



CMPT Enteric Parasitology Program

Innovation, Education, Quality Assessment, Continual Improvement

Challenge 0904-1

April, 2009

Hookworm

CMPT QA

This sample was verified by two reference laboratories. Both laboratories reported Hookworm ova.

One of the laboratories also reported *Blas-tocystis hominis* and *Giardia lamblia* cysts

SURVEY RESULTS

As shown in results table, 77% of the laboratories reported Hookworm (80% of those reporting results); one of them reported *Necator americanus* in the concentrate and slide.

Five out of 26 (20%) laboratories did not report Hookworm, and 4% (n=1) did not send a report due to high workload.

As shown in results table, 77% of the laboratories reported Hookworm; one reported *Necator americanus* in the concentrate and slide.

Cryptosporidium was reported by 8 laboratories (31%).

Five out of 26 (20%) laboratories did not report Hookworm, and 4% (n=1) did not send a report due to high workload.

The Committee recommends that all Proficiency Testing samples should be processed as routine samples even when there is a staff shortage or high workload .

METHODS

Microscopic examination

Microscopic identification of ova (eggs) in the stool is the most common method for diagnosing hookworm infection. Hookworm ova passed from feces are thin-shelled, oval or ellipsoidal shaped, contain a developing embryo that usually is in the 4- to 8-cell stage of division, and measure 55 to 75 µm long by 36 to 40 µm wide ^{1,2}.

Grading

** The Committee recommended that "Hookworm" and not *Necator americanus* should be reported since the two species can not be distinguished morphologically. It is also important to keep the report easy to interpret by the clinician and thus avoid misinterpretation of results.

Although *Cryptosporidium* was not the target parasite, the number of laboratories reporting it suggests the parasite was present in the sample and thus it was not considered for grading.

Unacceptable grade:

Reporting of *Cyclospora cayetanensis* was considered unacceptable. No other laboratory reported the parasite. It is possible that *Cyclospora* may have been mistaken for *Cryptosporidium*; *Cyclospora* oocysts measure 8 to 10µm, while *Cryptosporidium* oocysts measure from 4 to 6µm⁶.

Lack of reporting of hookworm is unacceptable. There was a considerable amount of hookworm in samples, with one of the reference laboratories reporting heavy and the second lab reporting moderate amount.

Table 904-1-1: Combined results received – Hookworm challenge

Reports	No. Reported	%	Grade
Hookworm +/- WBC, CLC	19	73	Acceptable
reported <i>Necator americanus</i> (n=1)			Acceptable**
and <i>B hominis</i> (n=12)			Acceptable
and <i>Cryptosporidium</i> (n=5)			Acceptable
and <i>E coli</i> (n=2)			Acceptable
and <i>E nana</i> (n=4)			Acceptable
and <i>E hartmanni</i> (n=2)			Acceptable
Hookworm and <i>Cyclospora cayetanensis</i>	1	4	Unacceptable
<i>Cryptosporidium</i> sp.	3	12	Unacceptable
and <i>E.nana</i> (n=1)			Unacceptable
and <i>Giardia lamblia</i> (n=1)			Unacceptable
<i>Giardia lamblia</i>, <i>E.nana</i>, <i>B.hominis</i>	1	4	Unacceptable
No ova or parasites	1	4	Unacceptable
No report due to high workload	1	4	Unacceptable
Total	26	100	

Major parasites in bold - WBC: white blood cells - CLC: Charcot Leyden Crystals

Table 904-1-2: Historic results – Hookworm challenge

Challenge	904-1	804-1	604-3	406-2
Results	77%	87.5%	100%	96%

Human hookworms include two nematode (roundworm) species, *Ancylostoma duodenale* and *Necator americanus*. The eggs of *Ancylostoma duodenale* and *Necator americanus* cannot be distinguished morphologically and thus it should be reported as “hookworm”. The hookworm larva sizes vary between species and sexes: *A. duodenale* adult females measure 10 to 13 mm; while those of *N. americanus* measure 9 to 11 mm; *A. duodenale* adult males measure 8 to 11 mm; *N. americanus* adult males measure 7 to 9 mm. The posterior end of the male has an umbrella-shaped bursa, with rib-like rays. There are chitinous specializations in the buccal capsules of both species ².

It is necessary to distinguish between the rhabditiform larvae of hookworms and those of *Strongyloides stercoralis* as *S. stercoralis*, requires different therapy ³.

LIFE CYCLE

Eggs are passed in the stool, and under favorable conditions (moisture, warmth, shade) hatch in 1 to 2 days. The released rhabditiform larvae grow in the feces and/or the soil, and after 5 to 10 days (and two molts) they become infective filariform (third-stage) larvae² which can survive 3 to 4 weeks in favorable environmental conditions.

On contact with the human host, the larvae penetrate the skin and are carried through the veins to the heart and then to the lungs. They penetrate into the pulmonary alveoli, ascend the bronchial tree to the pharynx, and are swallowed. The larvae reach the small intestine, where they reside and mature into adults.

Adult worms live in the lumen of the small intestine, where they attach to the intestinal wall with resultant blood loss by the host. Most adult worms are eliminated in 1 to 2 years, but longevity records indicate it can take several years. Larvae can survive

up to 3-4 weeks in moist, sandy or loamy soil with ambient temperatures of 24-32° C.

Some *A. duodenale* larvae, following penetration of the host skin, can become dormant (in the intestine or muscle). In addition, infection by *A. duodenale* may probably also occur by the oral and transmammmary route. *N.americanus*, however, requires a trans-pulmonary migration phase.

A smaller group of hookworms infecting animals can invade and parasitize humans (*A. ceylanicum*) or can penetrate the human skin (causing cutaneous larva migrans), but do not develop any further (*A. braziliense*, *A. caninum*, *Uncinaria stenocephala*).

In 1996, a report from Australia described cases of a new condition in humans, eosinophilic enteritis without gastric involvement. The condition is caused by *A. caninum* larva (the common dog hookworm) migrating to the human intestine when *A. caninum* larvae are ingested rather than through skin invasion¹.

GEOGRAPHIC DISTRIBUTION

Intestinal worms contracted from the soil (soil transmitted nematodes or geohelminths) mostly in areas with moist, warm climate, are prevalent throughout the developing world where primitive levels of sanitation, hygiene, and education are coupled with bare feet and the absence of properly constructed outhouses and flush toilets.

Hookworm, with a worldwide distribution in the tropics and sub tropics, is the second most common human helminthic infection (after ascariasis).

Necator americanus is distributed worldwide with higher incidence in Central and South America, the Caribbean, and Australia.

HISTORICAL INTEREST

The following article summary complements the story presented in [p0604-3](#) critique

Evidence from Hookworm eradication in the American South

In a study published in the Quarterly Journal of Economics (Feb 2007)⁵, Hoyt Bleakley evaluates the economic consequences of the successful eradication of hookworm disease from the American South, which started circa 1910.

The Rockefeller Sanitary Commission (RSC) surveyed infection rates and found that 40 percent of school-aged children in the South were infected with hookworm.

The RSC then sponsored treatment and education campaigns across the region. Bleakley concludes that this campaign substantially reduced hookworm disease almost immediately. Areas with higher levels of hookworm infection prior to the RSC experienced greater increases in school enrollment, attendance, and literacy after the intervention.

A substantial gain in income coincidental with exposure to hookworm eradication was also observed together with increased return to schooling.

A. duodenale is found in the Middle East, North Africa and Europe (especially the Mediterranean region) with cases reported from coal miners in Belgium and Great Britain and construction workers in Switzerland, Germany, and Italy ².

Approximately one-quarter of the world's population is infected with hookworm.

CLINICAL RELEVANCE

The pathogenesis is directly related to the number of worms present. Generally, a light worm burden is well tolerated while heavy infections may result in fatigue, weakness, abdominal pain, and diarrhea with blood loss (more severe in *A. duodenale*). Chronic infection leads to iron deficiency anemia, listlessness, pallor, and general retardation of development of afflicted children¹.

TREATMENT

In countries where hookworm is common and re-infection is likely, light infections are often not treated. In the United States, hookworm infections are generally treated.

Hookworm is generally treated with the drug *mebendazole*. This drug cures more than 99 percent of all cases of hookworm if given twice per day for three days. It kills both the worms and the eggs. This drug is contraindicated during pregnancy. *Mebendazole*—resistant strains have been reported.

Other drugs that may be given are *albendazole* and *pyrantel pamoate*, which are

given once per day for three days. See recommendations in *The Medical Letter (Drugs for Parasitic Infections)* for complete information⁴.

Since iron deficiency anemia is a major problem with a Hookworm infection, taking iron supplements and eating a high protein diet can improve the person's recovery.

REFERENCES

1. Ash LR, Orihel TC. 2003. pp. 2031-2046. *Tissue Helminths*. PR Murray PR et al. (eds.) *Manual of Clinical Microbiology*. 8th ed. Vol. 2. ASM Press, Washington, DC.
2. Bogitsh BJ, Carter CE, Oeltmann TN. 2005. *Visceral protozoa I: amoebae and ciliates*. Ch. 4. pp. 72-73. *Human Parasitology*. 3rd ed. Elsevier Academic Press. London.
3. Heelan JS. 2004. pp. 208-209. *Cases in Human Parasitology*. ASM Press, Washington, DC.
4. *The Medical Letter (Drugs for Parasitic Infections)*, 2004. [Link](#)
- 5- Bleakley H. Disease and Development: Evidence from Hookworm Eradication in the American South *Quarterly Journal of Economics* 2007 122:1, 73-117. [Link](#)
- 6- Garcia LS. 2007 *Diagnostic Medical Parasitology* Fifth edition. ASM press, Washington, DC

Recommended websites

CDC Division of Parasitic Diseases [Link](#)

CDC Hookworm photographs [Link](#)

Personal MD What is a hookworm infection? [Link](#)