Chapter 6
Intestinal Parasites

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Intestinal Parasitic Infections in Refugees

On October 31, 2011, this planet welcomed its seven billionth inhabitant. Of that difficult to encompass number, roughly one-third harbor a parasitic infection, more than half of which are intestinal [1]. Although many of these intestinal parasitic infections are subclinical and patients who have them are asymptomatic, they can cause significant morbidity and may result in mortality. The United States welcomes immigrants from parts of the world where people are constantly and continuously exposed to intestinal parasites, many of which are diagnosed and treated upon arrival in the US. Methodological differences in studying the prevalence of a given parasite (e.g., stool ova and parasites versus serology) as well as differing characteristics of refugees such as country of origin, age, and education level render the task of determining exact numbers of immigrants affected by intestinal parasites difficult. What we do know is that they are among the most commonly seen infections in refugees, with estimates ranging from 8.4 to 84 % of refugees in North America being affected [1, 2]. See Fig. 6.1 for prevalence of intestinal parasites in a large sample of refugees in Minnesota. Starting in 1999, the CDC began implementing

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A. Annamalai (ed.), *Refugee Health Care: An Essential Medical Guide*,
DOI 10.1007/978-1-4939-0271-2_6,

Parasite*	Total (N=26,956)	Somalia (N=11,602)	Ethiopia (N=3278)	Liberia (N=2723)	Other African Countries (N=1063)†	Laos (N=5959)	Vietnam (N=1215)	Burma (N=1116)
	number of refugees (percent)							
Any	4897 (18.2)	1775 (15.3)	423 (12.9)	565 (20.7)	242 (22.8)	1412 (23.7)	296 (24.4)	184 (16.5)
Multiple	436 (1.6)	138 (1.2)	41 (1.3)	85 (3.1)	34 (3.2)	75 (1.3)	55 (4.5)	8 (0.7)
Protozoans								
Any	2763 (10.3)	904 (7.8)	198 (6.0)	221 (8.1)	109 (10.3)	1119 (18.8)	57 (4.7)	155 (13.9)
Multiple	52 (0.2)	25 (0.2)	5 (0.2)	2 (0.1)	7 (0.7)	12 (0.2)	0	1 (0.1)
Giardia intestinalis	2368 (8.8)	629 (5.4)	179 (5.5)	204 (7.5)	80 (7.5)	1089 (18.3)	49 (4.0)	138 (12.4)
Entamoeba‡	447 (1.7)	300 (2.6)	24 (0.7)	19 (0.7)	36 (3.4)	42 (0.7)	8 (0.7)	18 (1.6)
Nematodes								
Any	1975 (7.3)	940 (8.1)	106 (3.2)	237 (8.7)	86 (8.1)	327 (5.5)	250 (20.6)	29 (2.6)
Multiple	172 (0.6)	27 (0.2)	12 (0.4)	37 (1.4)	10 (0.9)	34 (0.6)	45 (3.7)	7 (0.6)
Trichuris trichiura	1243 (4.6)	900 (7.8)	68 (2.1)	136 (5.0)	33 (3.1)	21 (0.4)	70 (5.8)	15 (1.3)
Hookworm	494 (1.8)	21 (0.2)	21 (0.6)	88 (3.2)	35 (3.3)	193 (3.2)	121 (10.0)	15 (1.3)
Ascaris lumbricoides	237 (0.9)	46 (0.4)	17 (0.5)	34 (1.2)	14 (1.3)	16 (0.3)	107 (8.8)	3 (0.3)
Strongyloides stercoralis	205 (0.8)	3 (<0.1)	13 (0.4)	23 (0.8)	15 (1.4)	132 (2.2)	13 (1.1)	6 (0.5)
Trematodes								
Schistosoma species	406 (1.5)	26 (0.2)	147 (4.5)	164 (6.0)	69 (6.5)	0	0	0

* A revised form for refugee screening data permitted reporting of additional infections to the Minnesota Department of Health beginning in 1998. The following intestinal parasites detected among newly arrived refugees were excluded from the analysis of the effect of albendazole treatment: *Blastocystis hominis* (1529 cases), *Hymenolepis nana* (360), *Dientamoeba fragilis* (100), *Clonorchis sinensis* (11), fasciola species (4), taenia species (17), *H. diminuta* (2), and diphyllobothrium species (1).

† Other countries included Benin, Burundi, Cameroon, Ivory Coast, Democratic Republic of Congo, Eritrea, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Sudan, Togo, and Uganda.

‡ This category includes pathogenic *Entamoeba histolytica* and nonpathogenic *E. moshkovskii* and *E. dispar*, which cannot be morphologically differentiated by means of standard light microscopy.

Fig. 6.1 Prevalence of intestinal parasites in a large refugee sample in Minnesota (Swanson SJ et al. N Engl J Med 2012;366:1498–1507)

recommendations for empiric antiparasitic treatment for refugees coming to the United States, both before departure and upon their arrival [3].

As one would expect, the prevalence of intestinal parasites in newly arriving refugees, especially the nematodes causing trichuriasis, ascariasis, and hookworm infection, has been significantly impacted by the implementation of pre-departure presumptive treatment in US-bound refugees [4]. Overall, there has been a decrease in intestinal parasitosis since starting empiric pre-departure therapy, as well as a shift in the most commonly found parasites when screened upon arrival to the United States [4] (see Fig. 6.2). Prior to implementation of pre-departure empiric therapy, the most commonly encountered organisms found during screening included hookworm infection and *Giardia* (a protozoan), whereas since 1999 the most commonly encountered helminth has become *Trichuris* [4]. Subsequent data has indicated that Strongyloides, which is not adequately treated with a single dose of albendazole, and schistosomiasis, which is not treated with albendazole, were highly prevalent infections in refugees [4]. These two parasites were of particular concern since not only are they common, they also cause chronic infection and can result in serious morbidity and even mortality. In 2007 ivermectin and praziquantel (for sub-Saharan African refugees) were recommended. Praziquantel was instituted in sub-Saharan Africans in 2010 but ivermectin has not been implemented to date [3].

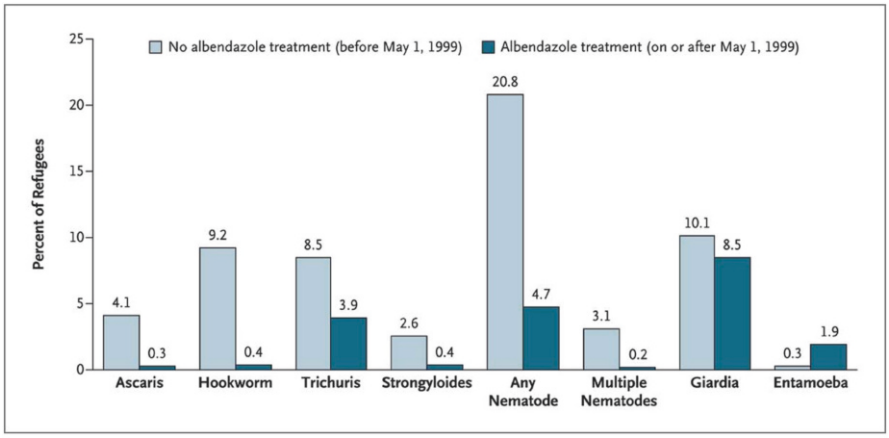

Fig. 6.2 Change in intestinal parasitosis with empiric pre-departure therapy (Swanson SJ et al. N Engl J Med 2012;366:1498–1507)

Screening Recommendations

Optimally, refugees arriving to the United States from Africa, Asia, and Southeast Asia should receive some form of presumptive therapy for intestinal parasites. This is typically performed by the International Organization for Migration (IOM) in their home countries or in refugee camps. If they have undergone presumptive therapy, new arrivals may have documentation of their treatment course.

The term "presumptive therapy" encompasses treatment for intestinal parasites which refugees coming from certain parts of the world can be "presumed" to have based on prevalence data from a given area. The principal intestinal parasites that are targeted, as well as the medications used with presumptive therapy are:

1. Soil-transmitted helminths (STH) including the roundworms, hookworm, *Ascaris*, and *Trichuris* (albendazole)
2. *Strongyloides* (ivermectin)
3. Schistosomes (praziquantel)

It is recommended that all refugees from South and Southeast Asia, except those with contraindications, be treated with albendazole and ivermectin. It is also recommended that all refugees from Africa should be treated with albendazole and praziquantel and those from non-*Loa loa* endemic areas with ivermectin for *Strongyloides* [3]. Please see Table 6.1 for a summary of these recommendations. Of particular note when considering presumptive therapy for Africans is the importance of the parasite *Loa loa*. In areas of *Loa loa* endemicity (see Table 6.2), there have been reports of encephalitis resulting from ivermectin therapy (which targets *Strongyloides*) in patients who have a concomitant *Loa loa* infection and a high microfilarial parasite load. Because of this, any patient who comes from a *Loa loa*

Table 6.1 Recommended medication regimen for presumptive treatment of parasitic infections [3]

	Regimens by pathogen		
Refugee population	Soil-transmitted helminths: albendazole	Strongyloidiasis: ivermectin	Schistosomiasis: praziquantel
Adults			
Asia, Middle East, North Africa, Latin American, and Caribbean	400 mg orally for 1 day	Ivermectin, 200 μg/kg/day orally once a day for 2 days	Not recommended
Sub-Saharan Africa, non-*Loa loa* endemic area	400 mg orally for 1 day	Ivermectin, 200 μg/kg/day once a day for 2 days	Praziquantel, 40 mg/kg (may be divided and given in two doses for better tolerance)
Sub-Saharan Africa, *Loa loa* endemic area	400 mg orally for 1 day	If *Loa loa* cannot be excluded, treatment may be deferred until after arrival in the United States Or Albendazole 400 mg twice a day for 7 days	Praziquantel, 40 mg/kg (may be divided and given in two doses for better tolerance)
Pregnant women			
Asia, Middle East, North Africa, Latin America, and Caribbean	Not recommended	Not recommended	Not applicable
Sub-Saharan Africa	Not recommended	Not recommended	Praziquantel, 40 mg/kg (may be divided and given in two doses for better tolerance)
Children			
Asia, Middle East, North Africa, Latin America, and Caribbean	12–23 months of age: 200 mg orally for 1 day. Presumptive therapy is not recommended for any infant less than 12 months of age	Ivermectin, 200 μg/kg/day orally once a day for 2 days Should not be used presumptively if ≤15 kg	Not applicable
Sub-Saharan Africa	12–23 months of age: 200 mg orally for 1 day. Presumptive therapy is not recommended for any infant less than 12 months of age	Ivermectin, 200 μg/kg/day orally once a day for 2 days Should not be used presumptively if ≤15 kg or from *Loa loa* endemic country	Children under ≤4 years of age should not receive presumptive treatment with praziquantel. Only for children from sub-Saharan Africa

Adapted from the Centers for Disease Control and Prevention

Table 6.2 *Loa loa* endemic countries in Africa [3]

African countries *NOT* endemic for *Loa loa* (may use ivermectin for presumptive Strongyloides therapy)		African countries endemic for *Loa loa* (use albendazole for 7 days for presumptive Strongyloides therapy)
Algeria	Mauritania	Angola
Botswana	Mauritius	Burundi
Burkina Faso	Morocco	Cameroon
Côte d'Ivoire	Mozambique	Central Africa Republic
Egypt	Namibia	Chad
Eritrea	Rwanda	Congo
Gambia	Senegal	Democratic Republic of the Congo
Ghana	Somalia	Equatorial Guinea
Guinea	South Africa	Ethiopia
Kenya	Swaziland	Gabon
Liberia	Tanzania	Guinea-Bissau
Libya	Togo	Niger
Madagascar	Zambia	Nigeria
Malawi	Zimbabwe	Sierra Leone
Mali		Sudan
		Uganda

Table 6.3 Contraindications to presumptive therapy

Albendazole contraindications	Children <1 year of age, pregnancy, refugees with known neurocysticercosis, evidence of cysticercosis (e.g., subcutaneous nodules), or with a history of unexplained seizures
Praziquantel contraindications	Children <4 years of age, refugees with known neurocysticercosis, evidence of cysticercosis (e.g., subcutaneous nodules), or with a history of unexplained seizures
Ivermectin contraindications	Children <15 kg or measuring <90 cm, pregnant women in any trimester, or breastfeeding women within the first week after birth
	Refugee is departing or has lived in a *Loa loa* endemic area

endemic country should *not* be treated presumptively with ivermectin before coming to the United States. Rather, they should be tested for *Strongyloides* in the United States and if positive, treated with high-dose albendazole or screened for *Loa loa* with a daytime blood smear, and if negative, treated with ivermectin [3]. These recommendations are not uniformly implemented due to logistics and funding issues. An updated list of pre-departure therapy received by each major resettlement group may be found at http://www.cdc.gov/immigrantrefugeehealth/guidelines/overseas/interventions.html.

There are a number of important exceptions which limit receipt of presumptive therapy including pregnancy, breastfeeding, and restrictions on use of medications at young ages. Please see Table 6.3.

Once in the destination country, post-arrival screening recommendations are tailored to whether or not the refugee received pre-departure treatment [5]. Please see Table 6.4.

Table 6.4 Overview of post-arrival screening recommendations

No pre-departure treatment	Pre-departure treatment with albendazole	Pre-departure treatment with albendazole and praziquantel	Complete pre-departure treatment including ivermectin
• Eosinophil count (all refugees) • Stool O&Px2 or presumptive albendazole (all refugees) • Presumptive treatment or schistosome serology (refugees from sub-Saharan Africa) • Presumptive treatment or Strongyloides serology (all refugees except those from *Loa-loa* endemic areas of sub-Saharan Africa) • Strongyloides serology and treat only if no contraindications (refugees from *Loa loa* endemic areas of sub-Saharan Africa)	• Eosinophil count (all refugees) • Presumptive treatment or schistosome serology (refugees from sub-Saharan Africa) • Presumptive treatment or Strongyloides serology (all refugees except those from *Loa-loa* endemic areas of sub-Saharan Africa) • Strongyloides serology and treat only if no contraindications (refugees from *Loa loa* endemic areas of sub-Saharan Africa)	• Eosinophil count • Presumptive treatment or Strongyloides serology (all refugees except those from *Loa-loa* endemic areas of sub-Saharan Africa) • Strongyloides serology and treat only if no contraindications (refugees from *Loa loa* endemic areas of sub-Saharan Africa)	• Eosinophil count—if elevated recheck in 3–6 months

Adapted from CDC Guidelines on Domestic Intestinal Parasites

Parasites Commonly Encountered in Refugees

The most commonly found intestinal parasites seen in newly arrived refugees to the United States have changed somewhat since the introduction of albendazole pre-departure treatment in 1999. Based on data collected from Minnesota between 1993 and 2007, infection with *Giardia lamblia* and *Trichuris* are now the most prevalent intestinal parasites seen. Among the nematodes, *Strongyloides*, *Ascaris*, and hookworm are the most common behind *Trichuris* [4]. Of course, geographic origin will play a very important role in modifying the initial differential formed when seeing a refugee patient (see Table 6.5), especially with less common organisms such as the non-schistosome flukes (e.g., paragonimiasis) and the cestodes (e.g., *Taenia* spp. and *Hymenolepis*). A summary of common parasites encountered in refugees follows.

Table 6.5 Predominant geographic distribution of intestinal parasites found in refugee populations [5]

Global	Africa[a]	Asia[a]	Latin America[a]	Middle East[a]	Eastern Europe[a]
Ascaris lumbricoides *Trichuris trichiura* Hookworm *Strongyloides stercoralis* *Enterobius vermicularis* *Fasciola* *Hymenolepis* Most protozoa, especially *Giardia intestinalis* (*lamblia*)	*Schistosoma mansoni* *Schistosoma haematobium* *Schistosoma intercalatum* *Taenia saginata* (especially Ethiopia and Eritrea)	*Fasciolopsis buski* Southeast Asia: *Opisthorchis viverrini* *Clonorchis sinensis* *Schistosoma japonicum* *Schistosoma mekongi* South Asia: *Taenia solium*	*Taenia solium* *Schistosoma mansoni* *Opisthorchis guayaquilensis* (Ecuador)	*Echinococcus* *Giardia*	*Diphyllobothrium latum* *Opisthorchis felineus*

[a]Organisms either unique to the location or particularly common or overrepresented

Protozoa

The protozoa are single-celled organisms which cause quite similar symptoms as a group, those being abdominal discomfort and diarrhea. They are also overall more likely *not* to cause disease than to cause disease in those who are affected.

Entamoeba histolytica. Although a causative agent of dysentery, *E. histolytica* more commonly causes mild gastrointestinal disease such as abdominal discomfort and loose stools. It can cause a more severe disease which involves bloody diarrhea (dysentery) and may become tissue invasive [6]. In this latter case, the most common site is the liver, where an abscess may form. It may also affect the lungs and brain, although these presentations are rare. In refugees *E. histolytica* causing clinical disease after arrival to the United States is rare. Although cysts are commonly reported in stool ova and parasite examination, these cysts are much more likely to be the indistinguishable, non-pathogenic, *E. dispar*. When reported in an asymptomatic person the diagnosis of *E. histolytica* should be confirmed with a stool antigen test prior to treating.

Giardia spp. This is the most commonly encountered parasite in refugee populations who receive ova and parasite stool screening. *Giardia* is the most common parasitic cause of diarrhea affecting people in both developed and developing countries, the latter far more than the former. Transmitted by fecal-oral contamination, it, like many others, preferentially affects those in poorer socioeconomic areas. Most infections are asymptomatic. There is lack of data regarding benefit versus cost and risk of adverse events in treating asymptomatic persons. Those with symptoms (e.g., bloating, burping, abdominal discomfort, diarrhea, or failure to thrive in small children) should be tested for this infection and treated accordingly. Routine screening in asymptomatic persons is not recommended; however, when encountered, most clinicians choose to treat. There is no consensus on this latter point.

Blastocystis hominis. Ubiquitous throughout the world, *Blastocystis* is the most commonly encountered organism in screening fecal cultures in new arrivals. In most individuals, this infection does not cause signs or symptoms and is not considered a pathogen. However, it has been associated with disease in certain individuals, particularly those with underlying immunodeficiency (e.g., HIV), and in travelers. If a person has gastrointestinal symptoms and no other etiology is found, it is reasonable to consider treatment.

Dientamoeba fragilis. A common parasite, D. fragilis, can cause abdominal pain, persistent diarrhea, and flatulence which may be chronic or acute, although many who are infected have no symptoms. It is transmitted via the fecal-oral route and when symptomatic should be treated.

Nematodes

Roundworms belong to the phylum Nematoda and are therefore commonly referred to as nematodes. Among the most abundant animals on earth, they are a common cause of infection and disease in the developing world, both acute and chronic, the latter having powerful effects on development.

Soil-transmitted helminths (STH) are a group which includes *Ascaris lumbricoides*, *Trichuris trichiura*, and the hookworms. They are commonly referred to together because of their very high prevalence, similarity in life cycle, and worldwide distribution. They also belong to the group of "neglected tropical diseases," along with several other infectious agents labeled so by the WHO because they affect a broad swath of humanity, often in developing countries, but do not garner the research and interest that other diseases often do [7, 8]. All soil-transmitted helminths need a soil cycle, and transmission in the United States is rare. They all have a limited life span, and within 5 years of leaving an endemic area, a refugee will be free of infection.

Ascaris lumbricoides (STH). The most common of the soil-transmitted helminths, nearly one in six people (roughly 1.2 billion humans) are infected [9]. The vast majority of infected individuals have no symptoms. However, with high numbers of worms, commonly referred to as a large worm burden, patients can suffer intestinal blockage. This is most common in children. In addition, the parasite may "wander" into areas where its presence may cause disease, such as blocking the gallbladder outlet (causing cholecystitis) or the appendix (causing appendicitis). Because of its life cycle, which involves passing through the lungs, patient may also present with respiratory symptoms such as cough, dyspnea, and wheezing.

Trichuris trichiura (STH). *Trichuris* is a parasite which inhabits the large intestine (most nematodes infect the small bowel) and is found in many areas where human feces are used as fertilizer (often referred to as "night soil"). One becomes infected by ingesting *Trichuris* eggs, and it can, like many other parasites, be asymptomatic or cause disease. More than 90 % of people infected are asymptomatic. Those who are symptomatic may experience watery, bloody, and painful bowel movements. In addition, it is associated with anemia. In children with heavy infections, growth retardation can occur. It has been associated with rectal prolapse.

Hookworm: *Ancylostoma duodenale*, *Necator americanus* (STH). Hookworm is found in areas where human feces are used as fertilizer or in areas where human wastes are deposited on the soil. Infection occurs via direct penetration of the skin, often of the lower extremities, and the first symptom is often an itchy rash at the site of infection. Once established in the small intestine, they can cause abdominal pain, as well as weakness and fatigue. They are most notable for the chronic anemia which may result from chronic infection, resulting in growth retardation in children. This is the most pathogenic of the soil-transmitted helminths.

Strongyloides stercoralis. Although a nematode that is very similar to hookworm, *Strongyloides* is generally not grouped with the other STHs. A roundworm roughly

the size of a mustard seed, *Strongyloides* is a soil-transmitted helminth which, like *Trichuris* and hookworms, infects humans via skin penetration, often of the feet and legs. Found throughout the world, but predominantly in tropical areas, *Strongyloides* often manifests itself with dermatologic, pulmonary, and intestinal symptoms such as rash, dry cough, and abdominal discomfort.

NOTE: Unlike most other helminths, *Strongyloides* is capable of autoinfection, i.e., the host can continually reinfect himself/herself and thus have a persistent, even lifelong infection. Also, *Strongyloide*s can become disseminated and result in "hyperinfection" which has a high mortality rate and is often misdiagnosed as Gram-negative sepsis; this is most often due to immunosuppression particularly following the administration of corticosteroids. Special attention must also be given when considering treatment of patients with *Strongyloides* who are from *Loa loa* endemic areas (please see Section "Screening Recommendations" above).

Loa loa. A nematode transmitted by the bite of deerflies of the genus *Chrysops*, loaiasis most often results in eye worm and red, itchy swellings of the skin referred to as Calabar swellings. It is found throughout west-central sub-Saharan Africa, in areas of high-canopied rain forest. One key factor making *Loa loa* infection of prime importance is that in patients treated with ivermectin for *Strongyloides* who were coinfected with Loa loa, there have been reports of encephalitis precipitated by the treatment; please see recommendations above.

Trematodes

Trematodes, also known as "flukes," are parasites which infect many different types of vertebrate hosts, including man. Their life cycle typically involves a freshwater snail as an intermediate before infection of the definitive vertebrate host.

Schistosoma spp. Widespread throughout the tropical world, Schistosome species are very important and at times overlooked parasites which can cause significant morbidity when chronic. Schistosomes have a complex life cycle which must involve certain freshwater snails, and humans are infected via the skin, usually by wading in areas populated by said snails. Initially, patients may have a dermatologic reaction at the site of skin penetration, including rash with vesicles and pruritus. Roughly 5–7 weeks after infection, patients may develop "Katayama fever," the syndrome of fever, headache, myalgias, abdominal pain (right upper quadrant often), and bloody diarrhea [10]. Serious neurologic complications can also occur at this time, including seizures and transverse myelitis. Untreated infections, which may last many years, lead to a chronic granulomatous disease which can cause liver disease and large intestinal symptoms with *S. mansoni*, *S. japonicum*, and *S. mekongi*, whereas chronic infection with *S. haematobium* can lead to renal disease and bladder cancer.

Opisthorchis spp., *Clonorchis sinensis*, *Fasciola hepatica* (liver flukes). Found in Asia, Southeast Asia, Eastern Europe, and countries of the former Soviet Union, liver flukes are contracted by eating undercooked freshwater fish. They inhabit the

bile tree of humans, and when they cause disease it results in symptoms of abdominal discomfort, diarrhea, and constipation secondary to bile duct inflammation and biliary obstruction. Chronic infection results in inflammation and scarring of the biliary tree, which can lead to gallbladder and bile duct cancers. In fact, some species may be mistaken for gallstones and only be discovered upon surgery.

Of note, *Fasciola*, the common liver fluke, is found in a more broad geographical swath and is acquired not by uncooked or undercooked seafood, but by eating raw freshwater plants, such as watercress (as well as undercooked sheep or goat livers) [11]. Symptoms are similar to the other liver flukes, despite this parasite's actively burrowing through the liver parenchyma to arrive at the biliary tree. The most commonly encountered liver flukes in refugees are *Opisthorchis* and *Clonorchis* and are seen mainly in SEA refugees (e.g., Laotian).

Paragonimus westermani (lung fluke). Paragonimiasis is most common in South and Southeast Asia, where humans are infected by eating raw or undercooked crab or crayfish. Symptoms of infection first involve the abdominal tract, with nausea, vomiting, and diarrhea, and may then be followed by pulmonary symptoms including chest pain, fever, and cough which may be productive of bloody sputum [12]. Given the prominence of hemoptysis, tuberculosis is often considered along with paragonimiasis in the differential diagnosis [13]. This infection is seen primarily in SEA refugees, currently most common in Burmese refugees.

Cestodes

Inhabiting the intestines of humans, cestodes have long been regarded with revulsion by man, most probably second to passage in the feces of entire worms of great length (e.g., Diphyllobothrium which can be over 10 ft when excreted) or of gravid proglottids (large, egg-laden segments of the worms), seen primarily with *Taenia* spp.

Hymenolepis nana (dwarf tapeworm). Found throughout the world, and particularly where there is poor hygiene, this parasite is commonly called the "dwarf tapeworm." Humans are infected by fecal-contaminated food or water, and most patients are asymptomatic with infection because of the small size of this tapeworm compared to the members of genus Taenia. Symptoms if present are usually of abdominal discomfort and weakness, and children with heavy infections may have perineal pruritus and therefore be misdiagnosed with pinworm infection. This is particularly common in Ethiopian and Somali refugees.

Taenia saginata (beef tapeworm). Found throughout the world, *Taenia saginata* is the largest tapeworm to cause human disease, reaching lengths of up to 10 m. Humans are infected by eating raw or undercooked beef and when symptomatic will often have abdominal discomfort, weight loss, and anorexia.

Taenia solium (pork tapeworm). The pork tapeworm, like the beef tapeworm, is found throughout the world and causes a similar clinical presentation when it affects the gastrointestinal system. However, unlike the beef tapeworm, *Taenia solium* eggs can be directly infectious to humans (i.e., there is the possibility of human-to-human infection). When another human is directly infected by eating eggs, the parasite can migrate to any number of different tissues and develop into cysts; the most worrying location is the brain, which results clinically in neurocysticercosis, which is a significant cause of adult onset seizures in many parts of the developing world [14]. In an immigrant, particularly from Central or South America, who presents with new onset seizures, neurocysticercosis must be on the differential.

Diphyllobothrium latum (fish tapeworm). Obtained through eating raw or undercooked fish, diphyllobothriasis is found primarily throughout the northern hemispheres and is more common within the United States than in refugee populations entering the United States. Symptoms, when present, may be vomiting, diarrhea, and weight loss. Of note is the propensity for vitamin B12 deficiency and consequent anemia.

Table 6.6 outlines the therapeutic regimens for the above parasites for adults.

All medications are dosed for adults and orally taken unless otherwise noted [15].

More detailed descriptions of organisms discussed above, as well as therapeutic treatment regimens, can be found in these references [2, 11, 13, 15].

Eosinophilia

An elevated eosinophil count may be the result of any number of infectious and noninfectious processes (see Tables 6.7 and 6.8), but in certain groups it can help bring to the fore the possibility of a latent and perhaps asymptomatic, parasitic infection. Unfortunately things are not as straightforward as they may seem; eosinophilia, or an absolute eosinophil count greater than 400/mm^3 in a peripheral blood sample, has both poor negative and poor positive predictive values as a marker of parasitosis in returning travelers [16]. However, as with all tests, a thorough history will reveal characteristics that render the above value more or less likely an indicator of parasitic disease. For example, in the case of patients who have had prolonged exposure to possible helminth infections, eosinophilia becomes much more useful as a possible indicator of underlying, chronic infection.

In the previous sections of this chapter, we have detailed the presumptive therapy which newly arrived immigrants should undergo upon arrival to the United States. It is important to recall that an elevated eosinophil count can take some time, from 3 to 6 months, to return to normal after treatment. Therefore, in patients who have been treated, a recheck of the peripheral eosinophil count should be performed 3–6 months afterward to ensure resolution. If the eosinophil count remains elevated, a more detailed work-up should be pursued, with particular emphasis on *Strongyloides*, soil-transmitted helminths, and *Schistosoma* species as these are the most common causes. During this work-up, it will as always be important to consider the

Table 6.6 Adult therapeutic regimens [15]

Intestinal pathogen	Treatment
Protozoa	
Entamoeba histolytica	Metronidazole 500–750 mg PO three times daily, duration 7–10 days; paromomycin 25–30 mg/kg per day/three doses per day for 7 days
Giardia intestinalis (aka *G. lamblia*, *G. duodenalis*)	Metronidazole 500 mg orally twice daily or 250 mg orally TID, duration 5–7 days
Blastocystis hominis	Metronidazole 750 mg TID, duration 5–10 days
Dientamoeba fragilis	Paromomycin 25–35 mg/kg per day in three divided doses, duration 7 days or metronidazole 500–750 mg TID, duration 10 days
Nematodes	
Ascaris lumbricoides	Albendazole 400 mg single dose
Trichuris trichiura	Albendazole 400 mg per day for 3 days
Ancylostoma duodenale, *Necator americanus*	Albendazole 400 mg single dose
Strongyloides stercoralis	Ivermectin 200 μg/kg for 1–2 days
Loa loa	Diethylcarbamazine 8–10 mg/kg orally in three divided doses daily for 21 days
Trematodes	
S. mansoni, *S. haematobium*	Praziquantel 40 mg/kg per day orally in two divided doses for 1 day, 6–8 h apart
S. japonicum, *S. mekongi*	Praziquantel 60 mg/kg per day orally in three divided doses for 1 day, 6–8 h apart
Opisthorchis viverrini, Clonorchis sinensis	Praziquantel 75 mg/kg/day orally, three doses per day for 2 days
Fasciola hepatica	Triclabendazole 10 mg/kg for 2 days
Paragonimus westermani	Praziquantel 25 mg/kg given orally three times per day for 2 consecutive days
Cestodes	
Hymenolepis nana	Praziquantel 25 mg/kg single dose
Taenia saginata, *Taenia solium*	Praziquantel 5–10 mg/kg single dose; BEWARE praziquantel with cysticercosis as it is cysticidal and may cause inflammation and provoke seizures
Diphyllobothrium latum	Praziquantel 5–10 mg/kg single-dose

geographic region from which the patient is coming, as this will be very important to help clarify the differential diagnosis and arrive at the most likely etiology. If 6 months after presumptive treatment the eosinophil count is still elevated, the differential must be broadened to include other infectious and noninfectious causes.

Finally, it should be noted that the duration of infection with parasites that result in an elevated eosinophil count can be very long, indeed with an organism such as *Strongyloides* it may last the entire life of the patient because of autoinfection. Other parasites with a long duration of infection are Schistosoma (32 years) and Loa loa

Table 6.7 Causes of eosinophilia (from CDC Domestic Intestinal Parasite Guidelines) [5]

Parasites causing eosinophilia commonly found on stool exam	Other parasitic infections associated with eosinophilia	Parasites commonly found in the stool NOT typically associated with eosinophilia	Nonparasitic causes of eosinophilia
Ascaris lumbricoides	Angiostrongylus	Entamoeba spp. (*E. histolytica*, *E. dispar*, others)	Asthma
Hookworm species	Anisakis	Cryptosporidium spp.	Atopy
Trichuris trichiura	Capillaria spp.	*Giardia intestinalis* (a.k.a. *G. lamblia* and *G. duodenalis*)	Drug allergy
Strongyloides	Cysticercosis		Eosinophilic leukemia
Tapeworms (*T. solium* and *T. saginata*)	Echinococcus spp.		Hodgkin's lymphoma
Schistosoma (*S. mansoni*, *S. haematobium*, *S. japonicum*)	Filariasis		Hypereosinophilic syndrome
Other flukes (Paragonimus, Opisthorchis, Fasciola)			Pemphigoid
			Pemphigus
			Polyarteritis nodosa

Table 6.8 Causes of eosinophilia in refugees, by region [5]

Region	Parasites causing eosinophilia
Africa	*Schistosoma mansoni*, *S. haematobium*, *S. intercalatum*
	Taenia saginata (esp. Ethiopia and Eritrea)
Asia	Overall: *Fasciolopsis buski*
	Southeast Asia: *Opisthorchis viverrini*, *Clonorchis sinensis*, *S. japonicum*, *Schistosoma mekongi*
	South Asia: *Taenia solium*
Latin America	*Taenia solium*
	Schistosoma mansoni
	Opisthorchis guayaquilensis (Ecuador)
Middle East	*Echinococcus*
Eastern Europe	*Diphyllobothrium latum*
	Opisthorchis felineus

(16–24 years). Hookworm and Ascaris are examples of parasites with relatively shorter life spans (3–5 years and 1–1.5 years, respectively) [17].

Treatment should be directed at the parasite identified during eosinophilia evaluation. However, despite a thorough investigation, it is quite possible that an etiologic cause may not be identified, in which case presumptive therapy may be reasonable. In this case, single-dose therapy with ivermectin and/or albendazole has been proposed [17].

Conclusion

Parasitic infections continue to be highly prevalent and an important cause of morbidity in newly arrived refugees. A complete history, including geographic risk factors and the screening recommendations outlined above, can help detect a majority of these intestinal parasitic infections. Recommendations on diagnosis and treatment of these infections are periodically updated by CDC and providers are encouraged to access this information for guidance on management.

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