Prevalence of Feline Heartworm Infections Among Cats with Respiratory and Gastrointestinal Signs: Results of a Multicenter Study

C.K. Robertson-Plouch a
A.R. Dillon b
W.R. Brawner b
J. Guerrero a

 a Merial, Limited, Iselin, NJ
 b College of Veterinary Medicine, Auburn University, AL

ABSTRACT

Although heartworm infection in cats was first described in 1921, the diagnosis of the infection remains elusive in many cases. This is due to nonspecific clinical signs of feline heartworm disease, typically low worm burdens, unique pathophysiology in the cat, and the limitations of currently available heartworm tests. Consequently, knowledge about this disease is still limited.

An objective of this study was to survey the occurrence and clinical presentation of feline heartworm infection among cats presenting with clinical signs consistent with heartworm disease. Two-hundred fifteen cases were submitted from 15 private practices in Florida, South Carolina, Tennessee, and Texas. Cats entered in the study were at least 6 months of age and presented with one or more of the following clinical signs: respiratory signs, including tachypnea, dyspnea, or coughing; gastrointestinal signs, including a pattern of intermittent vomiting unrelated to eating; or sudden death of uncertain etiology, particularly associated with respiratory distress prior to death.

Data collected included: history and indoor/outdoor lifestyle; physical examination findings; thoracic radiography evaluations; Knott or DIFIL® test results, DiroCHEK® antigen test results, and antibody test results (Animal Diagnostics, Inc. and Heska Corporation); and CBC results. Recheck examinations were scheduled for any cat with positive heartworm serological test results and for cats with radiographic signs consistent with or suggestive of feline heartworm disease.

Data from 215 cases were collected and analyzed: 94/215 (44%) tested antibody positive for one or both antibody tests that were performed; 18/94 (19%) of the antibody-positive cats were reported as living 100% indoors by their owners; (12%) of the antibody-positive cats spent less than or equal to 10% of their time outdoors.

Eleven of 215 cats (5%) were DiroCHEK antigen positive on initial examination. One cat was both DiroCHEK and microfilariae positive, but negative for both antibody tests. Radiographs were obtained for 10 of these cats and 6/10 had radiographic signs consistent with or suggestive of feline heartworm infection. At necropsy, heartworms were found in one other cat from which blood was not obtained. Additionally, two cats that had positive radiographic signs of heartworm infection converted from antigen-negative to antigen-positive status at
recheck examination for a total of 13/215 (6%) DiroCHEK antigen-positive cats.

One case that was submitted after acute death was DiroCHEK antigen positive, but interestingly, had relatively low antibody levels for both antibody tests.

Initial radiographs were available on 212 of the 215 cases. In 90/212 (42%) cases, initial thoracic radiographs showed signs consistent with or suggestive of heartworm disease. Follow-up radiographs showed varying progression with radiographic signs worsening, improving, or staying the same on individual cats.

Feline heartworm disease should be among the primary differential diagnoses in cats with respiratory disease, vomiting, or acute death. Radiography, antibody testing, and antigen testing are all useful tools to aid in making the diagnosis. A confirmed diagnosis may require doing multiple tests and clinical reevaluation. Cats classified by their owners as indoor only cats were found to be heartworm infected, thus lifestyle of the cat cannot rule out the disease. Actual antibody levels (high or low) may not correspond to severity of disease.

**INTRODUCTION**

Although heartworm infection in cats was first described in 1921, diagnosis of the infection still remains elusive in many cases. This is due to nonspecific clinical signs, typically low worm burdens, low frequency of microfilaremia, unique pathophysiology in the cat, and limitations of currently available diagnostic tests. As a result, it has been very difficult to determine the prevalence of feline heartworm disease (FHD) in specific geographic regions. In addition, the veterinarian currently has only a vague idea of which clinical signs should be considered as indicators of this disease in cats.

A recent search of reported cases of FHD indicated that the most common clinical signs observed were respiratory in nature. Cardiac evaluation of infected cats also showed evidence of right sided cardiac failure, or enlargement, or both. Gastrointestinal signs—predominantly chronic vomiting—also were prevalent in these cases. Sudden death, with no prior warning, also was observed in some cases described in the literature.

The purpose of the study described here was to survey the occurrence and clinical presentation of heartworm infection among cats presenting with clinical signs that are commonly associated with FHD.

**MATERIALS AND METHODS**

Veterinarians from 15 private practices in Florida, South Carolina, Tennessee, and Texas were asked to participate in the survey. Cats were to be at least 6 months of age and to present with one or more of the following clinical signs, which have previously been associated with feline heartworm infection: respiratory signs, including tachypnea, dyspnea, or coughing; gastrointestinal signs, including a pattern of intermittent vomiting unrelated to eating; or sudden death of uncertain etiology, particularly those associated with respiratory distress prior to death.

A history, including medical and lifestyle/environmental background, was obtained for each case. A physical examination was then performed, followed by thoracic radiographs. Findings on the radiographs were graded by an independent radiologist and an overall score was assigned to reflect how strongly the findings were suggestive of FHD. Scores were assigned as follows:

- **0** = no findings consistent with FHD
- **0.5** = bronchointerstitial pattern, consistent with FHD, but nonspecific
- **1, 2, 3** = increasing degrees of pulmonary artery enlargement, suggestive of FHD
Other tests included a complete blood count (CBC), and tests for circulating microfilariae (Knott or DIFIL®, Evsco), heartworm antigen (DiroCHEK®, Synbiotics Corporation), and heartworm antibodies (Animal Diagnostics, Inc. proprietary test and Heska® Diagnostic Lab Feline Heartworm Test).

Any cat found to be positive at the initial check for heartworm antigen or antibodies was scheduled for a follow-up physical examination and antibody/antigen test at 30 to 45 days, and a physical examination, antibody and antigen test, and radiographic evaluation at 60 to 90 days after the initial examination. Additionally, cats with radiographic score of 0.5 or greater (signs consistent with, or suggestive of, FHD) were scheduled for the 60 to 90 day recheck.

RESULTS

A total of 215 cases were submitted by the 15 participating veterinarians. Each cat demonstrated some clinical evidence suggestive of FHD. The distribution of clinical signs in antibody-positive cats and antibody-negative cats is shown in Figure 1. Overall, respiratory signs were the most prevalent observation or complaint at presentation, and many of these cats also demonstrated gastrointestinal problems.

Demographics and Background

Cats in the study were from clinics in Texas, Tennessee, South Carolina, and Florida, with a relatively even distribution among the four states (Figure 2). Data collected on the history and lifestyle of the 215 cats indicated that 97 (45%) were female and 118 (55%) were male. Eighty-seven (40%) of the cats lived entirely indoors and an additional 24 cats (11%) of the population spent at least 90% of their time indoors.

Hematology

The percentage of antibody-positive cats that were eosinophilic and/or basophilic was marginally higher than for antibody-negative cats.

Thoracic Radiographs

Of the 215 cases submitted to the study, 3 cases did not receive radiographs due to acute death. Of the 212 cats for which baseline radiographs were performed, 90 (42%) had scores indicative or suggestive of FHD (Table 1). Ac-

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Figure 1. Distribution of presenting clinical signs for cats in survey of feline heartworm in the southeastern United States.

Figure 2. Distribution of cases surveyed for prevalence of feline heartworm.
According to each cat’s reported lifestyle, 44% of the cats with radiographic evidence of heartworm (scores ≥0.5) spent all of their time indoors, plus another 9% were indoors at least 90% of the time.

Follow-up radiographs at 60 to 90 days after the initial examination were obtained for 81 cats, with 53 of these (65%) with scores ≥0.5 (signs consistent with or indicative of heartworm infection) (Table 1). Radiographs at this evaluation showed varying progression, with signs becoming slightly worse, improving, or staying the same in individual cats. It was noted that 13 cats with scores of zero (negative for signs of FHD) at the initial exam had a score of 0.5 at the follow-up, and 1 cat that was initially negative received a score of 2 (highly suggestive of FHD) at follow-up.

### Antigen Tests

Over the course of the study, 13 of 215 cats tested (6%) were positive for *Dirofilaria immitis* antigen by the DiroCHEK Canine Heartworm Antigen Test Kit. Eleven of these cats were positive on initial examination (Table 2), and an additional 2 cats that were initially negative were found to be positive at follow-up testing. Two cats that had initially tested positive for antigen were negative at follow-up. Of the 11 that initially tested antibody positive, 9 also tested positive on at least 1 antibody test, and 8 of these were positive on both antibody tests. Interestingly, 1 of the antigen-positive cats was found to have circulating microfilariae, but was negative for both antibody tests at baseline.

### Antibody Tests

At baseline, 94 (44%) of the 215 cats were antibody positive by the ELISA-based Heska and/or Animal Diagnostics’ tests. At the time of this study, the Animal Diagnostics’ test was considered positive at titer of ≥1:50, and the Heska test was considered positive at ≥5 antibody units per ml. Eighty-five of the cats with antibodies were detected by the Animal Diagnostics’ test, including 64 that were negative by the Heska antibody test. The Heska test was not conducted for three cats in the survey, and a total of 28 cats (13%) was positive by this test, including nine that were negative by the Animal Diagnostics’ test. The regional distribution of cats positive for heartworm antibodies is included in Table 2. Of the 94 cats positive by

| Table 1. Summary of Radiographic Results (Number of Cats Positive for Signs of Feline Heartworm/Number Radiographed) |
|---|---|---|---|---|---|
| Time | FL | SC | TN | TX | Total |
| Baseline | 31/56 | 20/51 | 20/56 | 19/49 | 90/212 (42.45%) |
| 60–90 days | 17/23 | 11/16 | 11/17 | 14/25 | 53/81 (65.43%) |

| Table 2. Results of Antigen and Antibody Tests for Cats at Initial Presentation (Number of Cats Positive/Number Tested) |
|---|---|---|---|---|---|
| Test | FL | SC | TN | TX | Total |
| DiroCHEK antigen | 6/56 | 1/52 | 1/56 | 3/51 | 11/215 (5.1%) |
| Heska antibody | 11/56 | 9/50 | 4/55 | 4/51 | 28/212 (13.2%) |
| Animal Diagnostics’ antibody | 23/56 | 22/52 | 17/56 | 23/51 | 85/215 (39.5%) |
one or both antibody tests, 37 of the antibody-positive cats were female and 57 were male.

Percentage of time the cat spent indoors was reported by each cat’s owner. Eighteen percent of the Heska antibody-positive cats and 21% of the Animal Diagnostics’ antibody-positive cats were reported by their owners to spend 100% of their time indoors. Fourteen percent of the Heska positive cats and 12% of the Animal Diagnostics’ positive cats were reported to be completely outdoor cats (Table 3).

At the 30 to 45 day recheck, only 51 cats had 1 or both antibody tests performed and 34 of these (67%) were positive. For the Heska antibody test, 2 antibody-negative cats at baseline became antibody positive at this follow-up evaluation and 3 antibody-positive cats became negative. For the Animal Diagnostics’ antibody test, 1 antibody-negative cat became positive, while 14 antibody-positive cats became negative.

At the 60 to 90 day recheck, 88 cats were retested with 1 or both antibody tests, with 46 of these (52%) positive. At this follow-up evaluation, 2 cats that were initially negative by the Heska test were positive for antibodies, and 5 cats that were initially positive were now negative. For the Animal Diagnostics’ tests, of the 130 cats initially testing negative, 21 became positive, and of the 85 initially testing positive, 15 became negative. As previously noted, one cat that was antigen positive and had circulating microfilaria was negative for heartworm antibody on both tests. Additionally, of the 3 cats that died acutely with signs of respiratory distress and postmortem diagnosis of heartworm, 2 of the cats had low antibody levels on 1 or both antibody tests.

### Microfilarial Tests

Microfilarial tests were performed on 211 cats; this data was not available for 4 cats. Only 1 cat was positive for microfilaria, and as noted above, was antigen positive but negative for both antibody tests.

### Deaths

Thirteen cats died during the course of the study, 5 of which were euthanized. Eight of the cats that died were positive on one or both antibody tests, positive on the DiroCHEK antigen test, or had baseline radiographic scores that were consistent with, or suggestive of FHD (Table 4). Heartworms were found in the pulmonary arteries or heart of 3 cats that died. An additional 3 cats showed histopathological evidence suggestive of heartworm disease. Two of the 13 cats died acutely; heartworms were identified in 1 of these cats and histopathological evidence suggestive of heartworm disease was on the other.

### DISCUSSION AND CONCLUSION

Cats presented with signs of respiratory disease, or chronic vomiting that is unrelated to

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### Table 3. Percentage of Time Spent Indoors by Cats Positive for Antigen and Antibody

<table>
<thead>
<tr>
<th>Test</th>
<th>100%</th>
<th>90%–99%</th>
<th>11%–99%</th>
<th>0%</th>
<th>Unknown</th>
</tr>
</thead>
<tbody>
<tr>
<td>DiroCHEK Ag positive (n=11)</td>
<td>1</td>
<td>1</td>
<td>7</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Heska Ab positive (n=28)</td>
<td>5</td>
<td>2</td>
<td>16</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Animal Diagnostics’ Ab positive (n=85)</td>
<td>18</td>
<td>10</td>
<td>45</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(9%)</td>
<td>(7%)</td>
<td>(57%)</td>
<td>(14%)</td>
<td>(4%)</td>
</tr>
<tr>
<td></td>
<td>(18%)</td>
<td>(12%)</td>
<td>(53%)</td>
<td>(12%)</td>
<td>(2%)</td>
</tr>
<tr>
<td>Case</td>
<td>State</td>
<td>Age</td>
<td>Sex</td>
<td>Indoors</td>
<td>Time (An Diag)</td>
</tr>
<tr>
<td>------</td>
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</tr>
<tr>
<td>1</td>
<td>TX</td>
<td>4</td>
<td>M</td>
<td>0</td>
<td>Pos</td>
</tr>
<tr>
<td>2</td>
<td>TN</td>
<td>9</td>
<td>M</td>
<td>NA</td>
<td>Neg</td>
</tr>
<tr>
<td>3</td>
<td>SC</td>
<td>3</td>
<td>M</td>
<td>0</td>
<td>Neg</td>
</tr>
<tr>
<td>4</td>
<td>TX</td>
<td>4</td>
<td>M</td>
<td>0</td>
<td>Neg</td>
</tr>
<tr>
<td>5</td>
<td>FL</td>
<td>11</td>
<td>F</td>
<td>20%</td>
<td>0</td>
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<tr>
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<td>SC</td>
<td>6.5</td>
<td>F</td>
<td>50%</td>
<td>Pos</td>
</tr>
<tr>
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<td>TX</td>
<td>11</td>
<td>M</td>
<td>100%</td>
<td>Neg</td>
</tr>
<tr>
<td>8</td>
<td>TN</td>
<td>9</td>
<td>M</td>
<td>50%</td>
<td>Neg</td>
</tr>
<tr>
<td>9</td>
<td>FL</td>
<td>2</td>
<td>M</td>
<td>100%</td>
<td>Neg</td>
</tr>
<tr>
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<td>TN</td>
<td>15</td>
<td>M</td>
<td>90%</td>
<td>Neg</td>
</tr>
<tr>
<td>11</td>
<td>TX</td>
<td>11</td>
<td>F</td>
<td>50%</td>
<td>Neg</td>
</tr>
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<td>TX</td>
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</tr>
<tr>
<td>13</td>
<td>TN</td>
<td>7</td>
<td>M</td>
<td>70%</td>
<td>0</td>
</tr>
</tbody>
</table>

*Died shortly after presentation to hospital following collapse  
†Died on examination table following acute dyspnea/collapse  
Histopathology suggestive of heartworm disease = includes: medial hypertrophy of pulmonary arteries with lymphocytic or plasmacytic perivasculitis, smooth muscle hypertrophy, or interstitial congestion  
NA = Not Available
eating, should be considered for further testing for feline heartworm disease. Although signs such as coughing, dyspnea, and vomiting are frequently associated with feline heartworm disease, they are also indicators of conditions such as bronchitis, asthma, lungworm infection, and others.

In this survey, 44% of cats presenting with clinical signs of heartworm were positive for presence of antibody to heartworm on initial examination. Thirteen cats (6%) were found to be antigen positive, and therefore conclusively diagnosed as heartworm positive. Ninety (42%) had radiographic scores >0.5, therefore indicative or suggestive of FHD.

Eosinophilia and, to a lesser extent, basophilia were observed in only a slightly greater percentage of cats that were positive by 1 or both antibody tests. While this correlation has been reported to occur 4 to 7 months after infection in cats, these clinical pathology measurements, by themselves, have not been found to be reliable indicators of the presence (or the absence, for that matter) of heartworm infection in cats.

A positive antigen test is a clear indication of a mature female worm present in the heart or pulmonary arteries. However, a negative antigen test is difficult to interpret because the cat could be negative for heartworm infection, or could be infected with only male adult worms, or the parasites could be immature. Antigen testing is a useful tool for a follow-up in cats that test positive on an antibody test, since a positive result confirms the suspicion of heartworm.

For detecting heartworm infection in the cat, ELISA-based antibody tests are more sensitive than antigen tests, but present varying degrees of specificity. A negative result may indicate a cat recently had larval stages of heartworm which failed to mature, or there are current infections less than 50 or 60 days old. The specificity of these tests have been greatly improved since their inception, as described by McCall and colleagues. In this survey, a greater number of cats was positive for heartworm antibodies with the Animal Diagnostics’ test kit than with the Heska test. Recently published information reports that the Animal Diagnostics’ test, which utilizes a combination of several heartworm antigens, detected heartworm antibodies in artificially infected cats at 1 month postinfection, while the Heska test, which uses one highly purified antigen, did not. Both tests performed with equal sensitivity when infections were 3 months old. While these data have not been replicated with naturally-occurring infections, it can be speculated that many of the infections in cats participating in this survey were relatively new. In this study, it became apparent that some cats infected with heartworm and showing clinical signs associated with heartworm did not have detectable antibody at the first examination, but converted to antibody positive on recheck examination. Therefore, cats presented with clinical signs associated with heartworm disease, but negative by an antibody test should be retested within 2 to 3 months. Actual antibody levels did not appear to correspond to severity of the disease in this study.

One of the notable findings in this survey was the high number of heartworm antibody-positive cats among those classified by their owners as indoor only cats, and others with limited exposure to the outdoors; thus, reported lifestyle did not rule out the potential for exposure to vectors for heartworm infection.

Feline heartworm disease should be among the primary differential diagnoses in cats with respiratory disease, vomiting, or acute death. This study demonstrated that no one test by itself will allow diagnosis of feline heartworm disease in every case. Radiography, antibody, and antigen testing are all useful tools to aid in
making the diagnosis; however, a confirmed diagnosis may require performance of multiple tests and clinical reevaluations 2 or 3 months after initial testing. The high prevalence of antibody-positive cats among cats showing signs consistent with feline heartworm, plus the challenge of confirming diagnosis of feline heartworm, and the lack of safe and effective treatment provide support for prescribing heartworm prophylaxis for cats.

**ACKNOWLEDGMENT**

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**REFERENCES**