Helminthology – Nematodes

Hookworm

Terry L Dwelle MD MPHTM
# Classification of Nematodes

<table>
<thead>
<tr>
<th>Subclass</th>
<th>Order (suborder)</th>
<th>Superfamily</th>
<th>Genus and Species</th>
<th>Probable prevalence in man</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secernentea</td>
<td>Strongylida</td>
<td>Ankylostomatoidea</td>
<td>Ankylostoma douodenale</td>
<td>716 million</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Necator americanus</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>A caninum</td>
<td>Thousands</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>A braziliense</td>
<td>Thousands</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>A ceylanicum</td>
<td>Rare</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Ternidens diminutus</td>
<td>Thousands</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Oesophagostomum apiostomum</td>
<td>Rare</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Syngamus laryngeus</td>
<td>Rare</td>
</tr>
</tbody>
</table>
General Information

- Two major species; Ankylostoma duodenale (old world), Necator Americanus (new world)
- Others; A caninum, A braziliense, A ceylanicum
- Prevalence – Africa, Asia, Central America, South America, Caribbean Islands, SE US
General Recognition Features

► Size
  - Necator americanis – male 7-9 mm, female 10-18 mm
  - Ankylostoma duodenale – male 8-11 mm, female 10-15 mm

► Structure
  - NA has a fused copulatory spicule vs AD
  - AD totally dorsally flexed. NA is dorsally flexed but with a ventral flex near the head
  - Two sets of reproductive organs
  - Distinctive mouth parts
  - Copulatory bursa ray patterns are distinctive

► Eggs
  - Thin shelled
  - 60-75 um X 35-40 um
General Recognition Features

Structure

- NA has a fused copulatory spicule vs AD
- AD totally dorsally flexed. NA is dorsally flexed but with a ventral flex near the head
- Two sets of reproductive organs
- Copulatory bursa ray patterns are distinctive for male worms

From Manson’s Tropical Disease, 20th Edition, Saunders, pp 1621
General Recognition Features

From Manson’s Tropical Disease, 20th Edition, Saunders, pp 1622

Figure III.63  Necator americanus. (12×.) Key as for Figure III.58.
General Recognition Features

A Duodenale

A Caninum

N Americanus

A Ceylanicum

General Recognition Features

Figure III.59  Bursa (A) and head (B) of male *Ancylostoma duodenale.*

Figure III.64  Bursa (A) and head (B) of *Necator americanus.*

From Manson’s Tropical Disease, 20th Edition, Saunders, pp 1621-1622
General Recognition Features

General Recognition Features
Life Cycle

- Definitive host – man
- Stage leaving the body – fertile eggs
- Infectious stage for the definitive host – L3 larvae
Prepatency and Incubation Period

- Prepatency – 8-12 weeks
- Incubation period – 4-12 weeks
**Life Cycle**

**L1 rhabdiform Larvae**
- Skin
- GI (Meat, Breast Milk)
- Eggs
- Small Intestine
- Esophagus
- Largnx
- Lungs
- Blood

**L3 Filariform Larvae**
- Skin
- GI (Meat, Breast Milk)
- Eggs
- Small Intestine
- Esophagus
- Largnx
- Lungs
- Blood

24-48 hours

- 5000/day NA, 20,000/day AD
- AD 5-7w, NA 4-6w

- Life span 5-10 years
- Rhabditis like esophagus
- Penetrates skin within a few minutes

Eggs (soil): loose, sandy

- 6 – 10 days
- GI: Meat, Breast Milk
Life Cycle

L1 rhabdiform Larvae
- Soil (loose, sandy)
- Eggs
  - 5000/day NA, 20,000/day AD
- Small Intestine
  - Life span 5-15 years

L3 Filariform Larvae
- Skin
- Blood
- Lungs
  - 6 – 10 days
- Esophagus
- Small Intestine

GI
- Meat
- Breast Milk

Penetrates skin within a few minutes
Signs and Symptoms

► Ground itch due to vesiculation and pustulation at the entry site
  ▪ Exposed portions of the body usually the soles of the feet or hands
► Asthma and bronchitis caused by migration of the larvae through the lungs
  ▪ 1-2 weeks associated with dry cough and wheezing
► Established infection associated with hookworm disease
Established Infection

- Light infection ($\leq 100$ worms)
  - Mild anemia
  - Fatigue
  - Lassitude
  - Digestive disturbances
  - Eosinophilia
Established Infection

- Heavy infection (≥400 worms) -
  - Fatigue
  - Lassitude
  - Eosinophilia
  - Epigastric apin
  - Perverted taste – pica, geophagy
  - Hematochezia / melena
  - Anemia
  - Edema associated with hypoalbuminemia
  - Heart failure
  - Hypothermia
  - Retinal hemorrhages
  - Irregular fever
  - Growth failure
Wakana disease

- Associated with oral infection with AD in Japan
- No larvae are found in the lung
- Has cough, dyspnea, eosinophilia, nausea and vomiting
- Seen one to several days after ingestion of larvae
- Etiology is not known
Infantile Disease

- Mostly reported from China
- Mainly caused by A Duodenale
- Transmission – trans-mammary, laying infants on infected soil, and rarely trans-placental
- Signs and symptoms – diarrhea, hematochezia/melena, anorexia, vomiting, pallor, massive hemorrhage
- Mortality – 12%
Diagnosis

► Eggs in the stool

- Heavy infection – Direct stool smear with saline or potassium iodide saturated with iodine
- Light infection – Concentration techniques (Kato-Katz, Beaver direct smear, Stoll egg counting technique)
- Late prepatent period Charcot Leyden crystals and eosinophils may be seen in the feces similar to whipworm
- > 20 eggs / mg associated with anemia in NA vs > 5 eggs / mg with AD
Strongyloides stercoralis larva
Hookworm Egg
Trichostrongylus Egg
Hookworm Capillaria Philippinensis
Hookworm Trichuris trichuria

Trichuris trichuria
Hookworm
# Treatment

<table>
<thead>
<tr>
<th>Drug</th>
<th>Adult</th>
<th>Pediatric</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albendazole</td>
<td>400 mg once</td>
<td>400 mg once</td>
</tr>
<tr>
<td>Mebendazole</td>
<td>100 mg bid X 3 days or 500 mg once</td>
<td>100 mg bid X 3 days or 500 mg once</td>
</tr>
<tr>
<td>Pyrantel pamoate</td>
<td>11 mg/kg (max 1 gm) X 3 days</td>
<td>11 mg/kg (max 1 gm) X 3 days</td>
</tr>
</tbody>
</table>
## Adverse Reactions

<table>
<thead>
<tr>
<th>Medication</th>
<th>Occasional: diarrhea, abdominal pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albendazole</td>
<td>Rare: leukopenia, alopecia, increased serum transaminase levels</td>
</tr>
<tr>
<td>Mebendazole</td>
<td>Occasional: diarrhea, abdominal pain</td>
</tr>
<tr>
<td></td>
<td>Rare: leukopenia, agranulocytosis, hypospermia</td>
</tr>
<tr>
<td>Pyrantel pamoate</td>
<td>Occasional: GI disturbances, headache, dizziness, rash, fever</td>
</tr>
</tbody>
</table>
Control Measures

- Sanitary disposal of feces
- Treatment of all known infected people. Screening of high risk groups (agricultural workers and children) may help.
- Wearing shoes in endemic areas
- Mass de-worming of school aged children