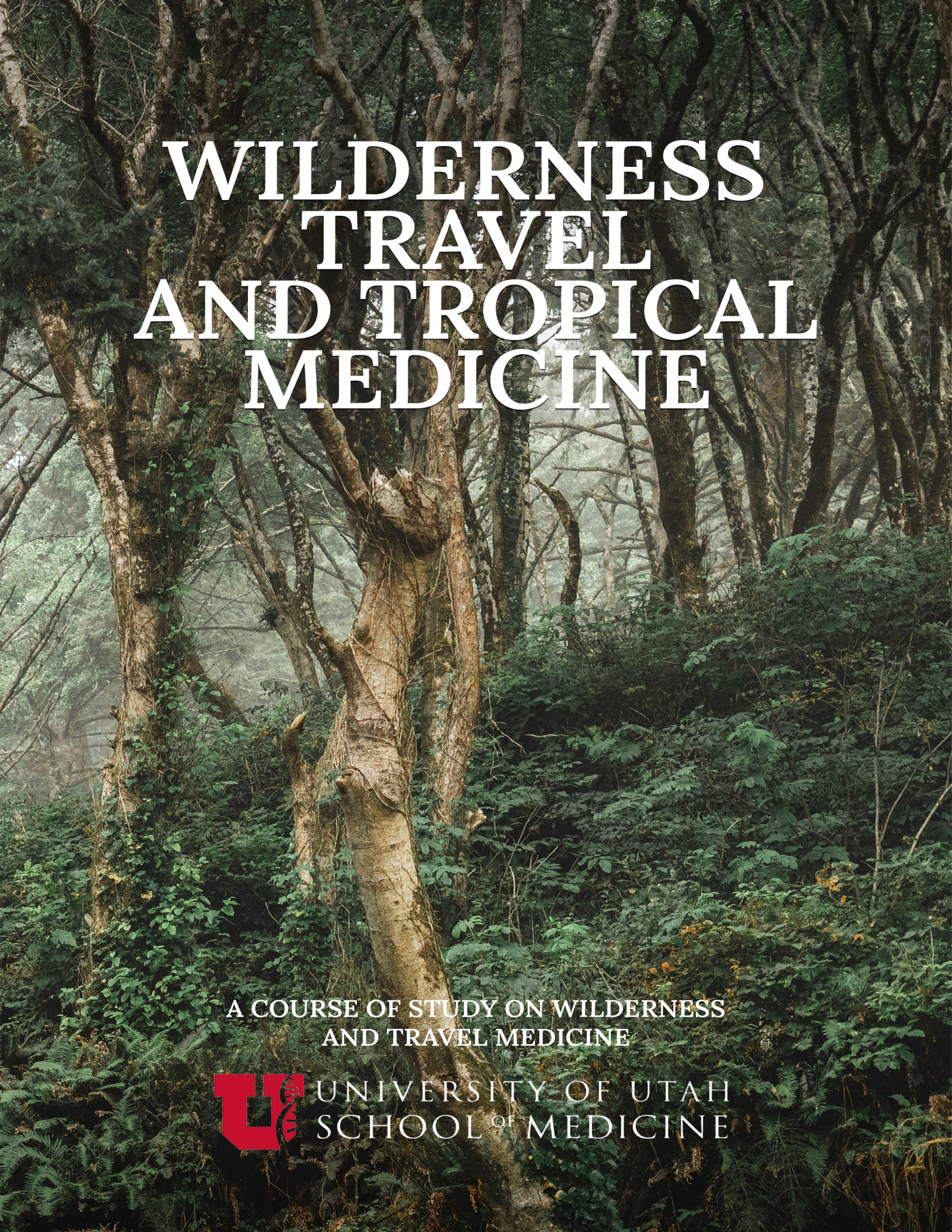


WILDERNESS TRAVEL AND TROPICAL MEDICINE

A COURSE OF STUDY ON WILDERNESS AND TRAVEL MEDICINE

UNIVERSITY OF UTAH SCHOOL OF MEDICINE

SENIOR EDITOR
Richard J. Ingebretsen, MD, PhD
University of Utah School of Medicine
Salt Lake City, Utah

EDITORS
Justin Coles, DO
McKay-Dee Family Medicine
Ogden, Utah

Stein Ingebretsen, MD
University of Utah School of Medicine
Salt Lake City, Utah

Jason Tanner, MD
Yale School of Medicine
New Haven Connecticut

Paul Schmutz, DDS
Salt Lake City, Utah

Chris Bazzoli, MD
The Ohio State University College of Medicine
Columbus, Ohio

Copy/Format Editor
Lisa Plante, MEd

ISBN: 978-1-7359710-3-2

Table of Contents

Click on a chapter to advance

Section 1: Preparing and Returning from Travel

Section 2: Bugs and Diseases that Infect Us When Traveling

Chapter 1: FEVER IN THE RETURNING TRAVELER

People are traveling more and going to places where exotic diseases exist. When these people return home, they may have developed a fever. Typically, a fever is caused by a common illness such as tracheobronchitis, pneumonia, or a urinary tract infection. However, a fever in a returning traveler should raise suspicion for a severe or potentially life-threatening tropical infection. If the returned traveler seeks medical help then, in addition to the usual medical history, the clinician should obtain a careful travel history, a description of the traveler's accommodations, information about pre-travel immunizations or medical prophylaxis during travel, sexual history while traveling and a list of exposures and risk factors. The extent and type of lymphadenopathy are important diagnostic clues. As well, a fever with an altered mental status is an alarm that requires urgent evaluation and treatment. Malaria must be considered in patients who traveled, even briefly, within an endemic area.

Of the 50 million people who travel annually from the industrialized world to the developing world, fever is a rather common complaint in the returned traveler. Up to 11% complain of a febrile illness. While the majority of these people will have infections that are common to the non-traveler, many types of infection will require that the differential diagnosis be expanded to include more exotic diagnoses such as malaria and dengue.

A systematic approach to the returned traveler with a fever is essential. Underlying medical health and findings on the physical exam, such as rash and swollen lymph glands, may reveal clues to the diagnosis. Furthermore, there are specific tests that should be considered in the returned febrile traveler. Here are some recommended rules to follow when examining a returned traveler with fever:

1. Always consider common causes such as urinary tract and upper respiratory tract infections. The fever may have nothing to do with the travel.
2. Most often, a returning traveler with a fever will have malaria. Second to that is typhoid fever, followed by dengue fever, in that order. Additionally, rickettsial diseases are becoming frequent causes of fever in returned travelers.
3. If a patient is particularly ill or has an altered mental status, meningococcemia and viral hemorrhagic fevers are possible. Though highly uncommon, one should consider these as potential diagnoses as they are medical emergencies.
4. Knowing how long it took for a fever to develop will help with the diagnosis. The chart below lists common diseases, and the time it takes to develop a fever after exposure. Note that malaria, the most common cause of a fever, is listed on both sides of the chart below.

Timeframe for Fevers to Develop in the Traveler after Exposure	
Less than 21 days	More than 21 days
East African trypanosomiasis	Acute HIV infection
Dengue fever	Acute systemic schistosomiasis
Japanese encephalitis	Amebic liver abscess
Leptospirosis	Borrelioses (Relapsing Fever)
Malaria	Brucellosis
Meningococcemia	Leishmaniasis
Non-typhoid salmonella	Malaria
Plague	Rabies
Typhoid fever	Tuberculosis
Typhus	Viral Hepatitis (A, B, C, D, E)
Viral Hemorrhagic fevers	West African Trypanosomiasis
Yellow fever	

Knowing what diseases are endemic to an area is very important in determining the cause of a fever in a traveler. Symptoms such as a generalized rash, body aches, headache, and fever are all significant but are non-specific. The greatest challenge for a clinician is to identify the cause of fever without a focus. Therefore, critical elements in a patient's history include:

- What were the dates and places of travel?
- Did they receive pre-travel prophylaxis? If so, what did they take?
- What was the quality of food and water where they traveled?
- What exposure did they have to insects, animals or to sick people?
- Did they have sexual intercourse with locals during travel?
- Did they become sick during travel? If so, what were the symptoms?

TYPES OF FEVER

Dengue Fever

Dengue fever has become a global disease. Nearly 1,000 cases of dengue fever occur each year in travelers returning to the United States. This number is likely an underestimation of the actual number of cases, as many American physicians typically fail to recognize the disease. Like malaria, dengue fever is transmitted by a mosquito. Unlike malaria, it is a viral infection that is transmitted by the Aedes mosquito, which feeds mostly during the day.

Four types of serotypes exist. While infection by one serotype imparts lifelong immunity to that infecting serotype, it may create a subsequent hyper-immune response after infection by a different serotype. These hyper-immune responses may manifest as dengue hemorrhagic fever, causing bleeding that can be seen in the gums, vomit, or stool, making the patient critically ill.

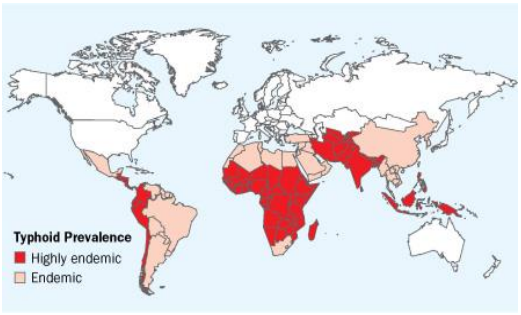
The typical incubation period of dengue fever is 3-10 days. If no hyper-immune response manifests, then it is followed by the abrupt onset of "break-bone" fever. Break-bone fever is a high fever with frontal headache, severe myalgia, and retro-orbital pain classically worsened with lateral eye gaze. About half of all patients will have a sunburn-like rash that blanches with pressure. While the diagnosis is essentially a clinical one, leucopenia and thrombocytopenia are often seen on a CBC.

A four-fold rise in antibody titer is the traditional method for confirmation, but is not specific to dengue fever and may react to other flaviviral infections. PCR and viral isolation diagnostic methods are becoming more common.

Many health practitioners don't think of dengue fever as a cause of illness in someone from Africa. During 1960–2010, a total of twenty-two countries in Africa reported sporadic cases or outbreaks of dengue fever. Twelve other countries in Africa reported dengue fever only in travelers. The presence of disease and high prevalence of antibodies to dengue virus in limited serologic surveys suggest endemic dengue virus infection in all or many parts of Africa. Dengue is likely under-recognized and under-reported in Africa because of low awareness by health care providers, other prevalent febrile illnesses, and lack of diagnostic testing and systematic surveillance.

Typhoid Fever

Most enteric fever (typhoid and paratyphoid) in cases worldwide are typhoid fever. As a result of safer water and food, typhoid fever cases in developed countries are not common. Worldwide, however, 16 million cases of typhoid fever occur annually, resulting in 600,000 deaths.



Patients with typhoid fever look similar to those with malaria. After an incubation period of 3-60 days, the first manifestations of typhoid fever are fever and malaise. Fever increases in a stepwise fashion. Associated symptoms include anorexia, vomiting, and abdominal pain. Diarrhea is more likely in children, whereas constipation is more likely in adults. Signs of typhoid fever include rose spots, hepatosplenomegaly, and fever spikes. Rose spots, which appear in fair-skinned persons, are maculopapular, pink-colored lesions on the trunk of the body. These spots typically only occur in 5% to 30% of patients. Laboratory tests are nonspecific. Findings include leucopenia, thrombocytopenia, elevated erythrocyte sedimentation rate/C-reactive protein level and elevated liver enzyme levels.

Typhoid fever should be suspected in patients with a spiking fever and leucopenia, who have visited a typhoid-endemic area and who have not received a typhoid fever vaccination. Blood cultures are positive in only 40% to 60% of patients. Sometimes urine or stool cultures are positive for S. Typhi when blood cultures are negative. The most sensitive way to collect S. Typhi is by bone marrow culture, though rarely used in routine clinical practice.

This map shows the distribution of typhoid fever throughout the world. As mentioned earlier, typhoid fever is not common in developed countries such as Western Europe and North America. For countries in South America, Africa, and Southern Asia, it is still very prevalent.

Salmonella Typhi (S. Typhi)

Salmonella infections are usually acquired via the food chain. A Salmonella case is an excellent example of how expatriate families visiting their homeland may not believe they can contract a tropical infection.

S. Typhi is treated with amoxicillin. While initially sensitive to amoxicillin, S. Typhi has become increasingly resistant to it and can relapse after treatment. Amoxicillin is associated with a relapse rate of 4% - 8%. In fact, amoxicillin and TMP/SMX resistance is common, and ciprofloxacin resistance is becoming more common. Alternatives for oral therapy include cefixime (Suprax) or azithromycin (Zithromax). Ciprofloxacin has been the drug of choice for empiric typhoid fever treatment. However, local fluoroquinolone resistance is high, such as in the Indian subcontinent. Also, fluroquinolones have untoward side effects, and clinicians should use them only if other antibiotics are not available or are ineffective. Azithromycin is highly effective for enteric fever.

For prevention when traveling, it is usually safe to consume bottled water, hot cooked food, dry food, and fruits and vegetables that can be peeled. Tap water, ice, fresh juices, salads, unpasteurized dairy products, uncooked sauces and toppings, open buffets, and food sold by street vendors should be avoided.

Malaria

Malaria should be suspected first in all returning travelers. If these patients present with a spiking fever, leucopenia, thrombocytopenia, and they confirm they visited a malaria-endemic area and did not take prophylaxis, they are very likely to have malaria. Each year there are more than 250 million cases of malaria worldwide.

Patients with low parasitemia may need multiple blood smears to produce a positive result. In the developing world, if malaria blood smears cannot be reliably performed, then rapid diagnostic tests that detect specific circulating malaria antigens may be used.

Malaria was, and remains, the most devastating disease of all time. Five species of Plasmodium can infect humans. The first four are: P. falciparum, P. vivax, P. malariae, and Plasmodium ovale. A fifth Plasmodium species, Plasmodium knowlesi, is an emerging human pathogen. Infection with P. knowlesi may occur following exposure to macaque monkeys in Southeast Asia. As well, P. ovale has recently been shown by genetic methods to consist of two subspecies: P. ovale curtisi and P. ovale walliker.

P. falciparum is the most dangerous type of malaria. It's also the most common species that infects humans and is the only malaria species that causes fulminant disease due to high parasitemia. This has the ability to bind to up to 80% of all red blood cells, causing widespread deformation that clogs capillaries and the microcirculation.

Summary of the five species of Plasmodium malaria that can infect humans:

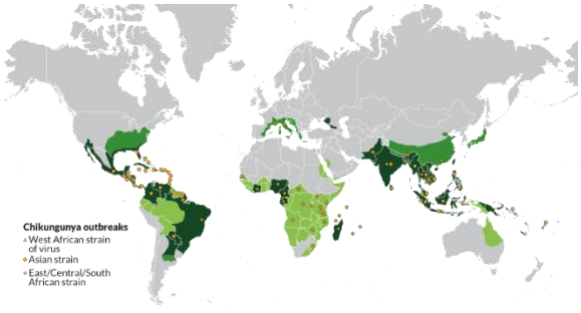
1. P. falciparum
2. P. vivax
3. P. malariae

4. Plasmodium ovale (two subspecies)
    - P. ovale curtisi
    - P. ovale walliker.
5. Plasmodium knowlesi

Malaria is acquired by humans when bitten by Anopheles mosquitoes, which are dusk to dawn feeders. When the bite occurs, the malaria sporozoites travel from the mosquito to the human liver. Here, they develop into merozoites and are released in the blood weeks or months later. When they are released into the blood, the merozoites feed on hemoglobin and rupture the red blood cells in 48 hours (for P. falciparum, P. vivax, and P. ovale, P. knowlesi) or 72 hours (for P. malariae). P. vivax and P. ovale can remain latent in the liver for months or years, and P. malariae can remain dormant in red blood cells for months or years. When red blood cells rupture, fever spikes occur. If the rupture happens synchronously, then there would be a fever recurring every third day or a fever recurring every fourth day. However, red blood cell rupture usually occurs asynchronously, and the fever spikes are typically random.

It is essential for travelers to know that taking malaria pills will not prevent a person from getting malaria. If a mosquito that has the malaria parasite bites a human, the parasite will enter the victim instantly, 100% of the time. That traveler now has malaria. The medicine itself only helps the person from getting as sick. Becoming infected with malaria and becoming ill with the disease are two different things. The person may or may not become sick depending on several factors, including chemoprophylaxis. More than 75% of travelers do not take adequate precautions. The only way for a traveler to prevent becoming infected with malaria is to avoid being bitten. DEET mosquito repellants are effective in preventing mosquitoes from biting. Persons should use a repellent that contains at least 30% DEET. People living in malaria-endemic countries develop partial immunity. However, if these people immigrate to a non-malaria area, this immunity rapidly wanes.

Chikungunya



Chikungunya is a crippling virus that, in one decade, has gone from an obscure tropical ailment to an international threat, causing more than three million infections worldwide. The virus has established itself in Latin America and the Caribbean and is now moving to cooler climates. Chikungunya rarely kills its victims, but it is a terrible disease. Symptoms include high fever, profound joint pain, chills, and headache that typically lingers for about one week. Many patients later develop severe joint pain that can recur for months or years. In East Africa, where the virus was first identified in 1952, Chikungunya (in the Makonde language) means “to walk bent over” or “to become contorted,” a reference to the stooped posture of many sufferers.

Chikungunya virus is transmitted to people by mosquitoes. The most common symptoms of chikungunya virus infection are fever and severe joint pain. There is no vaccine to prevent or medicine to treat chikungunya virus. Travelers can protect themselves best by avoiding mosquito bites. When traveling to countries with chikungunya virus, use insect repellent, wear long sleeves and pants, and stay in places with air conditioning or that use window and door screens. DEET has been proven to be the best chemical to repel the bite of the mosquito.

Leptospirosis

Leptospirosis is a bacterial disease that affects both humans and animals. It occurs worldwide, within rural and urban areas, and in temperate and tropical climates. The early stages of the disease may include high fever, severe headache, muscle pain, chills, redness in the eyes, abdominal pain, jaundice, hemorrhages in the skin and mucous membranes, including those in the lung. Patients can get diarrhea and a rash. Animals infected with the spirochetes of the genus Leptospira shed the bacteria through their urine intermittently or continuously throughout their lives.

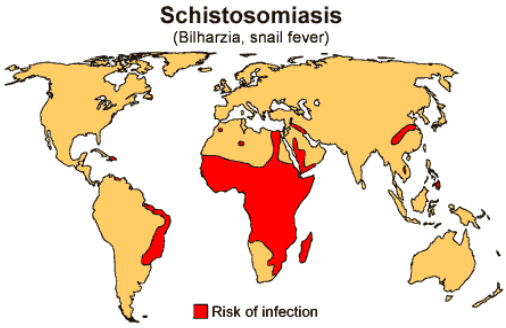
Human infection occurs through direct contact with the urine of infected animals or by contact with a urine-contaminated environment, such as surface water, soil, sand, and plants. Walking a beach barefoot can cause infection. Leptospires can gain entry through cuts and abrasions in the skin and mucous membranes of the eyes, nose, and mouth. Human-to-human transmission occurs only rarely. For the severe form of leptospirosis, antimicrobial therapy is recommended. However, its use is controversial for the mild form of leptospirosis.

A Cochrane Review found insufficient evidence to advocate for or against the use of antibiotics in the therapy for leptospirosis. If used, antibiotics such as doxycycline, ampicillin, or amoxicillin should be initiated as soon as the diagnosis made.

Rickettsia disease

Rickettsial diseases are globally distributed, arthropod-borne illnesses that are becoming increasingly important sources of fever in the returned traveler. This group of diseases caused by intracellular gram-negative bacteria includes Mediterranean Spotted Fever, African Tick Typhus, and Rocky Mountain Spotted Fever. Each syndrome may have some unique features of presentation, but most share some common symptoms, including fever, headache, malaise, nausea and vomiting, and a rash. Often there is an eschar at the site of the tick bite. Serologic testing is usually required to confirm the diagnosis. The treatment of choice is generally doxycycline.

Schistosomiasis



Schistosomiasis, also known as bilharzia, is a disease caused by parasitic worms. More than 200 million people are infected worldwide. In terms of impact, this disease is second only to malaria as the most devastating parasitic disease. The parasites that cause schistosomiasis live in certain types of freshwater snails. You can become infected when your skin comes in contact with contaminated freshwater. It is likely to occur 21 days after returning home from travel because of its prolonged incubation of one to two months. Most people have no symptoms when they are first infected. However, within days after becoming infected, they may develop a rash or itchy skin. Within 1-2 months of infection, people develop symptoms, including fever, abdominal pain, enlarged liver, blood in the stool or blood in the urine, and problems passing urine.

Yellow Fever

Yellow fever is an acute viral disease. In most cases, symptoms include fever, chills, loss of appetite, nausea, headaches, and muscle pains, particularly in the back. Symptoms typically improve within five days. In some people, within a day of improvement, the fever comes back, abdominal pain occurs, and liver damage begins causing yellow skin. If this occurs, the risk of bleeding and kidney problems increases.

The yellow fever virus causes the disease, and the Aedes aegypti mosquito spreads it. Yellow fever causes 200,000 infections and 30,000 deaths every year, with nearly 90% of these occurring in Africa. Almost 1 billion people live in an area of the world where the disease is common. It is common in tropical regions in South America and Africa, but not in Asia. The number of cases of yellow fever has been increasing. Thankfully, a safe and effective vaccine against yellow fever does exist.

Travelers should be vaccinated against yellow fever when they travel to countries where it is endemic. Yellow fever remains endemic in West Africa and South America. Many countries in these endemic areas, such as Gambia and Venezuela, do not require travelers to undergo yellow fever vaccination. International guidelines for travelers strongly recommend vaccination against yellow fever for persons traveling to these countries but, general practitioners and travel agencies may advise against vaccination because the country themselves do not require it.

Ebola and other Hemorrhagic Viruses

Ebola viruses are very deadly. If a patient has been in a country where Ebola or other hemorrhagic viruses are at risk, and they present with a fever, isolate the patient and call the local health department. Isolation is the first important step in the management of these types of diseases.

Assess the patient for international travel and for having been in countries within the last 21 days where Ebola is known to exist, even if the risk is low.

Symptoms of Ebola include a fever of ≥100.4°F (≥38°C), severe headache, muscle pain, weakness, fatigue, diarrhea, vomiting, abdominal pain, and unexplained hemorrhaging. Healthcare personnel are exposed to the Ebola virus by touching a patient's body fluids, contaminated medical supplies and equipment, or contaminated environmental surfaces. Splashes to unprotected mucous membranes (for example, the eyes, nose, or mouth) are particularly hazardous. Procedures that may increase environmental contamination with infectious material or create aerosols should be minimized.

CLICK HERE to take a practice EXAM on Fever in the Returning Traveler

CLICK HERE to listen to a PODCAST on Fever in the Returning Traveler

Chapter 2: Diarrhea in the Returned Traveler

There are many causes of diarrhea throughout the world: viruses, bacteria, protozoa, helminths, inflammatory bowel disease, irritable bowel, small bowel bacterial overgrowth, malabsorption, medications, and more. Not all of these causes present themselves in developed countries as they do in underdeveloped countries. When we think of a person who has traveled throughout the world, we also need to think of the global causes of diarrhea.

For diagnosis, diarrhea has been divided into two categories: Persistent and Acute. Persistent diarrhea lasts for one-two weeks, or longer. Acute diarrhea is a shorter timeframe. After determining whether the patient's diarrhea is considered acute or persistent, we can then narrow our differential diagnosis and better assess treatment options.

ACUTE AND PERSISTENT DIARRHEA

Acute Diarrhea

When considering treatment for someone with acute diarrhea, it's critical to know the potential pathogens of the areas they've visited. Without this knowledge, it's extremely difficult to decide on appropriate and cost-effective treatment modalities. Additionally, you must take into account any allergies of the patient, along with their potential sensitivity to the treatment prescribed.

An extremely common cause of acute diarrhea in the returned traveler is appropriately called Traveler's Diarrhea. The most common bacterial cause of traveler's diarrhea is *Escherichia Coli*, and it accounts for 20 - 50% of the traveler's diarrhea cases. Certain strains of E. coli are more toxic to the intestines than others, which causes diarrhea and illness. The highest percentage rate of this E. coli bacteria is in Latin America, and the lowest are in Asia. Diarrhea caused by E. coli is generally explosive, non-bloody, and accompanied by nausea, vomiting, cramps, and fever. Though gastroenteritis caused by bacteria, such as E. coli, is usually short-lived and self-limiting in adults, it has been reported to cause persistent diarrhea in children. The occurrence of traveler's diarrhea remains high during travel to high-risk tropical and semitropical regions, despite pre-travel advice. Self-treatment of illness remains the mainstay in the management of this disease.

Azithromycin shows a high degree of activity against diarrhea due to E. coli, multi-resistant shigella, and ciprofloxacin-resistant campylobacter. Azithromycin is the drug with the broadest activity against the bacterial pathogens causing traveler's diarrhea.

In most parts of Latin America and Africa, E. coli is the major pathogen encountered. In Asia, invasive pathogens such as shigella, salmonella, and campylobacter appear to be more common as causes of traveler's diarrhea. Throughout the world, campylobacter isolates are showing an increased rate of resistance to ciprofloxacin with very high rates (up to 84%) noted in Thailand. Rifaximin is approved by the U.S. Food and Drug Administration to treat traveler's diarrhea caused by E. coli with few side effects and low risk of developing antibiotic resistance. However, it is not effective against campylobacter jejuni, and there is no evidence of efficacy against shigella or

salmonella species. Prulifloxacin is a new antibiotic that seems to be very effective but has yet to be approved for use in most countries.

Some strains of E. coli are called enterohemorrhagic (EHEC) and produce a shigella-like toxin, which is a significant cause of foodborne illness. When these strains infect humans, they can create a severe complication called hemolytic-uremic syndrome (HUS). The best known of these strains is O157:H7. Some EHECs that induce bloody diarrhea lead to HUS in 10% of cases. The clinical manifestations of post-diarrheal HUS include acute renal failure, microangiopathic hemolytic anemia, and thrombocytopenia. The use of antibiotics has not yet demonstrated a clinical benefit. As well, antibiotics that interfere with DNA synthesis, such as fluoroquinolones, have been shown to increase the production of toxins. In Germany in 2011, nearly 4,000 people were infected with EHEC, with almost 800 developing HUS. Of those, 56 people died.

It is not known whether treatment with azithromycin for traveler's diarrhea will be effective in preventing chronic post-infectious irritable bowel syndrome. It is unclear how often this actually occurs. Some studies indicate up to 10% of people with bacterial diarrhea develop this while other studies show a much lower number.

Additionally, the use of anti-motility agents in children under ten years of age, or elderly patients, should be avoided, as they increase the risk of HUS with EHEC infections.

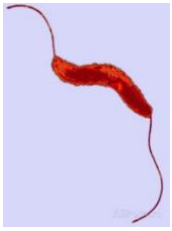
Norovirus

Perhaps the most common cause of acute diarrhea in the United States and Canada is the Norovirus. It is becoming an increasingly common cause of traveler's diarrhea in countries such as Mexico and Guatemala, as well as on cruise ships. In Africa and Asia, Norovirus is not particularly common. A recent study, called GEMS, was conducted over a three-year period at seven sites in Africa and Asia. They found that in Africa and Southwest Asia, you're far more likely to see rotavirus, cryptosporidium, shigella, and ETEC, which are other organisms that can cause diarrhea.

Dysentery

Dysentery is another form of diarrhea that travelers can contract. Rather than the profuse non-bloody diarrhea in traveler's diarrhea, dysentery in characterized not only by profuse diarrhea but also by the presence of blood.

Shigella is one bacterial cause of dysentery, affecting 15% of travelers. It is common in countries experiencing natural disasters, socioeconomic upheaval, and during times when clean food and water are hard to find. *Shigella* causes bloody, mucus-laden diarrhea, along with fever, cramps, and exhaustion.



Campylobacter species are other bacteria that can cause dysentery and invasive, bloody diarrhea. While all mammals can spread *campylobacter*, birds are known to be very active carriers of this disease. Most people who become ill with campylobacter will have diarrhea, cramping, abdominal pain, and fever within two to five days after exposure to the organism. The diarrhea is bloody and can be accompanied by nausea and vomiting. The illness typically lasts about one week. Some infected persons do not have any symptoms.

Unpasteurized milk can become contaminated if the cow has an infection with campylobacter in its udder or if the milk is contaminated with manure. Surface water and mountain streams can become contaminated from infected feces from wild birds -- almost all persons infected with campylobacter recover without any specific treatment. Patients should drink extra fluids as long as diarrhea lasts. Antimicrobial therapy is warranted only for patients with severe disease or those at high risk for severe disease. The antibiotics azithromycin and fluoroquinolones (e.g., ciprofloxacin) are commonly used for the treatment of these infections, but resistance to fluoroquinolones is common.

Many chicken flocks are infected with campylobacter but show no signs of illness. Campylobacter can be easily spread from bird to bird through a common water source, or through contact with infected feces. In 2011, campylobacter was found in 47% of raw chicken samples bought in grocery stores and tested through the National Antimicrobial Resistance Monitoring System (NARMS) in the United States.

Guillain-Barré Syndrome

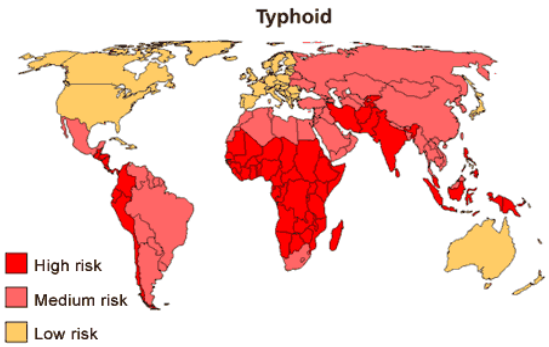
One potential complication from campylobacter infection is a disease called *Guillain-Barré Syndrome*. After infection from campylobacter, both the innate and the adaptive immune systems are activated. The innate system responds with an acute inflammatory reaction with the creation of granulocytes. The adaptive immune system mounts an antibody response that peaks in about two weeks. Since these particular antibodies can cross-react with myelin components, this can lead to the development of Guillain-Barré syndrome, which can include the development of muscle weakness.

Evidence of recent or ongoing Campylobacter jejuni infection has been found in approximately one out of every four cases of Guillain-Barré syndrome. It is increasingly accepted that C. jejuni infection is an important causal factor for Guillain-Barré syndrome. The risk of developing Guillain-Barré syndrome during the months following a symptomatic episode of C. jejuni infection is approximately 100 times higher than the risk in the general population.

Entamoeba histolytica is a parasite prevalent in Mexico, India, Africa, and Central and South America. It produces small stools that contain blood and mucus. If the condition becomes chronic, it can resemble inflammatory bowel disease (IBD). It is important to distinguish the two since corticosteroids used to treat IBD can have dangerous effects on people carrying the *Entamoeba histolytica* parasite.

Typhoid Fever

Another potential diagnosis in a patient with diarrhea is Typhoid fever. Persons with typhoid fever carry the bacteria *Salmonella typhi* in their bloodstream and intestinal tract. In addition, a small number of people, called carriers, recover from typhoid fever but continue to carry the bacteria. Between one and six percent of people infected with S. typhi become chronic, asymptomatic carriers. This is unknown to themselves or to others, which provides for the spread of typhoid fever. Both ill persons and carriers shed *Salmonella typhi* in their feces.



There are vaccines against Typhoid fever. The oral vaccine is typically effective for up to five years, whereas the injectable form is effective for only about two years. Booster vaccines will then need to be given. The oral vaccine needs to be completed one week prior to travel, and there are four doses. It cannot be given to children under the age of six. The injectable vaccine needs to be given two weeks prior to travel, and it is given as one single dose. It should not be given to children younger than age two. Both vaccines help the body build antibodies against *Salmonella typhi*. Anyone who received a vaccine that is more than two years old is recommended to get another when traveling to endemic areas.

One of the best options to reduce your risk of contracting Typhoid fever is to watch what you eat and drink while traveling. It is almost as important as being vaccinated, as vaccines are not entirely effective. The only valid method to prevent getting the disease is to watch what you eat and drink. Avoiding risky foods will also help protect you from other illnesses, including travelers' diarrhea, cholera, dysentery, and hepatitis A. Typhoid fever only live in humans. Avoiding water that is used by animals is a great idea, but if this is the only precaution you take, it won't help you avoid contracting Typhoid fever.

Ciprofloxacin, an antibiotic, is a first-line agent for treating Typhoid fever. However, in Asia, resistance rates are very high to Ciprofloxacin, so another antibiotic should be used. Ceftriaxone or azithromycin are recommended. While effective for the treatment of typhoid fever, as well as traveler's diarrhea, antibiotics don't always prevent you from contracting a disease.

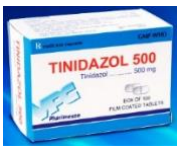
Typhoid Fever Vaccine Name	How Given	# of Doses Needed	Time Between Doses	Time immunization should be completed by (before possible exposure)	Minimum Age for Vaccination	Booster Needed Every...
Ty21a (Vivotif Berna, Swiss Serum and Vaccine Institute)	1 capsule by mouth	4	2 days	1 week	6 years	5 years
ViCPS (Typhim Vi, Pasteur Merieux)	Injection	1	N/A	2 weeks	2 years	2 years

Persistent Diarrhea

Parasites are the most likely cause of persistent diarrhea. While it is true that most travelers who get diarrhea have a bacterial or viral infection, these types are usually short-lived and self-limiting. When we say persistent diarrhea, we mean diarrhea that has lasted for more than one-two weeks. Patients with parasite related diarrhea will often trial antibiotics, but the antibiotics will have done little, if anything, to treat their diarrhea. In patients where a pathogen is identified, over a quarter of the patients had a parasite, namely Giardia.

The parasite, Giardia lamblia, causes the small intestine infection called Giardiasis. There is a 20% to 30% prevalence in the world's population. Giardia lamblia exists in two forms: an active form called a **trophozoite**, and an inactive form called a **cyst**. The active trophozoite attaches to the lining of the small intestine. The inactive cyst can survive for prolonged periods outside of the body. When it is ingested, stomach acids activate the cyst, and the cyst develops into the disease-causing trophozoite. It takes the ingestion of only ten cysts to cause an infection. In addition to humans, both domestic and wild mammals can become infected with giardia.

Symptoms of acute giardiasis include profuse watery diarrhea that later becomes greasy and foul-smelling with occasional bloating, abdominal cramping, and flatulation. Fever is a rare symptom of giardiasis. Many people have no symptoms at all but will still pass cysts in the stool. These patients are considered carriers of the parasite. In most patients, the illness is self-limiting and lasts two to four weeks. If untreated, the infection can potentially last for several months to years with continuing symptoms.



Tinidazole is the only medicine approved by the FDA for the treatment of Giardiasis. It is highly effective (>90%), and can be given as a single dose. It is well tolerated.

A very common treatment for giardiasis is metronidazole (Flagyl). It has an efficacy rate of 75% to 100%, but it often causes side effects. These include nausea, a metallic taste in the mouth, dizziness, and headache. Despite its effectiveness, metronidazole is not approved by the FDA in the U.S. for the treatment of giardiasis. Furazolidone and quinacrine are effective for treating giardiasis but are no longer available in the U.S. They are available in other parts of the world. Paromomycin, nitazoxanide, and albendazole are less effective than other treatments.

Because giardia infects the proximal small bowel, even multiple stools samples may fail to detect it. A duodenal aspirate may be needed for a definitive diagnosis. However, due to the high prevalence of giardia in persistent travelers' diarrhea, empiric therapy is reasonable even if a stool sample is negative.

Other intestinal parasites that are often implicated in persistent diarrhea include *Entamoeba histolytica*, *Cryptosporidium*, *Cyclospora*, *Isospora*, and *Microsporidia* (1,2,) but they are not as common as giardia.

Clostridium Difficile

Clostridium difficile classically causes persistent diarrhea after antibiotic administration for an unrelated bacterial infection. It has also been described in patients following the administration of malarial chemoprophylaxis. It can be a life-threatening infection if not treated appropriately. Suspicion should increase, particularly after multiple courses of empiric antibiotic therapy in a patient with a traveler's diarrhea that doesn't resolve. Treatment of C. difficile includes metronidazole, oral vancomycin, or fidaxomicin. There are increasing reports of resistance to vancomycin and metronidazole, but current recommendations are to use oral vancomycin for its treatment.

Tropical Sprue

Tropical sprue is a malabsorptive disorder that causes atrophy of the villus in the small intestines. It most often occurs in travelers who have spent more than one month in tropical latitudes. Tropical sprue is a disease that causes progressive villus atrophy in the small intestines. It is similar to non-tropical (celiac) sprue in that it impairs intestinal absorption. The etiology of tropical sprue is unclear. The current hypothesis is that the disease is caused by an infection that has yet to be identified. Patients will often have vitamin B12 and folate deficiencies. Antibiotics are the standard treatment for tropical sprue.

Patients will complain of diarrhea, weight loss, dyspepsia, bloating, and will eventually develop nutritional deficiencies. Tropical sprue is suspected from the clinical symptoms and a history of recent foreign travel to tropical countries. There are no specific blood tests to diagnose tropical sprue.

Tropical sprue occurs in countries contained within a narrow band, from 30 degrees north latitude to 30 degrees south latitude, though not in all countries. In the western hemisphere, it is seen in Haiti, the Dominican Republic, Puerto Rico, and Cuba, but not Jamaica or the Bahamas. In the Eastern world, it is seen in India, Burma, Indonesia, Borneo, Malaysia, Singapore, and Vietnam, but it is uncommon in Africa, China, and the Middle East.

Irritable Bowel Syndrome and Related Diseases

Irritable bowel syndrome is a functional GI disorder of diarrhea and constipation. E. coli is a bacterial diarrhea that is short-lived and self-limiting. Celiac sprue is an allergy to gluten and is controlled by avoiding foods that contain gluten.

Crohn's disease, Celiac disease, Ulcerative colitis, and Irritable bowel syndrome can all be seen after an acute case of traveler's diarrhea. A prevailing hypothesis is that an initiating endogenous pathogen triggers inflammatory bowel disease in genetically susceptible people.

Sometimes the onset of irritable bowel syndrome (IBS) can be traced to acute gastroenteritis. IBS that begins after enteritis has been termed post-infectious (PI)-IBS. To be labeled PI-IBS, symptoms should follow an episode of gastroenteritis or travelers' diarrhea if the investigation for microbial pathogens and underlying GI disease is negative.

Colorectal Cancer

Colorectal cancer can also cause persistent diarrhea in a returned traveler but typically occurs in higher-risk patient populations, namely those who are older than 50. They will often have blood in their stool, either grossly visible or occult, and can have new-onset iron deficiency anemia.

In a certain percentage of patients who present with persistent gastrointestinal symptoms, there is no specific source that can be identified. Patients may experience temporary enteropathy following an acute diarrheal infection, with villous atrophy, decreased absorptive surface area, and disaccharides deficiencies. This can lead to osmotic diarrhea, particularly when large amounts of lactose, sucrose, sorbitol, or fructose are consumed. The use of antimicrobial medications during the initial days of diarrhea may also lead to alterations in the intestinal flora and diarrhea symptoms.

CLICK HERE
to take a practice EXAM on
Diarrhea in the Returning Traveler

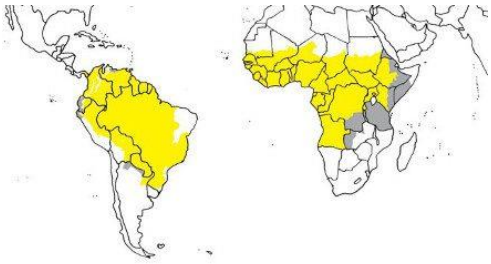
CLICK HERE
to listen to a PODCAST on
Diarrhea in the Returning Traveler

Chapter 3: Immunizations

Wilderness travelers go to places where there are many different and dangerous diseases. It is essential to receive proper vaccinations when traveling. Vaccination is when a vaccine is administered to a person. Immunization is what happens in the body after a person has the vaccination. The vaccine stimulates the immune system so that it can recognize the disease and protect from future infection. This chapter talks about some of the most important vaccines for world travel.

VACCINES FOR WORLD TRAVEL

Yellow Fever



Yellow fever is an acute viral infectious disease that is transmitted through the bite of infected mosquitoes, usually the Aedes. Though some cases of yellow fever are mild and self-limiting, yellow fever is often life-threatening disease, causing hemorrhagic fever and hepatitis (hence the term "yellow" from jaundice it can cause). This viral disease occurs in tropical areas of Africa and South America and is endemic in these areas. Each year there are an estimated 200,000 cases of yellow fever worldwide, leading to approximately 30,000 deaths.

About 99% of people develop immunity to yellow fever within one month of vaccination. Vaccination appears to be lifelong. Additional doses after the first vaccine are generally not needed. The vaccine can be used to control outbreaks of the disease, and it is given either by injection into a muscle or just under the skin.

Since the yellow fever vaccine is a live virus, it should not be given to those with weak immune function, those undergoing immunosuppressive therapies, or those who have had transplants, as they are on immuno-suppressant drugs. Yellow fever vaccine is generally safe for people, including those with HIV infection (but without symptoms). Patients with a malignant neoplasm have weakened immune systems and should not be given the vaccine.

Live vaccines administered to a pregnant woman pose a theoretical risk to the fetus. Therefore, live and attenuated virus vaccines generally are contraindicated during pregnancy. Benefits of vaccinating pregnant women usually outweigh potential risks when the likelihood of disease exposure is high, when infection would pose a risk to the mother or fetus, and when the vaccine is unlikely to cause harm. Thus, the yellow fever vaccine may be used for pregnant women if the benefit outweighs the risk.

Typhoid Fever

Typhoid causes high fever, weakness, stomach pains, headaches, and sometimes a rash. If it is not treated, it can kill up to 30% of the people who contract it. About 50% of people who contract typhoid become "carriers" and can spread the disease without knowing they have it.

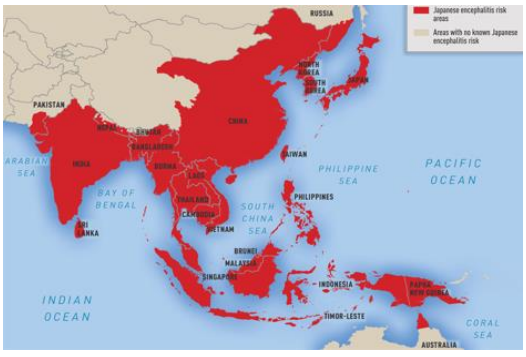
Typhoid fever is a systemic infection caused by the Gram-negative bacillus *Salmonella typhi*. Most salmonella types only cause a local infection of the gastrointestinal tract. However, as an invasive organism, typhoid fever can result in acute systemic infection. Intestinal hemorrhage and perforation may be life-threatening, as well as organ failure due to sepsis. Typhoid is spread by the fecal-oral route and is, therefore, associated with poor sanitation and ineffective personal hygiene. Typhoid infects about 21 million people per year around the world and kills about 200,000.

There are two vaccinations available for typhoid fever. The inactivated vaccine is given as a shot at least two weeks prior to travel. For patients receiving the shot, a booster dose is needed every two years for people who remain at risk. The other vaccine type is an attenuated vaccine, which is taken orally every other day for a week, with the last dose given at least one week before travel. For patients receiving the oral vaccine, a booster dose is needed every five years for people who remain at risk. Neither of these vaccines provides lifelong immunity.

The most common reaction to the typhoid vaccine shot (inactivated typhoid vaccine) is redness and swelling at the site of injection. A mild fever and a light headache are also common for this vaccine. For the oral (live typhoid vaccine), the most common reaction is a headache. Gastric symptoms such as stomach pain, nausea, vomiting, and rash are actually very rare. Neither form of vaccine has a high allergic rate. The risk of typhoid vaccine causing serious harm, or death, is extremely small. Typhoid vaccines are not 100% effective and are not a substitute for being careful about what a person eats or drinks.

The Live typhoid vaccine (oral) can be given to children ***older*** than age six. The Inactivated typhoid vaccine (shot) can be given to children ***older*** than age two. A person should wait at least three days after completing any antibiotic therapy before taking the oral vaccine. Several factors influence the age at which a vaccine is administered, including age-specific risks of the disease and its complications, the ability of children of a given age to develop an adequate immune response to the vaccine, and potential interference with the immune response by passively transferred maternal antibodies.

Japanese Encephalitis



Japanese encephalitis virus is a flavivirus related to dengue, yellow fever, and West Nile viruses and is spread by Culex mosquitoes. These mosquitoes often feed on pigs and wading birds (common to pig farms and rice fields, particularly in the rainy season). It cannot be transmitted by other humans.

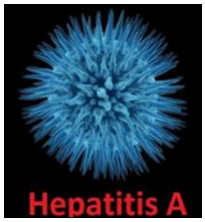
Japanese encephalitis is usually a mild illness. In many cases, there are no symptoms. Vaccines are available for adults and children. However, in a small number of cases (about 1 in 250 infected people), the illness is more serious. The case-fatality rate can be as high as 30%. Permanent neurologic or psychiatric sequelae can occur in up to 50% of those infected. The infection may start with fever,

tiredness, headache, and vomiting, and can sometimes cause confusion and agitation. This may progress to inflammation-causing encephalitis, which can cause permanent brain damage. Twenty-four countries in South-East Asia and Western Pacific regions have endemic transmission, exposing more than three billion people to the risks of infection.

Japanese encephalitis vaccine is not recommended for short-term travelers of less than one month whose visits will be restricted, primarily to urban areas or short trips outside in low transmission areas. However, a vaccine is recommended for travelers who plan to spend one month or more in endemic areas during the virus transmission season. This includes long-term travelers, recurrent travelers, or expatriates who will be based in urban areas but are likely to visit endemic rural or agricultural areas during a high-risk period of Japanese encephalitis virus transmission. This also includes travelers to endemic areas who are uncertain of specific destinations, activities, or duration of travel.

The Japanese encephalitis vaccine is more than 90% effective. How long this protection will last is not clear, but its effectiveness does appear to decrease over time. For those with HIV/AIDS, or for those who are pregnant, an inactivated vaccine should be used. The vaccines are relatively safe. Pain and redness may occur at the site of injection. There are at least 15 different vaccines available. Some are based on recombinant DNA techniques, others are based on a weakened virus, and others are an inactivated virus. In the United States, it costs between $100 and $200 US dollars for a course of immunizations.

Hepatitis A



Hepatitis A is usually spread by eating or drinking food or water contaminated with infected feces. It is not spread by blood to blood transmission. The first symptoms of hepatitis A usually show up anytime between two and six weeks after exposure to the virus. Globally, there are approximately 1.4 million symptomatic cases that occur each year, and about 102 million infections (symptomatic and asymptomatic). It is more common in regions of the world with poor sanitation and inadequate safe water. In the developing world, about 90% of children have been infected by age ten and thus are immune by adulthood. Only around 10–15% of people experience a recurrence of symptoms during the six months after the initial infection. Acute liver failure may rarely occur (with this being more common in the elderly).

Hepatitis A often occurs in outbreaks in moderately developed countries where children are not exposed when young, and vaccination is not widespread. The World Health Organization (WHO) estimated that, in 2016, 7,134 people died from hepatitis A worldwide. One of the largest outbreaks was in 1988 in Shanghai, China. The outbreak was related to food and water that affected more than 300,000 individuals.

Hepatitis A can be prevented by vaccination, good hygiene, and sanitation. The two types of vaccines are one containing inactivated hepatitis A virus, and another containing a live but attenuated virus. Both provide active immunity against future infection. The vaccine protects against the hepatitis A virus in more than 95% of cases for longer than 25 years. In the US, the

vaccine was first used in 1996 for children in high-risk areas, and in 1999 it was spread to areas with elevated levels of infection.

The vaccine is given by injection. An initial dose provides protection starting two to four weeks after vaccination. The second booster dose, given six to twelve months later, provides protection for over 25 years. After a single infection of hepatitis A, a person is immune for the rest of their life. Hepatitis A is an acute infectious disease of the liver caused by the hepatitis A virus (HAV). Many cases have few or no symptoms especially in the young. The time between infection and symptoms, in those who develop them is between two and six weeks. When symptoms occur, they typically last eight weeks and may include nausea, vomiting, diarrhea, jaundice, fever, and abdominal pain.

Travelers who are exposed to hepatitis A and who have not received the hepatitis A vaccine previously should undergo post-exposure prophylaxis. As well, they should be administered a single dose of single-antigen vaccine **or** immune globulin (IG) as soon as possible, preferably within two weeks.

All travelers for any purpose, frequency, or duration to countries that are mildly endemic with hepatitis A should be vaccinated for it. Taking into account the complexity of interpreting hepatitis A risk maps and the potential risk of foodborne hepatitis A in countries that are not endemic, many experts advise people who are traveling to consider hepatitis A vaccination regardless of their destination.

Although the Advisory Committee for Immunization Practices recommends hepatitis A vaccination for travelers, published maps may not be the best guide for determining endemicity in developing countries. Prevalence patterns of hepatitis A infection vary among regions within a country and missing, or obsolete data presents a challenge. Countries, where the prevalence of hepatitis A infection is decreasing have growing numbers of susceptible people, and risk for large outbreaks of hepatitis A. In recent years, large outbreaks of hepatitis A were reported in developed countries among people who had been exposed to imported food contaminated with hepatitis A. Recognized exposures to hepatitis A through infection in food handlers has also increased.

For healthy people aged one to forty years, a dose of monovalent hepatitis A vaccine is recommended. For people older than forty years, IG is preferred, but the vaccine can be used if IG is unavailable. IG is recommended for children less than one-year-old, for people who are immuno-compromised, for people who have chronic liver disease, and people for whom vaccine is contraindicated.

Information about the relative efficacy of the vaccine compared with IG post-exposure is limited, and data is not available for people aged forty years or older, or those with underlying medical conditions. Therefore, decisions to use the vaccine, or IG, should take into account patient characteristics, including older age and chronic liver disease. Of note is that years of experience have demonstrated that IG performs well as post-exposure prophylaxis in all populations and settings.

Babies and toddlers should be vaccinated whenever possible against common travel-related

diseases before they travel abroad. A number of factors influence the age at which a vaccine is given to a baby or toddler. These include age-specific risks of the disease and its complications, the ability of children to develop an adequate immune response, and potential interference with the immune response by passively transferred maternal antibodies. Many vaccines, such as typhoid, have strict requirements on age while others do not, such as the hepatitis A vaccine. Babies and children will be exposed to the same travel-related disease as adults. In addition, babies and toddlers need to be up to date on regular vaccines. Although some diseases such as polio, diphtheria, and pertussis are now practically nonexistent in developed countries, they still exist in many developing countries. Immunizations are particularly important if a child is likely to have close contact with local children.

Polio

Polio is a disease caused by a virus that affects the nervous system and is mainly spread by person-to-person contact. Polio can also be spread by drinking water, other drinks, or eating raw or undercooked food that is contaminated with the feces of an infected person. Most people with polio do not feel sick. Some people have only minor symptoms such as fever, fatigue, nausea, headache, nasal congestion, sore throat, cough, stiffness in the neck and back, and pain in the arms and legs. Most people recover completely. In rare cases, polio infection causes permanent loss of muscle function in the arms or legs (usually the legs). If there is a loss of function of the muscles used for breathing or infection of the brain, death can occur.

From the late 1940s to the early 1950s, polio crippled millions of people, making it one of the most feared diseases of the 20th century. Only three countries remain where polio has not been stopped: Afghanistan, Nigeria, and Pakistan. The affected areas in these three countries have become smaller. However, polio has been exported to countries that had previously been polio-free, and seven other countries have had cases of wild poliovirus and spread of polio in the last 12 months. Until polio is stopped everywhere, even polio-free countries are at risk for outbreaks.

Travelers going to certain parts of Africa and Asia may be at risk for polio. Everyone should be up to date with their routine polio vaccination series. In addition, a one-time adult polio vaccine booster dose is recommended for travelers to certain countries. A person should see individual country requirements for vaccine recommendation information.

If you are traveling to one of the following countries (that have had active spread of poliovirus in the past 12 months), for more than four weeks, the government of these countries may require you to show proof of polio vaccination when you are exiting that country. They are Afghanistan, Burma (Myanmar), Guinea, Laos, Madagascar, Nigeria, Pakistan, and Ukraine. This list may change frequently.

Rabies

For a human to contract rabies, two things must happen. First, a person must have contact with a rabid animal (*not necessarily a bite or a scratch).* Second, the contact must allow for the transmission of infected material, which will involve exposure to the saliva of the infected animal, usually through a bite or scratch. Contaminated tissue in the rabid animal includes saliva.

Another potentially infectious tissue is in the brain or nerve tissue. The virus is transmitted only when the virus gets into bite wounds, or open cuts on the skin, or onto mucous membranes (for example, into your eyes or your mouth). The virus then spreads from the site of the exposure to your brain and eventually spreads throughout your body's major organs.

Bites are the most common source of transmission. Scratches by infected animals are far less likely to cause infection but are still considered a potential source of rabies transmission. Rabies has rarely been transmitted by other means. However, documented examples include inhaling a large amount of bat secretions in the air of a cave by two cave explorers and inhaling the concentrated virus in laboratory workers who were studying rabies.

When treating rabies, there several important questions to consider when determining if a patient should receive post-exposure prophylaxis. The behavior of the animal is important because normal behavior would imply that an animal does not have rabies. Some animals are more likely to carry rabies, and other animals might be higher transmitters of the disease.

Raccoons are the most common wild animal carriers of rabies in the United States, Canada, and Europe. Bats are the most common animals responsible for the transmission of human rabies in these countries, accounting for more than half of human cases since 1980, and 74% since 1990. Rabid bats have been reported in all of these countries. Skunk, fox, and coyote can also be infected with rabies. The biggest carrier and transmitter of rabies in the world is the dog. Bats have tiny teeth, so tiny scratches caused by a bat might result in rabies. However, bites or scratches are often not confirmed in cases of human rabies traced to bats. Since 1990, in the 20 cases of human rabies associated with a bat, a definite history of a bat bite could be confirmed in only one case. It is unclear how the virus was transmitted in the other case, perhaps by an undetectable bite or scratch.

Reptiles, fish, or birds are not known to carry the rabies virus. Small rodents like squirrels, hamsters, guinea pigs, gerbils, chipmunks, rats, mice, and lagomorphs, including rabbits and hares, are almost never found to be infected with rabies. As well, these small rodents have not been known to transmit rabies to humans.

In most countries, patients receive one dose of immunoglobulin (HRIG) and four doses of the rabies vaccine over a 14-day period. If anatomically feasible, the full dose of HRIG is infiltrated around and into any wounds. Any remaining volume is injected intramuscularly at a site distant from the vaccine administration. HRIG is not administered in the same syringe or at the same anatomic site as the first vaccine dose. However, subsequent doses (i.e., on days 3, 7, and 14) of the vaccine in the 4-dose vaccine series can be administered in the same anatomic location in which HRIG was

administered. The first dose of rabies vaccine should be given as soon as possible after exposure (day 0), with additional doses on days 3, 7, and 14 days after the first vaccination.

Treatment after exposure is highly successful in preventing the disease if administered within six days after infection and completion of a 14-day treatment regimen. It is effective until the patient develops the disease. Thoroughly washing the wound as soon as possible with soap and water is very effective at reducing the number of viral particles. Exposed mucous membranes such as eyes, nose, or mouth should be flushed very well with water.

Veterinarians, veterinary technicians, animal control officers, wildlife rehabilitators, and zoo employees who have regular contact with potentially rabid animal species should be vaccinated for rabies. International travelers to areas with endemic canine rabies who are likely to come into contact with dogs or wild animals and where access to medical care and appropriate biologics may be limited should also be vaccinated regardless if they are close to medical care or not. Pre-exposure vaccines to rabies are effective.

CLICK HERE to take a practice EXAM on Immunizations Needed for Travel

CLICK HERE to listen to a PODCAST on Immunizations Needed for Travel

Chapter 4: Reducing the Risk of Mosquito Exposure

From the Earliest of Times…

The oldest known mosquito with an anatomy similar to modern species was found in Canadian amber that dated from the Cretaceous period, more than 79 million years ago.

ALL ABOUT MOSQUITOES

Mosquitoes are attracted by CO2, lactic acid, warm skin, and moisture. They also move toward the smell of soap, detergents, and perfumes. Only female mosquitoes have the mouth parts necessary for sucking blood. When biting with their proboscis, they stab two tubes into the skin: one to inject an enzyme that inhibits blood clotting; the other to suck blood into their bodies. They use the blood, not for their own nourishment, but as a source of protein and iron for their eggs. For food, both males and females eat nectar and other plant sugars.

Two Types of Habitats

All mosquitoes must have water to survive. They generally live in two types of habitats: **permanent water and floodwater areas**. Permanent water mosquitoes tend to lay their eggs on the surface of standing water at the edges of lakes and ponds and among the vegetation in swamps and marshes. Culex and Anopheles mosquitoes are among the most common permanent water mosquitoes. Some species prefer clean water, while others prefer stagnant or polluted water. These mosquitoes are most active when the average temperature is above 70 degrees Fahrenheit. Many permanent water mosquitoes can also breed in containers that accumulate water. such as wading pools, buckets, or toys left outside.

Floodwater mosquitoes lay their eggs in moist soil. The eggs will dry out as the ground dries, then hatch when rains saturate the ground. Floodwater habitats include drainage ditches that fill during storms, woodland pools created by melting snow, spring and early summer rains, floodplains along the banks of streams, rivers, and irrigated pastures and fields. Floodwater mosquitoes also breed in containers. For example, the Aedes prefers the insides of old tires where dirty water collects and tree holes that accumulate rainwater.

Mosquitoes can live in almost any environment, except for freezing climates. All mosquitoes need water to breed, so eradication and population-control efforts usually involve removal or treatment of standing water sources. Insecticide spraying to kill adult mosquitoes is also widespread. However, global efforts to stop the spread of mosquitoes are having little effect, and many scientists think global warming will increase their number and range.

The Three Species that Spread Human Disease

Globally, there are about 75 quadrillion mosquitos on earth. That is almost 20 million mosquitoes per person. But of the 3,000 species of mosquitoes, only three species bear the primary responsibility for the spread of human diseases.

Anopheles	Malaria, filariasis (also called elephantiasis), encephalitis	
Culex	Encephalitis, filariasis, and the West Nile virus	
Aedes	Yellow fever, dengue, and encephalitis, chikungunya, Zika	

Anopheles mosquitoes tend to prefer freshwater breeding sites and will bite at night in more remote settings. Anopheles mosquitoes breed during the warmer months. Females also deposit their eggs on the surface of the water. Unlike other mosquito larvae, Anopheles larvae do not have breathing tubes, so they must lie parallel to the surface and breathe through holes in their sides called spiracles. While Culex mosquitoes can breed and thrive in stagnant or polluted water, the Anopheles mosquitoes prefer clean water habitats in marshes, swamps, and rice fields, among others. The adult females usually live about two weeks and feed at dusk and dawn. Anopheles mosquitoes are the carriers of the parasite that causes malaria and transmit the germs through their saliva when they bite. More than one million deaths each year are attributed to malaria passed on by Anopheles mosquitoes.

Culex mosquitoes breed in standing water. They can be quite persistent in their biting habits, and their bites tend to be painful. Culex mosquitoes tend to hibernate over the winter and breed during the warmer months, laying rafts of eggs at night on the surface of standing water. They normally don't travel more than a few hundred yards from where they hatched. Adults feed primarily from dusk until a few hours after dark and are considered aggressive and persistent biters, although they prefer birds to people. It is the primary carrier of the West Nile virus.

Aedes mosquitoes have particularly painful bites, and they can travel up to 75 miles away from the breeding habitat. They tend to bite during the day in urban areas. Aedes mosquitoes are floodwater mosquitoes, meaning they lay their eggs on moist soil or in containers that periodically catch rainfall. They prefer to breed in tree holes, overflow ditches, and old tires. The eggs can survive drying and hatch once revived by water. Aedes mosquitoes tend to breed in warm weather, although some species can survive in colder environments. The adults feed day and night. Several species types are considered particularly troublesome. Aedes vexans, the inland floodwater mosquito, is known as a fierce and painful biter. Aedes albopictus, the Asian tiger mosquito, transmits dengue fever and eastern equine encephalitis while Aedes aegypti, the yellow fever mosquito, transmits dengue and yellow fever.

Diseases Spread by Mosquitoes

No other insect carries more disease or is responsible for more deaths on the planet than the mosquito. By transmitting diseases, mosquitoes cause the deaths of more people than any other animal, over 700,000 each year. According to the World Health Organization, in 2015, about 3.2 billion people, nearly half of the world's population, were at risk of malaria. Some of the most prominent diseases include:

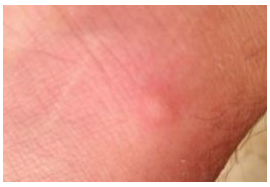
- Malaria
- Dengue Fever
- Yellow Fever
- Eastern Equine Encephalitis
- Japanese Encephalitis
- St. Louis Encephalitis
- West Nile Virus
- Western Equine Encephalitis
- Rift Valley Fever
- Chikungunya
- Zika

A mosquito uses the sharp tip of its straw-like mouth (proboscis) to pierce a person's skin. It locates the blood vessel and draws blood up through its mouth. As it does this, it injects saliva that contains an anticoagulant. If the blood were to clot around the mosquito's mouth, it would stick in the skin. With the saliva comes the disease. Every time an infected mosquito inserts its proboscis into the skin, that person is infected with the virus instantly, 100% of the time.

Mosquitoes transmit disease by both parasite and virus. In the case of malaria, parasites attach themselves to the gut of a female mosquito and enter a host as she feeds. In other cases, such as yellow fever and dengue, a virus enters the mosquito as it feeds on an infected human and is transmitted via the mosquito’s saliva to a subsequent victim.

The red bump and itching caused by a mosquito bite is an allergic reaction to the mosquito’s saliva. Although mosquito bites are itchy, try to avoid scratching. They'll go away on their own. If relief is needed, apply hydrocortisone cream or calamine lotion to the bite. A cold pack or baggie filled with crushed ice may help, too.

Avoid Being Bitten



The only way to avoid infection is to avoid being bitten. The following suggestions could help you avoid being bitten, whether you're out in the wilderness or in your backyard.

- A useful method to avoid mosquito bites is to stay indoors during certain times of the day. The most common mosquito species prefer to feed at dawn and dusk and will continue feeding two to three hours after dark. Try to avoid going outside as much as possible during these times. Be aware, however, that some species feed during the day and are aggressive biters.
- Wear clothing that is tightly woven, such as nylon, and is loose fitting so that a mosquito cannot bite through the clothing. Wear clothing with long sleeves and long socks with pants tucked into socks or boots. As well, wear light-colored clothing. Mosquitoes select prey is by honing in on the heat produced by warm-blooded bodies. Dark-colored clothing traps heat, making the wearer the warmest victim for the mosquito. Mosquitoes also have photosensitive eyes that can detect bright colors.
- Avoid using scented bath products. Although the reasons aren't clear, mosquitoes seem to be attracted to fragrances used in shampoos, colognes, perfumes, and lotions. Not every product or scent will attract them, but many do, so it is best not to wear colognes or perfumes, and use unscented shampoos, lotions, etc.
- The use of mosquito nets and screens is an effective way to prevent mosquitos from biting. Fit mesh screens around doors and windows to provide mosquito-free zones inside your home. Also, consider sleeping with a mosquito net over your bed. The mosquito netting has fine holes that are big enough to allow breezes to pass through easily, but small enough to keep mosquitoes and other biting insects out.
- Choose a campsite that is above and away from standing water.
- Permethrin is a naturally occurring compound with insecticidal and some repellant properties that will remain on clothing for weeks when properly applied. Permethrin is from a group of chemicals called pyrethroids that are a synthetic form of a natural insecticide found in chrysanthemum flowers. Like malathion, permethrin kills mosquitoes by disrupting their central nervous systems. It's not harmful to people and most animals in small amounts, but it is toxic to fish and bees and makes cats sick.

Mosquito Repellants

The United States Food and Drug Administration has approved three repellants for use in repelling insects and other insects. They are **DEET**, **Picaridin**, and **Lemon Oil Eucalyptus**. These are applied to uncovered skin.

DEET is the gold standard for insect repellents. It is sold in formulations of 5% to 35%. Use formulations of 10% or less in children and avoid use altogether in infants under six months of age. DEET and Picaridin can be applied to adults and children over two months of age and are appropriate to repel mosquitoes carrying the West Nile virus. However, DEET should not be

applied to the hands or near the mouth of the eyes of children. Thousands of studies have shown that DEET remains the best method of preventing the bite of mosquitoes. It is important to use 30 percent DEET to prevent the bite of the malaria-carrying Anopheles mosquito.

Other compounds such as Picaridin or Oil of Lemon Eucalyptus can be used to prevent mosquitoes from biting. Still, these will not be strong enough to prevent the bite of the more aggressive Anopheles mosquitoes found in malaria-infected countries. While Picaridin and Oil of Lemon Eucalyptus also been shown to repel mosquitoes, neither provides the same level of protection as DEET. Repellents that contain up to 30 percent DEET or Picaridin are also safe once a child is two months old. The American Academy of Pediatrics advises not to use any insect repellents on a baby who is not yet two months old.

Picaridin 20% concentration has been shown to have similar efficacy as 20% DEET for up to eight hours. Picaridin 7% has a similar efficacy to 10% DEET. Picaridin has notably less malodor and less staining of materials than DEET. Picaridin has been marketed as an alternative to DEET. It was created by the German company Bayer AG in the late 1980s. It quickly became popular in Australia and gained approval in the U.S. in 2003. As a receptor blocker, Picaridin doesn't actually repel mosquitoes. Instead, it keeps mosquitoes from locating prey. In two Australian Army studies, soldiers reported that Picaridin performed nearly as well as DEET, and caused less skin irritation. Five to ten percent of solutions of Picaridin is available in lotions, sprays, and wipes. Picaridin is considered safe for children, except for those two months and under.

Oil of Lemon Eucalyptus is developed from the lemon eucalyptus tree and is known as a biopesticide. It was initially discovered in China and recently earned a recommendation from the CDC. The oil is synthesized from the tree's twigs and leaves. It works by blocking mosquitoes' chemical receptors and is available in both sprays and lotions. Oil of Lemon Eucalyptus has performed well in tests providing about two hours of protection, but the label says that it is not recommended for children under the age of three. It is a naturally occurring chemical, unlike DEET and Picaridin, which are synthetic man-made substances.

Oil of Lemon Eucalyptus is generally considered to be the most effective *natural* repellent on the market. In 2005, the Centers for Disease Control added this to its list of recommended insect repellents. They found repellents with concentrations of at least 30% generally provide about two hours of full protection from mosquitoes and up to six hours under certain conditions, which is roughly equivalent to repellents with 10% to 15% percent DEET. However, it provides significantly less duration of protection than higher concentrations (20% to 50%) of DEET and Picaridin, which completely repel mosquitoes for five hours or more.

Other Repellants

Candles made from **Citronella** help keep mosquitoes away, as well as from biting. Studies have shown that when sitting near a candle made with Citronella, people will generally see about a 42% decrease in mosquito bites. Ordinary unscented candles will decrease bites by about 23%. Citronella is a naturally occurring repellent distilled from grasses. Oil of Citronella is a mixture of

many components. The exact composition varies with grass variety. However, the main ingredients are Citronellol, Citronella, and Geraniol.

Currently, **Oil of Citronella** can be found in over a dozen registered pesticide products. Oil of Citronella can be formulated into sprays, lotions, candles, pellets, and pouches. It can also be placed in some sunscreen products, wristbands, and flea collars. It works by masking scents attractive to mosquitoes, making it difficult for mosquitoes to locate their target. It has not been approved as a repellent by the Center for Disease Control.

Many years ago, Avon's Skin-So-Soft bath oil was suggested to have mosquito repellent properties. Since then, **Avon Company** has produced a line of **Skin-So-Soft products** specifically designed to repel mosquitoes. These currently incorporate mostly **IR3535** and Picaridin. These products were tested in cage studies done from 2002-2004 against two species of mosquitoes. In general, the length of protection was similar to that for DEET preparations of the same concentration. These products provided protection for an average of 10-15 minutes (range of 1-30 minutes) for all volunteers. This is not that long compared to other stronger strengths of other repellents such as DEET.

Skin-So-Soft, or IR3535, was developed by Merck & Company in the mid-1970s and has been used in Europe. Registered for use in the U.S. in 1999, IR3535 can be irritating to the eyes and may dissolve or damage plastics but poses few other safety risks. Consumer Reports determined that it performed as well as DEET against the Culex mosquitoes that sometimes carry the West Nile virus. However, the 20 percent formulation was slightly less effective than DEET in repelling mosquitoes that may carry yellow fever, dengue fever, and encephalitis.

Products containing DEET, Picaridin, and IR3535 are recommended by the Centers for Disease Control and Prevention (CDC) for adults and children two months of age and older. Picaridin is a chemical that's similar in effectiveness to DEET, but it's odorless, lighter, and less irritating. The CDC has also recommended Oil of Lemon Eucalyptus, but not for children younger than age three, as no testing has been done on children under three years of age.

Home Remedies as Repellants

Dryer sheets, along with a number of household items, including banana peels and Vicks VapoRub are all rumored to be mosquito repellents. They are not, in fact, effective repellents. Mouthwash and dish soap have no efficacy at all in repelling mosquitoes. The idea is that putting lemon dish soap or mouthwash in pools of water around the yard will attract and kill mosquitoes. In order for this to happen, a mosquito would have to both land on and subsequently become coated in the liquid in order to expire.

Insecticides

Malathion and permethrin are the two most popular and effective insecticides available. Malathion is an organophosphate that can be sprayed directly onto vegetation, including bushes where mosquitoes like to rest or used in a solution to fog the yard. It works by disrupting the mosquito's

central nervous system. In small amounts, it can be used for mosquito control. It poses no threat to humans or wildlife. In fact, malathion can also be used to kill head lice.

Both malathion and permethrin are also available in sprays for use inside the home. Permethrin can also be applied directly to nets and clothing as an additional barrier to help kill mosquitoes.

Insecticides are a quick and effective way to get rid of mosquitoes around the yard and garden where food products and people and animals are present. The effect is only temporary, however, usually lasting only as long as the insecticide is present. You should use insecticides when mosquitoes are unusually thick and only in combination with other forms of mosquito control. By itself, the insecticide is not a long-term solution.

CLICK HERE
to take a practice EXAM on Reducing the Risk of Mosquito Exposure

CLICK HERE
to listen to a PODCAST on Reducing the Risk of Mosquito Exposure

Chapter 5: Parasites

Anyone who travels into the backcountry, or to places around the world, are at increased risk for being infected with a parasite. While it's important to have a broad understanding of parasites, one should have specific knowledge about the parasites that can infect humans.

TYPES OF PARASITES

There are three main classes of parasites that can cause disease in humans:

- Protozoa
- Helminths
- Ectoparasites

Protozoa and helminths primarily affect the gut, while ectoparasites include lice and mites that can attach to, or burrow into, the skin, staying there for long periods of time. The majority of protozoa and helminths tend to be non-pathogenic or result in very mild illness. Some, however, can cause severe disease in humans. Fecal-oral transmission, where parasites found in the stool of one person end up being swallowed by another person, is the most common mode of transmission of parasitic protozoa and helminths. The initial symptoms tend to be gastrointestinal symptoms like diarrhea. When parasites invade the red blood cells or organs, the consequences can become more serious.

Protozoa

Protozoa are tiny single-celled organisms that multiply inside the human body. The protozoa giardia, for example, has a classic two-stage life cycle. In the first stage, called trophozoite, the parasite swims around and consumes nutrients from the small bowel. In the second stage, it develops into a non-moving cyst.

Helminths

Helminths**,** often called worms, are large multicellular organisms usually visible to the naked eye in their adult stages. As a general rule, helminths cannot multiply inside the human body. One major group of helminths are flatworms. Flatworms literally have flattened soft bodies. Their digestive cavity has only one opening for both the ingestion and removal of food. It's thought 80% of flatworms are parasitic. Tapeworms are one type of flatworm.

Another major group of helminths is nematodes, commonly known as roundworms. Nematodes are the most numerous multicellular animals on earth and can be found in almost every environment. Unlike flatworms, they do have a digestive system that extends from the mouth to the anus. More than 50% of the world's population is thought to be affected at one point during their life by at least one of six main classes of nematodes.

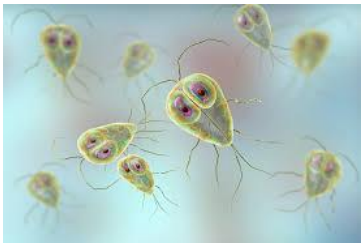
The eggs or larvae of these nematodes usually develop in the soil before being transmitted to the human host. For this reason, these nematodes are often called soil-transmitted helminths. A good example are hookworms, which infest humans by penetrating the skin from contaminated soil. Wearing appropriate footwear is an important way to prevent hookworm transmission.

Ectoparasites

Ectoparasites generally refer to organisms such as ticks, fleas, lice, and mites that can attach or burrow into the skin and remain there for long periods of time. Scabies, a contagious skin disease marked by itching and small raised red spots, is caused by the human itch mite. Scabies usually is spread by direct, prolonged, skin-to-skin contact. Head lice are small, wingless insects that live and breed in human hair and feed by sucking blood from the scalp.

Some parasites can lie dormant for extended periods of time. This can make the diagnosis of parasitic infestation challenging as there may be no symptoms, or symptoms can be vague and non-specific. The good news is that there are viable medications to treat many different kinds of parasites once they've been diagnosed. These medications do have side effects. but on the whole, they are very effective.

Giardia



Giardiasis is an infection of the small intestine that is caused by the parasite known as giardia lamblia. It is the most common cause of parasitic gastrointestinal disease. There is a 20% to 30% prevalence in the world's population. Symptoms of acute giardiasis are profuse watery diarrhea that later becomes greasy and foul-smelling with occasional bloating, abdominal cramping, and flatulation. Fever is rare. In most patients, the illness is self-limiting and lasts two to four weeks. In patients who are not treated, however, the infection can last for several months to years with continuing symptoms.

Symptoms of giardiasis are variable. Many people have no symptoms at all but still pass cysts in the stool and are considered carriers of the parasite. Others may develop acute or chronic diarrheal illnesses. Giardia is the most common parasitic pathogen in patients with persistent diarrhea. Suspicion for giardiasis should increase as symptoms continue. Because giardia infects the proximal small bowel, multiple stools samples may fail to detect it. A duodenal aspirate may be needed for a definitive diagnosis. Due to the high prevalence of giardia in persistent travelers' diarrhea, empiric therapy is reasonable if a stool sample is negative.

Other common intestinal parasites that can cause persistent diarrhea include cryptosporidium, entamoeba histolytica, and cyclospora, but they are not nearly as common as giardia. Giardia is found in almost every country in the world. It is shed in human and animal feces and can infect lakes, rivers, streams, ponds, and other bodies of water.

Giardia lamblia exists in two forms; an active form called a trophozoite, and an inactive form called a cyst. The active trophozoite attaches to the lining of the small intestine. The inactive cyst exists for prolonged periods outside the body. When it is ingested, stomach acid activates the cyst, and the cyst develops into the disease-causing trophozoite. It takes the ingestion of only ten cysts to cause infection. Domestic and wild mammals can become infected with giardia.

Tinidazole is the only medicine approved by the FDA in the USA for the treatment of giardiasis. Tinidazole is highly effective (>90%), can be given as a single dose, and is well tolerated.

Perhaps the most well-known drug to treat giardiasis is metronidazole (Flagyl.) It often causes gastrointestinal side effects, such as nausea and a metallic taste. It has an efficacy rate of 75% to 100%. Despite its effectiveness, metronidazole is not approved by the FDA in the USA for the treatment of giardiasis. Furazolidone and Quinacrine are effective for treating giardiasis but are no longer available in the USA. These two drugs are available in other parts of the world. Paromomycin, and albendazole are less effective than other treatments.

Treating giardiasis with natural remedies has shown some potential promise in some studies. Retrospective data is useful. Foods such as grapefruit, beet juice, garlic, and horseradish have all been mentioned as helping avert giardia. The advantage of these foods is they don't carry the toxic side effects of many of the medicines used to kill giardia, and they are safe to use with children.

Water filtration is an excellent way to prevent giardiasis. The cysts are quite large, as are the trophozoites. They are easily trapped in water filters. They are also responsive to heat. They do not respond as well to halogen therapy.

Cryptosporidium

Cryptosporidium is a microscopic parasite that causes the diarrheal disease cryptosporidiosis. Both the parasite and the disease are commonly known as "Crypto." While this parasite can be spread in several different ways, drinking water and recreational water are the most common way to spread the parasite.

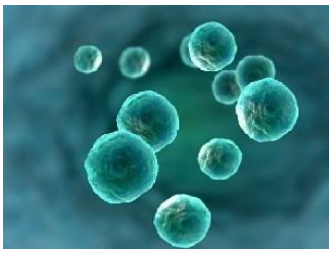
Cryptosporidium is protected by an outer shell, so it has a particularly high tolerance to chlorine, which allows it to survive for a long time in chlorinated water, like community pools. There have been many outbreaks of cryptosporidium in public pools and tap water throughout the world.

Cryptosporidium can be found in lakes, rivers, streams ponds, and other natural bodies of water. If the water isn't treated properly, hikers and campers can be at risk of becoming infected. Anyone who ingests the cysts can become ill, but children, pregnant women, and the immune-compromised are at a greater risk for developing it more severely. Once a cryptosporidium cyst is ingested, the cysts release a sporozoite, which then infects an epithelial cell in the gastrointestinal tract. It continues to reproduce inside the body. Thick-walled cysts are shed in the stool.

GEMS was a three-year, case-control study conducted at seven sites in Africa and Asia. Cryptosporidium, a pathogen not expected to be a significant contributor, was found to be the second leading cause of infants having moderate to severe diarrhea. The results were published in the May 2013 issue of The Lancet.

Signs and symptoms are not consistent with giardia. (E. Coli is more typically seen in undercooked ground beef, raw milk, and contaminated water.) Cryptosporidium is often found in recreational water. Symptoms usually appear sooner than ten days. Most healthy people with cryptosporidiosis recover within two weeks without treatment. If the patient has a compromised immune system, medications such as nitazoxanide (Alinia) can help relieve diarrhea by attacking the parasites. Azithromycin (Zithromax) may be given with one of these medications. Anti-motility agents slow the movements of intestines and increase fluid absorption to relieve diarrhea and restore normal stools. Fluid replacement is essential.

Cyclospora



Cyclospora is a protozoan parasite. It is endemic in geographic regions with warm or tropical climates. Cyclosporiasis typically has an onset after an incubation period of approximately one week and is characterized by protracted and often relapsing gastroenteritis. Cyclospora is transferred in a fecal to oral fashion but needs to mature outside the body in order to become infectious. This makes person-to-person transmission less likely.

The first foodborne outbreak of cyclosporiasis in central Europe occurred in Germany in 2001. The only foods associated with significant disease risk were two salad side dishes prepared from lettuce imported from southern Europe and spiced with fresh green leafy herbs. It is felt that farmworkers had contracted the disease while working in fields in central America and had transported the disease to fields in Europe.

Cyclospora occurs in many countries around the world but tends to be found mostly in tropical and subtropical climates. In regions where it has been studied, there has been a seasonal, yet inconsistent, pattern to infections. Numerous imported fresh fruits and vegetables, including raspberries, basil, and snow peas have been implicated in outbreaks of cyclosporiasis. Treatment is with trimethoprim-sulfamethoxazole.

Ascariasis

Ascariasis is a roundworm infection. It is thought to be the most common worm infection in people worldwide, with approximately one billion people infected. Most infected people have mild cases with no symptoms. However, a heavy infestation can lead to severe symptoms and complications. Ascariasis occurs most often in children in tropical and subtropical regions of the world, especially in areas with poor sanitation and hygiene. These worms are parasites that use a human body as a host to mature from larvae to adult worms. Adult worms, which reproduce, can be more than a foot (30 centimeters) long.

Ascaris isn't spread directly from person to person. Instead, a person has to come into contact with soil mixed with human feces that contain Ascariasis eggs or infected water. The microscopic ascaris eggs can't become infective without coming into contact with soil. In many developing countries, human feces are used for fertilizer, which allows human waste to mix with soil in yards, ditches,

and fields. Small children often play in the dirt, and infection can occur if they put their dirty fingers in their mouths. Unwashed fruits or vegetables grown in contaminated soil can also transmit the Ascaris eggs. Hand washing, cooking food, peeling fruit, washing fruits, vegetables, and salads will all help to prevent infection from Ascaris.

The Ascaris larvae hatch in the small intestine and then penetrate the intestinal wall to travel to the lungs via the bloodstream. After maturing for about a week in the lungs, the larvae break into the airway and travel up the throat, where they're coughed. This becomes a major symptom of this disease. They are then swallowed. Once back in the intestines, the parasites grow into male or female worms. Female worms can be more than 15 inches (40 centimeters) long and a little less than a quarter-inch (6 millimeters) in diameter. Male worms are generally smaller.

Male and female worms will mate in the small intestine. Female worms can produce 200,000 eggs a day, which exits the body in feces. The fertilized eggs must be in the soil for at least 18 days before they become infective. The whole process, from egg ingestion to egg deposits, takes about two or three months. Ascaris worms can live inside a person for one to two years. Anthelminthic, such as albendazole and mebendazole, are the drugs of choice for treatment of Ascaris infections, regardless of the species of worm. Infections are generally treated for 1-3 days.

Hookworm

The hookworm is a soil-transmitted worm and is one of the most common roundworms infecting humans. An estimated 576-740 million people in the world are infected. Infection is caused by *Necator americanus* and *Ancylostoma duodenale*. Hookworm infections occur in areas where human feces are used as fertilizer or where defecation onto soil occurs. Most people infected with hookworms have no symptoms. Persons who are infected for the first time may have gastrointestinal symptoms. The most serious effects of hookworm infection are blood loss leading to anemia and to protein loss.

Hookworms live in the small intestine. The eggs are passed in the feces of an infected person. If the infected person defecates outside, eggs are deposited in the soil. They can then mature into a form that can penetrate the skin of humans. Hookworm infection is mainly acquired by walking barefoot on contaminated soil. Anthelminthic medications, such as albendazole and mebendazole, are the drugs of choice for the treatment of hookworm infections. Infections are generally treated for 1-3 days. The recommended medications are effective and appear to have few side effects. Iron supplements may also be prescribed if the infected person has anemia.

Whipworm

A whipworm (*Trichuris trichiura*) infection, also known as trichuriasis, is an infection of the large intestine. This parasite is commonly known as a “whipworm” because it resembles a whip. A whipworm infection can develop after ingesting water or dirt contaminated with feces containing whipworm parasites. Anyone who has come into contact with contaminated feces can also contract a whipworm infection. The infection most often occurs in children. It is also more common in

people who live in regions with hot, humid climates and in areas with poor hygiene and sanitation. Persons in these areas are at risk if soil contaminated with feces enter their mouths or if they eat vegetables or fruits that have not been carefully washed, peeled, or cooked.

The larvae and adult worm live in the intestine of humans. The disease can cause severe and painful bowel movements, which contain a mixture of blood, mucus, and water. Because the worm consumes food and nutrients, children are at risk for growth retardation, anemia, and cognitive impairment. When enough worms congregate near the rectum, it can prolapse.

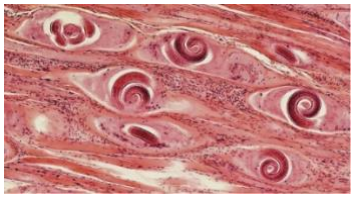
Trichinellosis

Trichinellosis is a parasitic roundworm infection caused by worms in the trichinella genus. Trichinellosis, also called trichinosis, is a disease that people can contract by eating raw or undercooked meat from animals infected with the microscopic parasite *Trichinella*. A classic sign of trichinosis is periorbital edema or swelling around the eyes, which may be caused by vasculitis. Splinter hemorrhaging in the nails is also a common symptom. Leg edema is typically caused by heart failure, renal failure, and low serum albumin.

Once consumed, the acid in the stomach releases the larvae, which invade the intestinal mucosa and mature into the adult worm. The adult worm releases more larvae into the circulatory system, which then encase themselves in the victim's muscles. Severe infections can lead to myocarditis, encephalitis, or pneumonia. The severity of symptoms caused by larval migration from the intestines depends on the number of larvae produced. As the larvae migrate through tissue and vessels, the body's inflammatory response results in edema, muscle pain, fever, and weakness.

Diagnosis is usually made by symptoms and is confirmed by serology. Cysts on a muscle biopsy would lead to a definitive diagnosis, but muscle biopsies are not frequently needed. A CBC will show an increase in eosinophils, which is not specific to trichinellosis. MRIs and stool samples are not useful in diagnosis. Safe and effective prescription drugs are available to treat both *Trichinella* infection and the symptoms that occur as a result of infection. Treatment should begin as soon as possible. The treatment decision will be based upon symptoms, exposure to raw or undercooked meat, and laboratory test results.

Tapeworm



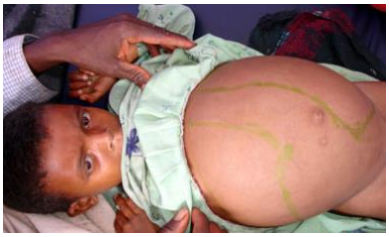
Tapeworm infection is caused by ingesting food or water contaminated with tapeworm eggs or larvae. If a person ingests certain tapeworm eggs, they can migrate outside the intestines and form larval cysts in body tissues and organs. If they ingest tapeworm larvae, however, they develop into adult tapeworms in the intestines. Intestinal tapeworm infections are usually mild, with only one or two adult tapeworms. But invasive larval infections can cause very serious complications.

Taeniasis is the name of the intestinal infection caused by adult tapeworms. There are three tapeworm species that cause **taeniasis** in humans:

- Taenia solium

- Taenia saginata
- Taenia asiatica

Only *T. solium* causes major health problems. After consuming the cysts in undercooked meat, humans will develop taeniasis, which is a tapeworm infection. These worms then lay eggs that are passed in human feces. Muscles infected with tapeworm cysts result from eating feces contaminated with tapeworm eggs.



Persons with taeniasis may have mild or no symptoms. They can, however, experience abdominal pain, loss of appetite, weight loss, and upset stomach. A visible symptom of taeniasis is the passing of tapeworm segments through the anus and in the feces. In rare cases, a tapeworm segment, or segments, can become lodged in the appendix, bile duct, or pancreatic ducts.

The development of cysts in muscle or brain tissue is called cysticercosis and is caused by larval cysts of the tapeworm *Taenia solium*. A person can contract cysticercosis by swallowing eggs found in the human feces of someone who has a taenial tapeworm. The eggs hatch and the larvae enter the systemic circulation and burrow into the striated muscles. Sometimes these larvae can make their way into other tissues, including the brain, eyes, or spinal tissue. This can result in serious neurologic problems.

Fascioliasis

Fascioliasis is a parasitic infection typically caused by *Fasciola hepatica*, also known as "the common liver fluke" or "the sheep liver fluke." Fascioliasis is found in all five continents, in over 50 countries, primarily where sheep or cattle are raised. People usually become infected by eating raw watercress or other water plants contaminated with immature parasite larvae. The immature larval flukes migrate through the intestinal wall, the abdominal cavity, and the liver tissue, then into the bile ducts, where they develop into mature egg-producing adult flukes. The liver becomes enlarged. *Fasciola* infection is both treatable and preventable.

Treatment for Fascioliasis is provided with triclabendazole, as recommended by the World Health Organization (WHO). In the USA, it is not FDA approved but is available through the CDC under an investigational protocol. A study of 24 subjects in Chile revealed cure rates of 79.2% with one dose and 100% with two doses. Nitazoxanide is an appropriate alternative to triclabendazole, especially for the chronic stage of infection. A pediatric study done in Mexico showed cure efficacy of 94% after one course and 100% after repeating the course.

Leishmaniasis

Leishmaniasis is a parasitic disease that is found in parts of the tropics, subtropics, and southern Europe. It is classified as a Neglected Tropical Disease (NTD). Leishmaniasis is caused by infection with *Leishmania* parasites, which are spread by the bite of the phlebotomine sandfly.

Leishmaniasis is a very complex disease, and treatment decisions should be individualized, with expert consultation. Diagnosis may be difficult, and biopsy may not reveal the cause. The skin sores of cutaneous leishmaniasis usually heal on their own, even without treatment. However, this can take months or even years, and the sores can leave ugly scars.

There are two forms of leishmaniasis: *cutaneous* and *visceral*. Cutaneous leishmaniasis starts as a papule or nodule. The lesion can become ulcerated. There may be regional lymphadenopathy. The skin lesions are seen within a few weeks to a few months after being bitten by the sandfly.

In general, all clinically manifested cases of visceral leishmaniasis and mucosal leishmaniasis should be treated, whereas not all cases of cutaneous leishmaniasis require treatment. Health care providers should consult experts about making a diagnosis and about the relative merits of various approaches. Examples of factors to consider are the form of leishmaniasis, the *Leishmania* species that caused it, the potential severity of the case, and the patient's underlying health.

Visceral leishmaniasis can be life-threatening. Patients may have prominent hepatosplenomegaly, fever, weight loss, anemia, leukopenia, and thrombocytopenia. History of travel to endemic regions, combined with physical findings, should increase suspicion for leishmaniasis.

Chagas disease

Chagas disease is caused by the parasite *Trypanosoma cruzi.* Triatomine bugs (also called reduviid bugs, "kissing" bugs, assassin bugs, cone-nosed bugs, and bloodsuckers) can live indoors, in cracks and holes of substandard housing, beneath porches, between rocky structures, in rock, wood, brush piles, beneath bark, in rodent nests, in animal burrows, or in outdoor dog houses or kennels. They are found in all of the southern United States, Mexico, Central America, and South America (as far south as southern Argentina).

The parasite that causes the disease is in the bug's feces. Transmission of Chagas disease from the triatomine bug to a human is not easy. The bug generally defecates on or near a person while it is feeding on his or her blood, generally when the person is sleeping. Transmission occurs when fecal material gets rubbed into the bite wound or into a mucous membrane (for example, the eye or mouth), and the parasite enters the body. The swelling around the eye is called Romaña's sign. It is the unilateral swelling of an eyelid caused either by rubbing the infected feces of the triatomine bug into the eye or a bug bite near that eye. It is one of the most recognizable signs of infection. It is important to note that not all triatomine bugs are infected with the parasite that causes Chagas disease.

About 20-30% of infected people can develop heart problems, including cardiomyopathy, bradyarrythmias, heart block, and ventricular arrhythmias. The United States is considered a nonendemic country for Chagas disease. As of 2016, about 240,000 persons living in the United States were believed to be infected with the *T cruzi* parasite.

African Sleeping Sickness

African sleeping sickness, or African trypanosomiasis, is transmitted by the bite of the tiny tsetse fly. The bite is painful and usually develops into a red sore called a chancre. Fever, severe headaches, irritability, swollen lymph nodes, and aching muscles, and joints are common symptoms of sleeping sickness. Some people also develop a skin rash. Progressive confusion, extreme fatigue, personality changes, and other neurologic problems occur after the infection has invaded the central nervous system. If left untreated, the infection becomes worse, and death will occur. The diagnosis and treatment of this disease are complex, and consultation is essential. There are two subtypes of this disease: *T. brucei rhodesiense* and *T. brucei gambiense*:

T. brucei rhodesiense, also called East African sleeping sickness, progresses more rapidly. It is found in the eastern and southern countries of Africa, with about 95% of cases being reported in Uganda, Tanzania, Malawi, and Zambia.

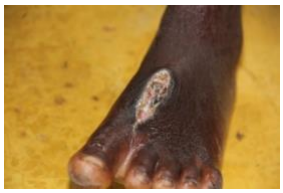
T. brucei gambiense, also known as West African sleeping sickness, progresses more slowly. It is found in some central and western countries, with most cases from the Democratic Republic of Congo, Angola, Sudan, Central African Republic, Republic of Congo, Chad, and northern Uganda.

Wuchereria Bancrofti

Wuchereria bancrofti is a human parasitic roundworm that is the primary cause of lymphatic filariasis. These filarial worms are spread by a mosquito vector. If the infection is left untreated, it can develop into a chronic disease called elephantiasis.

Elephantiasis is caused by small filarial worms blocking the lymphatic ducts. Most cases are caused by Wuchereria bancrofti. It is transmitted by several species of mosquitoes and is most commonly found in the tropics and subtropics of Africa, Asia, and the Western Caribbean. The infection is transmitted by mosquito vectors including the Culex, Anopheles, and Aedes. The worm makes its way into the lymphatic circulation. Most people who have been infected will be asymptomatic. After repeated infections, and perhaps thousands of bites, the parasite load becomes so high that patients develop symptoms. There is no cure for this problem, only prevention.

Buruli Ulcer



Buruli ulcer is caused by *Mycobacterium ulcerans*, that mainly affects the skin. *M. ulcerans* belongs to the family of bacteria that causes tuberculosis and leprosy. As such, it is treated in a similar fashion. These are not painful lesion. However, people with them are uncomfortable with the appearance. They are unique because they produce a toxin–mycolactone–which destroys tissue. Antibiotics have significantly improved treatment outcomes. But most villages do not have access to them. However, many Buruli ulcers require surgery with significant morbidity. These are not the same as Tropical ulcers, which are caused by many bacteria and are painful lesions.

CLICK HERE
to take a practice EXAM on Parasites

CLICK HERE
to listen to a PODCAST on Parasites

Chapter 6: Malaria

Epidemiologists estimate that four to five percent of all human deaths in *history* are attributable to Malaria. Currently, Malaria is responsible for the infection of 220 million people worldwide and caused over 700,000 deaths across the globe. Most deaths happen to children in Africa.

MALARIA'S MALEVOLENT PREVALENCE

The malaria parasite is prevalent in non-industrialized countries such as sub-Sahara Africa, Northern South America, and lower Asia. It was effectively eliminated from the United States in the 1950s, along with most other industrialized countries. Since people in industrialized countries tend to live indoors behind glass, the parasite cannot complete the reproductive cycle vector. This, plus campaigns to limit mosquitoes from laying eggs in water, have all led to the fact that malaria is generally not found in these countries. However, since the Anopheles mosquito is found in most industrialized countries, there is a constant risk of malaria returning.

Generally, malaria is found in wet, hot, humid places near bodies of freshwater. Recently, mosquitoes in Florida were found to have malaria parasites. Health departments and medical professionals need to be on constant alert and be aware of the potential return of this disease

Types of Malaria

There are five species and two subspecies of Plasmodium ovale that can infect humans and cause illness. Plasmodium ovale has recently been shown by genetic methods to consist of two subspecies, *P. ovale curtisi* and *P. ovale wallikeri*.

1. P. falciparum
2. P. vivax
3. P. malariae
4. Plasmodium ovale (two subspecies)
    - P. ovale curtisi
    - P. ovale walliker
5. Plasmodium knowlesi

P. falciparum is the deadliest form of malaria and is also one of the most common. It is the primary cause of death caused by malaria in the world and has developed a resistance to chloroquine, making this drug virtually useless in the treatment of this severe illness. Patients with severe falciparum malaria may develop liver and kidney failure, convulsions, and coma. P. falciparum is so

deadly because of its ability to invade up to 80 percent of all red blood cells in the human body. The other types of malaria affect fewer red blood cells.

P. vivax is the other most common form of malaria, but it is not nearly as severe. However, it is the leading cause of recurring malaria among the five types. **P. vivax** and **P. ovale** are closely related, both causing relapsing malaria. This relapse can happen because the parasites can remain dormant in the liver for many months, creating a reappearance of symptoms months or even years later. These two types of malaria are usually treated with chloroquine.

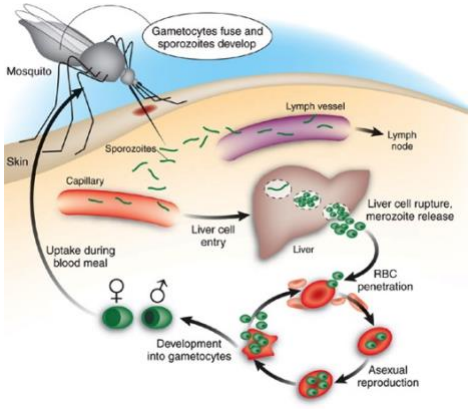
The other types of malaria affect fewer red blood cells. **P. vivax** infects no more than two percent of all the red blood cells. **P. ovale** and **P. malariae** only attack specific red blood cells, which means they do not cause severe anemia that can lead to the death of the human host. After the malaria parasite enters a human red blood cell (RBC), its cell shape is changed and becomes more rigid and sticky. This impairs the ability of the RBC to circulate and carry nutrition and oxygen to the tissues of the body. Infected RBCs tend to stick to the sides of the vessels making it more difficult for the RBCs that aren't infected to pass through. **P. malariae** is the only species that has a three-day cycle and, if left untreated, can live inside the host body for the rest of the human's life.

In recent years, cases of malaria due to **P. knowlesi** have been identified. Humans can be infected with this "monkey malaria" parasite while staying in rainforests or fringe areas in south-east Asia. These areas include parts of Cambodia, China, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam.

The natural primate host of **P. knowlesi** is the long-tailed macaque. Mosquitoes that feed on infected macaques can bite and infect humans. Infected humans can develop severe malaria, similar to that caused by Plasmodium falciparum. P. knowlesi malaria is an emerging disease first recognized in humans in 1965, and is increasingly recognized as a human health burden in the 21st century. The parasite has a cycle of 24 hours, so it can rapidly result in very high levels of parasitemia with fatal consequences. Symptoms may be atypical. Severe P. knowlesi malaria with organ failure may occur, and sporadic fatal outcomes have been described. P. knowlesi has no persistent liver forms, and relapses do not occur.

Malarial Reproduction

The asexual phase of malaria reproduction takes place in the human liver and the red blood cells. The malaria parasite comes from the stomach of the female mosquito. The female needs to bite a human to obtain a high-energy meal for the production of its own eggs. Once bitten, the parasites enter the human blood, where they travel and enter the liver and multiply asexually. They then re-enter the bloodstream, where one parasite will enter one red blood cell. Here they devour hemoglobin, destroying the red blood cells. The mosquito will then suck up blood from



a person infected with malaria, transmitting the parasite to the mosquitoes' stomach. Here sexual reproduction takes place, completing the life cycle. It's important to note that P. vivax and P. ovale may remain dormant in a human liver for (2) two to (4) four years.

The Anopheles mosquito is responsible for transmitting the malaria parasite. There are around 430 different types of Anopheles mosquitoes, all of which can carry the malaria parasite. They are found around the world, and primarily breed near swamps, ponds, and rain pools. Even though the malaria parasite has been eliminated from industrialized countries, its return remains a real threat. Anopheles mosquitoes have a 21-day lifespan. It takes about 14 days for the asexual phase of malaria to take place, making the time in which they have to infect humans very short.

A person is most likely to encounter an infected mosquito from dusk to dawn when mosquitoes become most aggressive when the temperatures cool off. This makes it rare to find anopheles mosquitoes in the middle of a big city. They also do not like to live in moving water, like rivers or saltwater, like the ocean. It is still possible to be infected in these areas, but the probability of it happening decreases significantly.

Transmission and Prevention

If a person is bitten by a mosquito carrying the malaria parasite, they will get the parasite. The severity of the disease will vary depending on the type of parasite involved and if the person has immunity, either innate or from medicine. There is a huge misconception that taking a pill, such as doxycycline or Malarone, will prevent a person from getting the malaria parasite. This is incorrect. Once an infected Anopheles mosquito bites a person, the human is now infected with the parasite. The medicine simply grants partial immunity so that the illness will not be as severe. In the case of falciparum, these drugs might keep the person from dying.

The only way to prevent malaria is to keep from being bitten. People who live in areas where malaria is present have developed partial immunity. Some people in these areas will have the malaria parasite in them for much of their life. That immunity quickly leaves a person should they travel to a part of the world where malaria is not present. Upon their return to a malaria infected country, this person is just as likely to develop malaria as someone who never had exposure before. It is thought that innate immunity can be up to 90 percent effective in preventing this disease. The immunity can also be passed down from parent to child.

Medications, like Malarone or doxycycline, do not prevent the mosquito from biting. DEET is the ingredient used in many of the bug repellants that repels all insects, including mosquitoes. DEET works by making it hard for mosquitoes and other insects to smell humans. There are no significant known problems with applying DEET to the skin of an adult. It has not been approved for infants, however. Hundreds of thousands of studies have shown that DEET remains the best method of preventing the bite of mosquitoes. It is important to use 30 percent DEET to prevent the bite of the Anopheles mosquito.

Permethrin is a powerful insecticide that will kill mosquitoes that land on material treated with permethrin. It is recommended to cover up with clothing and to sleep under netting that has been treated with permethrin. Permethrin is applied to clothing, bedding, and nets. It is a potent insecticide that allows for protection in areas covered by clothing. Permethrin is from the pyrethroid family. Pyrethroids are synthetic chemicals that act like natural extracts from the chrysanthemum flower. Permethrin is used in a number of ways to control insects.

Other compounds, such as Picaridin or Oil of Lemon, can be used to prevent mosquitoes from biting, but these will not be strong enough to prevent the bite of the more aggressive Anopheles mosquitoes found in malaria-infected countries.

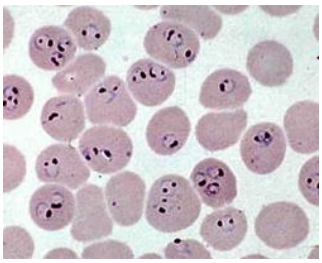
Symptoms of Malaria

The symptoms of malaria, including fever, chills, and sweating, coincide with the rupture of red blood cells. The incubation period between infection with malaria by a mosquito bite and initial symptoms may range from one week to one year. Generally, the incubation period ranges from 9-14 days for P. falciparum, 12-18 days for P. vivax, 18-40 days for P. ovale, and 10–12 days for P. knowlesi.

With malaria, the patient develops a high, intermittent fever. The pattern of fever may vary according to the species of malaria. However, there does not have to be a pattern to the fever. Initially, malaria feels like the flu with high fever, fatigue, body aches, and hot and cold stages. Signs and symptoms in children may be nonspecific, leading to delays in diagnosis. People also may have headaches, nausea, shaking chills, sweating, and weakness. Anemia is common in patients with malaria, in part due to the effects of the *Plasmodium* parasite on the red cells. It is extremely uncommon for malaria to cause skin lesions or rash.

Jaundice may be present in a patient with malaria. It could also be due to the rupture of the red blood cells, inflammation of the liver caused by the parasite, or as a consequence of taking anti-malarial medication.

Diagnosis



Malaria is diagnosed by seeing the parasite under the microscope. Blood taken from the patient is smeared on a slide for examination. Special stains are used to help highlight the parasite. Sometimes it is possible to identify the species of *Plasmodium* by the shape of the parasite. Whenever possible, smears should be reviewed by someone with expertise in the diagnosis of malaria. If the smears are negative, they can be repeated every 12 hours. Smears that are repeatedly negative suggest another diagnosis should be considered.

Two types of other tests are available for diagnosis of malaria. Rapid tests can show antigens that are present from Plasmodium. These tests take less than 30 minutes to perform. However, the reliability of rapid tests varies significantly from product to product. Thus, it is recommended that

rapid tests be used in conjunction with microscopy. A second type of test is the polymerase chain reaction (PCR), which detects malaria DNA. Because this test is not widely available, it is essential not to delay treatment while waiting for results.

Treatment

Malaria can be a severe, potentially fatal disease, especially when caused by P. falciparum. Treatment should be initiated as soon as possible. Patients who have severe P. falciparum malaria or who cannot take oral medications should be given the treatment by continuous intravenous infusion. Most drugs used in the treatment are active against the parasite in the blood and include chloroquine, atovaquone-proguanil (Malarone), artemether-lumefantrine (Coartem), quinine, quinidine, doxycycline (used in conjunction with quinine), clindamycin (used in combination with quinine), and artesunate. In addition, primaquine is active against the dormant parasite liver forms, hypnozoites, and prevents relapses. Primaquine should not be taken by pregnant women or by people who are deficient in G6PD (glucose-6-phosphate dehydrogenase). Patients should not take primaquine until a screening test has excluded G6PD deficiency.

Treating a patient with malaria depends on the species of the infecting parasite, the geographic area where the infection was acquired and its drug-resistance status, the clinical status of the patient, any accompanying illness or condition, pregnancy, and any drug allergies.

Relapse

Relapses of malaria may occur following infection from P. vivax or P. ovale, both of which can produce dormant liver stage parasites called hypnozoites. Relapses may cause disease months after the infectious mosquito bite. Reactivation of these hypnozoites has been reported up to thirty years after the initial infection in humans. The average timeframe is usually within 2–4 years. The factors precipitating this reactivation are not known. Chloroquine acts against the parasites in the blood and treats the malarial attack. The dormant forms of P. vivax and P. ovale from the liver can be eliminated with a complete course of primaquine. This is a 14-day course so compliance is a problem. It is most effective when the infection is from P. vivax. This medication works by preventing the blood forms of the parasite from developing.

A new medicine called Tafenoquine is being developed that has a shorter course than that of chloroquine. Also, antimalarial drugs taken for prophylaxis by travelers can delay the appearance of malaria symptoms by weeks or months, long after the traveler has left the malaria-endemic area. This can happen particularly with *P. vivax* and *P. ovale.* Such long delays between exposure and development of symptoms can result in misdiagnosis or delayed diagnosis because of reduced clinical suspicion by the health-care provider. Returned travelers should always remind their health-care providers of any travel in the past 12 months in areas where malaria is known to exist.

CLICK HERE
to take a practice EXAM on Malaria

CLICK HERE
to listen to a PODCAST on Malaria

Chapter 7: Dengue, Chikungunya, and Zika

Before discussing emerging diseases in the human population, we must first ask where these emerging diseases typically come from? Next, we need to know what does "emerging" really mean?

Emerging diseases typically come from animals. Scientists estimate that more than six out of every ten known infectious diseases in people are spread from animals. Here's how it works:

- First, in order to become sick from an animal, a person must be in contact with, or at least in the general area of, the animal.
- Next, the disease must make the 'jump' from animal to human. This is called ***spillover***.
- The disease, now within a human, may go away, or it might take hold and spread. If the disease remains in a human, even for a short time, it is said to ***emerge***.
- Diseases that come from animal reservoirs that are now in human reservoirs are said to be ***zoonotic***.

As humans continually get closer to where animals live, they are also closer to the diseases that animals carry and thus are more susceptible to the disease spillover. Zoonoses have different modes of transmission. In direct zoonosis, the disease is directly transmitted from animals to humans through media such as air (influenza), or through bites and saliva (rabies). In contrast, transmission can also occur via an intermediate species, referred to as a vector (mosquito, bats), which carries the disease pathogen without getting infected.

Modern diseases such as Ebola virus disease and salmonellosis are zoonoses. HIV was a zoonotic disease transmitted to humans in the early part of the 20th century, though it has now mutated to a separate human-only disease. Most strains of influenza that infect humans are human diseases, although many strains of swine and bird flu are zoonoses. These viruses occasionally recombine with human strains of the flu and can cause pandemics. Zoonoses can be caused by a range of disease pathogens such as viruses, bacteria, fungi and parasites.

A disease emerging from a spillover is a common event. Most spillover events result in a self-limited case with no further human to human transmission. Examples of this include rabies, anthrax, or histoplasmosis. Other zoonotic pathogens are able to be transmitted by humans and produce secondary cases, establishing chains of transmission. Some examples are the Ebola and Marburg filoviruses. Finally, some spillover events can result in the final adaptation of the microbe to the humans, who became a new stable reservoir. This occurred when Borrelia burgdorferi was identified after numerous cases of juvenile rheumatoid arthritis were found in Lyme, Connecticut, in the 1970's. It was identified by microbiologist Wilhelm "*Willy*" *Burgdorfer* in 1982 as the cause of Lyme disease. Developers had leveled trees in and around Lyme, Connecticut, and built houses where the trees once stood. These trees were home to owls, and other birds, which generally prey on mice. Since mice are the breeding ground for young ticks, the number of mice and ticks proliferated once the trees were gone. Opossums, which generally will eat thousands of ticks each week, also left when the trees were cut down, allowing the tick population to grow unchecked. With an unbelievable number of ticks present, Lyme disease spilled over and emerged into the human population.

In this chapter, we will look at three diseases that have spilled over and then emerged into the human population to become some of the more common zoonotic diseases that can infect people as they travel. These three diseases are **Dengue Fever, Zika Disease, and Chikungunya**.

DENGUE FEVER, ZIKA DISEASE, & CHIKUNGUNYA

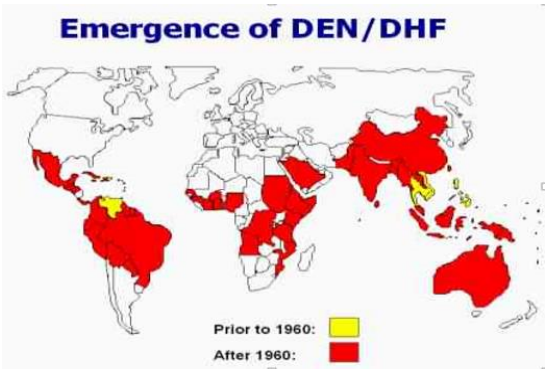
Dengue Fever

Dengue fever originated in monkeys and spilled over into humans around 800 years ago. It was restricted to Africa and Southeast Asia until the mid-20th century. Then the Dengue virus spread throughout tropical Southeast Asia via maritime shipments. No one is sure where the word Dengue comes from, but it is thought to be from a Swahili term for a bad or evil disease.

Dengue fever is spread through the bite of the female Aedes aegypti mosquito. This mosquito will usually bite during the day in urban areas. The mosquito becomes infected when it draws the blood of a person infected with the virus. After about one week, the mosquito can then transmit the virus while biting a healthy person. Dengue fever cannot be spread directly from person to person. One can avoid Dengue fever by preventing mosquito bites by using insect repellent and wearing long-sleeved shirts and long pants.

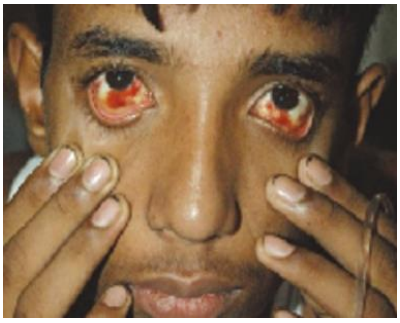
About 40% of the world's population lives in areas at risk for infection with Dengue. This is roughly 2.5 billion people. It is endemic in at least 100 countries. The Dengue virus is a leading cause of illness and death in the tropics and subtropics. As many as 400 million people are infected yearly. It is estimated by the World Health Organization (WHO) that 22,000 people die annually, mostly children.

Dengue has emerged as a global problem since about 1960. Although Dengue rarely occurs in North America or Europe, it is endemic in many popular tourist destinations in Latin America, Southeast Asia, and the Pacific islands.



Dengue fever is known as break-bone fever. It is that painful. This mosquito-borne viral illness with sudden onset often presents with the "Dengue triad" of fever, rash, and headache. Because of other intense pains, victims of Dengue often have contortions that bend their joints, giving the appearance that they have broken bones. Hence the name "break-bone fever."

There are four distinct but closely related serotypes of the virus that cause Dengue: DEN-1, DEN-2, DEN-3 and DEN-4. Recovery from infection by one provides lifelong immunity against that particular serotype. However, cross-immunity to the other serotypes, after recovery, is only partial and temporary. Subsequent infections by other serotypes increase the risk of developing severe Dengue. Typically, one type of Dengue virus inhabits an area, so it is essential to know if the patient had Dengue from another area, as this could mean an infection from a different serotype. This could increase the risk of Dengue hemorrhagic fever, which can be deadly.



If a patient's blood pressure begins to drop, and mild bleeding around the gums and from the nose become more severe, the patient has likely developed Dengue hemorrhagic fever. Dengue hemorrhagic fever is characterized by a fever that lasts from two to seven days, with general signs and symptoms consistent with Dengue fever. When the fever declines, warning signs may develop. This marks the beginning of a 24 to 48-hour period when the capillaries become excessively permeable, allowing the fluid component to escape from the blood vessels into the peritoneum (causing ascites) and pleural cavity (leading to pleural effusions). Without prompt, appropriate treatment, this may lead to failure of the circulatory system and shock, and possibly death. In addition, a patient with Dengue hemorrhagic fever has a low platelet count and has hemorrhagic manifestations, such as skin hemorrhages, bleeding from the nose and gums, the eyes, and possibly internal bleeding.

To confirm a diagnosis of Dengue fever, you would examine the skin, mouth, gums, and nose for signs of bleeding, including petechial hemorrhage, or rash on the skin. The principal symptoms of Dengue are high fever and at least two of the following symptoms: severe eye pain (behind eyes), joint and muscle pain, rash, and mild bleeding manifestation (e.g., nose or gum bleed, eyes, petechial, or easy bruising). There is no known manifestation of Dengue in the ear canals or the axilla or groin.

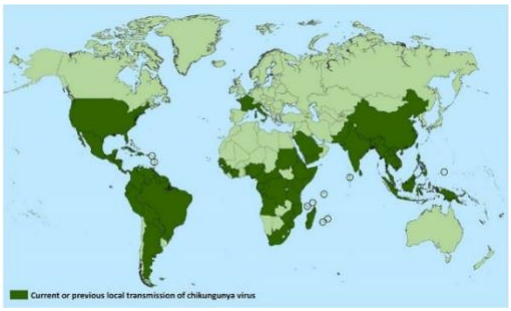
A Dengue vaccine is available to prevent Dengue fever in humans. As of 2019, one version is commercially available, known as **CYD-TDV**, and sold under the brand name **Dengvaxia**. The vaccine is only recommended in those who have previously had Dengue fever or populations in which most people have been previously infected. The value of the vaccine is limited by the fact that it may worsen outcomes in those who have not previously been infected. It is given as three injections over a year.

Chikungunya

Chikungunya is a viral disease transmitted to people through mosquito bites. Chikungunya virus is most often spread to people by the *Aedes aegypti* and *Aedes albopictus* mosquitoes. These are the same mosquitoes that transmit Dengue virus. They bite mostly during the day but can bite at night too. Originally, chikungunya was thought to be Dengue fever.

The roots of this viral illness date back to 1953 when it was first described during an outbreak in a Swahili village in the Newala district of Tanzania, Africa. It spilled over at some point from monkeys.

Chikungunya is aptly named. It is derived from a word in the Makonde language meaning "to become contorted," because the severe muscle and joint pain endured by the patient prevents them from moving normally or performing their daily activities. Prior to 2013, Chikungunya virus cases and outbreaks had been identified in countries in Africa, Asia, Europe, and the Indian and Pacific Oceans. In late 2013, the first local transmission of the Chikungunya virus in the Americas was identified in Caribbean countries and territories.



Chikungunya disease does not often result in death, but the symptoms can be very severe, painful, and disabling. Most people infected with the Chikungunya virus will develop some symptoms. These symptoms begin in less than a week, typically three to seven days after being bitten by an infected mosquito.

The most common symptoms are fever and intense joint pain. Other symptoms may include headache, muscle pain, joint swelling, and rash. Once a person has been infected, he or she is most likely to be protected from future infections. Most patients feel better within a week. However, in some people, joint pain may persist for months or years.

No vaccine exists to prevent the Chikungunya virus infection. Treatment is supportive. Prevent Chikungunya by avoiding the bite of the Aedes mosquito through the use of DEET, picaridin, and oil of lemon eucalyptus. Treat clothing with permethrin. Wear clothing that covers arms and legs. Use air conditioning or screens to keep mosquitoes outside or sleep under a mosquito bed net.

Zika

Its name comes from the Zika Forest of Uganda, where the virus was first isolated in 1947. The Zika virus is related to Dengue, Yellow fever, Japanese encephalitis, and West Nile viruses. In 1952, the first human cases of Zika were detected, and since then, outbreaks of Zika have been reported in tropical Africa, Southeast Asia, and the Pacific Islands.

Zika is spread by the daytime active *Aedes* mosquito. This mosquito also carries Dengue and Chikungunya, and typically lays its eggs in and near standing water, in places such as buckets, bowls, cracks in buildings, animal dishes, flower pots, and vases. Hence, these mosquitoes typically live near cities. They are aggressive daytime biters, but they can also bite at night. They prefer to bite people.

From 2007 to 2016, the Zika virus spread eastward across the Pacific Ocean to the Americas, leading to the 2015–16 Zika virus epidemic. The infection, known as the Zika virus disease, often causes no or only mild symptoms, similar to a very mild form of Dengue fever. While there is no specific treatment, paracetamol (acetaminophen) and rest may help with the symptoms. As of April 2019, no vaccines have been approved for clinical use, although several vaccines are currently in clinical trials.

The Zika virus disease generally has the mildest symptoms of the diseases discussed in this chapter. Most people who develop the disease do not have any symptoms. This complicates matters because a patient who has no symptoms can still transmit the disease for about one week if they are infected. This can happen if they are bitten by a mosquito, or if an infected male human has sexual relations. An infected female human who becomes pregnant exposes the fetus to birth defects, without knowing they have been ill.

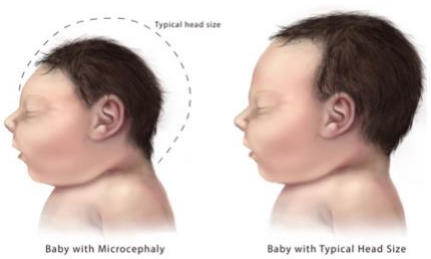
The most common symptoms of Zika are mild and include fever, rash, joint pain, and conjunctivitis. The symptoms are similar to Dengue fever and Chikungunya but are milder. In fact, the vast majority of people will not know that they contracted Zika. One study suggests about 80 percent of people who are infected don't even know they have the disease, while the other 20 percent suffer only a rash, mild fever, and headache. Zika fatalities are very rare, and symptoms usually last four to five days. The incubation time for Zika is unknown but is thought to be one week or less.

The risk of transmission of the Zika virus is about the same as Dengue fever and Chikungunya. It is higher than the Ebola virus, primarily due to the fact that Zika is spread by both mosquito transmission and sexual transmission. The Ebola virus is spread by contact of body fluids. Zika transmission is less frequent than the common cold, since the cold viruses are spread by simple contact and are highly contagious.

Scientists estimated how contagious Zika was in Colombia, South America, in 2016, by calculating what's called the reproduction number, or "R_o" (R nought). It's a mathematical term that explains the number of people who catch the disease, on average, in an outbreak. In Colombia, Zika's R_o was between three and six. This means that each person who caught Zika spread it to about four others during the outbreak. By comparison, the R_o for Ebola in West Africa was only between 1.5 and 2.0. This is why Zika has swept so quickly across the Western Hemisphere, while Ebola primarily stayed in West Africa.

Genetic findings, published in the journal *Science*, suggest an air traveler brought the virus to Brazil sometime between May and December of 2013, more than a year before Brazil reported the first cases of Zika in early 2015. The patterns in the Zika genes suggest the virus entered Brazil only once. It is also thought that the Zika virus was circulating in Haiti in 2014 before it became obvious that it was spreading so quickly in Brazil. A team of researchers investigated three mysterious infections in Haiti and found that they were all caused by the Zika virus.

Unlike its close cousin, Dengue fever, Zika ***does harm*** developing cells in a human fetus, causing a variety of issues such as microcephaly, and damage similar to multiple scl erosis. There is no evidence that it infects myocardia tissue, muscle cells, or gastrointestinal cells. The Zika virus has long been ignored as a rather harmless infection, causing little more than a rash and some achiness. Even then, these symptoms appeared in only a small percentage of infected people.



Zika is now known to cause severe and harmful effects on developing fetuses and adults as well. Researchers report that 1 in every 100 pregnant women infected with the virus during the first trimester will give birth to a baby with microcephaly. Microcephaly is an abnormally small head and the potential for neurological issues. There is one important caveat, however. These findings are from the 2013-14 outbreak of Zika, in French Polynesia. It remains to be seen whether these findings apply to other countries in the same way.

The Zika virus has ***not*** been found in breast milk. In fact, because of the benefits of breastfeeding, mothers are encouraged to breastfeed even in areas where the Zika virus is found. A pregnant woman can pass the Zika virus on to her fetus during pregnancy, and also near the time of birth. It is the cause of microcephaly and other severe fetal brain defects.

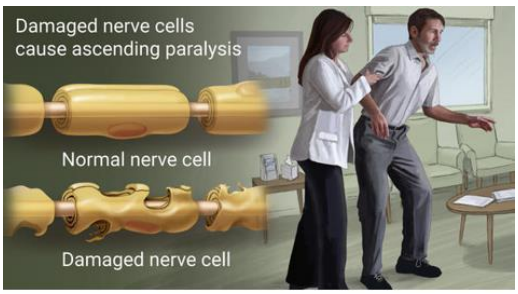
Zika can be passed through sex from a person who has Zika to his or her partners. Zika can be passed through sex, even if the infected person does not have symptoms at the time. It can be passed from a person with Zika before their symptoms start, while they have symptoms, and after their symptoms end. Though not well documented, the virus may also be passed by a person who carries the virus but never develops symptoms. Studies are underway to find out how long Zika stays in the semen and vaginal fluids of people who have Zika, and how long it can be passed to sex partners. It is known that Zika can remain in semen longer than in other body fluids, including vaginal fluids, urine, and blood.

For couples, where someone could be diagnosed with the Zika virus disease or had symptoms of Zika virus disease, they should consider using condoms or not having sex for at least six months after symptoms begin. Couples considering this decision should weigh the personal risks and benefits. A person's risk of having Zika virus disease will depend on the length of time he or she spent in areas with the Zika virus and whether he or she took steps to prevent mosquito bites while there.

Current guidelines for pregnant women regarding the Zika virus include the following:

- Consider postponing travel to any area where Zika virus transmission is ongoing.
- If you must travel to or live in one of these areas, talk to your health-care provider first and strictly follow steps to prevent mosquito bites.
- If you have a partner who lives in or has traveled to an area where Zika virus transmission is ongoing, either use condoms the right way every time or do not have sex during your pregnancy.

Zika is now known to cause severe and harmful effects on adults as well. New studies show startling brain and neurological conditions related to Zika.



Some patients have developed acute disseminated encephalomyelitis, an inflammation of the brain and spinal cord that damages the protective fatty myelin layer that covers nerve cells. That's similar to what multiple sclerosis does, but it's usually temporary, although the recovery can take months.

There may be a relationship between the Zika virus infection and Guillain-Barre Syndrome (GBS), but it is not known for certainty. However, patients with Zika have developed Guillain-Barre Syndrome (GBS). In the USA, the Centers for Disease Control (CDC) are concerned about GBS, and are actively investigating the link between Zika and this neurological disorder. The World Health Organization considers this association between the virus and the paralysis affecting seemingly healthy adults "alarming".

Blood Transfusions

Transmission of Zika, Dengue, and Chikungunya through blood transfusions is possible but rare. Collection methods do not preclude the transmission of these viruses. A number of cases of Zika from blood transfusions have been reported in Brazil, but the actual number is not known. Current guidelines for travelers returning from areas where these viruses are found are *not* to donate blood for 28 days.

CLICK HERE
to take a practice EXAM on Emerging Diseases

CLICK HERE
to listen to a PODCAST on Emerging Diseases

Chapter 8: TICKS

Ticks are not insects, although they are often mistaken for them. Ticks are classified as arachnids, or relatives of spiders, scorpions, and mites. They require blood for sustenance. Ticks don't jump or fly. Instead, they crawl up low brush or grass to find a host. They'll clasp onto the brush or grass with their back legs and reach their front legs out to grab onto a passing animal or human. This process is called questing.

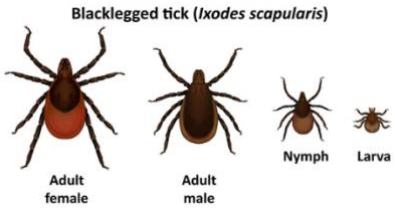
ALL ABOUT TICKS

Finding a Host

Ticks find their hosts by detecting an animal's breath and body odors, or by sensing body heat, moisture, and vibrations. Some ticks will attach quickly to their host, while others will wander their host looking for thinner skin, such as the ear. Depending on the tick species and the life stage, preparing to feed can take from ten minutes to two hours. On locating a suitable feeding spot, the tick grasps the host's skin and cuts into the surface. Ticks extract the blood by cutting a hole in the host's epidermis, into which they insert their hypostome, not their head, as ticks do not have a head. They keep the blood from clotting by excreting an anticoagulant or platelet aggregation inhibitor. Ticks satisfy all of their nutritional requirements as ectoparasites, feeding on a diet of blood in a practice known as hematophagy.

Ticks are obligate hematophages, which means they need blood to survive and to move from one stage of life to the next. They do not feed on plants at all. Ticks unable to find an animal or human host to feed on will die. This behavior is estimated to have evolved approximately 120 million years ago through adaptive pressures to a blood-feeding environment.

All stages of tick development are capable of blood-feeding for both male and female; at larva, nymph, and adult stage. Humans are usually bitten by the smaller larva or nymph, as they are not seen as easily on the skin or clothing.



Types of Ticks

There are over 800 species of ticks throughout the world, but virtually all ticks belong to one of two major families, the Ixodidae, or hard ticks, and the Argasidae, or soft ticks. The family called Nuttalliellidae comprises a single species of tick called Nuttalliella Namaqua. It is found in Southern Africa from Tanzania to Namibia and South Africa. Nuttalliellidae is not categorized into either hard or soft ticks.

Ixodidae has no fixed dwelling place except on the host. In fact, some of this family of ticks remain for most of their life on a single animal. People would rarely encounter these ticks, but sometimes their animal hosts bring the ticks into the home. For instance, bats that roost in the attic or chimney may have bat ticks. Similarly, ground-dwelling rodents may bring this family of ticks into homes

and cabins. These ticks may wander into human living spaces, particularly if their normal hosts have died or abandoned that roost or nesting site. Therefore, the brown dog tick can thrive and readily complete its entire life cycle within a human home, though this may not be its preferred environment.

Preferred Habitat

Ticks, particularly *Ixoides*, prefer to live at ground level, on short grasses, in shady, moist areas, and near the edge of wooded land. They will cling to grass and short shrubs usually no more than 18-24 inches (45 to 60 cm) off the ground. They also live in lawns and gardens, especially at the edges of woods and around old stone walls. Some misnomers: ticks cannot jump or fly, they do not drop onto passing people or animals, they do not live in trees or tall bushes, and they do not live on dead animals.

Nuttalliellidae ticks live in sand or in crevices or similar shelters near animal dens or nests, or in human dwellings where they might come out nightly when they smell carbon dioxide in the breath of their hosts and emerge from the sand to attack them. *Argasidae* ticks tend to live in places similar to *Nuttalliellidae*.

Ticks get on humans and animals only by direct contact. Once a tick gets on the skin, it generally climbs upward until it reaches a protected area.

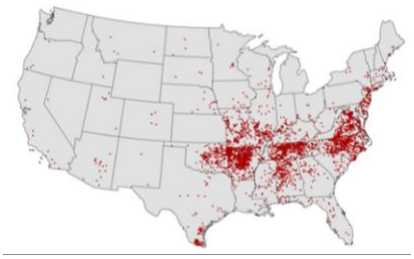
Tick species are widely distributed around the world, but they tend to flourish more in countries with warm, humid climates because they require a certain amount of moisture in the air to undergo metamorphosis, and because low temperatures inhibit their development from eggs to larvae. A habitat preferred by ticks is the interface where a lawn meets the woods. They are ground dwellers.

Disease Types and Transmission

Upward of 20 diseases are known to be transmitted from ticks to humans. Ticks transmit pathogens such as bacteria, viruses, and protozoa. Species of the bacterial genus *Rickettsia* are responsible for Typhus, Rickettsial pox, Boutonneuse fever, African tick bite fever, Rocky Mountain spotted fever, Flinders Island spotted fever, and Queensland tick typhus (Australian tick typhus). Other tick-borne diseases include Lyme disease and Q fever, Colorado tick fever, Crimean Congo hemorrhagic fever, Tularemia, Tick-borne relapsing fever, Babesiosis, Ehrlichiosis, Bourbon virus, and Tick-borne meningoencephalitis, as well as Bovine anaplasmosis and probably the Heartland virus.

Ticks are second only to the mosquito for being prolific at the transmission of diseases. Unlike the mosquito, which transmits disease instantaneously, transmission from a tick bite can take up to two to three days. Therefore, if you can remove a tick within 24 hours, your chance of contracting a disease is fairly low. It's not unheard of for ticks to be carrying three different diseases at one time, making diagnosis difficult.

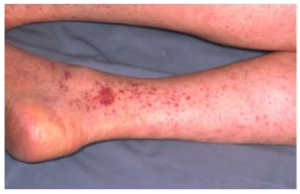
The best way to avoid disease transmission is to prevent ticks from attaching and to perform frequent tick checks. Know which ticks and which diseases are present in the area where you are hiking and camping. For example, ticks in South Carolina in the United States have the highest incident rate of Rocky Mountain Spotted Fever in the world.



Tick-borne diseases can present in an atypical fashion. There is the case of a 26-year-old male who, in 2018, was backpacking in the California Mountains in the United States. He reported a sudden onset of fever one week into the 14-day backpacking trip. He stayed in a cabin on the trail and remembered seeing mice. He did not recall being bitten or finding any ticks on himself during his trip. The next day his fever subsided for six (6) hours but then returned. This person had a relapsing fever. which is typically a self-limited disease and should improve over the course of one week. Victims of this disease may not find any ticks on themselves or even remember being bitten because the tick that usually carries relapsing fever (the ornithodoros tick) typically feeds at night and only for one to two hours. Tetracycline can be effective and is given every six (6) hours for ten (10) days, but not as a single dose.

Tick paralysis is potentially life-threatening if left untreated and unrecognized. It is easily confused with other paralytic etiologies, such as Guillain-Barre, but if recognized early, it is easily treated by finding the tick and removing it. Once the tick is removed, the paralysis should subside, and the diagnosis of tick paralysis is confirmed.

The endemic tick-borne disease, Rocky Mountain Spotted Fever, is most likely seen in South-Central States and Mid-Atlantic states in the United States. Interstate transportation can move this disease around, however. Recently this disease has been reported throughout Mexico, Canada, Central America, and South America, but it is not endemic in these areas. It is not found in Europe.

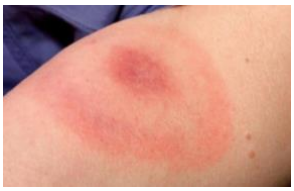


A peripherally located petechial rash with purpura is usually associated with Rocky Mountain Spotted Fever (*Rickettsia ricketsii*), although up to 10% of cases have no rash. Children are commonly infected with tick-borne illnesses due to the time they spend outside playing in a tick infested shrubs or wooded areas. Interestingly, the disease was named after the Rocky Mountain Lab located in the state of Montana, where it was discovered even though the disease is not typically found in the Rocky Mountains.

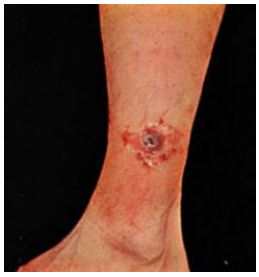
Erlichiosis is a bacterial infection that has similar symptoms to Rocky Mountain Spotted Fever, and other rickettsial diseases. It is often treated with doxycycline, which also covers *B. burgdoferi* and rickettsial infections. *Erlichiosis* is easily confused with these due to similar symptoms.

Colorado Tick Fever is another tick-borne virus. The most common symptoms are fever, chills, headache, body aches, and feeling tired. Some patients have a sore throat, vomiting, abdominal pain, or skin rash. About half of patients have a “biphasic” fever. This means they have several days of fever, feel better for several days, and then have a second short period of fever and illness.

Borrelia burgdorferi, usually called Lyme disease, is a common tick-borne disease and is seen in the Northeastern USA. As well, there are foci of Lyme borreliosis in forested areas of Asia, Northwestern, Central, and Eastern Europe. *B.* burgdorferi uses the Ixoides tick as a vector like many other tick-borne diseases. The targetoid rash is a very common and a distinguishing symptom of Lyme disease.



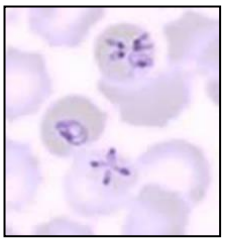
Babesiosis is a rare disease that is transmitted via the bite from the Ixoides tick. Babesiosis has been reported in North and South America, Europe, and Southern and Eastern Asia. In the United States, it is endemic to the Northeast, especially some of the islands off the East coast. It has features similar to a mild malarial infection and similarly infects red blood cells causing anemia. The so-called "Maltese cross formations" on the blood film are essentially diagnostic of babesiosis. Co-infection with Lyme disease is possible due to the shared vector.



Tularemia is seen worldwide but is not common and has little activity in Africa, Australia, England, and South America. It is most commonly seen in North America, concentrated in the south-central area of the United States. There are a few forms, but the most common, from tick bites, is the glandular ulcer disease, which presents with fever and regional tender lymphadenopathy. It can have secondary rash of variable forms. It is carried by both tick and the deer fly. In either case, it has an initial single erythematous lesion with central eschar.

Individual ticks can harbor more than one disease-causing agent. This means that patients can be infected with more than one pathogen at the same time. This fact compounds the difficulty in diagnosis and treatment. There are around 20 known tick-borne diseases of humans, with four (4) of these discovered from 2013-2016. However, not all ticks are infected. The percentage of ticks that are carriers vary for every geographical region on the earth. For example, in most places in the United States, 30-50% of deer ticks will be infected with *Borrelia burgdorferi,* the agent of Lyme disease. Other pathogens can be much rarer.

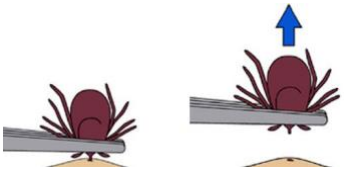
Tests for Lyme disease in the United States will not reliably detect infection with European species. Lyme disease can be contracted in temperate forested regions throughout Europe and northern Asia, although it is more common in Eastern and Central Europe than Western Europe. Lyme disease can be caused by several different species of Borrelia burgdorferi and may have somewhat different symptoms. For example, the initial rash, or erythema migrans, may last longer but have less associated inflammation. Additionally, not all tests in the United States will reliably detect infection with European species. Providers who suspect European-acquired Lyme disease should request different testing available from the European Concerted Action on Lyme Borreliosis.



Loose-fitting clothing helps to prevent ticks from attaching. Shirts should be tucked into pants and then pants into socks. Permethrin should be applied to clothes, and DEET should be applied to the skin. People can limit their exposure to tick bites by wearing light-colored clothing as well. Contrary

to popular belief, oil of citronella has no real benefit to preventing tick bites and is only mildly effective against mosquitoes

Tick Removal



Tick removal is simple. Pull it off the skin. You can use your fingers if needed, but if you have tweezers or some other tool, use it to grab the tick as close to the skin surface as possible. Then, pull the tick straight upward with steady, even pressure. Ticks don't have a 'head,' so the head can't be left in the skin. It has a small 'poker' called a hypostome. If for some reason this remains in the skin, the clinical consequences are non-existent.

Techniques such as taping or scraping with a credit card on the skin are only suitable to remove larval ticks. Vaseline does not ease, or speed, the removal of ticks. Touching it with a hot match or applying nail polish will not get the tick to 'back out' but will probably just kill it, leaving it stuck in the skin. However. freezing a tick using liquid nitrogen is also appropriate. Watch for local infection and symptoms of tick-borne illness (incubation period is three to thirty days), especially headache, fever, and rash. If you suspect that the tick may have had a disease such as Lyme Disease, RMSF, tularemia, or ehrlichiosis, a tetracycline such as doxycycline can be initiated while in the wilderness. Treatment for other tick-borne illnesses is supportive.

Ticks will remain on clothing after a wilderness trip. Wash clothes in hot water and use high heat in the dryer for at least one hour to ensure that all ticks are removed from clothing.

For tick removal, DO NOT USE:

- Petroleum jelly
- Fingernail polish
- Rubbing alcohol
- A hot match
- Gasoline
- Do not grab the rear end of the tick. Doing so expels gastric contents and increases the chance of infection
- Do not twist or jerk the tick, as this will most likely cause incomplete removal of the tick

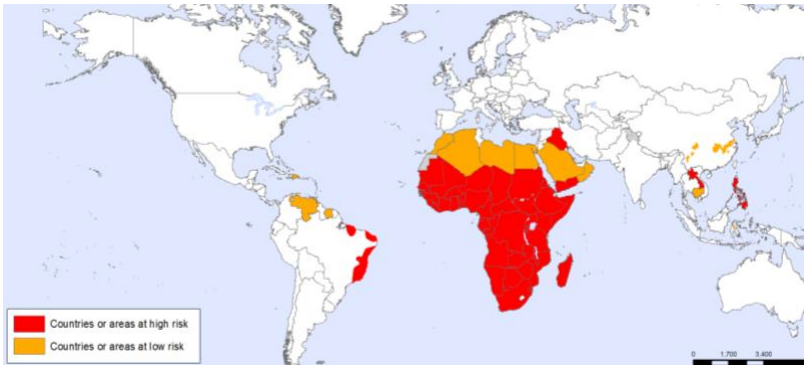
CLICK HERE to take a practice EXAM on Ticks

CLICK HERE to listen to a PODCAST on Ticks

Chapter 9: Schistosomiasis

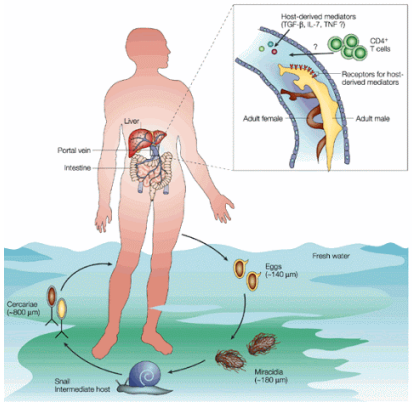
All it takes is a snail, a worm and some freshwater to become infected. Once you are, the disease could persist for decades -- and prove fatal. The culprits come as a pair: freshwater snails harboring parasitic worms. Once released from the snails, the worms can burrow into the skin and deep inside the body of any human daring to enter its waters. The infection at hand is schistosomiasis -- also known as bilharzia -- a chronic infection caused by parasitic Schistosoma worms that can live inside blood vessels for years on end causing fever, chills and inflammation in their wake. Wilderness and world travelers love to recreate in water. All it takes is a very short time in the water and a person is infected.

ALL ABOUT SCHISTOSOMIASIS



Schistosomiasis is prevalent in tropical and subtropical areas, especially in poor communities without access to safe drinking water and adequate sanitation. It is estimated that at least 90% of those requiring treatment for schistosomiasis live in Africa. More than 207 million people, 85% of who live in Africa, are infected with schistosomiasis and an estimated 700 million people are at risk of infection in 76 countries where the disease. Globally, 200,000 deaths are attributed to schistosomiasis annually.

Transmission



Freshwater becomes contaminated by Schistosoma eggs when infected people urinate or defecate in the water. The eggs hatch, and if certain types of freshwater snails are present in the water, the parasites develop and multiply inside the snails. The parasite leaves the snail and enters the water where it can survive for about 48 hours.

Schistosoma parasites can penetrate the skin of persons who are wading, swimming, bathing, or washing in contaminated water. Within several weeks, the parasites mature into adult worms and live in the blood vessels of the body where the females

produce eggs. Some of the eggs travel to the bladder or intestine and are passed into the urine or stool.

Types of Schistosomiasis

There are 2 major forms of schistosomiasis – intestinal and urogenital – caused by 5 main species of blood fluke. The different species will infect different parts of the body.

Two major Forms	Species	Geographical Distribution
Intestinal schistosomiasis	*Schistosoma mansoni*	Africa, the Middle East, the Caribbean, Brazil, Venezuela and Suriname
	Schistosoma japonicum	China, Indonesia, the Philippines
	Schistosoma mekongi	China, Indonesia, the Philippines
	Schistosoma guineensis and related *S. intercalatum*	Several districts of Cambodia and the Lao People's Democratic Republic
Urogenital schistosomiasis	*Schistosoma haematobium*	Africa, the Middle East, Corsica (France)

Symptoms

Within days after becoming infected, a person may develop a rash or itchy skin. Fever, chills, cough, and muscle aches can begin within 1-2 months of infection. Most people have no symptoms at this early phase of infection. Symptoms of schistosomiasis are caused by the body's reaction to the worms' eggs.

Intestinal schistosomiasis can result in abdominal pain, diarrhea, and blood in the stool. Liver enlargement is common in advanced cases and is frequently associated with an accumulation of fluid in the peritoneal cavity and hypertension of the abdominal blood vessels. In such cases there may also be enlargement of the spleen.

The classic sign of urogenital schistosomiasis is hematuria (blood in urine). Fibrosis of the bladder and ureter, and kidney damage are sometimes diagnosed in advanced cases. Bladder cancer is another possible complication in the later stages. In women, urogenital schistosomiasis may present with genital lesions, vaginal bleeding, pain during sexual intercourse, and nodules in the vulva. In men, urogenital schistosomiasis can induce pathology of the seminal vesicles, prostate, and other organs. This disease may also have other long-term irreversible consequences, including infertility.

Diagnosis

Schistosomiasis is diagnosed through the detection of parasite eggs in stool or urine specimens. Antibodies and/or antigens detected in blood or urine samples are also indications of infection.

Children with *S. haematobium* almost always have microscopic blood in their urine which can be detected by chemical reagent strips.

Treatment

Safe and effective medication is available for treatment of both urinary and intestinal schistosomiasis. Praziquantel, a prescription medication, is taken for 1-2 days to treat infections caused by all schistosome species.

Prevention and control

The control of schistosomiasis is based on large-scale treatment of at-risk population groups, access to safe water, improved sanitation, hygiene education, and snail control. The WHO strategy for schistosomiasis control focuses on reducing disease through periodic, targeted treatment with praziquantel through the large-scale treatment (preventive chemotherapy) of affected populations. It involves regular treatment of all at-risk groups. In a few countries, where there is low transmission, the interruption of the transmission of the disease should be aimed for. Groups targeted for treatment are:

- School-aged children in endemic areas.
- Adults considered to be at risk in endemic areas, and people with occupations involving contact with infested water, such as fishermen, farmers, irrigation workers, and women whose domestic tasks bring them in contact with infested water.
- Entire communities living in highly endemic areas.

CLICK HERE to take a practice EXAM on Schistosomiasis

CLICK HERE to listen to a PODCAST on Schistosomiasis