Drugs for Parasitic Infections

With increasing travel, immigration, use of immunosuppressive drugs and the spread of AIDS, physicians anywhere may see infections caused by parasites. The table below lists first-choice and alternative drugs for most parasitic infections. The table on page 12 summarizes the known prenatal risks of antiparasitic drugs. The brand names and manufacturers of the drugs are listed on page 14.

Infection		Drug	Adult dosage	Pediatric dosage
ACANTHAMOEBA keratitis				
Drug of choice:		See footnote 1		
AMEBIASIS *(Entamoeba histolytica)*				
asymptomatic				
Drug of choice:		Iodoquinol[2]	650 mg PO tid x 20d	30-40 mg/kg/d (max. 2g) PO in 3 doses x 20d
	OR	Paromomycin[3]	25-35 mg/kg/d PO in 3 doses x 7d	25-35 mg/kg/d PO in 3 doses x 7d
	OR	Diloxanide furoate[4]*	500 mg PO tid x 10d	20 mg/kg/d PO in 3 doses x 10d
mild to moderate intestinal disease				
Drug of choice:[5]		Metronidazole	500-750 mg PO tid x 7-10d	35-50 mg/kg/d PO in 3 doses x 7-10d
	OR	Tinidazole[6]	2 g once PO daily x 3d	≥3yrs: 50 mg/kg/d (max. 2g) PO in 1 dose x 3d
		either followed by		
		Iodoquinol[2]	650 mg PO tid x 20d	30-40 mg/kg/d (max. 2g) PO in 3 doses x 20d
	OR	Paromomycin[3]	25-35 mg/kg/d PO in 3 doses x 7d	25-35 mg/kg/d PO in 3 doses x 7d
severe intestinal and extraintestinal disease				
Drug of choice:		Metronidazole	750 mg PO tid x 7-10d	35-50 mg/kg/d PO in 3 doses x 7-10d
	OR	Tinidazole[6]	2 g once PO daily x 5d	≥3yrs: 50 mg/kg/d (max. 2g) PO in 1 dose x 3d
		either followed by		
		Iodoquinol[2]	650 mg PO tid x 20d	30-40 mg/kg/d (max. 2g) PO in 3 doses x 20d
	OR	Paromomycin[3]	25-35 mg/kg/d PO in 3 doses x 7d	25-35 mg/kg/d PO in 3 doses x 7d
AMEBIC MENINGOENCEPHALITIS, primary and granulomatous				
Naegleria				
Drug of choice:		Amphotericin B[7,8]	1.5 mg/kg/d IV in 2 doses x 3d, then 1 mg/kg/d x 6d plus 1.5 mg/d intrathecally x 2d, then 1 mg/d every other day x 8d	1.5 mg/kg/d IV in 2 doses x 3d, then 1 mg/kg/d x 6d plus 1.5 mg/d intrathecally x 2d, then 1 mg/d every other day x 8d
Acanthamoeba				
Drug of choice:		See footnote 9		

* Availability problems. See table on page 14.

1. Topical 0.02% chlorhexidine and polyhexamethylene biguanide (PHMB, 0.02%), either alone or in combination, have been used successfully in a large number of patients. Treatment with either chlorhexidine or PHMB is often combined with propamidine isethionate *(Brolene)* or hexamidine *(Desmodine)*. None of these drugs is commercially available or approved for use in the US, but they can be obtained from compounding pharmacies (see footnote 2). Leiter's Park Avenue Pharmacy, San Jose, CA (800-292-6773; www.leiterrx.com) is a compounding pharmacy that specializes in ophthalmic drugs. Propamidine is available over the counter in the UK and Australia. Hexamidine is available in France. The combination of chlorhexidine, natamycin (pimaricin) and debridement also has been successful (K Kitagawa et al, Jpn J Ophthalmol 2003; 47:616). Debridement is most useful during the stage of corneal epithelial infection. Most cysts are resistant to neomycin; its use is no longer recommended. Azole antifungal drugs (ketoconazole, itraconazole) have been used as oral or topical adjuncts (FL Shuster and GS Visvesvara, Drug Resist Update 2004; 7:41). Use of corticosteroids is controversial (K Hammersmith, Curr Opinions Ophthal 2006; 17:327; ST Awwad et al, Eye Contact Lens 2007; 33:1).
2. Iodoquinol should be taken after meals.
3. Paromomycin should be taken with a meal.
4. Not available commercially. It may be obtained through compounding pharmacies such as Panorama Compounding Pharmacy, 6744 Balboa Blvd, Van Nuys, CA 91406 (800-247-9767) or Medical Center Pharmacy, New Haven, CT (203-688-6816). Other compounding pharmacies may be found through the National Association of Compounding Pharmacies (800-687-7850) or the Professional Compounding Centers of America (800-331-2498, www.pccarx.com).
5. Nitazoxanide may be effective against a variety of protozoan and helminth infections (DA Bobak, Curr Infect Dis Rep 2006; 8:91; E Diaz et al, Am J Trop Med Hyg 2003; 68:384). It was effective against mild to moderate amebiasis, 500 mg bid x 3d, in a recent study (JF Rossignol et al, Trans R Soc Trop Med Hyg 2007 Oct; 101:1025 E pub 2007 July 20). It is FDA-approved only for treatment of diarrhea caused by *Giardia* or *Cryptosporidium* (Med Lett Drugs Ther 2003; 45:29). Nitazoxanide is available in 500-mg tablets and an oral suspension; it should be taken with food.
6. A nitroimidazole similar to metronidazole, tinidazole appears to be as effective as metronidazole and better tolerated (Med Lett Drugs Ther 2004; 46:70). It should be taken with food to minimize GI adverse effects. For children and patients unable to take tablets, a pharmacist can crush the tablets and mix them with cherry syrup (*Humco*, and others). The syrup suspension is good for 7 days at room temperature and must be shaken before use (HB Fung and TL Doan et al, Clin Ther 2005; 27:1859). Ornidazole, a similar drug, is also used outside the US.
7. Not FDA-approved for this indication.
8. Although A *Naegleria fowleri* infection was treated successfully in a 9-year old girl with combination of amphotericin B and miconazole both intravenous and intrathecal, plus oral rifampin (JS Seidel et al NEJM 1982;306:346). Amphotericin B and miconazole appear to have a synergistic effect, but Medical Letter consultants believe the rifampin probably had no additional effect (GS Visvesvara et al, FEMS Immunol Med Microbiol 2007; 50:1). Parenteral miconazole is no longer available in the US. Azithromycin has been used successfully in combination therapy to treat *Balmuthia* infection, but was changed to clarithromycin because of toxicity concerns and for better penetration into the cerebrospinal fluid. *In vitro*, azithromycin is more active than clarithromycin against *Naegleria*, so may be a better choice combined with amphotericin B for treatment of *Naegleria* (TR Deetz et al, Clin Infect Dis 2003; 37:1304; FL Schuster and GS Visvesvara, Drug Resistance Updates 2004; 7:41). Combinations of amphotericin B, ornidazole and rifampin (R Jain et al, Neurol Indian 2002; 50:470) and amphotericin B fluconazole and rifampin have also been used (J Vargas-Zepeda et al, Arch Med Research 2005;36:83). Case reports of other successful therapy have been published (FL Schuster and GS Visvesvara, Int J Parasitol 2004; 34:1001).

Infection		Drug	Adult dosage	Pediatric dosage
AMEBIC MENINGOENCEPHALITIS (continued)				
Balamuthia mandrillaris				
Drug of choice:		See footnote 10		
Sappinia diploidea				
Drug of choice:		See footnote 11		
ANCYLOSTOMA caninum (Eosinophilic enterocolitis)				
Drug of choice:		Albendazole[7,12]	400 mg PO once	400 mg PO once
	OR	Mebendazole	100 mg PO bid x 3d	100 mg PO bid x 3d
	OR	Pyrantel pamoate[7,13*]	11 mg/kg (max. 1g) PO x 3d	11 mg/kg (max. 1g) PO x 3d
	OR	Endoscopic removal		
Ancylostoma duodenale, see HOOKWORM				
ANGIOSTRONGYLIASIS *(Angiostrongylus cantonensis, Angiostrongylus costaricensis)*				
Drug of choice:		See footnote 14		
ANISAKIASIS (*Anisakis* spp.)				
Treatment of choice:[15]		Surgical or endoscopic removal		
ASCARIASIS (*Ascaris lumbricoides,* roundworm)				
Drug of choice:[5]		Albendazole[7,12]	400 mg PO once	400 mg PO once
	OR	Mebendazole	100 mg bid PO x 3d or 500 mg once	100 mg PO bid x 3d or 500 mg once
	OR	Ivermectin[7,16]	150-200 mcg/kg PO once	150-200 mcg/kg PO once
BABESIOSIS *(Babesia microti)*				
Drug of choice:[17]		Clindamycin[7,18]	1.2 g bid IV or 600 mg tid PO x 7-10d	20-40 mg/kg/d PO in 3 doses x 7-10d
		plus quinine[7,19]	650 mg PO tid x 7-10d	30 mg/kg/d PO in 3 doses x 7-10d
	OR	Atovaquone[7,20]	750 mg PO bid x 7-10d	40 mg/kg/d PO in 2 doses x 7-10d
		plus azithromycin[7]	600 mg PO daily x 7-10d	12 mg/kg/d PO x 7-10d
Balamuthia mandrillaris, see AMEBIC MENINGOENCEPHALITIS, PRIMARY				
BALANTIDIASIS *(Balantidium coli)*				
Drug of choice:		Tetracycline[7,21]	500 mg PO qid x 10d	40 mg/kg/d (max. 2 g) PO in 4 doses x 10d
Alternative:		Metronidazole[7]	750 mg PO tid x 5d	35-50 mg/kg/d PO in 3 doses x 5d
	OR	Iodoquinol[2,7]	650 mg PO tid x 20d	30-40 mg/kg/d (max 2 g) PO in 3 doses x 20d
BAYLISASCARIASIS *(Baylisascaris procyonis)*				
Drug of choice:		See footnote 22		
BLASTOCYSTIS hominis infection				
Drug of choice:		See footnote 23		
CAPILLARIASIS *(Capillaria philippinensis)*				
Drug of choice:		Mebendazole[7]	200 mg PO bid x 20d	200 mg PO bid x 20d
Alternative:		Albendazole[7,12]	400 mg PO daily x 10d	400 mg PO daily x 10d
Chagas' disease, see TRYPANOSOMIASIS				
Clonorchis sinensis, see FLUKE infection				

* Availability problems. See table on page 14.

9. Several patients with granulomatous amebic encephalitis (GAE) have been successfully treated with combinations of pentamidine, sulfadiazine, flucytosine, and either fluconazole or itraconazole (GS Visvesvara et al, FEMS Immunol Med Microbiol 2007; 50:1, epub Apr 11). GAE in an AIDS patient was treated successfully with sulfadiazine, pyrimethamine and fluconazole combined with surgical resection of the CNS lesion (M Seijo Martinez et al, J Clin Microbiol 2000; 38:3892). Chronic *Acanthamoeba* meningitis was successfully treated in 2 children with a combination of oral trimethoprim/sulfamethoxazole, rifampin and ketoconazole (T Singhal et al, Pediatr Infect Dis J 2001; 20:623). Disseminated cutaneous infection in an immunocompromised patient was treated successfully with IV pentamidine, topical chlorhexidine and 2% ketoconazole cream, followed by oral itraconazole (CA Slater et al, N Engl J Med 1994; 331:85) and with voriconazole and amphotericin B lipid complex (R Walia et al, Transplant Infect Dis 2007; 9:51). Other reports of successful therapy have been described (FL Schuster and GS Visvesvara, Drug Resistance Updates 2004; 7:41). Susceptibility testing of *Acanthamoeba* isolates has shown differences in drug sensitivity between species and even among strains of a single species; antimicrobial susceptibility testing is advisable (FL Schuster and GS Visvesvara, Int J Parasitiol 2004; 34:1001).
10. *B. mandrillaris* is a free-living ameba that causes subacute to fatal granulomatous amebic encephalitis (GAE) and cutaneous disease. Two cases of *Balamuthia* encephalitis have been successfully treated with flucytosine, pentamidine, fluconazole and sulfadiazine plus either azithromycin or clarithromycin (phenothiazines were also used) combined with surgical resection of the CNS lesion (TR Deetz et al, Clin Infect Dis 2003; 37:1304). Another case was successfully treated following open biopsy with pentamidine, fluconazole, sulfadiazine and clarithromycin (S Jung et al, Arch Pathol Lab Med 2004; 128:466).
11. A free-living ameba once thought not to be pathogenic to humans. *S. diploidea* has been successfully treated with azithromycin, pentamidine, itraconazole and flucytosine combined with surgical resection of the CNS lesion (BB Gelman et al, J Neuropathol Exp Neurol 2003; 62:990).
12. Albendazole must be taken with food; a fatty meal increases oral bioavailability.
13. Pyrantel pamoate suspension can be mixed with milk or fruit juice.
14. *A. cantonensis* causes predominantly neurotropic disease. *A. costaricensis* causes gastrointestinal disease. Most patients infected with either species have a self-limited course and recover completely. Analgesics, corticosteroids and careful removal of CSF at frequent intervals can relieve symptoms from increased intracranial pressure (V Lo Re III and SJ Gluckman, Am J Med 2003; 114:217). Treatment of *A. cantonensis* is controversial and varies across endemic areas. No antihelminthic drug is proven to be effective and some patients have worsened with therapy (TJ Slom et al, N Engl J Med 2002; 346:668). Mebendazole and a corticosteroid, however, appear to shorten the course of infection (H-CTsai et al, Am J Med 2001; 111:109; V Chotmongkol et al, Am J Trop Med Hyg 2006; 74:1122). Albendazole has also relieved symptoms of angiostrongyliasis (XG Chen et al, Emerg Infect Dis 2005; 11:1645).
15. A Repiso Ortega et al, Gastroenterol Hepatol 2003; 26:341. Successful treatment of *Anisakiasis* with albendazole 400 mg PO bid x 3-5d has been reported, but the diagnosis was presumptive (DA Moore et al, Lancet 2002; 360:54; E Pacios et al, Clin Infect Dis 2005; 41:1825).
16. Safety of ivermectin in young children (<15 kg) and pregnant women remains to be established. Ivermectin should be taken on an empty stomach with water.
17. Exchange transfusion has been used in severely ill patients and those with high (>10%) parasitemia (VI Powell and K Grima, Transfus Med Rev 2002; 16:239). In patients who were not severely ill, combination therapy with atovaquone and azithromycin was as effective as clindamycin and quinine and may have been better tolerated (PJ Krause et al, N Engl J Med 2000; 343:1454). Longer treatment courses may be needed in immunosuppressed patients and those with asplenia. Patients are commonly co-infected with Lyme disease (Med Lett Drugs Ther 2007; 49:49; AC Steere et al, Clin Infect Dis 2003; 36:1078).
18. Oral clindamycin should be taken with a full glass of water to minimize esophageal ulceration.
19. Quinine should be taken with or after a meal to decrease gastrointestinal adverse effects.
20. Atovaquone is available in an oral suspension that should be taken with a meal to increase absorption.
21. Use of tetracyclines is contraindicated in pregnancy and in children <8 years old. Tetracycline should be taken 1 hour before or 2 hours after meals and/or dairy products.

Infection		Drug	Adult dosage	Pediatric dosage
CRYPTOSPORIDIOSIS *(Cryptosporidium)*				
Non-HIV infected				
Drug of choice:		Nitazoxanide[5]	500 mg PO bid x 3d	1-3yrs: 100 mg PO bid x 3d 4-11yrs: 200 mg PO bid x 3d >12yrs: 500 mg PO q12h x 3d
HIV infected				
Drug of choice:		See footnote 24		
CUTANEOUS LARVA MIGRANS (creeping eruption, dog and cat hookworm)				
Drug of choice:[25]		Albendazole[7,12]	400 mg PO daily x 3d	400 mg PO daily x 3d
	OR	Ivermectin[7,16]	200 mcg/kg PO daily x 1-2d	200 mcg/kg PO daily x 1-2d
CYCLOSPORIASIS *(Cyclospora cayetanensis)*				
Drug of choice:[26]		Trimethoprim/ sulfamethoxazole[7]	TMP 160 mg/SMX 800 mg (1 DS tab) PO bid x 7-10d	TMP 5 mg/kg/SMX 25 mg/kg/d PO in 2 doses x 7-10d
CYSTICERCOSIS, see TAPEWORM infection				
DIENTAMOEBA fragilis infection[27]				
Drug of choice:		Iodoquinol[2,7]	650 mg PO tid x 20d	30-40 mg/kg/d (max. 2g) PO in 3 doses x 20d
	OR	Paromomycin[3,7]	25-35 mg/kg/d PO in 3 doses x 7d	25-35 mg/kg/d PO in 3 doses x 7d
	OR	Tetracycline[7,21]	500 mg PO qid x 10d	40 mg/kg/d (max. 2g) PO in 4 doses x 10d
	OR	Metronidazole[7]	500-750 mg PO tid x 10d	35-50 mg/kg/d PO in 3 doses x 10d
Diphyllobothrium latum, see TAPEWORM infection				
DRACUNCULUS medinensis (guinea worm) infection				
Drug of choice:		See footnote 28		
Echinococcus, see TAPEWORM infection				
Entamoeba histolytica, see AMEBIASIS				
ENTEROBIUS *vermicularis* (pinworm) infection				
Drug of choice:[29]		Mebendazole	100 mg PO once; repeat in 2wks	100 mg PO once; repeat in 2wks
	OR	Pyrantel pamoate[13]*	11 mg/kg base PO once (max. 1 g); repeat in 2wks	11 mg/kg base PO once (max. 1 g); repeat in 2wks
	OR	Albendazole[7,12]	400 mg PO once; repeat in 2wks	400 mg PO once; repeat in 2wks
Fasciola hepatica, see FLUKE infection				
FILARIASIS[30]				
Wuchereria bancrofti, Brugia malayi, Brugia timori				
Drug of choice:[31]		Diethylcarbamazine*	6 mg/kg/d PO in 3 doses x 12d[32,33]	6 mg/kg/d PO in 3 doses x 12d[32,33]
Loa loa				
Drug of choice:[34]		Diethylcarbamazine*	6 mg/kg/d PO in 3 doses x 12d[32,33]	6 mg/kg/d PO in 3 doses x 12d[32,33]

* Availability problems. See table on page 14.

22. No drug has been demonstrated to be effective. Albendazole 25 mg/kg/d PO x 20d started as soon as possible (up to 3d after possible infection) might prevent clinical disease and is recommended for children with known exposure (ingestion of raccoon stool or contaminated soil) (WJ Murray and KR Kazacos, Clin Infect Dis 2004; 39:1484). Mebendazole, levamisole or ivermectin could be tried if albendazole is not available. Steroid therapy may be helpful, especially in eye and CNS infections (PJ Gavin et al, Clin Microbiol Rev 2005; 18:703). Ocular baylisascariasis has been treated successfully using laser photocoagulation therapy to destroy the intraretinal larvae (CA Garcia et al, Eye 2004; 18:624).
23. Clinical significance of these organisms is controversial; metronidazole 750 mg PO tid x 10d, iodoquinol 650 mg PO tid x 20d or trimethoprim/sulfamethoxazole 1 DS tab PO bid x 7d have been reported to be effective (DJ Stenzel and PFL Borenam, Clin Microbiol Rev 1996; 9:563; UZ Ok et al, Am J Gastroenterol 1999; 94:3245). Metronidazole resistance may be common in some areas (K Haresh et al, Trop Med Int Health 1999; 4:274). Nitazoxanide has been effective in clearing organism and improving symptoms (E Diaz et al, Am J Trop Med Hyg 2003; 68:384; JF Rossignol, Clin Gastroenterol Hepatol 2005; 18:703).
24. No drug has proven efficacy against cryptosporidiosis in advanced AIDS (I Abubakar et al, Cochrane Database Syst Rev 2007; 1:CD004932). Treatment with HAART is the mainstay of therapy. Nitazoxanide (JF Rossignol, Aliment Pharmacol Ther 2006; 24:807), paromomycin (P Maggi et al, Clin Infect Dis 2000; 33:1609), or a combination of paromomycin and azithromycin (NH Smith et al, J Infect Dis 1998; 178:900) may be tried to decrease diarrhea and recalcitrant malabsorption of antimicrobial drugs, which can occur with chronic cryptosporidiosis.
25. G Albanese et al, Int J Dermatol 2001; 40:67; D Malvy et al, J Travel Med 2006; 13:244.
26. HIV-infected patients may need higher dosage and long-term maintenance. Successful use of nitazoxanide (see also footnote 5) has been reported in one patient with sulfa allergy (SM Zimmer et al, Clin Infect Dis 2007; 44:466).
27. A Norberg et al, Clin Microbiol Infect 2003; 9:65; O Vandenberg et al, Int J Infect Dis 2006; 10:255.
28. No drug is curative against *Dracunculus*. A program for monitoring local sources of drinking water to eliminate transmission has dramatically decreased the number of cases worldwide (M Barry, N Engl J Med 2007; 356:2561). The treatment of choice is slow extraction of worm combined with wound care and pain management (C Greenaway, CMAJ 2004; 170:495).
29. Since family members are usually infected, treatment of the entire household is recommended.
30. Antihistamines or corticosteroids may be required to decrease allergic reactions to components of disintegrating microfilariae that result from treatment, especially in infection caused by *Loa loa*. Endosymbiotic *Wolbachia* bacteria may have a role in filarial development and host response, and may represent a potential target for therapy. Addition of doxycycline 100 or 200 mg/d PO x 6-8wks in lymphatic filariasis and onchocerciasis has resulted in substantial loss of *Wolbachia* and decrease in both micro- and macrofilariae (MJ Taylor et al, Lancet 2005; 365:2116; AY Debrah et al, Plos Pathog 2006; e92:0829); but use of tetracyclines is contraindicated in pregnancy and in children <8 yrs old.
31. Most symptoms are caused by adult worm. A single-dose combination of albendazole (400 mg PO) with either ivermectin (200 mcg/kg PO) or diethylcarbamazine (6 mg/kg PO) is effective for reduction or suppression of *W. bancrofti* microfilaria, but the albendazole/ivermectin combination does not kill all the adult worms (D Addiss et al, Cochrane Database Syst Rev 2004; CD003753).
32. For patients with microfilaria in the blood, Medical Letter consultants start with a lower dosage and scale up: d1: 50 mg; d2: 50 mg tid; d3: 100 mg tid; d4-14: 6 mg/kg in 3 doses (for *Loa Loa* d4-14: 9 mg/kg in 3 doses). Multi-dose regimens have been shown to provide more rapid reduction in microfilaria than single-dose diethylcarbamazine, but microfilaria levels are similar 6-12 months after treatment (LD Andrade et al, Trans R Soc Trop Med Hyg 1995; 89:319; PE Simonsen et al, Am J Trop Med Hyg 1995; 53:267). A single dose of 6 mg/kg is used in endemic areas for mass treatment (J Figueredo-Silva et al, Trans R Soc Trop Med Hyg 1996; 90:192; J Noroes et al, Trans R Soc Trop Med Hyg 1997; 91:78).
33. Diethylcarbamazine should not be used for treatment of *Onchocerca volvulus* due to the risk of increased ocular side effects including blindness associated with rapid killing of the worms. It should be used cautiously in geographic regions where *O. volvulus* coexists with other filariae. Diethylcarbamazine is contraindicated during pregnancy. See also footnote 38.
34. In heavy infections with *Loa loa*, rapid killing of microfilariae can provoke encephalopathy. Apheresis has been reported to be effective in lowering microfilarial counts in patients heavily infected with *Loa loa* (EA Ottesen, Infect Dis Clin North Am 1993; 7:619). Albendazole may be useful for treatment of loiasis when diethylcarbamazine is ineffective or cannot be used, but repeated courses may be necessary (AD Klion et al, Clin Infect Dis 1999; 29:680; TE Tabi et al, Am J Trop Med Hyg 2004; 71:211). Ivermectin has also been used to reduce microfilaremia, but albendazole is preferred because of its slower onset of action and lower risk of precipitating encephalopathy (AD Klion et al, J Infect Dis 1993; 168:202; M Kombila et al, Am J Trop Med Hyg 1998; 58:458). Diethylcarbamazine, 300 mg PO once/wk, has been recommended for prevention of loiasis (TB Nutman et al, N Engl J Med 1988; 319:752).

Infection		Drug	Adult dosage	Pediatric dosage
FILARIASIS (continued)[30]				
Mansonella ozzardi				
Drug of choice:		See footnote 35		
Mansonella perstans				
Drug of choice:		Albendazole[7,12]	400 mg PO bid x 10d	400 mg PO bid x 10d
	OR	Mebendazole[7]	100 mg PO bid x 30d	100 mg PO bid x 30d
Mansonella streptocerca				
Drug of choice:[36]		Diethylcarbamazine*	6 mg/kg/d PO x 12d[33]	6 mg/kg/d PO x 12d[33]
	OR	Ivermectin[7,16]	150 mcg/kg PO once	150 mcg/kg PO once
Tropical Pulmonary Eosinophilia (TPE)[37]				
Drug of choice:		Diethylcarbamazine*	6 mg/kg/d in 3 doses x 12-21d[33]	6 mg/kg/d in 3 doses x 12-21d[33]
Onchocerca volvulus (River blindness)				
Drug of choice:		Ivermectin[16,38]	150 mcg/kg PO once, repeated every 6-12mos until asymptomatic	150 mcg/kg PO once, repeated every 6-12mos until asymptomatic
FLUKE, hermaphroditic, infection				
Clonorchis sinensis (Chinese liver fluke)				
Drug of choice:		Praziquantel[39]	75 mg/kg/d PO in 3 doses x 2d	75 mg/kg/d PO in 3 doses x 2d
	OR	Albendazole[7,12]	10 mg/kg/d PO x 7d	10 mg/kg/d PO x 7d
Fasciola hepatica (sheep liver fluke)				
Drug of choice:[40]		Triclabendazole*	10 mg/kg PO once or twice[41]	10 mg/kg PO once or twice[41]
Alternative:		Bithionol*	30-50 mg/kg on alternate days x 10-15 doses	30-50 mg/kg on alternate days x 10-15 doses
	OR	Nitazoxanide[5,7]	500 mg PO bid x 7d	1-3yrs: 100 mg PO q12h x 7d 4-11yrs: 200 mg PO q12h x 7d >12yrs: 500 mg PO q12h x 7d
Fasciolopsis buski, Heterophyes heterophyes, Metagonimus yokogawai (intestinal flukes)				
Drug of choice:		Praziquantel[7,39]	75 mg/kg/d PO in 3 doses x 1d	75 mg/kg/d PO in 3 doses x 1d
Metorchis conjunctus (North American liver fluke)				
Drug of choice:		Praziquantel[7,39]	75 mg/kg/d PO in 3 doses x 1d	75 mg/kg/d PO in 3 doses x 1d
Nanophyetus salmincola				
Drug of choice:		Praziquantel[7,39]	60 mg/kg/d PO in 3 doses x 1d	60 mg/kg/d PO in 3 doses x 1d
Opisthorchis viverrini (Southeast Asian liver fluke)				
Drug of choice:		Praziquantel[39]	75 mg/kg/d PO in 3 doses x 2d	75 mg/kg/d PO in 3 doses x 2d
Paragonimus westermani (lung fluke)				
Drug of choice:		Praziquantel[7,39]	75 mg/kg/d PO in 3 doses x 2d	75 mg/kg/d PO in 3 doses x 2d
Alternative:[42]		Bithionol*	30-50 mg/kg on alternate days x 10-15 doses	30-50 mg/kg on alternate days x 10-15 doses
GIARDIASIS *(Giardia duodenalis)*				
Drug of choice:		Metronidazole[7]	250 mg PO tid x 5-7d	15 mg/kg/d PO in 3 doses x 5-7d
	OR	Tinidazole[6]	2 g PO once	50 mg/kg PO once (max. 2 g)
	OR	Nitazoxanide[5]	500 mg PO bid x 3d	1-3yrs: 100 mg PO q12h x 3d 4-11yrs: 200 mg PO q12h x 3d >12yrs: 500 mg PO q12h x 3d
Alternative:[43]		Paromomycin[3,7,44]	25-35 mg/kg/d PO in 3 doses x 5-10d	25-35 mg/kg/d PO in 3 doses x 5-10d
	OR	Furazolidone*	100 mg PO qid x 7-10d	6 mg/kg/d PO in 4 doses x 7-10d
	OR	Quinacrine[4,45*]	100 mg PO tid x 5d	2 mg/kg/d PO in 3 doses x 5d (max 300 mg/d)
GNATHOSTOMIASIS *(Gnathostoma spinigerum)* [46]				
Treatment of choice:		Albendazole[7,12]	400 mg PO bid x 21d	400 mg PO bid x 21d
	OR	Ivermectin[7,16]	200 mcg/kg/d PO x 2d	200 mcg/kg/d PO x 2d
		either		
	±	Surgical removal		
GONGYLONEMIASIS *(Gongylonema* sp.*)* [47]				
Treatment of choice:		Surgical removal		
	OR	Albendazole[7,12]	400 mg/d PO x 3d	400 mg/d PO x 3d

* Availability problems. See table on page 14.

35. Diethylcarbamazine has no effect. A single dose of ivermectin 200 mcg/kg PO reduces microfilaria densities and provides both short- and long-term reductions in *M. ozzardi* microfilaremia (AA Gonzalez et al, W Indian Med J 1999; 48:231).
36. Diethylcarbamazine is potentially curative due to activity against both adult worms and microfilariae. Ivermectin is active only against microfilariae.
37. AK Boggild et al, Clin Infect Dis 2004; 39:1123. Relapses occur and can be treated with a repeated course of diethylcarbamazine.
38. Diethylcarbamazine should not be used for treatment of this disease because rapid killing of the worms can lead to blindness. Periodic treatment with ivermectin (every 3-12 months), 150 mcg/kg PO, can prevent blindness due to ocular onchocerciasis (DN Udall, Clin Infect Dis 2007; 44:53). Skin reactions after ivermectin treatment are often reported in persons with high microfilarial skin densities. Ivermectin has been inadvertently given to pregnant women during mass treatment programs; the rates of congenital abnormalities were similar in treated and untreated women. Because of the high risk of blindness from onchocerciasis, the use of ivermectin after the first trimester is considered acceptable according to the WHO. Doxycycline (100 mg/day PO for 6 weeks), followed by a single 150 mcg/kg PO dose of ivermectin, resulted in up to 19 months of amicrofilaridermia and 100% elimination of *Wolbachia* species (A Hoerauf et al, Lancet 2001; 357:1415).
39. Praziquantel should be taken with liquids during a meal.
40. Unlike infections with other flukes, *Fasciola hepatica* infections may not respond to praziquantel. Triclabendazole (*Egaten* - Novartis) appears to be safe and effective, but data are limited (DY Aksoy et al, Clin Microbiol Infect 2005; 11:859). It is available from Victoria Pharmacy, Zurich, Switzerland (www.pharmaworld.com; 41-1-211-24-32) and should be given with food for better absorption. Nitazoxanide also appears to have efficacy in treating fascioliasis in adults and in children (L Favennec et al, Aliment Pharmacol Ther 2003; 17:265; JF Rossignol et al, Trans R Soc Trop Med Hyg 1998; 92:103; SM Kabil et al, Curr Ther Res 2000; 61:339).
41. J Keiser et al, Expert Opin Investig Drugs 2005; 14:1513.
42. Triclabendazole may be effective in a dosage of 5 mg/kg PO once/d x 3d or 10 mg/kg PO bid x 1d (M Calvopiña et al, Trans R Soc Trop Med Hyg 1998; 92:566). See footnote 40 for availability.

Infection		Drug	Adult dosage	Pediatric dosage
HOOKWORM infection *(Ancylostoma duodenale, Necator americanus)*				
Drug of choice:		Albendazole[7,12]	400 mg PO once	400 mg PO once
	OR	Mebendazole	100 mg PO bid x 3d or 500 mg once	100 mg PO bid x 3d or 500 mg once
	OR	Pyrantel pamoate[7,13]*	11 mg/kg (max. 1g) PO x 3d	11 mg/kg (max. 1g) PO x 3d
Hydatid cyst, see TAPEWORM infection				
Hymenolepis nana, see TAPEWORM infection				
ISOSPORIASIS *(Isospora belli)*				
Drug of choice:[48]		Trimethoprim-sulfamethoxazole[7]	TMP 160 mg/SMX 800 mg (1 DS tab) PO bid x 10d	TMP 5 mg/kg/d/SMX 25 mg/kg/d PO in 2 doses x 10d
LEISHMANIA				
Visceral[49,50]				
Drug of choice:		Liposomal amphotericin B[51]	3 mg/kg/d IV d 1-5, 14 and 21[52]	3 mg/kg/d IV d 1-5, 14 and 21[52]
	OR	Sodium stibo-gluconate*	20 mg Sb/kg/d IV or IM x 28d	20 mg Sb/kg/d IV or IM x 28d
	OR	Miltefosine[53]*	2.5 mg/kg/d PO (max 150 mg/d) x 28d	2.5 mg/kg/d PO (max 150 mg/d) x 28d
Alternative:		Meglumine antimonate*	20 mg Sb/kg/d IV or IM x 28d	20 mg Sb/kg/d IV or IM x 28d
	OR	Amphotericin B[7]	1 mg/kg IV daily x 15-20d or every second day for up to 8 wks	1 mg/kg IV daily x 15-20d or every second day for up to 8 wks
	OR	Paromomycin[7,13,54]*	15 mg/kg/d IM x 21d	15 mg/kd/d IM x 21d
Cutaneous[49,55]				
Drugs of choice:		Sodium stibo-gluconate*	20 mg Sb/kg/d IV or IM x 20d	20 mg Sb/kg/d IV or IM x 20d
	OR	Meglumine antimonate*	20 mg Sb/kg/d IV or IM x 20d	20 mg Sb/kg/d IV or IM x 20d
	OR	Miltefosine[53]*	2.5 mg/kg/d PO (max 150 mg/d) x 28d	2.5 mg/kg/d PO (max 150 mg/d) x 28d
Alternative:[56]		Paromomycin[7,13,54]*	Topically 2x/d x 10-20d	Topically 2x/d x 10-20d
	OR	Pentamidine[7]	2-3 mg/kg IV or IM daily or every second day x 4-7 doses[57]	2-3 mg/kg IV or IM daily or every second day x 4-7 doses[57]
Mucosal[49,58]				
Drug of choice:		Sodium stibo-gluconate*	20 mg Sb/kg/d IV or IM x 28d	20 mg Sb/kg/d IV or IM x 28d
	OR	Meglumine antimonate*	20 mg Sb/kg/d IV or IM x 28d	20 mg Sb/kg/d IV or IM x 28d
	OR	Amphotericin B[7]	0.5-1 mg/kg IV daily or every second day for up to 8wks	0.5-1 mg/kg IV daily or every second day for up to 8wks
	OR	Miltefosine[53]*	2.5 mg/kg/d PO (max 150 mg/d) x 28d	2.5 mg/kg/d PO (max 150 mg/d) x 28d

* Availability problems. See table on page 14.

43. Another alternative is albendazole 400 mg/d PO x 5d in adults and 10 mg/kg/d PO x 5d in children (K Yereli et al, Clin Microbiol Infect 2004; 10:527; O Karabay et al, World J Gastroenterol 2004; 10:1215). Combination treatment with standard doses of metronidazole and quinacrine x 3wks has been effective for a small number of refractory infections (TE Nash et al, Clin Infect Dis 2001; 33:22). In one study, nitazoxanide was used successfully in high doses to treat a case of *Giardia* resistant to metronidazole and albendazole (P Abboud et al, Clin Infect Dis 2001; 32:1792).
44. Poorly absorbed; may be useful for treatment of giardiasis in pregnancy.
45. Quinacrine should be taken with liquids after a meal.
46. P Nontasut et al, Southeast Asian J Trop Med Pub Health 2005; 36:650; M de Gorgolas et al, J Travel Med 2003; 10:358. All patients should be treated with medication whether surgery is attempted or not.
47. ME Wilson et al, Clin Infect Dis 2001; 32:1378; G Molavi et al, J Helminth 2006; 80:425.
48. Usually a self-limited illness in immunocompetent patients. Immunosuppressed patients may need higher doses, longer duration (TMP/SMX qid x 10d, followed by bid x 3wks) and long-term maintenance. In sulfonamide-sensitive patients, pyrimethamine 50-75 mg daily in divided doses (plus leucovorin 10-25 mg/d) has been effective.
49. To maximize effectiveness and minimize toxicity, the choice of drug, dosage, and duration of therapy should be individualized based on the region of disease acquisition, a likely infecting species, and host factors such as immune status (BL Herwaldt, Lancet 1999; 354:1191). Some of the listed drugs and regimens are effective only against certain *Leishmania* species/strains and only in certain areas of the world (J Arevalo et al, Clin Infect Dis 2007; 195:1846). Medical Letter consultants recommend consultation with physicians experienced in management of this disease.
50. Visceral infection is most commonly due to the Old World species *L. donovani* (kala-azar) and *L. infantum* and the New World species *L. chagasi*.
51. Liposomal amphotericin B *(AmBisome)* is the only lipid formulation of amphotericin B FDA-approved for treatment of visceral leishmania, largely based on clinical trials in patients infected with *L. infantum* (A Meyerhoff, Clin Infect Dis 1999; 28:42). Two other amphotericin B lipid formulations, amphotericin B lipid complex *(Abelcet)* and amphotericin B cholesteryl sulfate *(Amphotec)* have been used, but are considered investigational for this condition and may not be as effective (C Bern et al, Clin Infect Dis 2006; 43:917).
52. The FDA-approved dosage regimen for immunocompromised patients (e.g., HIV infected) is 4 mg/kg/d IV on days 1-5, 10, 17, 24, 31 and 38. The relapse rate is high; maintenance therapy (secondary prevention) may be indicated, but there is no consensus as to dosage or duration.
53. Effective for both antimony-sensitive and -resistant *L. donovani* (Indian); miltefosine *(Impavido)* is manufactured in 10- or 50-mg capsules by Zentaris (Frankfurt, Germany at info@zentaris.com) and is available through consultation with the CDC. The drug is contraindicated in pregnancy; a negative pregnancy test before drug initiation and effective contraception during and for 2 months after treatment is recommended (H Murray et al, Lancet 2005; 366:1561). In a placebo-controlled trial in patients ≥12 years old, oral miltefosine 2.5 mg/kg/d x 28d was also effective for treatment of cutaneous leishmaniasis due to *L.(V.) panamensis* in Colombia, but not *L.(V.) braziliensis* or *L. mexicana* in Guatemala (J Soto et al, Clin Infect Dis 2004; 38:1266). "Motion sickness," nausea, headache and increased creatinine are the most frequent adverse effects (J Soto and P Soto, Expert Rev Anti Infect Ther 2006; 4:177).
54. Paromomycin IM has been effective against leishmania in India; it has not yet been tested in South America or the Mediterranean and there is insufficient data to support its use in pregnancy (S Sundar et al, N Engl J Med 2007; 356:2371). Topical paromomycin should be used only in geographic regions where cutaneous leishmaniasis species have low potential for mucosal spread. A formulation of 15% paromomycin/12% methylbenzethonium chloride *(Leshcutan)* in soft white paraffin for topical use has been reported to be partially effective against cutaneous leishmaniasis due to *L. major* in Israel and *L. mexicana* and *L. (V.) braziliensis* in Guatemala, where mucosal spread is very rare (BA Arana et al, Am J Trop Med Hyg 2001; 65:466). The methylbenzethonium is irritating to the skin; lesions may worsen before they improve.
55. Cutaneous infection is most commonly due to the Old World species *L. major* and *L. tropica* and the New World species *L. mexicana*, *L. (Viannia) braziliensis*, and others.

Infection		Drug	Adult dosage	Pediatric dosage
LICE infestation *(Pediculus humanus, P. capitis, Phthirus pubis)*[59]				
Drug of choice:		0.5% Malathion[60]	Topically	Topically
	OR	1% Permethrin[61]	Topically	Topically
Alternative:		Pyrethrins with piperonyl butoxide[61]	Topically	Topically
	OR	Ivermectin[7,16,62]	200 mcg/kg PO	≥15kg: 200 mcg/kg PO
Loa loa, see FILARIASIS				
MALARIA, Treatment of *(Plasmodium falciparum,*[63] *P. vivax,*[64] *P. ovale, and P. malariae*[65]*)*				
ORAL[66]				
P. falciparum or unidentified species acquired in areas of chloroquine-resistant *P. falciparum*[63]				
Drug of choice:[67]		Atovaquone/ proguanil[68]	2 adult tabs bid[69] or 4 adult tabs once/d x 3d	<5kg: not indicated 5-8kg: 2 peds tabs once/d x 3d 9-10kg: 3 peds tabs once/d x 3d 11-20kg: 1 adult tab once/d x 3d 21-30kg: 2 adult tabs once/d x 3d 31-40kg: 3 adult tabs once/d x 3d >40kg: 4 adult tabs once/d x 3d
	OR	Quinine sulfate **plus**	650 mg q8h x 3 **or** 7d[70]	30 mg/kg/d in 3 doses x 3 **or** 7d[70]
		doxycycline[7,21,71] **or plus**	100 mg bid x 7d	4 mg/kg/d in 2 doses x 7d
		tetracycline[7,21] **or plus**	250 mg qid x 7d	6.25 mg/kg/d in 4 doses x 7d
		clindamycin[7,18,72]	20 mg/kg/d in 3 doses x 7d[73]	20 mg/kg/d in 3 doses x 7d
Alternative:[67]		Mefloquine[74,75]	750 mg followed 12 hrs later by 500 mg	15 mg/kg followed 12 hrs later by 10 mg/kg
	OR	Artemether/ lumefantrine[76,77*]	6 doses over 3d (4 tabs/dose at 0, 8, 24, 36, 48 and 60 hours)	6 doses over 3d at same intervals as adults; <15kg: 1 tab/dose 15-25kg: 2 tabs/dose 25-35kg: 3 tabs/dose >35kg: 4 tabs/dose
	OR	Artesunate[76*] **plus** see footnote 78	4 mg/kg/d x 3d	4 mg/kg/d x 3d

* Availability problems. See table on page 14.

56. Although azole drugs (fluconazole, ketoconazole, itraconazole) have been used to treat cutaneous disease, they are not reliably effective and have no efficacy against mucosal disease (AJ Magill, Infect Dis Clin North Am 2005; 19:241). For treatment of *L. major* cutaneous lesions, a study in Saudi Arabia found that oral fluconazole, 200 mg once/d x 6wks appeared to speed healing (AA Alrajhi et al, N Engl J Med 2002; 346:891). Thermotherapy may be an option for cutaneous *L. tropica* infection (R Reithinger et al, Clin Infect Dis 2005; 40:1148). A device that generates focused and controlled heating of the skin has been approved by the FDA for this indication (*ThermoMed* – ThermoSurgery Technologies Inc., Phoenix, AZ, 602-264-7300; www.thermosurgery.com).
57. At this dosage pentamidine has been effective in Colombia predominantly against *L. (V.) panamensis* (J Soto-Mancipe et al, Clin Infect Dis 1993; 16:417; J Soto et al, Am J Trop Med Hyg 1994; 50:107). Activity against other species is not well established.
58. Mucosal infection is most commonly due to the New World species *L. (V.) braziliensis*, *L. (V.) panamensis*, or *L. (V.) guyanensis*.
59. Pediculocides should not be used for infestations of the eyelashes. Such infestations are treated with petrolatum ointment applied 2-4x/d x 8-10d. Oral TMP/SMX has also been used (TL Meinking and D Taplin, Curr Probl Dermatol 1996; 24:157). For pubic lice, treat with 5% permethrin or ivermectin as for scabies (see page 9). TMP/SMX has also been effective when used together with permethrin for head lice (RB Hipolito et al, Pediatrics 2001; 107:E30).
60. Malathion is both ovicidal and pediculocidal; 2 applications at least 7 days apart are generally necessary to kill all lice and nits.
61. Permethrin and pyrethrin are pediculocidal; retreatment in 7-10d is needed to eradicate the infestation. Some lice are resistant to pyrethrins and permethrin (TL Meinking et al, Arch Dermatol 2002; 138:220).
62. Ivermectin is pediculocidal, but more than one dose is generally necessary to eradicate the infestation (KN Jones and JC English 3rd, Clin Infect Dis 2003; 36:1355). The number of doses and interval between doses has not been established, but in one study of body lice, 3 doses administered at 7-day intervals were effective (C Fouault et al, J Infect Dis 2006; 193:474).
63. Chloroquine-resistant *P. falciparum* occurs in all malarious areas except Central America (including Panama north and west of the Canal Zone), Mexico, Haiti, the Dominican Republic, Paraguay, northern Argentina, North and South Korea, Georgia, Armenia, most of rural China and some countries in the Middle East (chloroquine resistance has been reported in Yemen, Oman, Saudi Arabia and Iran). For treatment of multiple-drug-resistant *P. falciparum* in Southeast Asia, especially Thailand, where mefloquine resistance is frequent, atovaquone/proguanil, quinine plus either doxycycline or clindamycin, or artemether/lumefantrine may be used.
64. *P. vivax* with decreased susceptibility to chloroquine is a significant problem in Papua-New Guinea and Indonesia. There are also a few reports of resistance from Myanmar, India, the Solomon Islands, Vanuatu, Guyana, Brazil, Colombia and Peru (JK Baird et al, Curr Infect Dis Rep 2007; 9:39).
65. Chloroquine-resistant *P. malariae* has been reported from Sumatra (JD Maguire et al, Lancet 2002; 360:58).
66. Uncomplicated or mild malaria may be treated with oral drugs. Severe malaria (e.g. impaired consciousness, parasitemia >5%, shock, etc.) should be treated with parenteral drugs (KS Griffin et al, JAMA 2007; 297:2264).
67. Primaquine is given for prevention of relapse after infection with *P. vivax* or *P. ovale*. Some experts also prescribe primaquine phosphate 30 mg base/d (0.6 mg base/kg/d for children) for 14d after departure from areas where these species are endemic (Presumptive Anti-Relapse Therapy [PART], "terminal prophylaxis"). Since this is not always effective as prophylaxis (E Schwartz et al, N Engl J Med 2003; 349:1510), others prefer to rely on surveillance to detect cases when they occur, particularly when exposure was limited or doubtful. See also footnote 79.
68. Atovaquone/proguanil is available as a fixed-dose combination tablet: adult tablets (*Malarone*; 250 mg atovaquone/100 mg proguanil) and pediatric tablets (*Malarone Pediatric*; 62.5 mg atovaquone/25 mg proguanil). To enhance absorption and reduce nausea and vomiting, it should be taken with food or a milky drink. Safety in pregnancy is unknown; outcomes were normal in 24 women treated with the combination in the 2nd and 3rd trimester (R McGready et al, Eur J Clin Pharmacol 2003; 59:545). The drug should not be given to patients with severe renal impairment (creatinine clearance <30mL/min). There have been isolated case reports of resistance in *P. falciparum* in Africa, but Medical Letter consultants do not believe there is a high risk for acquisition of *Malarone*-resistant disease (E Schwartz et al, Clin Infect Dis 2003; 37:450; A Farnert et al, BMJ 2003; 326:628; S Kuhn et al, Am J Trop Med Hyg 2005; 72:407; CT Happi et al, Malaria Journal 2006; 5:82).
69. Although approved for once-daily dosing, Medical Letter consultants usually divide the dose in two to decrease nausea and vomiting.
70. Available in the US in a 324-mg capsule; 2 capsules suffice for adult dosage. In Southeast Asia, relative resistance to quinine has increased and treatment should be continued for 7d. Quinine should be taken with or after meals to decrease gastrointestinal adverse effects.
71. Doxycycline should be taken with adequate water to avoid esophageal irritation. It can be taken with food to minimize gastrointestinal adverse effects.
72. For use in pregnancy and in children <8 yrs.
73. B Lell and PG Kremsner, Antimicrob Agents Chemother 2002; 46:2315; M Ramharter et al, Clin Infect Dis 2005; 40:1777.

Infection		Drug	Adult dosage	Pediatric dosage
MALARIA, Treatment of (continued)				
P. vivax acquired in areas of chloroquine-resistant *P. vivax*[64]				
Drug of choice:[67]		Mefloquine[74]	750 mg PO followed 12 hrs later by 500 mg	15 mg/kg PO followed 12 hrs later by 10 mg/kg
	OR	Atovaquone/ proguanil[68]	2 adult tabs bid[69] or 4 adult tabs once/d x 3d	<5kg: not indicated 5-8kg: 2 peds tabs once/d x 3d 9-10kg: 3 peds tabs once/d x 3d 11-20kg: 1 adult tab once/d x 3d 21-30kg: 2 adult tabs once/d x 3d 31-40kg: 3 adult tabs once/d x 3d >40kg: 4 adult tabs once/d x 3d
		either followed by		
		primaquine phosphate[79]	30 mg base/d PO x 14d	0.6 mg/kg/d PO x 14d
Alternative:[67]		Chloroquine phosphate[80]	25 mg base/kg PO in 3 doses over 48 hrs[81]	25 mg base/kg PO in 3 doses over 48 hrs[81]
	OR	Quinine sulfate	650 mg PO q8h x 3-7d[70]	30 mg/kg/d PO in 3 doses x 3-7d[70]
		plus		
		doxycycline[7,21,71]	100 mg PO bid x 7d	4 mg/kg/d PO in 2 doses x 7d
		either followed by		
		primaquine phosphate[79]	30 mg base/d PO x 14d	0.6 mg/kg/d PO x 14d
All *Plasmodium* species except chloroquine-resistant *P. falciparum*[63] and chloroquine-resistant *P. vivax*[64]				
Drug of choice:[67]		Chloroquine phosphate[80]	1 g (600 mg base) PO, then 500 mg (300 mg base) 6 hrs later, then 500mg (300 mg base) at 24 and 48 hrs[81]	10 mg base/kg (max. 600 mg base) PO, then 5 mg base/kg 6 hrs later, then 5 mg base/kg at 24 and 48 hrs[81]
PARENTERAL[66]				
All *Plasmodium* species (Chloroquine-sensitive and resistant)				
Drug of choice:[67,82]		Quinidine gluconate[83]	10 mg/kg IV loading dose (max. 600 mg) in normal saline over 1-2 hrs, followed by continuous infusion of 0.02 mg/kg/min until PO therapy can be started	10 mg/kg IV loading dose (max. 600 mg) in normal saline over 1-2 hrs, followed by continuous infusion of 0.02 mg/kg/min until PO therapy can be started
	OR	Quinine dihydro-chloride[83*]	20 mg/kg IV loading dose in 5% dextrose over 4 hrs, followed by 10 mg/kg over 2-4 hrs q8h (max. 1800 mg/d) until PO therapy can be started	20 mg/kg IV loading dose in 5% dextrose over 4 hrs, followed by 10 mg/kg over 2-4 hrs q8h (max. 1800 mg/d) until PO therapy can be started
	OR	Artesunate[76*]	2.4 mg/kg/dose IV x 3d at 0, 12, 24 and 48 hrs	2.4 mg/kg/dose IV x 3d at 0, 12, 24 and 48 hrs
		plus see footnote 78		
MALARIA, Prevention of[84]				
All *Plasmodium* species in chloroquine-sensitive areas[63,64,65]				
Drug of choice:[67,85]		Chloroquine phosphate[80,86]	500 mg (300 mg base) PO once/wk[87]	5 mg/kg base PO once/wk, up to adult dose of 300 mg base[87]

* Availability problems. See table on page 14.

74. At this dosage, adverse effects include nausea, vomiting, diarrhea and dizziness. Disturbed sense of balance, toxic psychosis and seizures can also occur. Mefloquine should not be used for treatment of malaria in pregnancy unless there is no other treatment option because of increased risk for stillbirth (F Nosten et al, Clin Infect Dis 1999; 28:808). It should be avoided for treatment of malaria in persons with active depression or with a history of psychosis or seizures and should be used with caution in persons with any psychiatric illness. Mefloquine can be given to patients taking β-blockers if they do not have an underlying arrhythmia; it should not be used in patients with conduction abnormalities. Mefloquine should not be given together with quinine or quinidine, and caution is required in using quinine or quinidine to treat patients with malaria who have taken mefloquine for prophylaxis. Mefloquine should not be taken on an empty stomach; it should be taken with at least 8 oz of water.
75. *P. falciparum* with resistance to mefloquine is a significant problem in the malarious areas of Thailand and in areas of Myanmar and Cambodia that border on Thailand. It has also been reported on the borders between Myanmar and China, Laos and Myanmar, and in Southern Vietnam. In the US, a 250-mg tablet of mefloquine contains 228 mg mefloquine base. Outside the US, each 275-mg tablet contains 250 mg base.
76. The artemisinin-derivatives, artemether and artesunate, are both frequently used globally in combination regimens to treat malaria. Both are available in oral, parenteral and rectal formulations, but manufacturing standards are not consistent (HA Karunajeewa et al, JAMA 2007; 297:2381; EA Ashley and NJ White, Curr Opin Infect Dis 2005; 18:531). In the US, only the IV formulation of artesunate is available; it can be obtained through the CDC under an IND for patients with severe disease who do not have timely access, cannot tolerate, or fail to respond to IV quinidine (www.cdc.gov/malaria/features/artesunate_now_available.htm). To avoid development of resistance, monotherapy should be avoided (PE Duffy and CH Sibley, Lancet 2005; 366:1908). In animal studies artemisinins have been embryotoxic and caused a low incidence of teratogenicity; no adverse pregnancy outcome has been observed in limited studies in humans (S Dellicour et al, Malaria Journal 2007; 6:15).
77. Artemether/lumefantrine is available as a fixed-dose combination tablet (*Coartem* in countries with endemic malaria, *Riamet* in Europe and countries without endemic malaria); each tablet contains 20 mg artemether and 120 mg lumefantrine (M van Vugt et al, Am J Trop Med Hyg 1999; 60:936). It is contraindicated during the first trimester of pregnancy; safety during the second and third trimester is not known. The tablets should be taken with food. Artemether/lumefantrine should not be used in patients with cardiac arrhythmias, bradycardia, severe cardiac disease or QT prolongation. Concomitant use of drugs that prolong the QT interval or are metabolized by CYP2D6 is contraindicated.
78. Adults treated with artesunate should also receive oral treatment doses of either atovaquone/proguanil, doxycycline, clindamycin or mefloquine; children should take either atovaquone/proguanil, clindamycin or mefloquine (F Nosten et al, Lancet 2000; 356:297; M van Vugt, Clin Infect Dis 2002; 35:1498; F Smithuis et al, Trans R Soc Trop Med Hyg 2004; 98:182). If artesunate is given IV, oral medication should be started when the patient is able to tolerate it (SEAQUAMAT group, Lancet 2005; 366:717).
79. Primaquine phosphate can cause hemolytic anemia, especially in patients whose red cells are deficient in G-6-PD. This deficiency is most common in African, Asian and Mediterranean peoples. Patients should be screened for G-6-PD deficiency before treatment. Primaquine should not be used during pregnancy. It should be taken with food to minimize nausea and abdominal pain. Primaquine-tolerant *P. vivax* can be found globally. Relapses of primaquine-resistant strains may be retreated with 30 mg (base) x 28d.
80. Chloroquine should be taken with food to decrease gastrointestinal adverse effects. If chloroquine phosphate is not available, hydroxychloroquine sulfate is as effective; 400 mg of hydroxychloroquine sulfate is equivalent to 500 mg of chloroquine phosphate.
81. Chloroquine combined with primaquine was effective in 85% of patients with *P. vivax* resistant to chloroquine and could be a reasonable choice in areas where other alternatives are not available (JK Baird et al, J Infect Dis 1995; 171:1678).

Infection		Drug	Adult dosage	Pediatric dosage
MALARIA, Prevention of (continued)				
All *Plasmodium* species in chloroquine-resistant areas[63,64,65]				
Drug of choice:[67]		Atovaquone/ proguanil[68]	1 adult tab/d[88]	5-8kg: ½ peds tab/d[68,88] 9-10kg: ¾ peds tab/d[68,88] 11-20kg: 1 peds tab/d[68,88] 21-30kg: 2 peds tabs/d[68,88] 31-40kg: 3 peds tabs/d[68,88] >40kg: 1 adult tab/d[68,88]
	OR	Doxycycline[7,21,71]	100 mg PO daily[89]	2 mg/kg/d PO, up to 100 mg/d[89]
	OR	Mefloquine[74,75,90]	250 mg PO once/wk[91]	5-10kg: 1/8 tab once/wk[91] 11-20kg: ¼ tab once/wk[91] 21-30kg: ½ tab once/wk[91] 31-45kg: ¾ tab once/wk[91] >45kg: 1 tab once/wk[91]
Alternative:[92]		Primaquine[7,79] phosphate	30 mg base PO daily[93]	0.6 mg/kg base PO daily[93]
MALARIA, Prevention of relapses: *P. vivax* and *P. ovale*[67]				
Drug of choice:		Primaquine phosphate[79]	30 mg base/d PO x 14d	0.6 mg base/kg/d PO x 14d
MALARIA, Self-Presumptive Treatment[94]				
Drug of Choice:		Atovaquone/ proguanil[7,68]	4 adult tabs once/d x 3d[69]	<5kg: not indicated 5-8kg: 2 peds tabs once/d x 3d 9-10kg: 3 peds tabs once/d x 3d 11-20kg: 1 adult tab once/d x 3d 21-30kg: 2 adult tabs once/d x 3d 31-40kg: 3 adult tabs once/d x 3d >40kg: 4 adult tabs once/d x 3d[69]
	OR	Quinine sulfate **plus**	650 mg PO q8h x 3 or 7d[70]	30 mg/kg/d PO in 3 doses x 3 or 7d[70]
		doxycycline[7,21,71]	100 mg PO bid x 7d	4 mg/kg/d PO in 2 doses x 7d
	OR	Artesunate[76*] **plus** see footnote 78	4 mg/kg/d PO x 3d	4 mg/kg/d PO x 3d
MICROSPORIDIOSIS				
Ocular *(Encephalitozoon hellem, E.cuniculi, Vittaforma corneae [Nosema corneum])*				
Drug of choice:		Albendazole[7,12] **plus** fumagillin[95*]	400 mg PO bid	
Intestinal *(E. bieneusi, E. [Septata] intestinalis)*				
E. bieneusi				
Drug of choice:		Fumagillin[96*]	20 mg PO tid x 14d	
E. intestinalis				
Drug of choice:		Albendazole[7,12]	400 mg PO bid x 21d	
Disseminated (*E. hellem, E. cuniculi, E. intestinalis, Pleistophora sp., Trachipleistophora sp.* and *Brachiola vesicularum*)				
Drug of choice:[97]		Albendazole[7,12*]	400 mg PO bid	
Mites, see SCABIES				
MONILIFORMIS *moniliformis* infection				
Drug of choice:		Pyrantel pamoate[7,13*]	11 mg/kg PO once, repeat twice, 2wks apart	11 mg/kg PO once, repeat twice, 2wks apart

* Availability problems. See table on page 14.

82. Exchange transfusion is controversial, but has been helpful for some patients with high-density (>10%) parasitemia, altered mental status, pulmonary edema or renal complications (VI Powell and K Grima, Transfus Med Rev 2002; 16:239; MS Riddle et al, Clin Infect Dis 2002; 34:1192).
83. Continuous EKG, blood pressure and glucose monitoring are recommended, especially in pregnant women and young children. For problems with quinidine availability, call the manufacturer (Eli Lilly, 800-821-0538) or the CDC Malaria Hotline (770-488-7788). Quinidine may have greater antimalarial activity than quinine. The loading dose should be decreased or omitted in patients who have received quinine or mefloquine. If more than 48 hours of parenteral treatment is required, the quinine or quinidine dose should be reduced by 30-50%.
84. No drug guarantees protection against malaria. Travelers should be advised to seek medical attention if fever develops after they return. Insect repellents, insecticide-impregnated bed nets and proper clothing are important adjuncts for malaria prophylaxis (Med Lett Drugs Ther 2005; 47:100). Malaria in pregnancy is particularly serious for both mother and fetus; prophylaxis is indicated if exposure cannot be avoided.
85. Alternatives for patients who are unable to take chloroquine include atovaquone/proguanil, mefloquine, doxycycline or primaquine dosed as for chloroquine-resistant areas.
86. Has been used extensively and safely for prophylaxis in pregnancy.
87. Beginning 1-2wks before travel and continuing weekly for the duration of stay and for 4wks after leaving.
88. Beginning 1-2d before travel and continuing for the duration of stay and for 1wk after leaving. In one study of malaria prophylaxis, atovaquone/proguanil was better tolerated than mefloquine in nonimmune travelers (D Overbosch et al, Clin Infect Dis 2001; 33:1015). The protective efficacy of *Malarone* against *P. vivax* is variable ranging from 84% in Indonesian New Guinea (J Ling et al, Clin Infect Dis 2002; 35:825) to 100% in Colombia (J Soto et al, Am J Trop Med Hyg 2006; 75:430). Some Medical Letter consultants prefer alternate drugs if traveling to areas where *P. vivax* predominates.
89. Beginning 1-2d before travel and continuing for the duration of stay and for 4wks after leaving. Use of tetracyclines is contraindicated in pregnancy and in children <8 years old. Doxycycline can cause gastrointestinal disturbances, vaginal moniliasis and photosensitivity reactions.
90. Mefloquine has not been approved for use during pregnancy. However, it has been reported to be safe for prophylactic use during the second and third trimester of pregnancy and possibly during early pregnancy as well (CDC Health Information for International Travel, 2008, page 228; BL Smoak et al, J Infect Dis 1997; 176:831). For pediatric doses <½ tablet, it is advisable to have a pharmacist crush the tablet, estimate doses by weighing, and package them in gelatin capsules. There is no data for use in children <5 kg, but based on dosages in other weight groups, a dose of 5 mg/kg can be used. Not recommended for use in travelers with active depression or with a history of psychosis or seizures and should be used with caution in persons with psychiatric illness. Mefloquine can be given to patients taking β-blockers if they do not have an underlying arrhythmia; it should not be used in patients with conduction abnormalities.
91. Beginning 1-2wks before travel and continuing weekly for the duration of stay and for 4wks after leaving. Most adverse events occur within 3 doses. Some Medical Letter consultants favor starting mefloquine 3 weeks prior to travel and monitoring the patient for adverse events, this allows time to change to an alternative regimen if mefloquine is not tolerated.

Infection		Drug	Adult dosage	Pediatric dosage
***Naegleria* species**, see AMEBIC MENINGOENCEPHALITIS, PRIMARY				
Necator americanus, see HOOKWORM infection				
***OESOPHAGOSTOMUM** bifurcum*				
Drug of choice:		See footnote 98		
Onchocerca volvulus, see FILARIASIS				
Opisthorchis viverrini, see FLUKE infection				
Paragonimus westermani, see FLUKE infection				
Pediculus capitis, humanus, Phthirus pubis, see LICE				
Pinworm, see ENTEROBIUS				
PNEUMOCYSTIS JIROVECI (formerly *carinii)* pneumonia (PCP)[99]				
Drug of choice:		Trimethoprim/ sulfamethoxazole	TMP 15 mg/SMX 75 mg/kg/d, PO or IV in 3 or 4 doses x 21d	TMP 15 mg/SMX 75 mg/kg/d, PO or IV in 3 or 4 doses x 21d
Alternative:		Primaquine[7,79]	30 mg base PO daily x 21d	0.3 mg/kg base PO daily x 21d
		plus clindamycin[7,18]	600 mg IV q6h x 21d, or 300-450 mg PO q6h x 21d	15-25 mg/kg IV q6h x 21d, or 10 mg/kg PO q6h x 21d
	OR	Trimethoprim[7]	5 mg/kg PO tid x 21d	5 mg/kg PO tid x 21d
		plus dapsone[7]	100 mg daily x 21d	2 mg/kg/d PO x 21d
	OR	Pentamidine	3-4 mg/kg IV daily x 21d	3-4 mg/kg IV daily x 21d
	OR	Atovaquone	750 mg PO bid x 21d	1-3mos: 30 mg/kg/d PO x 21d 4-24mos: 45 mg/kg/d PO x 21d >24mos: 30 mg/d PO x 21d
Primary and secondary prophylaxis[100]				
Drug of Choice:		Trimethoprim/ sulfamethoxazole	1 tab (single or double strength) daily or 1 DS tab PO 3d/wk	TMP 150 mg/SMX 750 mg/m^2/d PO in 2 doses 3d/wk
Alternative:		Dapsone[7]	50 mg PO bid or 100 mg PO daily	2 mg/kg/d (max. 100 mg) PO or 4 mg/kg (max. 200 mg) PO each wk
	OR	Dapsone[7]	50 mg PO daily or 200 mg PO each wk	
		plus pyrimethamine[101]	50 mg PO or 75 mg PO each wk	
	OR	Pentamidine	300 mg aerosol inhaled monthly via *Respirgard II* nebulizer	≥5yrs: 300 mg inhaled monthly via *Respirgard II* nebulizer
	OR	Atovaquone[7,20]	1500 mg PO daily	1-3mos: 30 mg/kg/d PO 4-24mos: 45 mg/kg/d PO >24mos: 30 mg/kg/d PO
River Blindness, see FILARIASIS				
Roundworm, see ASCARIASIS				
Sappinia diploidea, See AMEBIC MENINGOENCEPHALITIS, PRIMARY				
SCABIES *(Sarcoptes scabiei)*				
Drug of choice:		5% Permethrin	Topically once[102]	Topically once[102]
Alternative:[103]		Ivermectin[7,16,104]	200 mcg/kg PO once[102]	200 mcg/kg PO once[102]
		10% Crotamiton	Topically once/d x 2	Topically once/d PO x 2
SCHISTOSOMIASIS *(Bilharziasis)*				
S. haematobium				
Drug of choice:		Praziquantel[39]	40 mg/kg/d PO in 2 doses x 1d	40 mg/kg/d PO in 2 doses x 1d
S. japonicum				
Drug of choice:		Praziquantel[39]	60 mg/kg/d PO in 3 doses x 1d	60 mg/kg/d PO in 3 doses x 1d
S. mansoni				
Drug of choice:		Praziquantel[39]	40 mg/kg/d PO in 2 doses x 1d	40 mg/kg/d PO in 2 doses x 1d
Alternative:		Oxamniquine[105]*	15 mg/kg PO once[106]	20 mg/kg/d PO in 2 doses x 1d[106]
S. mekongi				
Drug of choice:		Praziquantel[39]	60 mg/kg/d PO in 3 doses x 1d	60 mg/kg/d PO in 3 doses x 1d

* Availability problems. See table on page 14.

92. The combination of weekly chloroquine (300 mg base) and daily proguanil (200 mg) is recommended by the World Health Organization (www.WHO.int) for use in selected areas; this combination is no longer recommended by the CDC. Proguanil (*Paludrine* – AstraZeneca, United Kingdom) is not available alone in the US but is widely available in Canada and Europe. Prophylaxis is recommended during exposure and for 4 weeks afterwards. Proguanil has been used in pregnancy without evidence of toxicity (PA Phillips-Howard and D Wood, Drug Saf 1996; 14:131).

93 Studies have shown that daily primaquine beginning 1d before departure and continued until 3-7d after leaving the malarious area provides effective prophylaxis against chloroquine-resistant *P. falciparum* (JK Baird et al, Clin Infect Dis 2003; 37:1659). Some studies have shown less efficacy against *P. vivax*. Nausea and abdominal pain can be diminished by taking with food.

94. A traveler can be given a course of medication for presumptive self-treatment of febrile illness. The drug given for self-treatment should be different from that used for prophylaxis. This approach should be used only in very rare circumstances when a traveler would not be able to get medical care promptly.

95. CM Chan et al, Ophthalmology 2003; 110:1420. Ocular lesions due to *E. hellem* in HIV-infected patients have responded to fumagillin eyedrops prepared from *Fumidil-B* (bicyclohexyl ammonium fumagillin) used to control a microsporidial disease of honey bees (MJ Garvey et al, Ann Pharmacother 1995; 29:872), available from Leiter's Park Avenue Pharmacy (see footnote 1). For lesions due to *V. corneae,* topical therapy is generally not effective and keratoplasty may be required (RM Davis et al, Ophthalmology 1990; 97:953).

96. Oral fumagillin (*Flisint* – Sanofi-Aventis, France) has been effective in treating *E. bieneusi* (J-M Molina et al, N Engl J Med 2002; 346:1963), but has been associated with thrombocytopenia and neutropenia. Highly active antiretroviral therapy (HAART) may lead to microbiologic and clinical response in HIV-infected patients with microsporidial diarrhea. Octreotide *(Sandostatin)* has provided symptomatic relief in some patients with large-volume diarrhea.

97. J-M Molina et al, J Infect Dis 1995; 171:245. There is no established treatment for *Pleistophora*. For disseminated disease due to *Trachipleistophora* or *Brachiola,* itraconazole 400 mg PO once/d plus albendazole may also be tried (CM Coyle et al, N Engl J Med 2004; 351:42).

Infection	Drug	Adult dosage	Pediatric dosage
Sleeping sickness, see TRYPANOSOMIASIS			
STRONGYLOIDIASIS *(Strongyloides stercoralis)*			
Drug of choice:[107]	Ivermectin[16]	200 mcg/kg/d PO x 2d	200 mcg/kg/d PO x 2d
Alternative:	Albendazole[7,12]	400 mg PO bid x 7d	400 mg PO bid x 7d
TAPEWORM infection			
— **Adult** (intestinal stage)			
Diphyllobothrium latum **(fish),** ***Taenia saginata*** **(beef),** ***Taenia solium*** **(pork),** ***Dipylidium caninum*** **(dog)**			
Drug of choice:	Praziquantel[7,39]	5-10 mg/kg PO once	5-10 mg/kg PO once
Alternative:	Niclosamide[108]*	2 g PO once	50 mg/kg PO once
Hymenolepis nana **(dwarf tapeworm)**			
Drug of choice:	Praziquantel[7,39]	25 mg/kg PO once	25 mg/kg PO once
Alternative:	Nitazoxanide[5,7]	500 mg PO once/d or bid x 3d[109]	1-3yrs: 100 mg PO bid x 3d[109] 4-11yrs: 200 mg PO bid x 3d[109]
— **Larval** (tissue stage)			
Echinococcus granulosus (hydatid cyst)			
Drug of choice:[110]	Albendazole[12]	400 mg PO bid x 1-6mos	15 mg/kg/d (max. 800 mg) x 1-6mos
Echinococcus multilocularis			
Treatment of choice:	See footnote 111		
Taenia solium *(Cysticercosis)*			
Treatment of choice:	See footnote 112		
Alternative:	Albendazole[12]	400 mg PO bid x 8-30d; can be repeated as necessary	15 mg/kg/d (max. 800 mg) PO in 2 doses x 8-30d; can be repeated as necessary
OR	Praziquantel[7,39]	100 mg/kg/d PO in 3 doses x 1 day then 50 mg/kg/d in 3 doses x 29 days	100 mg/kg/d PO in 3 doses x 1 day then 50 mg/kg/d in 3 doses x 29 days
Toxocariasis, see VISCERAL LARVA MIGRANS			
TOXOPLASMOSIS *(Toxoplasma gondii)*			
Drug of choice:[113]	Pyrimethamine[114]	25-100 mg/d PO x 3-4wks	2 mg/kg/d PO x 2d, then 1 mg/kg/d (max. 25 mg/d) x 4wks[115]
	plus		
	sulfadiazine[116]	1-1.5 g PO qid x 3-4wks	100-200 mg/kg/d PO x 3-4wks
TRICHINELLOSIS *(Trichinella spiralis)*			
Drug of choice:	Steroids for severe symptoms		
	plus		
	Albendazole[7,12]	400 mg PO bid x 8-14d	400 mg PO bid x 8-14d
Alternative:	Mebendazole[7]	200-400 mg PO tid x 3d, then 400-500 mg tid x 10d	200-400 mg PO tid x 3d, then 400-500 mg tid x 10d
TRICHOMONIASIS *(Trichomonas vaginalis)*			
Drug of choice:[117]	Metronidazole	2 g PO once or 500 mg bid x 7d	15 mg/kg/d PO in 3 doses x 7d
OR	Tinidazole[6]	2 g PO once	50 mg/kg once (max. 2 g)

* Availability problems. See table on page 14.

98. Albendazole or pyrantel pamoate may be effective (JB Ziem et al, Ann Trop Med Parasitol 2004; 98:385).
99. Pneumocystis has been reclassified as a fungus. In severe disease with room air $PO_2 \leq 70$ mmHg or Aa gradient ≥ 35 mmHg, prednisone should also be used (S Gagnon et al, N Engl J Med 1990; 323:1444; E Caumes et al, Clin Infect Dis 1994; 18:319).
100. Primary/secondary prophylaxis in patients with HIV can be discontinued after CD4 count increases to >200 x 10^6/L for >3mos.
101. Plus leucovorin 25 mg with each dose of pyrimethamine. Pyrimethamine should be taken with food to minimize gastrointestinal adverse effects.
102. Treatment may need to be repeated in 10-14 days. A second ivermectin dose taken 2 weeks later increases the cure rate to 95%, which is equivalent to that of 5% permethrin (V Usha et al, J Am Acad Dermatol 2000; 42:236; O Chosidow, N Engl J Med 2006; 354:1718; J Heukelbach and H Feldmeier, Lancet 2006; 367:1767).
103. Lindane (γ-benzene hexachloride) should be reserved for treatment of patients who fail to respond to other drugs. The FDA has recommended it not be used for immunocompromised patients, young children, the elderly, pregnant and breast-feeding women, and patients weighing <50 kg.
104. Ivermectin, either alone or in combination with a topical scabicide, is the drug of choice for crusted scabies in immunocompromised patients (P del Giudice, Curr Opin Infect Dis 2004; 15:123).
105. Oxamniquine, which is not available in the US, is generally not as effective as praziquantel. It has been useful, however, in some areas in which praziquantel is less effective (ML Ferrari et al, Bull World Health Organ 2003; 81:190; A Harder, Parasitol Res 2002; 88:395). Oxamniquine is contraindicated in pregnancy. It should be taken after food.
106. In East Africa, the dose should be increased to 30 mg/kg, and in Egypt and South Africa to 30 mg/kg/d x 2d. Some experts recommend 40-60 mg/kg over 2-3d in all of Africa (KC Shekhar, Drugs 1991; 42:379).
107. In immunocompromised patients or disseminated disease, it may be necessary to prolong or repeat therapy, or to use other agents. Veterinary parenteral and enema formulations of ivermectin have been used in severely ill patients with hyperinfection who were unable to take or reliably absorb oral medications (J Orem et al, Clin Infect Dis 2003; 37:152; PE Tarr Am J Trop Med Hyg 2003; 68:453; FM Marty et al, Clin Infect Dis 2005; 41:e5). In disseminated strongyloidiasis, combination therapy with albendazole and ivermectin has been suggested (S Lim et al, CMAJ 2004; 171:479).
108. Niclosamide must be chewed thoroughly before swallowing and washed down with water.
109. JO Juan et al, Trans R Soc Trop Med Hyg 2002; 96:193; JC Chero et al, Trans R Soc Trop Med Hyg 2007; 101:203; E Diaz et al, Am J Trop Med Hyg 2003; 68:384.
110. Patients may benefit from surgical resection or percutaneous drainage of cysts. Praziquantel is useful preoperatively or in case of spillage of cyst contents during surgery. Percutaneous aspiration-injection-reaspiration (PAIR) with ultrasound guidance plus albendazole therapy has been effective for management of hepatic hydatid cyst disease (RA Smego, Jr. et al, Clin Infect Dis 2003; 37:1073; S Nepalia et al, J Assoc Physicians India 2006; 54:458; E Zerem and R Jusufovic Surg Endosc 2006; 20:1543).
111. Surgical excision is the only reliable means of cure. Reports have suggested that in nonresectable cases use of albendazole (400 mg bid) can stabilize and sometimes cure infection (P Craig, Curr Opin Infect Dis 2003; 16:437; O Lidove et al, Am J Med 2005; 118:195).
112. Initial therapy for patients with inflamed parenchymal cysticercosis should focus on symptomatic treatment with anti-seizure medication (LS Yancey et al, Curr Infect Dis Rep 2005; 7:39; AH del Brutto et al, Ann Intern Med 2006; 145:43). Patients with live parenchymal cysts who have seizures should be treated with albendazole together with steroids (dexamethasone 6 mg/d or prednisone 40-60 mg/d) and an anti-seizure medication (HH Garcia et al, N Engl J Med 2004; 350:249). Patients with subarachnoid cysts or giant cysts in the fissures should be treated for at least 30d (JV Proaño et al, N Engl J Med 2001; 345:879). Surgical intervention (especially neuroendoscopic removal) or CSF diversion followed by albendazole and steroids is indicated for obstructive hydocephalus. Arachnoiditis, vasculitis or cerebral edema is treated with prednisone 60 mg/d or dexamethasone 4-6 mg/d together with albendazole or praziquantel (AC White, Jr., Annu Rev Med 2000; 51:187). Any cysticercocidal drug may cause irreparable damage when used to treat ocular or spinal cysts, even when corticosteroids are used. An ophthalmic exam should always precede treatment to rule out intraocular cysts.

Infection		Drug	Adult dosage	Pediatric dosage
TRICHOSTRONGYLUS infection				
Drug of choice:		Pyrantel pamoate[7,13]*	11 mg/kg base PO once (max. 1 g)	11 mg/kg PO once (max. 1 g)
Alternative:		Mebendazole[7]	100 mg PO bid x 3d	100 mg PO bid x 3d
	OR	Albendazole[7,12]	400 mg PO once	400 mg PO once
TRICHURIASIS (*Trichuris trichiura,* whipworm)				
Drug of choice:		Mebendazole	100 mg PO bid x 3d or 500 mg once	100 mg PO bid x 3d or 500 mg once
Alternative:		Albendazole[7,12]	400 mg PO x 3d	400 mg PO x 3d
	OR	Ivermectin[7,16]	200 mcg/kg PO daily x 3d	200 mcg/kg/d PO x 3d
TRYPANOSOMIASIS[118]				
T. cruzi (American trypanosomiasis, Chagas' disease)				
Drug of choice:		Nifurtimox*	8-10 mg/kg/d PO in 3-4 doses x 90-120d	1-10yrs: 15-20 mg/kg/d PO in 4 doses x 90-120d 11-16yrs: 12.5-15 mg/kg/d in 4 doses x 90-120d
	OR	Benznidazole[119]*	5-7 mg/kg/d PO in 2 doses x 30-90d	≤12yrs: 10 mg/kg/d PO in 2 doses x 30-90d >12 yrs: 5-7 mg/kg/d in 2 doses x 30-90d
T. brucei gambiense (West African trypanosomiasis, sleeping sickness)				
hemolymphatic stage				
Drug of choice:[120]		Pentamidine[7]	4 mg/kg/d IM x 7d	4 mg/kg/d IM x 7d
Alternative:		Suramin*	100-200 mg (test dose) IV, then 1 g IV on days 1,3,7,14 and 21	20 mg/kg on d 1,3,7,14 and 21
Late disease with CNS involvement				
Drug of Choice:		Eflornithine[121]*	400 mg/kg/d IV in 4 doses x 14d	400 mg/kg/d IV in 4 doses x 14d
	OR	Melarsoprol[122]	2.2 mg/kg/d IV x 10d	2.2 mg/kg/d IV x 10d
T. b. rhodesiense (East African trypanosomiasis, sleeping sickness)				
hemolymphatic stage				
Drug of choice:		Suramin*	100-200 mg (test dose) IV, then 1 g IV on days 1,3,7,14 and 21	20 mg/kg on d 1,3,7,14 and 21
Late disease with CNS involvement				
Drug of choice:		Melarsoprol[122]	2-3.6 mg/kg/d IV x 3d; after 7d 3.6 mg/kg/d x 3d; repeat again after 7d	2-3.6 mg/kg/d x 3d; after 7d 3.6 mg/kg/d x 3d; repeat again after 7d
VISCERAL LARVA MIGRANS[123] *(Toxocariasis)*				
Drug of choice:		Albendazole[7,12]	400 mg PO bid x 5d	400 mg PO bid x 5d
	OR	Mebendazole[7]	100-200 mg PO bid x 5d	100-200 mg PO bid x 5d
Whipworm, see TRICHURIASIS				
Wuchereria bancrofti, see FILARIASIS				

* Availability problems. See table on page 14.

113. To treat CNS toxoplasmosis in HIV-infected patients, some clinicians have used pyrimethamine 50-100 mg/d (after a loading dose of 200 mg) with sulfadiazine and, when sulfonamide sensitivity developed, have given clindamycin 1.8-2.4 g/d in divided doses instead of the sulfonamide. Treatment is usually given for at least 4-6 weeks. Atovaquone (1500 mg PO bid) plus pyrimethamine (200 mg loading dose, followed by 75 mg/d PO) for 6 weeks appears to be an effective alternative in sulfa-intolerant patients (K Chirgwin et al, Clin Infect Dis 2002; 34:1243). Atovaquone must be taken with a meal to enhance absorption. Treatment is followed by chronic suppression with lower dosage regimens of the same drugs. For primary prophylaxis in HIV patients with <100 x 10^6/L CD4 cells, either trimethoprim-sulfamethoxazole, pyrimethamine with dapsone, or atovaquone with or without pyrimethamine can be used. Primary or secondary prophylaxis may be discontinued when the CD4 count increases to >200 x 10^6/L for >3mos (MMWR Morb Mortal Wkly Rep 2004; 53 [RR15]:1). In ocular toxoplasmosis with macular involvement, corticosteroids are recommended in addition to antiparasitic therapy for an anti-inflammatory effect. In one randomized single-blind study, trimethoprim/sulfamethoxazole was reported to be as effective as pyrimethamine/sulfadiazine for treatment of ocular toxoplasmosis (M Soheilian et al, Ophthalmology 2005; 112:1876). Women who develop toxoplasmosis during the first trimester of pregnancy should be treated with spiramycin (3-4 g/d). After the first trimester, if there is no documented transmission to the fetus, spiramycin can be continued until term. If transmission has occurred *in utero*, therapy with pyrimethamine and sulfadiazine should be started (JG Montoya and O Liesenfeld, Lancet 2004; 363:1965). Pyrimethamine is a potential teratogen and should be used only after the first trimester.
114. Plus leucovorin 10-25 mg with each dose of pyrimethamine. Pyrimethamine should be taken with food to minimize gastrointestinal adverse effects.
115. Congenitally infected newborns should be treated with pyrimethamine every 2 or 3 days and a sulfonamide daily for about one year (JS Remington and G Desmonts in JS Remington and JO Klein, eds, *Infectious Disease of the Fetus and Newborn Infant,* 6th ed, Philadelphia:Saunders, 2006, page 1038).
116. Sulfadiazine should be taken on an empty stomach with adequate water.
117. Sexual partners should be treated simultaneously with same dosage. Metronidazole-resistant strains have been reported and can be treated with higher doses of metronidazole (2-4 g/d x 7-14d) or with tinidazole (MMWR Morb Mortal Wkly Rep 2006; 55 [RR11]:1).
118. MP Barrett et al, Lancet 2003; 362:1469. Treatment of chronic or indeterminate Chagas' disease with benznidazole has been associated with reduced progression and increased negative seroconversion (R Viotti et al, Ann Intern Med 2006; 144:724).
119. Benznidazole should be taken with meals to minimize gastrointestinal adverse effects. It is contraindicated during pregnancy.
120. Pentamidine and suramin have equal efficacy, but pentamidine is better tolerated.
121. Eflornithine is highly effective in *T.b. gambiense,* but not in *T.b. rhodesiense* infections. In one study of treatment of CNS disease due to *T.b. gambiense,* there were fewer serious complications with eflornithine than with melarsoprol (F Chappuis et al, Clin Infect Dis 2005; 41:748). Eflornithine is available in limited supply only from the WHO. It is contraindicated during pregnancy.
122. E Schmid et al, J Infect Dis 2005; 191:1922. Corticosteroids have been used to prevent arsenical encephalopathy (J Pepin et al, Trans R Soc Trop Med Hyg 1995; 89:92). Up to 20% of patients with *T.b.gambiense* fail to respond to melarsoprol (MP Barrett, Lancet 1999; 353:1113). In one study, a combination of low-dose melarsoprol (1.2 mg/kg/d IV) and nifurtimox (7.5 mg/kg PO bid) x 10d was more effective than standard-dose melarsoprol alone (S Bisser et al, J Infect Dis 2007; 195:322).
123. Optimum duration of therapy is not known; some Medical Letter consultants would treat x 20d. For severe symptoms or eye involvement, corticosteroids can be used in addition (D Despommier, Clin Microbiol Rev 2003; 16:265).

SAFETY OF ANTIPARASITIC DRUGS IN PREGNANCY

Drug	Toxicity in Pregnancy	Recommendations
Albendazole *(Albenza)*	Teratogenic and embryotoxic in animals	Caution*
Amphotericin B (*Fungizone*, and others)	None known	Caution*
Amphotericin B liposomal *(AmBisome)*	None known	Caution*
Artemether/lumefantrine *(Coartem, Riamet)*[1]	Embryocidal and teratogenic in animals	Caution*
Artesunate[1]	Embryocidal and teratogenic in animals	Caution*
Atovaquone *(Mepron)*	Maternal and fetal toxicity in animals	Caution*
Atovaquone/proguanil *(Malarone)*[2]	Maternal and fetal toxicity in animals	Caution*
Azithromycin (*Zithromax*, and others)	None known	Probably safe
Benznidazole *(Rochagan)*	Unknown	Contraindicated
Chloroquine (*Aralen*, and others)	None known with doses recommended for malaria prophylaxis	Probably safe in low doses
Clarithromycin (*Biaxin*, and others)	Teratogenic in animals	Contraindicated
Clindamycin (*Cleocin*, and others)	None known	Caution*
Crotamiton *(Eurax)*	Unknown	Caution*
Dapsone	None known; carcinogenic in rats and mice; hemolytic reactions in neonates	Caution*, especially at term
Diethylcarbamazine (DEC; *Hetrazan*)	Not known; abortifacient in one study in rabbits	Contraindicated
Diloxanide *(Furamide)*	Safety not established	Caution*
Doxycycline (*Vibramycin*, and others)	Tooth discoloration and dysplasia, inhibition of bone growth in fetus; hepatic toxicity and azotemia with IV use in pregnant patients with decreased renal function or with overdosage	Contraindicated
Eflornithine *(Ornidyl)*	Embryocidal in animals	Contraindicated
Fluconazole (*Diflucan*, and others)	Teratogenic	Contraindicated for high dose; caution* for single dose
Flucytosine *(Ancoban)*	Teratogenic in rats	Contraindicated
Furazolidone *(Furoxone)*	None known; carcinogenic in rodents; hemolysis with G-6-PD deficiency in newborn	Caution*; contraindicated at term
Hydroxychloroquine *(Plaquenil)*	None known with doses recommended for malaria prophylaxis	Probably safe in low doses
Itraconazole (*Sporanox*, and others)	Teratogenic and embryotoxic in rats	Caution*
Iodoquinol (*Yodoxin*, and others)	Unknown	Caution*
Ivermectin *(Stromectol)*	Teratogenic in animals	Contraindicated
Ketoconazole (*Nizoral*, and others)	Teratogenic and embryotoxic in rats	Contraindicated; topical probably safe
Lindane	Absorbed from the skin; potential CNS toxicity in fetus	Contraindicated
Malathion, topical *(Ovide)*	None known	Probably safe
Mebendazole *(Vermox)*	Teratogenic and embryotoxic in rats	Caution*
Mefloquine *(Lariam)*[3]	Teratogenic in animals	Caution*
Meglumine *(Glucantine)*	Not known	Caution*
Metronidazole (*Flagyl*, and others)	None known – carcinogenic in rats and mice	Caution*
Miconazole *(Monistat i.v.)*	None known	Caution*
Miltefosine *(Impavido)*	Teratogenic in rats and induces abortions in animals	Contraindicated; effective contraception must be used for 2 months after the last dose
Niclosamide *(Niclocide)*	Not absorbed; no known toxicity in fetus	Probably safe
Nitazoxanide *(Alinia)*	None known	Caution*
Oxamniquine *(Vansil)*	Embryocidal in animals	Contraindicated
Paromomycin *(Humatin)*	Poorly absorbed; toxicity in fetus unknown	Oral capsules probably safe
Pentamidine (*Pentam 300*, *NebuPent*, and others)	Safety not established	Caution*
Permethrin (*Nix,* and others)	Poorly absorbed; no known toxicity in fetus	Probably safe
Praziquantel *(Biltricide)*	Not known	Probably safe
Primaquine	Hemolysis in G-6-PD deficiency	Contraindicated

Pyrantel pamoate (*Antiminth*, and others)	Absorbed in small amounts; no known toxicity in fetus	Probably safe
Pyrethrins and piperonyl butoxide (*RID*, and others)	Poorly absorbed; no known toxicity in fetus	Probably safe
Pyrimethamine *(Daraprim)*[4]	Teratogenic in animals	Caution*; contraindicated during 1st trimester
Quinacrine *(Atabrine)*	Safety not established	Caution*
Quinidine	Large doses can cause abortion	Probably safe
Quinine *(Qualaquin)*	Large doses can cause abortion; auditory nerve hypoplasia, deafness in fetus; visual changes, limb anomalies, visceral defects also reported	Caution*
Sodium stibogluconate *(Pentostam)*	Not known	Caution*
Sulfonamides	Teratogenic in some animal studies; hemolysis in newborn with G-6-PD deficiency; increased risk of kernicterus in newborn	Caution*; contraindicated at term
Suramin sodium *(Germanin)*	Teratogenic in mice	Caution*
Tetracycline (*Sumycin*, and others)	Tooth discoloration and dysplasia, inhibition of bone growth in fetus; hepatic toxicity and azotemia with IV use in pregnant patients with decreased renal function or with overdosage	Contraindicated
Tinidazole *(Tindamax)*	Increased fetal mortality in rats	Caution*
Trimethoprim (*Proloprim*, and others)	Folate antagonism; teratogenic in rats	Caution*
Trimethoprim-sulfamethoxazole (*Bactrim*, and others)	Same as sulfonamides and trimethoprim	Caution*; contraindicated at term

*Use only for strong clinical indication in absence of suitable alternative.
1. See also footnote 76 on page 7.
2. See also footnote 68 on page 6.
3. See also footnotes 74 on page 7 and 90 on page 8.
4. See also footnote 113 on page 11.

Brand name and manufacturer table begins on next page.

MANUFACTURERS OF DRUGS USED TO TREAT PARASITIC INFECTIONS

albendazole – *Albenza* (GlaxoSmithKline)
Albenza (GlaxoSmithKline) – albendazole
Alinia (Romark) – nitazoxanide
AmBisome (Gilead) – amphotericin B, liposomal
amphotericin B – *Fungizone* (Apothecon), others
amphotericin B, liposomal – *AmBisome* (Gilead)
Ancobon (Valeant) – flucytosine
§ *Antiminth* (Pfizer) – pyrantel pamoate
• *Aralen* (Sanofi) – chloroquine HCl and chloroquine phosphate
§ artemether – *Artenam* (Arenco, Belgium)
§ artemether/lumefantrine – *Coartem, Riamet* (Novartis)
§ *Artenam* (Arenco, Belgium) – artemether
§ artesunate – (Guilin No. 1 Factory, People's Republic of China)
atovaquone – *Mepron* (GlaxoSmithKline)
atovaquone/proguanil – *Malarone* (GlaxoSmithKline)
azithromycin – *Zithromax* (Pfizer), others
• *Bactrim* (Roche) – TMP/Sulfa
§ benznidazole – *Rochagan* (Brazil)
• *Biaxin* (Abbott) – clarithromycin
§ *Biltricide* (Bayer) – praziquantel
† bithionol – *Bitin* (Tanabe, Japan)
† *Bitin* (Tanabe, Japan) – bithionol
§ *Brolene* (Aventis, Canada) – propamidine isethionate
chloroquine HCl and chloroquine phosphate – *Aralen* (Sanofi), others
clarithromycin – *Biaxin* (Abbott), others
• *Cleocin* (Pfizer) – clindamycin
clindamycin – *Cleocin* (Pfizer), others
Coartem (Novartis) – artemether/lumefantrine
crotamiton – *Eurax* (Westwood-Squibb)
dapsone – (Jacobus)
§ *Daraprim* (GlaxoSmithKline) – pyrimethamine USP
† diethylcarbamazine citrate (DEC) – *Hetrazan*
• *Diflucan* (Pfizer) – fluconazole
§ diloxanide furoate – *Furamide* (Boots, United Kingdom)
doxycycline – *Vibramycin* (Pfizer), others
eflornithine (Difluoromethylornithine, DFMO) – *Ornidyl* (Aventis)
§ *Egaten* (Novartis) – triclabendazole
Elimite (Allergan) – permethrin
Ergamisol (Janssen) – levamisole
Eurax (Westwood-Squibb) – crotamiton
• *Flagyl* (Pfizer) – metronidazole
§ *Flisint* (Sanofi-Aventis, France) – fumagillin
fluconazole – *Diflucan* (Pfizer), others
flucytosine – *Ancobon* (Valeant)
§ fumagillin – *Flisint* (Sanofi-Aventis, France)
• *Fungizone* (Apothecon) – amphotericin
§ *Furamide* (Boots, United Kingdom) – diloxanide furoate
§ furazolidone – *Furozone* (Roberts)
§ *Furozone* (Roberts) – furazolidone
† *Germanin* (Bayer, Germany) – suramin sodium
§ *Glucantime* (Aventis, France) – meglumine antimonate
† *Hetrazan* – diethylcarbamazine citrate (DEC)
Humatin (Monarch) – paromomycin
§ *Impavido* (Zentaris, Germany) – miltefosine
iodoquinol – *Yodoxin* (Glenwood), others
itraconazole – *Sporanox* (Janssen-Ortho), others
ivermectin – *Stromectol* (Merck)
ketoconazole – *Nizoral* (Janssen), others
† *Lampit* (Bayer, Germany) – nifurtimox
Lariam (Roche) – mefloquine
§ *Leshcutan* (Teva, Israel) – topical paromomycin
levamisole – *Ergamisol* (Janssen)
lumefantrine/artemether – *Coartem*, *Riamet* (Novartis)
Malarone (GlaxoSmithKline) – atovaquone/proguanil
malathion – *Ovide* (Medicis)
mebendazole – *Vermox* (McNeil), others
mefloquine – *Lariam* (Roche)
§ meglumine antimonate – *Glucantime* (Aventis, France)
† melarsoprol – *Mel-B*
† *Mel-B* – melarsoprol
Mepron (GlaxoSmithKline) – atovaquone
metronidazole – *Flagyl* (Pfizer), others
§ miconazole – *Monistat i.v.*
§ miltefosine – *Impavido* (Zentaris, Germany)
§ *Monistat i.v.* – miconazole
NebuPent (Fujisawa) – pentamidine isethionate
Neutrexin (US Bioscience) – trimetrexate
§ niclosamide – *Yomesan* (Bayer, Germany)
† nifurtimox – *Lampit* (Bayer, Germany)
nitazoxanide – *Alinia* (Romark)
• *Nizoral* (Janssen) – ketoconazole
Nix (GlaxoSmithKline) – permethrin
§ ornidazole – *Tiberal* (Roche, France)
Ornidyl (Aventis) – eflornithine (Difluoromethylornithine, DFMO)
Ovide (Medicis) – malathion
§ oxamniquine – *Vansil* (Pfizer)
§ *Paludrine* (AstraZeneca, United Kingdom) – proguanil
paromomycin – *Humatin* (Monarch); *Leshcutan* (Teva, Israel; (topical formulation not available in US)
Pentam 300 (Fujisawa) – pentamidine isethionate
pentamidine isethionate – *Pentam 300* (Fujisawa), *NebuPent* (Fujisawa)
† *Pentostam* (GlaxoSmithKline, United Kingdom) – sodium stibogluconate
permethrin – *Nix* (GlaxoSmithKline), *Elimite* (Allergan)
§ praziquantel – *Biltricide* (Bayer)
primaquine phosphate USP
§ proguanil – *Paludrine* (AstraZeneca, United Kingdom)
proguanil/atovaquone – *Malarone* (GlaxoSmithKline)
§ propamidine isethionate – *Brolene* (Aventis, Canada)
§ pyrantel pamoate – *Antiminth* (Pfizer)
pyrethrins and piperonyl butoxide – *RID* (Pfizer), others
§ pyrimethamine USP – *Daraprim* (GlaxoSmithKline)
Qualaquin – quinine sulfate (Mutual Pharmaceutical Co/ AR Scientific)
* quinidine gluconate (Eli Lilly)
§ quinine dihydrochloride
quinine sulfate – *Qualaquin* (Mutual Pharmaceutical Co/ AR Scientific)
Riamet (Novartis) – artemether/lumefantrine
• *RID* (Pfizer) – pyrethrins and piperonyl butoxide
• *Rifadin* (Aventis) – rifampin
rifampin – *Rifadin* (Aventis), others
§ *Rochagan* (Brazil) – benznidazole
* *Rovamycine* (Aventis) – spiramycin
† sodium stibogluconate – *Pentostam* (GlaxoSmithKline, United Kingdom)
* spiramycin – *Rovamycine* (Aventis)
• *Sporanox* (Janssen-Ortho) – itraconazole
Stromectol (Merck) – ivermectin
sulfadiazine – (Eon)
† suramin sodium – *Germanin* (Bayer, Germany)
§ *Tiberal* (Roche, France) – ornidazole
Tindamax (Mission) – tinidazole
tinidazole – *Tindamax* (Mission)
TMP/Sulfa – *Bactrim* (Roche), others
§ triclabendazole – *Egaten* (Novartis)
trimetrexate – *Neutrexin* (US Bioscience)
§ *Vansil* (Pfizer) – oxamniquine
• *Vermox* (McNeil) – mebendazole
• *Vibramycin* (Pfizer) – doxycycline
• *Yodoxin* (Glenwood) – iodoquinol
§ *Yomesan* (Bayer, Germany) – niclosamide
• *Zithromax* (Pfizer) – azithromycin

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* Available in the US only from the manufacturer.
§ Not available in the US; may be available through a compounding pharmacy (see footnote 4).
† Available from the CDC Drug Service, Centers for Disease Control and Prevention, Atlanta, Georgia 30333; 404-639-3670 (evenings, weekends, or holidays: 770-488-7100).
• Also available generically.

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