General Description

Schistosomiasis, also known as bilharziasis, is a human disease caused by a zoonotic parasite that infects a wide range of animals, including cattle, dogs, pigs, and rodents. It most commonly affects the health of school-age children.

Cause

- Blood flukes (trematode worms) of the genus Schistosoma; females 7-20 mm, males slightly smaller.
- Three major species of schistosomes, S. mansoni, S. haematobium, and the S. japonicum complex (including S. japonicum and S. mekongi) are distinguished by their snail vectors, location within the host vasculature, and egg morphology.

Transmission Mode

- The life cycle of trematode is completed in 2 different classes of hosts: definitive (ie., humans, domestic animals, wild animals) and intermediate (ie., freshwater snails; the amphibious snail Oncomelania for S. japonicum).
- Each species of schistosomes can infect only a single species of vector snail. A common factor in the population dynamics of many vector species is that they thrive on organic material and firm mud substrates. Usually they live in abundant aquatic vegetation that increases dissolved oxygen and provides food through green algae encrusting the submerged portion of the plants. Decayed vegetation also provides food and a suitable surface for depositing egg masses (Malek 1958). People become infected when larval forms of the parasite penetrate their skin during contact with infested water (see diagram at the end of article).
- Animal reservoirs maintain the infection in the environment, but if the snail population are kept under control steadily for years, the transmission chain will be cut.

Epidemiology of Schistosomiasis

- An estimated 700 million people worldwide may be at risk of infection as their agricultural, domestic and recreational activities expose them to infested water.
- Its high prevalence occurs among poor communities without access to safe drinking water and adequate sanitation.
- S. japonicum is limited to four countries: China, Thailand, Indonesia, Philippines ; in Indonesia, S. japonicum is limited to Lore Lindu, Central Sulawesi.
- It can be difficult to establish where transmission is likely to occur, based solely on the presence of suitable water bodies and intermediate host snails. There are areas where intermediate host snails occur, but there is no disease. The absence of disease in these areas could be due to unfavorable environmental conditions for parasite development. Such conditions could include too low or too high temperatures, which affect the metabolic processes of both the snail host and the parasite, thus interfering with parasite reproduction within the snail, snail growth and snail survival rate (Appleton, 1978). Temperature has been pointed to as the most important factor besides factors such as rainfall (water availability), water velocity, geomorphology and habitat stability.

Burden of Disease

- Second only to malaria in public health importance; the economic and health effects of schistosomiasis are considerable.
- The total DALYs (disability-adjusted life years; years lost due to the disability; 0 = healthy, 1 = death) lost to Schistosomiasis has based on anemia, stunting growth, and cognitive impairment, in addition to severe morbidity and death.
- Children are affected more severely with intestinal trematode infections; schistosomiasis can cause anemia, stunting and a reduced ability to learn, although the effects are usually reversible with treatment.
- It may affect people's ability to work and in some cases can result in premature death.

Symptoms and Signs

Acute

- Caused by the body's reaction to the cercarial penetration and worms' eggs, not by the worms themselves.
- Frequently asymptomatic
- Dermatitis, followed several weeks later by fever, chills, nausea, abdominal pain, diarrhea, malaise, and myalgia.

Cercarial dermatitis (swimmer's itch)

- Cercariae of Schistosoma species that infect birds and mammals other than humans can penetrate the skin. Although the organisms do not develop in humans, humans may become sensitized and develop pruritic maculopapular, then vesicular skin lesions at the site of penetration.
- Skin lesions may be accompanied by a systemic febrile response that runs for 5 to 7 days and resolves spontaneously.

Katayama syndrome

- Corresponds to maturation of the fluke and the beginning of oviposition; typically 2 to 4 weeks after heavy exposure.
- Caused by high worm load and egg antigen stimuli that result from immune complex formation and leads to a serum sickness –like illness.
- The most severe form and is most common in persons with S mansoni and S japonicum infections.
- High fever, chills, flu-like symptoms (including headache, cough) nausea, abdominal pain, malaise, myalgia, urticarial rashes, and dysentery; hepatosplenomegaly, lymphadenopathy; marked eosinophilia.
- Manifestations are more common and usually more severe in visitors than in residents of endemic areas and typically last for several weeks.

Chronic

- Vary with species
- Some of acute symptoms and signs are persistent
- Pathophysiology: eggs remain trapped in the intestinal or bladder wall or in the liver, eliciting the formation of granulomas and fibrosis. In the liver, fibrosis leads to portal hypertension and splenomegaly. The most severe forms of the disease are due to S. japonicum.
- Anemia, pedal edema, ascites, and abdominal distension with distended abdominal veins
- (Intestinal polyposis and signs of malnutrition)

Diagnosis

- Identify eggs in stool that appear 1 to 3 months after cercarial penetration.
- The Kato-Katz technique is a simple and sensitive quantitation technique used successfully in the field. It is a commonly used semi-quantitative method for counting eggs in persons with intestinal schistosomiasis and allows the degree of infection and treatment response to be assessed.
- For people from non-endemic or low transmission areas, serological and immunological techniques may be useful in the detection of infection but do not provide information about the worm burden or clinical status. Low sensitivity and cross-reactions between trematodes are other noted disadvantages. It is especially useful in the following situations: pre-patent period and in chronic and ectopic cases of schistosomiasis, in which the eggs are difficult to demonstrate in the stool.
- Ultrasonography is a sensitive procedure used to demonstrate hepatosplenic pathology in persons with schistosomiasis. Portable ultrasonography can be used to screen populations at the community level. In addition, it can be used to assess the effects of chemotherapy.

Differential Diagnosis

- Amoebiasis
- Hepatitis
- Inflammatory bowel disease
- Pancreatitis
- Tuberculosis
- Typhoid fever

Complication

- Pyogenic cholangitis
- Headache, seizures, myeloradiculopathy with lower limb and back pain, paresthesia, and urinary bladder dysfunction (central nervous system schistosomiasis due to S japonicum infection)
- Granulomatous reactions to eggs in the liver usually do not compromise liver function but may cause fibrosis and cirrhosis, which can lead to portal hypertension and subsequent hematemesis due to esophageal varices.
- Eggs in the lungs may produce granulomas and focal obliterative arteritis, which may cause pulmonary hypertension and cor pulmonale (hemoptysis, palpitation, and dyspnea upon exertion).
- Eggs lodged in the spinal cord can cause transverse myelitis, and those in the CNS can cause seizures

Treatment:

Praziquantel 600mg tablet

- 20 mg/kg PO TID for 1 day (at intervals 4-6 hour)
- <4 years old: Safety & efficacy not established
- Drug interacts with Cimetidine >> (up concentration of prazi)
- Adverse effects (1-10%)
    - Appetite loss; abdominal pain; nausea; vomiting
    - Dizziness; drowsiness; headache
    - Malaise; diaphoresis
- Adverse effects (<1%)
    - Diarrhea
    - Fever
    - Itching; rash; urticaria
- Pregnancy category: B; lactation: enters breast milk, do not nurse on the day of taking drug & 72 hour thereafter.

Treatment note

- Praziquantel does not prevent re-infection; is inactive against juvenile schistosomes, thus may not abort an early infection; and only has a limited effect on already developed liver and spleen lesions.
- Therapeutic failures have been reported, but it is difficult to determine whether they are due to reinfection or drug-resistant strains. Patients should be examined for living eggs 3 and 6 months after treatment. Retreatment is indicated if egg excretion has not decreased markedly.

Swimmer's itch

- Most cases do not require medical attention.
- Treatment is symptomatic with cool compresses, baking soda, or antipruritic lotions. Topical corticosteroids can also be used.

Disease Control and Prevention

Artemether has been used for personal preventive drug. It also enhances the efficacy of praziquantel if both of them are combined.

Regular treatment of all people in at-risk groups

- Treatment on a large scale with praziquantel, and at regular intervals. Such treatment is done without individual diagnosis, once the endemic area is defined, the overlap of diseases determined, and the algorithm for treatment agreed.
- Target populations:
    - School-aged children in endemic areas
    - Adults considered to be at risk in endemic areas, e.g. pregnant and breastfeeding women, people with occupations involving contact with infested water – such as fishermen, farmers, irrigation workers – and women whose domestic tasks bring them into contact with infested water
    - Entire communities living in endemic areas.

Snail control

About the snails

Oncomelania snails inhabit shallow waters characterized by lush, littoral macrophyte cover, and do not thrive in permanently flooded areas (i.e., rice paddies) or in riverine environments. They derive oxygen from water by use of gills, and are unable to breathe outside of their aquatic habitats. Many are amphibious, despite this fact.

Most amphibious species are restricted to areas of high rainfall and humidity where saturated ground is the rule, and the surrounding vegetation is covered with a persistent film of water. For example, *O. hupensis*, found in China, seeks out habitats that are flooded for 1-5 months during the rainy season, and spends the rest of the year in habitats with high humidity and residual water flow. Flash floods may transport them from one environment to another, but they often do not survive the journey.

Inseminated females store sperm and are capable of producing viable eggs for up to twelve weeks after fertilization without further contact with another snail. Females lay eggs individually, or a short chains of eggs on solid substrates. Eggs are laid mostly at night, or hidden from sunlight, since they require low temperatures and high humidity for optimal development. In tropical ecozones, eggs are produced year-round, but the total number is quite small, averaging 30 to 40. The life span of most laboratory-reared *Oncomelania* ranges from 6-9 months (*O. quadrasi*) to several years (*O. nosophora*). In native habitat, *O. quadrasi* survives for about 9 weeks, while *O. nosophora* lives somewhat longer; 16 weeks.

There are four environmental factors that affect the density and viability of snail populations.

1. Water levels control snail population densities, and tend to vary considerably between years and seasons. Optimal snail habitat usually falls into a narrow zone of elevation above the mean low water level for any given region. Flooding can prove problematic, as annual floods in certain environments have been found to drown adult snails. Large-scale floods have a measurable negative impact on snail populations. In environments where flooding continually occurs, *O. hupensis* lives about 1 year. In environments with less frequent or no flooding, the species can live at least twice as long, and often longer.

2. The current speed in riparian environments often determines the density of snail populations, and during times of high water may serve to re-locate large populations down river. Flood-driven currents can also devoid areas of snails. This feature of lentic ecosystems has proven to be problematic in controlling snail populations, since snails upstream from areas of flooding can easily re-populate barren zones.

3. Temperature can determine whether or not snails can reproduce. Below 10°C, which occurs usually in early spring in sub-tropical environments, reproduction is severely inhibited. Both adults and eggs succumb at temperatures that exceed 30°C.

4. Elevation also plays an important role in determining the density of snail populations, particularly for marshlands that lie above the mean low water level of lakes and rivers. Seasonal standing ponds or inlets with sparse vegetation are characteristic of these elevated areas. Optimal snail habitats are typified by expanses of flat, mid-level land with numerous dry-season ponds and streams, and thick grass covering the ground. These are the conditions found in areas at the ecotonal zones of rivers or permanent standing bodies of water with abundant littoral zone macrophytes. Marsh grass and silt along the banks maintain the shaded and humid microclimate optimal for a thriving snail population. Given this set of conditions, it is no wonder then that the density of different snail populations varies widely from season to season.

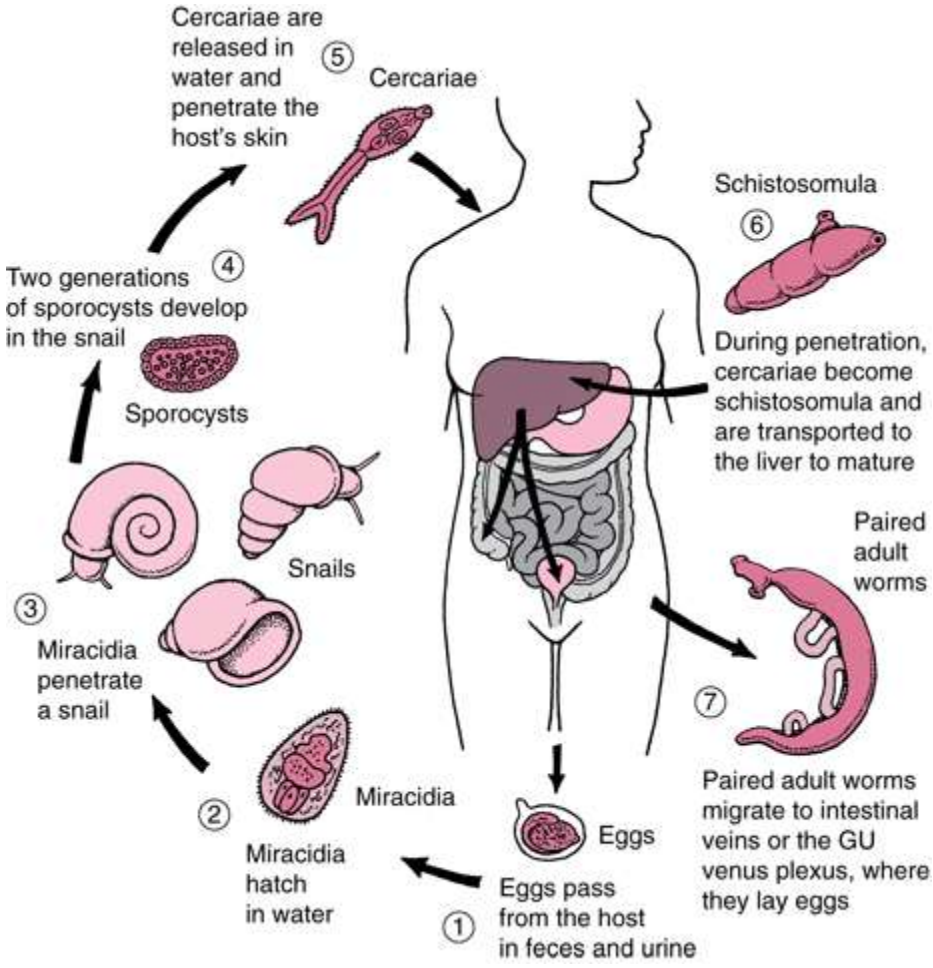
Plan of actions

- Prevent or remove aquatic vegetation
- Line canals with cement
- Periodically and rapidly dry irrigation canals
- Regularly fluctuate water levels
- Molluscide
    - Selective molluscicide treatment in snail-infested bodies of water at main human contact points is the preferred way to approach controlling snail populations.
    - Metallic salts, such as copper sulfate, were among the first agents used, and were most effective when applied to standing bodies of water. Copper sulfate was introduced by dragging burlap sacks filled with large CuSO4 crystals behind slow moving boats. This compound worked well enough, but it also limited algal growth, that in turn affected growth patterns of fish that served as primary sources of protein.
    - Newer molluscicides, such as nicotinanilide, organotin, dibromo-nitraozo-benzene, sodium pentachlorophenate, tritylmorpholine, sodium dichloro-bromopheno, niclosamide, and acetamide analogs replaced copper sulfate, as these were deemed safer to the environment.
    - Niclosamide is the only remaining commercially available molluscicide. While niclosamide is biodegradable, its "side effects" included the death of many fish species, as well as the targeted snail populations. It acts by depleting glycogen stores, and is the drug of choice for some adult tapeworm infections in humans.
    - Plant-derived molluscicides have proven too variable in their effectiveness and are difficult to manufacture
- Biological agents
    - Laboratory and field experiments employing microbial pathogens to snails and snail-specific metazoan parasites give a hint as to possible future control strategies for schistosomiasis.
    - A number of predator/competitor snail species are receiving more and more attention as potential control agents, as well. In well-controlled situations, such as small, artificial ponds, experiments carried out in some countries, snails out-competed Biomphalaria spp. for space and resources. Competitor snail species were also used successfully as a follow up measure after molluscicide use in some rivers of central Venezuela.

Improved sanitation and health education

Prevent contaminating water bodies with feces.

Schistosomiasis Transmission Diagram



1. Adult worms in humans reside in the veins in various locations: S. japonicum in the inferior mesenteric veins (veins of intestinal wall)
2. Eggs containing miracidia are eliminated with feces (S. japonicum) into water.
3. In water, the eggs hatch and release miracidia.
4. The miracidia swim and penetrate a snail (intermediate host).
5. Within the snail, the miracidia progress through 2 generations of sporocysts to cercariae. A single miracidium can multiply in the snail to produce nearly 100,000 cercariae.
6. The free-swimming cercariae are released from the snail and penetrate the skin of the human host.
7. During penetration, the cercariae lose their forked tail, becoming schistosomula. The schistosomulae travel through venous circulation to the heart, lungs, and liver, where they mature into adults worms in approximately 3 weeks.
8. The paired (male and female) adult worms migrate (depending on their species) to the intestinal veins in the bowel or rectum, where they reside and begin to lay eggs (thousands/day) for the duration of the host's life or the adult worm's life (3 to 7 years).