Companion animal lungworms - Treatment options

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University of Copenhagen, Denmark
Today’s selection

Feline
- *Aelurostrongylus abstrusus*

Canine
- *Crenosoma vulpis*
- *Angiostrongylus vasorum*
  - Anthelmintic treatment
  - Supportive treatment

Left out
- Capillaria aerophila (Ca, Fe),
- Oslerus osleri (Ca)
- Oslerus rostratus (Fe)

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From Empirical to Evidence-based treatment

Anthelmintic treatment

Early treatment based on:
- Expert opinions
- Case reports
- Case series

Now:
- Case – control studies
- Randomized, controlled, blinded studies
Aelurostrongylus abstrusus

Previously

- Fenbendazole 50 mg/kg SID for 15 days (Grandi et al. Vet Parasitol 2005;134:177-182), Five cats, naturally infected.

No adverse reactions reported
**Aelurostrongylus abstrusus**

Treatment options:

- Imidacloprid 10%/moxidectin 1% spot-on formulation (Advocate®) (Traversa et al. WAAVP, 2009) – Naturally infected animals, n=12
- Emodepside 2.1%/praziquantel 8.6% spot-on formulation (Profendor®) (Traversa et al. WAAVP, 2009) – Naturally infected animals, n=12
- Fenbendazole 18.75% oral solution SID for three days (Panacur®) (Traversa et al. WAAVP, 2009) – Naturally infected animals, n=12

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Lpg*, day -6 to -2</th>
<th>Lpg day 28±2</th>
<th>Reduction %</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Advocate®)</td>
<td>47.5</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>(Profendor®)</td>
<td>63.8</td>
<td>1.3</td>
<td>99.4</td>
</tr>
<tr>
<td>(Panacur®)</td>
<td>33.8</td>
<td>1.3</td>
<td>99.3</td>
</tr>
</tbody>
</table>

*Lpg= larvae per gram (faeces), mean

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Crenosoma vulpis

Previously (single case reports or small case series)

- Ivermectin 0.2 mg/kg s.c. once a week for 2 weeks
- Levamisole 7.5 mg/kg s.c. two times 2 days apart
- Fenbendazole 50 mg/kg SID for 3 days

Usually no supportive treatment reported
**Crenosoma vulpis**

Natural infections of *Crenosoma vulpis* and *Angiostrongylus vasorum* in dogs in Atlantic Canada and their treatment with milbemycin oxime

G. Conboy

**TABLE 2: Outcomes of the treatment of dogs infected with *Crenosoma vulpis* and/or *Angiostrongylus vasorum* with milbemycin oxime**

<table>
<thead>
<tr>
<th>Outcome</th>
<th><em>C. vulpis</em></th>
<th><em>A. vasorum</em></th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical cure/larval shedding ceased</td>
<td>32</td>
<td>2</td>
<td>46</td>
</tr>
<tr>
<td>Faecal samples not available</td>
<td>7</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Animal died</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>3</td>
<td>13</td>
</tr>
</tbody>
</table>

Veterinary Record (2004) 155, 16-18

G. Conboy, DVM, PhD, Department of Pathology and Microbiology, Atlantic Veterinary College, University of Prince Edward Island.
**Crenosoma vulpis**

Natural infections of *Crenosoma vulpis* and *Angiostrongylus vasorum* in dogs in Atlantic Canada and their treatment with milbemycin oxime

G. Conboy

0.5 mg/kg milbemycin oxime (Interceptor® Novartis) Single oral dose

Efficacy 32/32 with no adverse effects reported

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G. Conboy, DVM, PhD, Department of Pathology and Microbiology, Atlantic Veterinary College, University of Prince Edward Island,
Crenosoma vulpis

Treatment options:

- Imidacloprid 10%/moxidectin 2.5% spot-on formulation (single application) (Conboy et al. WAAVP, 2009)
- Experimental study, beagle dogs

<table>
<thead>
<tr>
<th>Group</th>
<th>Infection</th>
<th>4 weeks PI</th>
<th>5 weeks PI</th>
<th>8 weeks PI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (n=8)</td>
<td>100 L3</td>
<td>control</td>
<td>7.9-39.2 L1/g</td>
<td>70 (58-87)*</td>
</tr>
<tr>
<td>2 (n=8)</td>
<td>100 L3</td>
<td>treatment</td>
<td>negative</td>
<td>0</td>
</tr>
</tbody>
</table>

*adult C. vulpis on post mortem
Angiostrongylus vasorum

Natural infections of Crenosoma vulpis and Angiostrongylus vasorum in dogs in Atlantic Canada and their treatment with milbemycin oxime

G. Conboy

TABLE 2: Outcomes of the treatment of dogs infected with Crenosoma vulpis and/or Angiostrongylus vasorum with milbemycin oxime

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Infected with C vulpis</th>
<th>A vasorum</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical cure/larval shedding ceased</td>
<td>32</td>
<td>2</td>
<td>12</td>
</tr>
<tr>
<td>Faecal samples not available</td>
<td>7</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Animal died</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>3</td>
<td>13</td>
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</tbody>
</table>

Veterinary Record (2004) 155, 16-18

G. Conboy, DVM, PhD, Department of Pathology and Microbiology, Atlantic Veterinary College, University of Prince Edward Island,

Department of Small Animal Clinical Sciences, Frederiksberg Campus
Angiostrongylus vasorum – treatment strategy

- Treatment strategy
  - Treatment after diagnosis
  - Prophylactic
    - Supportive treatment
    - Anthelmintic treatment
# Angiostrongylus vasorum

## Previously

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dose</th>
<th>Efficacy</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fenbendazole</td>
<td>50 mg/kg SID for 5-7 days</td>
<td>2/2</td>
<td>Brennan, <em>Irish Vet Jour</em> 2004;57:103</td>
</tr>
<tr>
<td>Fenbendazole</td>
<td>20 mg/kg SID for 21 days</td>
<td>2/2</td>
<td>Martin et al <em>JSAP</em> 1993; 34:20</td>
</tr>
<tr>
<td>Ivermectin</td>
<td>0.2 mg/kg s.c. q7d, for two weeks</td>
<td>2/2</td>
<td>Martin et al <em>JSAP</em> 1993; 34:20</td>
</tr>
<tr>
<td>Ivermectin</td>
<td>0.2 mg/kg s.c. q7d, for four weeks</td>
<td>1/1</td>
<td>Bourque et al <em>Can Vet Jour</em> 2002;43:876</td>
</tr>
<tr>
<td>Levamisole</td>
<td>10 mg/kg s.c SID for 3 days</td>
<td>8/8</td>
<td>Dodd <em>Vet Rec</em> 1973;92:195</td>
</tr>
</tbody>
</table>
Angiostrongylus vasorum

Natural infections of *Crenosoma vulpis* and *Angiostrongylus vasorum* in dogs in Atlantic Canada and their treatment with milbemycin oxime

G. Conboy

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**TABLE 2: Outcomes of the treatment of dogs infected with *Crenosoma vulpis* and/or *Angiostrongylus vasorum* with milbemycin oxime**

| Outcome                        | Infected with 
<table>
<thead>
<tr>
<th>C. vulpis</th>
<th>A. vasorum</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical cure/larval shedding ceased</td>
<td>32</td>
<td>2</td>
</tr>
<tr>
<td>Faecal samples not available</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Animal died</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>3</td>
</tr>
</tbody>
</table>

Veterinary Record (2004) 155, 16-18

G. Conboy, DVM, PhD, Department of Pathology and Microbiology, Atlantic Veterinary College, University of Prince Edward Island,

Department of Small Animal Clinical Sciences, Frederiksberg Campus
Angiostrongylus vasorum

Natural infections of Crenosoma vulpis and Angiostrongylus vasorum in dogs in Atlantic Canada and their treatment with milbemycin oxime

G. Conboy

0.5 mg/kg milbemycin oxime p.o. (Interceptor® Novartis), 4 times 1 week apart

Efficacy 14/16 – clinical signs resolved

One dog died

Veterinary Record (2004) 155, 16-18

G. Conboy, DVM, PhD, Department of Pathology and Microbiology, Atlantic Veterinary College, University of Prince Edward Island,
Angiostrongylus vasorum

Angiostrongylus vasorum infection in 23 dogs (1999-2002)

50 mg/kg fenbendazole (Panacur®Intervet) SID for 5-21 days

Efficacy 16/20 – resolution of clinical signs in all dogs

Three dogs died

P. S. Chapman, A. K. Boag, J. Guitian and A. Boswood


Department of Small Animal Clinical Sciences, Frederiksberg Campus
**Angiostrongylus vasorum**

Efficacy and safety of imidaclorpid/moxidectin spot-on solution and fenbendazole in the treatment of dogs naturally infected with *Angiostrongylus vasorum* (Baillet, 1866)

J.L. Willesen a,*, A.T. Kristensen a, A.L. Jensen a, J. Heine b, J. Koch a

Veterinary Parasitology 147 (2007) 258–264

Randomized, blinded, controlled, multi centre field-trial study

<table>
<thead>
<tr>
<th><strong>Group A</strong></th>
<th><strong>Group B</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Moxidectin 2,5 mg/kg topically (Advocate®)</td>
<td>Fenbendazol 25 mg/kg p.o. SID for 20 dage (Panacur®)</td>
</tr>
</tbody>
</table>
Results

Animals included in study  
\( n = 54 \)

Randomized to IMI/MOX  
\( n = 27 \)
- Treated according to protocol  
  \( n = 23 \)
- Deviation from Protocol  
  \( n = 1 \)
- Withdrawn from study  
  \( n = 3 \)

Randomized to FENBENDAZOLE  
\( n = 27 \)
- Treated according to protocol  
  \( n = 23 \)
- Treated with IMI/MOX  
  \( n = 3 \)
- Withdrawn from study  
  \( n = 1 \)

Numbers of dogs included in efficacy and safety dataset  
\( n = 50 \)

IMIDACLOPRID/MOXIDEXTIN (\( n = 27 \)) FENBENDAZOLE (\( n = 23 \))
Fisher's exact test

<table>
<thead>
<tr>
<th></th>
<th>Positiv</th>
<th>Negativ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advocate</td>
<td>4</td>
<td>23</td>
</tr>
<tr>
<td>Panacur</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>44</td>
</tr>
</tbody>
</table>

P value: 0.6740
P value summary: ns
One- or two-sided: Two-sided
Statistically significant?
(α < 0.05) No

Treatment success IMI/MOX
23/27 x 100 = 85.2%
95% CI (66.3-95.8)

Treatment success FENBENDAZOLE
21/23 x 100 = 91.3%
95% CI (71.9-98.9)
## Angiostrongylus vasorum

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dose</th>
<th>Efficacy</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Milbemycin oxime</td>
<td>0.5 mg/kg weekly four times</td>
<td>14/16</td>
<td>Conboy <em>Vet Rec</em> 2004;155:16</td>
</tr>
<tr>
<td>Fenbendazole</td>
<td>50 mg/kg SID for 5 to 21 days</td>
<td>16/20</td>
<td>Chapman et al <em>JSAP</em> 2004;45:435</td>
</tr>
<tr>
<td>Imidaclorpheid 10% / moxidectin 2.5%</td>
<td>0.1 ml/kg Single dose</td>
<td>23/27</td>
<td>Willesen et al <em>Vet Par</em> 2007;147:258</td>
</tr>
<tr>
<td>Fenbendazole</td>
<td>25 mg/kg SID for 20 days</td>
<td>21/23</td>
<td>Willesen et al <em>Vet Par</em> 2007;147:258</td>
</tr>
</tbody>
</table>
Supportive treatment

Antibiotics (prevent 2º infections)

Corticosteroids (prevent anaphylactic reactions)
• Reported by Soland J, Bolt G. in a dog treated with Levamisole (JSAP; 1996; 37:594)
• Suggested mechanism – antigen release due to rapid worm kill
• ½-1 mg/kg for 3-10 days
Supportive treatment

Fluid therapy
- Crystalloids
- Colloids

Transfusion therapy
- Fresh Frozen Plasma
- Whole blood
- Packed red blood cells

Oxygen

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Cor pulmonale – pulmonary hypertension

1° Tx - Anthelmintic treatment
2° Tx - Reduce pulmonary arterial pressure
  • Sildenafil (PDE-5 inhib) – short acting
  • Tadalafil (PDE-5 inhib) - long acting
  • Pimobendan (PDE-3 and Ca++ sensitiser)
## Supportive treatment

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Chapman et al., 2004 (n=23)</th>
<th>Willesen et al., 2007 (n=54)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antibiotics</td>
<td>9%</td>
<td>18%</td>
</tr>
<tr>
<td>Corticosteroids</td>
<td>22%</td>
<td>15%</td>
</tr>
<tr>
<td>Antibiotics + corticosteroids</td>
<td>NA</td>
<td>6%</td>
</tr>
<tr>
<td>Bronchodilators</td>
<td>4%</td>
<td>0%</td>
</tr>
</tbody>
</table>

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## Classification

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description of classification and recommended diagnostic work-up</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mild</strong></td>
<td>Asymptomatic, occasional cough, gag, miscellaneous clinical signs, no changes or mild increase in density of interstitial and bronchial tissue</td>
</tr>
<tr>
<td></td>
<td>1. Baermann test (faeces collected on three consecutive days)</td>
</tr>
<tr>
<td></td>
<td>2. Thoracic radiographs (if not already obtained)</td>
</tr>
<tr>
<td><strong>Moderate</strong></td>
<td>Frequent cough, dyspnoea, moderate increase in interstitial and bronchial tissue, possible focal alveolar pattern present</td>
</tr>
<tr>
<td></td>
<td>1. Possible hospitalisation (based on a case by case assessment)</td>
</tr>
<tr>
<td></td>
<td>2. Direct faecal smear; if negative → 3.</td>
</tr>
<tr>
<td></td>
<td>3. Baermann test (faeces collected on three consecutive days)</td>
</tr>
<tr>
<td></td>
<td>4. Thoracic radiographs (if not already obtained)</td>
</tr>
<tr>
<td></td>
<td>5. Haematological profiles</td>
</tr>
<tr>
<td><strong>Severe</strong></td>
<td>Clinical bleeding, marked dyspnoea, marked diffuse interstitial and bronchial patterns, often with localised or extensive alveolar opacities in major portions of the lung field</td>
</tr>
<tr>
<td></td>
<td>1. Hospitalisation (supportive therapy)</td>
</tr>
<tr>
<td></td>
<td>2. Direct faecal smear; if negative → 3.</td>
</tr>
<tr>
<td></td>
<td>3. Baermann test (faeces collected on three consecutive days)</td>
</tr>
<tr>
<td></td>
<td>4. Thoracic radiographs (if not already obtained)</td>
</tr>
<tr>
<td></td>
<td>5. Haematological and biochemical profiles and urinalysis</td>
</tr>
<tr>
<td></td>
<td>6. Coagulation profiles (Fibrinogen, D-dimer, APTT, PT)</td>
</tr>
<tr>
<td></td>
<td>7. Thromboelastography</td>
</tr>
</tbody>
</table>

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**Angiostrongylus vasorum**

Prophylactic options:
- Imidacloprid 10%/moxidectin 2.5% spot-on formulation (single application) (Schnyder et al. WAAVP, 2009)
- Experimental study, controlled, blinded, randomized study to evaluate prophylactic efficacy and safety.

<table>
<thead>
<tr>
<th>Group</th>
<th>Infection</th>
<th>4 dpi</th>
<th>32 dpi</th>
<th>L1</th>
<th>PM (adult worm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (n=8)</td>
<td>200 L3</td>
<td>Treatment</td>
<td>No Tx</td>
<td>No L1</td>
<td>No adult worms</td>
</tr>
<tr>
<td>2 (n=8)</td>
<td>200 L3</td>
<td>No Tx</td>
<td>Treatment</td>
<td>No L1</td>
<td>No adult worms</td>
</tr>
<tr>
<td>3 (n=8)</td>
<td>200 L3</td>
<td>No Tx</td>
<td>No Tx</td>
<td>47 dpi</td>
<td>99 adult worms (mean)</td>
</tr>
</tbody>
</table>

dpi = days post infection
PM = post mortem
Summary / conclusion

- Treatment of *Aelurostrongylus abstrusus / crenosoma vulpis* and *Angiostrongylus vasorum* are increasingly evidence-based.

- Treatment can be done using safe and efficacious treatment protocols.

- The use of prophylactic treatment might be indicated in endemic areas or in cats dogs previously diagnosed with lungworm infections.

- The need for evidence based supportive treatment remains to be solved.
Acknowledgements

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Vet Tech. Gitte Wagner

Dr. Eric Morgan
Dr. Ryan Jefferies

Corporation:
Bayer HealthCare, Animal Health, Germany

Referring Veterinarians

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Faculty of Life Sciences, University of Copenhagen, DK
Phone: +45 353 32955, Fax: + 45 353 32929

Department of Small Animal Clinical Sciences, Frederiksberg Campus
Thanks for your attention

Questions?

Department of Small Animal Clinical Sciences, Frederiksberg Campus