PLANNING AND PREPARATION • RESPONDING TO ACCIDENTS • MOUNTAIN MALADIES • INJURIES • ILLNESSES • PREPARING FOR THE UNEXPECTED

CHAPTER 24
FIRST AID

First aid is one of the supportive skills of a truly competent self-reliant climber. Most skilled mountaineers grow adept at avoiding and mitigating hazards in the mountains, because it is far preferable to prevent injuries rather than to be experts at treating injuries. Yet accidents and illness can strike mountaineers, just as they can hit anyone at home.

The mountain environment and the physical demands of wilderness travel bring with them new types of injuries and illnesses. Mountaineers may be far away from emergency medical services, so the climbing party must be able to provide first aid. Additionally, mountaineers have a proud history of coming to the aid of injured and ill people in other parties. All climbers should be trained in wilderness first aid.

There are two components to mountaineering accident response: the framework for responding to an accident, and the techniques for treating specific conditions. This chapter begins with planning and preparation, then presents the accident response framework, in the form of seven simple responses appropriate to most backcountry accidents. Following that are medical conditions associated with the backcountry, from mountain-specific maladies to injuries to illnesses. However, many of the essential first-aid

skills, such as cardiopulmonary resuscitation (CPR), splinting, and wound care, are limited in scope or omitted here, because this book is not intended to be a comprehensive first-aid text. These skills are best learned by taking first-aid classes focused on outdoor activities and by regularly refereshing your knowledge and practicing your skills.

PLANNING AND PREPARATION

A mountaineering party should determine the general first-aid skills of the party and any relevant personal medical information, such as allergies to bee stings, diabetes, et cetera, while planning the climb. Opinions differ on the best format for gathering this information. Some climb leaders like to ask for medical information individually from each party member in advance of the trip. The information is then shared with any assistant leader and elsewhere as needed. This approach protects individual privacy, but it has the disadvantage of not giving other party members the information they might need to be most helpful to a stricken person. Thus another approach is to ask for this information publically, from the group as a whole, at the trailhead before heading for the climb. Another element of planning for emergency response is making sure that everyone carries a personal first-aid kit.

FIRST-AID KIT

In a mountaineering party, each member carries a basic personal first-aid kit. Table 24-1 lists suggested contents of a personal mountaineering first-aid kit, to which climbers can add as experience, need, and training dictate. Some first-aid items may be found elsewhere in the climber's personal supplies, such as a tweezers on a multitool or tape from a repair kit. Personal emergency medications such as epinephrine for allergies should be well labeled and their location made known to other members of the party. It is wise to put the first-aid kit in a plastic bag to keep the contents dry.

TABLE 24-1. BASIC FIRST-AID KIT

Adhesive bandages
Skin closures or cyanoacrylate glue
Hemostatic gauze pad
Nonadherent dressings
Self-adhering roller bandage or wrap

Medical tape
Antiseptic
Blister prevention and treatment supplies
Gloves, nitrile
Tweezers
Needle
Nonprescription pain killer
Nonsteroidal anti-inflammatory
Antidiarrheal
Antihistamine
Topical antibiotic
Accident report form and pencil
Any personal prescriptions (including asthma inhalers, epinephrine, etc.)

On longer trips or in remote areas, the items and quantities can be adjusted, and a group first-aid kit may make sense. Avoid the temptation to strip a first-aid kit below the bare minimum simply to reduce weight. On most trips, the first-aid kit will not be needed, but that does not make it less essential. An appropriate emergency communication device such as a phone, satellite communicator, or PLB, can expedite medical assistance in a serious situation (see "Requesting Outside Assistance" in Chapter 25, Alpine Rescue).

RESPONDING TO ACCIDENTS

A commonly shared framework for responding to an emergency makes all the difference in how a climbing party translates knowledge and skill into effective action. Without such a framework, accident response will be chaotic and inefficient. The effective response to an accident in the mountains can be simplified into seven steps, as shown in Table 24-2, which are covered below in detail.

STEP 1: TAKE CHARGE OF THE SITUATION

The climb leader is responsible for managing the overall accident response. Safety of survivors is the first priority. Identify, then avoid or mitigate, threatening hazards. Designate a first-aid provider if one has not been established. As appropriate, designate first-aid assistants. Choose a spot for

team members to aggregate resources such as first-aid kits, packs, ropes, racks, et cetera, so they are readily accessible. The climb leader maintains the big picture, thinks ahead to the next steps, delegates assignments, and, importantly, avoids being drawn into details that distract from managing the entirety.

TABLE 24-2. THE SEVEN STEPS IN ACCIDENT RESPONSE

STEP	ACTION TO TAKE
1. Take charge of the situation.	The climb leader is in charge of the party. Safety of the party is the number-one priority. The climb leader designates a first-aid provider to oversee care. The first-aid provider is usually the person with the best medical skills.
2. Approach the patient safely.	There may be dangerous or deadly considerations, such as rockfall, avalanche, steepness, to evaluate. Avoid reckless haste!
3. Perform emergency rescue and urgent first aid.	In a dangerous or unworkable environment, the patient may have to be rescued before treatment can begin. The first-aid provider checks CAB-B—**C**irculation + **A**irway + **B**reathing + deadly **B**leeding—and administers urgent first aid.
4. Protect the patient.	Protect the patient from the elements and preemptively treat for shock and hypothermia; provide psychological support.
5. Check for other injuries.	Conduct a thorough secondary examination and record findings on an accident report form (see Figure 24-1).

6. Make a plan.	Decide how best to evacuate the injured person.
7. Carry out the plan.	Implement, monitor, and adapt the plan.

If there are several patients, use triage to direct the party's limited resources toward actions likely to have the most benefit and away from actions that can wait or are hopeless.

STEP 2: APPROACH THE PATIENT SAFELY

Gather first-aid supplies, rescue equipment, and other gear and supplies that will be needed. Do not endanger party members in the effort to reach an injured person. Avoid any adrenaline-fueled, tunnel-vision haste to reach the patient. The climb leader selects the best approach strategy. In technical terrain, this could require ropes and rescue techniques. (See Chapter 25, Alpine Rescue.)

STEP 3: PERFORM EMERGENCY RESCUE AND URGENT FIRST AID

Move a patient only if there is imminent danger to the patient or rescuers. Otherwise, do not move the patient until the first-aid provider is satisfied that the move will not aggravate injuries. Patients do not have to be lying on their back to be examined and treated. If the patient must be moved out of danger, do so in such a way as to minimize further injury. Note the patient's body position and mechanism of the injury, and attempt to determine whether it is likely that a back or neck injury has occurred. Attempt to support and immobilize any obvious injured area as well as the neck and spine during emergency extrication.

Protect Rescuers from Bloodborne Pathogens

Protect rescuers from the patient's blood and body fluids that might transmit communicable infectious diseases. Protective measures that create a barrier between the skin and mucous membranes include disposable gloves, eye-wear

such as sunglasses, or perhaps a bandanna. In situations with considerable bleeding or vomiting, wearing raingear offers additional protection.

Make an Initial Assessment

If the patient is unresponsive, check the patient's CAB-B vital indicators and begin emergency first aid under these circumstances:

Circulation: Is pulse present?
Airway: Is airway clear?
Breathing: Is patient breathing?
Bleeding: Does patient have any heavy bleeding?

SPECIAL CIRCUMSTANCES FOR WITHHOLDING OR TERMINATING CPR

The first-aid provider may withhold or terminate CPR if any of these conditions occur:

- There is unacceptable risk to the rescuer.
- The rescuer is exhausted.
- The environment is one in which CPR is impossible.
- Injuries are incompatible with life.
- The patient's body is frozen solid.
- The avalanche victim is pulseless with obstructed airway and was buried for more than 35 minutes.
- There is no return of a heartbeat after 30 minutes of CPR (except for a hypothermic patient).

Perform Wilderness CPR

If a pulse is absent, you should begin cardiopulmonary resuscitation (CPR) if able. Performing CPR in the wilderness is different from performing CPR minutes away from a hospital; it requires special consideration of injuries and circumstances specific to wilderness settings. See the sidebar "Special Circumstances for Withholding or Terminating CPR"; these are based on recommendations from the International Commission for Alpine Rescue on the termination of CPR in mountain rescue (see Resources). If you do perform CPR, do so in accordance with the training you have received.

Manage Serious Bleeding

If there is deadly bleeding, use direct pressure over a hemostatic dressing or clean clothing. If bleeding persists, apply a pressure dressing. Elevating a limb is not effective. Applying pressure to a pressure point is effective for about a minute before ancillary circulation is established. If bleeding continues uncontrolled, use a tourniquet 1 inch (2.5 centimeters) wide that incorporates windlass tightening. Place it 2 to 3 inches (5 to 7 centimeters) above the hemorrhage and tighten it until bleeding stops. Using a tourniquet may lead to permanent injury, especially when used longer than about two hours. Before then slowly release the tourniquet to see if the bleeding can be controlled by other means. See the "Management of Bleeding" sidebar.

MANAGEMENT OF BLEEDING

- Take precautions (gloves, sunglasses, raingear) to protect rescuers from the patient's blood and body fluids.
- Apply a hemostatic dressing.
- Apply direct pressure to control bleeding.
- Use pressure dressings on top of existing ones.
- Apply a tourniquet when all else fails.
- Treat for shock with feet elevated 6 to 12 inches (15 to 30 centimeters).

SYMPTOMS AND SIGNS OF SHOCK

The patient may experience these symptoms:

- Nausea
- Thirst
- Weakness
- Fear and/or restlessness
- Sweating
- Shortness of breath

Observers may note these signs:

- Pulse rapid but weak
- Breathing rapid and shallow
- Skin cool and clammy

- Lips and nail beds blue
- Restlessness
- Face pale
- Eyes dull
- Pupils dilated
- Unresponsiveness (a late sign)

STEP 4: PROTECT THE PATIENT

The first-aid provider should protect the patient from the environment—heat, cold, precipitation, et cetera—and prevent shock. See the sidebar "Symptoms and Signs of Shock." Make every effort to maintain the patient's body temperature. Initial protection from the elements can be done quickly and usually without moving the patient.

STEP 5: CHECK FOR OTHER INJURIES

Once the patient has been stabilized and treated initially for life-threatening conditions, the first-aid provider checks for other injuries. Conduct a systematic head-to-toe secondary survey, looking for the clues listed in the "Signs of Injury" sidebar. The exam needs to be visual and tactile. For best results, examine bare skin while making thorough observations for possible injuries, unless environmental conditions are prohibitive.

The person conducting the examination should use an accident report form, such as the one in Figure 24-1, to guide the exam. The report provides information in the event of a change in the patient's condition or in case evacuation becomes necessary and the injured person is turned over to outside assistance for treatment. Perform repeated reassessments to detect changes or deterioration in the patient's condition.

STEP 6: MAKE A PLAN

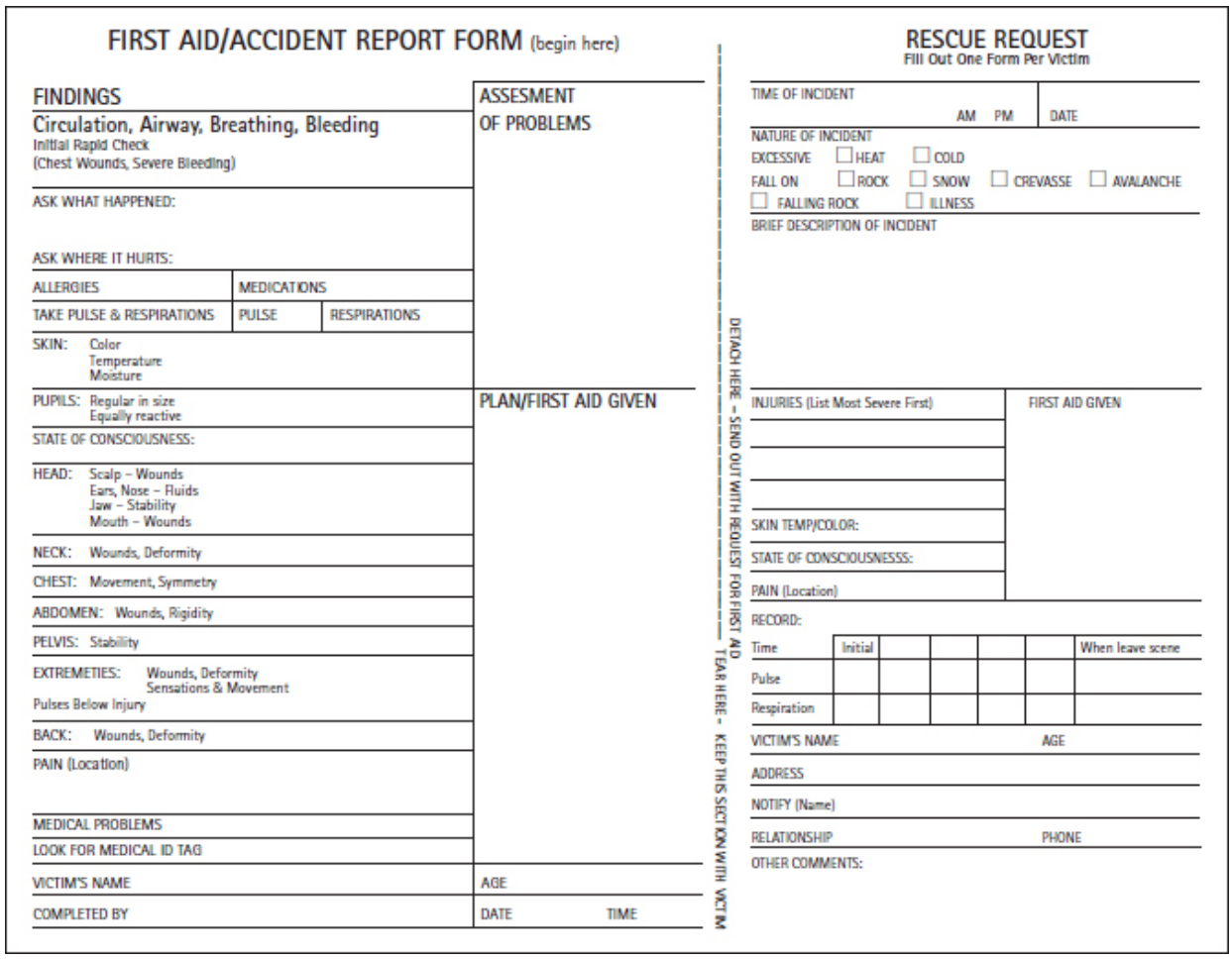
Up until this point, the steps primarily have included urgent first aid and thorough assessment. Additional first aid may be required, such as wound care, splinting an injured limb, hydration, medicating for pain, and preventing shock and hypothermia. The patient may need evacuation, which may be within the resources of the party or may require additional resources from

outside organizations. Finally, the needs of the remaining party members have to be considered. All of these are brought together in a plan.

A patient who is not ambulatory nearly always requires additional assistance to evacuate. Carrying a patient by litter requires proper equipment and a large number of people to assist, which is beyond the capabilities of most climbing parties. Self-evacuation should not be attempted if there are any indications of serious head, neck, or back injuries (see "Injuries" later in this chapter). Other factors to consider in deciding whether to attempt a self-evacuation—in addition to the patient's condition—include the terrain, the weather, the time of day, the amount of time a self-evacuation will take, the strength and skills of other party members, and the practicality of stopping en route if an outside evacuation becomes the preferred option. If self-evacuation is the plan, party members will have to plan and organize the effort.

SIGNS OF INJURY

- Unilateral differences
- Discoloration or bruising
- Disfigurement
- Bleeding or loss of other fluids
- Swelling
- Pain or tenderness
- Limited range of motion
- Guarding of a particular body part
- Numbness



FIRST AID/ACCIDENT REPORT FORM (begin here)

FINDINGS
Circulation, Airway, Breathing, Bleeding
Initial Rapid Check
(Chest Wounds, Severe Bleeding)

ASK WHAT HAPPENED:

ASK WHERE IT HURTS:

ALLERGIES | MEDICATIONS

TAKE PULSE & RESPIRATIONS | PULSE | RESPIRATIONS

SKIN: Color, Temperature, Moisture

PUPILS: Regular in size, Equally reactive

STATE OF CONSCIOUSNESS:

HEAD: Scalp – Wounds; Ears, Nose – Fluids; Jaw – Stability; Mouth – Wounds

NECK: Wounds, Deformity

CHEST: Movement, Symmetry

ABDOMEN: Wounds, Rigidity

PELVIS: Stability

EXTREMETIES: Wounds, Deformity; Sensations & Movement
Pulses Below Injury

BACK: Wounds, Deformity

PAIN (Location)

MEDICAL PROBLEMS

LOOK FOR MEDICAL ID TAG

VICTIM'S NAME

COMPLETED BY

ASSESMENT OF PROBLEMS

PLAN/FIRST AID GIVEN

AGE

DATE TIME

DETACH HERE – SEND OUT WITH REQUEST FOR FIRST AID – TEAR HERE – KEEP THIS SECTION WITH VICTIM

RESCUE REQUEST
Fill Out One Form Per Victim

TIME OF INCIDENT AM PM | DATE

NATURE OF INCIDENT
EXCESSIVE ☐ HEAT ☐ COLD
FALL ON ☐ ROCK ☐ SNOW ☐ CREVASSE ☐ AVALANCHE
☐ FALLING ROCK ☐ ILLNESS

BRIEF DESCRIPTION OF INCIDENT

INJURIES (List Most Severe First) | FIRST AID GIVEN

SKIN TEMP/COLOR:

STATE OF CONSCIOUSNESS:

PAIN (Location)

RECORD:

Time	Initial					When leave scene
Pulse						
Respiration						

VICTIM'S NAME AGE

ADDRESS

NOTIFY (Name)

RELATIONSHIP PHONE

OTHER COMMENTS:

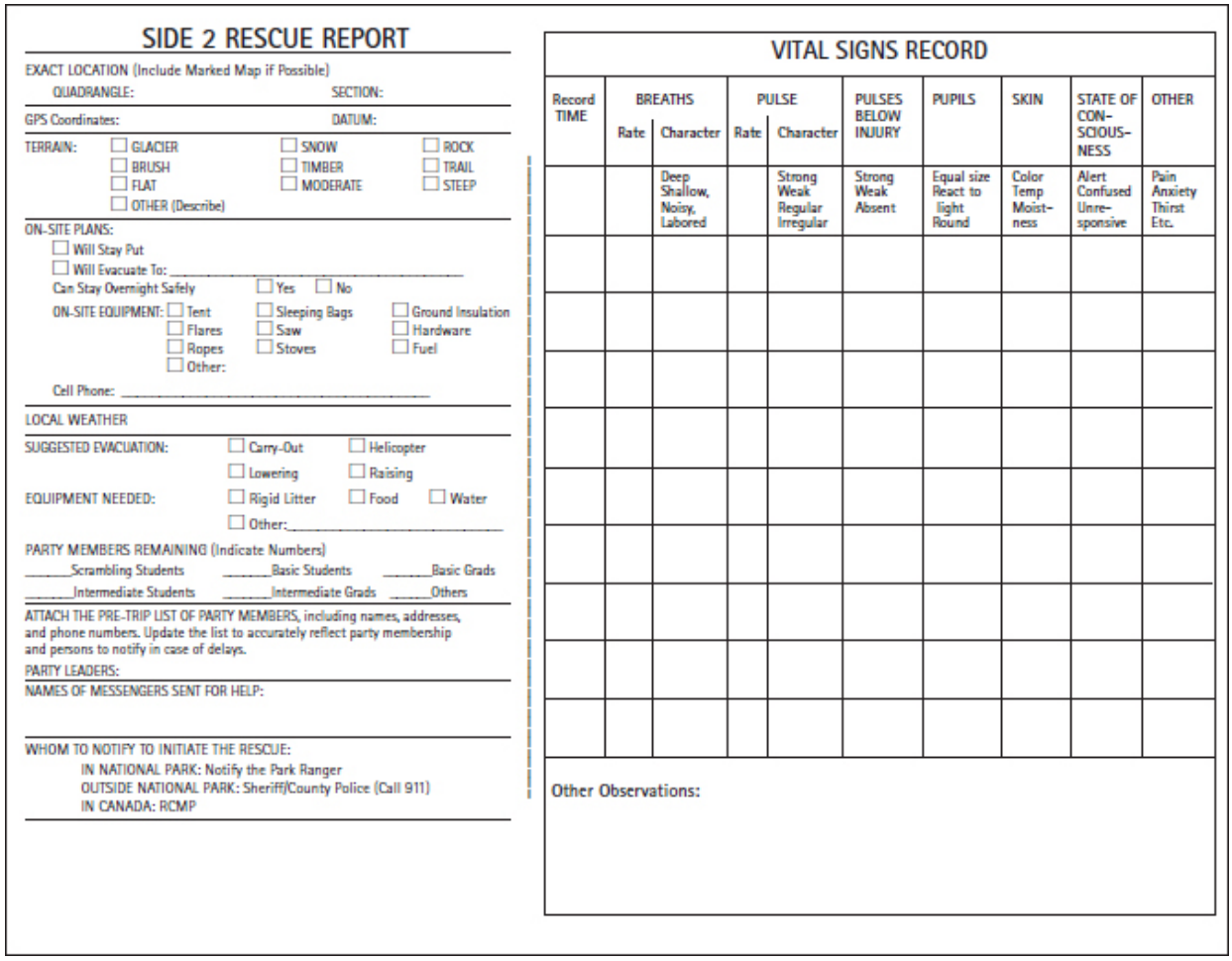
Fig. 24-1. Accident report form and rescue request form.

On the other hand, if the climb leader decides to seek outside help, the party will need a plan for obtaining assistance and taking care of all members remaining in the wilderness. If the party has an emergency communication device such as radio, phone, PLB, or satellite communicator, consider that it is better to request rescue assistance early, rather than the party finding themselves with a deteriorating patient in the middle of the night or a storm and unable to continue self-evacuation. If the plan is to dispatch people to request help, try to send at least two of the party's stronger and more competent members, along with the completed accident report form with information on the patient's condition, the condition of the rest of the party, adequacy of survival supplies, and the party's specific location. Rescue agencies appreciate early notification as well to assist with planning and mobilization. See Chapter 25, Alpine Rescue, for more details.

STEP 7: CARRY OUT THE PLAN

While executing the plan, the party monitors their progress and looks for opportunities to improve the plan. Monitor the patient and provide reassurance and support. Give fluids and carbohydrates if the patient can swallow and tolerate them without nausea. If in doubt, start with occasional sips of water to ensure tolerance without nausea or vomiting, a hardship the patient doesn't need. Remain vigilant because shock may be delayed.

At this stage, psychological support becomes important for the patient and anyone involved in helping the seriously injured. Keep an eye out for anyone behaving irrationally or in an agitated or dazed fashion. Often such individuals can be assigned a simple task that will refocus them.



SIDE 2 RESCUE REPORT

EXACT LOCATION (Include Marked Map if Possible)
QUADRANGLE: SECTION:
GPS Coordinates: DATUM:
TERRAIN: ☐ GLACIER ☐ SNOW ☐ ROCK ☐ BRUSH ☐ TIMBER ☐ TRAIL ☐ FLAT ☐ MODERATE ☐ STEEP ☐ OTHER (Describe)
ON-SITE PLANS:
☐ Will Stay Put
☐ Will Evacuate To: _____
Can Stay Overnight Safely ☐ Yes ☐ No
ON-SITE EQUIPMENT: ☐ Tent ☐ Sleeping Bags ☐ Ground Insulation ☐ Flares ☐ Saw ☐ Hardware ☐ Ropes ☐ Stoves ☐ Fuel ☐ Other:
Cell Phone: _____
LOCAL WEATHER
SUGGESTED EVACUATION: ☐ Carry-Out ☐ Helicopter ☐ Lowering ☐ Raising
EQUIPMENT NEEDED: ☐ Rigid Litter ☐ Food ☐ Water ☐ Other: _____
PARTY MEMBERS REMAINING (Indicate Numbers)
_____Scrambling Students _____Basic Students _____Basic Grads
_____Intermediate Students _____Intermediate Grads _____Others
ATTACH THE PRE-TRIP LIST OF PARTY MEMBERS, including names, addresses, and phone numbers. Update the list to accurately reflect party membership and persons to notify in case of delays.
PARTY LEADERS:
NAMES OF MESSENGERS SENT FOR HELP:
WHOM TO NOTIFY TO INITIATE THE RESCUE:
IN NATIONAL PARK: Notify the Park Ranger
OUTSIDE NATIONAL PARK: Sheriff/County Police (Call 911)
IN CANADA: RCMP

VITAL SIGNS RECORD

Record TIME	BREATHS		PULSE		PULSES BELOW INJURY	PUPILS	SKIN	STATE OF CONSCIOUSNESS	OTHER
	Rate	Character	Rate	Character					
		Deep Shallow, Noisy, Labored		Strong Weak Regular Irregular	Strong Weak Absent	Equal size React to light Round	Color Temp Moist-ness	Alert Confused Unresponsive	Pain Anxiety Thirst Etc.

Other Observations:

Fig. 24-1. (continued) Accident report form and rescue request form.

Party members may need to prepare to spend time where they are: setting up a shelter, rationing food, and perhaps getting ready for a night in the

wilderness. See Chapter 25, Alpine Rescue, for details on rescue and evacuation methods.

MOUNTAIN MALADIES

Certain conditions are associated with mountaineering activities. The mountain environment can expose climbers to extremes of heat, cold, sun exposure, and altitude. Field treatment may be challenging since it is rare to be able to remove the ill climber from the causes. Bear in mind if one person is suffering others in the party could be close behind.

DEHYDRATION

Water is the most important nutrient. Maintaining good hydration reduces the risk of heat-related, cold-related, and altitude illnesses. It improves overall physical performance as well.

Individuals vary in the rate at which their bodies lose water. Water loss occurs through sweating, respiration, urination, and diarrhea. Gaining altitude increases urinary and respiratory losses. Various medications can influence the body's ability to maintain water balance, by changing how much a person sweats or feels thirst or by increasing or decreasing urine output. Conditioning can play a role in the body's efficient maintenance of water balance.

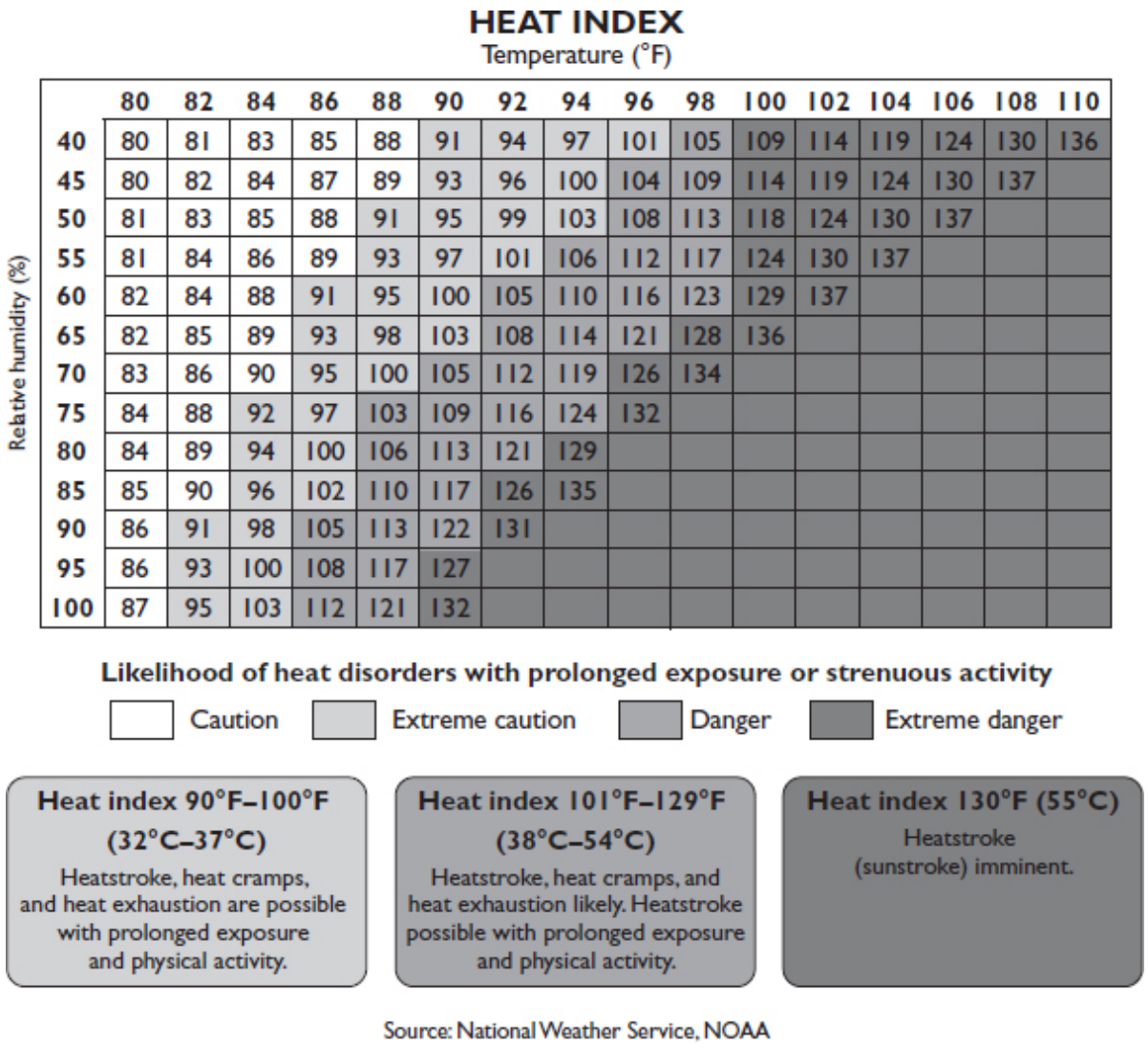


Fig. 24-2. Heat index.

Climbers may not be aware how much water their body is losing. If they do not urinate periodically during the day, or if their urine color becomes darker, they are not drinking enough fluids. Other indications of fluid dehydration are a flushed feeling, headache, or decrease in, or lack of, sweating.

Always begin mountaineering outings well hydrated. Drink a cup (or more) of water 15 minutes before starting out. Once under way, one strategy is to continue drinking fluids at a rate of 1 to 1.5 cups (0.2 to 0.3 liter) every 20 to 30 minutes of intense aerobic activity. This rate of drinking helps maintain hydration without making the stomach distended from the volume taken in. If climbers have been without water for some time and finally get a chance to hydrate, most people can tolerate drinking a pint (0.5 liter), but not two,

immediately without stomach distension. Spread the second pint over 15 minutes to avoid that bloated feeling.

Commercial sports and electrolyte drinks are not necessary, but are often useful—especially to make hydration more palatable in warmer climates where more sweating occurs. Electrolytes—body salts—lost through sweating can also be replaced by eating snacks that have some salt content.

EXERCISE-ASSOCIATED HYPONATREMIA

A relatively uncommon fluid-electrolyte disorder called exercise-associated hyponatremia (EAH) is generally caused by drinking too much water, which decreases blood sodium levels for up to 24 hours after prolonged activity. The body has the ability to excrete and sweat about 1–1.5 quarts (1–1.5 liters) of water per hour. Consumption of water in excess of this may eventually result in overhydration, decreasing sodium.

To differentiate between dehydration and overhydration, track the patient's water intake and urination. It may be helpful to determine the capacity of water containers and a timeline of when they have been filled. With heat illnesses, expect increased thirst, rapid heart rate, diminished urination (darker-colored urine), and dizziness, faintness, or lightheadedness only upon standing; these indicators are less likely with EAH.

HEAT-RELATED CONDITIONS

Heat builds up by exertion or by exposure to a hot environment. Humans lose heat largely through their skin. If a person builds up more heat than the body can lose, heat-related illness can result. High humidity impairs heat dissipation because it slows evaporation by perspiration. High temperature combined with high humidity and strenuous exertion *are dangerous conditions for an intense activity to take place*; these can lead to overheating, which can cause a range of problems, from the crippling pain of heat cramps to heat exhaustion or heatstroke. Treatment in the field can be challenging especially when it is hot, sunny, and there is little water, shade, or snow.

Heat Index

The heat index in Figure 24-2 provides a measure of apparent temperature increase due to the effect of increasing humidity. For example, if the ambient

air temperature is 90 degrees Fahrenheit (32 degrees Celsius), at a relative humidity of 40 percent, the perceived temperature will be 93 degrees Fahrenheit (33 degrees Celsius); at a relative humidity of 90 percent, the perceived temperature will be 122 degrees Fahrenheit (50 degrees Celsius).

Heat Cramps

Muscle cramps, especially in the legs, can develop if a climber becomes dehydrated or electrolyte-imbalanced during sustained exertion. In general, less-conditioned climbers are more likely to develop heat cramps than climbers who are in better shape. Heat cramps are avoidable if water and electrolytes are replenished throughout the climb. Rest, massage, and gentle, slow stretching of the affected muscles usually help. Replacing water and electrolytes is important. Severe leg cramps on an approach or strenuous climb may be a warning sign of pending heat exhaustion.

SIGNS AND SYMPTOMS OF HEAT EXHAUSTION

- Headache
- Cool and clammy skin
- Dizziness
- Fatigue
- Nausea
- Thirst
- Rapid pulse and respiratory rate

Heat Exhaustion

Of the two major kinds of heat illness, heat exhaustion is the milder affliction compared with heatstroke (see below). In the effort to reduce body temperature, blood vessels in the skin become so dilated (and sweating-related moisture loss so pronounced) that circulation to the brain and other vital organs becomes inadequate. The result is an effect similar to fainting (see the “Signs and Symptoms of Heat Exhaustion” sidebar). The following people are susceptible to heat exhaustion: the elderly, the poorly conditioned, individuals on medications that interfere with sweating, people inadequately acclimatized to a hot climate, and individuals who are dehydrated or salt-depleted.

Treatment of heat exhaustion consists of resting—reclining with feet up—preferably in the shade, removing excess clothing, and drinking plenty of fluids and electrolytes. Applying water over the head, skin, and clothing can promote evaporative cooling. On average, it takes one hour to get a quart (liter) of fluid into the circulatory system.

Heatstroke

Heatstroke, also called sunstroke, is a life-threatening emergency. In heatstroke, the body's heat gain is so substantial that body core temperature rises to dangerous levels: 105 degrees Fahrenheit (41 degrees Celsius) or more. The most reliable symptom is altered mental state, which might manifest as irritability, combativeness, delusions, or incoherent speech. See the "Signs and Symptoms of Heatstroke" sidebar for others.

SIGNS AND SYMPTOMS OF HEATSTROKE

- Altered mental state: confusion or uncooperativeness, advancing toward unconsciousness
- Rapid pulse and respiratory rate
- Headache
- Weakness
- Flushed, hot skin (wet with sweat or sometimes dry)
- Seizures
- Loss of coordination

Treatment of heatstroke must be immediate. Move the patient to the shade. Cool the head and body by packing them in snow or through evaporative cooling by splashing on water and vigorously fanning the person. Remove clothing that retains heat. Add ice packs (snow) to the neck, groin, and armpits, where large blood vessels are located near the body surface. Once body temperature has dropped to 102 degrees Fahrenheit (39 degrees Celsius), the cooling efforts can be stopped. However, continue to monitor the patient's temperature, mental status, and general condition, because temperature instability may continue for some time, and body temperature could climb again, necessitating more cooling. If the patient's gag reflex and swallowing ability are intact, cold drinks may be provided, since rehydration is critical. The ill person may not be able to continue for some hours. A

heatstroke patient must be evaluated by competent medical personnel and should not resume activity until after such an evaluation.

COLD-RELATED CONDITIONS

Cold-related illness and injuries can be localized or systemic. With immersion foot, Raynaud's disease, frostnip, and frostbite, the loss is localized, whereas with cold stress and hypothermia, the loss is systemic. Body heat is lost to the environment through evaporation (sweating and breathing), radiation (from uncovered skin), convection (from windy conditions), and conduction (from touching, sitting, or lying on something cold).

Windchill

For a given cool temperature, as wind speed increases it draws away heat by convection. The windchill index, Figure 24-3, provides a mathematical measure of how wind can accelerate the rate of cooling from exposed skin compared with the ambient temperature. For a given temperature, as wind speed increases, it draws more heat from exposed skin. The calculation of windchill is based on heat-transfer theory. For example, if the air temperature is minus 10 degrees Fahrenheit (minus 23 degrees Celsius) and the wind is blowing at 25 miles per hour (40 kilometers per hour), then the windchill temperature is minus 37 degrees Fahrenheit (minus 38 degrees Celsius). At this temperature and at this wind speed, exposed skin can freeze in 10 minutes.

By definition, the windchill index temperature is lower than the air temperature, but loss of heat by windchill cannot cause temperature to drop below the ambient air temperature; it's a measure of cooling and not a measure of ambient temperature. Windchill is of greater significance when the air temperature is relatively cool—that is, when there is risk of frostbite or hypothermia. Keep in mind that windchill cools all warm surfaces while windchill index depicts cooling only on exposed skin; if a climber is properly dressed for the conditions of the mountain environment using windproof materials, the windchill effect can be reduced or eliminated (see "Layering" in Chapter 2, Clothing and Equipment).

Hypothermia

Hypothermia, a cold-related illness that affects the entire body, occurs when cold overcomes the body's ability to maintain a normal temperature. As the body tries to maintain normal core temperature, blood is diverted away from the skin surface and from extremities. Cold stress results when the body's core temperature is between normal and 95 degrees Fahrenheit (35 degrees Celsius). Below this temperature reside the three stages of hypothermia. Unless remedied, hypothermia becomes a life-threatening condition that must be assertively treated to prevent the patient's death. In contrast, other cold-related illnesses—frostbite and immersion foot—are localized in their effects and do not have the same urgency.

A classic example of cold stress occurs when active backcountry winter skiers stop for lunch and wait until they stop sweating and start to feel cool before donning more clothing. The added clothing, at ambient temperature, initially draws even more heat from the skiers. Even within the time frame of a modest lunch break, the skiers progressively feel colder and start shivering; the added clothing doesn't warm them up, and they can't wait to get on the move to warm up.

WINDCHILL INDEX

Temperature (°F)

Wind speed (mph)	Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
	5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
	10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
	15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
	20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
	25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
	30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
	35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
	40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
	45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
	50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
	55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
	60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite times

30 minutes | 10 minutes | 5 minutes

Source: National Weather Service, NOAA

Fig. 24-3. Windchill index.

Usually hypothermia occurs after prolonged exposure to a chilly environment rather than exposure to extreme cold. A drizzly day with the

temperature around 25 degrees Fahrenheit (minus 4 degrees Celsius) and a strong breeze is a more typical setting for hypothermia than minus 10 degrees Fahrenheit (minus 23 degrees Celsius) at the ice cliffs. Wet clothing and exposure to wind are major mechanisms for losing body heat. Direct contact with snow or cold rock also robs the body of heat. Dehydration, inadequate food intake, and fatigue are risk factors. An active climber immobilized suddenly by injury in a cool, cold, or windy environment is particularly susceptible.

Hypothermia symptoms vary depending on the individual and the extent to which and the amount of time body core temperature has been reduced (see Table 24-3). Initially, signs and symptoms of cooling lag behind the drop in body core temperature. Typically, the hypothermia patient does not notice the early signs. Shivering is an initial indication of core cooling as the body attempts to rewarm itself through muscular work. As cooling continues, cognitive and physical processes progressively decline.

The distinction between mild and moderate hypothermia is blurry. There is no practical way to accurately measure core temperature in the mountains even with a rectal thermometer. In early hypothermia, symptoms include intense shivering, fumbling hand movements, stumbling, dulling of mental functions, and uncooperative or isolative behavior. The climbing party can evaluate coordination by having the person walk an imaginary tightrope for 15 feet (5 meters), heel to toe. As core temperature slides further, shivering becomes increasingly violent, but at some point it ceases. The patient may not be able to walk but may still be able to maintain posture. Muscle and nervous system function continue declining. Muscles become stiff and movements uncoordinated. Behavior is confused or irrational.

TABLE 24-3. STAGES OF CORE COOLING

STAGE	TEMP. (°F)	TEMP. (°C)	SELF-CARE	SHIVERING	MENTAL STATUS
Cold stress	95–98.6	35–37	Yes	Yes	Alert
Mild hypothermia	90–95	32–35	No	May cease	Diminished
Moderate hypothermia	82–90	28–32	No	Will cease	Conscious
Severe to profound hypothermia	<82	<28	No	No	Unconscious

In severe to profound hypothermia—body core temperatures below 82 degrees Fahrenheit (28 degrees Celsius)—shivering stops and consciousness will gradually be lost. As hypothermia further progresses, it may be extremely difficult to observe a pulse or respiration. The patient's pupils may dilate.

Hypothermia is an emergency condition that will lead to death unless treated. Treat preventively rather than wait until signs and symptoms appear and then be faced with trying to stop, overcome, and reverse the body's inability to generate sufficient heat. The priorities of treatment are to stop heat loss and rewarm (see the "Tips for Preventing Hypothermia" sidebar). Help an ambulatory patient (one who can walk) don clothing, consume food and water, and keep traveling—muscle activity is likely to be the quickest way to warm up.

Treatment of a nonambulatory hypothermic patient (for example, an excavated avalanche victim) begins with ending further heat loss by stopping the person's exposure to the elements. Insulate the patient from the ground, out of the wind and precipitation; remove wet clothing. In mild hypothermia cases, it may suffice to supply dry clothing, add insulation under and around the patient, and shelter the person from the wind and elements. If the patient's gag reflex and swallowing ability are intact, offer liquids, sweet liquids, energy gels, and carbohydrates for food energy for shivering. Use heat packs and hot water bottles. Contrary to mountain lore, supplying warm drinks is not as important as simply replenishing fluids. (Consider this: pouring a teaspoonful of warm water into a cupful of ice water would not be an effective way to warm up the cup.) Treat dehydration until urine output is restored.

Most hypothermia patients with altered consciousness require active rewarming, which can be very challenging for small parties to accomplish in the wilderness. Place hot water bottles wrapped in mittens or socks, to avoid burning, at the patient's chest, neck, armpits, and groin, where large blood vessels are located near the body surface. Enclose the patient in a wrap of clothing, sleeping bags, and sleeping pads to insulate against heat loss. Direct body contact with a (warm) party member is less effective than using heat packs or hot water bottles. While ensuring enough fresh air to prevent carbon monoxide poisoning as well as preventing burns, it may be possible to use a tarp or rain fly set up around the seated patient to capture the heat (sauna-like) from a climbing stove. Allow the recovering patient to shiver for at least 30 minutes before exercise to thermally stabilize them.

TIPS FOR PREVENTING HYPOTHERMIA

- Avoid sweat wetness.
- Avoid windchill by covering exposed skin.

- Maintain hydration.
- Wear adequate insulation and shells.
- Stay well fed.
- Pace yourself to avoid sweating and fatigue.
- Prior to prolonged stops, don chilled clothing to warm it up.
- If you are starting to feel cool, regardless of moving or stopping, put on more warm clothing.

A profoundly hypothermic patient must be handled gently to avoid inadvertently sending cold blood from the surface circulation back to the heart; this "afterdrop" could cause heart rhythm abnormalities such as ventricular fibrillation. Do not offer oral liquids to a semiconscious patient. Rewarm the patient slowly to minimize afterdrop. Limit limb movement and keep the patient horizontal. Once a patient has adequate energy reserves, the most effective means of heating may be for the patient to walk.

Before starting CPR, feel for a carotid pulse for 1 minute. If there is no detectable pulse, start chest compressions, including rescue breathing. Because a profoundly hypothermic person may appear dead, it is essential not to give up on resuscitation efforts until the patient is warm, has received adequately performed CPR, and still shows no signs of life. Keep in mind the saying that "no one is dead until warm and dead." Severely hypothermic patients have tolerated delayed and interrupted CPR to make full neurologic recovery. As in heatstroke, once the severely hypothermic patient is back to normal body core temperature, the patient must still be monitored because temperature-regulating mechanisms may not be stable for a considerable period.

The party must know when to call off a summit quest. Watch out for each other. When a party member becomes exhausted, that person is often "too tired" to bother adding clothing, to eat, or to drink, making hypothermia more likely to occur. Shivering must never be ignored. Because hypothermia interferes with a mountaineer's judgment and perception, climbing partners must be annoyingly persistent in telling a shivering climber to don warmer gear. (See the "Tips for Preventing Hypothermia" sidebar above.)

Raynaud's Disease

Raynaud's disease is a chronic, temporary, intense vasoconstriction (constriction of blood vessels) of the tissue in which cold is a frequent trigger. A climber with Raynaud's disease may appear to have frostbite. Initially, involved fingers turn white and stiff and feel numb due to diminished blood supply. Later they may turn bluish due to a lack of oxygen. After the blood vessels reopen, the flushing may turn the area red. Those with a history of Raynaud's will be familiar with the course of an episode. These climbers are more susceptible to frostbite or cold injuries and need to use preventive measures—avoid triggers (exposure to cold weather without adequate clothing or touching cold gear, such as an ice axe, for instance) and use good warm gloves or mittens and chemical heat packs—to keep their hands warm and also to treat an episode. Treat as for frostnip (see below).

Frostnip

Frostnip, commonly mistaken for frostbite, is a superficial nonfreezing cold injury associated with intense vasoconstriction (constriction of blood vessels) in exposed skin—usually fingers, cheeks, ears, or nose. It is a common occurrence. Waiting too long to don gloves is a frequent cause. Treat by donning insulated clothing, warming the skin with direct contact with something warm (warm skin or bottles full of hot water), breathing with cupped hands over the nose, and using chemical heat packs in gloves or boots. Exercise increases dilation of blood vessels in limbs, which should help. Rewarming may be painful, but frostnip does not result in long-term damage. The occurrence of frostnip may signal conditions favorable for frostbite (see below).

Frostbite

Frostbite is true tissue freezing; ice crystals form in the body's internal fluids, leading to tissue dehydration and eventual tissue death. Frostbitten tissue is cold, hard, and pale or darkly discolored and is numb. Frostbite can be classified as superficial (little permanent tissue loss expected) or deep (tissue loss expected). The distinction is usually difficult to make in the wilderness. The affected body part can be severely and permanently damaged, and effects can persist for years. Skin injury is common. Frostbitten tissue is fragile and should never be massaged.

Avoid frostbite by wearing condition-appropriate, non-constrictive clothing in layers, and cover exposed areas. Mittens can be warmer than gloves. Dry

feet are important; avoid constricting boots. Chemical hand and toe warmers are helpful. Wiggle toes and fingers; prompt the party members to check and move theirs. Avoid skin contact with cold metal or stove fuel, which can cause frostbite on contact. Stop and warm fingers and toes before they go numb.

Treatment for frostbite starts with treating for any accompanying hypothermia (see above). Superficial frostbite can be warmed against another warm body—for example, placing a cold finger or foot against a warm belly. In the wilderness, it is undesirable to rewarm a deeply frozen body part, because if the thawed body part is then refrozen, tissue death will be more extensive. Instead, evacuate the patient to a medical facility for rewarming. A frozen foot, once thawed, is impossible to walk on; the patient will have to be carried out. However, do not attempt to retard spontaneous rewarming by deliberately packing the area in snow, keeping it in cold water, or traveling in a chilled vehicle.

In the rare instance in which wilderness rewarming is considered advisable, the frostbitten part should be warmed in a water bath that is 104 to 108 degrees Fahrenheit (40 to 42 degrees Celsius), about the temperature of a hot tub. In the wilderness, it will be challenging to maintain water in this temperature range. Do not use hotter water, as the frostbitten part is extremely susceptible to thermal injury. Rewarming of an extremity will take 30 to 45 minutes and will be painful; pain medication may be necessary. The frostbitten patient should lie down with the injured part elevated. Blisters often emerge during rewarming; do not rupture these blisters. Gently wash any open wounds or already ruptured blisters with a skin antiseptic, and cover them with sterile dressings loose enough to accommodate some swelling. Patients require additional treatment in a hospital setting to minimize secondary effects.

Immersion Foot

Immersion foot, also called trench foot, occurs when a person's feet have been wet and cold for a period ranging from several hours to days. The injury appears to be a kind of trauma to nerves and muscles caused by diminished oxygen distribution (hypoxia), rather than an injury to blood vessels and skin as in frostbite. Immersion foot could occur after a climber wades across a stream and hikes for several hours with wet boots, and soggy feet or on a multiday trip on which the feet never dry out. Immersion foot results in

whitish, pulseless, tingling feet; typically, the unhappy mountaineer discovers these symptoms in the tent at night. Prevention consists of assuring the feet are dry for eight hours a day.

Treat immersion foot by drying, gently rewarming, and slightly elevating the feet. Following rewarming, the affected feet shift through a painful phase in which they fill with congested blood and other bodily fluids, which may last several days; they become reddened and swollen, with a bounding pulse. It may be necessary to cool the feet in order to tone down the intensity of this phase. After the feet have been rewarmed, the climber may not be able to walk due to pain for 24 to 48 hours. The patient is at risk for recurrence of immersion foot. Infection and gangrene may occur in severe cases.

CONDITIONS RELATED TO ULTRAVIOLET RADIATION

Intense ultraviolet (UV) radiation from the sun, particularly when it is reflected off snow and ice, can burn an unprepared mountaineer at high altitudes. For every 1,000 feet (305 meters) above sea level, UV radiation increases about 5 to 6 percent. Burn injuries from overexposure to UV radiation are potentially serious but preventable.

Sunburn

Cloud cover does not filter out UV radiation effectively, so skin can burn even on an overcast day. Burned skin can range from bright red to blistered. Certain medications such as tetracycline, sulfa drugs, and diuretics can increase the skin's sensitivity to sun and thus to the danger of its burning.

Sunburn should be treated like any other burn: cool the burned area, cover it, and treat for pain. Blistered areas in particular should be covered with sterile dressings to minimize the risk of infection.

The most effective prevention is to cover exposed skin with clothing and use adequate sunscreen. Tightly woven clothing is effective in screening UV radiation; there is no need to use special clothing with an ultraviolet protection factor (UPF) rating. Hats should include a wide brim to protect the back of the neck as well as face and ears. A handkerchief, neck gaiter, or thin balaclava can help cover the face. When skin must be exposed, sunscreen products extend the time that can be spent in the sun without getting burned. (See "Sun Protection" in Chapter 2, Clothing and Equipment.)

Snow Blindness

Snow blindness (ultraviolet keratitis) is a potentially serious problem that results when the outer layers of the eyes are burned by UV radiation. The cornea (the clear layer at the front of the eye) is most easily burned. Its surface can become roughened and blistered. With further radiation, the lenses of the eyes can become burned as well. Snow blindness sets in 6 to 12 hours after the UV radiation exposure. Dry, sandy-feeling eyes become light sensitive, then reddened and teary, and then extremely painful. Recovery takes one or more days.

Prevention of snow blindness is straightforward. In high-UV environs, climbers must wear either goggles or glacier sunglasses with side shields to block UV radiation bouncing off the snow. Choose sunglasses that block 99 to 100 percent of both UVA and UVB rays. Glare can be filtered out with a darkly tinted or polarized lens, but these features do not filter out the burning UV light. If climbers lose their eye protection, emergency goggles can be fashioned out of duct tape or cardboard by cutting narrow horizontal slits for each eye. (See “Sun Protection” in Chapter 2, Clothing and Equipment.)

Treatment of snow blindness includes providing pain relief and preventing further injury. Cool compresses may reduce pain, and sunglasses help with photosensitivity. Remove contact lenses unless the patient can tolerate them and they are needed for evacuation. Advise the snow blindness patient to avoid rubbing the eyes and to rest. There is no evidence to support therapeutic bandaging of the eyes. Topical antibiotic ointments, anti-inflammatories, and systemic pain medications may be used. Recheck for light sensitivity at half-day intervals.

HIGH-ALTITUDE CONDITIONS

With increasing elevation pressure, temperature and humidity decrease while ultraviolet radiation increases. It becomes difficult to climb as efficiently or powerfully as at lower elevations. As elevation increases, the body’s organs and tissues struggle to get the oxygen they need for metabolism. Eventually, climbers enter the state of reduced oxygen called hypoxia. Hypoxia is greatest during sleeping.

Physiological Adaptations to Altitude

One adaptation to high-altitude hypoxia is an increase in the rate and depth of breathing. After ascending to high altitude, a climber's respiratory rate continues to increase for several days. The increase in respiratory rate also results in greater expiration of carbon dioxide, which lowers dissolved carbon dioxide in the blood. Another normal adaptation to high-altitude hypoxia is that the kidneys send more water on to the bladder as urine, ridding the body of more fluid. This diuresis makes the blood slightly thicker; the change begins promptly on ascent and continues for several weeks. Eventually the body produces a greater number of red blood cells in an effort to increase oxygen-carrying capacity.

Acclimatization

The body adapts to the environmental change of high altitude, but complete acclimatization takes time. The single most critical reason people get sick at high altitude is that they ascend too high too fast. The single most important way to prevent altitude illness is to undertake a slow ascent to high elevation. On lengthy trips above 10,000 feet (about 3,000 meters), limit increases in sleeping elevation to about 1,000 to 1,500 feet (about 300 to 460 meters) per night. Two or three times a week, allow an additional night at the same elevation as the night before. Be sure to maintain adequate fluid intake.

Insomnia

The ability to sleep soundly deteriorates at high altitude. Most mountaineers have insomnia at altitude, waking up more often during the night and getting less deep sleep. Commonly, an irregular breathing rhythm appears during sleep and sometimes during wakefulness, too. There are periods of apnea (no breathing) interspersed with periods of hyperventilation, an alternating rhythm known as Cheyne-Stokes respiration. The low carbon dioxide content of the blood appears to drive this odd change in breathing. A small dose (one-quarter tablet) of acetazolamide at bedtime decreases Cheyne-Stokes respiration and may aid sleep. New evidence suggests that prescription sleeping pills help with insomnia at altitude; despite concerns that they depress respiration, they have been used at altitude without adverse consequences.

Radial Keratotomy

Hypoxia at altitude causes temporary edema and thickening of the cornea, which may cause increased farsightedness and decreased visual acuity in climbers who have had the radial keratotomy (RK) procedure. One approach is to take along glasses or goggles of different corrective prescriptions. Research is unclear as to altitude effects on laser-assisted in-situ keratomileusis (LASIK) or photorefractive keratectomy (PRK).

Retinal Hemorrhage

At high altitude, an increase in retinal blood flow and subsequent retinal vein dilation can lead to retinal hemorrhages in many climbers. Climbers should be instructed to descend if they develop altered vision. The presence of high-altitude retinal hemorrhage has been associated with altitude illness.

SIGNS OF ACUTE MOUNTAIN SICKNESS

People with AMS usually have a headache, plus one of the following:

- Insomnia
- Listlessness and/or lassitude
- Loss of appetite
- Nausea
- Vomiting
- Lightheadedness or dizziness made worse when in an upright position

Acute Mountain Sickness

At least half of the sea-level residents who travel rapidly to moderate altitude —8,000 to 14,000 feet (2,400 to 4,300 meters)—experience some degree of acute mountain sickness (AMS). This is a collection of nonspecific symptoms that can resemble a case of flu, a hangover, or carbon monoxide poisoning from stove use inside an inadequately ventilated shelter. Headache is the cardinal symptom, often accompanied by fatigue, loss of appetite, nausea, and, occasionally, vomiting (see the “Signs of Acute Mountain Sickness” sidebar). Headache onset is usually 2 to 12 hours after arrival at a higher altitude and often during or after the first night. Headaches tend to be localized in the occipital or temporal areas. AMS can vary widely in severity but generally resolves with 24 to 72 hours of acclimatization.

AMS can progress in severity. In cases wherein symptoms such as headache and nausea progress, a descent of 2,000 to 3,000 feet (600 to 900 meters) in elevation is the best treatment. The diagnosis of AMS is confirmed if the condition improves upon descent. It is important to differentiate AMS from the more ominous HACE and HAPE (see below).

Some medicines can be used to deal with altitude-related health problems; climbers should ask their physician about the appropriateness of such drugs for their situation. Some mountaineers use acetazolamide (Diamox) the night before or the morning of the ascent and through the first 48 hours at high altitude in order to prevent AMS or block its recurrence. Potential problems caused by this medication are tingling of the extremities, ringing in the ears, nausea, frequent urination, and a change in the sense of taste. It is better to test this possibility at home rather than in the mountains. Acetazolamide does appear to be effective in preventing and treating AMS as well as the breathing changes brought on by high altitude. The steroid dexamethasone is effective in preventing and treating AMS as well as HACE and HAPE; it is usually reserved for treatment or when rapid elevation gain prevents normal acclimatization.

High-Altitude Cerebral Edema

High-altitude cerebral edema (HACE) usually develops in unacclimatized climbers above 10,000 feet (about 3,000 meters), although it can occur as low as 8,500 feet (2,600 meters). HACE may be just the severe manifestation of AMS. HACE rarely occurs out of the blue and more often occurs in people who have had AMS that is worsening. Generally, it takes from one to three days at high altitude for HACE to develop. Vessels in the brain respond to the stress of high altitude by becoming leaky, resulting in the brain swelling with increased fluid. Ultimately, the brain swells inside its rigid container of cranial bones.

Early signs of this deadly condition include deteriorating coordination, headache, loss of energy, and altered mental status, ranging from confusion or signs of not thinking clearly to hallucinating. Use the coordination test: ask the person to walk an imaginary tightrope for 15 feet (5 meters), heel to toe, to check for ataxia. Nausea and forceful vomiting may be present.

Once HACE develops, it may advance rapidly. The patient may become somnolent and lapse into a coma. Descent is critical to survival. On some expeditions, portable hyperbaric chambers (such as the Gamow bag) are used

to create an artificial lower elevation in the effort to stabilize the patient for a few hours. Supplemental oxygen can also be helpful. Drugs such as dexamethasone are beneficial; acetazolamide might be an additional part of the treatment.

High-Altitude Pulmonary Edema

In high-altitude pulmonary edema (HAPE), body fluids leak into the lungs to a degree that interferes with respiratory function. HAPE is a potentially fatal condition and survival depends on a rapid response. HAPE is a different disease from AMS or HACE and can occur quite suddenly in climbers who were otherwise performing well. Occasionally, HAPE and HACE do occur together.

Early signs of HAPE may overlap with more benign problems, such as a persistent cough caused by simple bronchial irritation from dry, high-mountain air. Decreasing ability to exercise, needing to take more frequent rest breaks, or falling behind companions might be more subtle signs of HAPE. Breathlessness and a hacking cough appear as HAPE develops. Rates of breathing and pulse increase.

If HAPE is allowed to advance, breathing will require effort and will include bubbling noises. Lips and nail beds may appear dusky or tinged with blue, reflecting the body's inability to transfer oxygen into arterial blood due to the water barrier in the lungs. Some affected people also develop a low-grade fever, making it difficult to distinguish HAPE from pneumonia; one indicator of HAPE is how rapidly it worsens with continued ascent.

The key to treating HAPE is to descend. A descent of 3,000 feet (900 meters) will resolve nearly all HAPE cases that are caught early. If descent is impossible, oxygen and a Gamow bag are useful. Ultimately, however, real descent must occur. Some mountaineers use the drug nifedipine, which widens blood vessels, to help prevent or treat HAPE. Studies suggest that drugs for erectile dysfunction, including tadalafil and sildenafil, also can be used for treatment of HAPE in both men and women, particularly when descent is not feasible.

INJURIES

One study of the National Outdoor Leadership School courses over a five-year period showed that 80 percent of the injuries suffered by course

participants were sprains, strains, and soft-tissue injuries. To minimize the extent of injuries from a mountaineering accident, apply skillful and caring first aid. Specific treatments for serious injuries are beyond the scope of this book, so hands-on instruction in mountaineering first aid is essential. (See Resources in the back of the book for detailed first-aid texts.)

BLISTERS

All wilderness travelers dread blisters. These bubbles under the skin, filled with clear or blood-tinged fluid, probably represent the most common health-related reason for ending outings. Small blisters generally are a source of minor irritation and discomfort, but larger blisters can cause significant pain, and if they rupture, they can lead to serious infection and ulceration. Blisters result from the skin rubbing against socks and the inner lining of the boot—often, new or poorly fitting boots. Blisters happen when boots are too large or too loosely laced or when socks are lumpy or wrinkled. Moisture tends to soften the skin, so wet boots or socks promote blister formation.

Fig. 24-4. Blisters: a, starting out as a hot spot; b, tape the hot spot to prevent blister formation; c, doughnut-cushion a blister once it forms.

A blister usually becomes noticeable first as a hot spot (fig. 24-4a), a localized sensation of heat that increases in size and intensity over time. Inspect such spots immediately, and take preventive measures. Place a generous strip of waterproof plastic adhesive tape or Moleskin over the spot (fig. 24-4b). Other suitable products include 2nd Skin and Dr. Scholl's Molefoam; some sufferers are successful with duct tape or waterproof first-aid tape. Avoid using adhesive bandage strips (such as Band-Aids) for covering hot spots; these strips seem to promote blister formation when the nonadhesive dressing pad balls up and rubs against the already sensitive skin. Sometimes antichafing products can help as well to prevent hot spots, but these products don't always work in footwear.

Once a blister has formed, avoid opening it unless absolutely necessary; opening a blister may introduce infection to the area. The body will reabsorb

the blister fluid after several days, and it will heal. If the hike or whatever activity caused the blister must be continued, pad the blister and protect it from rupture by layering a "doughnut" of padding to a depth that keeps pressure off the blister itself (fig. 24-4c). The padding doughnut must be deeper and wider than the blister. Tape the padding well to prevent it from becoming displaced.

If a blister breaks open, wash and dress it with sterile dressings, as with any open wound. Infection is a concern; avoid further tissue damage if at all possible.

To prevent blisters, fit boots properly. Break them in slowly and thoroughly before launching into any extended hikes. The areas most prone to blistering are over the heel or Achilles tendon at the back of the ankle and on the toes. If you tend to blister easily, pad the blister-prone areas with tape or adhesive foam, but do not pad them so much that a new pressure point is created around the edge of the foam. Keep feet dry, and wear adequate, well-fitting socks. Invest in new socks: threadbare socks can cause blisters.

CHAFING

In addition to foot blisters, friction chafing can occur due to repetitive motion at a number of places on the body, especially between the thighs. Chafing is commonly caused by clothing that doesn't fit, cotton fabrics, dirty clothing, sweat, and sand or dirt. In severe cases it can painfully rub away the skin. For chronic chafing, find and eliminate the source. Lubricating products may help preventively. As for foot blisters, take immediate action after becoming aware of the irritation. It will only get worse without intervention.

BURNS

Burns happen in the wilderness when climbers handle hot cookware and stoves (see also "Sunburn" earlier in this chapter). Burned skin can range from bright red to blistered to charred (first, second, and third degree, respectively). Cool a burn within 30 minutes to reduce pain and depth of injury; use cold water, or snow if available. Filtered or treated water is preferred. Do not drain any blisters and avoid contamination where the skin has been broken. Superficial burns or those with a few blisters can be covered with a topical antimicrobial agent and a nonadherent dressing. More extensive blistering and deeper skin damage, especially to the face and hands, need additional bandaging and urgent medical care.

Burns can also occur from friction against skin. Use of proper gloves when doing certain activities like rappelling will minimize this risk. If these injuries do happen, treat them as you would other burns. Also see "Lightning Strikes" later in this section.

EYE INJURIES

Corneal abrasions are one of the most common eye conditions in the backcountry, and they are usually caused by a foreign body, a blow to the eye, or the extended use of contact lenses. Symptoms include feeling as though there is something caught in the eye even when nothing has been found. Remove any small foreign body from the affected eye. If the eyeball may be ruptured or if deep scratches are apparent in the cornea, then evacuate the affected individual immediately. Treat corneal abrasions with topical antibiotics and frequent use of artificial tears. Sunglasses may help reduce sensitivity to light, but there is no evidence supporting eye patching for corneal abrasions. If the injury is still bothersome after 24 hours, seek further treatment.

WOUND CARE

Wounds such as scrapes, cuts, and punctures are common in the wilderness. The goals of wound care are to prevent infection, avoid further trauma, and optimize healing. When providing first aid to someone else, put on protective gloves to prevent exposure to any possible blood-borne pathogens. All grossly contaminated wounds should be thoroughly irrigated with sanitized (filtered, chemically treated, or boiled) water. Pressure irrigation using a syringe or a hydration bladder is more painful but will dislodge dirt and other contaminants more effectively. Gentle scrubbing may be needed to clean the wound. Apply topical antimicrobial agents to reduce the risk of infection before covering the wound with a nonstick dressing and bandage. Lacerations can be closed with skin closures (Steri-Strips) or cyanoacrylate glue if the wound is clean. Use a hemostatic gauze pad where bleeding is persistent.

SPRAINS, STRAINS, AND FRACTURES

Strains are muscle injuries; sprains are injuries to ligaments. The most common type of injury that keeps a party from self-rescue and requires outside assistance is injury to the ankle or foot. While this chapter cannot adequately

cover the details of fractures, emergency splinting in the backcountry can be used for severe sprains or fractures until the patient is self-evacuated or rescued. Strains can be quite painful and debilitating. Being well conditioned, hydrated, and properly warmed up helps prevent strains. Be careful not to push yourself or your party too quickly.

Taping an Ankle Strain or Sprain

The most common ankle sprain results in an injury to the ligaments on the outside of the ankle. Taping a severe ankle sprain or strain, as well as some fractures, may allow a party to self-rescue. Ankle taping is a skill that must be practiced to keep it in a climber's first-aid repertoire. The standard prescription for ankle taping is the "closed basket weave" using 1.5-inch-wide (3.8-centimeter-wide) adhesive tape, as shown in Figure 24-5. Ideally, the skin should be dry, clean, shaven, and free from lotions or oils that keep the tape from sticking to the skin.

To tape an ankle, follow these steps:

1. **Anchor strips.** First place two adjacent anchor strips all the way around the leg just below the calf (fig. 24-5a). Place a third strip all the way around the foot at the arch.
2. **U-shaped strips.** Then with the foot flexed, run a U-shaped arch strip (stirrup strip) from the medial (inner) calf anchor strip, beneath the foot then under tension up to the lateral (outer) calf anchor strip. Place a U-shaped heel strip (horseshoe strips) from the arch anchor strip back around and above the heel and forward to the other side arch anchor, perpendicular to the stirrup strip (fig. 24-5b).

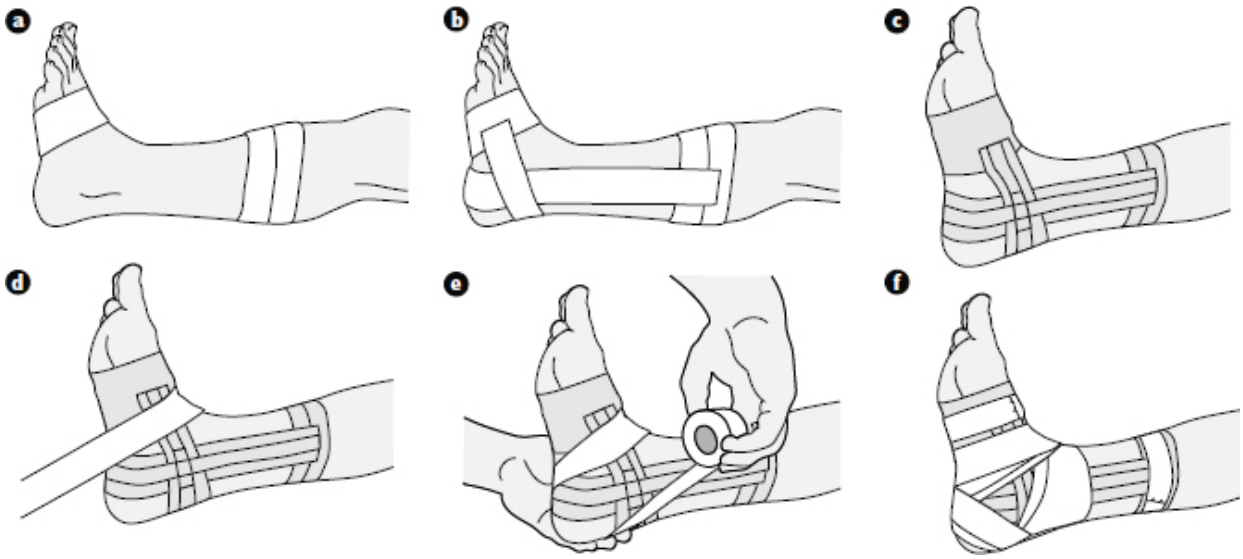


Fig. 24-5. Taping an ankle: a, attach anchor strips; b, add U-shaped strips; c, create the basket weave with layered U-shaped strips; d and e, apply figure-eight heel locks; f, add cover strips.

3. **Basket weave.** Alternate three stirrup strips with three horseshoe strips, with a half strip overlap, working from back to front and bottom to top for a basket-weave appearance. (fig. 24-5c).
4. **End locks.** Apply two figure-eight heel locks: starting from the high lateral (outer) ankle, descend medially across the ankle (to inner ankle), around the heel, under the foot, and medially up the foot, returning to the start (fig. 24-5d and e).
5. **Cover strips.** Add strips to cover ends of stirrups and horseshoe strips (fig. 24-5f).

After taping the ankle, ask about the patient's comfort and check circulation: gently squeeze the toes—the nail bed should turn white, and once the squeeze is released the toes should return to a pink color within a second or two. If the climber develops pain or the skin turns bluish or cold or numb, the tape may need to be loosened or removed.

Splinting a Sprain or Fracture

Several principles apply in backcountry splinting (see the "Fracture Management" sidebar). Splints should be well padded to avoid damage to skin and superficial tissues. This is often accomplished by wrapping elastic bandages around the splint material or by using a soft material to cover the injured limb. A structural aluminum malleable (SAM) splint is highly

versatile, lightweight, and reusable. Because it can be rolled, flattened, curved, cut, or folded, a SAM splint is adaptable to many types of injuries.

FRACTURE MANAGEMENT

- Take precautions to protect the first-aid provider from potential contamination from the injured person's blood.
- Assess the limb and/or joint for circulation, sensation, and function.
- Expose the injury site, and control bleeding if present.
- Apply dressings to wounds as needed.
- Prepare a splint.
- Stabilize the injured extremity and apply the splint without excessive movement of the extremity.
- Use padding to fill any large gaps between limb and splint.
- Immobilize the fracture site and joints above and below it.
- Reassess circulation, bleeding, and sensation periodically.

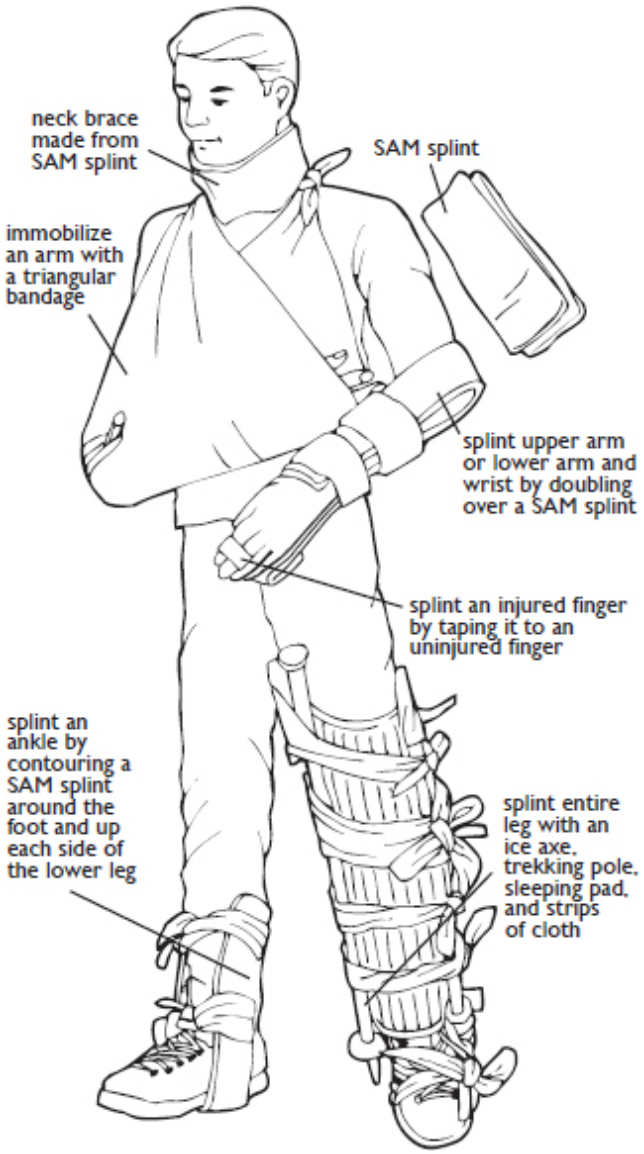


Fig. 24-6. Stabilize an injured area with a SAM splint (doubled to brace a neck, doubled over to an appropriate length to splint all of a forearm or wrist, or wrapped around a foot and secured with bandannas to splint an ankle) or improvise with available materials (injured finger taped to adjacent finger, injured hand immobilized with a triangular bandage, entire injured leg splinted with ice axe, trekking pole, and sleeping pad).

For extremity splinting, when possible immobilize the joints above and below the injury with the splint. Splint the injury in a position that is comfortable and natural. For an upper-extremity injury, the patient will generally hold the injured arm in toward the chest, cradling it with the uninjured arm; splint the arm in this position. For a lower-extremity injury, strive to make the splint as comfortable as possible and in line with the patient's body.

Improvising a splint is often necessary (fig. 24-6). For example, if no appropriate material is readily available, a lower-leg injury can often be protected by taping the injured leg to the uninjured leg. Similarly, an injured finger can be secured to the adjacent finger for temporary protection. Splints can be fashioned from a wide variety of materials, including sticks and mountaineering equipment such as a backpack's internal stays, a rolled-up backpack, sleeping pads, trekking poles, or an ice axe. Spare webbing, twisted duct tape, bandannas, or athletic tape can be used to secure an improvised splint.

Swelling can be expected for hours after a fracture or severe sprain. Take care to avoid applying splints too tightly, which can impair circulation to the affected limb. After applying a splint, periodically reassess the patient by checking pulse, skin temperature, and sensation below the injury while awaiting outside care.

To minimize swelling of the injured extremity, a bag of snow or ice can be incorporated into the splint by wrapping the bag in the elastic bandage that secures the splint. Care must be taken to remove the bag periodically to avoid cold injury to soft tissue. In general, the snow or ice should be applied for no more than 20 minutes at a time. The injured extremity should also be elevated to minimize swelling.

HARNESS SUSPENSION TRAUMA

A motionless climber hanging from a harness is facing a life-threatening emergency. Harness leg straps restrict blood flow, which leads to blood pooling in the legs and lowered core blood pressure. The loss of blood pressure may lead to death within minutes.

The priority is to end suspension. If possible, lower the climber to a ledge. If the climber is conscious, he or she should move their legs, transfer weight to any available feature, or stand in improvised aiders made from slings or a prusik. If a climber is unconscious, a rescuer should immediately strive to raise and keep the legs horizontal until the climber can be relocated. The rescued climber can lie flat to help restore normal blood circulation and chemistry. Monitor and treat any secondary effects.

HEAD, NECK, AND BACK INJURIES

Head and spine injuries are common causes of death in alpine wilderness accidents. Blunt force injuries often are caused by falling objects, such as

rock or ice, or by a fall in which the climber's head or back strikes a hard object. For all head injuries, assume that there is a neck (cervical spine) injury until an examination proves otherwise. For all cervical spine injuries, the patient must be monitored for potential head and brain injury. See the "Indicators of Possible Head Injuries" sidebar.

INDICATORS OF POSSIBLE HEAD INJURIES

- Blunt force to head or neck
- Unconsciousness
- Drainage of blood or clear fluid from the ears, nose, or eyes
- Unequal eye pupil size or unequal constricting response of the pupils to light
- Black eyes
- Very slow pulse
- Fluctuations in respiratory rate
- Headache
- Disorientation and confusion
- Seizure
- Vomiting

Indicators of possible neck and spine injuries include significant spinal pain or tenderness, numbness, tingling, or paralysis. Some factors that may make it hard to determine if there is a cervical spine injury include head injury, severe or distracting injuries, age greater than 65, and intoxication.

Less-serious injuries may be treatable by the party. A cervical collar is unnecessary with an uninjured spine or stable spine injury, including neck sprains, strains, and even mild fractures (for example, a mild compression fracture). The challenge is to determine if the injury is serious or not. Patients who have had a minor accident, are ambulatory since the injury, are in a sitting position, have delayed onset of neck pain, have an absence of midline cervical spine tenderness, and are able to actively rotate the neck and spine 30 degrees in each plane should not require a cervical collar.

Serious injuries of the head, neck, and spine have the potential to be permanently disabling. With severe injuries, immobilizing the head and spine until rescuers can arrive is the best first-aid treatment. Neutral alignment should be restored and maintained, unless such a maneuver causes the patient

to resist, experience increased pain, or exhibit a new or worsening neurologic deficit. Light to moderate traction should be used when returning a cervical spine to the neutral position. An improvised cervical collar should be used.

LIGHTNING CAN STRIKE A CLIMBER IN VARIOUS WAYS

- Direct strike of a mountaineer in the open who could not find shelter
- Splash strike, in which the lightning current jumps from an object onto a mountaineer who sought shelter nearby
- Contact injury, from holding an object that lightning hits
- Step voltage, transmitted along the ground or through an object near a climber (even a wet rope)
- Blunt trauma or blast effect, created by the shock wave from a nearby strike

If the patient is in significant risk of further injury or death, they may need to be moved. When transferring a patient with possible neck injuries, grab the patient's trapezius muscles (tops of the shoulders between neck and point of the shoulder) and firmly squeeze the patient's head between your forearms, which are placed approximately at the level of the patient's ears. Move the patient as a unit, minimizing movements of the neck and back.

Lightning Strikes

The high-mountain environment receives many more thunderstorms each year than coastal areas do, as the weather systems mass against the mountains before rising over them. Summer afternoons are the most likely time for thunderstorms, and therefore lightning, to endanger the mountaineer. Most lightning ground strikes occur directly below a cloud and hit the nearest high point. But lightning strikes can emanate from several miles away toward high points ahead of (or, less frequently, behind) the main thunderhead cloud formation—"out of a clear blue sky." Therefore, mountaineers can be in danger of a lightning strike at times even when the storm is not directly overhead (see the "Lightning Can Strike a Climber in Various Ways" sidebar).

Lightning-caused injuries include cardiac arrest, burns, and internal injuries. The most immediate danger from being struck by lightning is cardiac

arrest. Lightning burns often take several hours to develop after the strike; these burns are usually superficial (similar to first-degree burns) and do not usually require treatment (see "Burns" earlier in this section), although serious internal injuries can also occur. The patient may be knocked unconscious or have temporary paralysis. The eyes, a vulnerable port of entry for electrical current, can be damaged in a lightning strike. Ear damage also may occur; a patient might not respond to your questions because of a loss of hearing caused by the strike.

After the lightning strike, the patient does not present an electrical hazard to rescuers. Proceed promptly with first aid, assessing CAB-B: Circulation, Airway, Breathing, and deadly Bleeding (see "Responding to Accidents" earlier in this chapter). It is important to get the lightning-strike patient to a medical facility, because vital body functions may remain unstable for a considerable time after resuscitation. For information on how to avoid being struck by lightning, see "Thunder and Lightning" in Chapter 28, Mountain Weather.

ILLNESSES

One study of the National Outdoor Leadership School's courses over a five-year period showed that 60 percent of the illnesses experienced by course participants were nonspecific viral illnesses or diarrhea. Hygiene appeared to have a significant impact on these illnesses.

GASTROINTESTINAL DISORDERS

Gastrointestinal (GI) disorders can cause a wide range of symptoms, from a mildly upset stomach to weeks of diarrhea. The onset of any GI disorder will ruin a trip. Understanding, preventing, and treating these disorders is increasingly important to climbers.

Fecal-oral contamination. In mountaineering environments, the most common cause of gastrointestinal infections that entail diarrhea and abdominal cramping is fecal-oral contamination. Most often, the source of the feces is mountaineers themselves. Some rock climbing routes may be contaminated with feces from previous parties. On glacier routes, handling ropes that have dragged through soiled snow and ice can lead to contamination. Water bottles as well as food can become contaminated from soiled hands. Animal waste also presents a risk.

To keep from contaminating your hands, simply wash them with biodegradable soap and water before eating and especially after defecation. This simple step can help a climber avoid many intestinal disorders. Climbers often are gregarious at rest stops—but think twice before offering your snack bag for each person to plunge a hand into; pouring some contents into each person's hands is less risky. Avoid camping near rodent burrows. Cover food and water so that they are secure from rodent invasion at night.

Food poisoning. The symptoms of food poisoning—generally vomiting and diarrhea, but can also be as simple as an upset stomach—arise rapidly following ingestion of food contaminated by pathogenic bacteria, viruses, or parasites as well as chemical or natural toxins. Symptoms tend to subside within 12 hours. Provide water and electrolytes as tolerated, since dehydration is a side effect of vomiting and diarrhea. The patient may need a few hours to regain strength. To prevent food poisoning, use dietary discretion when traveling. Avoid consuming raw fruits or vegetables, raw meat, raw seafood, tap water, and ice made from tap water. Instead, stick to boiled or treated water, properly cooked meat and vegetables, bottled beverages, and reputable eating establishments.

Contaminated water. While the water flowing in the streams and rivers of the backcountry may look pure, it can still be contaminated with bacteria, viruses, parasites, and other contaminants. The incubation period of the pathogens can be a clue to which kind is the source: Bacterial and viral pathogens have an incubation period of 6 to 72 hours. Protozoal pathogens such as *Cryptosporidium*, *Giardia intestinalis*, or *Giardia lamblia* generally have an incubation period of one to three weeks and rarely present symptoms in the first few weeks of travel.

Bacterial and viral illnesses begin with the sudden onset of bothersome symptoms that can range from mild cramps and urgent loose stools to severe abdominal pain, flatulence, fever, vomiting, and bloody diarrhea. Untreated bacterial diarrhea lasts three to seven days. Viral diarrhea generally lasts two to three days. Parasitic diarrhea, such as giardiasis and cryptosporidiosis, generally has a more gradual onset of low-grade symptoms, with two to five loose stools per day. Protozoal diarrhea can persist for weeks to months without treatment. An acute bout of gastroenteritis can lead to persistent gastrointestinal symptoms, even in the absence of continued infection.

For most intestinal infections associated with diarrhea, treatment during a climbing trip consists of adequately replacing fluids and electrolytes. This can

be challenging if the climber is also nauseated. Mix a packet of replacement electrolytes into treated drinking water; a packet is generally equal to 1 teaspoon of salt and 8 teaspoons of sugar and is added to 1 quart (liter) of water. If electrolyte replacements are not available, simply replace fluids. Provide palatable foods and broths with a substantial salt content.

If the party is heading into regions with questionable hygiene and water disinfection practices, seek medical advice about antibiotics that can be taken to help ward off infection, and also ask about antimotility (antidiarrheal) drugs. However, taking such drugs is not a substitute for dietary discretion or prudent water treatment practices (see Chapter 3, Camping, Food, and Water).

TICKBORNE DISEASES

Ticks are arachnids that can carry Lyme disease, Rocky Mountain spotted fever, and other infections. Tick bites may appear anywhere on the body. Three to 30 days after a tick bite (7 days on average), disease signs and symptoms can appear, including fever, chills, headache, fatigue, muscle and joint aches, and swollen lymph nodes. A rash at the site of the bite occurs in 70 to 80 percent of infected persons, expanding in area up to 12 inches (30 centimeters) across and sometimes resembling a target or "bull's-eye" appearance. Skin may feel warm but is rarely itchy or painful.

After being in tick habitat, shower as soon as possible to wash ticks off before they attach and to more easily find and remove them. Conduct a full-body tick check using a mirror to view all parts of your body. Examine gear for hitchhiking ticks. Once you are at home, tumble clothes in a dryer on high heat for an hour to kill remaining ticks. If you do find a tick that has attached itself, avoid folklore remedies such as "painting" the tick with nail polish or petroleum jelly or using heat to make the tick detach from the skin. Do not wait for it to detach; follow these steps to remove it:

1. Use fine-tipped tweezers to grasp the tick as close to your skin's surface as possible.
2. Pull outward with steady, even pressure. Don't twist or jerk the tick; this can cause its mouth parts to break off in your skin. If you are unable to easily remove a mouth part, leave it alone.
3. Thoroughly clean the bite area and your hands with soap and water.

Reducing exposure to ticks is the best defense against tickborne infections. Avoid wooded and brushy areas with high grass and leaf litter. Repel ticks by applying 20 percent to 30 percent DEET or 20 percent picaridin on exposed

skin and clothing; 0.5 percent permethrin applied to clothing and gear such as boots, pants, socks, and tents remains protective through several washings. (See "Insect Repellent" in Chapter 2, Clothing and Equipment.) Light-colored clothing helps you spot ticks, which are usually a dark brown.

OTHER ENVIRONMENTAL FACTORS

From centipedes to poison oak, some insects, plants, and animals are poisonous and can cause painful or debilitating conditions. Check with those knowledgeable of local risks and prevention for the area you are visiting.

PANIC AND ANXIETY

Mountaineering outings are usually refreshing and rejuvenating experiences. In extreme situations, such as a serious accident, nearly all climbers have to deal with their own and one another's stress, anxiety, or even panic. Some people also have a tendency toward intense anxiety in response to certain physical situations in climbing, such as exposure to heights or to enclosed spaces. This tendency can erupt in a panic response during a step-across move on a cliff face or while squeezing up a rock chimney. If affected, a climber may freeze and refuse to go on. The climber may hyperventilate (breathe rapidly) or be unable to recognize that there are safe moves available. The person's ability to fully assess the situation will be blocked; physical movements will be clumsy and fearful, raising the risk of a mishap.

If hyperventilation is a problem, breathing into a bag to increase the concentration of carbon dioxide in the inhaled air can slow the breathing rate. Redirecting the climber's focus onto a useful physical task is a strategy for interrupting the snowballing effect of panic. Fellow climbers can help by maintaining an atmosphere of confident acceptance and support, by pointing out an option for retreat if appropriate, and by calmly and matter-of-factly prompting a panicked climber to use these self-calming techniques, which are helpful in such situations:

- Recognize the panic as an adrenaline reaction to perceived risk.
- Focus on slow, steady, deep breathing.
- Run through the options for safe movement.
- Follow them one at a time.

PREPARING FOR THE UNEXPECTED

It is tempting to assume that carefully reading first-aid texts is sufficient training. Unfortunately, first aid is very much like any other skill: people can read, even memorize, all of the greatest texts on skiing, and yet if they do not practice, they simply will not be good skiers. The same is true with first aid: to be truly competent in first aid, climbers must practice and refresh their skills periodically. The best training strategy is to take advantage of courses offered by many respected organizations.

Practicing first aid will help a climber prepare for dealing with the large element of uncertainty that accompanies mountaineering accidents and serious injuries: uncertainty about what happened; uncertainty about the nature, extent, or seriousness of injuries; uncertainty about what should be done; uncertainty about what the outcome will be. An injured person does not wear a big sign saying what is injured and how to best care for it.

Practicing first aid will also help a climber prepare for the alarm and emotion accompanying accidents. Serious accidents are frightening, and they tend to flood people's minds with a spectrum of emotions, which can interfere with a calm, thoughtful, and rational response. Practicing first-aid scenarios in outdoor first-aid classes can help climbers respond well even when the situation is overwhelmingly stressful. Keeping a cool head and having the skills to provide first aid gives mountaineers confidence in facing whatever a climbing expedition might bring.