Systemic manifestations of *Cuterebra* infection in dogs and cats: 42 cases (2000–2014)

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**OBJECTIVE**  
To document clinical signs in cats and dogs with *Cuterebra* infection, determine the outcome of infected animals, and determine whether Yorkshire Terriers were more commonly affected than other breeds of dogs.

**DESIGN**  
Retrospective case series.

**ANIMALS**  
22 cats and 20 dogs with *Cuterebra* infection.

**PROCEDURES**  
Medical records of dogs and cats with *Cuterebra* infection were reviewed for signalment, history, clinical and laboratory findings, treatment, duration of hospitalization, and outcome.

**RESULTS**  
Most (16/20 [80%]) of the dogs weighed ≤ 4.5 kg (10 lb), and Yorkshire Terriers were overrepresented (8/20 [40%]), compared with dogs of other breeds. Ten (50%) dogs and 3 (14%) cats had systemic inflammatory response syndrome at the time of initial evaluation, and 8 (40%) dogs but none of the cats had disseminated intravascular coagulation. The overall mortality rate was 17% (7/42), but was higher for dogs (6/20 [30%]) than cats (1/22 [4.5%]). All 6 dogs that died weighed ≤ 4.5 kg and had systemic inflammatory response syndrome, disseminated intravascular coagulation, or both.

**CONCLUSIONS AND CLINICAL RELEVANCE**  
Results indicated that *Cuterebra* infection can cause severe systemic illness in small-breed dogs. Yorkshire Terriers were more commonly affected than were dogs of other breeds and, subjectively at least, appeared to be more likely to develop severe systemic illness. (J Am Vet Med Assoc 2017;251:1432–1438)

*Cuterebra* spp are large, nonbiting, bee-like flies and are the most common cause of furuncular myiasis in North America. Cuterebral infection results in production of a cutaneous warble, or furuncle, where the larva produces an air pore; the larva can sometimes be seen to extrude from this pore. Female *Cuterebra* flies typically lay eggs around the burrows of small mammals. The eggs rapidly hatch in response to the mammal’s body heat, and the infective larvae attempt to attach to the host. These larvae (first instars) typically enter the host through the eyes, mouth, nasal cavity, or a wound and, from there, migrate through body cavities or muscle fascia to eventually settle at a subcutaneous site where the warble is formed. The larva molts to a third instar, at which time it leaves the host to pupate and become a fly. Most cuterebral infections occur in the summer months when the flies are most active. Rabbits and rodents are considered typical hosts of *Cuterebra* spp, whereas humans, dogs, and cats are atypical hosts. Typical hosts rarely develop serious clinical signs of infection, but infection in atypical hosts can result in aberrant larval migration. There have been numerous studies describing the various manifestations of myiasis in these atypical hosts. One of the most detrimental manifestations occurs as a result of CNS infection. This has been well characterized in cats by Glass et al and has also been seen in dogs. In addition, cuterebral migration is suspected to be the cause of feline ischemic encephalopathy. Other non-CNS locations of infection described in dogs and cats include the eye, trachea, nasal cavity, thorax, and skin. Similar cases of myiasis involving humans have been reported, except that CNS, intrathoracic (excluding upper respiratory tract), and abdominal cavity involvement have not been documented. Sepsis as a result of infection with other fly species has been documented and is more commonly seen in tropical and subtropical regions.
Apart from lethargy and signs of depression associated with CNS involvement in cats,2,17 systemic signs resulting from Cuterebra infection in dogs and cats have been infrequently reported.21–23 Most clinical signs that have been reported can be attributed to the site of the warble, rather than to any systemic consequences of the infection. For example, tracheal infection can result in severe respiratory compromise,9,10 Systemic inflammatory response syndrome, DIC, and multiple organ dysfunction can occur but appear to be uncommon, and the mortality rate for non–CNS-related Cuterebra infections is considered low. At our institutions, however, we have observed a number of small-breed dogs, particularly Yorkshire Terriers, that developed severe systemic signs and died following Cuterebra infection, raising the question of whether the response to Cuterebra infection is somehow different in small-breed dogs than in medium-sized dogs, large-breed dogs, or cats, which do not seem to have similar outcomes.

The purpose of the study reported here was to document clinical signs in cats and dogs with Cuterebra infection and determine the outcome of infected animals. Specifically, we sought to determine whether severe clinical illness or death was more common among small-breed dogs, particularly Yorkshire Terriers, than in other patient populations.

Materials and Methods

Case selection criteria

The medical records database at the Michigan State University Veterinary Teaching Hospital for patients examined between January 1, 2000, and August 31, 2014, and the medical records of the 404 Veterinary Emergency and Referral Hospital for patients examined between July 1, 2013, and August 30, 2014, were searched to identify dogs and cats infected with Cuterebra larvae or for which a diagnosis of cuterebral myiasis had been made. The only inclusion criterion was that a Cuterebra larva had to have been seen by a veterinarian. No cases were eliminated on the basis of location of the Cuterebra larva.

Medical records review

Clinical data collected included signalment, dates of initial examination and discharge or death, results of physical examination performed at the time of initial examination, location of the Cuterebra larva, and treatment while in the hospital. Any clinicopathologic data or diagnostic imaging results that were available were also collected. For animals that remained in the hospital for longer than the initial visit, daily vital signs, results of any clinicopathologic testing or diagnostic imaging, treatment, and any other clinically relevant findings were collected. Pertinent history (eg, whether the patient was a stray), housing status (indoor vs outdoor), previous treatments, and whether the patient had been seen primarily by the emergency service or had been referred were also noted. Because multiple laboratories were used, laboratory results were considered abnormal if values were outside reference ranges provided by the laboratory performing the test.

Patients were classified as to whether SIRS or DIC was documented at any time during the hospitalization period. Patients were considered to have SIRS on the basis of criteria described by DeClue24 (Appendix) and were considered to have DIC if they had evidence of a coagulopathy and low platelet count and were systemically ill.25,26

Statistical analysis

Data were tabulated with a spreadsheet, and statistical analyses were performed with standard software. Although some patients had follow-up examinations, each patient was included only once in the statistical analysis.

Patients were classified as systemically ill if SIRS or DIC was documented at any time during the hospitalization period or if there was subjective evidence of illness, as ascertained by duration of hospitalization, physical examination findings (including location of the Cuterebra larva), clinical notes, and results of clinicopathologic testing. A χ² test was then used to compare frequency of systemic illness between dogs and cats.

A Fisher test was used to determine whether Yorkshire Terriers were overrepresented among dogs with Cuterebra infection. All patients examined at the Michigan State University Veterinary Teaching Hospital or the 404 Veterinary Emergency and Referral Hospital during the study period were used in this analysis, with Yorkshire Terriers with and without Cuterebra infection compared with dogs of all other breeds (and mixed breeds) with and without Cuterebra infection.

Results

A total of 20 dogs and 22 cats met the criteria for inclusion in the study. In 41 cases, a Cuterebra larva was removed by a clinician at the Michigan State University Veterinary Teaching Hospital or the 404 Veterinary Emergency and Referral Hospital or by the referring veterinarian (Figures 1 and 2). In the remaining case, a Cuterebra larva was not physically removed, but a characteristic warble highly suggestive of Cuterebra infection was found within the trachea; therefore, this case was included in the study. There was no documented evaluation of any of the larvae by a parasitologist, apart from 1 larva that was identified as either Cuterebra buccata or Cuterebra emasculator by a parasitologist. For the remaining larvae, a presumptive diagnosis of Cuterebra spp was made on the basis of the characteristic appearance of the larvae and the fact that other larval infections are uncommon in North America.4,5,17

Mean body weight for the 20 dogs included in the study was 4.1 kg (9.0 lb; range, 1.4 to 20.9 kg [3 to 46 lb]), with 16 (80%) dogs weighing ≤ 4.5 kg (10 lb), 3 (15%) weighing > 4.5 kg but ≤ 9.1 kg (20 lb), and 1
Eight dogs and 2 cats had been brought to the hospital multiple times. Mean number of visits per patient was 1.5 (range, 1 to 4) for the dogs and 1.2 (range 1 to 4) for the cats, with each patient having 0 to 2 *Cuterebra* larvae removed at each visit. One kitten had 5 *Cuterebra* larvae removed at 1 visit. Mean hospitalization time was longer for dogs (mean, 2.2 days; range, 0 to 11 days) than for cats (mean, 1.1 days; range, 0 to 5). The cat that was hospitalized for 5 days was a stray and was being boarded at the hospital before being taken to animal control.

All 42 patients were examined during the summer months, with 21 (50%) seen in July, 17 (40%) seen in August, and 4 (10%) seen in September. When all patient visits (n = 57) were considered, 8 of the 57 (14%) visits involved an initial complaint of *Cuterebra* infection, 8 (14%) involved an initial complaint of epistaxis, and 19 (33%) involved an initial complaint of respiratory signs, including sneezing, gagging, and coughing. Thirty-one patients were seen primarily through the emergency or general practice service, and 11 had been referred. Twenty-eight (67%) patients were seen on an outpatient basis, and 14 (33%) were hospitalized. *Cuterebra* larvae were primarily located within the subcutaneous tissues of the neck, flank, or ab-
domen (n = 39) and were associated with a substantial local inflammatory response in 18 of these sites. None of the patients had neurologic abnormalities. Two dogs sneezed out *Cuterebra* larvae, and 1 dog had a *Cuterebra* larva flushed from the nasal cavity.

Eleven patients had neutrophilia at the time of initial examination, and only 1, a cat, had eosinophilia. Eleven patients had thrombocytopenia; platelet clumping was noted in 4 dogs. The thrombocytopenia was persistent in 6 patients that had sequential CBCs (15 CBCs in total).

All 13 patients that had a urinalysis performed had proteinuria. Five patients had repeated urinalyses performed, and proteinuria resolved in 2. All 6 dogs in which the urine protein-to-creatinine ratio was measured had evidence of glomerular disease (ie, ratio > 3; range, 3.2 to 16). All 13 patients with proteinuria had a low serum albumin concentration (mean, 2.1 g/dL; range, 1.7 to 2.7 g/dL) suggestive of PLN. One patient had glucosuria, but blood glucose concentration was within reference limits. Urine specific gravity was > 1.050 in all dogs tested at the time of admission or at their initial visit (n = 8), but 2 of these patients subsequently became anuric and both were euthanized because of severe systemic illness. Eight patients had proteinuria with an active sediment, and 3 of these 8 patients also had substantial numbers of granular casts, consistent with severe renal disease. Urine samples from 8 patients were submitted for bacterial culture, but only 1 had bacterial growth.

One cat had high serum ALT activity and bilirubin concentration; this cat was systemically ill and remained in the hospital for 4 days, but survived to discharge. Follow-up testing revealed that ALT activity and bilirubin concentration had normalized. Results of serum biochemical testing for the remaining 21 cats were unremarkable. Six cats underwent testing for FeLV antigen and anti-FIV antibody; and results for all 6 were negative.

Four dogs had high serum alkaline phosphatase and ALT activities while hospitalized. Two additional dogs also likely had high hepatic enzyme activities, but the samples were severely icteric and hemolytic, and accurate results could not be obtained with the in-house analyzer that was used. Three dogs had azotemia at the time of initial examination; 2 of these dogs developed anuric renal failure and were subsequently euthanized.

Thoracic radiography was performed in 12 of the 42 patients, abdominal radiography was performed in 3, and abdominal ultrasonography was performed in 6. Other diagnostic testing included liver function testing (ie, measurement of baseline serum ammonia and bile acids concentrations), echocardiography, measurement of leptospirosis and tick-borne disease titers and colloidal oncoprotein pressure, bacterial culture of specimens from the site of the *Cuterebra* larva, fine-needle aspiration of the liver and lymph nodes, and cytologic examination of peritoneal or pleural fluid.

Two dogs and a cat underwent endoscopic airway examination. The 2 dogs had evidence of a warble with in the trachea; 1 of these dogs had reportedly sneezed or coughed out a *Cuterebra* larva during a previous visit. The cat had evidence of severe rhinitis, and a *Cuterebra* larva was removed from the nasal cavity.

In 1 cat, histologic examination of a soft tissue swelling ventral to the mandible revealed fragments of a metazoan parasite with a chitinous wall surrounded by liquefactive necrosis and localized eosinophilic, lymphocytic, and granulomatous cellulitis, consistent with *Cuterebra* infection and a localized response. This was the only cat that had systemic signs.

Four dogs underwent postmortem examination. One had laryngeal obstruction due to inflammation and swelling within the pharynx; a *Cuterebra* larva was found migrating through the masseter muscle, and there was severe, diffuse subcutaneous edema over the head and neck. This dog also had evidence of acute renal tubular necrosis and septicemia. The remaining 3 dogs had various combinations of hepatic necrosis (n = 2), pigmentary nephropathy (3), and renal tubular necrosis (2). There was evidence of DIC in 2 of the dogs and findings suggestive of DIC in the third.

Three of the 22 (14%) cats fulfilled the criteria for SIRS at admission; all of these cats survived and were discharged. Ten of the 20 (50%) dogs fulfilled the criteria for SIRS at admission, and 5 of these dogs died or were euthanized as a result of their illness. One additional dog died on hospitalization day 5. Although this dog did not fulfill the criteria for SIRS at admission, it was classified as having SIRS on 2 separate occasions. Seven dogs had multiple days when they fulfilled the criteria for SIRS. All dogs that developed SIRS weighed ≤ 9.1 kg. Eight dogs had evidence of DIC at admission, and 1 dog developed DIC within 24 hours after being hospitalized. All 9 of these dogs weighed ≤ 4.5 kg. There were 7 dogs that had both DIC and SIRS, and 5 of these dogs were euthanized or died. None of the cats developed DIC.

The overall mortality rate for all patients with *Cuterebra* infection was 17% (7/42). One cat was euthanized because of suspected septic peritonitis resulting from *Cuterebra* larval migration through the abdominal cavity, but the remaining 21 cats survived and were discharged from the hospital. Of the 6 dogs that died, all weighed ≤ 4.5 kg and had DIC, SIRS, or both. The overall mortality rate for all dogs was 30% (6/20) and was 38% (6/16) for dogs that weighed ≤ 4.5 kg.

Treatments varied widely and included extraction of the *Cuterebra* larva (with or without sedation or anesthesia; Figure 3), IV or SC fluid administration, and administration of antimicrobials (ampicillin, amoxicillin, amoxicillin-clavulanic acid, metronidazole, and cephalozin), corticosteroids (dexamethasone and prednisone), antiemetics and gastric protectants (metoclopramide, ondansetron, dolasetron, famotidine, cimetidine, and sucralfate), an angiotensin-converting enzyme inhibitor (enalapril), liver protectants (S-adenosyl methionine and milk thistle), an antitussive (hydrocodone), and analgesics (tramadol, hydromorphone,
The reasons for the high rate of systemic illness among dogs in the present study were unknown. Rupture of larvae during extraction has been suggested to result in anaphylaxis and hypersensitivity reactions, but this was not reported for any of the patients in the present study, making it an unlikely explanation for the systemic illness. Others have postulated that when the larvae die, there can be a greater inflammatory response as a result of exposure of larval antigens to the immune system. Again, however, this would not necessarily explain the systemic illness seen in the present study because some patients developed systemic signs prior to identification of the warble. Hence, we assume that illness occurred during larval migration. Another hypothesis may be that smaller patients have a greater biological response to the larvae, but this also seems unlikely, in that cats, rabbits, and rodents do not seem to develop as severe systemic signs as the dogs in the present study, despite being of similar or smaller size and often having much higher parasite loads. It would have been interesting to compare the size of the *Cuterebra* larvae removed, as there may be different host reactions depending on the life stage of the larvae (ie, first vs second vs third instar). Unfortunately, the size of the larvae in the present study was not always noted. It was not uncommon for small kittens to have numerous larvae, with 1 kitten in the present study having 5 larvae, but not have any clinical signs. Thus, a greater response to antigen-antibody complexes and toxins released from the larvae appears to be a more likely explanation for why small dogs in the present study seemed to have more severe systemic signs than cats, although the reasons why this should be so are unclear. In cats with ischemic encephalopathy, brain infarction is suspected to be a result of a toxic factor elaborated by the parasite, although the nature of this toxin is not known. It is conceivable that this same toxic factor may contribute to the development of systemic signs outside the CNS, although it does not explain why cats would appear to have less severe systemic signs with non-CNS infection.

Six dogs in the present study had clinically important proteinuria and concurrent hypoalbuminemia, consistent with PLN. Two previous case reports documented PLN in dogs with *Cuterebra* infection. One of these dogs was a Yorkshire Terrier; the other was a mixed-breed dog, but body weight was not reported. For both of these dogs, the proposed pathogenesis of the PLN was deposition of antigen-antibody complexes in the kidneys resulting in glomerulonephritis, although in the report by Latra and Nestor, the exposure to the antigen was perhaps greater, as the larva had ruptured during removal. In the present study, dogs with proteinuria had high urine protein-to-creatinine ratios, consistent with severe glomerular disease. However, some of these dogs also had active urine sediments and effusions that may have contributed to the protein loss. Of note, in 2 of the 5 dogs in which follow-up urinalyses were performed, the proteinuria resolved following removal of the larvae. In the 4 dogs that underwent postmortem examination, renal abnormalities (pigmentary nephritis and necro-

**Figure 3**—Photograph of *Cuterebra* larvae removed from the dog (top) and kitten (bottom) in Figures 1 and 2. The larva removed from the dog likely represented a second instar. The larva removed from the kitten likely represented a third instar.

buprenorphine, butorphanol, and meloxicam). Other medications included furosemide, lactulose, vitamin K, plasma transfusion, packed RBC transfusion, praziquantel–pyrantel pamoate, and ivermectin. Some patients received no treatments apart from removal of the larvae. The *Cuterebra* larvae were not reported to have broken during extraction in any patient, but information regarding the state of the removed *Cuterebra* larvae was variably reported in the medical records.

**Statistical analysis**

Frequency of systemic illness was not significantly (\(P = 0.167\)) different between cats (12/22 [55%]) and dogs (15/20 [75%]). Yorkshire Terriers examined during the study period were significantly (\(P < 0.001\)) more likely to be infected with *Cuterebra* larvae (0.41%; 95% confidence interval, 0.18% to 0.81%) than were dogs of all other breeds (0.01%; 95% confidence interval, 0.01% to 0.01%).

**Discussion**

Results suggested that, for the population studied, *Cuterebra* infection was more common among Yorkshire Terriers than among dogs of other breeds. We were not able to determine whether severe clinical illness or death was more common among small-breed dogs than among larger dogs, because all but 1 of the 20 dogs included in the study weighed ≤ 9.1 kg. However, 15 of the 20 dogs were systemically ill, 11 had signs indicative of SIRS at admission or while hospitalized, and 9 had evidence of DIC at admission or while hospitalized. Ultimately, 6 of the 20 (30%) dogs died or were euthanized. In contrast, although the frequency of systemic illness did not differ between cats (12/22 [55%]) and dogs (15/20 [75%]), only 3 cats had SIRS, none had DIC, and only 1 was euthanized.

Small Animals

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sis) were identified, although specific immunohistochemical staining and electron microscopy were not performed to further characterize the lesions. We believe that findings of the present study, in conjunction with the previously published case reports, confirm that PLN can develop in dogs with *Cuterebra* infection and may lead to anuric renal failure and death.

Development of DIC and SIRS is apparently uncommon in human patients with myiasis, and these conditions are most often seen in tropical and subtropical regions. *Cuterebra* infection has not been reported to cause systemic illness in humans, but sepsis and subsequent systemic signs have been documented in neonates infected with *Drosophila* and *Chrysomya* larvae. One of these neonates developed hyperbilirubinemia and cellulitis; the other had signs of sepsis, and *Staphylococcus aureus* was cultured from the blood. Both neonates responded once the larvae were removed and antimicrobials were administered. The mechanism of the hyperbilirubinemia was not known, but it resolved rapidly with removal of the larvae.

In contrast to the outcome for dogs in the present report, only 1 cat was euthanized. Cats with CNS *Cuterebra* infection have been reported to develop lethargy, signs of depression, and hypo- or hyperthermia, but these signs have been attributed to inflammation of the CNS rather than widespread systemic disease. None of the patients in the present study had evidence of neurologic involvement, apart from signs of depression attributed to severe systemic illness. A potential reason for this was that patients were included in the study only if *Cuterebra* larvae were seen, which likely excluded patients with CNS involvement. In many patients with CNS infection, the larvae are not found, but there may be strong evidence suggesting their presence on the basis of MRI findings, clinicopathologic findings, signalment, time of year, or results of postmortem examination. An ELISA has been developed to help identify cats with *Cuterebra* infection, but is not commercially available at this time. Neither of the institutions involved in the present study had a neurology service or in-house MRI during the study period, and this may have also reduced the number of patients with neurologic signs or precluded diagnosis of CNS cuterebrasis.

Only 1 patient in the present study had eosinophilia, but 11 had neutrophilia. There do not appear to be consistent hematologic findings that support a diagnosis of cuterebrasis because some patients may have leukocytosis, with or without eosinophilia, and others may have an unremarkable hemogram.

Treatment of patients in the present study varied, but most had the *Cuterebra* larvae removed manually, with or without surgical debridement. This was in line with what is generally recommended in the veterinary literature. Many veterinary authors suggest the use of diphenhydramine and dexamethasone prior to larval removal, as this may reduce the risk of secondary hypersensitivity reactions should the larva rupture during the removal process. Also, lidocaine may help to paralyze the larvae if they are motile. Note that surgical removal of larvae may result in small pieces of the larva remaining, which can result in a foreign body reaction. Thus, surgery is not recommended by some human physicians. To encourage spontaneous extrusion of the larvae by asphyxiation, a variety of materials have been used to close the air pore of the warble. Some of these materials are untraditional and can include liquid paraffin, monkey meat, heavy oil, pork fat, and bacon. Notably, efficacy of these treatments has not been documented in veterinary medicine. Some patients in the present study expelled the larvae from their respiratory tract without the need for intervention, and this has also been reported for some human patients. Interestingly, only patients examined at Michigan State University after 2010 were treated with ivermectin, which did not appear to have an impact on patient outcome. Given the inflammatory reaction that may occur once the larva has died, one could argue that the use of ivermectin is not advised. Clinical trials are required to determine the best approach; however, one might assume that if a larva is identified and removed promptly, this would likely result in less severe systemic signs and an overall improved prognosis.

All of the patients in the present study were seen in the summer (July, August, or September), which was consistent with findings in previous reports of *Cuterebra* infection involving humans and animals and represents the most active time for *Cuterebra* flies. The Michigan State University Veterinary Teaching Hospital is located in south-central Michigan, and the 404 Veterinary Emergency and Referral Hospital is 370 miles east, in southern Ontario. Therefore, their climates and latitudes (42.7°N and 44.0°N, respectively) are similar. In addition to the time of year, risk factors for *Cuterebra* infection appeared to be travel history and escaping or being a stray, which likely reflected greater exposure to the larvae in the environment. Of note, 2 cats and 1 dog reportedly lived indoors only, highlighting that patients can be at risk for infection regardless of whether they are permitted outdoors. Unfortunately, data regarding heartworm status or treatment were not available for these patients, as it would have been interesting to know whether heartworm preventatives would be protective against infection.

Similar to previous reports, many of the patients in the present study had a history of upper respiratory tract signs, such as coughing, gagging, or epistaxis. This was not surprising, given that the upper respiratory tract is suspected to be the most common entry site of the larva.

There were several limitations to the present study. The *Cuterebra* larvae were not definitively identified by a parasitologist, and the diagnosis of cuterebrasis was made on the basis of the characteristic appearance of the larvae and geographic location. Other fly species may result in furuncular cutaneous myiasis in North America (such as *Wohlfahrtia vigil*), and there is a potential that the *Cuterebra* larvae may have been misidentified, although this was considered unlikely.

Inherent limitations of retrospective studies such as this include inadequate medical records as well as mis-coding or inappropriate coding of diagnoses. The latter may have been the reason for the lack of neurologic cases
being identified. Many of the cases included in the study underwent minimal diagnostic testing. For example, the medical record for the cat that was euthanized contained only the initial vital signs and results of a blood gas analysis, even though a diagnosis of septic peritonitis had been made. Two institutions participated in the study, which increased not only the number of cases but also the number of clinicians involved in case management. The number of patients included in the study was not sufficient to perform statistical analysis of risk factors. However, identifying risk factors was not the intent of our study, which instead attempted to describe an unusual clinical syndrome in small-breed dogs and increase clinicians’ awareness of this condition.

In conclusion, findings of the present study indicated that Cuterebra infection can result in severe systemic illness in small-breed dogs. Yorkshire Terriers were more commonly affected than were dogs of other breeds and, subjectively at least, appeared to be more likely to develop severe systemic illness. For those patients with severe systemic disease, PLN, liver disease, anuric kidney failure, multiple organ dysfunction, SIRS, and DIC were all identified, and many systemically ill patients died or were euthanized.

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Footnotes

a. PROC FREQ, SAS, version 9.3, SAS Corp, Cary, NC.
b. VetScan VS2 Chemistry Analyzer, Abaxis North America, Union City, Calif.
c. Snap 4Dx test, Idexx Laboratories, Westbrook, Me.

References


Appendix

Criteria used to diagnose SIRS in dogs and cats.24 Patients that fulfilled ≥ 2 of the 5 criteria were considered to have SIRS.

<table>
<thead>
<tr>
<th>Species</th>
<th>Heart rate (beats/min)</th>
<th>Respiratory rate (breaths/min)</th>
<th>Body temperature (°C [°F])</th>
<th>Total WBC count (cells/μL)</th>
<th>Band neutrophil fraction (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dogs</td>
<td>&gt; 60</td>
<td>&lt; 32 or &gt; 40</td>
<td>&lt; 37.8 (100.0) or &gt; 39.7 (103.5)</td>
<td>&gt; 12,000 or &lt; 4,000</td>
<td>&gt; 10</td>
</tr>
<tr>
<td>Cats</td>
<td>&lt; 140 or &gt; 225</td>
<td>&gt; 40</td>
<td>&lt; 37.8 (100.0) or &gt; 39.7 (103.5)</td>
<td>&gt; 19,500 or &lt; 5,000</td>
<td>&gt; 5</td>
</tr>
</tbody>
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