Helminthic infections

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Helminths

- Worm is classified as a parasite
- Contaminate food, water, air, feces, pets, wild animals, toilet seats and door handles

Prevention:
- Frequent hand washing
- Frequent cleaning of bathrooms and kitchens
- Thorough cooking of beef, pork, sausage, and bear meat.
Common helminths

- Roundworm
  - Hatch/live in intestines
- Symptoms
  - fatigue,
  - Weight loss
  - Irritability
  - Poor appetite
  - Abdominal pain
  - Diarrhea
- Untreated
  - Anemia
  - malnutrition
  - Untreated
  - Anemia
  - malnutrition
Common helminths

- **Trichina spiralis** (trichinosis)
  - Ingested via undercooked pork, sausage, or bear meat
  - Spread throughout bloodstream and lymphatic system
  - Symptoms
    - Vomiting
    - Diarrhea
    - Muscle cramps
  - Untreated
    - Penetration of muscles, heart, and brain
    - Death
Common helminths

- **Tapeworms**
  - Ingested via undercooked beef
  - Live in intestines
  - **Symptoms**
    - Usually absent
    - May include abdominal pain, fatigue, weight loss, diarrhea
Infection vs. disease

- Successful parasites live in, but do not kill their hosts
- Protozoa multiply within hosts
  - Expression of disease depends on host factors
- Helminths do not multiply within hosts
  - Severity of disease depends on parasite burden and immunologic response to parasites
Parasite modes of entry

- Ingestion
- Arthropod bites
- Penetration of intact skin or mucous membranes
Spread and tropisms

- Some parasites must migrate to certain locations within the host in order to complete their life cycle.
- Non-human parasites, in humans, often fail to migrate properly and become “dead-end infections”
Mechanisms for evading the host response

- **antigenic variation** - *trypanosomes*
- **intracellular infection** - *plasmodia*
- **encystation*** - *amoebae, cestodes*
- **camouflage** - *schistosomes*

* “cyst” has multiple meanings
Tissue damage and host response

- direct destruction of tissue
- hypersensitivity reactions
- eosinophilia
  - occurs with helminths, not protozoa
  - results from tissue migration
Classification of helminths

Nematodes (roundworms)
Platyhelminthes (flatworms)
Trematodes (“flukes”)
Cestodes (“tapeworms”)

Helminth forms

- Egg
- Larva
- Cyst
- Adults
Helminthic diseases

- Intestinal
  - Others
  - Strongyloides

- Invasive
  - Trichinosis
  - Filaria
  - Schistosomiasis

- roundworms
  - (autoinfection cycle)
    - (muscle pain, uncooked carnivores)
      - (worms in lymphatics or under skin)

- flukes
  - Cysticercosis
  - Echinococcus

- tapeworms
  - (cysts in brain, seizures)
    - (massive cysts in liver or lung)
Pinworm transmission

- Embryonated eggs are on clothes, bedding, bathroom fixtures or dust.
- Embryonated eggs are ingested (fingersucking is considered a source of infection).
- Reinfection occurs by direct anus to mouth transfer, with eggs found under fingernails of children who have scratched the anal area.
Pinworm lifecycle

1. Adult males and females inhabit ileocecal.
2. Female migrates out of anus and deposits eggs in perianal region then dies.
3. Eggs hatch within a few hours and larvae return to large intestine via anus (retroinfection), crawl into genitourinary tract, or eggs are reingested by the host.
Clinical presentation and complications

- Frequently asymptomatic
- Most frequent symptom: nighttime perianal itching
- Also: abdominal pain, insomnia, restlessness, anorexia, diarrhea
- Less common: vaginitis, PID, dysuria, and UTI, leading to infertility
- Bacterial infections secondary to itching
Diagnosing Pinworms

- **Visual inspection**
  - With a flashlight, inspect the anal area during early morning hours while child is asleep

- **Cellophane tape sample**
  - Using a tongue depressor, apply the sticky side of a piece of tape to the perianal area and then to a glass slide, sticky side down. Commercial kits are available. The sample undergoes microscopic examination by a physician.
Prescription therapy

- **Mebendazole (Vermox):**
  - Adult / pediatric > 2yrs: 100mg x 1 dose
  - Repeat in 2 weeks if symptoms do not resolve
  - Indications: roundworm, pinworm, hookworm, trichinosis, some tapeworms
  - MOA: blocks glucose uptake by parasite until death ensues
  - Precautions:
    - Pregnancy (category C) - animal studies showed teratogenic effects
    - Breast feeding - excretion into breast milk is unknown
    - Hepatic disease (eliminated by liver)
    - Inflammatory bowel disease
Prescription Therapy

- **Alternative: Albendazole (Albenza)**
  - **Dosing**
    - Adult/peds >2 yrs: 400mg x 1 dose
    - May repeat in 3 weeks
  - **MOA:** same as mebendazole
  - **Precautions:**
    - Liver dysfunction or biliary tract disease
    - May cause bone marrow dysfunction
    - Pregnancy Cat. C – animal studies showed teratogenic effects
    - Breast feeding - not recommended due to lack of clear data
Non-rx therapy

- **Pyrantel**
  - Used in veterinary practice for pinworms, roundworms, and hookworms
  - **MOA:** depolarizing neuromuscular agent
  - Poorly absorbed; 50% excreted unchanged in feces
  - **Dosing:** Single dose of 11mg/kg for adults & peds
    - Max single dose = 1gm
    - Same dosing for children < 2yrs or <25#, but must first check with physician
    - 2nd dose may be required in 2 weeks
    - May be taken without regards to meals
  - **Side effects**
    - GI tract: N,V,D, abdominal cramps
    - Less common: headache, dizziness, drowsiness, rash, fever, weakness
Non-rx therapy

Pyrantel

Precautions/contraindications

- Hypersensitivity to the drug
- Pre-existing liver dysfunction or severe malnutrition
- Pregnancy category C – use only under direction of physician (animal studies have revealed no harmful effects)
- Breastfeeding – poorly absorbed → low concentrations in breast milk
- Children < 2 years of age or weighing <25#, use only under direction of physician
Intestinal nematodes

Larvae pass through lungs

Larvae penetrate through intact skin

Larvae enter bloodstream

Eggs ingested

Eggs

Eggs hatch from eggs

Adult worms in the intestine

trichiuris enterobius

strongyloides hookworm

ascaris
Strongyloides life cycle

- Adult worms in the intestine
- Eggs
- 1st stage larvae hatch from eggs
- Larvae penetrate through intact skin
- Larvae enter bloodstream
- Larvae pass through lungs
- Larvae molt twice to form filariform larvae (infectious)
- Autoinfection
Strongyloides - clinical features

- uncomplicated
  - GI upset
- autoinfection
- hyperinfection
  - rash
  - bronchospasm, CXR infiltrates
  - diarrhea
  - profound eosinophilia
  - recurrent Gram-negative bacteremia
Trichinella spiralis - life cycle

- “cycle of carnivorism” among hogs and rats
- Humans ingest encysted larvae in infected, undercooked pork
- Larvae exist in stomach and burrow into small intestinal mucosa
- Adult males and female reemerge and produce larvae which penetrate intestine and circulate in bloodstream
- Larvae enter skeletal muscle cells and encyst
Clinical features of trichinosis

- Most common sxs:
  - muscle pain and tenderness
  - fever +/- chills
  - edema (often periorbital)
- >10% eosinophilia (often ~50%)
- elevated CPK
- +/- chronic neurologic/myocardial sxs
- self-limited (2% mortality)
Treatment of trichinosis

- Antihelminthics (albendazole) to kill any intestinal adults
- Steroids to relieve inflammatory reactions
- Antipyretics
Life cycles of two types of filaria

<table>
<thead>
<tr>
<th>Arthropod vector</th>
<th>Adult worm pairs</th>
<th>Larvae (microfilariae)</th>
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<tbody>
<tr>
<td>Lymph-dwelling</td>
<td>mosquitoes</td>
<td>circulate</td>
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<td>(e.g. <em>Wuchereria bancroftii</em>)</td>
<td>peripheral lymphatics</td>
<td>in bloodstream</td>
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<tr>
<td>Skin-dwelling</td>
<td>biting flies</td>
<td>skin nodules</td>
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<td>or migratory</td>
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*O. volvulus* microfilaria in skin snip
O. volvulus nodule
Dirofilaria in a human lung
Role of endosymbiont *Wohlbachia* sp. in filariasis infection

- Rickettsia-like organisms required for fecundity and viability of filaria
- *Wohlbachia*-free worms produce less inflammation in tissue
- Implications for rx:
  - Ivermectin kills microfilaria only
  - Tetracycline may destroy adult worms
Geographic distribution of schistosomiasis

- S. mansoni
- S. hematobium
- S. japonicum
Schistosomiasis - life cycle

S.m.  S.h.  S.j.
“pipestem” fibrosis
Schistosomiasis - pathogenesis

- egg granuloma (type IV reaction) --> fibrosis
- morbidity ~ worm (egg) burden
- concomitant immunity to schistosomula
- adult worms: invisible to the immune system (survive for years)
Schistosomiasis - clinical features

- Cercarial dermatitis
- Intestinal schistosomiasis (granulomas --> polyps, protein loss, malabsorption, strictures)
- Hepatosplenic schistosomiasis (portal hypertension --> ascites, varices, splenomegaly, normal hepatic function)
- Urinary schistosomiasis (hematuria, chronic infection, obstruction)
- Other (cardiopulmonary, CNS, etc.)
Drug treatment of schistosomiasis

- Praziquantel increases permeability of adult parasite to Ca$^{++}$.
- Tetanospasm --> death
Control of Schistosomiasis

- **REDUCE CARRIERS**
  - mass rx program

- **ELIMINATE SNAILS**
  - molluscicides
  - destroy snail habitats
  - snail-eating fish

- **PREVENT WATER CONTAMINATION**
  - latrines, toilets
  - public health education

- **PREVENT HUMAN EXPOSURE**
  - water systems
Tapeworms

- **Definitive hosts**: harbor adult worms
- **Intermediate hosts**: harbor tissue cysts (containing worm heads)

Humans acquire infection two ways:
- ingestion of eggs from feces (to acquire tissue cysts)
- ingestion of tissue cysts in undercooked meat (to acquire a tapeworm)
Taeniasis

- Tapeworm
- Cysticercosis

Ingestion of undercooked pork → 
Poor sanitation → 
Poor hygiene → 
Tapeworm → 
Cysticercosis
Isolated cysticerci

Hydatid cyst
Echinococcosis

Cystic Hydatid Disease

- Contact with dogs
- Ingestion of entrails
- Ingestion of eggs in pastures
Treatment of cysticercosis and echinococcosis

- Antihelminthic therapy (e.g., albendazole, praziquantel)
- (Echinococcus only)
- Surgical removal
- Irrigation-evacuation of cysts
Comparison of *pork tapeworm* and *Echinococcus* life cycles

**Definitive hosts (adult tapeworms)**
- Dog

**Intermediate hosts (tissue cysts)**
- Sheep
- Pig

**Dead-end hosts**
- Human

**Hosts**
- Dog
- Sheep
- Pig
- Human