1

2

Question #1

28-year-old F

- Recurrent crampy abdominal pain for several months
- Just returned home after living for two years in Tanzania
- Colonoscopy reveals small white papules
- Biopsy reveals an egg with eosinophilic granulomatous inflammation

What is the most likely diagnosis?

A. *Entamoeba histolytica*
B. *Ascaris lumbricoides*
C. *Wuchereria bancrofti*
D. *Schistosoma mansoni*
E. *Paragonimus westermani*

3

Major Helminth Pathogens

TREMATODES

Blood flukes
- *Schistosoma mansoni*
- *Schistosoma japonicum*
- *Schistosoma haematobium*

Liver flukes
- *Fasciola hepatica*
- *Clonorchis sinensis*
- *Opisthorchis viverrini*

Lung flukes
- *Paragonimus westermani*

Intestinal flukes
- *Fasciolopsis buski*
- *Metagonimus yokagawai*

CESTODES

Intestinal tapeworms
- *Taenia solium*
- *Taenia saginata*
- *Diphyllobothrium latum*
- *Hymenolepis nana*

Larval cysts
- *Taenia solium*
- *Echinococcus granulosus*
- *Echinococcus multilocularis*

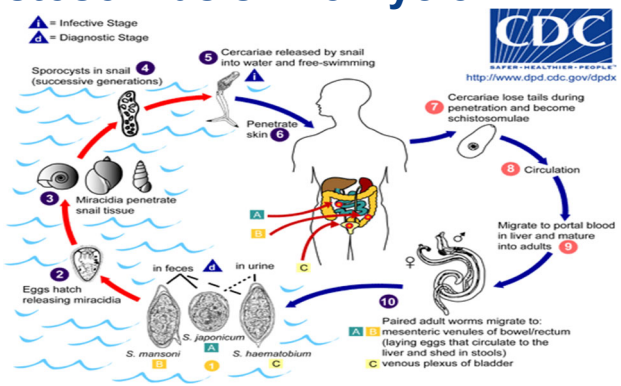
NEMATODES

Intestinal
- *Ascaris lumbricoides*
- *Ancylostoma duodenale*
- *Necator americanus*
- *Trichuris trichiura*
- *Strongyloides stercoralis*
- *Paracapillaria philippinensis*
- *Enterobius vermicularis*

Tissue Invasive
- *Wuchereria bancrofti*
- *Brugia malayi*
- *Onchocerca volvulus*
- *Loa loa*
- *Trichinella spiralis*
- *Angiostrongylus cantonensis*
- *Anisakis simplex*
- *Toxocara canis/cati*
- *Baylisascaris procyonis*
- *Gnathostoma spinigerum*
- *Dracunculus medinensis*

4

Schistosomiasis Life Cycle



5

Acute Schistosomiasis

Cercarial dermatitis (Swimmer's itch)

- Urticarial plaques and pruritic papules
- Occurs upon re-exposure to cercariae penetrating skin in a sensitized individual
- Symptoms develop minutes to days after water exposure
- Can occur with human or avian schistosomes

Katayama fever

- Fever, myalgias, abdominal pain, headache, diarrhea, urticaria
- Occurs in previously unexposed hosts
- Symptoms typically start 3 - 8 weeks after water exposure
- Eosinophilia, elevated AST and alkaline phosphatase
- No reliable way to confirm diagnosis acutely as serology and stool O/P frequently negative

6

Chronic Schistosomiasis

Schistosoma species

- *S. mansoni (Sm)*
- *S. japonicum (Sj)*
- *S. intercalatum (Si)*
- *S. mekongi (Smk)*
- *S. haematobium (Sh)*
- *S. haematobium/S. bovis hybrid (Sh/b)*

From Senegal, outbreak 2013 in Corsica, France

Intestinal and hepatosplenic disease (**S. mansoni +** Sj, Si, Smk, Sh/b)

- Granulomatous colitis
- Portal hypertension

Genitourinary disease (S. haematobium + Sh/b)

- Granulomatous cystitis
- Bladder fibrosis and cancer
- Obstructive uropathy

Pulmonary Disease (Sm, Sh, Sj)

CNS disease

- CNS disease (eggs to brain/spinal cord, esp *S. japonicum*)

7

Schistosomiasis

Chronic genital disease

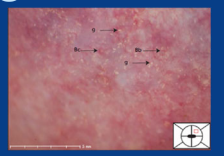
Increasingly recognized

Primarily due to *S. haematobium*

Women (vaginal and cervical lesions)
- Pelvic pain
- Dysmenorrhea
- Dyspareunia
- Post-coital bleeding
- Endometritis/salpingitis

Men
- Epididymitis
- Prostatitis

WHO Female Genital Schistosomiasis Pocket Atlas



Sand Grains

Sandy Yellow Patches

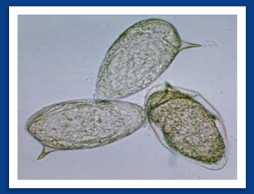
Abnormal Vessels

Rubbery Papules

8

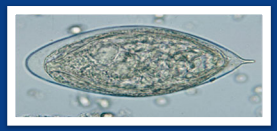
Schistosome Eggs

S. mansoni
(Lateral spine)



CDC DPDx image library

S. haematobium
(Terminal spine)



CDC DPDx image library

9

Question #2

PREVIEW QUESTION

IDBR INFECTIOUS DISEASE BOARD REVIEW 2025

A 25-year-old Peace Corps worker in Madagascar reports passing thin, white, flat tissue fragments in her stool. The microbiology lab reports the tissue fragments are proglottid segments of *Taenia solium*.

What is a long-term complication that can occur as a result of infection with the larval form of this parasite?

A. HTLV-1 infection
B. Bladder cancer
C. Appendicitis
D. Liver abscess
E. Seizures

10

Major Helminth Pathogens

TREMATODES

Blood flukes
- *Schistosoma mansoni*
- *Schistosoma japonicum*
- *Schistosoma haematobium*

Liver flukes
- *Fasciola hepatica*
- *Clonorchis sinensis*
- *Opisthorchis viverrini*

Lung flukes
- *Paragonimus westermani*

Intestinal flukes
- *Fasciolopsis buski*
- *Metagonimus yokagawai*

CESTODES

Intestinal tapeworms
- *Taenia solium*
- *Taenia saginata*
- *Diphyllobothrium latum*
- *Hymenolepis nana*

Larval cysts
- *Taenia solium*
- *Echinococcus granulosus*
- *Echinococcus multilocularis*

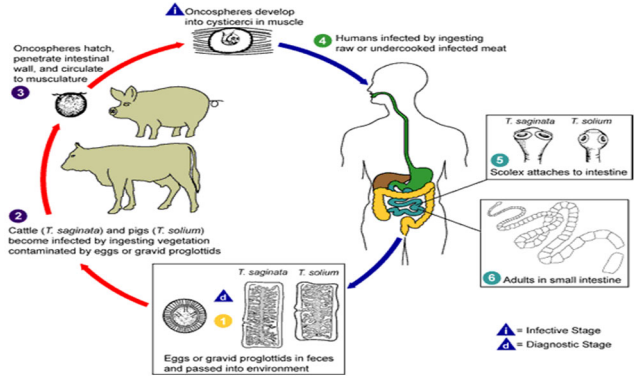
NEMATODES

Intestinal
- *Ascaris lumbricoides*
- *Ancylostoma duodenale*
- *Necator americanus*
- *Trichuris trichiura*
- *Strongyloides stercoralis*
- *Paracapillaria philippinensis*
- *Enterobius vermicularis*

Tissue Invasive
- *Wuchereria bancrofti*
- *Brugia malayi*
- *Onchocerca volvulus*
- *Loa loa*
- *Trichinella spiralis*
- *Angiostrongylus cantonensis*
- *Anisakis simplex*
- *Toxocara canis/cati*
- *Baylisascaris procyonis*
- *Gnathostoma spinigerum*
- *Dracunculus medinensis*

11

Taenia Life Cycle



12

Taenia Life Cycle

Taenia solium
- Tapeworm is acquired by eating larvae in pork
- Adult tapeworm causes few symptoms

Taenia saginatum
- Acquired by eating larvae in undercooked beef
- Causes few symptoms
- Can grow to 10 m

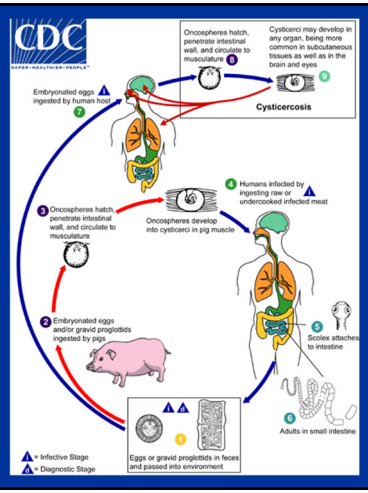
Diphyllobothrium latum *(can grow > 10 m)*
- Acquired by ingesting fish with larvae
- ***B12 deficiency in up to 40% of patients**

Dx: Eggs/proglottids in stool **Rx**: Praziquantel (not FDA-approved)

13

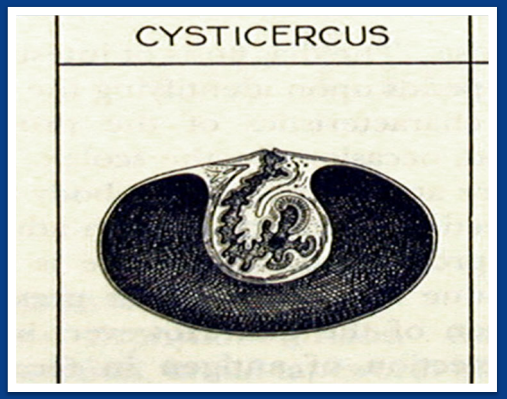
For some cestodes, humans can be infected by the larval stages, and this can cause severe pathology.

14



15

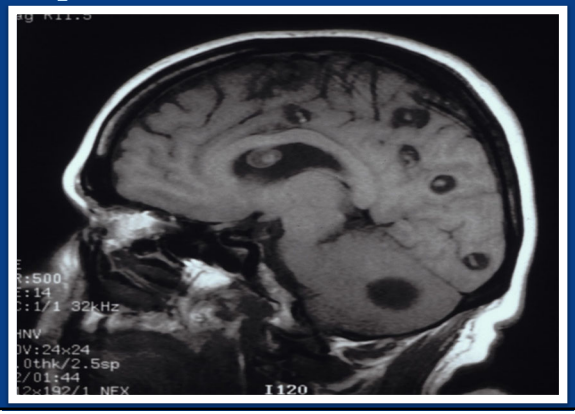
Cysticercus: a fluid filled bladder containing the invaginated head (scolex) of the larval form of a tapeworm.



Neva and Brown, Basic Clinical Parasitology 6th Edition

16

Neurocysticercosis



17

Neurocysticercosis

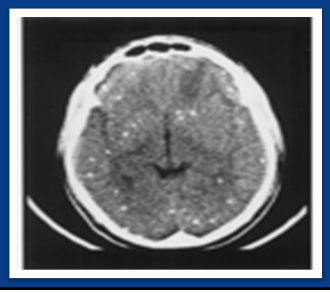
Can cause:

- Seizures
- Hydrocephalus
- Headaches
- Focal neurologic deficits

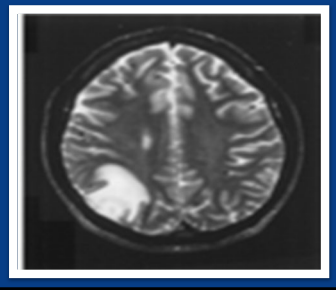
18

Neurocysticercosis

Multiple old calcifications



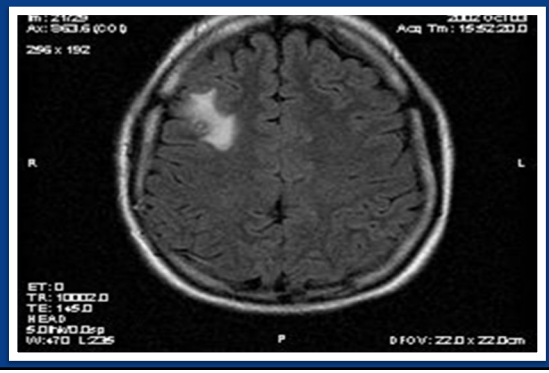
Perilesional edema – typically occurs around dying cysts and is a frequent finding on initial presentation of seizure or terrible headache.



19

Cysticercosis:

Single lesion disease is diagnostic challenge



20

Neurocysticercosis

Diagnosis:

Definitive = tissue biopsy, multiple cystic lesions each with scolex on imaging, retinal cysticercus on fundoscopy

Presumptive = suggestive lesions on imaging

Cysticercosis serology → supportive (sensitive if high burden of disease)

qPCR and antigen testing of CSF → sensitive for subarachnoid and intraventricular neurocysticercosis, and can be used to help gauge duration of treatment *(available at NIH, contact Dr. Elise O'Connell oconnellem@mail.nih.gov)*

Treatment: *Medical therapy decreases risk of future seizures, but has immediate risk of increasing seizures/brain inflammation*

If hydrocephalus or diffuse cerebral edema: initial treatment with steroids and/or surgery (not anti-parasitic Rx)

If no increased ICP: 1-2 viable cysts → albendazole for 1-2 viable cysts

> 2 viable cysts → albendazole + praziquantel

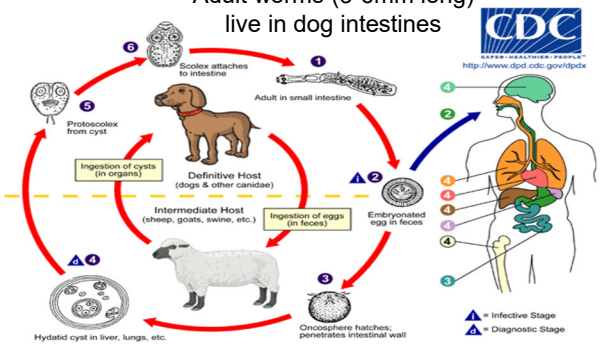
AND corticosteroids started before anti-parasitic therapy

****2017 IDSA Guidelines for Diagnosis and Treatment of Cysticercosis****

21

Echinococcus granulosus

Adult worms (3-6mm long) live in dog intestines



Humans = Accidental hosts

Infected by ingestion of eggs in dog feces

22

Echinococcus granulosus

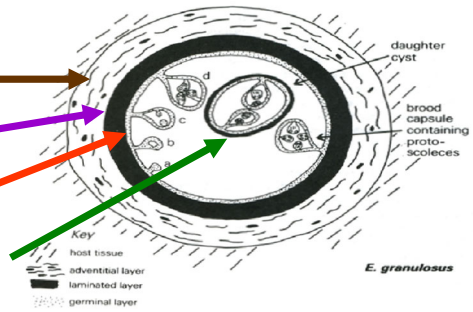
Hydatic cyst = "watery vessel"

Surrounding inflammatory response of fibrosis and chronic inflammation

Outer acellular laminated layer

Inner, nucleated germinal layer (PLURIPOTENTIAL TISSUE!)

Internal cystic fluid and daughter cysts



Echinococcus and Hydatid Disease 1995.

23

Echinococcus granulosus - Presentation

Most cysts (65%) in the liver
25% in the lung, usually in the right lower lobe
Rest occur practically everywhere else in the body

Common presentations

- Allergic symptoms/anaphylaxis due to cyst rupture after trauma
- Cholangitis and biliary obstruction due to rupture into biliary tree
- Peritonitis b/c intraperitoneal rupture
- Pneumonia symptoms due to rupture into the bronchial tree

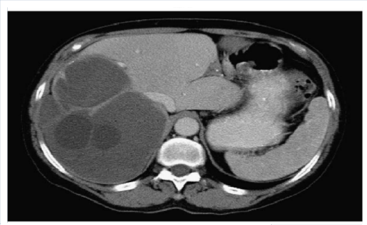
Uncommon presentations

- Bone fracture due to bone cysts
- Mechanical rupture of heart with pericardial tampanode
- Hematuria or flank pain due to renal cysts

24

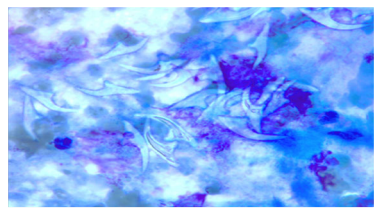
Echinococcus granulosus - Diagnosis

Radiology



Clinical Radiology (2006) 61, 737–748

Microscopy



Serology

IgG ELISA about 85% sensitive for liver cysts of E. granulosus

Only 50% sensitive in cases of single pulmonary cyst

25

Echinococcus granulosus - Treatment

Reasons for not spilling cyst contents

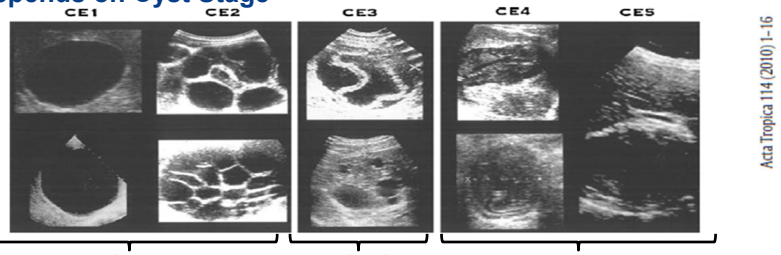
1. Anaphylaxis may occur
2. Spilled protoscoleces can reestablish infection

Typically treat with albendazole for several days before surgery or PAIR (usually 3d-1wk before, and 1-3 months after)

26

Cystic Echinococcus Treatment:

Depends on Cyst Stage



Acta Tropica 114 (2010) 1–16

ACTIVE		TRANSITIONAL	INACTIVE
Unilocular Simply cyst Cyst wall visible	Multivesicular Multiseptated cysts	Anechoic content Detached membrane Solid matrix	Heterogenous, hypoechoic or hyperechoic No daughter cysts CE5 with thick calfied wall
---ALB +/- PAIR or Surgery---	---SURGERY---	---SURGERY--- ---PAIR if no solid matrix---	---NO TREATMENT---

27

Major Helminth Pathogens

TREMATODES

Blood flukes
- *Schistosoma mansoni*
- *Schistosoma japonicum*
- *Schistosoma haematobium*

Liver flukes
- *Fasciola hepatica*
- *Clonorchis sinensis*
- *Opisthorchis viverrini*

Lung flukes
- *Paragonimus westermani*

Intestinal flukes
- *Fasciolopsis buski*
- *Metagonimus yokagawai*

CESTODES

Intestinal tapeworms
- *Taenia solium*
- *Taenia saginata*
- *Diphyllobothrium latum*
- *Hymenolepis nana*

Larval cysts
- *Taenia solium*
- *Echinococcus granulosus*
- *Echinococcus multilocularis*

NEMATODES

Intestinal
- *Ascaris lumbricoides*
- *Ancylostoma duodenale*
- *Necator americanus*
- *Trichuris trichiura*
- *Strongyloides stercoralis*
- *Paracapillaria philippinensis*
- *Enterobius vermicularis*

Tissue Invasive
- *Wuchereria bancrofti*
- *Brugia malayi*
- *Onchocerca volvulus*
- *Loa loa*
- *Trichinella spiralis*
- *Angiostrongylus cantonensis*
- *Anisakis simplex*
- *Toxocara canis/cati*
- *Baylisascaris procyonis*
- *Gnathostoma spinigerum*
- *Dracunculus medinensis*

28

Intestinal Helminths - Lifecycles

Strongyloides and Hookworms

SKIN → LUNGS → GUT

Ascaris

INTESTINE → LIVER → LUNGS → INTESTINE

29

Ascaris lumbricoides

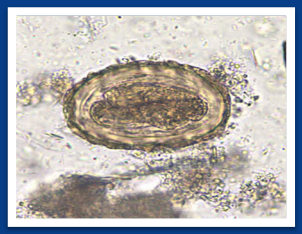
- Large numbers of worms can cause abdominal distention and pain or intestinal obstruction
- Can cause "Loeffler's syndrome" - an eosinophilic pneumonitis with transient pulmonary infiltrates
- Cholangitis and/or pancreatitis b/c aberrant migration

30

Ascaris lumbricoides - Diagnosis

Will not find eggs until 2-3 months after pulmonary symptoms occur
After 2-3 months, easy to find eggs since females make 200,000/day

Unfertilized



Fertilized

Rx: albendazole or mebendazole

CDC DPDx

31

Hookworms

Ancylostoma duodenale and Necator americanus

also Ancylostoma ceylanicum (zoonotic from dogs/cats in Asia)

- MAJOR cause of ANEMIA and protein loss (b/c plasma loss)
- Pneumonitis associated with wheezing, dsypnea, dry cough (usually, a few days to weeks after infection)
- Urticarial rash
- Mild abdominal pain

If sensitized → papulovesicular dermatitis at entry site "ground itch"

If worms migrate laterally → **cutaneous larvae migrans**
(especially dog and cat hookworms, as late as 2-8 wks after exposure to *A. braziliense*)

Hookworms are still endemic in the U.S. → 35% of individuals from a rural community in Alabama had *N. americanus* in their stool samples

Am. J. Trop. Med. Hyg., 97(5), 2017, pp. 1623–1628

32

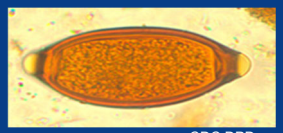
Trichuris trichiura (Whipworm)

4cm long nematode

Life cycle: Fecal-oral

In heavy infections:
- Loose and frequent stools
- Tenesmus
- Occ blood to frank blood
- In heavily infected children:
  rectal prolapse

Dx: eggs are football shaped with two polar plugs



CDC DPDx

33

Question #3

A 25-year-old F from rural Peru presents with shortness of breath, bilateral interstitial infiltrates, fever, loose stools, hypotension, and *E. coli* bacteremia. She has received > 4weeks of high dose corticosteroids and cyclophosphamide for a recent diagnosis of lupus nephritis.

Which of the following anthelmintic agents should be included in her treatment regimen?

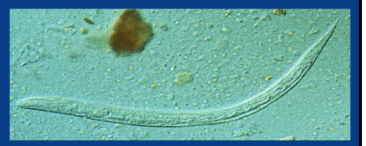
A. *Albendazole*
B. *Ivermectin*
C. *Praziquantel*
D. *Pyrantel pamoate*
E. *Diethylcarbamazine*

34

Strongyloides stercoralis

(Can complete lifecycle in host!)

Usual manifestations
GI: Mild abdominal/epigrastric pain
Pulm: Wheezing, transient infiltrates
Skin: Urticarial rashes, larva currens



Hyperinfection syndrome
→ Immunocompromised state
steroids, TNF-inhibitors, HTLV-1, malignancy, malnutrition….NOT HIV
→ Large burden of parasites

GI: Nausea, vomiting, abdominal pain, diarrhea, intestinal erosions
b/c millions of larvae in intestinal mucosa

Pulmonary: Diffuse infiltrates, wheezing, dyspnea, cough

Systemic: Fever and hypotension due to gram negative sepsis

-- Often do not see eosinophilia in hyperinfection --

35

Strongyloides stercoralis

Diagnosis:
- Stool o/p (sensitivity is low - 30-60%)
- Serology

Treatment of choice: Ivermectin

Prevention in patients from endemic countries who are about to be immunosuppressed
- Empirically treat or check serology and treat if positive

36

Ivermectin

Activates nematode glutamate-gated chloride channels causing muscle paralysis

Drug of choice
- Strongyloides
- Onchocerca volvulus (microfilaricidal only)
- Also has activity against Ascaris, whipworm, cutaneous larva migrans, gnathostomiasis AND ectoparasites such as scabies and lice

Image created with Google Imagen3

ADVERSE EFFECTS
- Altered mental status in 13-year-old boy given standard dose for scabies due to a mutation in ABCB1 (aka P glycoprotein 1 and MDR1) *NEJM 2020; 383:787-789*
- Reports of seizures, ataxia, and confusion after ingestion of large veterinary doses *NEJM 2021; 385:2197-2198*

37

Question #4

A 32-year-old M from Cameroon reports intermittently experiencing a worm crawling across his eye.

Which of the following tests can be used to confirm the most likely diagnosis?

A. *Brain MRI scan*
B. *Midnight blood draw*
C. *Noon blood draw*
D. *Skin snip*
E. *Scrotal ultrasound*

38

Major Helminth Pathogens

TREMATODES

Blood flukes
- *Schistosoma mansoni*
- *Schistosoma japonicum*
- *Schistosoma haematobium*

Liver flukes
- *Fasciola hepatica*
- *Clonorchis sinensis*
- *Opisthorchis viverrini*

Lung flukes
- *Paragonimus westermani*

Intestinal flukes
- *Fasciolopsis buski*
- *Metagonimus yokagawai*

CESTODES

Intestinal tapeworms
- *Taenia solium*
- *Taenia saginata*
- *Diphyllobothrium latum*
- *Hymenolepis nana*

Larval cysts
- *Taenia solium*
- *Echinococcus granulosus*
- *Echinococcus multilocularis*

NEMATODES

Intestinal
- *Ascaris lumbricoides*
- *Ancylostoma duodenale*
- *Necator americanus*
- *Trichuris trichiura*
- *Strongyloides stercoralis*
- *Paracapillaria philippinensis*
- *Enterobius vermicularis*

Tissue Invasive
- *Wuchereria bancrofti*
- *Brugia malayi*
- *Onchocerca volvulus*
- *Loa loa*
- *Trichinella spiralis*
- *Angiostrongylus cantonensis*
- *Anisakis simplex*
- *Toxocara canis/cati*
- *Baylisascaris procyonis*
- *Gnathostoma spinigerum*
- *Dracunculus medinensis*

39

Filariae:

Tissue-invasive, thread-like nematodes, transmitted by arthropod vectors

	Adults	Microfilariae
Wuchereria bancrofti *Brugia malayi* (lymphatic filariasis) --mosquitoes--	lymphatics	blood (night)
Loa loa (eyeworm) --Chrysops flies--	SQ tissues (moving)	blood (day)
Onchocerciasis (river blindness) --blackflies--	SQ tissues (nodules)	skin

40

Treatment of Filariasis

	Treatment	Avoid
Lymphatic filariasis	**DEC**	**---**
Loa Loa	**DEC**	**DEC and Ivermectin if high microfilaria level**
Onchocerciasis	**Ivermectin**	**DEC**

ADVERSE EFFECTS
Loa with high microfilaremia → encephalopathy and death
Onchocerciasis → severe skin inflammation and blindness

41

W. bancrofti and B. malayi



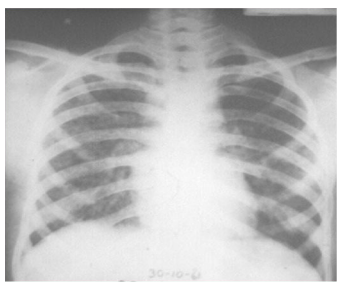
- Asymptomatic microfilaremia
- Lymphangitis
  - Retrograde (filarial lymphangitis)
  - Bacterial skin/soft tissue infections (dermatolymphangioadenitis)
- Lymphatic dysfunction
  - Lymphedema, elephantiasis, hydrocele, chyluria

42

Tropical Pulmonary Eosinophilia

- Paroxysmal nocturnal asthma
- Pulmonary infiltrates
- Peripheral blood eosinophilia ($>3{,}000/mm^3$)
- Elevated serum IgE
- Rapid response to anti-filarial therapy

Likely due to excessive immune response to microfilariae in lung vasculature



43

Lymphatic filariasis: Diagnosis

Definitive diagnosis
- Identification of microfilariae in nighttime blood
- Detection of circulating antigen in blood (only Wb)
- Identification of adult worm (by tissue biopsy or ultrasound "filaria dance sign")

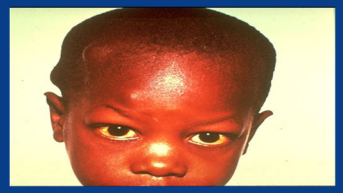
Presumptive diagnosis
- Compatible clinical picture + positive antifilarial antibodies

Treatment
- DEC, doxycycline
- NOTE: Triple drug single dose therapy (DEC/albendazole/ivermectin) is now recommended by W.H.O. for mass drug administration eradication campaigns in areas that are NOT co-endemic for Loa loa or Onchocerca

44

Manifestations of Onchocerciasis

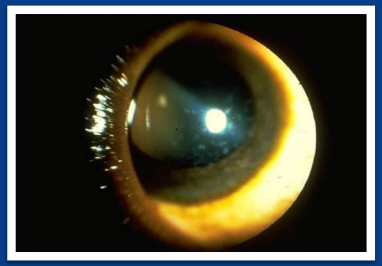
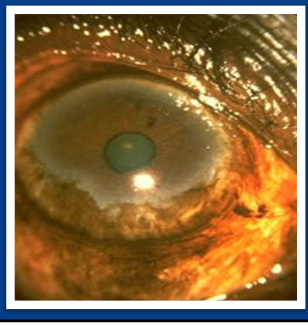
Skin: Nodules, pruritus, rash, depigmentation, lichenification




45

Manifestations of Onchocerciasis

Eye: Punctate keratitis, sclerosing keratitis, chorioretinitis

46

Onchocerciasis

Diagnosis

- Serology
  - Anti-filarial
  - Onchocerca-specific
- Parasitologic: skin snips, nodulectomy

Treatment

Ivermectin

Moxidectin (FDA approved in 2018…has much longer half-life)

→ Both are primarily microfilaricidal

→ Therefore, need repeated treatments for many years

(Alternative: **doxycycline** for 6 weeks, which kills endosymbiotic *Wolbachia* bacteria, kills adult worms)

47

Loiasis: Clinical Manifestations

- Asymptomatic microfilaremia
- Non-specific symptoms
  - Fatigue, urticaria, arthralgias, myalgias
- Calabar swellings
- Eyeworm
- End organ complications (rare)
  - Endomyocardial fibrosis, encephalopathy, renal failure

48

Calabar Swelling

49

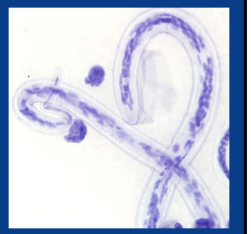
Loiasis: Diagnosis

Definitive diagnosis

- Identification of adult worm in subconjunctiva
- Detection of Loa microfilaria in **noon blood**

Presumptive diagnosis

- Compatible clinical picture + positive antifilarial antibodies



CDC DpDx

50

Possible Question Hints

Freshwater exposure + eosinophilia → Schistosomiasis
Crab/crayfish + pulmonary sxs + eosinophilia → Paragonimus
Cysticercosis → ANY food contaminated with tapeworm eggs
Allergic symptoms after trauma → Echinococcus
Itchy feet return to tropics → ground itch due to hookworms
Gram- sepsis after corticosteroids or TNF inhibitor → Strongyloides hyperinfection
Subcutaneous nodules → Onchocerca volvulus
Blood microfilaria night → lymphatic filariasis (day = Loa loa, skin = Ov)
Muscle pain + eosinophilia → Trichinella
Eosinophilic meningitis → Angiostrongylus
Abdominal pain after sushi → Anisakis
Eosinophilia + F + ↑ AST/ALT in child → visceral larva migrans

51

Good Luck!

Ed Mitre
edwardmitre@gmail.com

52