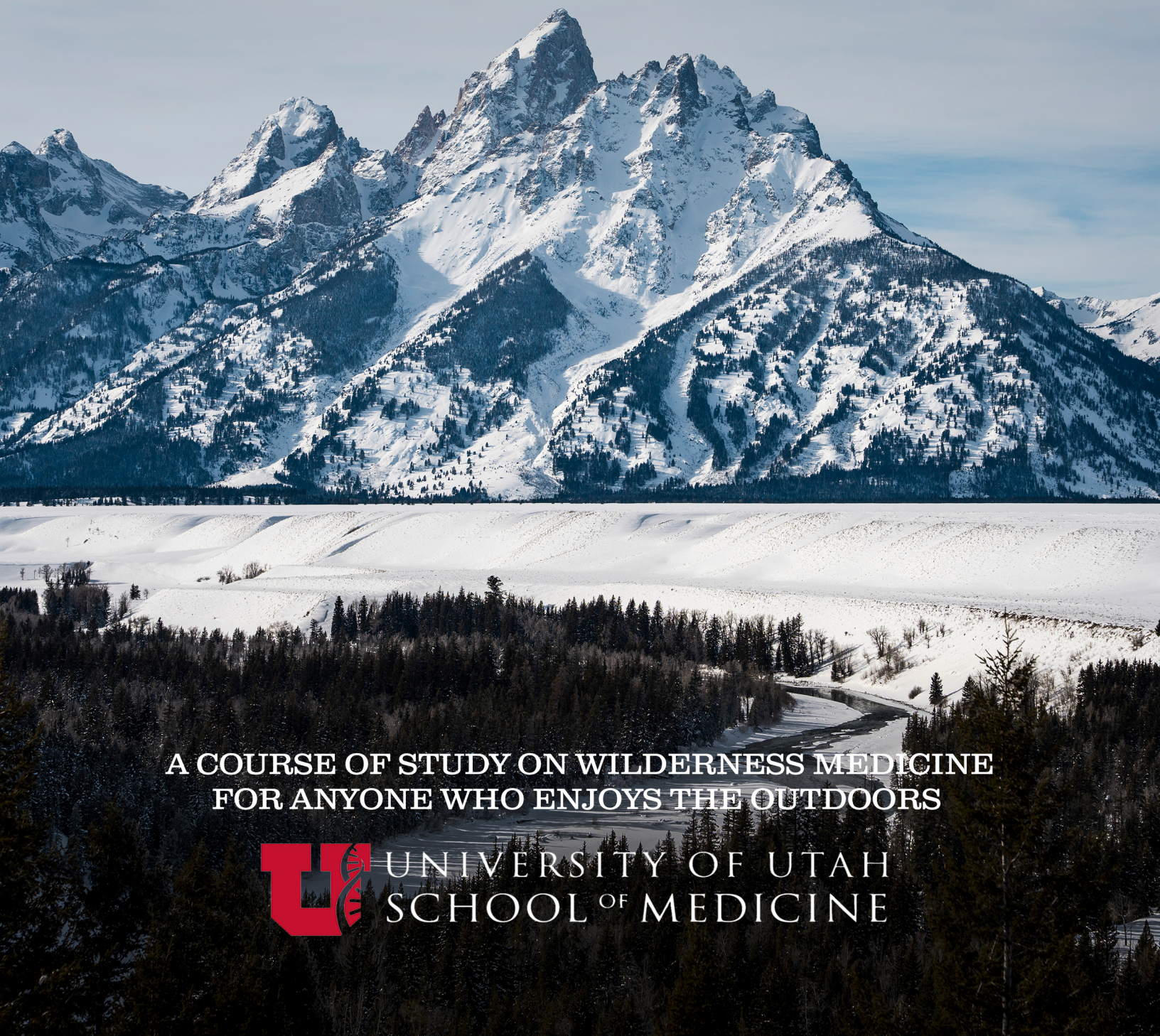
BWLS©

BASIC WILDERNESS LIFE SUPPORT



A COURSE OF STUDY ON WILDERNESS MEDICINE
FOR ANYONE WHO ENJOYS THE OUTDOORS

UNIVERSITY OF UTAH
SCHOOL OF MEDICINE

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Chapter 1: Caring for an Injured Patient

The management of someone injured is probably the most important topic in all of sports outdoor medicine. There are **four effective survey techniques** that are used in your initial assessment of a sick or injured biker. These four survey techniques are: **scene survey, primary survey, secondary survey, and ongoing survey.**

Survey Techniques

Scene Survey

The first survey technique is the scene survey. When you first approach a scene, the tendency is to approach the patient immediately and start rendering aid. Don't. You must first make sure that the scene is safe before you enter to assess the victim. Potential hazards include bikers on single track trails that could come around a corner and hit the rescuer(s) and injured biker. This survey should take only a few moments. This can effectively be performed while discovering the mechanism of injury (MOI) and the nature of the illness (NOI).

Primary Survey

The second survey technique is the primary survey. The purpose of the primary survey is to keep the victim alive. To help prioritize the treatment of injuries during the primary survey, refer to the table below which uses the **MARCH** acronym. It's important to note that preventing major hemorrhage is the top priority, even coming before Airway.

Primary Survey prioritization using MARCH

M	Massive hemorrhage
A	Airway (with C-spine precautions)
R	Respiration
C	Circulation
H	Hypothermia/Hyperthermia or Hike vs. Helicopter

Anytime there is major bleeding you should always take steps to stop the bleeding first. Typically, direct pressure is done to stop heavy bleeding. Away from help however, don't hesitate to use a tourniquet. It is a fast and simple method to stop a major bleed.

If a victim is unresponsive, assume there is a C-spine injury even if there is no clear mechanism. Therefore, for Airway, you should hold the C-spine as a precaution during your primary assessment. If the patient becomes responsive later, you can re-evaluate the need to hold C-spine.

Next, you can quickly check for a victim's Respiration before evaluating their pulse. Checking the pulse falls under Circulation when using MARCH. If they are not breathing, or if they do not have a pulse, you will need to initiate CPR at this time.

Hypothermia/Hyperthermia refers to making sure that the patient is warm and dry and whether the patient will need to be evacuated or not (thus the alternative of Hike vs. Helicopter). Using the MARCH prioritization as you quickly go through the primary survey ensures that your patient is alive and as stable as possible. Learn it well.

Secondary Survey

The third survey technique is the secondary survey. This survey is done after the primary survey and can be remembered using the **SAMPLE** acronym.

Secondary Survey using SAMPLE

S	Symptoms/Subjective
A	Allergies
M	Medications
P	Prior medical history
L	Last oral intake
E	Events leading up to illness/injury

Address these items to the victim as questions and pay close attention to what they say. It they cannot answer, ask if family, friends, or people at the scene might be able to help with some or all the questions. As well, you can look for medical alert tags and bracelets on the victim. Check backpacks, purses and wallets for medical information too.

Ongoing Survey

The fourth survey technique is the ongoing survey. You should repeat this survey as often as needed. If the patient is unstable, go through the survey more frequently. Until the patient is in the hands of medical help, you should continue assessing them with the Ongoing survey.

If at any time, there is a change in the patient's status you should always go back and repeat the primary assessment. This is essential to determine what caused the change in the patient's medical status.

Ongoing Survey using AVPU

A	Alert
V	Verbal
P	Pain
U	Unresponsive

Scene Safety

In a case where the scene is not safe for the victim, you may need to move them to a safe location. For example, consider a situation where a biker falls in a race and is right on the trail. This fallen person is now in danger of being hit. Should you move the patient to a safer location and risk causing a potential spinal injury? Clearly, the scene is not safe. You need to move the injured person away from the trail. If you started treating the victim here, you would be subjecting the victim, yourself, and other rescuers to additional injury.

When considering scene safety, it is important to keep in mind the **risk-to-benefit ratio**. Moving the victim(s) may result in spinal injury but keeping them at the base of the cliff could result in more injury or even death if there is rockfall. In this case, the risk of rockfall outweighs the risk of spinal injury in moving the patient. Be careful of the spine!

Blood Sweep

A crashed biker could easily have cuts on their skin. A quick look will determine if they are bleeding. This is known as the blood sweep and allows you to identify any major bleeding. It's important to look under layers of clothing when doing your sweep, as blood can collect between these layers. It's recommended to perform the sweep in small segments to determine where the bleeding is coming from.

The blood sweep also allows you to find deformities in the musculoskeletal system. A crashed biker might have internal bleeding. There is little you can do if someone is bleeding to death inside their body, other than evacuate them as quickly as possible. At least you will know to do this. Remember also, that people will often bleed on the 'street' or they will bleed in one place and then stumble to another place. Be sure to look on the ground or the street for blood.

Chapter 2: How to Treat Wounds

Wound management in the wilderness backcountry is different than wound management in an urban setting. One significant difference is that backcountry wounds are often dirty or may become dirty. There's often a lack of first aid material too. A single abrasion wound may use up all the gauze pads in your entire kit, leaving nothing for other injuries. You may not have the appropriate first aid material for closing a wound, such as sutures or steri-strips. And, if the injury happens at night, seeing the wound could be difficult without proper lighting. The following addresses these types of issues in managing wounds in the wilderness.

Types of Issues in Wilderness Wound Management

Exposure

The first step to any wound management after the primary survey is to gain exposure to the injured area. You may have to first remove equipment from the patient, such as a backpack, helmet, or gloves. Be mindful of exposing only what is necessary, as hypothermia can occur even in mild climates.

Hemostasis – Stop the Bleeding

The next step is to stop the bleeding. This is called hemostasis. If the wound is such that a person is going to bleed out, this becomes emergent and is first in the primary survey using the **MARCH** protocol, where '**M**' stands for massive hemorrhage. Direct pressure is the first step in stopping any blood loss. The application of direct pressure controls bleeding from most wounds. Use the cleanest materials available and apply direct pressure to the source of bleeding. This may take several minutes. Larger wounds may require direct pressure for a longer period of time. Scalp wounds may require continuous pressure.

If direct pressure does not stop the bleeding, use a tourniquet. Rapid arterial bleed can cause a patient to go into shock very quickly. If a tourniquet is used for more than several hours, it places the patient at risk for limb loss. Elevation of the limb above the heart alone is rarely sufficient to stop bleeding. You should always check for distal neurological function to ensure adequate blood flow to the extremity.

How to Place a Tourniquet

- Place the tourniquet over clothing, if possible, about two to four inches above the wound.
- Do not place the tourniquet on a joint or directly over a wound or a fracture.
- Once the tourniquet is in place, it should be tightened so that all bleeding stops. Secure the windlass so that it does not unwind.
- Mark the time that you placed the tourniquet on the patient's forehead, so it is clearly visible to other personnel when they care for the victim.
- There is no need to intermittently loosen a tourniquet for "perfusion" of an extremity.

Cleaning/Debridement

All wounds need to be cleaned. "High-pressure" irrigation is the most important intervention to prevent infection and decrease bacteria content for most wounds.

Irrigate the wound with a solid stream of the cleanest water available. You can use a with a catheter tip to create a high-pressure stream of water, or you can fill a plastic bag with water. Poke a small hole in the corner of the bag, and then close the top of the bag to create a seal to force a stream of high-pressure water from the bag. An alternative would be to use your syringe plastic water bottle that has an adjustable top.

It is important to remove visible foreign matter from the wound to minimize infection, inflammation, discomfort, and skin tattooing. If possible, remove any clearly devitalized tissue, which may serve as a culture medium for any remaining bacteria.

Dressing a Wound

Dressing a wound is difficult in the wilderness but very important. It protects wounds from the dirty wilderness environment, helps with the prevention of infection, and can be accomplished in several ways. If a commercial pad or dressing is not available, improvise using a 4 x 4 pad covered in an antibiotic ointment. Cover this dressing with an absorbent gauze dressing, then secure with tape. If the injury is on a flexible part of the body you might want to immobilize the joint using a splint to prevent the wound from reopening.

When to Evacuate a Wound

The injuries that require considerations for evacuations are:

- Complex or mutilating wounds
- Grossly contaminated with penetrating debris
- Laceration of eyelid, ear or cartilage
- Penetration of bone, joint or tendon
- Bites of hands, legs or feet
- Amputations

Scabs

Contrary to popular belief on letting a wound scab over, recent studies have shown that keeping the wound environment moist promotes wound healing and reduces scar formation. This can be done with daily application of Vaseline, honey, or a clean and moist dressing. When wounds are kept exposed to the air, they will dry and form a scab.

Scabs slow the wound healing process. Wounds should be kept moist for the entire duration of healing. Grass doesn't grow well under a rock, and skin cells do not grow well under a scab. A wound should be rinsed daily to keep scab formation to a minimum. Dressing inspection and dressing changes should happen daily, if possible.

Rules for Wound Healing

- Keep them clean
- Keep them moist
- Keep them covered

Closing a Laceration

Closing a laceration in the wilderness is difficult. The decision to close a wound is broken down to two courses of action:

1. Primary closure: You can close it with sutures (if you know how), staples, tape, or skin glue.

2. Delayed primary closure: You can pack it with gauze, wrap it and clean it often until you get additional medical help.

Closing the wound with sutures, staples, tape, or tissue adhesive has the advantage of immediate treatment with better mobility and less pain. However, the risk of infection is higher. If you decide to pack the wound, the infection rate will be less, but it is more painful, and the patient will have less function of the area. Each method has the same outcome.

Steri-strips or tape: Closure may be simply achieved by placing steri-strips or tape of some kind over the wound and pulling the wound together. If necessary, trim the hair around the edges of the wound so the tape will adhere better. Duct tape with perforations made with a safety pin may suffice. This will allow for better drainage of fluid from the wound.

Sutures and staples: These can both be used effectively if continued cleanliness of the wound can be assured, and are more appropriate for large wounds and those in high-tension areas. Staples can be used anywhere except the face.

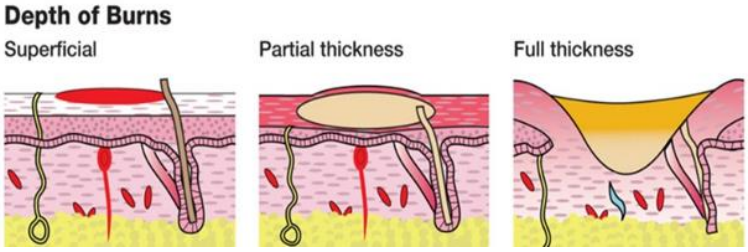
Skin Glue: Skin glue can be used for closing small and uncomplicated lacerations. The glue is applied on top of the wound and serves as a bandage to close the wound. Glue "bandages" are good because they produce an impenetrable barrier that requires a cleansed wound. If an injury is on a flexible part of the body, such as an elbow or a finger, immobilize the joint with a splint to prevent reopening of the wound.

Burns

Burn injuries are common in the wilderness, where many sources of heat are used. Before initiating treatment, a burn must first be classified, as its classification determines how it is treated. Burns are classified three ways:

- by Depth
- by Area
- Location on the body

In **superficial** burns, the skin can become red and painful. Mild sunburns are a type of superficial burn.



Partial-thickness burns are generally very painful as the burn depth is at the level of the nerve endings. They blister and can have skin discoloration.

Full-thickness burns are deep and are classically painless. They burn through the dermis.

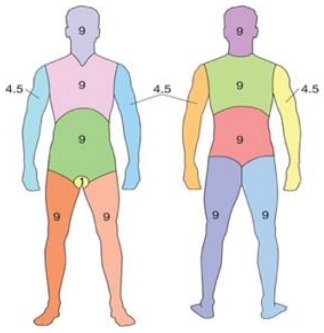
Treatment of Superficial Burns

Treat superficial burns with aloe-vera gel and, for comfort, cool the area with damp, wet cloths. Aloe vera has no antimicrobial properties, however. Leaving the wound to dry increases scar formation and slows wound healing, so keep the burn moist. Patients with these types of burns might be able to stay in the backcountry if the pain is controlled.

Treatment of Partial and Full Thickness Burns

Partial and full-thickness burns are more serious and will be painful. Gently clean the burn with cool water to remove loose skin and debris and trim away all loose skin. Apply a thin layer of antibacterial Ointment (i.e., Silvadene) to the burn and cover it with a non-adhesive, sterile dressing. Inspect the wound and change the dressing at least once a day. These types of burns will likely be too painful for the victim to stay in the backcountry. Do not apply ice directly to burns for more than 15 minutes, as this may cause more tissue damage due to a decreased blood supply to the area.

Know the **TBSA** (Total Body Surface Area) for burns to aid in decision making for evacuation.



The Rule of Nines	
Each arm	9%
Each leg	18%
Front of trunk	18%
Back of trunk	18%
Head and neck	18%
Groin	1%

When to Esvacuate a Burn

Burn injuries that require evacuation consideration are:

- Partial thickness burns greater than 10% body surface area
- Full thickness burns greater than 1% body surface area
- Partial- or full-thickness burns involving the face, hands, feet or genitals
- Electrical burns
- If the burn victim is medically ill
- Uncontrolled pain
- Burns complicated by smoke or heat inhalation (evidence of smoke inhalation include difficulty breathing, hoarse voice, singed nasal hairs, or carbon in patient's sputum)

Blisters

A blister is a pocket of fluid between the upper layers of skin, and are common to develop in the wilderness. The most common causes of blisters are friction (i.e., from poor fitting shoes), freezing of the skin (frostbite), and burns.

The blister bubble is formed from the epidermis, the uppermost layer of skin. Its purpose is to protect and cushion the layers underneath. Blisters can be filled with serum, plasma, blood, or pus, depending on how and where they are formed. Friction blisters usually form a 'hot spot' (sore spot) first.

If a small blister or hot spot forms, place a dual-layer pad over that area. Blist-o-ban is one such material. These pads address the two causes of friction blisters, the friction and shear forces on the skin. The dual layer will allow the bandage to glide smoothly in all directions, deflecting friction and shear forces away from the skin. The key to preventing blisters is to reduce 'hot spots' by properly breaking in boots and reducing moisture by wearing wool socks.

You can treat a blister that has already formed, by cutting a hole in the moleskin and placing the ring of moleskin around the blister. This reduces the pressure placed on the blister. This should help reduce the pain. It is not recommended to pop or drain blisters that are small (<2cm or <0.75 in).

When should a blister be opened? The answer is not clear. In general, if the blister is 2 cm in diameter or larger, then it is likely to rupture spontaneously and may be amenable to initial treatment by intentionally rupturing it. However, there is no best answer to this issue. In those cases where it is large enough or it has already ruptured, wash the area, and puncture the base of the blister with a sterile needle or sterilized safety pin.

What Ointment should be used on a Wound?

Honey has been used in wound care for thousands of years to prevent infection and speed the healing process. **Medihoney** works by keeping the wound bed moist and slowly releasing an antibacterial agent into the wound site. Most normal honey has varying levels of hydrogen peroxide, but Medihoney specifically uses **Manuka honey**, which also contains methylglyoxal. This helps it to fight a broader range of bacteria strains.

Topical First Aid Antibiotics are available over the counter. These include **bacitracin**, **neomycin**, and **polymyxin B sulfate**. Some also contain the anesthetic lidocaine for pain relief. These products are well tested. There is a large allergic reaction rate to neomycin, so clinics are moving away from this. Make sure someone is not allergic to sulfa, and bacitracin is sulfa based.

Silvadene Cream 1% (silver sulfadiazine) is a topical antimicrobial drug indicated as an adjunct for the prevention and treatment of wounds and in patients with second- and third-degree burns. It contains both silver as antimicrobials, but it also contains emollients that help ease the pain.

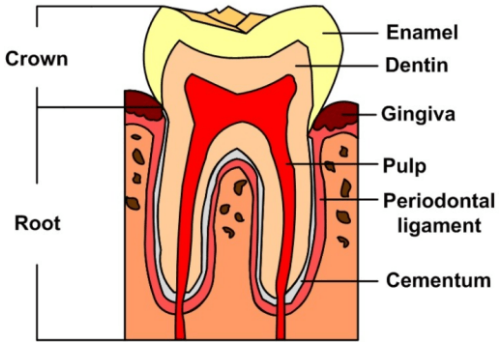
Chapter 3: Injured and Painful Teeth

Dental problems are common and provoke considerable anxiety. Most people don't even think to learn about dental problems and procedures beforehand. Teeth may be subject to trauma along with other parts of the body. This chapter is to teach dental first aid, and to help get a person back home where a dentist can take care of the dental problem.

Basic Dental Anatomy

Let's start with basic anatomy. This will help you as you learn how to treat dental problems. Each tooth is made up of the same four components: **enamel**, **dentin**, **cementum,** and **pulp**.

Enamel is the substance that covers the anatomic crown of the tooth. It is the hardest substance in the body. The enamel is the first line of protection for the tooth. It can withstand biting pressure but does not have the ability to regrow once fully formed. It chips easily. In fact, the entire enamel can be chipped off in a fall.

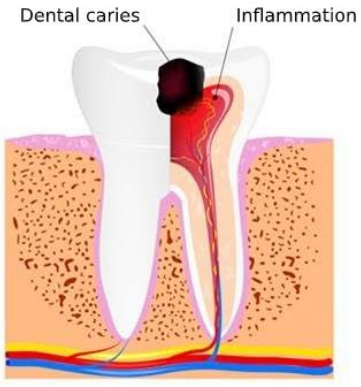


The **dentin** is the substance that lies beneath the enamel and the cementum. It is not as hard as enamel, and it makes up a significant portion of the tooth. The dentin is comprised of microscopic tubes. If the tubules become exposed, teeth become very sensitive to cold and air.

The **cementum** is the substance that covers the root of the tooth. It is also very thin and not as hard as the enamel but has a similar hardness to bone. The **pulp** is the final component, and it is where all the nerves and blood vessels that supply the tooth are housed. If the pulp is exposed, you get a toothache. If a filling encroaches on the pulp, that can hurt also. The supporting tissue consists of the **gingiva** (gum), **periodontal ligament**s (PDL), and **bone**.

Tooth Ache (Pulpitis)

Inflammation of pulp is the primary cause of most toothaches and is often the precursor for more serious dental and facial infections. The pain can range from mild to debilitating and can be steady or intermittent. Inflammation can arise from bacterial entry into the pulp from tooth decay, also called a cavity. Sometimes a filling has been placed near the pulp, and this can cause pain. Trauma can cause inflammation of the pulp, which causes pain. Early on, the tooth will be sensitive to a stimulus such as heat or cold, or sweet or sugary food placed on the tooth. Sometimes the tooth will frequently remain achy or painful after the stimulus has been removed.



It will usually have sensitivity or pain to stimuli such as cold, hot, sweets, or tapping. In the early stages, it may be difficult to identify which tooth is causing the pain. In these cases, the tooth may look normal, or have a small cavitary lesion. In later stages, tooth decay may be obvious. The treatment of pulpitis is first to remove any irritants or debris, usually by swishing the mouth with warm water. You can give Ibuprofen, which is great in for reducing pain. All patients with pulpitis should see a dentist upon returning home.

When a Filling Falls Out

When fillings or crowns fall out, the tooth can hurt. To correct the situation until you can get to a dentist, you should first remove any debris in or around the tooth. You can rinse the mouth or try to pick debris out if necessary. Once this is done, you need to fill the hole in the tooth with some temporary filling material.

There really are two products that you can choose to put in your first aid kit.

- **Cavit** comes pre-mixed and will harden once placed in the mouth. Cavit can be thinned, if necessary, by mixing it with petrolatum jelly (Vaseline).
- **IRM** comes in a powder/liquid form that requires mixing. The advantage of IRM is that it can be mixed to any consistency.

Dental Trauma

Injuries to teeth are common during high-adventure activity, such as mountain biking, skiing, climbing, or rafting. Trauma can be isolated to the tooth, but it often involves the soft tissue and supporting tissue as well. Clean the region well to remove blood or debris.

Chipped Tooth

These are common in backcountry sports where almost anything can strike the mouth. When you look at it, you will see an obvious chip in the tooth. The pulp is usually not exposed, but it might still be sensitive to stimulus (hot, cold, sweets). The treatment is pain management. You can smooth sharp edges by placing temporary filling (IRM, Cavit, soft wax, or tape) over the tooth. Usually, you can wait until you get to the dentist.

Tooth Fracture

A fracture is where a very large part of the tooth is broken. When you examine the area, there will be a loose piece of tooth, and there will be pain or irritation on biting. The treatment is to remove any loose fragment(s), and then cover the tooth with a temporary filling. This will help with pain, but you will likely need to give Ibuprofen. A temporary filling will help with the pain, but a dentist needs to repair this.

When a Tooth is Knocked Loose

Trauma to the mouth may not fracture a tooth. Instead, it can be knocked loose. In time, the tooth can reattach and become secure again. Patients should eat soft foots and take Ibuprofen. If the tooth is very loose, it should be sprinted to the tooth to the next tooth using Cavit or tape until the patient go to the dentist. The tooth will need to be realigned.

When a Tooth is Knocked Out

Having a tooth knocked out on a wilderness trip is not uncommon. Quick action is needed to increase the survival of the tooth. The longer the tooth is out of the mouth, the less the chance for survival of the tooth.

The best thing to do is to try to put the tooth back in its socket, so be careful of the tooth. A tooth can survive with a high rate of success if reimplanted in the first 20 minutes after the accident. This isn't always practical when you consider the amount of time needed to assess the situation, secure the scene, survey the patient, find the tooth, prepare the tooth and socket, and get the tooth back into the socket. While not ideal, the prognosis is still good if this can all be done within the 1st hour. When handling the tooth, do not scrub, scrape, disinfect, or let the root surface dry out. Rinse the tooth with water to remove debris. Remove clotted blood from the socket, using gentle irrigation and suction. Replace the tooth gently with steady pressure to displace any accumulated blood. This will hurt. The tooth will then need to be splinted in place. This may be difficult but necessary. Cavit or tape is good, or you might need to improvise with material on hand.

Transport Solutions

If you cannot reimplant the tooth, take it to the dentist as quickly as possible. Here is a quick rundown of what is good to use and what you should avoid. Unfortunately, there is not a good medium that is also commonly taken into the back country.

The Best Solutions

Hank's Balanced Salt Solution	While this is probably the best medium, it is mostly used in research application and not readily available. There are two companies that have such a kit (Save-A-Tooth and EMT), A tooth will last 24 hours in this solution.
Milk	Milk is everywhere and does an excellent job in maintaining a knocked-out tooth. Milk will help a tooth to last for about 6 hours. If you have a choice of milk products choose the one with the least amount of fat, in other words – skim milk.

Not So Great Solutions

Salt water	This is great for irrigating but not good for tooth storage. It can be found in some First Aid Kits.
Saliva	Saliva will do in a pinch, but it has some limitations. There are enzymes and bacteria in our saliva that overtime will damage a tooth. This will protect a tooth for about 30 minutes.

Poor Solutions

Water	Water destroys the cells on the tooth. It can be used to rinse the tooth but isn't a good storage medium.
Sports Drinks	Sports drinks are not good and can damage a tooth.

Chapter 4: Biking

Mountain Biking Injuries

When people think of mountain bike injuries, they first think of fractures and dislocations. However, those types of injuries are low on the list, accounting for just a few of the total injuries. Most fractures and dislocation occur while mountain biking happens in the upper extremity, where they can be subject to high compressive forces. Injuries involving the radius, clavicle, and wrist bones are among the most common biking fractures, while common dislocations involve the shoulder.

Type of Cycling Injury	Percentage
Wound	35%
Bruise	25%
Strain	15%
Tendinitis	7%
Fracture	4%
Dislocation	3%

Body Part Percentage			
Neck	50%	Thighs	8%
Knees	42%	Elbows	5%
Groin	35%	Head	4%
Hand	31%	Hips	4%
Shoulders	31%	Ankles	4%
Back	30%	Achilles	4%
Feet	30%		

Wounds and bruises are the most common types of injuries people tend to sustain when biking. The most common parts of the body that are injured for which bikers seek medical care are the neck, knees, buttocks/groin, and upper extremities. Head injuries are common and can be very serious. High speed, technical terrain, and proximity of other bikers in races all increase the likelihood of head injuries. Thus, bikers should ALWAYS wear a helmet. The style, shape, and size of helmets can vary. Mountain bikers should always check with the manufacturer's recommendation when determining which type of helmet is correct for their given style of riding. As well, any time a fall involves an impact to the head, the integrity of the helmet should be checked to make sure it is still suitable for continued use.

Head Injuries

Head injuries from biking can result in a concussion. Clinical findings of a concussion depend on the severity and location of the injury. Look for clear liquid leaking from the ears or nose, as this may be a sign of a skull fracture and would constitute a medical emergency. The treatment of a concussion (Traumatic Brain Injury, or **TBI**) varies with the severity.

With a mild concussion, there is no specific treatment, and patients are usually monitored for 24 hours. More severe concussions can require intensive monitoring, care, and even surgery depending on the extent of the injury. A CT scan is often used to help the care team with the assessment.

One should use extreme caution when treating a concussion in a wilderness setting. A general rule is if symptoms worsen and last longer than 15 minutes, evacuate the patient. A patient evacuation may also be required if other symptoms are present. Head injuries are often accompanied with neck and spinal cord injury. Thus, caution and proper evacuation techniques should be used when moving a patient that has suffered a head injury to ensure that no neck and spinal cord damage is caused.

Common Signs of a Concussion	
Headache	Vertigo
Slurred speech	Nausea
Vomiting	Vacant stare
Delayed speech	Delayed motor
Disorientation	Confusion
Memory deficits	Loss of consciousness
Intense emotions	Dizziness

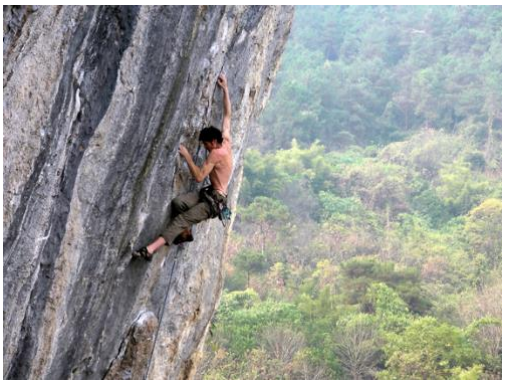
Other Biking Injuries

Not all biking injuries are the result of a hard crash. Some injuries come from small micro-injuries over an extended period. For example, **Micro-Whiplash syndrome** is the result of tail vibrations on the neck. We all recognize that the human head is heavy. Placing a helmet on it makes it heavier, and then it vibrates up and down while riding. Micro-Whiplash syndrome, along with generalized neck and back pain, can be avoided by ensuring the bike is properly fitted and adjusted for the rider. Massaging, ice, stretching, and non-sedating pain relievers can help in the management of such injuries.

Saddle associated symptoms are also common among bike riders. Proper saddle height and positioning can help avoid many of the saddle associated symptoms and injuries. If the saddle height is too low, patellar tendonitis and quadriceps tendonitis can occur, often presenting with patellar pain, swelling, and joint tenderness. Thus, correcting the saddle height can aid in the alleviation of the pain. Conversely, if the saddle is positioned too high, saddle sores and chafing are common and can present as localized skin irritation. Keeping the area clean and dry, and wearing seamless shorts can help prevent and alleviate the symptoms associated with saddle sores and chaffing. As well as correcting saddle position, standing intermittently, when completing long bike rides, can help avoid pudendal nerve injury.

Proper Bike Set Up to Reduce Medical Problems	
1. The rider should sit on the seat with their heel on the pedal. The height should then be adjusted so the leg on the pedal is straight. That is the proper seat height.	
2. When adjusting the seat angle for males, generally the level is slightly elevated in the back, and for women generally the seat angle is depressed in the back. Handlebar adjustments are usually necessary as well.	
3. The handlebar is generally positioned one to four inches below the level of the saddle, and the rider's nose should be directly over the handlebar. The proper adjustment should allow for about one third of the rider's body weight to be resting on the arms. However, the height and positioning of the handlebars can be adjusted during long rides to help with back and neck pain.	

Chapter 5: Rock Climbing



Rock climbing has been around for a very long time. Paintings dating from the second century show Chinese men rock climbing. But recently, it was discovered that climbing is older than that. New research shows that rock climbing began in Africa millions of years ago, when a primate ancestor of homo sapiens, put their hands on the hard, vertical surface of the earth and moved upwards. Our African ancestors were superb climbers who used their rock skills for hunting, safety, and ceremonial purposes. In early America, the cliff-dwelling Anasazi in the 12th century are thought to have been great climbers. In the 1880's, European rock climbing became an independent pursuit outside of mountain climbing. But it is generally thought that the sport of rock climbing began in the last nineteenth century in Europe. It is now a distinct athletic activity.

How Rock-Climbing Injuries Happen

Falling is what we think of first when we think of a rock-climbing injury. As climbers ascend their routes they often place or clip into pieces of equipment in the rock. This equipment helps catch a climber who has fallen. For every foot above the last anchor point a climber goes, they will fall two feet before the rope begins to slow them down. Climbing ropes are dynamic and can stretch up to 30% of their length to reduce the force felt by a climber. A skilled belay partner can also let slack out or jump to further soften a fall. The actual physics is very complex but can be thought of simply as the longer it takes a climber to stop falling, the less force this person will feel.

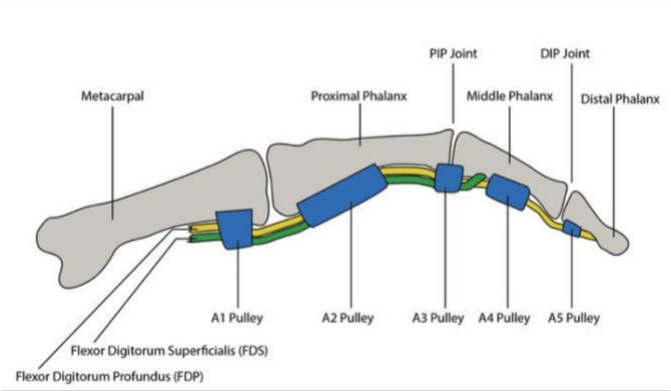
Another common injury happens when a climber passes their leg in front of the rope and then falls. The rope will grab their leg and flip them upside down causing the head or neck to impact the rock. This can cause severe spinal traumas and concussions. Helmets worn while climbing can reduce the impact from these dangerous falls.

The most dangerous moment for a climber is not while ascending but the transition to descending. At the top of a route, climbers build anchors to protect themselves. When done with a climb, climbers will remove this protection and momentarily shift from one safety system to another. Sadly, mistakes have been made at this critical moment, with climbers thinking they are secured to their second system and fall the full length of the route. This is the most common mistake that results in climbing deaths.

Belaying a climber is not as safe as it appears. For example, the belayer can be slammed into the wall by a falling climber. This happens when the belayer does not let out slack on a fall, creating a pendulum effect as the belayer is pulled into the air, ultimately swinging the belayer into the climbing wall. This is the cause of many traumatic climbing injuries including sprained and broken ankles and arms. Belayers can also be injured by falling rocks. Falling climbers have hit belayers. There are many cases where climbers have become stranded when their belayer is injured or killed by falling debris.

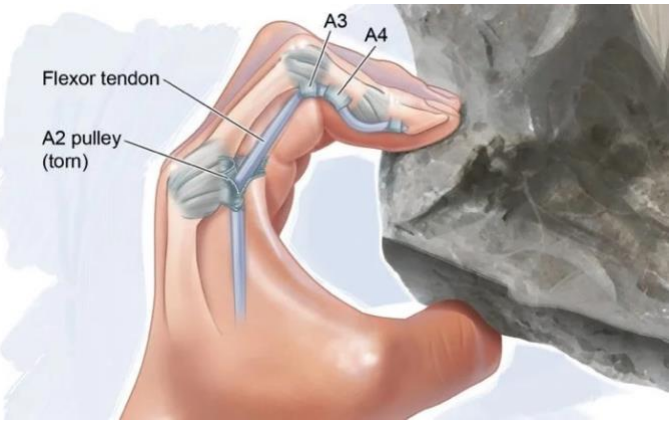
Overuse Injuries of the Hands

While many injuries in climbing are traumatic in nature, many common injuries are overuse injuries. These injuries often happen when a person climbs in a manner that overloads the tendons, joints, and muscles. If you have rock climbed for any length of time, you are familiar with many of these types of injuries.



A discussion of rock-climbing overuse injuries needs to start with the tendons of the hands. Tendons are held tightly to the bones by bands that medicine calls 'pulleys.' There are five pulleys in the fingers. They are named A1 through A5. The A1, A3, and A5 pulleys are smaller and considered minor pulleys (mostly due to size and not importance). The A2 and A4 pulleys are larger and are sometimes called the major pulleys. The pulleys do not wrap all the way around the fingers. They are attached to the front of the fingers only. The tendons which flex our fingers are held tightly to the bones. Pulleys are there to prevent what is called 'bowstringing.' The issue for rock climbers is the crazy amount of force that they experience through the finger tendons which can overload the pulleys. With enough force, the pulleys can become injured or even rupture. The pulleys often become inflamed and become painful. The A2 pulley is often cited as the most injured pulley that presents to clinicians.

The basic mechanism for flexor tendon pulley injury is a force that is applied to the pulley above what it can tolerate when a climber uses the 'crimp grip.' The best form of prevention is gentle climbing and focus on good technique. Climbers should focus on using their feet to make upward progress instead of pulling harder with the hands. And climbers should make a conscious effort to use the full crimp grip less often when possible.



Finger pulley tears are frustrating because they take time to heal. Applying ice and taking an anti-inflammatory is the first step to healing a finger pulley injury. Patients will need to take time off climbing until the fingers have healed. When easing back into climbing, stick to big jugs and other holds that avoid putting direct pressure on the injured finger(s). Taping these fingers while climbing during the healing process is an effective way to prevent worsening the injury.

Rock Climbing Shoes

Rock climbing shoes are most often made of leather uppers with rubber toe and heel caps. The rubber of climbing shoes is specially formulated to stick to rock features and improve friction. Depending on individual preference as well as climbing difficulty level, these athletes may wear

climbing shoes are several sizes smaller than street shoe size. This is because climbing shoes have variable features to improve performance on different terrain. These features include downturned toes for overhanging rock and stiff toe boxes for climbing shoes specific for crack climbing. While designed for performance, rock climbing shoes can contribute to many acute and chronic climbing-related injuries.

Suspension Trauma

Suspension trauma is a condition where climbers will become lightheaded or even pass out after the body remains motionless in a harness in a vertical or sitting position for a period. This happens when blood pools in the legs because the leg muscles sit idle and don't squeeze the blood up to the brain. It is often seen when a climber is maneuvering an overhead rock and leaves the wall and cannot make it around the cliff and hangs suspended.

The climber will begin to be lightheaded and ultimately pass out as blood pools in the legs. This can be a life-threatening situation. Symptoms typically occur after suspension for over an hour, but 20% of patients will have an onset of these symptoms within 5-10 minutes. The highest priority for field care of the suspension trauma patient is urgent evacuation to the ground.

Chapter 6: Hiking and Backpacking

Understanding Feet & Shoes for Hiking and Backpacking

Foot problems

Any discussion of hiking and backpacking medicine begins with our feet. There are 28 bones in each foot, which is nearly one-fourth of all the bones in the entire body. As well, there are 30 joints and more than 100 muscles, ligaments, and tendons. These make the feet flexible so that they can adapt to uneven surfaces, but it becomes complicated when there's an injury.

Toes

The big toe plays an essential role during hiking. The toe's function is to grip the feet to the walking surface. Although the big toe carries part of the bodyweight with each step, no weight rests on the big toe as the body stands. We stand on our heels.

Arches

The foot has three arches. They are designed to act like springs, aid in propulsion, and store energy. The arches shape is designed in a similar manner to a spring and bears the weight of the body and absorbs the shock that is produced with walking. The metabolic energy saved by the arch is due to the spring that it supplies that would otherwise be done by active muscles.

Arch Supports

Correct arch suport is an essential issue in backcountry medicine, especially with hikers and trekkers, because they typically carry an additional weight on their back. A person with a low arch, or flat feet, often stands and walks with their rotated in the wrong position. This makes the hiker susceptible to heel pain, arch pain, and plantar fasciitis.

With high arches, there is less surface area for absorbing impact. This places excessive pressure on the back part of the foot and the forefoot areas. This can make a person susceptible to foot conditions such as heel pain and plantar fasciitis. Having proper arch support becomes vital in making the backcountry trip successful. Most shoes have useless inserts, rather than arch supports. These should be removed, and arch supports placed inside. If people really need new shoes but cannot afford them, arch supports are a less expensive alternative and offer significant help.

Shoes

There is probably nothing more important for foot care than having proper shoes that fit appropriately. Shoes are activity specific. Running and walking shoes are made for straight-ahead, forward motion, while basketball and tennis shoes are made for side-to-side movements. Hiking

shoes are designed with stiff bottoms enabling the shoes to grab onto rocks. Climbing shoes are made to point and give strength to the toes. If someone does not use the right shoe for their outdoor support, then knee, hip, and back pain may result. When shoes are old and worn out, they will tilt your feet, forcing you to strike the ground in an awkward way. Even the slightest angle can hurt your feet and cause back and hip pain. On average, replace the shoes you wear daily every six months at most. For other shoes, keep an eye on the soles and replace or resole them once you notice that the support is getting low.

Proper Shoe Fit

While it may seem counter-intuitive, you don't want your shoes to be tight or press too hard on your feet. In doing so, they will increase the force on your skin, increasing the chance of a blister.

Here is how to fit your shoes:

- To check proper fit around your heel, place your index finger between your shoe and your foot. You should be able to slide your finger between them with little force. If your finger cannot fit, the shoes are too tight. If your finger has too much room, the shoes are too large.

- Stand up with the shoes on and make sure you have a half-inch (about the width of your finger) between your longest toe and the front of the shoe. Your toes need wiggle room so that you don't get blisters, calluses, or damaged toenails.

Protecting Your Feet for Wilderness Activity

'Prevention is worth a pound of cure.' This is so true with shoes. Here is what you need to know to prevent foot problems in the wilderness.

Clip Your Toenails

From a medical perspective, it is critical to clip your toenails before a hike. If they're too long, your boots or shoes will push into the nails. The nail(s) will be traumatized, and blood will form under them. The nails will then lift from their beds. This is painful and might quickly end the hike or trek.

One or Two Socks

There is no definitive data to show that wearing two socks is better than wearing just one sock while hiking or trekking. It comes down to personal preference. What is clear is having the appropriate sock to protect your feet. If you choose to have two socks, the first sock should be a thin, skin-tight, moisture-wicking synthetic sock. Its purpose is to reduce friction by fitting tightly onto your foot and reducing moisture by wicking it away from your foot to your second (outer) sock. The purpose of the second (outer) sock is to reduce friction by serving as a cushion between your foot and the boot and to reduce moisture by absorbing it from the first sock.

Wear the Right Socks

Hiking socks are rarely made from a single fabric, but rather from a blend that creates the right balance of comfort, warmth, durability, and fast drying. These are the most common materials you'll find in hiking socks:

- **Wool:** Wool is the most popular hiking sock material and is recommend above all others. Most wool socks use blends of wool and synthetic materials for better durability and faster drying.
- **Polyester:** Polyester is a synthetic material that insulates, wicks moisture, and dries quickly.
- **Nylon:** This is another synthetic option that is occasionally used as the primary material. It adds durability and can help improve drying times.
- **Silk**: A natural insulator, silk is comfortable and lightweight, but not as durable as other options. It's occasionally used in sock liners for reliable moisture wicking.
- **Spandex:** Many hiking socks include a small percentage of spandex. This elastic material helps socks hold their shape and keep bunching and wrinkling to a minimum.

Avoid 100% cotton socks at all costs. It absorbs and collects sweat but dries very slowly. This means that when they get wet, they stay wet.

Blister Care and Hot Spots

A blister is a pocket of fluid between the upper layers of skin, but still under the epidermis. Blisters commonly develop on the feet when performing activities such as hiking and backpacking. Blisters can be filled with serum, plasma, blood, or pus, depending on how and where they form. Blisters are formed by friction. Friction is formed by the force the shoe pushes on the foot and how slippery the skin and the shoe/sock interact.

Successful preventive strategies are aimed at making the shoe and foot more slippery and reducing the force that shoe puts on the foot. Having proper material in one's socks and having shoes that fit well are the ways to prevent blisters.

Blisters usually form a 'hot spot' (sore spot) first. If one of these does form, place a dual-layer pad over that area. **Blist-o-ban** is one such material. These pads address the two causes of blisters, the slipperiness, and the force of the shoe on the foot. The dual layer will allow the bandage to glide smoothly in all directions, deflecting friction away from the skin. The key to preventing blisters is to reduce 'hot spots' by properly breaking in boots and reducing moisture by wearing wool socks.

You can treat a blister that has already formed by cutting a hole in moleskin or duct tape and placing the ring around the blister. This reduces the pressure placed on the blister. This should help reduce the pain too. It is not recommended to open or drain blisters that are small (<2cm or <0.75 in).

When should a blister be opened? The answer is not clear. In general, if the blister is 2 cm in diameter or larger, then it is likely to rupture spontaneously and may be amenable to initial treatment by intentionally rupturing it. However, there is no best answer to this issue. In those cases where it is large enough, or it has already ruptured, wash the area, and puncture the base of the blister with a sterile needle or sterilized safety pin. Trim the external flap of skin from the blister, apply an antibiotic ointment, and cover the blister with a

sterile dressing. This can be protected with moleskin or mole foam.

Understanding Clothing and Heat

Clothing

Clothing might seem like an afterthought when one is headed hiking of backpacking. Still, it's the first and most important layer of protection between you and the elements. No level of skill or planning can make up for ill-chosen clothing if the weather takes a turn for the worse. It's essential to understand the fundamentals of layering to make sure you can stay safe in any conditions.

Heat from Our Bodies

To understand the use of clothing, it is first essential to understand heat. Our bodies are hot. The normal human body temperature is averaged at around 98.6°F (37°C). Since the air around us is usually much cooler, heat is always leaving our bodies. So, all we can do is control the heat flow as it leaves our bodies. Clothing is designed to control how much, and how quickly, heat can leave the body.

How Body Heat is Given Off

Heat moves from hot to cold in three ways:

1. **Radiation** is how most heat leaves the body.
2. **Conduction** occurs when the body is in contact with any object that is cooler than the body. Heat loss by conduction can be a significant when the body is wet.
3. **Convection** occurs when the heat is transferred away with wind. Heat loss by convection can be significant with exposure to cold wind.

When it is cold, we bundle up to keep heat in, and when it is hot, we take clothes off to allow more heat to leave our bodies. One of the best conductors of heat is ***water***. One of the poorest conductors of heat is ***air***. For example, in the summer, when we want to conduct heat out of our bodies, we go swimming. If we want to keep heat in our bodies, we will surround ourselves with air. Fibers and fabrics, such as wool, are excellent insulators because they have a lot of air in them. Since water is a good conductor of heat, the inside layers of clothing are designed to move or 'wick', water away from the skin.

Layering

Heat transfer out of the body is best controlled with clothing worn in layers. Body heat is trapped in the dead air space in the middle layer creating insulation, while perspiration is wicked away from the skin and through to the outer layer to prevent conductive losses. Wind and rain cannot penetrate the outer layer, therefore limiting convective heat loss. Not all clothing is designed to insulate.

Base layer

This is the layer of clothing directly against your skin, and its purpose is to wick sweat away to keep you dry. This includes socks, underwear, and an initial pant/shirt base layer if in colder conditions.

Middle layer
The middle layer is for insulating. This layer functions to retain body heat by creating 'dead air.' This can be clothing such as shirts and pants, thus an extension of the wicking layer.

The Outer layer
The outer layer, or shell, is a water- or wind-resistant barrier between you and the elements, keeping the wind from blowing across someone and causing convection loss of heat.

If you don't plan on wearing these three layers throughout your trek, it would be prudent to at least pack these types of layers to have just in case. If conditions change, you can always peel off layers to cool down or add layers if the weather takes a colder turn. Some clothing will help move heat away from the body. For example, in hot environments, loose-fitting clothing should be worn to move heat away from the body, as this facilitates ventilation.

Types of Fabric

What types of fabric are more appropriate to wick water from the skin, insulate from heat, or even facilitate heat loss? This topic has been discussed by recreationists of all experience levels. It can take some experimentation to figure out what works best for you. Here are some basic guidelines to consider when choosing the fabric that best fits your activity and goals:

Wool

Wool is a very popular choice and with good reason. Wools 3D wavy crimp-type fibers trap air easily. Eighty percent of the material is air. It's an excellent insulator and will keep body heat contained in cold weather. Wool also absorbs a lot of water. For example, merino wool can hold 30% of its weight in water absorption before the wearer can even feel it on their skin. Even with the water that it has absorbed, the wool maintains insulation, which is a huge plus for this material. Wool is also wind resistant. These properties make it an ideal fabric choice for most activities. Many people use wools as their base layer. Once maligned for being itchy, ultra-fine merino wool is itch-free, naturally breathable, moisture-wicking, fairly fast-drying, and not prone to odors.

Fleece

Polyester and Nylon are synthetics, such as fleece, that offer quick-drying capabilities at a more affordable cost. These fabrics are quite durable and make great slacks and shirts. Synthetic fibers have 3D patterns that imitate wool. Synthetics are warm when wet, but do not absorb moisture. They dry quickly, are as warm as wool, and are only half the weight of wool. One problem is that synthetics have poor wind resistance. They can also develop an odor worse than

wool. Overall, however, synthetics are a fantastic and affordable option that many choose as their base layers.

Down

"Down" is the under plumage that is found beneath the feathers of ducks, geese, and other waterfowl. It is natural insulation. Goose down insulation itself does not consist of feathers. Goose down frequently contains terms like "600+ fill goose down" or "900+ fill goose down" lines. These numbers indicate how much goose down is added to the coat or sleeping bag, for example. This is known as the "fill rating." The higher the number, the more goose down insulation is added into the coat or sleeping bag, and the warmer it should be.

Down is very soft, provides excellent insulation, and is very lightweight. It must be packed in compartments for this reason. It is excellent to use for sleeping bags and coats as it packs well, and it conforms to the user. The problem with down is that it will clump when it is wet and lose its ability to create dead air space, thus losing its insulative ability.

Silk

Silk is a soft, luxurious fabric that is quite thin and light, making it a great choice for moderate, cool-weather conditions. The downside is that it doesn't wick moisture away from the skin as well as wool or synthetics, so it isn't a good option for warmer days or activities with a great deal of exertion. Another consideration of silk is that, like synthetics, it can be prone to odor. The softness of silk also results in it being a less durable fabric, and its vulnerability to abrasion and sunlight results in a shorter lifespan than the other fabrics discussed.

Cotton

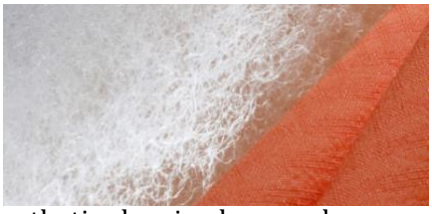
Cotton is never a good choice for outdoor activities, even when layering. There's a reason that experienced recreationists use the phrase "cotton kills." Cotton does not effectively wick moisture away from your skin, it doesn't dry quickly, and it is a very poor insulator. While wool will keep you warm when you're wet, cotton will keep you cold when you're wet. Even cotton socks should be avoided, as wet and cold feet are a recipe for disaster. So, in reality, cotton does not kill, but hypothermia does. It's easier to get hypothermia when you wear cotton, not because it doesn't insulate you as well as other materials, but because it just doesn't insulate you as well when it is wet. Cotton is a comfortable and cheap option for lounging around at the campsite but should be avoided for active pursuits.

Synthetic Fibers

Synthetic fabrics are human-made and produced entirely from chemicals to create fabrics like polyester, rayon, acrylic, and many others.

Over the years, synthetic fibers have increasingly grown in popularity. They are resistant to insects and fungus and have little to no ability to absorb moisture. Synthetics can easily create dead space. And because they are usually cheaper to produce, they are cheaper to buy.

A serious drawback of synthetic fibers is that they will melt. Since they have little to no ability to absorb water, they will always insulate, even when wet. This makes synthetic clothing ideal in wet environments like river trips. However, synthetic clothes are heavy and do not pack well, so they are not suggested for hiking.



Microchannels can be created in the fibers to create **Quallofil** and **PolarGuard**. Quallofil is made by Du Pont and is used both in sleeping bags and in many insulated jackets. The problem with Quallofil is that it is a bit on the heavy and bulky side. PolarGuard, and all its various derivatives, is considered the "premiere" synthetic insulation and is used in most high-quality synthetic sleeping bags and clothing. New iterations have made the material significantly less bulky, while at the same time improving the insulating abilities by around 10%.

Super thin fibers are a small synthetic fiber. They are very tiny, so manufacturers can put more of these in clothing. That means dead air space and more insulation. Since they are small, they are also light and pack well. They stay dry and keep their warmth when wet. There are not too many negatives with this material. Primaloft and Thinsulate are examples.

Tying it all Together

Now that you've learned about the basics of layering, fabric types, and sun protection, it's time to bring it all together. We've discussed the three main layers (sweat-wicking, insulating, shell) and three optimal fabrics (wool, synthetic, silk), but how do you combine those?

The Base layer (wicking). This layer needs to be one of the high-performance fabrics, such as wool, synthetic, or silk. Its purpose is to wick sweat away to keep you dry. Many consider this to be the most important layer of all, as this is the layer that keeps you cool and comfortable when you're working up a sweat. The weight of this base layer can also change depending on the season and activity. Examples of wicking layers are Capilene, Lifa, and Dryline

The Middle layer (insulating). The middle layer functions to retain body heat. This is the layer that will keep you warm and is typically the thickest or heaviest-weight material of the three. Wool and down are popular choices for mid-layers, but you can also choose fleece or synthetics with high-loft options such as Polar-guard, Micro-loft, and Primaloft. For wet weather, it would be wise to choose those synthetic pile or fleece options, as down can get soggy and lose its insulating capabilities in very wet conditions. Synthetics are also breathable and easier to ventilate and wash. A good rule of thumb for the mid-layer in colder weather would be to plan on wearing a synthetic as your go-to and to always pack an extra down jacket. Down "puffies" are easily compressible and lightweight, so they add substantial function at a low weight.

The Outer layer (shell). The outer layer is a water- or wind-resistant barrier between you and the elements. Being the first line of defense against the elements, this layer needs to be able to repel rain and snow while simultaneously being breathable. You don't want your perspiration to build up inside your layers; that would defeat the purpose altogether. In very wet conditions, go for something completely waterproof, with features like sealed seams, zipper guards, and cinch-able

hoods. Things like armpit zips and mesh pockets can help you ventilate even while working up a sweat in wet conditions. In drier conditions, you can consider using a lighter shell that is just windproof. These typically aren't very waterproof but are highly breathable, and pack down small enough to fit into a pack.

Now that you know the essentials of dressing for the outdoors, you can simply mix and match your layers to prepare appropriately for any conditions. Remember that what you wear is what is keeping you safe against whatever mother nature throws at you. There is no bad weather, only bad clothing.

Chapter 7: Skiing and Snowboarding

Improper Equipment Maintenance

The overall occurrence of skiing related injuries has decreased by 50 percent since the 1970's. This is in large part due to the improvement of the equipment with safety release bindings and hard-shell boots that allow for better control.

However, while the number of lower limb fractures has decreased, the number of soft tissue injuries has drastically increased. This trend is most likely associated with the newer equipment being used. Even though the equipment has continued to improve, the need for constant maintenance of equipment is always required. Nearly half of all downhill skiing accidents are the result of improper equipment maintenance. About 70 percent of the lower leg fractures and knee injuries that have occurred while skiing is a result of improper binding release. Thus, it is crucial that the settings on the bindings be adjusted to the skier.

Soft Tissue Knee Injuries

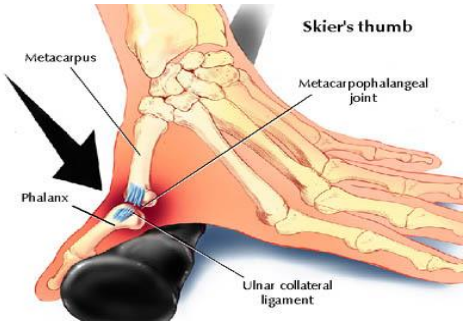
Soft tissue knee injuries are the most common within the sport. Beginner skiers are especially suspectable **to medial collateral ligament (MCL)** injuries because most beginner to low-intermediate skiers are taught to use the "snowplow," or "wedge" technique. If they turn too sharply, or one ski catches, the MCL is subject to high stresses. If a knee injury is suspected, the patient's knee should be immobilized with a splint, and the patient taken off the hill.

The most injured structure of the knee is the **anterior cruciate ligament (ACL)**. The ACL's role is to prevent backward motion of the femur on the tibia, as well as hyperextension at the knee. An injury to the ACL is often the result of a movement such as cutting or twisting that place too much stress on the ligament. Many skiers who suffer from an ACL injury report hearing an audible "pop" or "snap" just prior to the knee giving out. Placing snow and immobilizing the knee is important until medical care is available.

Although soft tissue knee injuries encompass most lower extremity injuries, fractures still occur. Many fractures typically occur at the top of the boot because the hard shell of the boot provides support wherever the boot covers. Such an injury has coined the term "boot top" fracture. This injury needs to go to the hospital. The boot should be kept on until medical care is obtained.

Upper Extremity Injuries

The skier's thumb injury is the most common upper extremity injury and typically occurs on hardpacked snow. It happens when the skier falls on their ski pole, which acts as a lever between thumb and index finger. It can also occur when the thumb catches some snow during a fall. Symptoms are tenderness in the area with deep throbbing pain. The treatment is to splint the hand in a functional position and seek medical help.



Re-cap of Common Ski Related Injuries	
Head Injury	At worst, head injuries can cause a bleed in the brain. Most other injuries will be less severe and may require suturing. Generally, head injuries are severe, could become worse, and will need proper management off of the slope.
Medial Collateral Ligament Tear	Found on the inside of the knee, its ultimate purpose is to prevent the knee from bending fully inwards. While skiing or snowboarding, an MCL tear may occur because of the impact caused by the force of one leg falling on another. As a result of this injury, skiers will likely experience severe pain, as well as bruising and swelling. While standing with this injury is possible, it will be painful.
Anterior Cruciate Ligament Injury	This is one of the most common sports injuries. The ACL is subject to injury in any sport that involves rapid maneuvering. Skiing and snowboarding both involve sudden turns that could potentially cause an ACL tear. Located in the center of the knee, the ACL controls how far the femur can move in relation to the tibia. ACL injuries occur when people pivot while standing, hyperextend, or stop suddenly. Often, people suffering from an ACL injury will hear a popping sound.
Shoulder Injury	Depending on the way a skier and/or snowboarder falls, a shoulder injury may be common as well. Because the shoulder connects the arms to the torso, there are plenty of body structures that may be affected. The ligaments, muscles, and tendons may be affected by the fall as well, and as a result, become weakened. Shoulder injuries require individualized treatment.
Wrist Fracture	This is a common injury for skiers. During a fall, it's instinctual to attempt to catch your balance by reaching out a hand for support. If you are suffering from a wrist injury while skiing, then it's imperative to stop skiing.
Skier's Thumb	The thumb is an especially vulnerable joint. Thumb ligament injuries are the second most common skiing injuries, surpassed only by MCL injuries in the knee. Skier's Thumb is an acute injury that often happens when falling with your hand in the ski pole strap. Your thumb can get caught and pulled away from the hand, which can cause a ligament tear. This can result in difficulty with grasping.

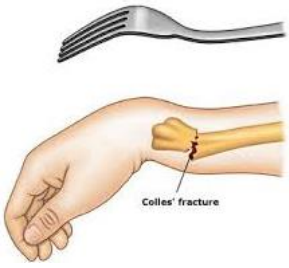
Boot Top Fracture	One of the worst ski injuries that can occur to the lower extremity is the boot top fracture. These fractures occur as the tibia and/or fibula fracture above the top of the boot. They almost always require surgical intervention as the tibia has the highest rate of non-union among all bones in the body.

Just like mountain biking, skiing also should be done with a helmet. However, helmets of any sort only offer protection to a certain extent. The Consumer Product Safety Commission suggests helmets offer little protection beyond 12 mph. Unfortunately, the use of helmets can give patrons of sports a false sense of security, leading to reckless behaviors. When assisting a patient who has fallen, one should always be suspicious of a head injury and vigilant for the common signs of concussions, as discussed previously.

Snowboarding

Snowboarding is another high-velocity sport where injures are common. Since the equipment and technique required for snowboarding are different from skiing, so too are the commonly seen injuries.

A toe side fall on a snowboard happens when the snowboarder falls face forward toward the ground. These types of falls can be violent and come unexpectedly to the snowboarder. Because of the suddenness, there often is a delayed response in being able to reach out their hands to brace the fall. This can lead to clavicular fractures, shoulder separations, and/or facial and head injuries.



However, in the circumstance where the snowboarder does have time to reach their arms out to brace for the fall, the violent nature of a toe side fall can result in a severe wrist or humeral fractures. The most common wrist fracture seen among snowboards is the “dinner fork” fracture.

Wrist guards have become more prevalent in the protection against wrist injuries seen in snowboarding. However, while the wrist guards are effective at preventing wrist injuries, the equipment may result in the transfer of forces to more proximal joints and bones, leading to forearm fractures, posterior elbow dislocations, or shoulder injuries.

The other common type of fall associated with snowboarding is a heel side fall. This occurs when the snowboarder falls back towards the ground. Because the snowboarder is falling backward, they are usually unable to use their arms to brace the fall. Consequently, this leads to buttock contusions, spinal compressions, and head injuries.

Chapter 8: Water Sports

Drowning Occurrences in the Young

Nearly 80% of people who die from drowning are male. Drug and alcohol are involved in half of adolescent and adult deaths associated with water recreation. Trauma from water recreation is secondary to dives, falls, and horseplay. And failure to wear a personal floatation device (PFD), while boating, results in a staggering 88% of drowning deaths.

Drowning – The Lungs

The lungs the organ system that is primarily involved in drowning pathophysiology. During the drowning process, the victims become panicked, which causes an increase in respiratory rate. At some point, victims are thrust underwater and have to hold their breath. Victims inhale water into their lungs, causing pulmonary damage. They become very hypoxemic, which will then cause secondary organ damage. The heart becomes ischemic, and neurological injury can result.

Arrhythmias – Irregular Heartbeats

Heart arrhythmias, or irregular heartbeats, are a common problem after drowning but are not usually caused by electrolyte disturbances such as high calcium, high magnesium, or high sodium, as the volume of aspirated water is rarely enough to disturb plasma electrolytes. The arrhythmias are typically secondary to severe hypoxemia that causes an ischemia in the cardiac conduction system.

Hypoxia

Hypoxia (lack of oxygen) causes injury and inflammation in the brain that can lead to cerebral edema and increased intracranial pressure. This process can occur after a relatively short period of hypoxia, which is why oxygenation is so important in the management of submersion injury. After resuscitating patients, it is important to monitor them for further neurologic deterioration, as reperfusion injury can occur.

Drowning itself is quick and silent, although it may be preceded by distress, which is more visible. Generally, in the early stages of drowning, very little water enters the lungs. A small amount of water entering the trachea can cause a muscle spasm that seals the airway and prevents the passage of both air and water until unconsciousness occurs. This means a person drowning is unable to shout or call for help or seek attention, as they cannot get enough air. The instinctive drowning response is the final set of autonomic reactions in the 20 to 60 seconds before sinking underwater. To the untrained eye, it can look like calm, safe behavior. Persons trained in rescue learn to recognize drowning people by watching for these movements.

Rescue

A drowning person may grab the rescuer, submerging the rescuer in the process. Thus, it is advised that the rescuer approach with a buoyant object, or from behind, twisting the victim's arm on their back to restrict movement. If the rescuer does get pushed underwater, they should dive downwards to escape the victim.

The priority is then to transport the victim to the water's edge in preparation for removal from the water. The victim is turned onto their back with a secure grip used to tow from behind. If the person is cooperative, they may be towed in a similar fashion held at the armpits. If the person is unconscious, they may be pulled in a similar way held at the chin and cheeks, ensuring that the mouth and nose are well above the water.

Since drowning is mainly an oxygenation problem, rescue breaths should be started immediately. Even before chest compression. The sooner you can get air into the lungs, the better. The European Resuscitation Council recommends that five (5) rescue breaths be initiated instead of two (2) breaths when starting CPR. Most patients with respiratory arrest will respond after the first few rescue breaths.

Prevention

Prevention is more important than any action one can take after a submersion incident has occurred. Alcohol should be avoided when participating in or supervising water activities. Everyone on a boat should always wear approved personal flotation devices that will support the person's head above water, even if the person becomes unconscious. Camp far enough away from water so that people, especially children, do not accidentally wander into the water.

Chapter 9: Lightning

Background

The power of lightning is immense. For every ten feet of ascension through the air, there is a 300-volt potential difference in electricity. This amounts to approximately 380,000 volts at the top of the atmosphere. This powerful "battery" tries to discharge through lightning strikes, striking the earth more than 100 times each second and 8 million times per day.

Worldwide, approximately 50,000 thunderstorms occur per day. The annual fatality count is not known, and estimates vary. The National Geographic estimates that about 2,000 people are killed worldwide by lightning.

Types of Issues Encountered with Lightning

Thunderbolts often rain down with great fervor in tropical central Africa. The weather patterns in Africa bring in warm air from the Atlantic Ocean that collides with mountains, producing many thunderstorms and lightning year-round. The North and South Poles, however, rarely experience thunderstorms and, therefore, have almost no lightning. In the United States, lightning researchers estimate that 22 million lightning flashes strike the ground each year. The most lightning prone region is Florida.

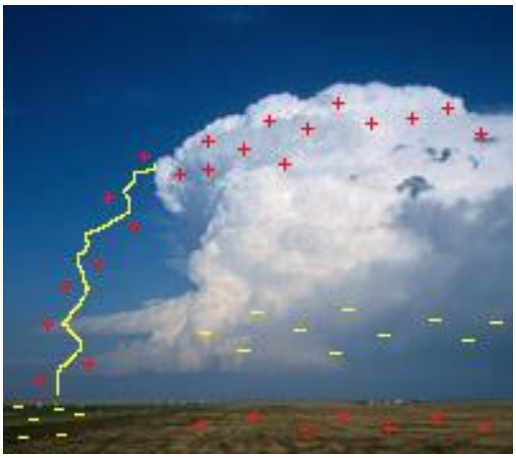
Location of Lightning Deaths	**Percentage**
Open fields, sport parks, in/on water	54%
Under trees	23%
On beaches	12%
Working on farm equipment	7%
Other	
Standing near open windows, riding a bike	4%

The Physics of Lightning

As lightning connects from the clouds to the ground, the second stroke of lightning will return from the ground to the clouds (upward streamer) following the same channel as the first strike. The heat from the electricity of this return stroke raises the temperature of the surrounding air to around 27,000 C° (48,632 F°). The heated air is compressed, raising the air from 10 to 100 times the normal atmospheric pressure. The compressed air explodes outward, forming a shock wave of compressed particles in every direction. Like an explosion, the rapidly expanding waves of compressed air create a loud, booming burst of noise that we call thunder. If a person is near this wave, significant trauma is likely.

When does lightning Strike?

Not all lightning forms in the negatively charged (the lower area) of the thunderstorm cloud. Some lightning originates at the top of the thunderstorm, the area carrying a large positive charge. Lightning from this area is called positive lightning. Positive lightning is particularly dangerous because it frequently strikes away from the rain core, usually ahead of the thunderstorm. It can strike as far as 5 or 10 miles (8 or 16 kilometers) from the storm in areas that most people do not consider to be a lightning-risk area. Therefore, most lightning strikes happen prior to a storm. So, get to shelter before a storm strikes.



Types of Injuries from Lightning

Injury from lightning can occur by several mechanisms:

***Ground current**:* When a lightning strike hits the ground, the electricity does not disappear into the earth. It spreads out in the ground as a potentially deadly current with voltages decreasing from the point of the strike. If a person happens to be standing in a place affected by a ground current, it can travel up one leg, through the body (and potentially stopping the heart and breathing), and then down the other leg.

***Side splash**:* This refers to lightning that jumps from an object to a person, or even from one person to another. Side splash occurs because lightning follows the path with the least electrical current resistance to the ground.

***Upward streamer**:* The third most common cause of lightning deaths and injuries are the upward leaders, also called "streamers," that rise from high objects and the ground just prior to lightning strikes.

***Direct strike**:* Lightning that hits someone directly from the sky is called a direct strike. This rarely happens.

***Contact**:* It is well known that lightning when it strikes a building can get into the wiring or the water pipes and kill someone talking on a phone with a cord or someone taking a shower. This does happen, but such "contact strikes" are as rare as direct strikes.

***Blunt Trauma**:* This occurs from the impact of the concussive force of the strike itself or from being thrown due to the extreme nature of the muscular contraction from the electrical charge. Blunt Trauma is responsible for most of the lightning injuries.

Deaths Due to Lightning by Type	
Ground current	50-55%
Side splash	30-35%
Upward streamer	10-15%
Contact	3-5%
Direct strike	3-5%

Treatment for Lightning Strikes

The most common cause of death in lightning strikes is a cardiopulmonary arrest. Persons who have been hit by lightning and are in respiratory arrest may need only artificial respiration to prevent the secondary hypoxic arrest. Almost all persons hit by lightning who do not have cardiac and/or respiratory arrest at the scene survive, even though they may be seriously injured. Resuscitation for persons struck by lightning must be initiated immediately.

Pathophysiology Effects from a Lightning Strike

In addition to flowing on the outside of the body (flashover), the electrical current may also enter the body through the cranial orifices (eyes, ears, nose, and mouth) and flow through the body. This may explain why some patients have certain injuries such as ocular and/or ear, and others do not. Although the current flow occurs over a very short period, the amount of current is huge with an amazing amount of energy.

The identification of a victim of a lightning strike is easy if the strike was witnessed. However, there may be situations where it is unclear. Lightning injuries must be suspected when in the outdoors and in weather conditions conducive to lightning. Always follow the MARCH protocol. Call for evacuation to the closest medical facility. Any patient who is a victim of a lightning strike should be evacuated as soon as possible.

Reduce Risk

"When thunder roars go indoors." If you hear thunder, then you should seek shelter. There is no safe place outdoors. There is little you can do to substantially reduce your risk if you are outside in a thunderstorm. The only completely safe action is to get inside a safe building or vehicle. If you absolutely cannot get to safety, you can *slightly* lessen the threat of being struck with the following tips. But, don't be deceived--you are **NOT** safe outside.

If you are outside, and thunderstorm develops, these tips can ***slightly*** lessen the threat of being struck by lightning:

- Avoid open fields, the top of a hill, or a ridge top.
- Crouched positions offer little protection.
- Stay away from tall, isolated trees or other tall objects.
- If you are in a forest, stay near a lower stand of trees.
- If you are in a group, spread out to avoid the current traveling between group members.
- If you are camping in an open area, set up camp in a valley, ravine, or other low areas.
- Remember, a tent offers NO protection from lightning.
- Stay away from water, wet items such as ropes, and metal objects such as fences and poles. Water and metal do not attract lightning, but they are excellent conductors of electricity. The current from a lightning flash will easily travel for long distances.

A house or other substantial building offers the best protection from lightning. However, people should stay away from windows and doors, and avoid contact with anything that conducts electricity, such as landline telephones.

Cars provide good protection. Lightning flows around the outside of a car, and the majority of the current flows from the car's metal cage into the ground below. It is not the rubber tires that protect you.

The best rule is that if you see lightning or hear thunder go indoors. The threat of lightning continues for a much longer period than most people realize. Wait at least 30 minutes after the last clap of thunder before leaving shelter. And remember, don't be fooled by sunshine or blue sky.

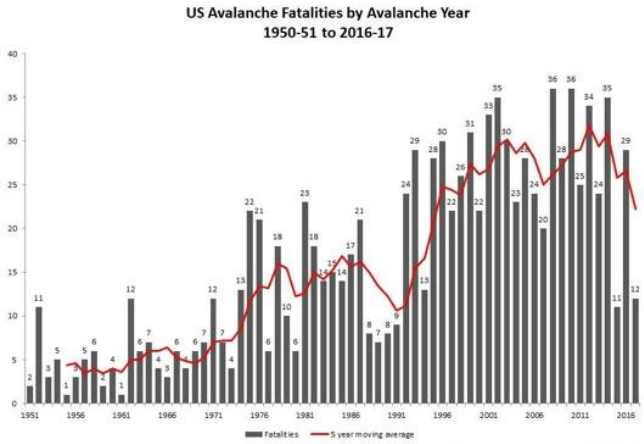
Chapter 10: Avalanche

This chapter outlines important medical concepts related to avalanches but does not cover all aspects of avalanche safety. To be truly safe from an avalanche, a person needs to take an avalanche safety course. To understand avalanches is one of the more critical topics in wilderness medicine, if not for any other reason in that injury and death rates are rising.

Avalanche Facts

Most avalanches occur spontaneously during storms with increased snowfall. The second-largest cause of natural avalanches is changes in the snowpack, such as melting due to the sun. Artificial triggers of avalanches include skiers, snowmobiles, and controlled explosive work. Contrary to popular belief, avalanches are not triggered by loud sounds.

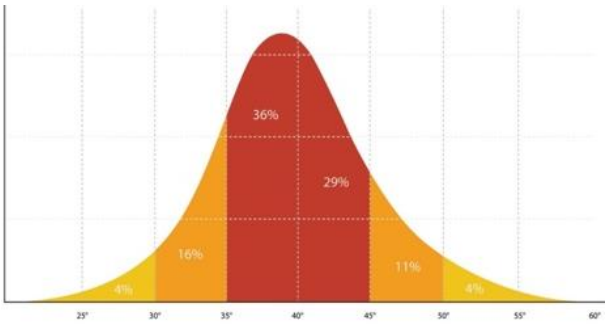
Injury and death due to avalanches have dramatically increased over the past two decades. Sadly, human factors contribute to nearly all avalanche accidents. In the vast majority of avalanche burials, the victim, or someone in the victim's party triggered the avalanche. Snowmobiler's account for the largest group of backcountry users who are killed in avalanches.



The most crucial factor in avalanche survival is the amount of time someone is buried in the snow. Asphyxiation (suffocation) is the predominant mechanism of death among avalanche victims. Hypothermia is a rare cause of death among avalanche victims. Avalanches can reach speeds of up to 100 mph in less than 10 seconds, so trauma is also a cause of death and injury. As many as one-third of avalanche victims sustain significant blunt trauma.

Slope Angle

Slope angle should be one of the first things that come to mind when traveling in the backcountry. It is a primary factor in every avalanche.



Avalanches happen when four elements of snow are present:

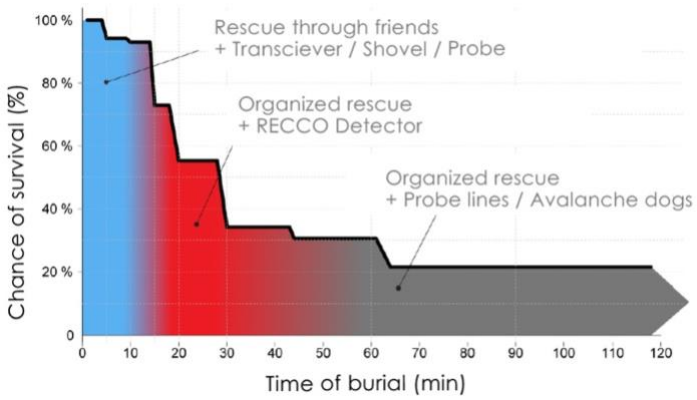
1. A slab of snow
2. A weak layer of snow
3. A trigger (like new snow)
4. A slope angle steep enough for snow to slide, generally between 25-55 degrees

Not all slopes are steep enough to slide, and some are too steep to form slabs regularly. Recognizing what slopes are safe to ride and what slopes are prone to avalanching is an integral part of making safe backcountry decisions.

The best way to answer the important question of "can this slope slide" is to know the angles of the slopes you are riding. The most common slope angles on which avalanches typically happen is between 36-38 degrees, though it is important to note that not all avalanches start on slopes with these precise angles. If a gentle slope of 25 degrees or less is connected to a larger, steeper slope it is still possible to trigger a slide from below without ever getting on the steepest part of the slope. This is known as remote triggering and is a common way that riders get drawn into an avalanche in the backcountry, especially in avalanche run-out zones. When traveling in terrain that requires the crossing of avalanche run-out zones, it is imperative to cross one at a time and always keep a watchful eye on one another.

Only about one-fourth of avalanche victims have massive trauma as the primary cause of death. Multiple injuries, such as spinal and long bone fractures, blunt abdominal trauma, and head injuries are sustained as the avalanche victim is dragged over rocks and through trees.

Air pressures under an avalanche are much higher than atmospheric pressure. This is due to the heavy nature of the snow and the snow's power. Victims find that snow is 'forced' into their airway. If a victim can be rescued within 18 minutes, the survival rate is higher than 91%. The survival rate drops to 34% in burials between 19 and 35 minutes.



If chest movement is not restricted to the point of compromising breathing mechanics, then survival depends on the size of the air space created near the victim's face as the snow flows downhill to a stop. All air pockets will ultimately fail for two reasons: 1) Heat from the expired air causes ice to form around the mouth and prevents fresh air to enter the lung. 2) Re-breathing expired air will cause the victim to breathe in carbon dioxide and will eventually death from asphyxiation.

Avalanche Safety and Survival

Most injuries can be avoided by good decision making, minimizing risk by traveling wisely with good techniques, and avoiding high-risk terrain. When it comes to risk management, people behave and think differently. This is particularly true in young people, where the risk of injury from avalanche is highest.

Here are some critical rules that you are strongly urged to follow:

- When traveling on snow terrain, never go directly above any member of your party.

- Avoid gullies and narrow valleys, as these serve as run-out zones where avalanches that start further up the mountain can funnel through, and usually burying everything at the bottom of the gully.
- Travel on ridgelines above avalanche start zones, or in dense forest, or well away from damaged vegetation.
- Travel from one safe zone to another, one person at a time. If an exposed area needs to be crossed, never expose more than one person at a time. Keep the rest of the party in a safe area so they can perform a rescue if an avalanche does occur.
- Be on the lookout for "red flags," such as collapsing, cracking snow, or sinking into wet snow.
- Start on low angle slopes, which are less than 25°, before venturing to steeper slopes. This gives you the opportunity to better assess snow stability before traveling on more risky slopes.
- Always call the Forest Service or Avalanche Forecast Center for a report of the current snow conditions.
- Always carry avalanche rescue equipment including at a minimum, an electronic avalanche rescue transceiver (beacon), and a shovel and probe. Practice using them.

Avalanche Victim Rescue

If an avalanche is witnessed, the survivors should make every effort to maintain sight of the victim as he/she is pushed down the slope. Once the survivors lose sight of the victim, a mental note should be made of the area where the victim was last seen using fixed landmarks such as rocks and trees.

Since more than one avalanche is possible in the same area, extreme caution should be used by the rescuers to avoid getting caught in a second avalanche.

Transceivers (beacons), shovels, and probes constitute the basis of avalanche survival and rescue equipment. Transceivers work on the assumption that an avalanche victim can be found within the "golden eighteen minutes" after burial. After 18 minutes, the chance of survival dramatically decreases. If a member of a party is buried in an avalanche, rescuers should switch their transceivers from the "send" to the "receive" mode. This will allow rescuers to pick up the signal transmitted by the victim's beacon.

Treatment

Low oxygen and high carbon dioxide levels are significant threats to life in avalanche victims. As with any victim, primary attention should first be given to the **MARCH** protocol. Because major trauma is frequently associated with avalanche burial, cervical spine precautions should be used when extricating the victim. Keep in mind the patient's exposure to the environment. Snow can be insulating, but once the victim is extracted from the snow and exposed to wind, core body cooling can accelerate if the body is not properly insulated against the environment. Any avalanche burial victim should be evacuated immediately.

Other Methods

The best way to avoid being caught in an avalanche is to not be near the trigger points for one. However, there are several devices that might increase your chance of survival if you are caught in one. Make no mistake, though, a person's primary goal is to never be in an avalanche.

Avalanche Airbags

Avalanche airbags help a person avoid being buried by making the user an even larger object, relative to the moving snow, which forces the person toward the surface. Avalanche airbags work on the principle of inverse granular convection.

Avalanches, like mixed nuts and breakfast cereal, are considered granular materials and behave in a fluid-like way, where smaller particles settle to the bottom of the flow and larger particles rise to the top. Provided the airbag is deployed correctly, the chances of a complete burial are significantly reduced.

Avalung

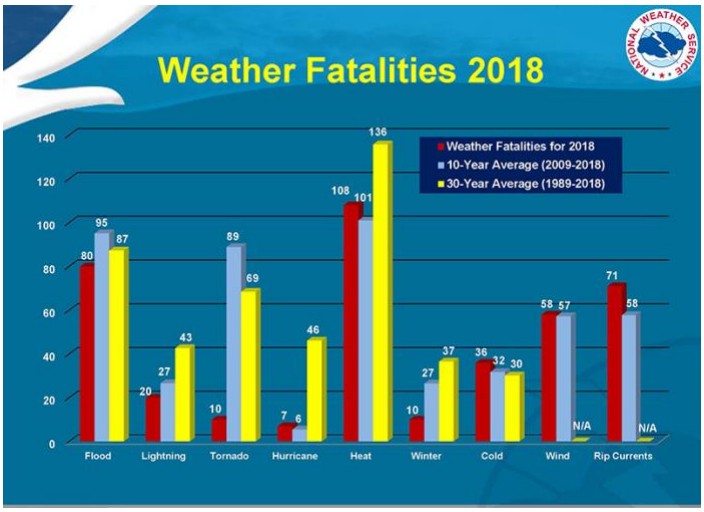
A device called the Avalung has been introduced for use in avalanche terrain. During an avalanche burial, victims not killed by trauma usually suffer from breathing in carbon dioxide, as the snow around them melts from the heat of the victim's breath and then refreezes, disallowing oxygen flow to the victim and allowing toxic levels of CO_2 to accumulate. The Avalung helps this situation by drawing breath over a large surface area in front and pushing the warm exhaled carbon dioxide behind. This buys additional time for rescuers to dig the victim out.

Chapter 11: Flash Floods

In September 2015, a flash flood in Zion National Park killed seven highly trained canyoners as they navigated Keyhole Canyon. The group had been planning their trip into Keyhole for months and decided to ignore a moderate level warning of flooding from the National Weather Service the morning before entering the canyon. What began as a 40% chance of rain turned into a devastating flash flood that took their lives. The victims were described as extremely cautious and experienced. The same flood continued to kill twelve members of a small community in Southern Utah. Flash Floods are extremely dangerous, even for the most experienced outdoorsmen, and must be treated with extreme caution.

The Unpredictability of Flash Floods

A flash flood is a flood that begins within six hours of heavy rainfall. The danger associated with flash floods is due to their sudden onset, which leaves little time for people to prepare or evacuate. Flash flooding is the second leading cause of natural disaster-related deaths in the U.S., with approximately 100 deaths occurring each year. While they can be particularly problematic in the backcountry, flash floods are not restricted to wilderness areas and can happen anytime and anywhere.



Weather conditions, as well as topography and soil conditions, influence the formation of flash floods and should be considered when planning a wilderness activity. Arid deserts are particularly susceptible to flash flood conditions due to the often-impermeable clay-like soil, the funneling effects of slot canyons, and the infrequency of storms. A storm occurring many miles away can quickly flood a desert area. This is a major problem because when adventurers go into the backcountry, they see blue skies above them and may have no idea that it is heavily raining 30 miles away. A flash flood can present four to five hours after rainfall and after the storm has passed.

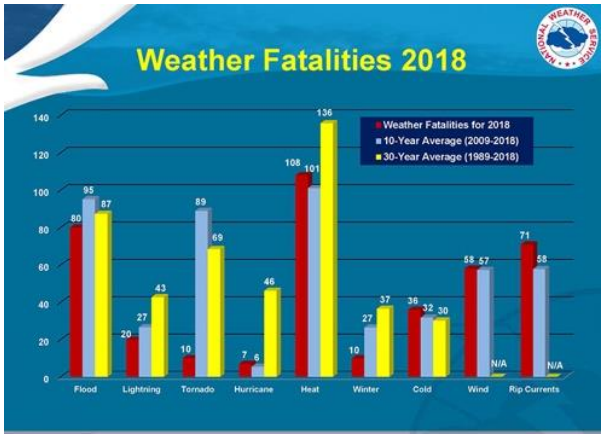
The head of a flash food is often choked with debris, dirt, and rock, giving it a dark brown color, and slowing down its speed, causing water to back up behind it. It is a 'moving dam', and it has incredible momentum. Even a small flood could knock a person over. A surprising fact to most is

that more than half of the flood-related fatalities in the U.S. occur in vehicles such as cars or trailers. Being inside a vehicle during a flood can offer a false sense of security, when in fact, most vehicles lose complete control in less than six inches of water and begin to float in a foot of water. Vehicles often flip once floated, trapping their passengers. Never attempt to drive through a flooded area. You need to abandon your vehicle if it does become surrounded by water and seek higher ground. It is not uncommon for trees or even boulders to be carried by floodwaters. This debris has the potential to harm or kill anyone or any animal in its path. It is difficult to gauge the speed, depth, and contents of floodwater, and for that reason, one should never attempt to cross flowing flood water. If you are caught in a flood, seek higher ground immediately.

The best way to prevent flood-related injuries is prevention through planning and exercising caution when conditions are variable. When planning a trip, it is important to be aware of the flooding potential for the immediate backcountry area you will be in. As well, you should be aware of the drainage potential and slope of the land. Remember, flash floods usually occur hours after a rainstorm has ended. If the conditions are wrong, "turn around, don't drown" (TADD).

Chapter 12: Heat Releated Illnesses

Heat-Related illnesses are the most common cause of weather-related deaths in outdoor medicine. The 30-year average is well above all other outdoor-related weather deaths.



To understand heat illnesses, it is essential to understand what heat is and how the body handles heat. The normal human body temperature is averaged around 98.6°F (37°C). This fact is critical in understanding heat-related illnesses.

Another important fact to know is that the body is only approximately 10-25% efficient in processing the food that we eat into energy. All the unused energy is given off as heat. If the body can't divest that excess heat, the human core temperature could rise above the average temperature of 98.6oF (37oC). That rise is known as hyperthermia.

The Science Behind Body Heat Loss

Body heat is given off three ways:

1. **Radiation** occurs whenever the air temperature surrounding the body is less than 20°C (68°F). Heat loss by radiation is constantly occurring during the winter months when temperatures fall significantly below this threshold.
2. **Conduction** occurs when the body is in contact with any object that is cooler than the body. Heat loss by conduction can be a significant issue when in contact with snow, ice, or cold water.
3. **Convection** occurs when the heat is transferred away from the body through circulating air currents. This is like sitting in front of a fan, and it's why we feel cooler when the wind is blowing. Heat loss by convection can be significant during winter storms with exposure to the wind.

Evaporation is the process that occurs when you sweat. It utilizes all three methods of heat transfer and is not a separate method. This same process can occur when wearing wet clothes.

It is crucial to keep in mind the different ways that heat is lost from the body to prevent heat-related illness. Heat moves from hot temperatures to cool temperatures. No heat can be transferred when two objects are at the same temperature. When air temperatures rise, radiation no longer works, and the body relies on convection and conduction. Water (sweat) is poured onto the skin to facilitate heat loss by wind and conduction. When the air temperature is the same as the body temperature, then no heat can be lost from the body and the body temperature will start to rise dramatically. **Hyperthermia** is the name of the illness that happens when the body cannot transfer heat, or at least not transfer heat fast enough.

Medical Conditions

Anything that prevents heat from being transferred from the body will increase the risk of developing hyperthermia. Some medical conditions prevent heat from leaving the body. Diseases that cause water loss, such as dehydration, vomiting, and diarrhea, will promote heat retention. Obesity is an excellent insulator and will cause the body to hold onto heat.

Environmental Factors

There are environmental factors that will increase the risk of developing hyperthermia. Anything that will raise the body temperature or raise the temperature of the environment around the body will to this. These would include exercising in a hot climate, lack of air conditioning or proper ventilation, inappropriate clothing, a decreased fluid intake being inside a hot tent, or being inside an auto in the sun or sitting in a hot tub.

Physiological Response to Heat Stress

The first, and most apparent, response to heat is a person's skin will turn red. This is because veins dilate to increase blood flow that causes the body to lose heat faster. Simultaneously, the core vessels will constrict to shunt heat away from the core to the skin. The heart responds by increasing heart rate and cardiac output. The net effect is increased blood flow to the skin, which facilitates heat transfer to the environment. Sweat glands are activated to increase the amount of evaporative heat loss.

Clinical Manifestation

There are important clinical manifestations of heat injury that occur on a spectrum of severity, ranging from minor to life-threatening:

<u>Heat Cramps</u>

Heat cramps are caused by a loss of salt in the body. This happens when the lost fluid is replaced by a fluid solution without enough salt. Cramps typically involve only one muscle group (usually the calves) but can occur in any muscle. Cramps are brief, intermittent, and involuntary contractions of the muscle. They hurt. This happens after a lot of activity in a hot environment and drinking a liquid without salt.

The key to treatment is to replace the lost salt. This is done by eating salty snacks and electrolyte drinks. If needed, you can place ¼ to ½ teaspoon of salt in a quart of water. If the person does not respond to this treatment, then evacuation might be required. Drinking plain water will worsen the situation and stretching the muscles will not address the underlying cause of cramps due to low salt. There is a misconception that a lack of potassium causes heat cramps. This is not the case. It is sodium (salt is sodium chloride) that is involved in skeletal muscle contraction.

<u>Heat Syncope (fainting)</u>

Heat syncope results from dehydration, dilation of blood vessels in a hot environment, and pooling of blood in the legs while standing. Patients are typically not profoundly dehydrated or hyperthermic. Heat syncope usually affects two populations: the **non-acclimatized** and the **geriatric** demographic.

Heat syncope usually afflicts standing, stationary individuals. Blood vessels are dilated to facilitate heat transfer to the environment. The combined effect of these factors leads to less blood coming from the heart and therefore less blood going to the brain. That can cause fainting. People will usually have lightheadedness, dizziness, restlessness, nausea, and will experience yawning. There may be some jerking of the muscles associated with this.

For initial treatment, lie the patient flat and elevate their feet. People will get better once the patient lies down. And blood back to the brain. Those who maintain proper hydration are less likely to experience heat syncope.

Heat Exhaustion

Heat Exhaustion is a form of heat illness that represents significant water and salt loss. Symptoms of heat exhaustion include weakness**,** fatigue, nausea with or without vomiting, headache, and thirst.

Headache is a common symptom of heat exhaustion and is often accompanied by dehydration. Headache is the first sign of dehydration. Although heat exhaustion isn't as severe as heatstroke, it isn't something to be taken lightly. Without proper intervention, heat exhaustion can progress to heat stroke, which can damage the brain and other vital organs and even cause death. Other signs of heat exhaustion include fast heart and fast breathing rate, profuse sweating, orthostatic hypotension, elevated body temperature. and an altered mental status.

Treatment for heat exhaustion is to give the patient water and electrolytes. **As well:**

- Stop all immediate activities.
- Move the patient from direct sunlight to a cool, shaded area.
- Loosen tight clothing.
- Give them water as quickly as possible without causing them to vomit.
- Increase heat loss by using the three methods of heat transfer: convection, conduction, and radiation.

- Make the patient "sopping wet" with comfortable room temperature water and fan the patient with anything that increases air movement and thus the evaporation of the water.
- Get them out of the sun and 'fan' them to increase convective heat loss.

Heat Stroke

Heatstroke is a true medical emergency and is classically defined as severe hyperthermia, with a temperature > 40° C [104° F], neurological problems, and a loss of sweating.

Neurological abnormalities are the best indicators of significant heat injury. These include:

- Stumbling gait.
- Irritability, confusion, combativeness, bizarre behavior, seizures, hallucinations, and fainting.
- The victim may lapse into a coma.

Treatment includes active cooling. Remove all restrictive clothing and utilizes cold-water immersion. This has been shown to reduce the body temperature twice as fast as evaporative cooling and has been shown to be safe in young, healthy heatstroke victims. This cooling could include a lake, pool, river, or stream. If you can't immerse them, pour cool/cold water on them. The victim's skin should be kept "sopping wet" and continuously fanned to promote evaporation. If available, ice packs and cold compresses may be placed in an area where large arteries run, such as the groin, arm pit, and neck. The initial treatment goal is to drop the body temperature as rapidly as possible.

Evacuation Guidelines

Any patient with a loss of consciousness, more than one episode of syncope, or signs of heatstroke, should be evacuated. A patient with severe heat cramps that do not respond to salt solutions, or someone who has multiple cramps, should also be considered for evacuation depending on the situation. Patients showing signs of heatstroke should be evacuated. Patients with heat exhaustion do not need to be evacuated as long as they can be treated in the field, they respond well to treatment, and they do not develop signs of heatstroke.

Prevention

The most significant risk of developing heat-related injuries is dehydration. Most of the risk factors involve dehydration. Previous episodes of heat exhaustion or heat stroke are also risk factors for developing a heat-related illness. High humidity inhibits the body's ability to lose heat through sweating and evaporation. Increased physical exertion, wearing heavy clothing that does not 'breathe,' lack of acclimatization, and not drinking enough water will all increase the risk of heat illness.

Rehydration should include a combination of water and electrolytes to maintain proper balance in the body. Too much water in the absence of electrolytes can lead to dangerously low levels of sodium, causing neurological damage and dysfunction.

Consistently clear urine is a reliable way to gauge hydration status. It is, best to assess one's hydration status based on the color of the urine. The onset of a headache is often the beginning of heat illness, and the goal of hydration is to avoid heat illness altogether. It is best to catch signs of dehydration well before the onset of a headache and heat illness.

Preventative measures for heat-related illness include wearing loose-fitting clothing, which helps to dissipate heat by promoting airflow over the body and facilitates evaporative cooling. This is the most efficient way to cool the body. Dark-colored clothing absorbs light and increases body temperature and should be avoided. Tight-fitting clothing is restrictive and prevents efficient airflow that is needed to create evaporation. Dousing often in cooling fluids or misting sprays can be another effective method of cooling.

Acclimatization also decreases the incidence of heat injuries and improves performance in hot environments. Heat acclimation or acclimatization plays a large part in the body's physical responses and overall ability to cope with heat exposure. Adults should gradually increase the time and intensity of activity in a hot environment over 7-10 days. Children and the elderly require 10-14 days to maximize acclimatization. Acclimatization can be done using saunas and steam rooms 7-10 days in advance of a trip.

Chapter 13: Cold-Related Illnesses

Hypothermia (cold illness) is most often associated with prolonged exposure to cold winter activities such as skiing, snowshoeing, and mountaineering or sports activities in the rain or cold temperature. It can also result from immersion accidents. But hypothermia can also be a danger during the hot summer months. Both the elderly and young babies have a challenging time with thermoregulation and are susceptible to becoming hypothermic due to elevated levels of air conditioning indoors. As well, windy days and wet, cold weather in the summer are risk factors for hypothermia, as is cold water even on a hot day. It is crucial to be mindful of this and to be aware of the signs and symptoms of hypothermia year-round.

It is important first to understand how the body loses heat. Heat is lost from the body through radiation, conduction and convection, and evaporation. It is important to remember there is no such thing as "cold." If something feels cold, it just has less heat. Heat moves or is transferred, from a warmer object to a colder object. The human body is continuously transferring a significant amount of heat to the cooler environment around it. Our body temperature is about 37° C (98.6° F), and we are rarely in temperatures that are hotter than we are.

Hypothermia and Heat Loss

Three Methods for Heat Loss

1. **Radiation** occurs whenever the air temperature surrounding the body is less than 20°C (68°F). Heat loss by radiation is constantly occurring during the winter months when temperatures fall significantly below this threshold.
2. **Conduction** occurs when the body is in contact with any object that is cooler than we are. Heat loss by conduction can be a major issue when in contact with snow and ice.
3. **Convection** occurs when heat is transferred away from the body through circulating air currents. This is like sitting in front of a fan. This is why we feel cooler when the wind is blowing. Heat loss by convection can be significant during winter storms when exposed to the wind.

Evaporation is the process that occurs when you sweat. It utilizes all three methods of heat transfer and is not a separate method. This same process can occur when wearing wet clothes.

It is crucial to keep in mind the different ways that heat is lost from the body to prevent cold-related injuries, especially when out in the field. When searching for possible places for shelter, look for areas that are dry (conduction), insulated (radiation), out of the wind (convection), and no direct contact with ice and snow (conduction). This will limit the effects of evaporation, radiation, conduction, and convection.

The single most important aspect of hypothermia and other cold-related injuries prevention is adequate preparation. By being aware of changing weather conditions, bringing the proper gear, having a backup plan in case of an emergency, and being aware that cold-related injuries can occur in above-sub-zero temperatures, you are significantly lowering your chances of developing hypothermia or other cold related injuries in the wilderness. Remember, cold-related injuries are

much easier to *prevent* than they are to *treat* in the wilderness. Therefore, preparation and prevention are crucial.

Physiology of Hypothermia

The healthy body maintains a core temperature of 37°C +/- .5°C (98.6°). When the body begins to lose heat, shivering utilizes muscle activity to produce heat. Additionally, because most of the heat loss from the body occurs at the skin, the narrowing of blood vessels, also called vasoconstriction, prevents blood from reaching the skin. Therefore, the blood is not cooled as fast. As the body continues to lose heat, some organs, including the heart and lungs, begin to shut down. This is the body's last attempt to conserve heat and protect the brain.

A core body temperature of 35°C (95°F) or less defines hypothermia. The perception of temperature is closely linked to skin temperature rather than core temperature. For example, shivering may begin when the core temperature is 37 degrees Celsius (98.6°F). Hypothermia compromises heart function, leading to decreased output and fatal heart rhythms. The body must expend energy to shiver and to vasoconstrict the vessels. Ultimately, the depletion of energy stores leads to a loss of temperature equilibrium and the dilation of blood vessels. When this occurs, blood rushes back to the skin, and the individual feels warm. This may lead to the phenomenon known as "paradoxical undressing," whereby hypothermic individuals take off their clothes despite being cold.

Classifications of Hypothermia

Mild hypothermia is defined by a core temperature ranging from 32° to 35° C (89.6-95°F). The cold temperature defense mechanisms are still working and will cause the patient to start to turn blue and create a sensation of cold. The victim may start to shiver uncontrollably. Their mental status may become impaired with varying degrees of confusion and disorientation. Urinary frequency is common due to increased renal perfusion caused by elevated cardiac output and peripheral vasoconstriction, increasing blood flow to the kidneys. The victim may have an elevation in their vital signs.

Moderate hypothermia is defined by a core temperature ranging from 28° to 32°C (82.4-89°F). The victim's blood pressure, heart rate, and respiratory rate will decrease. As well, victims are more confused, their pupils will dilate, and their muscles will tighten. Thermoregulation is less effective (shivering), and rewarming is required. Shivering ceases at and below a core temperature of 30°C (86°F).

Severe hypothermia is defined as a core temperature between 24°C and 28°C (75.2-82.4°F). At this temperature, the victim will go into a deep coma with dilated pupils and muscular rigidity. Their blood pressure will be barely detectable, and their pulse may be as low as 10 to 20 beats per minute. Life-threatening heart beats are easily induced in these victims with even with the slightest of movements.

Profound hypothermia is when the core temperature falls below 24°C (75.2°F). There is little chance of survival at this point.

Modified Swiss Staging System

Stage	Clinical Symptoms	Typical Core Temperature
Mild	Conscious, shivering	32 to 35°C (92 to 95˚F)
Moderate	Impaired consciousness, not shivering	28 to 32°C (82 to 90˚F)
Severe	Unconscious, not shivering, vital signs present	240C to 28°C (77 to 82˚F)
Profound	No vital signs	< 24°C (75˚F)

Treatment of Hypothermia

The most important consideration in treating hypothermia in the field is preventing further heat loss. To accomplish this, remove the victim from the situation that caused him or her to become cold. Transport them to a shelter, removing wet clothing, and providing an insulating barrier around the patient. Keep them out of the wind.

Remember that the three methods of heat loss are from **radiation**, **conduction**, and **convection**. Prevent conductive heat loss with the use of insulating materials, including clothes, blankets, sleeping bags, and sleeping pads. Evaporative heat loss is addressed through the application of a vapor barrier, such as bubble wrap or a tarp. Anything that can be done to help rewarm the victim will be helpful, such as sitting by a fire, and carbohydrate-rich food or beverages. Importantly, avoid alcoholic beverages, which may exacerbate hypothermia by causing peripheral vasodilatation. Handle the patient gently, as excessive physical stimulation may precipitate fatal heart beats. In a rescue situation, it is important to remember the premise that "no one is dead until they are warm and dead."

For the treatment of mild hypothermia, you need to remove the victim from the elements and shelter them to avoid further heat loss. The individual should completely undress, then dress in dry clothes and be wrapped in blankets, taking special care to cover the head and neck to avoid heat loss from radiation. Carbohydrate-rich beverages, and foods may be helpful in both rewarming and meeting the increased caloric requirement for shivering, taking care to avoid alcohol. Limited exercise may generate some heat. However, this is not advised in moderate and severe hypothermia. Do not use baths or water immersion to treat even mild hypothermia. Body-to-body rewarming may improve the comfort of the mildly hypothermic patient because of decreased shivering but should not be done at the expense of delayed evacuation. Those suffering from mild hypothermia will have a favorable outcome as long as the cooling process is halted.

For the treatment of moderate hypothermia, the individual has exhausted their capacity to achieve rewarming by shivering, and active rewarming must be performed in order to get their body temperature to a near-normal level. You should attempt rewarming in the field with items such as large electric heat pads or blankets, and warm water bottles. The areas of the human body with the highest potential for conductive heat loss include the axillae, chest, and back.

For severe hypothermia**,** treatment is a true medical emergency that requires aggressive treatment and prompt medical management with evacuation for initiation of active core rewarming. These

victims have no ability to reheat themselves at this stage. It is important to consider that victims suffering from this condition may exhibit altered mental status if they are still conscious. Care must be taken in handling victims suffering from this condition as extremely cold core temperatures can cause cardiac irritability. Even the slightest jolt may cause these individuals to degenerate into life-threatening dysrhythmia, such as ventricular fibrillation. This becomes extremely important in determining when CPR needs to be initiated. Victims with severe hypothermia may have faint pulses, severe bradycardia, and appear to be dead. So, it is important to assess vital signs over a minimum of 60 seconds.

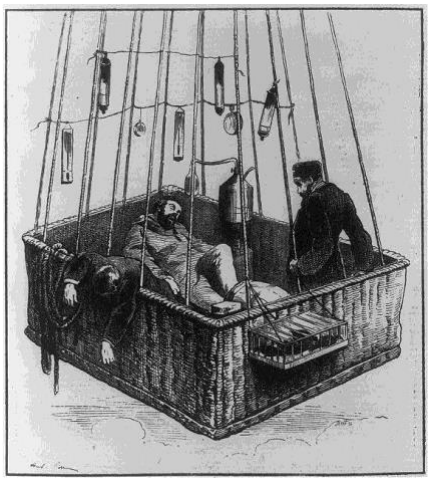
If the patient has vital signs, even if very slow, CPR should NOT be performed. After determining that the patient has no vital signs, CPR (including breathing) should be initiated.

Evacuation Guidelines

Evacuation guidelines indicate that all victims with moderate to severe hypothermia must be evacuated from the wilderness. They have lost the capacity to rewarm themselves and it is extremely difficult to actively rewarm these victims in the wilderness setting. Victims with mild hypothermia may not require evacuation if they are able to warm themselves, and they do not develop any sequelae from the episode. When transporting hypothermic patients, handle the individual very gently to prevent degeneration into a fatal rhythm, and keep him or her horizontal to prevent exacerbating potential hypotension.

The single, most important aspect of hypothermia treatment is adequate **prevention** through preparation. Hypothermia is the "killer of the unprepared," but even experienced and prepared outdoors, people have succumbed to this ailment. You should be aware of weather conditions and bring appropriate gear. Have a contingency plan in case a bad situation happens.

Chapter 14: Altitude Illness



What would happen to you if you were taken immediately to the summit of Mt. Everest? The answer is you would pass out, and likely die within minutes. A similar scenario occurred in the balloon flight of the 'Zenith' in 1875. At that time, ballooning had progressed to where high altitudes were obtained, and scientists were going to dizzying heights to discover the effects of 'thin' air. Three French scientists wanted to go higher than anyone had before. When they reached the 'death zone' of about 27,000 feet (8,200 meters), they passed out. One of the scientists awoke to find the other two were dead. The Zenith crashed to the earth outside of Ciron, France. The two men had died of altitude illness.

WHAT IS ALTITUDE ILLNESS?

Most people are unaware that ascending to altitude includes an inherent risk of becoming ill and even dying. There are many tragic stories of people dying on the mountain just because they were high in elevation. About 100 years after the flight of the Zenith, in 1978, Messner and Habler ascended Mt Everest without oxygen. They went as high as the Zenith, yet, they survived. The difference is that they allowed time for their bodies to acclimate.

The problem is *not* a lack of oxygen at altitude, as the oxygen content of the atmosphere is stable up to 10,000m+ (32,800 ft). The issue is that the pressure of oxygen decreases logarithmically as altitude increases, which causes hypobaric hypoxia (low oxygen pressure). This is the reverse effect of diving, where the pressure of oxygen increases dramatically. Altitude illness is extremely rare at elevations below 2,000m (6,500 ft).

In simple terms, we need the pressure to push oxygen into our bloodstream. If there is not enough pressure when a person is at altitude, then the body will reduce the pressure inside the vessels by lowering the levels of carbon dioxide, by hyperventilating. Unfortunately, hyperventilating removes the CO2 that drives us to breath and eventually lowers are breathing. Rate. To allow us to continue breathing fast, our kidneys secrete bicarbonate, causing people to urinate more at altitude.

Swelling

The most severe symptoms of altitude sickness arise from edema, or fluid accumulation, in the body. This can occur anywhere, including the tissues under the skin. The most severe consequences of this swelling happen in the brain and the lungs.

At very high altitude, swelling in the brain is called acute mountain illness (**AMS**), which progresses as the edema increases to be called high altitude cerebral edema (**HACE**). As edema forms in the lungs, it is called high altitude pulmonary edema (**HAPE**).

The physiological cause of altitude-induced edema is not conclusively established. It is currently believed, however, that **HACE** is caused by opening of cerebral blood vessels, resulting in higher blood flow and, consequently, higher pressures in the vessels in the brain. On the other hand, **HAPE** may be due to general vessel constriction in the lung circulation which, with constant or increased blood flow out of the heart. This also leads to increases in lung vessel pressures.

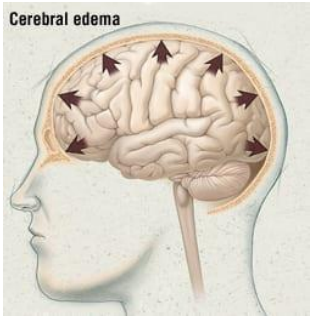
Acute Mountain Sickness (AMS)

Medical history is the key to diagnosing Acute Mountain Sickness (**AMS**) because there are no specific physical exam findings. It is vital to assess the rate of ascent and the total elevation gain. AMS is a common. It is diagnosed as a headache, and at least one of the following symptoms:

- Dizziness or lightheadedness
- Fatigue or weakness
- Nausea/vomiting/anorexia
- Insomnia

The most significant risk factors for AMS are a prior history of AMS, fast or high ascents, and obesity. Men and women and children are equally susceptible.

High Altitude Cerebral Edema (HACE)



As edema in the brain increases, symptoms become more profound, and AMS progresses to HACE, a life-threatening disease. HACE is defined as severe AMS symptoms with additional apparent neurologic dysfunction:

- Poor muscle control: this is the most common sign of HACE
- Altered level of consciousness
- Severe lack of energy: While the boundary between AMS and HACE can be blurry, HACE almost never occurs without AMS symptoms first. The progression of AMS to coma typically occurs over 1 – 3 days. HACE and HAPE are often present simultaneously.

High Altitude Pulmonary Edema (HAPE)

HAPE usually evolves over two to four days after ascent to altitude. The criteria for HAPE diagnosis are symptoms of at least two of the following.

- Shortness of breath at rest
- Cough
- Weakness or decreased exercise performance
- Chest tightness or congestion

The primary symptoms are shortness of breath at rest, cough, and exercise intolerance. The initial sign will often be a marked decrease in exercise tolerance in an individual as compared to previous days. Occasionally, frothy pink sputum is produced, but this is usually later in the illness. Mild cases may resolve within hours after a descent. In contrast, severe cases may progress to death within 24 hours, particularly if descent is delayed.

Prevention

Slow ascent is the safest method to facilitate acclimatization and to prevent any altitude illness. Current recommendations for climbers without experience at high altitude are to spend two to

three nights at 2500 – 3000 meters before a further ascent. Increases of greater than 600 meters in sleeping altitude should be avoided. One should consider an extra night of acclimatization for every 300 – 900 meters of altitude gain. Medicines can help but are no substitute for a gradual ascent.

AMS/HACE
There is a medicine called acetazolamide that can help. But going up slowly is a better way to prevent altitude illness. This medicine works by increasing the breathing rate. Since, during a hike, people are already breathing fast, its effects are felt mostly at night during sleep.

HAPE
Prevention for HAPE is to limit the ascent rate to no more than 350 meters (1155 ft) a day.

Treatment

AMS
The treatment for acute mountain sickness (AMS) is to discontinue ascent and rest. Descent is the best treatment.

HACE
The treatment for HACE is IMMEDIATE descent (almost always with assistance). This is imperative and should not be delayed. Even modest elevation losses can be helpful. In addition to descent, administering a medicine called dexamethasone can be used as you go down. Recovery with prolonged problems can last for weeks. Most who survive eventually fully recover neurologically.

HAPE
The treatment for HAPE is IMMEDIATE descent. All that may be required is 500 to 1000 meters of descent before improvement is observed. The patient should rest after a descent. No intervention should delay an opportunity to descend.

Chapter 15: Treating Water

It is not difficult or time-intensive to treat water while in the back country. Portable water purification devices are relatively inexpensive, self-contained, and are easily transported into the back country. The purpose of water purification is to eliminate pathogens that will cause symptoms and disease in humans. Water purification techniques can also get rid of toxic compounds and unpleasant tastes in the water. There are multiple methods that are all effective at treating water. It's recommended that you use at least two methods to ensure that the water is safe to drink.

To understand how to treat water, let's first review some Terms and Definitions:

Term	Definition
Purify	Removes taste, odor and smell
Disinfect	Removes or destroy pathogens
Sterilize	Destroys all life forms
Filtration	Mechanical process of forcing water through a membrane to remove pathogens
Effectiveness	Specialist companies will often advertise a certain reduction 99.99% effective, instead of sterilization. This takes into consideration a phenomenon known as light and dark repair (photoreactivation and base excision repair) in which a cell can repair DNA that has been damaged by UV light.

Achieving Drinkable Water

Water sterilization is not necessary. The goal is to remove pathogens that cause disease in humans. Water purification, besides removing pathogens, also removes bad tastes and odors. While making water more tasteful it is not essential, it makes it more enjoyable. These definitions become important as you chose the method to treat water. The public and outdoor retail stores often equate the term purification with disinfection. Advertising campaigns and promotions speak about the need to 'purify' water, when they should be saying 'disinfect.' The most common pathogens causing illness are bacteria, viruses, protozoa and parasites

Finding the Best Water

To process of making water safe to drink starts with finding the best available water. Streams can purify themselves thanks to settling, UV rays, and predatory bacteria. Settling is when the dirt and harmful particles settle out to the bottom of the stream. UV rays from the sunlight are able to damage or destroy the pathogens that can exist in the water. If no stream is around, it is a reasonable choice to skim the top layer of a clear lake because the UV rays from the sun will still have cleaned the top layer.

A slow flowing river and a pond are the worst places to get water because bacteria and parasites tend to thrive in these environments. If your only choice is to drink from a water source that isn't flowing rapidly, be aware that blue-green algae can produce toxins that can make you sick. Water treatment will not get rid of the toxins.

The single most important aspect of finding good drinking water is to get close to the source. For example, you can look for a watercourse that is draining from a large snowbank high on a steep slope. The second most important principle is to make sure the water is cold. Test the water with your hand to see if it is quite cold. Extremely cold water means it has not traveled far from its icy source. Also, look for fast-moving water.

Pre -Treatment

Once the best source of water has been found, then pretreatment might be necessary. This is done if the water has contaminants such as sediment, leaves, small twigs, or particles. It is important to understand that these pretreatment procedures do not disinfect water. Bacteria, viruses and other pathogens are found on particles in water, so removing them is essential.

Screening

The screening process is the first step in the pretreatment of water and is intended to remove the largest of the contaminants. You screen out unwanted debris by pouring water through a cloth, such as a bandana, handkerchief, or even a T-shirt into you water bottle.

Standing

This is another step that allows particles that were too small to pass through the screening material to fall to the bottom of the container.

Flocculating

This is a method of removing particulate matter that are so small they would normally stay suspended in water indefinitely. You add specific chemicals to the water that cause agglomeration of the particulates until a complex forms-up, that is large enough to precipitate. This process takes several minutes. One common chemical used is “alum,” often used in canning and pickling. It is easily found in grocery stores and is also a component of baking powder. As well, the fine, white ashes from burned wood are rich in mineral salts that can be used.

Water Treatment - Boiling

Boiling water will kill all human pathogens. Lower temperatures can be effective if the contact time is longer. However, without a thermometer, it is too difficult and risky to gauge temperature short of boiling.

The Centers for Disease Control in the United States (CDC) recommends boiling water for at least (3) three minutes if your location is above 6,562 feet (2000m). One important characteristic of boiling points is that they decrease in temperature with increased elevation. For instance, water boils at only 86°C (187°F) at an elevation of 14,000 feet (4,300m). The boiling point of water at sea level is 100°C (212°F). At this temperature, disinfection has generally occurred by the time the water boils. This is because most organisms are effectively killed at temperatures below this boiling point (see table). However, since it is difficult to determine the exact temperature of the water, boiling it for (3) three minutes is the safest way to ensure that the water has been treated.

The disadvantage to boiling is that the water is now hot and doesn't taste very good, unless you are making soup. If you are in a hot environment, it will never cool down. Another disadvantage is that the gear needed to boil water is usually heavy to carry.

Effective Times for Disinfection Using Heat

Pathogen	Thermal Death
Giardia lamblia, *Entamoeba histolytica* cysts	After 2 to 3 minutes at 60° C (140° F)
Cryptosporidium oocysts	After 2 minutes at 65° C (149° F)
Enteric viruses	Within seconds at 80° to 100° C (176° F to 212° F)
Bacteria	Within seconds at 100° C (212° F)
Hepatitis A virus	After 1 minute at 92° C (198° F)

Water Treatment - Filtering

Filters screen out bacteria, protozoa, and helminths, including their cysts and eggs. However, they are not reliable for eliminating viruses. Viruses tend to adhere to other particles, or clump together, which allows some of them to be removed by filtration. Nevertheless, because they are so small (less than 0.1 micron), that viruses cannot be eradicated by filters alone.

Because filters work by trapping small particles in their pore matrix, they clog and become less effective over time. Operating a pump as it becomes clogged can force pathogens through it and contaminate the water. Some new water filters will 'backwash' the filtering mechanism to help avoid this problem.

For practical usage, filters could be utilized as the only disinfection method in areas where human and animal excrement are low, and in watershed areas that are protected. In these situations,

recent rainwater that has landed in the middle of a trail has likely not been contaminated with human or animal waste. When uncertain, one should use an additional method of disinfection (i.e., halogenation) as a final step.

Chemical/Halogenation Treatment

Iodine and chlorine can be very effective as disinfectants against viruses and bacteria. Their effectiveness against protozoa and helminths, as well as their eggs and cysts, varies greatly. For example, while Giardia lamblia is effectively killed, Cryptosporidium cysts are extremely resistant to halogen disinfection.

However, the major problem with chemical disinfection is improper treatment by the user. Disinfection depends on both halogen concentration and contact time. Chlorine is more sensitive to these factors and is thus less suitable for cold, contaminated water. Household cleaners, such as bleach, vary widely in concentration and are not a recommended chlorine source for disinfection of drinking water as they have some efficacy against bacteria, but not viruses.

Another challenge with chemical treatment, although not as serious a problem with halogens, is their unpleasant taste. This can be remedied in several ways but must be done after disinfection. A “pinch” of ascorbic acid (vitamin C) has been shown to neutralize taste, closely matching that of distilled water. Flavored drink mixes, especially containing ascorbic acid, can also help mask the unpalatable iodine or bleach flavor.

Iodine is an effective, simple, and cost-effective means of water disinfection for people who are in the wilderness and need to treat their water. However, there is considerable concern about its potential effect on the thyroid gland. Thus, the use of iodine for water disinfection requires a risk-benefit decision based on iodine's benefit as a disinfectant and the changes it induces in thyroid physiology. By using appropriate disinfection techniques and following guidelines from the manufacturer, most people can use iodine safely. It is possible to use a much lower concentration of iodine if the contact time is longer or the water temperature is warmer.

Summary of Treatment Method Efficacy

Infectious Agent	Heat	Filtration	Chemical
Bacteria	+	+	++
Viruses	+	-	+
Protozoa and cysts	++	++	+
Helminths and oocytes	++	++	-

Ultraviolet Radiation (UVR) Treatment

UVR has recently gained popularity as a portable means of water disinfection. UV light is electromagnetic radiation. Ultraviolet (UV) rays penetrate harmful pathogens in water and destroy illness-causing microorganisms by attacking their genetic core (DNA).The effectiveness of this process is related to exposure time and lamp intensity, as well as general water quality parameters. Ultraviolet light treatment does not remove organisms from the water, it merely

inactivates them. UV light acts on thymine, one of the four base nucleotides in DNA, preventing microbes from reproducing. Without reproduction, the microbes become far less dangerous.

Water must have a low level of turbidity for UV treatment to work effectively. Dissolved organic matter, such as natural organic matter; certain inorganic solutes, such as iron, sulfites, and nitrites; and suspended matter and particles will absorb UV radiation or shield microbes from UV radiation. This results in lower delivered UV doses and reduced microbial disinfection. Thus, a pre-filter step to rid water of particles might be necessary. UV water works as well in cold water as it does in warmer water. The number of bacteria has no effect on UV irradiation.

Reactivation of pathogens is a significant risk in water that has been treated with UV irradiation. Water treated with UV radiation still contains the microbes present in the water, with their means for reproduction having been turned "off". However, if such UV-treated water containing neutered microbes is exposed to visible light for any significant period, a process known as photo reactivation takes place. To avoid ingesting reactivated and dangerous microbes, UV treated water must not be exposed to visible light for any significant period of time prior to consumption.

The other long-term disadvantage is that ultraviolet purification offers no residual treatment. Unlike chlorine which maintains a presence in the water after the treatment and continues to disinfect the water, ultraviolet radiation does not stay in the water., a chlorine compound should be added to water already purified by ultraviolet radiation. Ultraviolet radiation has several other potential drawbacks to consider. Extra batteries may be needed for longer trips, and the lights themselves tend to be fragile if dropped.

Chlorine Dioxide Treatment

This compound has shown promising results. Liquid and tablet options are becoming increasingly commercially available. It has a wider range of effective pH and often does not require more than simple mixing. Giardia lamblia and Cryptosporidium cause diarrhea in backcountry travelers. Their cysts are generally readily filtered from water, but chemical treatment of both cysts has proven problematic. Cryptosporidium is highly resistant to chlorine disinfection. Giardia cysts are much less responsive to chorine but somewhat more sensitive to iodine with high enough concentrations and contact time.

Recent studies have shown that both Cryptosporidium and Giardia inactivation will occur with chlorine dioxide treatment. Chlorine dioxide is very different from elementary chlorine. Despite the name, chlorine is not the chemical that ends up purifying the water. Chlorine dioxide releases a very reactive form of oxygen (similar to ozone) that neutralizes pathogens.

One of the most important qualities of chlorine dioxide is its high-water solubility, especially in cold water. Also, chlorine dioxide imparts a much less offensive taste than other halogens used to purify water. Chlorine dioxide has been used safely in industrial and municipal applications for over 70 years.

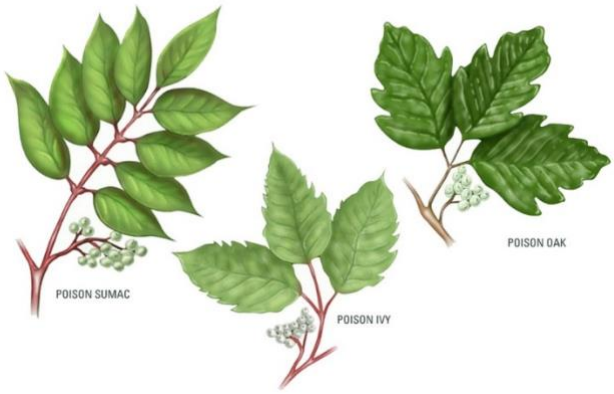
Purifying Water

Tannins and humics are natural organic matter that leach into wilderness water as plants decay, staining it a tea color. They're not harmful in small quantities, but they do impart odors and a bitter taste to the water. Using an activated carbon filter can remove bad taste and purify the water. Activated carbon has long been used in treatment devices because of its absorptive properties. Activated carbon is great for catching many contaminants that are so small they pass through a micro-filter. Simply put, it is tiny bugs or germs that are the primary focus of treatment because of their immediate and serious risk to health.

Chapter 16: Skin Problems

Things that Irritate the Skin

Poison Ivy, Oak, and Sumac



These plants all contain a toxic resin called urushiol, which is responsible for the characteristic reaction. Urushiol is contained within the leaves, fruit, root, and stem of the plant. The urushiol compound is not a defensive measure. Rather, it helps the plant to retain water. The plant must be broken open to release the resin. It is not difficult to do this, even raindrops can release the resin. Urushiol is remarkably adhesive and can cling to pets, garden tools, and clothing. Urushiol is very heat stable and can attach to smoke particle making it possible for people who burn these plants to breath it into their airway and lungs causing a frightening possibility. The toxin is resistant and last on objects for months and even years

These three plants are mostly found throughout the continental United States. In general, poison ivy grows east of the Rocky Mountains, poison oak west of the Rocky Mountains, and poison sumac in the southeastern United States. Poison sumac is much less common than poison ivy or poison oak. It has 7 to 13 leaflets on each leaf stem. The leaves have smooth edges and pointed tips. It grows as a shrub or a small tree.

The most common reaction from exposure to one of these plants is an itchy red rash on the skng that that touched the plant. The rash often includes fluid-filled vesicles or bullae in a linear arrangement. The vesicles do not contain urushiol and rupture of the vesicles does not spread the disease. In a first-time exposure, the appearance of skin lesions is commonly within 24 to 48 hours but may be delayed up to 21 days.

Avoidance of these plants is the way to prevent the rash. If you are exposed, wash the area with warm or cold water. Soap is very useful. Rubbing alcohol is very effective at getting rid of the resin. When cleansing, take special care to remove resin from the fingernails to prevent further spread of the resin.

If needed, you can apply a topical steroid cream. Rub it on three times per day directly to the rash. This will also help to get rid of the rash. Antihistamines will help also. Calamine lotion, Aveeno oatmeal bath soaks will help with the rash as well. Some people use burrow's solution or

Domeboro astringent. Most rashes will get better on their own in 1-3 weeks, but this is a long time for some to have that itching. If the rash is severe and these don't work, you might need to take oral steroids.

Zanfel® Poison Ivy Wash is a product that studies have shown to remove urushiol from the skin after an outbreak. It can provide relief of itching and pain. Zanfel works by binding to the urushiol oil, and, when rinsed off, takes the oil with it. Tecnu Extreme® works in a similar fashion.

Sunburn

Sunburn is inflammation of the skin that is caused by overexposure to the sun's ultraviolet (UV) rays. Generally, there are two classes of UV rays are clinically important in sun exposure: UVA and UVB. UVA rays penetrate the skin deeply. They damage the DNA of the skin cells, contributing to the development of skin cancers. UVB rays affect the more superficial layers of the skin and are the chief cause of skin reddening and sunburns. They also play a role in the development of skin cancer. The tanning effect of the skin is also a response to UVA and UVB exposure. Ultraviolet light is not safe for the skin. UV rays strike the skin and cause multiple effects. Skin redness appears as the local blood vessels dilate and inflammatory mediators (including histamine) are released. Fair-skinned people are particularly susceptible to sunburn because their skin produces only small amounts of the protective pigment, melanin. Even dark-skinned people, while they have a lower risk, can develop skin cancer.

The best way to treat a sunburn is to avoid one. In the wilderness, a sunburn can cause significant problems including ending someone's trip. People should limit sun exposure to eary in the day or late in the evening. Keep contact time to minimum.

Covering up is the best. Wear breathable full-length clothing, use wide-brimmed hats, and seek shade. When the sun cannot be avoided, sunscreen should be worn. Everyone six months of age and older should use sunscreen. Infants younger than 6 months of age should be kept out of the sun because their skin is thin and susceptible to burning. Sunscreens have not been approved for infants.

When choosing sunscreen, it is important to find options labeled as "broad spectrum." The FDA requires a sunscreen to effectively protect against both UVA and UVB in order to be labeled as broad spectrum. This is an important detail as UVA is implicated in the development of skin cancer and sunscreens that only block UVB rays will not afford appropriate protection.

Sunscreen effectiveness is defined by the SPF. Even though very few people know what it is, SPF is actually pretty straightforward. SPF stands for "Sun Protection Factor" and is a measure of the sunscreen's ability to protect your skin from UVB rays. The basic calculation works like this. If it takes 1 minute for your unprotected skin to start turning red in the sun, using an SPF 15 sunscreen theoretically prevents reddening 15 times longer. Let's say that someone purchases an SPF 30 sunscreen. If it typically takes 10 minutes until that person's skin starts to burn, by using the SPF 30, they are theoretically protected from the sun for 300 minutes, or 5 hours. Unfortunately,

sunscreens wash off the skin easily. Even sweat will cause them to wear away. There are no such thing as waterproof sunscreens and the definitely do not last all day.

The mainstays of therapy are pain control and skin care. Pain control can be achieved with acetaminophen or with Ibuprofen. Benadryl has shown so benefit for itching relief. Cool soaks in water, cold showers, or applying moisturizers such as aloe vera are excellent. Topical steroids show little to no benefit at all. Stronger pain medicine may be needed.

Chapter 17: Bites and Stings

There are different animals and bugs all over the world. When you travel you will be exposed to a wide variety of bites and stings. Overall, the general management of a bite or sting is the same as a typical wound. You should conduct a primary and secondary survey to ensure the scene is safe and the victim is stable Infection is common with animal bites. Bites are tetanus-prone wounds, so ensure that your tetanus immunization is up to date.

Types of Bites and Stings

Bears

North American bears include the brown bear (Grizzly and Kodiak), American black bear, and polar bears. These bears are fast (running up to 40 mph), large (140 to 1,400 pounds), and have a keen sense of smell and hearing. A bear's sight is equal or less in acuity to that of a human. Bear attacks are more common in the summer months when wilderness visitors are more numerous, and bears are not hibernating.

There are many suggestions for preventing attacks. People should make noise. There are hand clickers that can be used, but even talking will allow a bear to hear and move away from you. However, be extra cautious in environments where a bear may not be able to hear you, such as near loud streams and in uneven terrain. Bikers should avoid common bear areas, such as streams with spawning fish, berry groves, and carcasses.

Pepper spray can be useful if discharged directly at a charging bear's head when it is within thirty feet. Pepper spray is not to be used as a repellent. It is a specific aerosol bear deterrent. Its active ingredients are capsaicin. This is extremely irritating to the bear's lungs, and it will immediately retreat.

If you encounter a **brown bear**, it will likely think you are attacking it. Therefore, you should do the following:

- Do not look into the bear's eyes, as this is interpreted by the bear as a sign of aggression.
- Do not make any sudden movements and do not run.
- Do not act aggressively toward the bear. However, you should stand your ground, but be submissive.
- If attacked, quickly get into the fetal position with your neck protected, because attacking bears are "head oriented". If rolled onto your back, protect your face with your elbows.

If you encounter a **black bear**, it is likely attacking you for food. Take the following actions:

- Yell and throw things and act aggressively toward the bear. Black bears usually flee in response to aggression.
- If the black bear attacks, then you should continue to fight and kick against the bear as much as possible. The reason for this is that the bear is attacking you because he wants to eat you and has lost the fear of humans.

After a bear attack, the possibility of significant injury is high, so all bear attack victims should be considered blunt trauma victims and, therefore, candidates for immediate evacuation.

Mountain Lions

The mountain lion, also known as the cougar, puma, panther, or catamount, is a large cat species native to the Americas. The historic range of the mountain lion includes almost all North and South America. They are meeting humans with increasing frequency. They hunt by stealth, then pounce and break the victim's neck. They can be scared off by using aggressive behavior toward the animal, although this is less likely in the case of a mountain lion with a cub or one that is wounded. When confronted, face it, talk very loudly, and make yourself appear as a threat. Do not turn and run away from a mountain lion; they can run much faster and will chase you. If you have small children with you, pick them up, as they preferentially attack children. If a mountain lions attacks, fight back using anything available, including rocks, sticks, and bare fists. Be aware that they are close to urban areas as well, and attacks happen on trails used by bikers and hikers.

Snakes

The easiest way to classify snakes for medicine is by three families: **Vipers, Round Snakes, and Sea Snakes.**

		
Viper (rattle snake)	Round Snake (coral snake)	Sea Snake

Family	Classification	Description	Types
Viper	Cortalidae	Triangular head	Cottonmouths, rattlesnakes, copperheads, puff adder, gaboon
Round snakes	Elapidae	Round head	Coral, mambas, kraits
Sea snakes	Sub class of Elapidae	Found in oceans	

Snakes are found everywhere on land except the North and South Poles, the islands of New Zealand, and the islands of Hawaii. They are found in fewer numbers in places like Europe and Scandinavia. Snakes can live near the tops of mountains (Timber rattlesnake) or in grassy fields. Sea snakes are found in warm coastal waters from the Indian Ocean to the Pacific. They live in the tropical and warm regions, but not in the Atlantic Ocean, or the North American coast above the Gulf of California. All sea snakes are deadly. Knowing the location of snakes and whether or not they are venomous to humans is important medically.

All snakes have specialized salivary glands that produce saliva that dissolves animal and human tissue. This is how they digest and eat their prey. However, about 15% of snakes have taken it further and developed venomous saliva that will kill their prey.

Pit Vipers

In North America, pit vipers are found in 47 of the 48 contiguous states except for Maine. The pit viper includes multiple species of rattlesnake, copperhead, and the cottonmouth (water moccasin). Pit vipers have specific recognizable anatomy including a triangle-shaped head, catlike, elliptical pupils, and heat-sensing pits between eyes and nose. Venom is dispersed from ducts in the fangs. About 25% of pit viper bites are "dry" or without injection of venom. Pit viper venom dissolves tissue, blood, and nerve tissues. Therefore, they are very painful bites. These are painful bites with patients reporting severe burning at the bite site within minutes. Soft tissue will swell outward from the bite, and blood oozing from the bite is common. Bruising occurs as blood cells 'dissolve' and patients will feel weak. Tingling will happen in the mouth, face, and extremities as fasciculations occurs while nerve tissues are destroyed.

The treatment of viper bites is simple. Evacuate all victims of bites from venomous snakes. There is no other treatment.

Coral Snakes

Coral snakes in North America have a very distinct color banding pattern. The bite of the coral snake typically involves a finger, toe, or fold of skin, because the coral snake is unable to open its jaws wide. These are not painful bites. There is minimal or no local swelling. It may be difficult to see the bite(s). Fang marks may be difficult to identify. Symptoms will often progress rapidly once they appear. These are nausea and vomiting, headache, abdominal pain. The treatment of a Coral snake bite is evacuation for definitive care. It is a venomous snake bite and needs to be treated urgently. Evacuate without any other treatment.

Snake bite treatment has been plagued over the years with poor suggestions and very bad information that has been adopted as fact. Here a list of things to avoid because they are either harmful to the victim or do not work:

- The Sawyer Extractor™ has been touted to remove venom. This is not the case. Do NOT use this device.
- In North America, do NOT use pressure immobilization.
- Electric shock therapy should NOT be used in any snakebite and can be harmful.
- Local application of ice does not work and may make it work.
- Do NOT cut and suck on the wound, as this maneuver may infect the wound with oral bacteria and is ineffective at removing venom.
- Do NOT use a tight-fitting tourniquet that restricts arterial or venous flow.

Mosquitoes

No other insect carries more disease or is responsible for more deaths on the planet than the mosquito. According to the World Health Organization in 2015 about 3.2 billion people, nearly half of the world's population, are at risk of malaria.

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. Sometimes more than one disease will be injected into the human. So, every time an infected mosquito inserts its proboscis into the skin, that person is

infected with the disease instantaneously, 100% of the time. Thus, the only way of being infected is to avoid being bitten.

Suggestions for avoiding a mosquito bite:

- Mosquitoes are most active at dusk, so staying indoors during that time will decrease contact.
- Choose a campsite that is above and away from standing water.
- Wear clothing with long sleeves and long socks with pants tucked into socks or boots.
- Wear clothing that is tightly woven, such as nylon, and is loose fitting so that a mosquito cannot bite through the clothing.
- Permethrin is a naturally occurring compound with insecticidal and some repellant properties that will remain on clothing for weeks when properly applied.

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 Eucalypt**us. 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. You should use formulations of 30% to 35% in malaria areas on adults.

Picaridin 20% concentration has been shown to have a similar efficacy as 20% DEET for up to eight hours. Picaridin 7% has similar efficacy to 10% DEET. Picaridin has notably less malodor and less staining of materials than DEET.

Lemon Oil Eucalyptus 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.

Multiple other repellants have been studied extensively. Noteworthy among them is **IR3535**, which is marketed by Avon as "**Skin-So-Soft Bug Guard Plus**". Studies demonstrate a half-life of 20 min to 6 hrs. Overall, it's less effective than 12.5% DEET

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. Then, they clasp on with their back legs and reach their front legs out to grab onto a passing animal or human. This process is called **questing**. Ticks find their hosts by detecting animals' breath and body odors, or by sensing body heat, moisture, and vibrations.

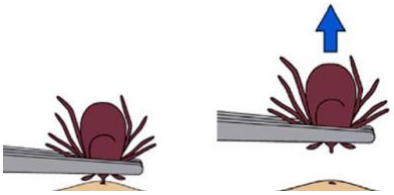
Tick species are widely distributed around the world, but they tend to flourish more in countries with warm, humid climates because they require a certain amount of moisture in the air to

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.

Ticks are second only to the mosquito for being prolific at transmission of diseases. But unlike the mosquito which transmits disease instantaneously, transmission from a tick bite can take up to 2-3 days. So, if you can remove a tick within 24 hours, your chance of getting a disease is low. It's not unheard of for ticks to be carrying three different diseases at one time, making a diagnosis difficult. Upward of 20 diseases are known to be transmitted from ticks to humans.

Prevention of ticks attaching, and frequent tick checks is the best way to prevent the transmission of disease. Know which ticks and which diseases are present in the area where you are hiking and camping.

Shirts should be tucked into pants and then pants into socks. Permethrin should be applied to clothes and DEET, should be applied on the skin. People can limit their exposure to tick bites by wearing light-colored clothing as well.



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, it does not matter. Watch for local infection and symptoms of tick-borne illness (incubation period 3 to 30 days), especially headache, fever, and rash. If you suspect that the tick may have had a disease, you should see a physician.

Hymenoptera

Hymenoptera is the order of insects that includes ants, bees, and wasps. More people die in the U.S. from bee, hornet, and wasp stings than from any other animal bites or stings. A single sting to an allergic person can be fatal in minutes to hours.

A local reaction is the most common reaction from a sting. It consists of a small red patch that burns and itches. The generalized reaction consists of diffuse red skin, hives, swelling of lips and tongue, wheezing, abdominal cramps, and diarrhea. The treatment of stings is straightforward. Scrape away the stinger in a horizontal fashion as soon as possible by any available means. Wash the site with soap and water. Place ice or a cold compress on the site. Give pain relief. Topical steroid cream can be helpful for swelling, as are oral antihistamines. If hives occur with wheezing and respiratory difficulty, then epinephrine should be given immediately. Or go straight to the hospital.

Scorpions

Scorpions are found in desert and semiarid climates between 50 degrees north and south latitude. Most scorpion stings result in only local pain and inflammation. In the United States, the most

medically important scorpion is the bark scorpion (genus Centruroides); found primarily Arizona and New Mexico.

The treatment of a scorpion sting is to clean the sting site with soap and water. Ice should be used if available. There are studies that suggest ice will help to neutralize the pain. For the vast majority of stings, this is enough. If the scorpion is identified as a bark scorpion evacuate as soon as possible, because the victim may decompensate rapidly. The need for evacuation is more significant in children and elders.

Chapter 18: Eating Right

Fueling your body properly is a key part of any hike. If you have a strong stomach and you're only going on a short hike, you can eat almost anything. Head out for multiple days, however, and you'll want to plan more for proper backpacking nutrition. Improper nutrition can lead to bonking (where your body crashes due to a lack of energy), hunger, dehydration, and a plain bad time. When you give your body what it needs, you'll feel strong and comfortable on the trail. Follow these rules of backpacking nutrition, and you'll be at your hiking peak:

Fuel with Carbs

You should eat 30 to 60 grams (120 to 240 calories) of carbohydrates per hour when hiking

Eat a lot when you are in the backcountry. It is no time to diet. What do you eat? Carbohydrates are the body's preferred primary energy source while hiking and backpacking since they're easier for your body to process than fats or protein. We use glucose exclusively for quick muscle contraction movements such as jumping, running, climbing, and forceful paddling. Backpacking nutrition wisdom holds that you should eat 30 to 60 grams (120 to 240 calories) of carbohydrates per hour. This will keep you going. It will improve strength and endurance and delay fatigue and hitting the 'wall.' If you don't consume enough carbohydrates, the body will burn muscle protein and stored body fat. You will feel weak and might not make your goal.

A few examples of good carb choices while hiking are energy gels, shot blocks, sports drinks, dried fruit, protein bars and candy bars. Great sources of carbohydrates to include in your eating patterns prior to hiking include whole grains such as brown or wild rice, quinoa, oats, and whole grain pastas/breads; starchy vegetables such as potatoes, peas, and winter squash; beans, legumes, and lentils; and fruits of all kinds. That is because we can store a lot of energy in our muscles and liver and blood before a hike.

It may be difficult to consume as many carbohydrates as recommended, and it's important that your diet is composed of a variety of nutrients, not just carbohydrates. Adjust your diet appropriately and focus on timing of meals. Make sure to eat before, during, and immediately after physical activity and always keep some easily digested carbohydrates in your 24-hour kit/backpack such energy gels, honey, jelly, and hard candies.

Consume Electrolytes

You should drink electrolytes, not just water.

You should drink electrolytes, not just water, particularly when you are in the heat. As the temperatures rise, not consuming enough electrolytes can be devastating to your performance. For performance levels to remain high, you need to replenish sodium, chloride, potassium, magnesium, manganese, and calcium on a consistent basis. High water intake without electrolyte replacement over many hours will not be enough. It can lead to hyponatremia. This can be a life-threatening condition where your body doesn't have enough salts to function.

Electrolytes help retain fluid by drawing water into cells. An electrolyte supplement or sports drink with electrolytes is beneficial if you are drinking a large volume of fluid, and/or sweating heavily.

This is especially important for rehydration following exercise. To avoid electrolyte imbalance, you need to consistently replenish by consuming salty snacks such as pretzels, salted nuts, or salted chips or drink electrolyte replacement sport drinks. If you are going to treat water as your primary water source, you can add electrolyte supplements.

Eat for Recovery as Soon as you are Done

There is a 30 to 45-minute post-exercise window when your body is especially receptive to replenishing and repairing muscle tissue. A 4:1 ratio of carbohydrates to protein is ideal. The carbohydrates replace lost muscle sugar (glycogen) and protein provides amino acids to repair the muscle tissue. Powdered sports recovery drinks are a good option because they are in a powdered form and have everything tired muscles need. Really any whole foods are great.

Yes, Drink Before you Feel Thirsty

We don't think of it this way, but hydration is a part of nutrition. Thirst is an early symptom of dehydration. By the time the thirst response is activated, you're already 2 to 3 percent dehydrated. This will diminish endurance by 10 percent. Start your hike hydrated by consuming 14 to 22 ounces of water about 2 hours before exercise. During the hike, drink to thirst. A good goal is to drink 6 to 12 ounces of water or sports drink every 15 to 20 minutes. Recover by drinking 16 to 20 ounces of water or sports drink every hour for a few hours after the hike to fully rehydrate.

Chapter 19: Assembling a First Aid Kit

A frequent and relevant question asked in wilderness medicine is the type of first aid kit one should bring on a trip. It depends! This chapter covers helpful guidelines to assist us in choosing the appropriate items for that planned trip.

General Guidelines

General guidelines include asking yourself several questions to identify important aspects of your trip, such as:

- What type of activity or sport will your group engage in on this trip?
- How long is the trip going to be?
- How big is the group?
- Is this a group kit or your own individual kit?
- How far are you from help, and how easy will it be to evacuate if needed?
- What diseases are endemic to the area you're going to?
- What are the diseases and known conditions of the participants who are going?
- How far away from definitive care will you be on your trip?
    - For example, a backpacking trip of seven days over high, mountainous terrain far from civilization requires a medical kit that is lightweight and contains items that can treat emergencies related to high-altitude illness, cold exposure, trauma, geographically specific infectious diseases, and avalanches.
    - In contrast, a one-day river trip near a highway where weight is less of an issue and evacuation may be aided by a nearby vehicle would be entirely different. You would want items to treat emergencies related to water sports, cold exposure, and trauma.

Pre-Made Medical Kits

Premade medical kits are filled with items to cover general cuts and scrapes. They are not specific enough to cover a broad array of injuries. First aid kits tend to emphasize treatment, but they also deal with prevention items, such as water treatment material and gloves. First aid kits should emphasize improvisation and multiple uses. For example, duct tape can be used for numerous issues rather than one specific issue. If you are aware of the medical condition of the participants and recognize endemic or common diseases in the area, you can take the appropriate medicines with you.

Containers

Containers for first aid kits will vary along with the contents. For example, a six-day trek over mountainous terrain far from cities will require a medical kit that is lightweight and contains items that can treat emergencies related to high-altitude illness, cold exposure, trauma, and geographically specific infectious diseases. A three-day river trip with four young, healthy people can be in a metal container, it can be more substantial, and can contain items to treat abrasions as well as items for a twisted ankle and splints.

Many commercial kits are available and carry essential supplies and equipment but do not contain prescription medications. Making your own kit is an option and can save money. Either way, you will need to adjust and bring items that pertain to the specific activities and location planned.

PAWS

Though it's not practical to list each item that should go in every type of medical kit, some general items are helpful to have. The acronym PAWS is an excellent way to remember the category of items to include in a first aid kit.

P	Prevention / Procedures
A	Analgesics / Antibacterials / Antiseptics
W	Wound care
S	Survival

Prevention/Procedures

Prevention

These are items for the prevention of illness and potential problems:

- Water filter and water purification tablets
- Gloves
- Sunscreen/lip balm
- Sunglasses
- Blister prevention and treatment
- Insect repellant and barriers (netting / treated clothes)

Procedures

There are specific tools of your trade that may be used in a variety of situations:

- Wound care material: steri-strips, tape, gauze, Medi-honey, sutures, etc.
- Scissors
- Dental repair material: Cavit, eugenol, etc.
- Blood pressure cuff and stethoscope
- Flashlight
- Syringe
- Flexible splints
- Safety pins
- Needles
- Tweezers

Analgesics, Antibiotics, Anaphylaxis

There should be medicine available in each kit that covers pain and infection that could be encountered. You should know what diseases are common in the area you're headed. As well, you should know the diseases and chronic conditions of the people traveling in your group.

Analgesics

Tylenol (also called Paracemetol and Acetaminophen) belongs to a class of drugs that relieves pain and lowers fevers. It does not prevent the clotting of blood, so it is safe to use in head injuries.

Aspirin prevents blood from clotting, which promotes bleeding. Therefore, it should not be used in any kind of head injury. Aspirin, also known as acetylsalicylic acid (ASA), is a medication used to treat pain, fever, and inflammation.

Ibuprofen is used to relieve pain from various conditions such as headache, dental pain, menstrual cramps, muscle aches, or arthritis. It is also used to reduce fever and to relieve minor aches and pain due to the common cold or flu. Ibuprofen is a nonsteroidal anti-inflammatory drug (NSAID). It works by blocking your body's production of certain natural substances that cause inflammation. This effect helps to decrease swelling, pain, or fever.

Antibiotics

Select antibiotics that cover a broad spectrum of pathogens. Here are some common broad-spectrum antibiotics to consider taking:

- Doxycycline: lung, skin, and tick/mosquito-borne infections
- Cipro: HEENT, enteric, lung, skin, and urinary infections
- Amoxicillin /clavulanic acid: HEENT, lung, skin, enteric
- Azithromycin: HEENT, lung, skin, enteric organisms

Anaphylaxis

Anaphylaxis is one of the true medical emergencies that one may see in the wilderness. You should always be prepared to treat an anaphylactic patient.

- EpiPen®
- antihistamines
- albuterol inhaler
- oral steroids
- Ranitidine

Wound Care

Regardless of the activity, abrasions and lacerations are among the most commonly experienced injuries. As a result, appropriate and adequate supplies for wound care are one of the essential parts of a medical kit. Having each person on the trip bring their own necessary wound supplies will help to ensure that enough wound care supplies are available. Below are different treatment options for primary wound care:

- Gloves
- Alcohol swabs, antiseptic wipes
- Gauze
- Steri-strips, benzoin
- Tape
- Ace bandages
- Irrigation equipment
- Band-aids
- Antibiotic ointment, Medihoney
- Gauze wrap
- Q-tips

Survival

The potential for the group members to be separated, and other worst-case scenarios need to be considered. Below is a list of items each group member should carry at all times.

- Map, compass, knife, fire starter, matches
- Communication equipment: satellite phones
- Space blanket
- Knives