This chapter will train you on infectious diseases that may occur in the wilderness setting:

- Understand the incidence and epidemiology of infectious diseases as they pertain to wilderness travel.
- Describe the most common gastrointestinal infections that may occur in the wilderness and be able to describe their clinical presentation, treatment, and prevention.
- Describe the clinical presentation, treatment, and prevention of malaria.
- Describe two ways to ascertain the risk of malaria on a proposed trip and the best way to find the correct preventive medication.
- Explain the appropriate treatment and management of a person who sustains a bite from an animal that is worrisome for rabies.
- Describe various tick borne diseases in terms of their clinical presentation and treatment.
Diseases Affecting the Gastrointestinal System

- Gastrointestinal illnesses are the most commonly encountered infectious diseases in the wilderness.
- Up to 50% of wilderness travelers are affected by gastrointestinal diseases, mainly diarrhea.
- The vast majority of these diseases are transmitted through contaminated food or water.
- Among the most common organisms causing symptomatic disease are: *Staphylococcus aureus*, *Salmonella* species, enterotoxigenic *E. coli*, *Campylobacter jejuni*, *Giardia lamblia*, and viruses.

**Staphylococcal Enteritis**

**Pathophysiology**
- Acute gastroenteritis may result from eating food contaminated by a toxin produced by *Staphylococcus aureus*.
- *Staphylococcus* colonizes human skin; food may easily become contaminated during its preparation.
- While the bacteria can grow in any food, those that are high in protein, such as mayonnaise, milk, cream, custard and meat products, are most conducive to overgrowth of *Staphylococcus*.
- If contaminated food is left unrefrigerated for several hours, as is commonly encountered in the wilderness, the bacteria are allowed to multiply and the enterotoxin is produced.
  - The toxin is heat resistant and cannot be eliminated by reheating or boiling contaminated food.
  - Upon ingestion, the toxin acts on the gastrointestinal tract to cause the acute gastroenteritis characteristic of the disease.

**Clinical presentation**
- Staphylococcal gastroenteritis is characterized by acute onset of nausea, severe vomiting, mild diarrhea and abdominal cramps.
- Symptoms may occur within one to six hours after ingestion of contaminated food, with an average time of onset of three hours.
- The etiology of food poisoning may be clinically deduced when multiple victims present with vomiting and diarrhea after consuming the same food.
- Staphylococcal food poisoning is self limited, and symptoms typically resolve within twenty four hours.

**Treatment**
- Treatment is supportive and based upon symptoms, with fluid and electrolyte replacement as the primary goal.
- Anti-emetic medications may be used.
- Antibiotic therapy is ineffective and unnecessary because the toxin is pre-formed and cannot be neutralized.

**Prevention**
- Staphylococcal enteritis may be avoided by using proper hygiene and sanitation with food preparation.
- Hand sanitation with alcohol gels or hand washing with soap and water is essential.
- Food prepared in the wilderness must be consumed immediately after preparation, and leftovers should be disposed of properly.

**Non-dysenteric gastroenteritis**

**Pathophysiology**
- Acute, watery diarrhea associated with wilderness travel domestically or internationally may be caused by a variety of organisms.
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- Enterotoxigenic *E. coli* accounts for 30% – 70% of “traveler’s diarrhea.”
- Viral gastroenteritis is another common cause, with Norwalk and rotaviruses being the most common agents.
- Worldwide, *Vibrio cholera* accounts for a significant number of deaths, though it is rare in travelers as a large inoculum is required for infection.
- In general, these agents produce a toxin-mediated secretory diarrhea resulting in the secretion of water and electrolytes into the intestinal lumen.
- These enteric pathogens are typically spread by fecal-oral contamination, with contaminated food and water as the most common vehicles for transmission.

Clinical Presentation
- Symptoms include profuse watery diarrhea, abdominal cramping, nausea and vomiting, and malaise.
- Adults are usually afebrile, but low-grade fever may be present.
- Incubation times from ingestion to clinical presentation usually range from twelve to seventy-two hours.
- Cholera can lead to massive fluid losses and is characterized by explosive “rice water stools” produced at a rate of up to one liter per hour.

Treatment
- Non-dysenteric diarrhea typically runs a self-limited course with symptoms resolving within one week.
- The mainstay of treatment is replacement of fluid and electrolyte losses.
- Oral intake should at least approximate fluid losses in stool.
- A variety of oral rehydration solutions may be used:
  - U.S. Public Health Service Formula:
    - Glass 1
      - 8 oz fruit juice
      - ½ teaspoon baking soda
      - ½ teaspoon honey or corn syrup
    - Glass 2
      - 8 oz water
      - 1 pinch table salt
  - Drink equal amounts from each glass alternating between the two.
  - WHO Oral Rehydration Solution may be purchased as small packets in most developing countries.
    - Add one packet to a liter of disinfected water.
    - For a WHO ORS equivalent, add to one liter of clean water:
      - 3/4 teaspoon of salt (two finger pinch)
      - ½ teaspoon baking soda (one finger pinch)
      - 2-3 tablespoons of sugar (three finger scoop)
      - ¼ teaspoon potassium chloride salt substitute (small pinch)--if available
  - Sports drinks such as Gatorade or Power Ade may be used if diluted to half strength with clean water.
    - Only disinfected or bottled water and juices should be used.
    - Urine volume and color should be monitored as an indicator of hydration status.
- Antidiarrheal medications
  - Loperamide (Imodium) may be used with noninvasive gastroenteritis to reduce cramping and fluid losses.
  - Bismuth subsalicylate (Pepto-Bismol) is an effective treatment for travel related diarrhea and has comparable treatment results to antibiotic therapy in mild to moderate cases. An appropriate adult dose of bismuth subsalicylate is 2 tablespoons or 2 tablets PO every hour up to eight doses in 24 hours.
- More severe cases of travel related gastroenteritis may warrant empiric antibiotic therapy.
  - The treatment of choice is ciprofloxacin 500mg PO BID for 3 days.
  - Azithromycin 500 mg PO qd for 3 days or trimethoprim/sulfamethoxazole 160mg/800mg DS tablets PO BID for 3 days may be used for cases when quinolones are not acceptable options (e.g. pregnancy or children).
  - For cholera, the treatment of choice is doxycycline 300mg PO q day, but ciprofloxacin 500 mg PO BID is also effective. For cholera, treatment should be extended to 7 to 10 days.
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Bacterial Dysentery

Pathophysiology
- Invasive bacterial infections of the intestines produce more severe symptoms, including bloody diarrhea and fever.
- Up to 15% of travel related diarrhea is due to dysentery.
- Causative organisms include *Salmonella*, *Shigella*, *Campylobacter*, enterohemorrhagic *E. coli*, *Yersinia enterocolitica*, and *Aeromonas hydrophilia*.
- Most organisms causing dysentery are spread by a fecal-oral route mainly through contaminated food and water.
  - *Salmonella* species are widespread and are commonly found in raw eggs, poultry and meat.
  - Domestic animals and pets such as dogs, cats, birds, turtles and lizards are also common carriers of *Salmonella*.
  - *Shigella* is highly contagious and easily spread from person to person as ingestion of only a few organisms can cause infection.
  - *Campylobacter* is a very common contaminant of natural water supplies and is also common in unprocessed milk and raw poultry products.
  - Enterohemorrhagic *E. coli* is also transmitted in contaminated food and water, particularly undercooked meats such as hamburger.
  - *Aeromonas hydrophilia* is spread through contaminated water and is more common in children.
  - Patients with a history of prior antibiotic use may develop overgrowth of *Clostridium difficile* resulting in pseudomembranous enterocolitis.

Clinical Presentation
- Acute onset of severe, intermittent abdominal cramps followed by diarrhea that may be copious, watery, and foul smelling.
- Blood and pus may be present in stools.
- Fever; often as high as 104°F (40°C) is a distinguishing feature as compared to noninvasive diarrhea.
- Headache and myalgias are often present and vomiting may be minimal.
- The patient may experience severe abdominal pain and tenderness, especially in the lower abdomen.
- Rebound tenderness and guarding may be present on physical exam.
- Symptoms of bacteremia and sepsis may develop, especially in association with *Salmonella* and *Shigella* infections.
- Incubation periods vary from 8 hours to 8 days (longer in *C. difficile* colitis) and symptoms may persist from 1-10 days.

Treatment
- Fluid replacement with oral rehydration is again the most important aspect of treatment.
- Empiric antibiotic therapy should be initiated in suspected cases of bacterial dysentery.
- Ciprofloxacin 500mg PO BID for at least 3 days is the treatment of choice.
- In cases of antibiotic associated diarrhea where *C. difficile* is suspected, metronidazole 500 mg PO TID may be initiated.
- Antidiarrheal medications such as loperamide (Imodium) or diphenoxylate with atropine (Lomotil)
  - The classic teaching is that these medications should generally be avoided as they may allow for retention of the toxic bacteria and may increase the carrier state for *Salmonella*.
  - However, voluminous or frequent diarrhea is generally incompatible with most wilderness activities, so the antimitotility agents are more commonly used in this setting.
  - If one elects to prescribe antimotility agents, they should always be prescribed with antibiotics in order to lower the potential risks of their use. This area is not well studied in the medical literature.
- Bismuth subsalicylate (Pepto-Bismol) may be used safely in cases of dysentery, but slows absorption of oral antibiotic medications.
## Protozoal Causes of Diarrhea

- Common protozoal causes of gastroenteritis include *Giardia lamblia*, *Entamoeba histolytica*, *Cryptosporidium*, and *Cyclospora*.
- All are transmitted via the fecal-oral route, mainly in contaminated water and food.
- Protozoal infections can result in chronic diarrhea, but symptoms vary widely from asymptomatic disease to acute dysentery.

### Giardiasis

**Pathophysiology**
- *Giardia lamblia* is a single-celled parasite that exists in a cyst form and a trophozoite form.
- Symptomatic disease is caused by the trophozoite.
- Infected individuals and animals pass the cyst form in stools. These cysts can survive in the environment for 3 months or longer.
- Beaver, deer, dogs, cattle, sheep and rodents are common carriers of *Giardia*, and many natural water sources may have *Giardia* cysts present despite being in remote or "pristine" locations.
- Drinking contaminated water is the primary source of infection with an infectious dose being as low as 10-25 cysts.
- However, many individuals remain completely asymptomatic after exposure to *Giardia*, even in high concentrations.
- The disease may also be transmitted in a direct person to person manner if proper hygiene is not observed.

### Table: Common Protozoal Infections

<table>
<thead>
<tr>
<th>Cause</th>
<th>Incubation</th>
<th>1st line Treatment</th>
<th>Alternative Treatment</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Salmonella</em> spp (nontyphoidal)</td>
<td>8-72 hours</td>
<td>Supportive therapy. Ciprofloxacin 500 mg PO BID x 7 days if systemic symptoms present.</td>
<td>Azithromycin</td>
<td>Carried by domestic animals and pets. Common in poultry, eggs. May develop sepsis in severe cases.</td>
</tr>
<tr>
<td><em>Shigella</em> spp</td>
<td>1-3 days</td>
<td>Ciprofloxacin 500 mg PO BID x 3-5 days</td>
<td>TMP/SMZ, azithromycin</td>
<td>Highly contagious, may lead to sepsis.</td>
</tr>
<tr>
<td><em>Campylobacter</em></td>
<td>1-7 days</td>
<td>Ciprofloxacin 500 mg PO BID x 3-5 days</td>
<td>Azithromycin</td>
<td>Common in lakes and streams.</td>
</tr>
<tr>
<td><em>Enterohemorrhagic E. coli</em></td>
<td>3-8 days</td>
<td>Ciprofloxacin 500 mg PO BID x 3-5 days</td>
<td>Avoid antibiotic tx if E. coli 0157:H7</td>
<td>Hemolytic uremic syndrome may develop 5-15 days post-infection in 5-10% of cases</td>
</tr>
<tr>
<td><em>Yersinia enterocolitica</em></td>
<td>1-5 days</td>
<td>Ciprofloxacin 500 mg PO BID x 3-5 days</td>
<td>TMP/SMZ</td>
<td>Carried by wild and domestic animals.</td>
</tr>
<tr>
<td><em>Aeromonas hydrophilia</em></td>
<td>1-5 days</td>
<td>Ciprofloxacin 500 mg PO BID x 3-5 days</td>
<td>TMP/SMZ, tet racycline</td>
<td>Common in children.</td>
</tr>
<tr>
<td><em>Clostridium difficile</em></td>
<td>1-12 weeks</td>
<td>Metronidazole 500 mg PO tid x10-14 days</td>
<td>Vancomycin orally</td>
<td>Associated with prior antibiotic use.</td>
</tr>
</tbody>
</table>
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Clinical Presentation
- Incubation time is one to three weeks after ingestion; so many travelers may develop symptoms well after returning home.
- Diarrhea is the most common feature of giardiasis and is present in up to 90% of symptomatic cases.
- The severity of diarrhea varies and may result in mild to moderate amounts of foul smelling soft stool, but can be copious and explosive.
- A characteristic “rotten egg” odor is associated with the intestinal gas and feces.
- Other symptoms: malaise, bloating, abdominal cramping, nausea, and occasionally vomiting and low grade fever.
- Untreated, symptoms typically last 7-10 days, but chronic diarrhea (> 2 weeks) may develop and can have a cyclical pattern of worsening symptoms every few weeks.

Treatment
- Metronidazole 250 mg PO TID for 3-5 days is standard therapy.
- Tinidazole 2 g PO x 1 dose, or quinacrine 100 mg PO TID for 5 days, are also effective treatments.
- Furazolidone 100 mg PO qid for 7 days may be used for children.
- No single treatment is effective in all cases, and multi-drug therapy may be needed in resistant cases.

Amebiasis

Pathophysiology
- Amebiasis is caused by Entamoeba histolytica, a ubiquitous parasite found around the world.
- It is particularly prevalent in tropical countries.
- The organism exists in a cyst and a trophozoite form with the cyst form being excreted in stool.
  - The cysts are transmitted through fecal-oral contamination of food or water or through direct contact with an infected person.
  - Ingested cysts become trophozoites that invade the colon wall and cause a variety of intestinal symptoms.

Clinical Presentation
- Most individuals are asymptomatic, and many become chronic carriers.
- Symptomatic individuals may develop alternating constipation and diarrhea over 1 to 3 weeks, abdominal cramping, weight loss, anorexia, and nausea.
- More severe infections may develop weeks to months after infection; resulting in symptoms of dysentery with fever and bloody stools.
- Trophozoites may migrate to other locations in the body causing extraintestinal metastases in the liver, skin, pericardium and brain. Liver abscesses can form acutely or may present years after infection with symptoms of fever, RUQ pain, and weight loss.

Treatment
- Empiric treatment for amebiasis may be initiated in a patient with dysentery who does not respond to an appropriate antibiotic.
- Diagnosis may be made by stool ova and parasite examination if the patient seeks medical treatment either during or after travel.
- Antibiotic therapy for symptomatic disease includes metronidazole 750 mg PO TID for 10 days or tinidazole 1 g PO BID for 3 days. This treatment should be followed by a course of iodoquinol, paromomycin or diloxanide to eradicate the cysts and prevent the carrier state.
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**Cryptosporidium**

Pathophysiology
- *Cryptosporidium* is a protozoan that is present throughout the environment, including up to 97% of large streams, lakes and reservoirs in the U.S.
- The organism is resistant to iodine and chlorine disinfectants.
- Transmission may occur through ingestion of contaminated water and possibly food.

Clinical Presentation
- Cryptosporidia typically cause a self limited diarrheal illness that develops 2 – 14 days after ingestion.
- Symptoms include watery diarrhea, crampy abdominal pain, anorexia, malaise, and flatulence.
- Severity of disease varies from asymptomatic infection to stools occurring more than seventy times daily in immunocompromised patients.

Treatment
- No effective treatment has been found, and eradication of the infection is the result of the patient’s own immune function.
- Supportive therapy consists of fluid and electrolyte replacement.

**Cyclospora**

Pathophysiology
- *Cyclospora cayetanensis* is a protozoan parasite that is most commonly transmitted in contaminated water in developing countries.
- An outbreak in the U.S. in 1996 was traced to the consumption of imported raspberries.
- *Cyclospora*, like *Cryptosporidium*, may be resistant to halide treatment.

Clinical presentation
- Infection typically causes watery diarrhea that may last for weeks.
- Other symptoms: anorexia, weight loss, bloating, abdominal cramping, flatulence, nausea, vomiting, myalgias, low grade fever and fatigue.

Treatment
- Antibiotic treatment with TMP/SMX 160 mg/800 mg DS tablets PO BID for 7 days is effective.
- Water may not be reliably decontaminated by filtration or halide treatment and should be boiled to avoid *Cyclospora* infection.

**Other Gastrointestinal Infections**

**Hepatitis A**

Pathophysiology
- Hepatitis A virus causes acute inflammation of the liver.
- It is transmitted fecal-orally through direct contact or contaminated food or water.
- It is present worldwide, but is more common in developing nations.

Clinical Presentation
- Incubation period from the time of ingestion is 15 – 50 days.
- Symptoms vary from mild gastroenteritis to fulminant liver failure.
- Typical presentation includes acute onset of fever, lethargy, anorexia, and nausea followed by darkening of urine (usually after 3 – 10 days) and jaundice.
- Abdominal pain and vomiting, as well as itching and joint pain, may be present.
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- Physical exam may reveal hepatosplenomegaly.
- Symptoms usually resolve without treatment in several days to 2 weeks, with jaundice resolving after 3 – 4 weeks.
- Chronic infection does not occur.
- Fulminant liver failure is a rare complication, occurring in 0.5% – 1% of cases.

Treatment
- Provide supportive care, and evacuate for advanced medical care if symptoms become severe.
- No specific medical therapy is available.

Prevention
- Hepatitis A vaccine is recommended for all travelers to developing nations. A single dose vaccine followed by a booster at 6-12 months provides protection for 10 years.
- Unimmunized contacts of hepatitis A patients should receive an injection of gamma globulin 0.2 ml/kg.
- Appropriate measures for hygiene and water disinfection should be followed vigilantly.

Typhoid fever

Pathophysiology
- Typhoid fever is a systemic illness caused primarily by the organism Salmonella typhi.
- S. paratyphi produces a similar illness but usually of shorter duration.
- Typhoid fever occurs worldwide, but is most commonly contracted in developing nations.
- Humans are the only hosts for S. typhi and transmission occurs most commonly through ingestion of contaminated food and water.
- Contact with chronic carriers of S. typhi may also lead to infection.
- Once ingested, the bacteria penetrate the intestinal mucosa, causing bacterial enteritis as well as bacteremia and systemic illness.

Clinical Presentation
- The incubation period of S. typhi is seven to fourteen days.
- Initial symptoms include fever, headache, abdominal pain and malaise.
- Gastroenteritis may occur early in the disease, but often does not present during the first ten days of illness.
- Constipation may also occur.
- The temperature rises slowly during the first week of the disease. During weeks two and three, a continuous high fever up to 104°F (40°C) persists.
- A notable feature of the febrile state is a relative bradycardia.
- A characteristic rash of “rose spots”, 2 – 4 mm macular blanching lesions, may appear on the trunk during days 7-10 of the illness.
- Physical exam may reveal splenomegaly after the first week.
- Worsening diarrhea may develop during the third week.
- After three weeks, the fever typically begins to abate and symptoms begin to resolve spontaneously in uncomplicated cases.
- Complications of typhoid fever include intestinal perforation, gastrointestinal hemorrhage, sepsis with multisystem failure, and pneumonia.

Treatment
- Treatment of typhoid fever involves supportive care and management of fluids and electrolytes.
- Antibiotic treatment reduces the duration of disease and decreases the complication rate.
  o Antibiotic treatment of choice for oral treatment is ciprofloxacin 500 mg PO BID for 10 days.
  o IV antibiotic regimens include ceftriaxone 2 g IV q 24 hours for 14 days or ciprofloxacin 400 mg IV q12 hours for 10 days.
  o Azithromycin 1 g PO once daily for 5 days is a reasonable alternative therapy.
Chloramphenicol treatment has been used successfully in the past at a dose of 50mg/kg/day divided qid for 2 weeks. Increasing bacterial resistance and the rare incidence of aplastic anemia associated with chloramphenicol use have led to its relegation to a position of second line therapy.

Prevention of Gastrointestinal Disease

- Proper hygiene and sanitation practices are essential in preventing infectious diseases of the GI tract.
- The wilderness traveler must be vigilant to insure that food and water do not become contaminated.
- Wash hands thoroughly with soap or hand disinfectant before preparing and eating meals.
- Cooking and eating utensils should be cleaned with boiling water or bleach solution prior to each use.
- **Diet**
  - Avoid raw or undercooked meat, fish and seafood.
  - When traveling internationally, avoid street vendors, raw vegetables and fresh salads.
  - Avoid unpasteurized milk, cheese, and other dairy products.
  - Peeled fruits and vegetables are generally safe.
  - Do not rinse food in water that has not been disinfected.
- **Water**
  - Use appropriate methods of water disinfection
  - When traveling internationally, avoid tap water and ice cubes made from untreated water.
  - Purchase name brand bottled water.
    - It is important that you always check the seal on any water bottle prior to drinking; if dining out, request that you break the seal and open the bottle yourself.
    - Sometimes the vendors will recycle the bottles and fill them with tap water. Of course, they will bring the open water bottle to your table so that you will not recognize this trick.
- **Prophylaxis**
  - Bismuth subsalicylate has been shown to be safe and effective in prophylaxis of diarrheal illness, reducing incidence of disease by up to 65%.
    - The recommended regimen is 2 tablets or 2 tablespoons four times daily.
    - Side effects include darkened stools and tongue, and possibly constipation and nausea.
    - Avoid concurrent aspirin use.
  - In general, antibiotic prophylaxis is not recommended.
  - In short term trips to high risk areas where circumstances may demand more aggressive strategies of prevention, the following broad spectrum antibiotics may be used:
    - Norfloxacin 400 mg PO q day
    - Ciprofloxacin 500mg q day
    - Ofloxacin 400 mg q day
    - TMP/SM 160 mg/80 mg DS tablet, 1 PO q day
    - Doxycycline 100 mg PO q day

Evacuation Guidelines

- Any victim with moderate to severe abdominal pain that does not improve over 12 – 24 hours should be evacuated.
- Victims unable to take sufficient oral rehydration fluids for more than 24 hours should be evacuated.
- Anyone experiencing mental status changes, signs of significant dehydration, hematemesis or copious bloody stools should be evacuated immediately.
- Victims with signs and symptoms of dysentery who do not respond to appropriate antibiotic therapy in 24 – 48 hours should be evacuated.
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Malaria

Pathophysiology
- Malaria is a parasitic infection caused by protozoa of the genus *Plasmodium*.
- Malaria is one the most common infections worldwide, with 300 – 500 million cases occurring annually with over 2.5 million deaths.
- The female *Anopheles* mosquito transmits the parasites, which invade and destroy red blood cells.

<table>
<thead>
<tr>
<th>Organism</th>
<th>Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Plasmodium falciparum</em></td>
<td>Worldwide, esp. sub-Saharan Africa, Amazon, Haiti, SE Asia</td>
</tr>
<tr>
<td><em>Plasmodium vivax</em></td>
<td>Worldwide, esp. Mexico, Central America, N. Africa, Middle East, India</td>
</tr>
<tr>
<td><em>Plasmodium ovale</em></td>
<td>West Africa</td>
</tr>
<tr>
<td><em>Plasmodium malariae</em></td>
<td>Worldwide</td>
</tr>
</tbody>
</table>

Clinical presentation
- Symptoms typically present 1 – 2 weeks after exposure to an infected mosquito.
- Initial symptoms include muscle soreness and low grade fever, which progress to paroxysms of shaking chills followed by high grade fever and drenching sweats.
- Cycles of chills and fever last several hours and may occur every 2 – 3 days, depending on the specific organism.
- Headaches, myalgias, and backaches are also common and may be severe.
- Other symptoms include nausea, vomiting, diarrhea, severe anemia, and darkened urine (aka blackwater fever.)
- Severe *P. falciparum* infection may present with constant fever and high levels of parasitemia that can lead to cerebral malaria.
  - Symptoms of cerebral malaria include high fever, confusion, coma, seizures, and possibly death.
  - Mortality rates of cerebral malaria are greater than 20%.
  - Other complications of severe infection include pulmonary edema, acute renal failure, profound hypoglycemia and lactic acidosis.
- Physical exam may reveal splenomegaly and a tender abdomen in advanced infections.

Prevention
- A combination of personal protective measures and chemoprophylaxis is essential to avoid malaria infection in endemic areas.
- The *Anopheles* mosquito is most likely to bite between dusk and dawn.
  - Limit exposure by using mosquito nets and wearing protective clothing impregnated with an insecticide such as permethrin.
  - Light colored clothes with long sleeves and long pants are recommended.
  - Insect repellent containing DEET (no higher than 35% concentration is necessary) should be applied to exposed skin.
- Consult with a travel clinic or the CDC recommendations to determine the appropriate chemoprophylaxis for the region of travel ([http://www.cdc.gov/travel](http://www.cdc.gov/travel)).
- Options for chemoprophylaxis include:
  - Chloroquine
  - Mefloquine (Lariam)
  - Doxycycline
  - Atovaquone/proguanil (Malarone)
  - Pyrimethamine / sulfoxime (Fansidar)
  - Primaquine
  - Drug choice is based on the risk of chloroquine-resistant *P. falciparum* and patient contraindications (e.g. pregnant women and children.) Chloroquine resistance is particularly common throughout sub-Saharan Africa and also occurs in South America, Southeast Asia, and Oceania.
  - Weekly drug regimens (chloroquine, mefloquine) should be initiated 1-2 weeks before traveling to an endemic area, while daily dosing regimens may be started 1-2 days before travel.
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Treatment
- Malaria infection can occur despite careful behavior modification and chemoprophylaxis. For wilderness travel in endemic areas, appropriate medications should be taken for self treatment.
- Recommended treatment regimens should be determined through consultation with a travel clinic or the CDC.
- Treatment should be initiated when signs and symptoms suggest malarial infection and medical care is not immediately available.
- Anyone suspected of having malaria should be evacuated, especially in areas where *P. falciparum* is predominant.

Rabies

Pathophysiology
- Rabies is caused by an RNA virus in the Rhabdoviridae family.
- The virus is transmitted in the saliva of infected animals.
- Only 2 – 3 deaths are reported annually in the US, but worldwide an estimated 55,000 people die each year from rabies.
- In the US, over 90% of animal rabies occurs in wildlife, with less than 5% occurring in dogs.
- In most developing nations, however, dogs account for up to 90% of reported animal rabies.
- Major vectors for rabies worldwide include dogs, bats, foxes, raccoons, skunks, coyotes and mongooses. Bats are the most common vector for human infection in the U.S. Unlikely animal vectors include small rodents, birds and reptiles.
- Following inoculation, the rabies virus travels through the peripheral nervous system to the central nervous system. The virus multiplies in the CNS then spreads throughout the body via the cranial and peripheral nerves.

Clinical Presentation
- Rabies infection causes acute encephalitis, which is almost always fatal.
- The incubation period varies from 9 days to more than a year with most cases presenting within 20-90 days.
- Incubation time is directly related to the location of the inoculation site and the distance the virus must travel before reaching the CNS. Rabies resulting from a bite involving the head or face has an average incubation period of 30 days, while a bite to the foot has an average incubation period of 60 days.
- Prodromal symptoms are nonspecific and may include malaise, headache, fatigue, fever, irritability, insomnia, depression, nausea, vomiting, sore throat, abdominal pain and anorexia.
- Approximately half of patients experience pain, pruritus or paresthesias at the inoculation site.
- The prodromal period lasts from 2 – 10 days.
- Following the prodrome, patients will develop signs of CNS disease.
- Rabies exists in two forms, furious rabies and paralytic rabies. Humans more commonly develop the furious form.
  - Furious Rabies
    - Hyperactivity
    - Disorientation
    - Agitation
    - Hallucinations
    - Aggressive or bizarre behavior
    - Hyperthermia
    - Tachycardia
    - Hypertension
    - Excessive salivation
  - Paralytic Rabies
    - Progressive lethargy
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- Incoordination
- Confusion
- Stupor
- Ascending paralysis
  - Both furious and paralytic forms of rabies are fatal with symptoms leading to coma and death.

Treatment
- There is no proven therapy for treatment of rabies.
- Anyone suspected of exposure should undergo appropriate post-exposure prophylaxis (see below.)
- Untreated patients survive an average of 8 days after onset of symptoms.
- With intensive care, the duration of illness may last up to 28 days.
- A single case report in 2005 described survival in a rabies patient who did not receive post-exposure prophylaxis.
  - Treatment included coma induction and antiviral treatment.
  - The patient sustained moderate neurologic sequelae but returned to independent functioning.

Prevention
- Wilderness travelers most at risk include spelunkers, professional hunters, wildlife workers, and those traveling to endemic areas for extended periods or to remote areas without medical care.
- Pre-exposure vaccines are given in 3 doses over 3 – 4 weeks, and may be administered intramuscularly or intradermally depending on the vaccine type (HDCV, PCEC, or RVA). Boosters are given according to exposure risk.
- Post exposure prophylaxis consists of three steps
  - Wash the wound immediately with soap and water.
  - Administer human rabies immune globulin (HRIG) 20 IU/kg. Current CDC recommendations call for the full dose of HRIG to be infiltrated at the site of the wound, if possible. If the location of the wound precludes infiltrating the full dose, the remainder should be injected intramuscularly at a site distant from vaccine administration using a clean needle and syringe.
  - Immunize with the intramuscular rabies vaccine (HDCV or RVA). A 1 cc dose is given at 0, 3, 7, 14 and 28 days.
  - Anyone suspected of rabies exposure should be immediately evacuated for appropriate medical treatment.

Tick-Borne Diseases

Lyme Disease

Pathophysiology
- Lyme disease is caused by the spirochete *Borrelia burgdorferi*.
- It is transmitted by *Ixodes* species ticks.
- 12 U.S. states report 95% of cases: Massachusetts, Connecticut, Maine, New Hampshire, Rhode Island, New York, New Jersey, Pennsylvania, Delaware, Maryland, Michigan, and Wisconsin

Clinical Presentation
- Lyme disease presents with 3 distinct stages.
- Stage I
  - Usually develops 3 days to 1 month after a tick bite.
  - 95% of patients develop the classic rash called *erythema chronicum migrans*. This is a characteristic rash that may be uniformly red or have a more complex "bull's eye" appearance due to central clearing.
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- Other symptoms
  - Malaise, fatigue, lethargy 80%
  - Headache 64%
  - Fever and chills 59%
  - Stiff neck 48%
  - Multiple annular lesions 48%
  - Regional lymphadenopathy 41%

- Stage II
  - Includes neurologic problems, such as meningitis, cranial nerve palsies (esp. CN VII), and radiculoneuritis.
  - Cardiac problems, such as carditis and heart block, may also be present.

- Stage III develops months to years later with arthritis, often involving the knee.

**Treatment**

- The following treatment regimens are recommended:
  - Doxycycline 100 mg PO BID or 1-2 mg/kg BID
  - Amoxicillin 500 TID or 25-50 mg/kg/day divided Q8H

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**Rocky Mountain Spotted Fever**

**Pathophysiology**

- RMSF is a serious disease caused by the spirochete *Rickettsia rickettsii*.
- The spirochete is transmitted by Ixodid ticks, (dog ticks and wood ticks.)
- Despite its name, most cases occur in southern and eastern states of the U.S.
- Reported mortality rates range from 3% – 9%.

**Clinical Presentation**

- Most cases present during spring and early summer, but infections can occur throughout the year.
- The incubation time is 2 – 14 days.
- Early symptoms may be nonspecific and include mild chills, anorexia, and malaise, which then progress to the classic triad of fever, severe headache, and rash. Other symptoms include myalgias, bone pain, abdominal pain, and confusion.
- The rash characteristically begins on the ankles and wrists and spreads centrally and to the palms and soles. The rash starts as a maculopapular rash and progresses to a petechial rash. Patients may appear quite toxic.

**Treatment**

- In addition to supportive care, the following treatment regimens are recommended:
  - Doxycycline 100 mg PO BID or
  - Chloramphenicol 50 mg/kg/day divided into 4 doses
- Treatment should be continued for at least three days after defervescence.
- Any patient suspected of RMSF infection should be evacuated immediately.
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**Tick Paralysis**

**Pathophysiology**
- Tick paralysis is an acute, ascending, flaccid motor paralysis caused by neurotoxic venom secreted from the salivary glands of ticks of both Ixodidae and Argasidae families.
- In the U.S., most cases occur in the Pacific Northwest and the Rocky Mountain areas.
- There is a similar tick paralysis in Australia that has greater morbidity.
- April through June are the highest months of risk in the U.S.

**Clinical Presentation**
- Symptoms typically develop 5 – 7 days after tick attachment.
- Early symptoms may include irritability and paresthesias of the hands and feet.
- Over 24 – 48 hours, ascending paralysis develops with loss of deep tendon reflexes.
- This presents in a fashion similar to Guillain-Barré Syndrome.

**Treatment**
- Treatment involves removal of the tick and supportive care.
- Symptoms usually resolve within hours to 1 day of removal.
- In Australia, there is an antivenin to administer before removal of the tick. The antivenin is given because victims usually worsen after removal of the tick.

**Colorado Tick Fever**

**Pathophysiology**
- Colorado tick fever is a viral illness transmitted by the wood tick, primarily during spring and early summer.
- Most cases occur in mountainous regions of the Western U.S. and Canada.

**Clinical Presentation**
- The average incubation time is 3 – 4 days.
- Symptoms include fever, chills, lethargy, headache, myalgia, ocular pain, photophobia, abdominal pain, nausea, and vomiting.
- A rash occurs in 5% – 12% of infected patients.
- Acute symptoms last up to one week, with fatigue sometimes lasting much longer.
- 5% – 10% of children develop meningitis or encephalitis.
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**Treatment**
- Treatment is supportive.
- Persons with symptoms of Colorado tick fever should be evacuated for medical evaluation.

**Ehrlichia**

**Pathophysiology**
- Ehrlichiosis is a rickettsial infection that presents as a febrile illness similar to Rocky Mountain spotted fever, but without the characteristic rash.
- Two forms of ehrlichiosis exist:
  - Human monocytic ehrlichiosis (HME)
  - Human granulocytic anaplasmosis (HGA)

**Clinical Presentation**
- Average incubation time is one to two weeks, but symptoms may present as early as 2 days after exposure.
- The characteristic symptoms are high fever and headache.
- Myalgias, headache, and chills occur in over two-thirds of cases, while nausea, vomiting, arthralgias, and cough occur in 25% – 50%.
- Ehrlichiosis has a reported mortality rate ranging from 2% – 10%.
- Rash occurs only rarely.

**Treatment**
- Recommended treatment is doxycycline 100 mg PO BID for three to five days after defervescence.
- Anyone suspected of this illness should be evacuated for appropriate medical care.

**Tularemia**

**Pathophysiology**
- Tularemia or “rabbit fever” is caused by the bacterium *Francisella tularensis*.
- It may be contracted through exposure to ticks, deer flies, and mosquitoes or by contact with infected animals, such as rabbits, muskrats, foxes and squirrels.
- In the U.S., the most common vectors of transmission are ticks.
- The disease has been reported from all 49 continental states, but is most common in the south central states, mainly Arkansas, Missouri, and Oklahoma.

**Clinical Presentation**
- Patients typically present with a history of fever, chills and myalgias, followed by an irregular ulcer at the site of the inoculation, which may persist for months.
- Regional lymphadenopathy develops, and these nodes may necrose and suppurate.
- Incubation time is 3 – 5 days.

**Treatment**
- The treatment of choice is streptomycin 10 mg/kg IM every 12 hours for 7 to 10 days. The daily dose should not exceed 2 g.
- The doses for alternative agents are:
  - Gentamicin 3 to 5 mg/kg IM or IV daily, given every eight hours for 7 to 10 days
  - Tetracycline 500 mg PO QID
  - Doxycycline 100 mg PO BID for 14 days
  - Chloramphenicol 25 to 60 mg/kg per day IV in four divided doses (not to exceed 6 g/day in adults) for 14 days
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Borrelia – Relapsing Fever

Pathophysiology
- Relapsing fever is caused by spirochetes of the Borrelia genus.
- Both tick-borne and a louse-borne forms of the disease affect humans.
- The tick-borne form is transmitted by ixodid and argasid ticks.
- The disease occurs worldwide, with most U.S. cases occurring west of the Mississippi.

Clinical Presentation
- Incubation time averages around seven days.
- Symptoms include fever, chills, severe headache, lethargy, arthralgias, photophobia, petechiae and splenomegaly.
- As the name implies, relapses of fever are characteristic.
  - The pattern is usually three days of symptoms with seven days between each relapse.
  - There is an average of three relapses.

Treatment
- Treatment is with doxycycline 100 mg PO BID

Babesiosis

Pathophysiology
- Babesiosis is caused by an intra-red blood cell protozoan parasite.
- It is spread by Ixodes ticks, as is Lyme disease.
- In the U.S., most cases are reported from the northeastern coastal areas.

Clinical Presentation
- This disease causes a febrile illness that is worse in asplenic patients.
- The incubation time is 1 – 3 weeks and symptoms include malaise, fatigue, anorexia, shaking chills, fever, headache, and blood in the urine.
- Nausea, vomiting, and abdominal pain may be present.
- Hemoglobinuria is a predominant sign.
- These symptoms are all similar to those of malaria, so babesiosis is often misdiagnosed as malaria.
- The diagnosis is made with a peripheral blood smear.

Treatment
- The treatment for mild cases is symptomatic.
- More severe cases may be treated with combination therapy of quinine/clindamycin or atovaquone/azithromycin.
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Questions

1) Which one of the following is correct regarding gastroenteritis in the wilderness environment?
   a) All victims should be started on antibiotics at the first episode of diarrhea
   b) Antimotility agents, such as diphenoxylate, should be used on all cases of diarrhea
   c) Bloody diarrhea in conjunction with a fever of 104º F should be treated with oral antibiotics
   d) Enterotoxigenic *E. coli* accounts for 10% of “traveler’s diarrhea.”
   e) Staphylococcal food poisoning is best treated with an anti-staphylococcal antibiotics

2) In which one of the following regions would chloroquine alone be least effective for malaria prophylaxis?
   a) Central America
   b) Eastern Europe
   c) Mexico
   d) Middle East
   e) Sub-Saharan Africa

3) Which of the following is the most appropriate treatment for Rocky Mountain Spotted Fever?
   a) Azithromycin 1 g PO daily
   b) Ciprofloxacin 500 mg PO BID
   c) Ceftriaxone 2 g IV q 24 hours
   d) Doxycycline 100 mg PO BID
   e) Metronidazole 500 mg PO BID

4) Which one of the following animals is responsible for most cases of human rabies in the U.S.?
   a) Bats
   b) Beavers
   c) Dogs
   d) Foxes
   e) Raccoons

5) True or False: Rocky Mountain Spotted Fever is a self limited disease and can be effectively managed in the wilderness.

6) Three hours after eating dinner, all members of your backpacking camp develop acute onset of vomiting and diarrhea. What is the most appropriate management?
   a) Azithromycin 1g PO daily
   b) Ciprofloxacin 500 mg PO BID
   c) Immediate evacuation
   d) Metronidazole 500 mg PO TID
   e) Supportive care and oral rehydration solution

7) A 16 year-old female is one week into a two week camping trip in Colorado when she complains of weakness in her legs and difficulty walking up the hills. She was fine before the trip. On examination you find a symmetric weakness of the legs with absent Achilles and patellar reflexes. She has no rashes. Which one of the following is most appropriate in evaluating and treating this patient?
   a) Amoxicillin 500 mg PO TID
   b) Azithromycin 1 g PO daily
   c) Doxycycline 100 mg PO BID
   d) Oral rehydration with a balanced salt and glucose solution
   e) Thorough evaluation for a tick with removal if one is found

Answers: 1c, 2e, 3d, 4a, 5 False, 6e, 7e