**Subject:** Water use and Treatment

**Catchy Title:**

**Presenters Name:**

**When to teach this topic:** To be taught on the first day when it is time to get water. You will want to check the map for an appropriate water source to do this.

**Who is this for (level of experience and age of participants):** For those interested in the outdoors from 6th grade on.

**Resources:**
- PSO Leader Manual – in resource box and for use at the Expeditionary
- The Backpackers Field Manual
- Other:

**Materials needed:**

**Outcomes:** Things for you to know and teach so that all participants will be able to know and do each following bullet by the end of this lesson.

- Leaders will understand the difference between purifying and filtering water.
- Leaders will understand how to select water to be treated.
- Leaders will understand how to treat water with iodine.
- Leaders will understand how to teach others to treat water.
- Leaders will understand how to safely use drink mixes with treated water.
- Leaders will be able to know and teach how to thread and burp water bottles after and during treatment.
- Leaders can teach and identify what the consequences for not treating water are, ie, understand and explain giardia.
Introduction/Hook: If you are going to take a horse to water...make sure it’s thirsty. Make sure you are doing this at a time when the participants need this information and are ready to hear it (are people warm, hydrated and well fed?).

Very short activity/introduction:

Procedures & Activities Steps, e.g. models, structured practice, guided practice, independent work. Include time allotments for all steps in each section. Usually 5-10 minutes per section. Timing is very important.

Explain & Demonstrate:

   Step 1 __ minutes

   Step 2 __ minutes

   Step 3 __ minutes

   Step 4 __ minutes

Practice (individually if appropriate):

How to Assess each individuals skills:

Closure/Evaluation: How will you close the lesson? How will the students remember what they learned today? Homework? Summary? Quiz? When? Usually allow at least 5 to as much as 10 minutes for this section.

Evaluation: Analyze the strengths and weakness of the lesson as it actually happened. Include things to avoid next time you teach the lesson, and what went particularly well. How was the timing of the lesson?
Load heavier items into the large top compartment in the position where you want most of the weight. Then fill this and the remaining compartments with lighter items. Tents and tarps can be lashed to the extender bars at the top of the pack, and sleeping bags can usually be lashed to the frame at the bottom of the pack.

**Internal Frame Pack**
Your gear will help form the structure of support for an internal frame pack. For easy, level hiking, a high center of gravity is best. To achieve this, load bulky, light gear low in the pack and stack heavier gear on top of it. For steeper terrain, a lower center of gravity is best. Place heavier items a little lower and closer to your back than usual.

**With external and internal frame packs, remember to pack all contaminants, gas, etc., below the food.**

**Water Purification**

**Iodine Treatment**
- Liquid Iodine Concentration: The amount of iodine needed to kill all of the beasties effectively varies depending on:
  - time water will be sitting before drinking
  - temperature and clarity of water (strain through SUMP screen if cloudy)
  - concentration of iodine
    * If iodized water sits for twice as long, you can generally use half the iodine. On personal trips you can use 5 drops for 1 hour.
- **For your PSO and Passages Trips add 10 drops for 30 minutes in 1 QUART/.9 LITERS OF WATER!**
- Make sure to burp the bottle so that treated water leaks through all of the threads, hoses, nozzles on the system you are using.
- Water bags - You can treat water in Camelbak type systems just as you would in a water bottle. MAKE SURE YOU KNOW HOW MANY QUARTS YOUR SYSTEM HOLDS!
- Let the water sit for at least 30 minutes before drinking.
- After the water has been treated (and the waiting period is over), add 50 milligrams of vitamin C to eliminate any taste.

**Any Other Treatments**
- Follow directions on the container.
- If using a filter method, be sure to have a backup method on hand.
- Remember, boiling water is always a sure way to purify it.

**Bear Bagging and Critter Resistant Canisters**

In the Pacific Northwest bears and raccoons can be attracted to your campsite by food and hygiene odors. Always check with a ranger about precautions and regulations. Some campsites in the Olympics and Cascades have permanent bear wires, but other areas will require you to carry a bear rope or Critter Resistant Canisters (CRCs). Check ahead of time to make sure you know what to expect. Check with the U.S. Forest Service or National Park Service for more information.
B. Eating properly in the mountains is necessary for optimum performance: hiking up a steep trail with a 40-pound backpack can burn up calories at the rate of 300-600 per hour.

C. Morale and energy will drop if proper attention is not given to food preparation and eating. Learning is impaired and thus safety is compromised. Recognize and control the stress associated with food.

D. Assume that participants, particularly younger ones, are not familiar with nutrition and how to prepare meals.

E. Meals are an important social event and, as such, need to be orderly in preparation, serving, and eating. See *Mealtime Themes and Activities in Games and Initiatives* for ideas on how to structure meals.

F. Eating with your participants is important means of building rapport with them.

G. Assist in food planning.
   1. Specify numbers and types of meals required, i.e., cold and hot meals.
   2. Work with cooks early on and providing sample menus.
   3. Teach principles of nutrition.
   4. Set clear standards with regard to group eating, such as requiring that the group circle up before eating, insisting that no one eats until everyone is served, etc.

H. Organize and pack food so it can be identified and retrieved easily, e.g., by meals, by day. Make a list and divide weight appropriately.

I. No cooking should be done in tarps, except in an emergency.

J. See *PCOBS Cookbook* for more complete information.

II. Water purification and conservation.

A. Water intake.
   1. At least 3-4 quarts of water are needed daily when exercising at altitude in warm weather. Soldiers in the Israeli Army drink 11 quarts a day. This intake requires concerted effort and vigilant monitoring by self and others. Thirst is not an adequate indicator of fluid needed.
   2. Dehydration lowers resistance to hypothermia and heat-related disorders, and predisposes one to headaches, nausea, lassitude, constipation, and mountain sickness.
   3. Watch urine color. Dark urine infrequently voided indicates insufficient fluid intake.
4. Dehydration is not a simple lack of water, but a complex condition involving the depletion of electrolytes, especially salt, potassium, and magnesium. It can usually be corrected simply by rehydrating and eating a good diet.

B. Purification
1. Do not trust the purity of surface water in backcountry areas. Game and grazing animals and careless backpackers have caused severe biological pollution, even in apparently pristine alpine water.
2. These are the main contaminating organisms in our course areas:
   a) *Giardia lamblia*, a flagellate (tailed) protozoan endemic to the United States, appears to be carried into remote drainages by animals and people. Of the main contaminating organisms it is the most troublesome; it causes an illness called *giardiasis*. Symptoms include diarrhea, sulfurous belches and flatulence, malaise, and weight loss, but they do not appear until one to four weeks after ingestion. Because of this delayed onset of symptoms, giardiasis is clearly distinguishable from viral or bacterial infections, in which signs and symptoms appear in a matter of days. Giardiasis can be debilitating and will recur until treated. It responds well to atabrine or metronidazol (Flagyl, which is not safe for pregnant women to take). The life cycle of *Giardia* includes cyst stages that are somewhat resistant to water purification methods, but they do succumb to chlorination, iodination, filtration, and boiling.
   b) Bacteria are one-celled animals with simple cell structure, e.g., *salmonella, shigella, E. coli*. The presence of diarrhea-causing bacteria in high mountain water is due almost entirely to contamination by human waste, and contamination can be removed as for *Giardia* and other protozoa. Signs and symptoms of illnesses caused by bacteria include common gastrointestinal disorders such as cramping, diarrhea, flatulence, and loose foamy stools.
Infection with these organisms responds well to antibiotics.

c) Viruses are incomplete organisms that must live on a larger cell. Water contamination by viruses results only from human waste. Signs and symptoms of illness are the same as for bacteria. Viral infections do not respond well to antibiotics.

3. The three effective means of treating water are adding chemicals, heating, and filtering. Time and temperature are the critical elements when adding iodine to water or heating water. The tables below are outlines to be followed when treating water by two of these methods:

a) The addition of two percent tincture of iodine solution in an ethyl-alcohol base is the standard form of water purification used by PCOBS. As the chart below shows, temperature is the critical variable in determining the time it takes to disinfect water effectively.

<table>
<thead>
<tr>
<th>Temp.</th>
<th>Clear Water</th>
<th>Cloudy Water</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warm</td>
<td>5 drops/15 min</td>
<td>10 drops/30 min</td>
</tr>
<tr>
<td>Cold</td>
<td>5 drops/60 min</td>
<td>10 drops/60 min</td>
</tr>
<tr>
<td></td>
<td>10 drops/30 min</td>
<td></td>
</tr>
</tbody>
</table>

b) Alternatively, boiling water is a reliable way to destroy most infectious organisms. Disadvantages of this method are inconvenience and amount of fuel necessary. The following are guidelines for this method if it needs to be used.

Thermal Death Points

- Giardia: 158 degrees F / 3 minutes
- Viruses: 212 degrees F / 1 or 2 seconds
- Bacteria: 212 degrees F / 1 or 2 seconds

4. DO NOT add drink mixes until after the purification period.

RESOURCE:
Field Water Disinfection, Howard Backer, MD, 1990

III. Stoves.
If the trip is for more than seven days, you should do a sterilization about once a week. Clean the items as described above, then prepare a rinse pot. Add a sterilization compound like chlorine bleach to a large pot of cool water (don’t use hot water; it deactivates the sterilization chemical). Use the same proportion as you would for purifying water. Rinse all cups, spoons, pots, and utensils with this water and then air dry. Then rinse again with boiling water. Use a pot gripper to avoid scalding your hands.

**TRICKS OF THE TRAIL**

**Cleaning Tips**

- Having a hot drink at the end of the meal offers an opportunity for personal cups and spoons to be rinsed out with hot water.
- Oily foods will leave more of a residue that is difficult to clean out with natural materials. On a long trip, you may want to wash periodically with biodegradable soap to remove this oily layer, which could harbor bacteria.
- On coastal trips you can boil salt water for your first rinse. Then clean with lightly soapy water and follow with a chlorine or iodine rinse.
- Don’t use scouring pads. They get gunked up with food particles and become a bacteria haven.

**WOMEN’S HYGIENE ISSUES**

Both women and men need to be comfortable talking about menstruation in the wilderness. For women who have not been in the backcountry before, the physical exertion of the trip can cause their period to start early or not to occur at all. Neither of these is uncommon or dangerous, but for a woman who is used to being very regular, it may be cause for concern.

Proper hygiene is important in minimizing the possibility of infections. Women should clean themselves daily, washing from front to back to keep fecal bacteria from entering the vagina or urethra. Wash your hands thoroughly after cleaning yourself. Premoistened, unscented cleaning towelettes can be a good way of preventing contamination from dirty hands. Keeping yourself odor-free is important when traveling in bear country.

**TAMPONS VS. PADS**

Some women have a definite preference for one form of protection. There are also some considerations for the backcountry. Tampons take up less space, may be more comfortable for strenuous hiking, and are preferable in bear country. To avoid infections, use tampons with applicators; tampons without applicators require scrupulously clean hands for insertion and are not recommended in the backcountry. Make sure you have sufficient supplies for the trip, even if you are not expecting your period. For some women, the increase in physical activity from daily hiking can bring on an early menstruation.

**ON DISPOSAL OF TAMPONS, PADS, AND TOWELETTES**

These should be packed out. Crush aspirin over soiled tampons and pads, then wrap them in tin foil. This will minimize the odor, which is particularly important in bear country, as bears may be attracted by the scent of blood. Hang in the bear bag (see Traveling in Bear Country, page 155).

**WATER PURIFICATION**

Dipping your head into a cold mountain stream and taking a long refreshing drink is an experience that has basically vanished from the wilderness areas of America. With the increased use of the wilderness there has also been an increase in the amount of bacteriological contamination of backcountry water supplies. The U.S. Environmental Protection Agency reports that 90 percent of the world’s water is contaminated in some way. There are a variety of microscopic organisms that can contaminate water supplies and cause potentially serious, even fatal, illnesses among wilderness travelers. The major danger in the backcountry from these infections is fluid loss due to diarrhea and vomiting, which can lead to hypovolemic shock and possibly death (see Diarrhea or Vomiting, page 315; Fluid Electrolyte Replacement, page 286; Shock, page 238).

In order to drink the water, you should be prepared to treat it. There are numerous methods of water purification, described below in order of effectiveness. Remember, however, that infections can also be spread through poor personal hygiene, something that purifying your water won’t prevent.

**Biologically Contaminated vs. Toxic Water**

*Biiologically contaminated* water is water that contains microorganisms such as *Giardia* (a common microorganism that, if not killed, leads to intestinal disorders), bacteria, or viruses that can lead to infections (see Gastrointestinal Infections, page 316). *Toxic* water sources contain chemical contamination from pesticide runoffs, mine tailings, and so on. Boiling, filtering, or chemically treating water can remove or kill microorganisms, but it will not remove chemical toxins. This is also the case when using a solar still (see page 223).
is the most certain way of killing all microorganisms. According to residents of Medical Society, water temperatures above 160°F (70°C) kill hogens within 30 minutes and above 185°F (85°C) within a few minutes. In the time it takes for the water to reach the boiling point (212°F (100°C)) from 160°F (70°C), all pathogens will be killed, even at high alti- To be extra safe, let the water boil rapidly for one minute, especially at r altitudes since water boils at a lower temperature (see page 88.)

CAL PURIFICATION
are two types of chemical treatment: those using iodine and those chlorine. There are a variety of products on the market, so follow the ion on the bottle. Be advised that many of the tablets have an expira-date and become ineffective after that point. Also, once the bottle has opened, the tablets must be used within a certain period. When in t, buy a new bottle. Remember that chemical purification methods may be partially effective, depending on the water temperature.

General Chemical Treatment Procedures
The effectiveness of all chemical treatment of water is related to the temperature, pH level, and clarity of the water. Cloudy water often requires higher concentrations of chemical to disinfect.
- If the water is cloudy or filled with large particles, strain it, using a cloth, before treatment. Large particles, if swallowed, may be puriﬁed only “on the outside.”
- Add the chemical to the water and swish it around to aid in dissolving. Splash some of the water with the chemical onto the lid and the threads of the water bottle so that all water areas are treated.
- The water should sit for at least 30 minutes after adding the chemical to allow puriﬁcation to occur. If using tablets, let the water sit for 30 minutes after the tablet has dissolved.
- The colder the water, the less effective the chemical is as a purifying agent. Research has shown that at 50°F (10°C), only 90 percent of Giardia cysts were inactivated after 30 minutes of exposure. If the water temperature is below 40°F (4°C), double the treatment time before drinking. It is best if water is at least 60°F (16°C) before treating. You can place the water in the sun to warm it before treating.
- Chemically treated water can be made to taste better by pouring it back and forth between containers, after it has been adequately treated.

Other methods include adding a pinch of salt per quart or adding flavorings (e.g., lemonade mix, etc.) after the chemical treatment period.

Iodine Treatment
Iodine is light sensitive and must always be stored in a dark bottle. It works best if the water is over 68°F (21°C). Iodine has been shown to be more effect than chlorine-based treatments in inactivating Giardia cysts. Be aware that some people are allergic to iodine and cannot use it as a form of water purification. Persons with thyroid problems or on lithium, women over ﬁfty, and pregnant women should consult their physician prior to using iodine for puriﬁcation. Also, some people who are allergic to shellﬁsh are also allergic to iodine. If someone cannot use iodine, use either a chlorine-based product or a non-iodine-based ﬁlter, such as the PUR Hiker Microfilter, MSR Water Works, or the Katadyn Water Filter.

Generally, the procedure is as follows:
- **Liquid 2% Tincture of Iodine** Add 5 drops per quart when the water is clear. Add 10 drops per quart when the water is cloudy.
- **Polar Pure Iodine Crystals** Fill the Polar Pure bottle with water and shake. The solution will be ready for use in one hour. Add the number of capsules (per quart of water treated) listed on the bottle, based on the temperature of the iodine solution. The particle trap prevents crystals from getting into the water being treated. It is important to note that you are using the iodine solution to treat the water, not the iodine crystals. The concentration of iodine in a crystal is poisonous and can burn tissue or eyes. Let the treated water stand for 30 minutes before drinking. In order to destroy Giardia cysts, the drinking water must be at least 68°F (20°C). The water can be warmed in the sun before treating or hot water can be added. Refill the treatment bottle after use so that the solution will be ready one hour later. Crystals in the bottle make enough solution to treat about 2,000 quarts. Discard the bottle when empty.
- **Potable Aqua** This is an iodine tablet product. Follow the manufacturer’s instructions for use.

Chlorine Treatment
Chlorine can be used for persons with iodine allergies or restrictions. Remember that water temperature, sediment level, and contact time are all elements in killing microorganisms in the water. Halazone is an example of a chlorine tablet product. To use, follow the manufacturer’s instructions.
BOILING

Boiling is the most certain way of killing all microorganisms. According to the Wilderness Medical Society, water temperatures above 160°F (70°C) kill all pathogens within 30 minutes and above 185°F (85°C) within a few minutes. So in the time it takes for the water to reach the boiling point (212°F or 100°C) from 160°F (70°C), all pathogens will be killed, even at high altitude. To be extra safe, let the water boil rapidly for one minute, especially at higher altitudes since water boils at a lower temperature (see page 68.)

CHEMICAL PURIFICATION

There are two types of chemical treatment: those using iodine and those using chlorine. There are a variety of products on the market, so follow the directions on the bottle. Be advised that many of the tablets have an expiration date and become ineffective after that point. Also, once the bottle has been opened, the tablets must be used within a certain period. When in doubt, buy a new bottle. Remember that chemical purification methods may only be partially effective, depending on the water temperature.

General Chemical Treatment Procedures

- The effectiveness of all chemical treatment of water is related to the temperature, pH level, and clarity of the water. Cloudy water often requires higher concentrations of chemical to disinfect.
- If the water is cloudy or filled with large particles, strain it, using a cloth, before treatment. Large particles, if swallowed, may be purified only "on the outside."
- Add the chemical to the water and swish it around to aid in dissolving. Splash some of the water with the chemical onto the lid and the threads of the water bottle so that all water areas are treated.
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Other methods include adding vorings (e.g., lemonade mix, Iodine Treatment

Iodine is light sensitive and must best if the water is over 68°F (21°C) effect than chlorine-based treatments. Persons with thyroid and pregnant women should consider purification. Also, some people react to iodine. If someone cannot use or a non-iodine-based filter, such as the Katadyn Water Filter. Generally, the procedure is as follows:

- Liquid 2% Tincture of Iodine: Add 10 drops
- Polar Pure Iodine Crystals: Shake the solution with the number of capsfuls (per quart) based on the temperature of the water.
- The chemical should be added to the water, and the water should sit for at least 30 minutes before drinking. Iodine treated water must be at least 60°F (16°C) before drinking. If the water was treated in the sun, it must be at least 60°F (16°C) before drinking.

Potable Aqua: This is a filter and a purifier. Remember to follow the manufacturer's instructions for use.

Chlorine Treatment

Chlorine can be used for person. Remember that water temperature all elements in killing microorganisms.
FILTRATION

There are a number of devices on the market that filter out microorganisms. A water filter pumps water through a microscopic filter that is rated for a certain-size organism. The standard size rating is the micron (the period at the end of this sentence is about 600 microns). Depending on the micron rating of the filter, smaller organisms (like viruses) can pass through. Be cautious when selecting a filter. You should know what potential organisms you need to treat for. You don’t want to go to an area where a virus like hepatitis A is present in the water (a problem in some developing countries) with a filter that will handle only a larger organism like Giardia.

Common microorganisms and the filter size needed:

<table>
<thead>
<tr>
<th>Organism</th>
<th>Examples</th>
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<th>Filter Type</th>
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<td>Water filter</td>
<td>1.0-4.0 microns</td>
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There are two basic types of filters (descriptions of several popular models begin on the facing page).

- **Membrane Filters** use thin sheets with precisely sized pores that prevent objects larger than the pore size from passing through. **Pro:** Relatively easy to clean. **Con:** Clog more quickly than depth filters. **Example:** PÜR Hiker.
- **Depth Filters** use thick porous materials such as carbon or ceramic to trap particles as water flows through the material. **Pros:** Can be partially cleaned by backwashing. Activated carbon filters also remove a range of organic chemicals and heavy metals. **Con:** Rough treatment can crack the filter, rendering it useless. **Examples:** MSR WaterWorks II, Katadyn.
TRICKS OF THE TRAIL

Backups Always have at least one backup method for water purification in case one fails. This can be any combination of methods. I'm the cautious type, so I always have two backup methods: water filter and 2% tincture of iodine or Polar Pure Iodine crystals. And I can always boil the water. If boiling is your backup method, make sure you have enough fuel.

Fix the Taste Adding vitamin C (about 50 milligrams) to iodized water completely eliminates any taste or color of iodine. You must wait until the iodine has purified the water before adding the vitamin C. The vitamin C in drink mixes like Tang has the same effect.

FILTRATION

There are a number of devices on the market that filter out microorganisms. A water filter pumps water through a microscopic filter that is rated for a certain-size organism. The standard size rating is the micron (the period at the end of this sentence is about 600 microns). Depending on the micron rating of the filter, smaller organisms (like viruses) can pass through. Be cautious when selecting a filter. You should know what potential organisms you need to treat for. You don't want to go to an area where a virus like hepatitis A is present in the water (a problem in some developing countries) with a filter that will handle only a larger organism like Giardia.

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**Note:** There is a difference between a water filter and a water purifier. Filters do not filter out viruses, but there are water purifiers, like the PUR Scout, that pass the water through both a filter and an iodine compound that kills any smaller organisms that have passed through the filter. These purifiers kill all microorganisms down to 0.004 microns; however, the filter should not be used by people who are allergic to iodine.

**Common Practices for Using a Water Filter**
- Filter the cleanest water you can find. Dirty water or water with large suspended particles will clog your filter more quickly.
- Prefilter the water either through a prefiler on the pump or strain it through a bandanna.
- If you must filter dirty water, let it stand overnight for particles to settle out.

TRICKS OF THE TRAIL

Some water filters come as sealed cartridges, making it impossible to inspect the actual filter cartridge. If the filter takes a serious fall, it could crack internally. If the filter inside cracks, unfiltered water can flow through the crack. Treat your filter with care, and if it takes a significant impact, throw it away. Remember, any intake hose from a water filter has been submerged in unfiltered water. Treat this hose as "contaminated" and keep it in a separate plastic bag.

PUR HIKER AND PUR VOYAGER WATER FILTER

You should carefully read the product literature that comes with your PUR Hiker Filter for the latest instructions and information on how to assemble and
canoe. With this accomplished, the victims should go to either end of the
rescue canoe and hold on.

(4) The rescuers then pull the swamped vessel over their canoe, empty the water, and
return it to the water right side up.

(5) The rescuers can then assist the victims by holding their craft, enabling them to climb
back in (either one at a time or both at once on opposite sides of the canoe).

IV. INSTRUCTIONAL STRATEGIES & MATERIALS:
A. Timing
1. A pre-trip discussion of safety considerations is advisable.
2. At the first swim site, demonstrate the process for selecting a proper swim area to show the safety
   considerations that are involved.

B. Strategies
1. A “teachable moment” can be used to instruct proper canoe loading and unloading techniques, and
   should accompany this lesson.
2. PFD’s should be serviceable and fitted before the trip departs.
3. Participants can practice canoe-over-canoe rescues during the trip.

C. Activities
1. Ask students to discuss specific safety considerations.
2. Assign a different person each day to be responsible for swim site selection.
3. Include safety concerns as part of daily debriefings. Were there any potential problems?
4. A canoe race during which participants capsize boats, put on PFD’s, and paddle back to shore is an
effective teaching technique. Be sure to have a safety boat standing by.

23. Water Treatment

I. GOAL: To have participants understand when, why, and how to treat water.

II. OBJECTIVES:
A. Participants will be able to explain when water should be treated.
B. Participants will be able to explain why water should be treated.
C. Participants will be able to describe three methods of water treatment and demonstrate one of those methods.

III. CONTENT:
A. When Should Water be Treated?
1. Whenever there is any doubt about water purity.
2. Due to the presence of pathogenic bacteria, protozoans, and enteroviruses throughout the
   world, there are few places totally free of contaminants.
3. It should be understood that consuming untreated water is a gamble — be prepared to pay the price!

B. Why Does Water Have to be Treated?
1. Bacterial and protozoan pathogens
   a. These are single-cell organisms capable of causing disease that are present in all water.
   b. There are many different pathogens, but a common one is Giardia lamblia.
      (1) Giardia lamblia is a protozoan.
      (2) It is one of the most identifiable problems in wilderness water consumption today.
      (3) It is a parasite that causes the gastrointestinal illness Giardiasis.
      (4) It occurs throughout the United States.
(5) Symptoms of Giardiasis include:
   (a) Diarrhea
   (b) Abdominal cramps
   (c) Flatulence
   (d) Nausea
   (e) An eventual nutritional deficiency due to malabsorption of nutrients

(6) Diagnosis and treatment
   (a) Diagnosis is through examination of fecal smears.
   (b) It is most commonly treated with drugs such as quinacrine, metronidazole, furazolidone and tinidazole.

(7) Other facts about Giardia
   (a) Giardia is carried and spread by all mammals (not just beaver).
   (b) One stool can contain up to three hundred million cysts, which are infectious forms of Giardia.
   (c) ingesting as few as ten cysts can cause the disease.
   (d) The length of illness ranges from a few days to three months.
   (e) Most infected individuals (75%) experience no symptoms and never realize they have had it (Bloch & Patzkowsky, 1985).
   (f) All backpackers must consider themselves carriers of Giardia and dispose of their human waste appropriately. (See "Lavatory Construction and Use" lesson.)
   (g) Should symptoms of diarrhea, flatulence, and/or nausea persist, a physician should be consulted.

(8) Some noted physicians feel Giardiasis is blown out of proportion because:
   (a) Most people won’t even know they have ingested cysts.
   (b) A few people will get an intestinal upset similar to a nasty hangover.

(c) Fewer still will get a troublesome illness which responds well to therapy.
(d) As one doctor put it, “This...places Giardiasis in the category of blisters and mosquito bites: a nuisance reminder of a trip in the wilderness for some, with an occasional hiker developing a more serious complication” (Welch, 1986).

(9) Legal implications
   Although the chances of a participant getting seriously ill are remote, trip leaders may be considered negligent if no preventative measures are taken.

2. Enteroviruses (intestinal viruses)
   a. They are simpler and generally smaller than bacteria.
   b. The symptoms may be treated, but generally the body’s immune system eliminates them.
   c. Human viruses can only come from other humans, and therefore only spread as a result of human contamination.
   d. Enterovirus symptoms are similar to Giardia, but are usually short-lived.
   e. Enteroviruses may be considered less of a concern than other pathogens when backpacking in North America because of their short-term effect on the digestive system. However, the symptoms are still very discomforting.

C. Methods of Treating Water
1. Boiling
   a. Microorganisms such as Giardia, viruses, and harmful bacteria are sensitive to heat.
   b. Various sources recommend conflicting times and temperatures for heating water. The range includes:
      (1) Temperatures: 122° F (50° C) - 212° F (100°C)
      (2) Time: 0-15 minutes at these temperatures.
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(5) Symptoms of Giardiasis include:
   (a) Diarrhea
   (b) Abdominal cramps
   (c) Flatulence
   (d) Nausea
   (e) An eventual nutritional deficiency due to malabsorption of nutrients

(6) Diagnosis and treatment
   (a) Diagnosis is through examination of fecal smears.
   (b) It is most commonly treated with drugs such as quincline, metronidazole, furazolidone and tinidazole.

(7) Other facts about Giardia
   (a) Giardia is carried and spread by all mammals (not just beaver).
   (b) One stool can contain up to three hundred million cysts, which are infectious forms of Giardia.
   (c) Ingesting as few as ten cysts can cause the disease.
   (d) The length of illness ranges from a few days to three months.
   (e) Most infected individuals (75%) experience no symptoms and never realize they have had it (Bloch & Patzkowsky, 1985).
   (f) All backpackers must consider themselves carriers of Giardiasis and dispose of their human waste appropriately. (See “Latrine Construction and Use” lesson.)
   (g) Should symptoms of diarrhea, flatulence, and/or nausea persist, a physician should be consulted.

(8) Some noted physicians feel Giardiasis is blown out of proportion because:
   (a) Most people won’t even know they have ingested cysts.
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2. Enterovirus
   a. They infect bacteria
   b. The symptoms may be similar to the bovine enterovirus
   c. Humans are also an important host of human enterovirus
   d. Enterovirus is also spread through the bite of mosquitoes
   e. Enterovirus is spread by direct contact with infected animals

C. Methods of Treatment
   1. Boiling
      a. Microorganisms are inactivated
      b. Various other methods include:
         (1) Treat with boiling
         (2) Treat with treatment
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c. Research indicates that water which reaches a full boil is safe to drink. Additional boiling time is not necessary.
d. **Advantages of boiling**
   (1) It is inexpensive — the only expense is the fuel.
   (2) It is completely effective when the water reaches a full boil.
   (3) Boiling does not affect the taste of the water.
e. **Disadvantages of boiling**
   (1) It takes time and consumes fuel.
   (2) It is inconvenient for drinking water along the trail.

2. **Filtration**
   a. Filters are commercially available that will filter out Giardia and bacteria. Some filters will even filter out large viruses.
   b. Filters must trap particles at least as small as 0.5 microns.
   c. **Advantages of filtration**
      (1) It is easy to filter drinking water along the trail.
      (2) Filtration does not affect the taste of the water.
   d. **Disadvantages of filtration**
      (1) Filters are generally slow (1-3 minutes per liter).
      (2) Filters are often ineffective against enteroviruses.
      (3) Filtration is a more expensive method due to the cost of filters ($30-$175).

3. **Chemical treatment**
   a. **Crystalline iodination**
      Commercial brands are available such as “Polar Pure.”
      (1) A small amount of water is added to an iodine solution. After this water is disinfected (how long it takes depends on water temperature) the solution is added to a larger water source to achieve a final concentration of saturated iodine solution.
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Water Treatment

b. Iodine tablets
   Commercial brands are available such as "Potable Aqua" or "Globaline."
   (1) A tablet which releases an iodine solution is added directly to the water.

   (2) Advantages of iodine
      (a) It is readily available.
      (b) It is easy to use.
      (c) If used properly, it is usually effective.

   (3) Disadvantages of iodine
      (a) Water must sit for 30 minutes or longer (up to several hours if it is cold water) before consumption.
      (b) Iodine affects the taste of the water.
      (c) Tablets have a limited shelf life and lose effectiveness from frequent exposure to air.
      (d) As with any chemical, large concentrated doses have the potential to be toxic.

c. Chlorination
   Commercial brands are available such as "Halazone" tablets.
   (1) Advantages of chlorination
      (a) It is readily available.
      (b) It is inexpensive.
      (c) It is easy to use.
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IV. INSTRUCTIONAL STRATEGIES & MATERIALS:

A. Timing
   This topic should be introduced immediately and course policy communicated as to what types of treatment will be used.

B. Strategies
   1. It is essential that if water is to be treated, instructors set a consistent example.
   2. When teaching this class, it is important to demonstrate at least one means of water treatment.
      a. Filtration or chemical treatment are preferable methods of water treatment to demonstrate.
      b. Use the water source as a classroom setting and demonstrate the whole sequence from water acquisition to treatment and consumption.

C. Materials
   1. Equipment for at least one type of water treatment
   2. Water container
   3. Water source (stream, lake, or spring)