Preventing Injuries and Illnesses in the Wilderness

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KEYWORDS

• Wilderness • Injury • Travel • Review
• Adolescents • Prevention

Getting away for the weekend, summer wilderness trips, and organized outdoor outings are becoming increasingly popular. These outings provide a way to decompress from the stresses of routine family life, school, and work while enjoying the benefits of exercise and experiencing the beauty of nature. It allows families, friends, and peer groups to spend time together, often in challenging and educational settings. The wilderness also can be fraught with dangers under the best of circumstances. Trouble is foreseeable when teenagers are placed in this setting who have the drive to explore and test their limits while pushing their physical capabilities at a developmental time when they are both impulsive and have a sense of invulnerability.

Some of the concerns for the practitioner to consider include potential injuries and illnesses that occur during various wilderness experiences and the frequency with which they occur, as well as the age, gender, medical or psychological conditions that place youth at greater risk. This article focuses on common injuries and illnesses as well as dangerous scenarios encountered in the outdoors. The authors emphasize the need for greater understanding, education, and preventive measures regarding youth trips into the wilderness.

EPIDEMIOLOGY

The 2000 National Survey on Recreation and the Environment surveyed over 57,000 individuals who were 16 years of age or older across the United States.[1] It found that 97% of Americans had participated in outdoor recreation activities in the past year. Hiking, backpacking, and developed (family or group campgrounds) camping

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experiences had increased significantly, with an estimated 72 million people hiking in 2002 and 24 million backpackers spending an average of 17 days per year in the woods.

There are limited data about the morbidity and mortality associated with such activities. Most data in the United States comes from the National Parks Services, organized outfitters such as the National Outdoor Leadership School (NOLS), and surveys of hikers on major trails. Because research on wilderness injuries is limited to descriptive studies, determining accurate injury rates are difficult.[2] The literature is also limited in children and teens. Many of the studies in adults are consistent, however, and some data can be extrapolated to youth.

In a 1987 to 1988 study of 224 hikers who successfully hiked the entire 2100-mile Appalachian Trail,[3] 82% responded to a 3-page survey regarding their experience. Eighty-two percent of the respondents reported an injury or illness, with the most common injuries being extremity or joint related. The loss of at least one day of hiking from an illness or injury occurred in 52% of hikers, diarrhea in 63% (only 7% drank exclusively from protected water), and foot blisters in 7%. Hypothermia or frostbite was reported in four hikers, hospitalization in three hikers, and one hiker reported being struck by lightning. The most frequent allergic reaction was caused by insect bites.

Ten years later, in a 1997 prospective study of 334 hikers on the Appalachian Trail who had planned to hike at least 7 days or longer, complete data were obtained from 280 respondents.[4] The most common medical complaints included feet blisters in 180 (64%), diarrhea in 156 (56%), skin irritation in 143 (51%), acute joint pain in 102 (36%), sunburn in 72 (26%), tick bites in 68 (24%), dehydration in 55 (20%), heat exhaustion in 13 (5%), and hypothermia in 13 (5%) of the participants. The risk of diarrhea was significantly greater in those who reported that they frequently drank untreated water from the streams or ponds (odds ratio [OR] = 7.7; 95% confidence interval [CI]: 2.7 to 23; $P<.0001$). In contrast, routine washing of cooking utensils and hands after bowel movements was associated with a significantly decreased risk of diarrhea (OR = 0.46; 95% CI: 0.22 to 0.97; $P = .04$). Eighty-eight hikers (31%) did not complete the hike as expected, with reported reasons of injury, time limitations, and psychosocial problems.

In the NOLS study (1999 to 2002), involving 1679 students and 233 staff, 678 injuries were reported, of which 50% were from sprains and strains of knees, ankles, and back (most commonly caused by falls, slips, and overuse factors). Thirty-one percent were from soft tissue injuries including burns, blisters, wound infections, and stings. There were 549 illnesses reported, of which 26% were gastrointestinal and 17% were respiratory.[5]

In a 2-year US National Parks study, children and adolescents ($\leq$19 years of age) accounted for 13% of the 356 deaths.[6] Adolescents made up 23% of search-and-rescue operations in Alaska's National Park Service units that resulted in a death.[7] In a study of the California-based National Parks Service, children and adolescents suffered disproportionately more with hypothermia, diarrhea, and noninsect anaphylaxis.[8] In a 5-year study in five contiguous counties in western Washington State, there were 40 wilderness recreational deaths among children and adolescents aged 12 months to 19 years, of which 34 occurred in teens 13 to 19 years of age.[9] Most deaths were associated with hiking, swimming, and river rafting, with the youngest children experiencing drowning and closed head injury as the most frequent cause of death. In 27 of the 40 deaths, youth were lacking in basic preparedness including inadequate clothing layers and the absence of life vests. In another study of wilderness injuries in Mount Rainier and Olympic National Parks in Washington State over a 5-year period,

there were no youth deaths, but almost 25% of those injured were under the age of 18 years. Children sustained more injuries during the winter months compared with adults, emphasizing the importance of cold weather preventive measures.[10]

In a study from a nationally representative sample of emergency department visits for outdoor recreational injuries over a 2-year period, 52% of 212,700 injuries per year were in 10- to 24-year-olds, and 68% were males. Fractures and sprains were the most common injuries.[11] The epidemiology shows that illness and injuries in the wilderness are prevalent among children and adolescents and that this population is at a greater risk for certain types of injuries compared with adults. Education, preparedness, and prevention efforts will be necessary to help minimize these events as the popularity of wilderness activities grows.

PREVENTION OF INJURIES AND ILLNESSES

Injury prevention has the potential to make a significant difference in decreasing the number of child and adolescent wilderness-related incidents, although more rigorous study is needed. The NOLS has introduced significant programmatic changes that include providing fitness information to their students in their enrollment packets; reducing backpack weights; carefully planning wilderness courses; and stressing the importance of good camp hygiene, hand washing, and disinfecting drinking water. NOLS was able to document a decrease in injury rate from 2.3 incidents per 1000 program days from 1984 to 1989 to 1.07 incidents per 1000 program days from 1999 to 2002, and an illness rate dropping from 1.50 to 0.87 incidents per 1000 program days during the same time period.[5]

Preparticipation Evaluation and Anticipatory Guidance

Many youth seek a medical visit before a wilderness experience to make sure their immunization status is up to date or to obtain travel medications such as antidiarrheals, antibiotics, or analgesics. Often a preparticipation evaluation is required by sponsoring organizations to decrease liability. While the benefits of such a preparticipation evaluation are being further evaluated,[12] physicians should take this opportunity to question children, adolescents, and parents, about their wilderness plans, to assess their preparedness, and to provide anticipatory guidance to help youth and their families avoid preventable injuries and illness.

Although most teens will have no significant medical conditions, one cannot assume this for all. Identifying risk factors or pre-existing medical and mental health conditions or a lack of physical fitness is important for their safety and for the group with which they may travel. It is important for youth to be able to accurately assess and have realistic expectations regarding their physical abilities and experience level when preparing for a wilderness trip. Gender and age, periods of rapid growth, poor coaching, poor dynamic balance, and previous injury are associated with an increased risk for sports injury.[13] There is some evidence in the sports literature that life stress can be a strong predictor of injury.[14] Fears such as that of heights or claustrophobia are better addressed before confronting these dilemmas on mountains or in caves, where the situation could become frightening or dangerous.

Educating youth about the need for certain protective equipment and the signs and symptoms of dehydration, altitude sickness, hypothermia, and other risks potentially can prevent injury and illnesses. There is evidence in the sports injury literature that supports preseason conditioning, functional training, and strength and balance programs.[15] There is sufficient evidence that health care providers should be recommending clean drinkable water by filtering, chemicals, or boiling. Lack of adequate

protection from the sun and lack of clean water can lead to sunburn, heat exhaustion, and heat stroke. It seems prudent to recommend appropriate clothing and attention to weather conditions, because cool temperatures, winds, rain, and exhaustion can lead to hypothermia. A suggestion for a first aid kit that includes simple dressings, Band-Aids and analgesics seems reasonable. Because of the high incidence of gastrointestinal distress, hikers may benefit from carrying antacids and antidiarrheals. International trips may require additional vaccinations, medications, and water purification supplies. It is imperative to have information available regarding necessary travel medications and informational brochures for commonly visited international destinations.

Basic Survival Skills

Safety starts with having a well thought out plan regarding the trip, necessary gear, and potential problems. The type of trip, including location, length of travel time, risk of illness or injury, and distance from rescue or medical access, have a major impact on and should dictate the type of equipment and supplies that are necessary for a wilderness trip (**Table 1**). Having extra food and a plan for bringing or accessing water will help if delays occur. Getting lost is always possible and so it is safer to travel with at least one buddy and inform friends or family of detailed travel plans. Basic wilderness skills include knowing how to read a contour map[16] and how to align it with a compass' north direction to find one's way.[17] More recent rescue tools include cellular phones (if cell towers are available) and global positioning satellite (GPS) units. New technology, however, can lead to a false sense of security, and basic map reading and survival skills are essential for anyone venturing into the wilderness.

PREVENTION OF SPECIFIC CONDITIONS

Hypothermia, Trench Foot, and Frostbite

Hypothermia is the number one killer in the wilderness, with over 700 people dying each year in the United States.[18,19] It results from the lowering of body temperature at a rate faster than the body can generate heat that interferes with the body's ability to regulate basic functions. It is often caused by a lack of warm clothes or rain gear given weather conditions. Additive factors include the sudden wetting of the body by rain or falling into water with aggravation by wind and exhaustion. Hypothermia starts with core temperatures dropping to 35.5°C (96°F) when shivering is apparent and progresses to mental status changes with core temperatures from 35° to 32°C (95 to 90°F). Muscle rigidity with the loss of fine motor skills, physical collapse, and unconsciousness occurs at 32° to 30°C (90° to 86°F), and death occurs from cardiac arrhythmias at temperatures less than 25°C (77°F).

Trench foot is caused by many hours of wet or damp conditions at a temperature just above freezing and can cause difficulty walking, numbness, and eventually, gangrene. Severe frostbite of exposed fingers, toes, ears, and the nose results from tissue necrosis caused by vasoconstriction and venous thrombosis.[20]

Prevention measures include following weather reports and avoiding bad weather conditions. It is important to stay dry, because wet clothes, in particular cotton and down feathers, lose up to 90% of their insulation properties when wet, and it can be nearly impossible to dry these items if the weather does not cooperate. When it is getting cold, avoid wind, because it rapidly carries away body heat and can result in hypothermia. It is best to remove wet clothing when possible, because it pulls heat away from the body.

Winter brings special challenges, and appropriate clothing becomes critical for survival. Layering of clothing provides better temperature control, because air

Table 1
Equipment: packing considerations for a wilderness trip[a]

Upper body	T-shirts (cotton, synthetic), long sleeved shirts (light/medium weight), jackets (fleece, waterproof shell, goose down/synthetic down)
Lower body	Underwear (short/long, light/midweight), shorts, pants (hiking, fleece, waterproof shell, snow, goose down/synthetic down)
Head	Hats (synthetic, baseball cap, warm, windproof), balaclava, face mask, glasses (sun, prescription), ski goggles, bandanas
Hands	Lightweight gloves/liners, heavyweight gloves or mittens, chemical hand-warming packets
Feet	Socks (liner, wool, light/heavyweight), shoes (walking, trail), hiking/climbing/mountaineering boots, vapor barrier socks, down booties, chemical foot-warming packets
Sleeping	Sleeping bags (light/heavyweight), tents and camping related gear, foam mats: comfort/warmth, lightweight air mattress: comfort/warmth
Climbing gear	Shoes, harness, trekking poles, snow shoes, crampons, ice axe/tools, technical climbing equipment
Food	Water purification, meals (fresh, dehydrated), energy bars/gels/drinks, Gatorade/electrolyte replacement powder, snack food
Accessories	Backpack/travel bags, tent/camping equipment, padlocks, waterproof stuff sacks, duct tape, maps, compass, headlamp/flashlight/lanterns, multipurpose knife/tool, watch/alarm clock, repair kits (sewing, gear), lighter, matches (flint), water bottles, cooking equipment, sunscreen, bug spray, plastic/zip-lock bags, binoculars, trash bags, books, playing cards, ear plugs, camera, first aid kit, medications, international travel accessories

[a] Dependent on the extent of the trip and expected weather conditions.

between layers provides insulation. Additionally, layers are easy to add and remove when weather conditions change. There are four clothing layers to consider: inner layer, middle layer, insulation layer, and outer layer. The preferred inner layer is light or midweight short or long underwear that wicks sweat from skin during high aerobic activity to stay comfortable without being damp. It also provides extra insulation. Unfortunately, while cotton is comfortable when dry, it absorbs and holds sweat and takes a long time to dry. The preferred underwear is polypropylene, other new synthetic fabrics, or silk, with silk being the least durable. Midlayer clothing includes protection in moderate-to-warm conditions and includes long pants, long-sleeved shirts, shorts, and T-shirts. They should be lightweight, comfortable, and durable. The next insulation layer includes clothing (vests, jackets, pullovers, and sweaters) that provides additional warmth when conditions warrant. Ideally, they should be warm, lightweight, not too bulky, and breathable (ie, allow sweat and excess body heat to escape). Wool, pile, and fleece are common insulation layers that retain some insulation capabilities even when wet. The outer layer of clothing protects from wind, rain, and snow. This clothing should not be too bulky, heavy, or interfere with outdoor activities. Ideally, waist, cuffs, underarm, and neck region with a hood for the head can be sealed to keep out elements or opened for additional ventilation. Lots of pockets help for storage. These items should be breathable to keep the user dry and warm. Rain gear made of polyvinylchloride (PVC) is inexpensive and waterproof but not breathable. Fabrics like GORE-TEX are more expensive but do a good job at being both waterproof and breathable.[21] Nearly all waterproof material is less breathable than other fabrics. It is important to notice excessive sweating and overheating while wearing waterproof clothing and understand that if the weather suddenly turns cold, hypothermia is a serious risk if additional clothing is not available.

Boots should be insulated and waterproof to keep feet dry. Wearing two pairs of socks, one a liner sock and the other an outer, wool sock, will help provide insulation and wick perspiration away from the feet. Simply pulling trouser legs or using gaiters over the top of boots will block water, snow and rocks from getting into boots. Mittens are warmer than fingered gloves, although they decrease dexterity. Chemical hand and foot warmers are inexpensive and should be considered for winter outings. Wearing a warm hat, scarf around the neck, and ski mask over the face will reduce heat loss significantly.

The treatment of hypothermia is to reverse the process and rewarm the entire body when the hypothermic person is in a safe place. This can include a warm bath of 38° to 43°C (100° to 110°F) or wrapping the victim in a warmed sleeping bag with another person. If conscious, it is critical to give hot, sweetened drinks.

Lightning Safety

There are over 2000 thunderstorms in progress above the earth's surface at any given time, which amounts to approximately 8 million lightning strikes each day. Lightning travels as fast as 100,000 miles a second and lasts from .01 to .0001 second. There are approximately 500 human lightening strikes per year in the United States, resulting in 50 deaths. Although uncommon, these events are severe, and survivors often experience significant disabilities.[22] To estimate the distance from a lightning strike, count seconds from lightning to thunder, and then divide the number of seconds by five to get the distance in miles. Seek shelter when lightning is separated from thunder by 30 seconds or less, or approximately 5 to 6 miles away. Resume activities 30 minutes after lightning has passed.

Always monitor the weather, and if lightning is predicted or a storm is approaching, avoid mountain ridges, summits, drainages, shallow caves, open fields, isolated trees,

and rappelling down mountainsides. Remove and avoid metal objects like fences, posts, bikes, and small boats that can conduct electricity. Run to the nearest safe building, vehicle, or lower stand of trees or scuba dive if on the water.

Sunburn

Natural sunlight contains ultraviolet (UV) photons UVB and UVA. These photons strike the skin and generate free radicals that damage DNA. Damaged DNA releases prostaglandins and cytokines, which lead to dilation of cutaneous blood vessels and recruitment of inflammatory cells. Sunburn is an acute toxic reaction to UV radiation that causes cutaneous edema, redness, swelling, pain, and peeling of the skin. It can cause systemic symptoms including itching, fever, and nausea. UV radiation in excess can cause first- or second-degree burns. It often takes 4 to 6 hours after excessive sun exposure for symptoms to develop.

Certain antibiotics, oral contraceptives, and tranquilizers sensitize some people to sunburn. Those with fair skin or freckles have a greater risk. Sunburn can occur at all temperatures, and it occurs significantly faster at higher altitudes. The sunlight also reflects off of snow, ice, and water. It is necessary to put sunscreen on parts of the body where the reflections of the sunlight hit, such as in the nostrils, under the chin and on the palms of the hands. The DNA damage caused by UV light is irreversible and increases the risk for skin cancer and premature aging of the skin. Melanoma is 20 times more common in whites than in African Americans and four times more common in whites than in Hispanics.[23]

Eyes are sensitive to sun exposure, and over time this can lead to cortical cataracts and pteryglum. Pteryglum is a fleshy tissue that grows in a triangular shape over the cornea and may interfere with vision. It is common throughout the world, with highest rates seen in tropical countries near the equator. Sunglasses should block out 99% to 100% of UVA and UVB radiation.[24]

The best protection against sunburn is to use long-sleeved clothing and hats, avoid sun exposure between 10 AM and 4 PM, and use sunscreen. Sun tanning can prevent sunburn, as it increases melanin, a photoprotectant pigment. Unfortunately, tanning beds have less UVB and more UVA, and excessive tanning has been associated with an increased risk of melanoma.[25] Using sunscreen prevents squamous cell skin cancer, while the evidence for preventing melanoma is mixed.[26] Sunscreens contain organic molecules and pigments that absorb, scatter, and reflect UV radiation. It is best to use broad-spectrum sunscreens against both UVA and UVB. Sun blocks differ from sunscreens in that they block all sun exposure and contain either zinc oxide or titanium dioxide but can be irritating to the skin. Sun Protection Factor (SPF) is the time needed for UVB radiation to cause minimal erythema with sunscreen versus no sunscreen based on 1 oz of sunscreen lotion applied to an average adult's entire body surface; SPF 10 blocks out 90% UVB and SPF 20 blocks out 95%. In general, one does not need more than SPF 20. It is best to apply sunscreen 15 to 30 minutes before exposure, reapply 15 to 30 minutes after exposure, and then every 2 to 3 hours. Use waterproof formulations for water-based activities and plan on reapplying after 80 minutes in the water. When at higher elevations or on snow or ice, sunscreen should be reapplied every hour. Lip balm with SPF 15 or greater should be used to prevent sunburned and chapped lips.

Most first-degree sunburns resolve with time and may only need symptomatic relief. Lidocaine or benzocaine spray or ointment can help with pain. Hydrating the skin with aloe vera or vitamin E, which also reduces inflammation, improves comfort. Hydrocortisone cream may reduce inflammation and itching.

Dehydration, Heat Exhaustion, and Heat Stroke

Maintenance fluids are needed to replace approximately 1.5 L of urine per day and additional 1 L of water loss from respiration, perspiration, and stool. In a typical day, one needs about 2 to 2.5 L (or eight 8 oz drinks) of fluids to maintain adequate body fluid levels. Fruits and vegetables contain significant water and count toward maintenance fluids. Extreme weather conditions and high levels of exertion lead to significant on-going water and electrolyte losses from perspiration and breathing. At high levels of activity and extreme hot or cold temperatures, it may be necessary to drink up to 1 L of fluid/h, often a difficult task.

Usually, the body is able to cool itself by sweating. When unable to replace fluids, heat exhaustion can progress to life-threatening heat stroke as core temperature rises. In 2001, there were 300 deaths in the United States related to excessive heat exposure.[27] Preventive measures include scheduling activities before 10 AM or after 4 PM, when it is cooler outside. Young children and some adolescents will be more sensitive to heat, and care must be taken to avoid heat-related illness. It is best to wear loose-fitting clothes, drink sufficient fluids, and be aware of the first signs of dehydration including thirst, muscle cramps, fatigue, and lightheadedness.

Treatment measures for heat-related illnesses include reducing the body temperature by washing with cool water, taking sips of water, finding cooler or shaded areas, and evacuation, when possible. Having packets of oral rehydration salts or powdered sports drinks on hand will help to replace electrolyte losses, as long as clean water is available.

Traveler's Diarrhea

Traveler's diarrhea is commonly experienced in the wilderness. Having access to potable water is critical. Two liters of water only cover maintenance fluids, so additional water must be carried or be available along the route while hiking or traveling. Unfortunately, streams and lakes can have debris, dirt, and infectious agents such as *Giardia, Cryptosporidium, Shigella, Salmonella,* and *Entamoeba*.

There are four ways to avoid contaminated water:

1. Bring sufficient potable water
2. Use a commercial lightweight hiker's water filtering system that will significantly reduce particles, organisms, and sediment and make water taste better
3. Boil water for 1 minute to kill all microorganisms (although this does not neutralize chemical pollutants, and water needs to cool before it can be used)
4. Use chemical tablets, typically chlorine purification tablets; 1 tablet per liter or 32 oz bottle (kills microorganisms in 30 minutes).

Good hygiene, including hand washing with soap and water, and using antiseptic alcohol spray or gels, also reduces the risk for infection and should be practiced after going to the bathroom and before drinking and eating.

Blisters

Hiking on hard, rough terrain for miles is hard on the feet. Blisters can occur randomly, in any season, and with most activities. Early hot spots should not be ignored. Significant blisters can derail a trip.

The skin has three layers: the epidermis, subdermis, and subcutaneous tissue. The epidermis, which is avascular, has five layers: stratum corneum, stratum lucidum, stratum granulosum, stratum spinosa, and stratum germinativum (or basale). Most blisters form between the stratum germinativum and stratum spinosa of the epidermis due to horizontal shear forces that cause delamination and fluid leaking into the space.

To prevent blisters, feet should be kept dry and clean. Feet can be conditioned by walking barefoot to toughen the skin. New hiking shoes or boots should be well broken in, ideally for at least 3 months, before any long hikes or hiking trips. Toenails should be trimmed. Synthetic socks wick excess moisture away from the surface. The goal is to create weaker shear layers between the skin and sock, between multiple socks, or between the sock and footwear. Two socks are recommended.

Once blisters have formed, collagen, the principal protein of connective tissue, is necessary for healing. If the top layer of the blister is left intact, the damaged area remains moist and heals. If the top skin is removed, the damaged area must be kept moist. If the blister is left unbroken and pressure continues, pain and more delamination continue. If the blister is punctured, in most cases it will refill with fluid, and the risk of infection is increased.

If a blister has occurred and the trip is over, it may be best to leave the blister intact. To complete a day hike, the blister can be drained with a sterile needle and the skin around the blister can be padded with moleskin or similar fabric. To complete a multiple-day hike, the blister can be drained, covered with Second Skin (Spenco Medical Corporation, Waco, TX, USA) or a petroleum-based ointment and gauze, and secured in place with a porous cloth tape.

Sprains, Strains, and Fractures

Injuries can usually be traced to:

Bad judgment about using (or not using) equipment
Bad judgment about one's performance or ability
Weather-related hazards
Equipment failure.

Lower extremity injuries such as knee or ankle sprains most often result from falling and tripping in the wilderness. The 175,000 anterior cruciate ligament (ACL) knee injuries per year are usually sports related and occur frequently in active, healthy 15- to 24-year-olds. The cost of ACL reconstructive surgery, not including initial evaluation or rehabilitation, is just under $1 billion per year in the United States.[28] More serious injuries can lead to concussions and even death.

It is important to match the necessary physical conditioning for the planned activity. Training and physical conditioning techniques are numerous, with both resources, as well as methods that lack scientific evidence, available in bookstores and online. The training process ideally should be accomplished gradually over a longer period of time. Time to train is not always available. Shorter training periods are typically adequate to get into shape for so weekend trips. More extensive training should be undertaken for long wilderness trips (more than a week) or expeditions. Consultation with a nutritionist and personal trainer can help when working toward reaching specific training goals. The necessary gear depends on the wilderness endeavor, but needs to be available, in working order, and fit appropriately, well in advance of the planned trip. Examples of necessary gear include life jackets for water activities and helmets for biking or rappelling (see **Table 1**). Fortunately, gear has gotten lighter, more durable, and accessible locally or on the Internet.

Bites and Stings

Most insect, bee, and wasp bites cause a localized reaction and can become infected from scratching. If there has been previous exposure, anaphylactic shock is possible and can be life threatening. Mosquitoes also are known to carry arboviral

encephalitides such as West Nile virus and equine encephalitis, malaria, dengue fever, and yellow fever. Ticks can carry Lyme disease, Rocky Mountain spotted fever, and tularemia. Fleas can harbor plague.[29]

Netting and long-sleeved clothing help to prevent insect bites. Avoid going outdoors during dawn and dusk when mosquitoes are most active and use an insect repellent such as 30% to 50% DEET (N,N-Diethyl-meta-toluamide) or 15% picaridin. DEET provides longer protection and needs to be applied less often. Clothing also can be sprayed with repellent. Permethrin can be applied to clothing and bed netting to repel insects. Avoid walking around barefoot. If stung and the stinger is still present, it can be removed by scraping. Apply cold to reduce swelling.

The best way to remove ticks is to grasp them as close to the skin as possible and pull out with steady pressure. An antiseptic (>60% alcohol) should be used afterwards on the hands and bite area. Do not use petroleum jelly or burn the tick.

All vaccinations should be up to date. If traveling outside the United States, check the Centers for Disease Control and Prevention Web site and make health care appointments in sufficient time to allow immunizations to produce antibodies to become effective.[30]

Teenage boys have a perilous attraction to snakes (and small rodents). Fortunately, the risk of being bitten by a snake is small. There are an estimated 45,000 snakebites yearly in the United States (about 40% occurring from people handling snakes), although only about 6680 persons require treatment for snake venom poisoning. The four poisonous snakes in the United States are rattlesnakes, cottonmouth moccasin, copperhead, and coral snakes. The number of deaths from snake bites in the United States typically ranges from 9 to 14 per year.[30] Most deaths are attributed to rattlesnakes and occur in children, in the elderly, in untreated, or undertreated patients, or in cases complicated by other serious disease states.[31]

Be familiar with venomous snakes in the area to be traveled. Avoid rocky areas, heavy vegetation and where heavy rodent infestations exist. Prevent rodents from getting into camp areas by keeping these areas clean. Snakebites can be avoided by simply moving away from a snake after a snake is encountered. If a bite should occur, it is important to keep calm. The wound should be cleaned. The limb should be immobilized below the heart and the person evacuated. There should not be an attempt to cut the skin, suck out the venom or use a tourniquet.

Wilderness Stress

While many seek a wilderness experience to avoid the stresses of daily life, they often confront a unique set of stressors in the wilderness that can challenge one's coping mechanisms. Because it is an uncontrolled environment in terms of terrain, weather, insects, and wildlife, the outdoors can lead to uncertainty. Many people experience a loss of privacy, and some experience a sense of isolation. Physical activity can lead to exhaustion. Injuries and illnesses such as those described, can lead to pain and discomfort and contribute to distress. The need to have adequate food and water increases significantly on multiple-day trips and adds additional stress. Although some may thrive in wilderness, others experience distress, regardless of one's prior experience or expertise.

Symptoms of distress include anxiety, angry outbursts, doubts about one's abilities, inability to make judgments or take action, nausea, fatigue, dizziness, decreased appetite, fear, restlessness, and headache. It is common for high-altitude endeavors to magnify the extent of these symptoms. Long-term effects after the incident can include difficulty sleeping, dreams or mental images about the incident, depression, anger or grief, feelings of isolation, and anxiety.

Ideally, identifying stress-inducing situations in advance and then planning accordingly will help to reduce levels of distress when in the wilderness. Practice sessions can include discussions of how to cope with severe weather conditions, equipment failure or deficiencies, injuries or illnesses, and difficult group dynamics.

Altitude Illness

High-altitude areas are becoming popular tourist destinations, and it is common for children and adolescents to be included in these trips. The benefits from such travel must be weighed against the environmental concerns of hypoxia and cold. Altitude sickness occurs when there is a lack of sufficient time for acclimatization. The oxygen level decreases with altitude at a time when the demand for oxygen due to physical activity increases. Hypoxia occurs at greater than 2000 m (6560 ft), and above 5500 m (18,045 ft) supplemental oxygen is sometimes used to help prevent altitude illness or to treat people with severe acute mountain sickness (AMS), high-altitude pulmonary edema (HAPE), or high altitude cerebral edema (HACE). Serious complications begin at 3000 m (9840 ft). The initial symptoms of altitude sickness include headache, lassitude, drowsiness, dizziness, chilliness, nausea and vomiting, facial pallor, dyspnea, and cyanosis. These are followed by high-altitude pulmonary edema and cerebral edema that can be fatal.[32]

AMS can be difficult to assess in children, because the signs and symptoms may be expressed differently than in adults. AMS, however, is becoming increasingly recognized in young children and often results from the rapid ascent to altitudes above 2500 m.[33] AMS may manifest as fussiness, a lack of playfulness, change in stool pattern, vomiting, and appetite and sleep disturbances.[34] There is some evidence that children are more susceptible to AMS than adults. In a study of high-altitude illness in the mountain regions of Chile, compared at the same elevation, all of the children, 50% of the teenagers, and 27% of the adults developed AMS.[35] A recent study in the Himalayas followed 36 children between 3 and 15 years of age, who underwent a rapid ascent from 1950 to 4380 m, during a pilgrimage trip to Gosaikunda Lake in the Langstang National Park Region of Nepal.[36] AMS was diagnosed in 17 of 36 (47.2%) of the children. AMS was seen in only 25% of the children who took 2 or more days (and 2 or more nights) to ascend, compared with 75% of the children who rested only one night before completing the same ascent. The study concluded that the risk of AMS and its severity in children, like adults, is increased by the rapidity of ascent.

The prevention measures for altitude illness include optimal physical conditioning and gradual ascent. Sleeping elevation should not be greater than 300 to 500 m/d. There should be a period of rest and inactivity for 1 to 2 days after arrival at high altitudes. The use of supplemental oxygen and medications such as bronchodilators, steroids, and acetazolamide have a role in prevention and treatment of altitude illness, but many of these therapies have not been tested in children at altitude and should be used with caution. The most important treatment of altitude illness is to safely return to lower altitudes as quickly as possible.

SUMMARY

Participating in wilderness experiences is increasing significantly in the pediatric population and is associated with minor and sometimes catastrophic injury causing lifelong disability or death. There is a need to move away from descriptive studies to an analytic etiologic approach that seeks to explain why and how injuries and illnesses occur in the wilderness and then to develop and introduce injury prevention strategies in a controlled way.[37] There is also a need for large-scale injury surveillance programs.

Preventing injuries and illnesses in the wilderness is an important endeavor in keeping children and adolescents healthy as well as making outdoor activities enjoyable. Prevention is well within the skill set of pediatricians.

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