DNA and is most often performed on blood or urine specimens. PCR sensitivity corresponds to the phase of disease; the bacteremic phase occurs in the first 10 days after infection, and the bacteriuric phase occurs after the first week of illness.⁶ Because the timeline of infection is often difficult to discern, to increase sensitivity of testing, both whole blood and urine samples should be collected before antimicrobial drugs are administered.^{18,24} A positive result in a dog with a compatible clinical presentation suggests leptospirosis; however, a negative result does not rule out leptospirosis because bacteremia is transient and bacteriuria is intermittent. The reported prevalence of positive urine PCR results (0% to 25%, depending on region) in the absence of clinical signs is low; therefore, positive PCR results should be interpreted in light of clinical signs.²⁹⁻³⁴ Recent vaccination does not interfere with PCR results.

TREATMENT

Patients with suspected or confirmed leptospirosis should receive a combination of antimicrobial therapy (as outlined by consensus guidelines¹⁸) and supportive care tailored to each patient according to severity of clinical signs and affected organ systems. If the index of suspicion for the disease is high, these treatments should not be delayed while awaiting confirmatory diagnosis.

Antibiotic Therapy

The recommended antibiotics for dogs with leptospirosis are IV penicillin derivatives or oral doxycycline.¹⁸ Because clinical signs in dogs often include vomiting or decreased appetite, initial therapy should be given parenterally rather than orally (**BOX 2**). After gastrointestinal signs have resolved, oral doxycycline should be administered (**BOX 2**) for 2 weeks to clear leptospires from the renal tubules and eliminate the carrier status.^{18,24}

Other antibiotics have been investigated for use in people with leptospirosis. These drugs include ceftriaxone or azithromycin,^{35,36} however, their use in dogs has not been fully investigated and they are not recommended as first-line therapies. Because in experimental models, fluoroquinolones do not seem to completely clear leptospires, these drugs are not recommended for treatment of leptospirosis.²²

Supportive Care

Dogs with leptospirosis may require different levels of supportive care, depending on the severity of illness and affected organ systems. Recommendations commonly include maintaining adequate hydration with IV fluid therapy; correcting electrolyte and acid-base derangements; and administering anti-emetics, anti-hypertensives, pain control medications, and nutritional support.



FIGURE 2. A 6-month-old intact male Labrador retriever dog with leptospirosis and iatrogenic overhydration. **(A)** At presentation to the family veterinarian, the dog had acute kidney injury and anuria; leptospirosis was diagnosed. At the referral center, initial examination revealed overhydration with edema of the face and eyelids, chemosis, and serous nasal discharge. **(B)** After treatment with intermittent hemodialysis and parenteral antibiotic administration, the overhydration resolved.

BOX 3 Precautions to Take Around Hospitalized Leptospirosis Patients⁷

- Place warning signs on patient's cage
- Limit movement of patient through the hospital (although isolation is not needed)
- Wear personal protective equipment (gloves, disposable gown, eyewear/facemask) when handling the patient
- Do not pressure wash animal cages (to avoid aerosolization of leptospires)
- Minimize urinary contamination (walk the patient frequently)
- Clean with disinfectant solutions that will inactivate leptospires (e.g., bleach, iodine-based products, accelerated hydrogen peroxide, quaternary ammonium)
- Launder bedding normally with hot water and detergent

Renal Injury

Dogs that have leptospirosis-associated kidney injury and are polyuric may require high rates of fluid administration; however, those that are oliguric or anuric may become iatrogenically overhydrated after initial fluid resuscitation if not monitored diligently (**FIGURE 2**). Because fluid requirements can change rapidly throughout the course of disease, hydration status should be monitored regularly by observing changes in body weight, respiratory rate, blood pressure, central venous pressure (if possible), and urine output. Indwelling urinary catheter placement may be needed to closely monitor urine output; if oliguria or anuria is a concern, referral to a 24-hour facility should be considered. Renal replacement therapy (hemodialysis) is recommended for patients with oliguria (urine output less than 2 mL/kg/hour) or anuria despite overhydration, progressive hyperkalemia, or progressive azotemia in the face of appropriate therapy.

Hepatic Injury

Leptospirosis-associated hepatic injury can lead to clinical manifestations of hepatic insufficiency (e.g., hepatic encephalopathy and hypoglycemia). Treatment for these conditions is supportive and typically leads to improved hepatic function.

In addition to the leptospirosis patient, any other dogs living in the same household should receive oral doxycycline therapy for 2 weeks.

Pulmonary Injury

A severe consequence of leptospirosis is leptospirosis-associated pulmonary hemorrhage syndrome, for which oxygen therapy and mechanical ventilation are recommended, according to the severity of clinical signs. In people, improvements have been noted with cyclophosphamide therapy³⁷ and plasma exchange³⁸ but not with dexamethasone and desmopressin;³⁹ however, these therapies have not been investigated in dogs.

Hospitalized Patients

BOX 3 lists precautions that should be taken when leptospirosis patients are hospitalized.

For these dogs, renal function, electrolytes, acid-base status, packed cell volume, and serum protein levels should be monitored daily (or more frequently if markedly abnormal). During the course of hospitalization, complete blood counts every 48 hours are recommended to assess for thrombocytopenia. Biochemical changes often normalize within 1 to 2 weeks of therapy. As the polyuria resolves and the patient can maintain adequate hydration without additional fluid support, IV fluids can be tapered off and the dog can be discharged from the hospital. However, these patients should be re-examined within 1 week of discharge and then every 1 to 3 weeks thereafter until clinically stable.

Other Household Dogs

In addition to the leptospirosis patient, any other dogs living in the same household should receive oral doxycycline therapy for 2 weeks (**BOX 2**). Treatment is recommended because the dogs' exposure histories are probably similar.^{18,24}

PROGNOSIS

If aggressive and appropriate medical therapy is administered, including hemodialysis when indicated, the prognosis for dogs with leptospirosis is good. The rate for survival to hospital discharge is approximately 80%.⁴⁰ For dogs with mild to moderate disease that is treated conservatively and for dogs with severe azotemia treated with hemodialysis,⁴⁰ the short-term prognosis is also good. However, the prognosis for dogs that need hemodialysis but do not receive it is grave. If severe pulmonary hemorrhage syndrome develops, the prognosis becomes worse and survival rates drop to 40% to 50%.¹⁵ Some leptospirosis patients will have lasting chronic renal changes and will need long-term monitoring and care for chronic kidney disease.⁴¹

ZOONOTIC POTENTIAL

Any dog with suspected or confirmed leptospirosis should be handled appropriately because leptospires in the urine and/or blood present a zoonotic threat (**BOX 3**). The zoonotic risk is thought to decrease significantly after the patient has received appropriate antimicrobial therapy for 72 hours.¹⁸

CONCLUSIONS

Several tests are available for diagnosing leptospirosis, and the greatest accuracy is achieved with use of a combination of these tests. Although many patients require aggressive therapy, if appropriate care is provided, the prognosis is ultimately good. **TVP**

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