31 Environmental Emergencies

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Related Chapters

The following chapters provide additional information related to topics discussed in this chapter:

- **1** Introduction to Emergency Medical Care
- **2** The Well-Being of the EMT
- **15** Communication and Documentation
- **20** Allergic Reaction
- **21** Poisoning and Overdose Emergencies
- **25** Bleeding and Shock
- **32** Obstetric and Gynecologic Emergencies

Standard

Trauma (Environmental Emergencies)

Competency

Applies fundamental knowledge to provide basic emergency care and transportation based on assessment findings for an acutely injured patient.

Core Concepts

- Effects on the body of generalized hypothermia; assessment and care for hypothermia
- Effects on the body of local cold injuries; assessment and care for local cold injuries
- Personal effects on the body of exposure to heat; assessment and care for patients suffering from heat exposure
- Signs, symptoms, and treatment for drowning and other water-related injuries
- Signs, symptoms, and treatment for bites and stings

Objectives

After reading this chapter, you should be able to:

- **31.1** Define key terms introduced in this chapter.
- **31.2** Describe processes of heat loss and heat production by the body. (pp. 851–852)
- **31.3** Recognize predisposing factors and exposure factors in relation to hypothermia. (pp. 853–854)
- **31.4** Recognize signs and symptoms of hypothermia. (pp. 854–855)
- **31.5** Describe the indications, contraindications, benefits, and risks of passive and active rewarming techniques. (p. 855)
- **31.6** Prioritize steps in assessment and management of patients with varying degrees of hypothermia. (pp. 855–857)

31.7 Discuss assessment and management for early or superficial local cold injury and for late or deep local cold injury. (pp. 857–860)

31.8 Discuss the effects of heat on the human body. (p. 860)

31.9 Differentiate between assessment and management priorities for heat emergency patients with moist, pale, normal-to-cool skin and those with hot skin that is either dry or moist. (pp. 860–863)

31.10 Anticipate the types of injuries and medical conditions that may be associated with water-related accidents. (pp. 863–864)

31.11 Discuss the assessment and management of the following water-related emergencies:
- **a.** Drowning (including rescue breathing and care for possible spinal injuries) (pp. 864–868)
- **b.** Diving accidents (p. 868)
- **c.** Scuba-diving accidents (pp. 868–870)

31.12 Describe safe techniques for water rescues and ice rescues. (pp. 870–873)

31.13 Discuss the assessment and management of the following types of bites and stings:
- **a.** Insect bites and stings (pp. 873–875)
- **b.** Snakebites (pp. 875–877)
- **c.** Poisoning from marine life (p. 877)

Key Terms

active rewarming, *p. 855*
air embolism, *p. 869*
central rewarming, *p. 856*
conduction, *p. 851*
convection, *p. 852*
decompression sickness, *p. 869*
drowning, *p. 864*
evaporation, *p. 852*
hyperthermia, *p. 860*
hypothermia, *p. 853*
local cooling, *p. 857*
passive rewarming, *p. 855*
radiation, *p. 852*
respiration, *p. 852*
toxins, *p. 873*
venom, *p. 873*
water chill, *p. 851*
wind chill, *p. 852*

ENVIRONMENTAL EMERGENCIES CAN occur in any setting—wilderness, *rural,* suburban, and urban areas. They include exposure to both heat and cold; drownings and other water-related injuries; and bites and stings from insects, spiders, snakes, and marine life. The keys to effective management are recognizing the patient's signs and symptoms and providing prompt and proper emergency care. However, as an EMT, you also must recognize that exposure may not be the only danger to the patient. Environmental emergencies can involve preexisting or cause additional medical problems and injuries.

Exposure to Cold

How the Body Loses Heat

If the environment is too cold, body heat can be lost faster than it can be generated. The body attempts to adjust to these temperature differences by reducing perspiration and circulation to the skin—shutting down avenues by which the body usually gets rid of excess heat. Muscular activity in the form of shivering and the rate at which fuel (food) is burned within the body both increase to produce more heat. At a certain point, however, not enough heat is generated to be available to all parts of the body. This may result in damage to exposed tissues and a general reduction or cessation of body functions.

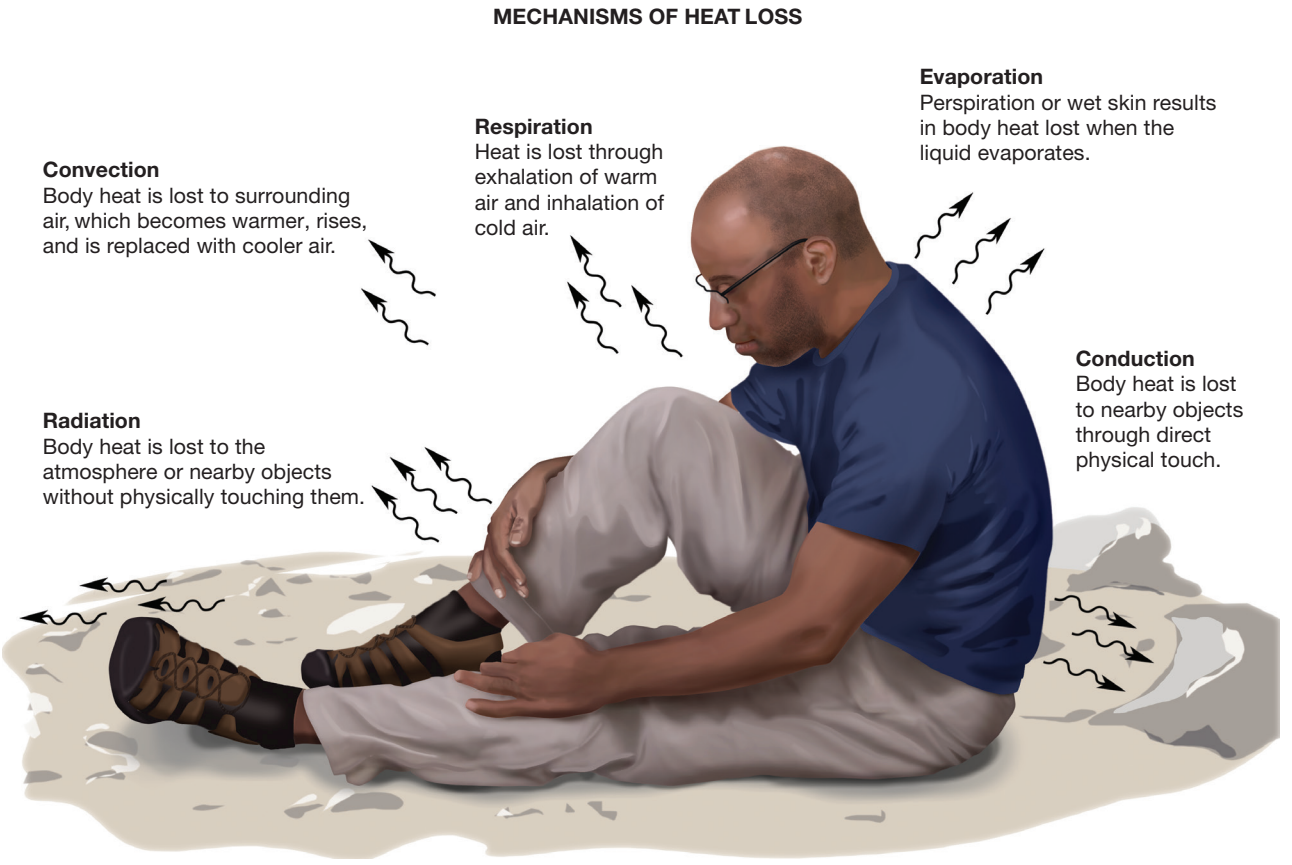
To be able to prevent or compensate for heat loss, the EMT must be aware of the ways in which a body loses heat (Figure 31-1):

- **Conduction.** The transfer of heat from one material to another through direct contact is called ***conduction***. Heat will flow from a warmer material to a cooler one. Although body heat transferred directly into cool air is a problem, ***water chill*** is an even greater

conduction
the transfer of heat from one material to another through direct contact.

water chill
chilling caused by conduction of heat from the body when the body or clothing is wet.

FIGURE 31-1 Mechanisms of heat loss.



problem because water conducts heat away from the body twenty-five times faster than still air. Patients with wet bodies or clothing are especially susceptible to water chill in cold environments. Heat loss through conduction can be a major problem when a person is lying on a cold floor or another cold surface. However, a person who is standing or walking around in cold weather will lose less heat than a person who is lying on the cold ground.

- **Convection.** When currents of air or water pass over the body, carrying away heat, ***convection*** occurs. The effects of a cold environment are worsened when moving water or air surrounds the body. ***Wind chill*** is a frequent problem. The faster the wind speed, the greater the heat loss. For example, if it is 10°F with no wind, the body will lose heat, but if there is a 20 mph wind, the amount of heat lost by the body is much greater.
- **Radiation.** In conduction and convection, heat is "picked up" by the surrounding (still or moving) air or water. In ***radiation*** the body's atoms and molecules send out rays of heat as they move and change. If you were in the vacuum of outer space with no air or water around to pick up heat, you would still lose heat by radiating it out into space. Most radiant heat loss occurs from a person's head and neck.
- **Evaporation.** ***Evaporation*** occurs when the body perspires or gets wet. As perspiration or water on the skin or clothing vaporizes, the body experiences a generalized cooling effect.
- **Respiration.** ***Respiration*** causes loss of body heat as a result of exhaled warm air. The amount of heat loss depends on the outside air temperature as well as the rate and depth of respirations.

convection
carrying away of heat by currents of air, water, or other gases or liquids.

wind chill
chilling caused by convection of heat from the body in the presence of air currents.

radiation
sending out energy, such as heat, in waves into space.

evaporation
the change from liquid to gas. When the body perspires or gets wet, evaporation of the perspiration or other liquid into the air has a cooling effect on the body.

respiration
breathing. During respiration, body heat is lost as warm air is exhaled from the body.

Table 31-1 Stages of Hypothermia

Core Body Temperature		
Fahrenheit	**Celsius**	**Symptoms**
99°F–96°F	37.0°C–35.5°C	Shivering.
95°F–91°F	35.5°C–32.7°C	Intense shivering, difficulty speaking.
90°F–86°F	32.0°C–30.0°C	Shivering decreases and is replaced by strong muscular rigidity. Muscle coordination is affected, and erratic or jerky movements are produced. Thinking is less clear, general comprehension is dulled, and possible total amnesia exists. Patient generally is able to maintain the appearance of psychological contact with surroundings.
85°F–81°F	29.4°C–27.2°C	Patient becomes irrational, loses contact with the environment, and drifts into a stuporous state. Muscular rigidity continues. Pulse and respirations are slow, and cardiac dysrhythmias may develop.
80°F–78°F	26.6°C–20.5°C	Patient loses consciousness and does not respond to spoken words. Most reflexes cease to function. Heartbeat slows further before cardiac arrest occurs.

Generalized Hypothermia

When cooling affects the entire body, a problem known as ***hypothermia***, or generalized cooling, develops. Exposure to cold reduces body heat. With time, the body is unable to maintain its proper core (internal) temperature. If this cooling is allowed to continue, hypothermia leads to death. The stages of hypothermia are described in Table 31-1. Although specific temperatures are listed for particular signs and symptoms, there is some variation in the temperatures at which these events occur. The sequence of signs and symptoms generally follows the signs and symptoms listed in the table.

Predisposing Factors

Patients with injuries, chronic illness, or certain other conditions will show the effects of cold much sooner than healthy persons. These conditions include shock (hypoperfusion), burns, head and spinal-cord injuries, generalized infection, and diabetes with hypoglycemia. Those under the influence of alcohol or other drugs also tend to be affected more rapidly and more severely than others. The unconscious patient lying on the cold ground or other cold surface is especially prone to rapid heat loss through conduction and will tend to have greater cold-related problems than one who is conscious and able to walk around.

NOTE: *Be aware that hypothermia can develop in temperatures well above freezing.*

Obvious and Subtle Exposure

At times it is obvious that a patient has been exposed to cold and is probably suffering from hypothermia. With other patients, however, exposure is subtle—that is, not so obvious, and not the first thing you may think about. Consider, for example, the elderly patient who has

> "Heat and cold can affect you too. Dress appropriately and plan for the weather you'll encounter out there."

(© Daniel Limmer)

CORE CONCEPT

Effects on the body of generalized hypothermia; assessment and care for hypothermia

hypothermia
(HI-po-THURM-e-ah)
generalized cooling that reduces body temperature below normal, which is a life-threatening condition in its extreme.

GERIATRIC NOTE

Hypothermia is often an especially serious problem for the aged. The effects of cold temperatures on the elderly are more immediate. During the winter months, many older citizens on small, fixed incomes live in unheated rooms or rooms that are kept too cool. Failing body systems, chronic illnesses, poor diets, certain medications, and a lack of exercise may combine with the cold environment to bring about hypothermia.

PEDIATRIC NOTE

Since infants and young children are small with large skin surface areas in relation to their total body mass and have little body fat, they are especially prone to hypothermia. Because of their small muscle mass, infants and children do not shiver very much or at all—another reason the very young are susceptible to the cold. You will learn in the chapter "Obstetric and Gynecologic Emergencies," that a crucial part of the care for newborn infants is to dry them (to prevent heat loss from evaporation) and cover their heads (to prevent heat loss by radiation and convection).

fallen during the night and is not discovered until morning. A broken hip or other injuries may claim your attention, but if your patient has been on the cold floor all night, he is probably also suffering from hypothermia. The patient trapped in a wrecked auto is probably suffering a variety of injuries, but if the weather is cool and extrication from the vehicle takes a while, the patient can easily develop hypothermia as well.

Consider the possibility of hypothermia in the following situations when another condition or injury may be more obvious:

- **Ethanol (alcohol) ingestion.** Has the intoxicated patient passed out on a cold floor or been wandering around outdoors in cool or cold weather?
- **Underlying illness.** Does the patient have a circulatory disorder or other condition that makes him especially susceptible to cold?
- **Overdose or poisoning.** Has the patient been lying in a cold garage or on a cold floor? Is he sweating heavily in a cool environment with evaporation causing excessive heat loss?
- **Major trauma.** Has the patient been lying on the ground or trapped in wreckage during cold weather? Is shock (hypoperfusion, or inadequate circulation of the blood) preventing parts of the body from being warmed by circulating blood?
- **Outdoor resuscitation.** Is your patient getting too cold? If your patient is a drowning patient who has been in the water, has exposure to cool water caused hypothermia?
- **Decreased ambient temperature (for example, room temperature).** Is your patient living in a home or apartment that is too cold?

Remember that the injured patient is more susceptible to the effects of cold than a healthy individual. Protect the patient who is entrapped or for any other reason must remain in a cool or cold environment for a period of time. The major course of action is to prevent additional body heat loss. It may be neither practical nor possible to replace wet clothing, but you can at least create a barrier to the cold with blankets, a salvage cover, an aluminized blanket, a survival blanket, or even articles of clothing. A plastic trash bag can serve as protection from wind and water. Keep in mind that the greatest area of heat loss may be the head, so provide some sort of head covering for the patient.

When the patient's injuries allow, place a blanket between his body and the cold ground or between him and the wreckage he is pinned in. Rotate warm blankets from the heated ambulance to the patient. If the patient will remain trapped for a period of time, plug holes in the wreckage with blankets.

PATIENT ASSESSMENT

Hypothermia

Consider the impact of the following factors when assessing a patient: air temperature, wind chill and/or water chill, the patient's age, the patient's clothing, the patient's health, including underlying illness and existing injuries, how active the patient was during exposure, and possible alcohol or drug use.

The following list contains common signs and symptoms of hypothermia. Note that decreasing mental status and decreasing motor function both correlate with the degree of hypothermia:

- Shivering in early stages when the core body temperature is above 90°F. In severe cases, shivering decreases or is absent.
- Numbness, or reduced or lost sense of touch.
- Stiff or rigid posture in prolonged cases.
- Drowsiness and/or unwillingness or inability to do even the simplest activities. In prolonged exposures, the patient may become irrational, drift into a stuporous state, or actually remove clothing.
- Rapid breathing and rapid pulse in early stages, and slow or absent breathing and pulse in prolonged cases. (The patient's slow pulse and respirations require that you spend at least 30 to 45 seconds performing a check for a pulse and respirations.) Blood pressure may be low or undetectable.
- Loss of motor coordination, such as poor balance, staggering, or inability to hold things.
- Joint/muscle stiffness, or muscular rigidity.
- Decreased level of consciousness or unconsciousness. In extreme cases, the patient has a "glassy stare."
- Cool abdominal skin temperature. (Place your hand inside the clothing with the back of your hand against the patient's abdomen.)
- Skin may appear red in early stages. In prolonged cases skin is pale or cyanotic. In most extreme cases, some body parts are stiff and hard (frozen).

During primary assessment, be sure to check an awake patient's orientation to person, place, and time. (Can he tell you his name? Where he is? What day it is?) Perform a secondary assessment to help you estimate the extent of hypothermia. Assume severe hypothermia if shivering is absent.

Decision Point

- Does the patient have an altered mental status?

Passive and Active Rewarming

Passive rewarming allows the body to rewarm itself. It involves simply covering the patient and taking other steps, including removal of wet clothing, to prevent further heat loss. These actions allow the body to naturally regain its warmth. ***Active rewarming*** includes application of an external heat source to the body. All EMS systems permit passive rewarming. Although some allow the active rewarming of a hypothermic patient who is alert and responding appropriately, many do not. Follow your local protocols.

passive rewarming
covering a hypothermic patient and taking other steps to prevent further heat loss and help the body rewarm itself.

active rewarming
application of an external heat source to rewarm the body of a hypothermic patient.

Active rewarming can prove to be a dangerous process if the patient's condition is more serious than believed. If you are allowed to rewarm a patient with hypothermia who is alert and responding appropriately, do not delay transport. Rewarm the patient while en route. The emergency care steps that follow assume a protocol that permits active rewarming of a patient who is alert and responding appropriately to your intervention. Follow your local protocols.

PATIENT CARE

Hypothermic Patient Who Is Alert and Responding Appropriately

For the hypothermic patient who is alert and responding appropriately, proceed with active rewarming:

1. Remove all of the patient's wet clothing. Keep the patient dry, and dress the patient in dry clothing or wrap in dry, warm blankets. Keep the patient still, and handle him very gently. Do not allow the patient to walk or exert himself. Do not massage his extremities.
2. During transport, actively rewarm the patient. Gently apply heat to the patient's body in the form of heat packs, hot water bottles, electric heating pads, warm air, radiated

POINT of VIEW

"I was riding my horse on the beach. It is a wonderful feeling. Well, it was until I got thrown. Now I've been thrown before, and you get back up. This time I broke bones.

"To make it worse, it was winter. No one was around.

"I shivered for a while. I yelled and yelled. I tried to move but no luck. Then I stopped shivering and started to get tired. It is funny looking back on that day. I kind of relaxed there at the end. Now I know that means I was on the final glide path. I was heading out.

"Someone finally saw the horse just standing there and came over to figure out why. By that time, I was like an ice cube.

"I remember the EMTs coming along and warming me up. Blanket after blanket and the heat in the ambulance was blasting. Those guys must've been boiling. I'm very thankful for them—and for the person that finally called for help. Without them, I wouldn't be telling this story."

heat, and even your own body heat. Do not warm the patient too quickly. Rapid warming will circulate peripherally stagnated cold blood and rapidly cool the vital central areas of the body, possibly causing cardiac arrest. If transport is delayed, move the patient to a warm environment if at all possible.

3. Provide care for shock. Provide oxygen, warmed and humidified if possible.
4. Give the alert patient warm liquids at a slow rate. When warm fluids are given too quickly, the patient's circulation patterns change. Blood is sent away from the core and instead routed to the skin and extremities. Do not allow the patient to eat or drink stimulants.
5. Except in the mildest of cases (shivering), transport the patient. Continue to provide high-concentration oxygen and monitor vital signs. Never allow a patient to remain in or return to a cold environment.

Take the following precautions when actively rewarming a patient:

- Rewarm the patient slowly. Handle the patient with great care, just as if there were unstabilized cervical-spine injuries.
- Use ***central rewarming***. Heat should be applied to the lateral chest, neck, armpits, and groin. You must avoid rewarming the limbs. If they are warmed first, blood will collect in the extremities due to vasodilation (dilation of blood vessels), possibly causing a fatal form of shock (see the chapter titled "Bleeding and Shock"). If you rewarm the trunk and leave the lower extremities exposed, you can control the rewarming process and help prevent most of the problems associated with the procedure.
- If transport must be delayed, giving the patient a warm bath is very helpful. However, keep the patient alert enough so he does not drown. Do not warm the patient too quickly.
- Keep the patient at rest. Do not allow the patient to walk. Since the blood is coldest in the extremities, exercise or unnecessary movement could quickly circulate the cold blood and lower the core body temperature.
- Avoid any rough handling of the hypothermic patient. Such activity may set off fatal dysrhythmias, especially ventricular fibrillation.

central rewarming
application of heat to the lateral chest, neck, armpits, and groin of a hypothermic patient.

PATIENT CARE

Hypothermic Patient Who Is Unresponsive or Not Responding Appropriately

A patient who is unresponsive or not responding appropriately has severe hypothermia. For this patient, provide passive rewarming. Do not try to actively rewarm the patient with severe hypothermia. Remove the patient from the environment, and protect him from further heat loss. Active rewarming may cause the patient to develop ventricular fibrillation

and other complications. Active rewarming can be initiated after arrival at the emergency department in a more monitored setting.

For the patient with severe hypothermia, you should:

1. Ensure an open airway.
2. Provide high-concentration oxygen that has been passed through a warm-water humidifier. If necessary, you can use the oxygen that has been kept warm in the ambulance passenger compartment. If there is no other choice, you can use oxygen from a cold cylinder.
3. Wrap the patient in blankets. If available, use insulating blankets. Handle the patient as gently as possible, as rough handling may cause ventricular fibrillation. Do not allow the patient to eat or drink stimulants. Do not massage his extremities.
4. Transport the patient immediately.

Extreme Hypothermia

In cases of extreme hypothermia, you will find the patient unconscious with no discernible vital signs. The heart rate can slow to less than 10 beats per minute, and the patient will feel very cold to your touch (core body temperature may be below 80°F). Even so, it is possible that a patient in this condition is still alive! Provide emergency care as follows:

- Assess the carotid pulse for 30 to 45 seconds. If there is no pulse, start CPR immediately and prepare to apply the AED.
- If there is a pulse, follow the care steps for a patient who is unresponsive or not responding appropriately as previously listed.

Because the hypothermic patient may not reach biological death for more than 30 minutes, the hospital staff will not pronounce a patient dead until after they have rewarmed him and applied resuscitative measures. This means you cannot assume that a severe hypothermia patient is dead on the basis of body temperature and lack of vital signs. As medical personnel point out, "You're not dead until you're warm and dead!"

Local Cold Injuries

Cold-related emergencies also can result from ***local cooling***. Local cooling injuries, those affecting particular (local) parts of the body, are classified as (1) early or superficial and (2) late or deep.

CORE CONCEPT

Effects on the body of local cold injuries; assessment and care for local cold injuries

local cooling
cooling or freezing of particular (local) parts of the body.

Local cooling most commonly affects the ears, nose, face, hands and fingers, and feet and toes. When a part of the body is exposed to intense cold, blood flow to that part is limited by the constriction of blood vessels. When this happens, tissues freeze. Ice crystals can form in the skin and, in the most severe cases, gangrene (localized tissue death) can set in, which may ultimately lead to the loss of the body part.

As you read the following pages, notice how the signs and symptoms of early or superficial cold injuries are progressive. First, the exposed skin reddens in light-skinned individuals. In dark-skinned individuals, the skin color lightens and approaches a blanched (reduced-color or whitened) condition. As exposure continues, the skin takes on a gray or white blotchy appearance. Exposed skin becomes numb because of reduced circulation. If the freezing process continues, all sensation is lost and the skin becomes dead white.

PATIENT ASSESSMENT

Early or Superficial Local Cold Injury

Early or superficial local cold injuries (sometimes called frostnip) are brought about by direct contact with a cold object or exposure to cold air. Wind chill and water chill also can be major factors. In this condition tissue damage is minor and response to care is good. The tip of the nose, tips of the ears, upper cheeks, and fingers (all areas that are usually exposed) are most susceptible to early or superficial local cold injuries. The injury, as its name suggests, is localized with clear demarcation of its limits. Patients are often unaware of the onset of an early local cold injury until someone indicates that there is

something unusual about the person's skin color. The following list contains common signs and symptoms:

- The affected area in patients with light skin reddens; in patients with dark skin, it lightens. Both then blanch (whiten). Once blanching begins, the color change can take place very quickly.
- The affected area feels numb to the patient.

PATIENT CARE

Early or Superficial Local Cold Injury

Emergency care for early local cold injury is as follows:

1. Get the patient out of the cold environment.
2. Warm the affected area.
3. If the injury is to an extremity, splint and cover it. Do not rub or massage the area, and do not reexpose it to the cold.

Usually the patient can apply warmth from his own bare hands; blow warm air on the site; or if the fingers are involved, hold them in the armpits. During recovery from an early local cold injury, the patient may complain about tingling or burning sensations, which is normal. If the condition does not respond to this simple care, begin to treat for a late or deep local cold injury.

PATIENT ASSESSMENT

Late or Deep Local Cold Injury

Late or deep local cold injury (also known as frostbite) develops if an early or superficial local cold injury goes untreated. In late or deep local cold injury, the skin and subcutaneous layers of the body part are affected. Muscles, bones, deep blood vessels, and organ membranes can become frozen. The following list contains common signs and symptoms of this condition:

- Affected skin appears white and waxy. When the condition progresses to actual freezing, the skin turns mottled or blotchy, and the color turns from white to grayish yellow and finally to grayish blue. Swelling and blistering may also occur (Figure 31-2).
- The affected area feels frozen but only on the surface. The tissue below the surface is still soft and has its normal resilience, or "bounce." With freezing, the tissues are not resilient and feel frozen to the touch.

NOTE: *Do not squeeze or poke the tissue. The condition of the deeper tissues can be determined by gently feeling the area. Do the assessment as if the affected area had a fractured bone.*

FIGURE 31-2 Local cold injuries. *(© Edward T. Dickinson, MD)*

PATIENT CARE

Late or Deep Local Cold Injury

Initial emergency care for late or deep local cold injury—frostbite and freezing—is as follows:

1. Administer high-concentration oxygen.
2. Transport to a medical facility without delay, protecting the frostbitten or frozen area by covering it and handling it as gently as possible.
3. If transport must be delayed, get the patient indoors and keep him warm. Do not allow the patient to drink alcohol or smoke because constriction of blood vessels and decreased circulation to the injured tissues may result. Rewarm the frozen part as per local protocol, or request instructions from medical direction.

NOTE: *Never listen to myths and folktales about the care of frostbite. Never rub a frostbitten or frozen area. Never rub snow on a frostbitten or frozen area. There are ice crystals at the capillary level; rubbing the injury site may cause them to seriously damage the already injured tissues. Do not break blisters or massage the injured area. Do not allow the patient to walk on an affected extremity. Do not thaw a frozen limb if there is any chance it will be refrozen.*

Active Rapid Rewarming of Frozen Parts

Active rewarming of frozen parts is seldom recommended. The chance of permanently injuring frozen tissues with active rewarming is too great. Consider it only if local protocols recommend it, if you are instructed to do so by medical direction, or if transport will be severely delayed and you cannot reach medical direction for instructions. If you are in a situation where you must attempt rewarming without instructions from a physician, follow the procedure described here.

You will need warm water and a container in which you can immerse the entire site of injury without the limb touching the sides or bottom of the container. If you cannot find a suitable container, fashion one from a plastic bag supported by a cardboard box or wooden crate (Figure 31-3). Proceed as follows:

1. Heat water to between 100°F and 105°F. You should be able to put your finger into the water without experiencing discomfort.
2. Fill the container with the heated water, and prepare the injured part by removing clothing, jewelry, bands, or straps. Thawed areas often swell, so you need to remove potentially constricting items beforehand.
3. Fully immerse the injured part. Do not allow the injured area to touch the sides or bottom of the container. Do not place any pressure on the affected part. Continuously stir the water. When the water cools below 100°F, remove the affected part and add more warm water. The patient may complain of moderate pain as the affected area rewarms, or he may experience intense pain. Pain is usually a good indicator of successful rewarming.

FIGURE 31-3 Rewarming the frozen part.

4. If you complete rewarming of the part (it no longer feels frozen and is turning red or blue), gently dry the affected area, and apply a dry sterile dressing. Place dry sterile dressings between the patient's fingers and toes before dressing his hands and feet. Next cover the site with blankets or whatever is available to keep the area warm. Do not allow these coverings to come in direct contact with the injured area or to put pressure on the site. First try to build some sort of framework on which the coverings can be placed.
5. Keep the patient at rest. Do not allow the patient to walk if a lower extremity has been frostbitten or frozen.
6. Make certain that you keep the entire patient as warm as possible without overheating him. Cover the patient's head with a towel or small blanket to reduce heat loss. Leave the patient's face exposed.
7. Continue to monitor the patient.
8. Assist circulation according to local protocols (some systems recommend rhythmically and carefully raising and lowering the affected limb).
9. Do not allow the limb to refreeze.
10. Transport as soon as possible with the affected limb slightly elevated.

Exposure to Heat

Effects of Heat on the Body

CORE CONCEPT

Personal effects on the body of exposure to heat; assessment and care for patients suffering from heat exposure

The body generates heat as a result of its constant internal chemical processes. A certain amount of this heat is required to maintain normal body temperature. Any heat that is not needed for temperature maintenance must be lost from the body. If it is not, the result is ***hyperthermia***, an abnormally high body temperature. If left unchecked, it will lead to death. Heat and humidity are often associated with hyperthermia.

hyperthermia
(HI-per-THURM-e-ah)
an increase in body temperature above normal, which is a life-threatening condition in its extreme.

As you learned earlier, heat is lost through the lungs or the skin. Mechanisms of heat loss include conduction, convection, radiation, evaporation, and respiration. Consider what can happen to the body in a hot environment. Air being inhaled is warm, possibly warmer than the air being exhaled. The skin may absorb more heat than it loses. When high humidity is added, the evaporation of perspiration slows. To make things even more difficult, consider all this in an environment that lacks circulating air or a breeze, which would increase convection and evaporative heat loss.

Since evaporative heat loss is reduced in a humid environment, moist heat can produce dramatic body changes in a short time. Moist heat usually tires people quickly and frequently stops them from harming themselves through overexertion. Dry heat, in contrast, often deceives people. They continue to work or remain exposed to excess heat far beyond what their bodies can tolerate.

The same rules of care apply to heat emergencies as to any other emergency. You will need to perform the appropriate steps of assessment, remaining alert for problems other than those related to heat. Collapse due to heat exhaustion, for example, may result in a fall that can fracture bones. Preexisting conditions such as dehydration, diabetes, fever, fatigue, high blood pressure, heart disease, lung problems, or obesity may hasten or intensify the effects of heat exposure, as will ingestion of alcohol and other drugs.

Age, diseases, and existing injuries all must be considered. The elderly may be affected by poor thermoregulation, prescription medications, and lack of mobility. Newborns and infants also may have poor thermoregulation. Always consider the problem to be greater if the patient is a child or elderly person who is injured or living with a chronic disease.

Patient with Moist, Pale, and Normal or Cool Skin

Prolonged exposure to excessive heat can create an emergency in which the patient presents with moist, pale skin that may feel normal or cool to the touch, a condition generally known as *heat exhaustion*. The individual perspires heavily, often drinking large quantities of water. As sweating continues, the body loses salts, bringing on painful muscle cramps

(sometimes called *heat cramps*). A person who is actively exercising can lose more than a liter of fluid through perspiration per hour.

Healthy individuals who have been exposed to excessive heat while working or exercising may experience a form of shock brought about by fluid and salt loss. This condition is often seen among firefighters, construction workers, dockworkers, and those employed in poorly ventilated warehouses. It is a particular problem during prolonged heat waves early in the summer, before people have become acclimatized to summer heat.

PATIENT ASSESSMENT

Heat Emergency Patient with Moist, Pale, and Normal or Cool Skin

The following are common signs and symptoms of a heat emergency patient with moist, pale, and normal or cool skin:

- Muscular cramps, usually in the legs and abdomen
- Weakness or exhaustion and sometimes dizziness or periods of faintness
- Rapid, shallow breathing
- Weak pulse
- Heavy perspiration
- Loss of consciousness is possible but is usually brief if it occurs.

Decision Point

- What is the color and condition of the patient's skin?

PATIENT CARE

Heat Emergency Patient with Moist, Pale, and Normal or Cool Skin

Emergency care of a heat emergency patient with moist, pale, and normal or cool skin includes the following steps:

1. Remove the patient from the hot environment, and place him in a cool environment (such as in shade or an air-conditioned ambulance).
2. Administer oxygen by nonrebreather mask at 15 liters per minute.
3. Loosen or remove clothing to cool the patient by fanning without chilling him. Watch for shivering.
4. Put the patient in a supine position. Keep him at rest.
5. If the patient is responsive and not nauseated, have him drink small sips of water. If this causes nausea or vomiting, do not give any more water. Be alert for vomiting and airway problems. If the patient is unresponsive or vomiting, do not give water. Transport the patient to the hospital on his left side.
6. If the patient experiences muscular cramps, apply moist towels over cramped muscles.
7. Transport the patient.

Decision Point

- What is the color and condition of the patient's skin?

Patient with Hot Skin, Whether Dry or Moist

When a person's temperature-regulating mechanisms fail and the body cannot rid itself of excessive heat, you will see a patient with hot and dry or possibly moist skin. When the skin is hot—whether dry or moist—this condition, generally known as *heat stroke*, is a true emergency. The problem is compounded when, in response to loss of fluid and salt, the patient stops sweating, which prevents heat loss through evaporation. Athletes, laborers, and others who exercise or work in hot environments are especially at risk for this condition, as are the elderly who live in poorly ventilated apartments without air conditioning and children left in cars with the windows rolled up.

PATIENT ASSESSMENT

Heat Emergency Patient with Hot Skin, Whether Dry or Moist

The following are common signs and symptoms of a heat emergency patient with hot and dry or hot and moist skin:

- Loss of consciousness or altered mental status (Altered mental status is mandatory for a determination of heat stroke.)
- Rapid, shallow breathing
- Full and rapid pulse
- Generalized weakness
- Little or no perspiration
- Dilated pupils
- Potential seizures; no muscle cramps

Decision Point

- What is the color and condition of the patient's skin?

PATIENT CARE

Heat Emergency Patient with Hot Skin, Whether Dry or Moist

Emergency care of a heat emergency patient with hot and dry or hot and moist skin is as follows (Figure 31-4):

1. Remove the patient from the hot environment, and place him in a cool environment (in the ambulance with the air conditioner running on high).
2. Remove the patient's clothing. Apply cool packs to his neck, groin, and armpits. Keep the skin wet by applying water by sponge or wet towels. Aggressively fan the patient.
3. Administer oxygen by nonrebreather mask at 15 liters per minute.
4. Transport immediately. If transport is delayed, continue to attempt to cool the patient with ice packs. In addition, you can cover the patient with a sheet, and wet and fan the patient to enhance heat loss by evaporation.

FIGURE 31-4 Aggressively cool in a heat emergency where the patient's skin is hot and either dry or moist.

PEDIATRIC NOTE

For infants or young children, cooling is started using tepid (lukewarm) water. This water can then be replaced with cooler water at the recommendation of medical direction.

Beware of what you are told by some patients. They may not believe heat emergencies are serious. Many simply want to return to work. Nevertheless, conduct a thorough primary assessment plus a secondary assessment. If you have any doubts about his condition, tell the patient why he should be transported and seek his permission to do so. You may have to spend a little time with some patients to gain their confidence.

Water-Related Emergencies

Water-Related Accidents

CORE CONCEPT

Signs, symptoms, and treatment for drowning and other water-related injuries

Drowning is the first thing people think of in connection with water-related accidents. However, there are many types of injuries resulting from many types of accidents that can occur on or in the water. Boating, water-skiing, wind-surfing, jet-skiing, diving, and scuba-diving accidents can produce fractured bones, bleeding, soft-tissue injuries, and airway obstructions. Even auto collisions can send vehicles or passengers into the water, resulting in any of the injuries usually associated with motor-vehicle collisions as well as the complications caused by the presence of water.

Medical problems such as heart attacks can also cause, or be caused by, water accidents or can simply take place in, on, or near the water. Remember, too, that some water accidents happen far away from pools, lakes, or beaches. For example, bathtub drownings do occur. Adults as well as children can drown in only a few inches of water.

Inside Outside

HYPOTHERMIA AND HYPERTHERMIA

Hypothermia and hyperthermia are serious conditions that, when not treated, can lead to death. The following chart explains the pathophysiology behind the main categories of patient presentation.

Inside	Outside
The body undergoes many changes as hypothermia develops. The cardiovascular and central nervous systems are perhaps the most affected by hypothermia. The heart becomes more irritable and prone to dysrhythmias as the body becomes colder. The CNS becomes more sluggish and less responsive.	Hypothermia with normal mental status
At about 91.5°F (33°C), electrical activity in the brain activity becomes abnormal.	Hypothermia with altered mental status
Hyperthermia with cool skin indicates the body is still able to deal with the heat through normal mechanisms (e.g., sweating). Body temperature is a balance of inside and outside temperatures.	Hyperthermia with cool skin
The skin is the major cooling mechanism of the body. When the skin is hot, it indicates that this system is no longer able to dissipate enough heat to maintain a normal body temperature and rapid cooling is necessary. A core temperature that has reached about 105.8°F (41°C) is the critical point.	Hyperthermia with hot skin

NOTE: *Do not attempt a rescue in which you must enter deep water or swim unless you have been trained to do so and are a very good swimmer. Except for shallow pools and open shallow waters with uniform bottoms, the problems faced in water rescue are too great and too dangerous for the poor swimmer or untrained person. If this bothers you—having to stand by, not being able to help—then take a course in water safety and rescue. (Both the American Red Cross and the YMCA offer water safety and rescue courses.) Otherwise, if you attempt a deep-water or swimming rescue, you will probably become a patient yourself.*

PATIENT ASSESSMENT

Water-Related Accidents

Learn to look for the following problems in water-related-incident patients:

- **Airway obstruction.** This may be from water in the lungs, foreign matter in the airway, or swollen airway tissues (which is common if the neck is injured in a dive). Spasms of the vocal cords may be present in some cases of drowning.
- **Cardiac arrest.** This is often related to respiratory arrest or occurs before drowning.
- **Signs of heart attack.** Some untrained rescuers too quickly conclude that chest pains are due to muscle cramps as a result of swimming.
- **Injuries to the head and neck.** These are expected to be found in boating, water-skiing, and diving accidents, but they are also very common in swimming accidents.
- **Internal injuries.** While doing the physical exam, stay on the alert for musculoskeletal injuries, soft-tissue injuries, and internal bleeding.
- **Generalized cooling, or hypothermia.** The water does not have to be very cold and the length of stay in the water does not have to be very long for hypothermia to occur.
- **Substance abuse.** Alcohol and drug use are closely associated with adolescent and adult drownings. Elevated blood alcohol levels have been found in more than 30 percent of drowning patients. The screening for drug use has not been as extensive as that done for alcohol, but research indicates that other drugs are a contributory factor in many water-related accidents.
- **Drowning.** The patient may be discovered under or facedown in the water. He may be unconscious and without discernible vital signs or may be conscious, breathing, and coughing up water.

Provide assessment and care for any of the previously noted problems as you have learned in other chapters of this text. Drowning is discussed in detail next.

Drowning

drowning
the process of experiencing respiratory impairment from submersion/immersion in liquid, which may result in death, morbidity (illness or other adverse effects), or no morbidity.

In 2002 the World Health Organization (WHO) adopted a definition of ***drowning*** that is different from the traditional one. According to the WHO, "Drowning is the process of experiencing respiratory impairment from submersion/immersion in liquid. Drowning outcomes are classified as death, morbidity, and no morbidity." (Excerpt from Drowning in Violence and Injury Prevention by the World Health Organization, http://www.who.int/violence_injury_prevention/other_injury/drowning/en/. Copyright © 2014 by the World Health Organization. Used by permission of the World Health Organization.) Morbidity means the patient experiences illness or other adverse effects, such as unconsciousness or pneumonia. The American Heart Association has also adopted this definition of drowning. The WHO definition does not describe near drowning. Hence, the term *near drowning* is no longer used.

The process of drowning often begins as a person struggles to keep afloat in the water. He gulps in large breaths of air as he thrashes about. When he can no longer keep afloat and starts to submerge, he tries to take and hold one more deep breath. As he does, water may enter the airway. There is a series of coughing and swallowing actions, and the patient involuntarily inhales and swallows more water. As water flows past the epiglottis, it triggers a reflex spasm of the larynx. This spasm seals the airway so effectively that no more than a small amount of water reaches the lungs. Unconsciousness soon results from hypoxia (oxygen starvation).

About 10 percent of the people who die from drowning die just from the lack of air. In the remaining patients, the person typically attempts a final respiratory effort and draws water into the lungs, or the spasms subside with the onset of unconsciousness and water freely enters the lungs.

Some patients who drown in cold water can be resuscitated after 30 minutes or more in cardiac arrest. Once the water temperature falls below 70°F, biological death may be delayed. The colder the water, the better the patient's chances for survival, unless generalized hypothermia produces lethal complications.

Rescue Breathing in or out of the Water

Transport for the drowning patient should not be delayed. You may initiate care when the patient is out of the water (already out when you arrive or in the water when you arrive but rescued by others before you initiate care). At other times, you may need to initiate care while the patient is still in the water—especially rescue breathing and immobilization for possible spine injuries. Chest compressions will be effective only after the patient is out of the water.

If needed, rescue breathing should begin without delay. If you can reach the non-breathing patient in the water, provide ventilations as you support him in a semi-supine position. Continue providing ventilations while the patient is being removed from the water. If there are no signs of trauma and there is no mechanism of injury (such as reported diving) to suggest a spinal injury, then avoid attempts at immobilization as it may interfere with effective rescue breathing. If the patient is already out of the water, begin rescue breathing or CPR on the land.

You may encounter airway resistance as you ventilate the drowning patient. However, you will probably have to ventilate more forcefully than you would other patients. Remember, you must provide air to the patient's lungs as soon as possible.

A patient with water in the lungs usually has water in the stomach, which will add resistance to your efforts to provide rescue breathing or CPR ventilations. Since the patient may have spasms along the airway or swollen tissues in the larynx or trachea, you may find that some of the air you provide will go into the patient's stomach. Remember, the same problem will occur if you do not properly open the airway or if your ventilations are too forceful.

If gastric distention interferes with artificial ventilation, place the patient on his left side. With suction immediately available, the EMT should place his hand over the epigastric area of the abdomen and apply firm pressure to relieve the distention. This procedure should be done only if the gastric distention interferes with the EMT's efforts to artificially ventilate the patient in an effective manner.

Care for Possible Spinal Injuries in the Water

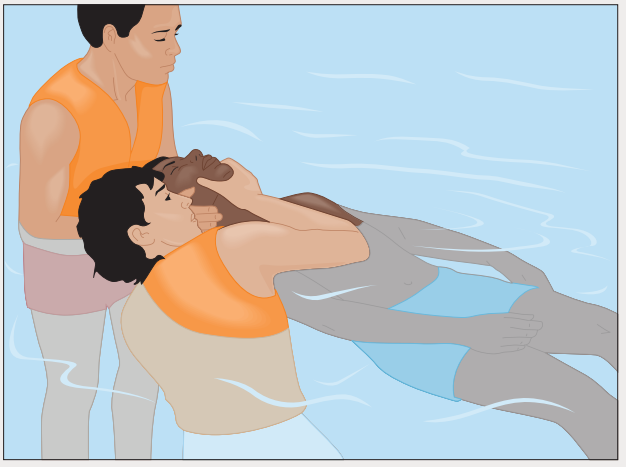
Injuries to the cervical spine can be encountered in water-related accidents. Most often, these injuries are received during a dive or when the patient is struck by a boat, skier or ski, or surfer or surfboard. Even though cervical-spine injuries are the most common of the spine injuries seen in water-related accidents, there can be injury anywhere along the spine. This is in contrast to simple immersion drownings without trauma involved in which spinal injuries are very rare.

In water-related accidents, assume that the unconscious patient has neck and spinal injuries. If the patient has head injuries, also assume that there are neck and spinal injuries. Keep in mind that a patient found in respiratory or cardiac arrest will need resuscitation started before you can immobilize the neck and spine. Also, realize that you may not be able to carry out a complete assessment for spinal injuries while the patient is in the water. Take care to avoid aggravating spinal injuries, but do not delay basic life support. Do not delay removing the patient from the water if the scene presents an immediate danger. When possible, keep the patient's neck rigid and in a straight line with the body's midline (Scan 31-1). Use the jaw-thrust maneuver to open the airway.

If the patient with possible spinal injuries is still in the water, you are a good swimmer with proper training, and you are able to aid in the rescue, secure the patient to a long spine board before removing him from the water. This may help prevent permanent neurological damage or paralysis. This type of rescue requires special training in the use of the spine board while in the water. This rigid device can "pop up" very easily from below the water surface. Make certain that you know how to control the board and how to work in the water.

HEAD-CHIN SUPPORT

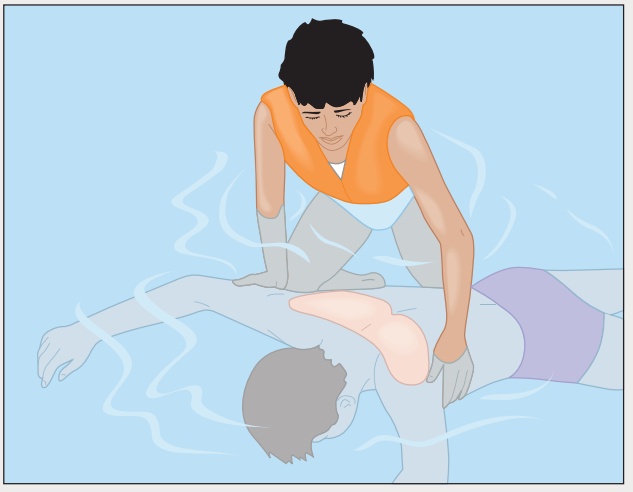
TWO RESCUERS IN SHALLOW WATER



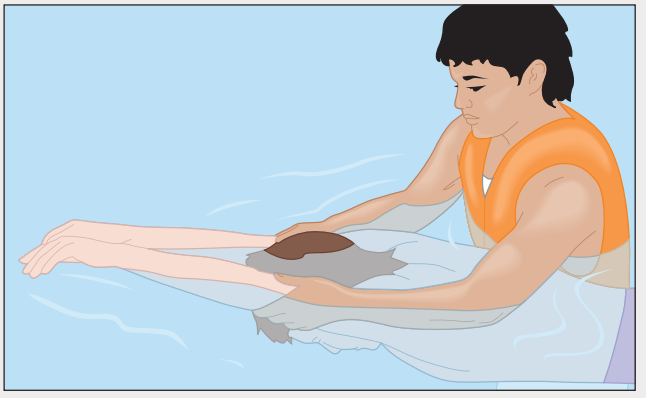
When there are two rescuers present, perform the head-chin support technique to provide in-line stabilization of a patient in shallow water.

HEAD-SPLINT SUPPORT

ONE RESCUER IN SHALLOW WATER



1. When you find a patient facedown in shallow water, position yourself alongside the patient.



2. Extend the patient's arms straight up alongside his head to create a splint.

3. Begin to rotate the torso toward you.

NOTE: *Unless you are a very good swimmer and trained in water rescue, do not go into the water to save someone.*

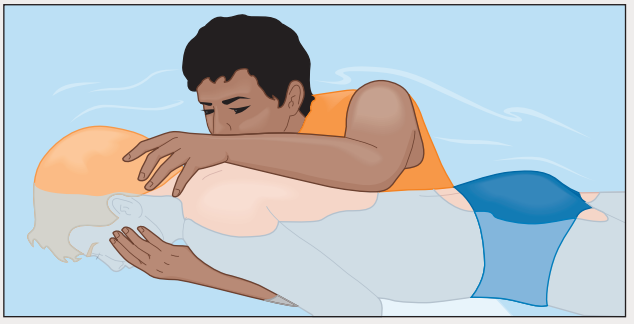
(continued)

4. As you rotate the patient, lower yourself into the water.

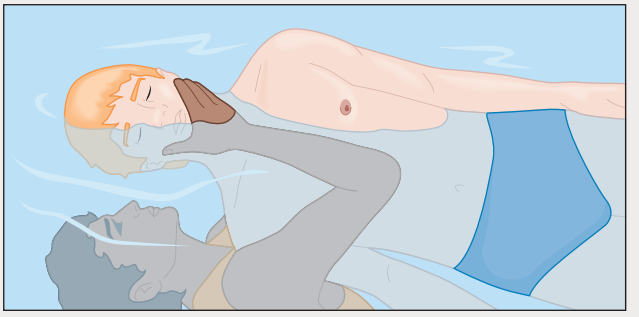
5. Maintain manual stabilization by holding the patient's head between his arms.

HEAD-CHIN SUPPORT

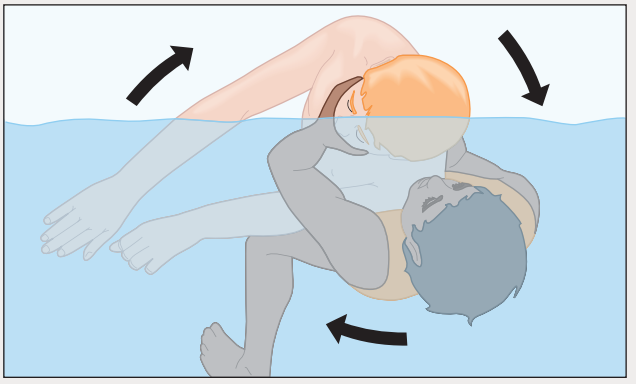
ONE RESCUER IN DEEP WATER



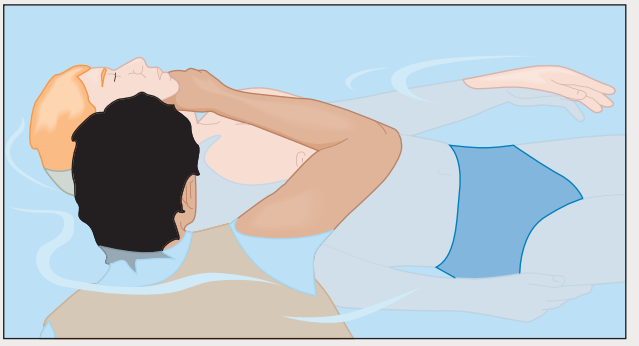
1. When you find a patient facedown in deep water, position yourself beside him. Support his head with one hand and the mandible with the other.



2. Rotate the patient by ducking under him.



3. Continue to rotate until the patient is faceup.



4. Maintain in-line stabilization until a backboard is used to immobilize the patient's spine.

PATIENT CARE

Water-Related Incidents

In all cases of water-related incidents, assume that the unconscious patient has neck and spinal injuries. If the patient is rescued by others while you wait on shore, or if the patient is out of the water when you arrive, you should:

1. Do a primary assessment, protecting the spine as much as possible.
2. Provide rescue breathing. If there is no pulse, begin CPR and prepare to apply the AED. Protect yourself by using a pocket face mask with a one-way valve or bag-valve-mask unit.
3. Look for and control profuse bleeding. Since the patient's heart rate may have slowed down, take a pulse for 60 seconds in all cold-water rescue situations before concluding that the patient is in cardiac arrest.
4. Provide care for shock (as described in the chapter "Bleeding and Shock"), administer high-concentration oxygen, and transport the patient as soon as possible.
5. Continue resuscitative measures throughout transport. Initial and periodic suctioning may be needed.

The drowning patient receiving rescue breathing or CPR should be transported as soon as possible. If resuscitation and immediate transport are not required, cover the patient to conserve his body heat and complete a secondary assessment. Uncover only those areas of the patient's body involved with the stage of the assessment. Care for any problems or injuries detected during the assessment in the order of their priority.

If spinal injury is not suspected, place the patient on his left side to allow water, vomit, and other secretions to drain from the upper airway. Suction as needed. When transport is delayed and you believe that the patient can be moved to a warmer place, do so without aggravating any existing injuries. Do not allow the drowning patient to walk. Transport the patient. A significant number of patients who appear normal after a drowning episode have delayed effects, so persuade the patient to accept transport to a hospital.

Information supplied to the dispatcher or to the hospital from the scene and during transport is critical in cases of drowning. The hospital emergency department staff needs to know if this is a fresh- or saltwater drowning, if it took place in cold or warm water, and if it is related to a diving accident. You may be asked to transport the patient to a special facility or to a center having a hyperbaric chamber when decompression therapy is needed.

Diving Accidents

Water-related accidents often involve injuries that occur when individuals attempt dives or enter the water from diving boards. In the majority of these accidents, the patient is a teenager. Basically the same types of injuries are seen in dives taken from diving boards, poolsides, docks, boats, and the shore. The injury may be due to the diver striking the board or some object on or under the water. From great heights, injury may result from impact with the water.

Most diving accidents involve the head and neck, but you will also find injuries to the spine, hands, feet, and ribs in many cases. Any part of the body can be injured depending on the position that the diver is in when he strikes the water or an object. This means that you must perform a primary assessment. You must also perform a secondary assessment on all diving-accident patients. Do not overlook the fact that a medical emergency may have led to the diving accident.

Emergency care for diving-accident patients is the same as for all accident patients if they are out of the water. Care provided in the water and during removal from the water is the same as for any patient who may have neck and spine injuries. Remember, you should assume that any unconscious or unresponsive patient has neck and spinal injuries.

Scuba-Diving Accidents

Diving accidents involving scuba (self-contained underwater breathing apparatus) gear have increased with the popularity of the sport, especially since many untrained and inexperienced persons are attempting dives. Today more than 2 million people scuba dive for sport or

as part of their industrial or military jobs. Added to this are a large number who decide to "try it one time," without the benefits of lessons or supervision. Well-trained divers seldom have problems. However, those with inadequate training place themselves at great risk.

Scuba-diving accidents include all types of body injuries and drownings. In many cases the scuba-diving accident was brought about by medical problems that existed prior to the dive. There are two special problems seen in scuba-diving accidents: air emboli in the diver's blood and decompression sickness.

An ***air embolism***—more accurately called an *arterial gas embolism (AGE)*—is the result of gases leaving a damaged lung and entering the bloodstream. Severe damage may lead to a collapsed lung. Air emboli (gas bubbles in the blood) are most often associated with divers who hold their breath because of inadequate training, equipment failure, underwater emergency, or attempts to conserve air during a dive. However, a diver may develop an air embolism in very shallow water (as little as 4 feet). An automobile-collision patient also may suffer an air embolism if, when trapped below water, he takes gulps of air from air pockets held inside the vehicle. When freed, the patient may develop air emboli in the same way as a scuba diver.

air embolism
gas bubble in the bloodstream. The plural is air emboli. The more accurate term is *arterial gas embolism (AGE)*.

Decompression sickness is usually caused when a diver comes up too quickly from a deep, prolonged dive. The quick ascent causes nitrogen gas to be trapped in the body tissues then in the bloodstream. Decompression sickness in scuba divers takes from 1 to 48 hours to appear, with about 90 percent of cases occurring within 3 hours of the dive. Divers increase the risk of decompression sickness if they fly within 12 hours of a dive. Because of this delay, carefully consider all information gathered from the patient interview and reports from the patient's family and friends. This information may provide the only clues relating the patient's problems to a scuba dive.

decompression sickness
a condition resulting from nitrogen trapped in the body's tissues, caused by coming up too quickly from a deep, prolonged dive. A symptom of decompression sickness is "the bends," or deep pain in the muscles and joints.

The following are common signs and symptoms of scuba-diving problems:

Air Embolism (Rapid Onset of Signs and Symptoms)

- Blurred vision
- Chest pains
- Numbness and tingling sensations in the extremities
- Generalized or specific weakness, possible paralysis
- Frothy blood in the mouth or nose
- Convulsions
- Rapid lapse into unconsciousness
- Respiratory arrest and cardiac arrest

Decompression Sickness

- Personality changes
- Fatigue
- Deep pain to the muscles and joints (the "bends")
- Itchy blotches or mottling of the skin
- Numbness or paralysis
- Choking
- Coughing
- Labored breathing
- Behavior similar to intoxication (such as staggering)
- Chest pains
- Collapse leading to unconsciousness

For a patient with signs and symptoms of either air embolism or decompression sickness, follow the same emergency care steps:

1. Maintain an open airway.
2. Administer the highest possible concentration of oxygen by nonrebreather mask.

FIGURE 31-5 Proper positioning of a scuba-diving accident patient.

3. Rapidly transport all patients with possible air emboli or decompression sickness.
4. Contact medical direction for specific instructions concerning where to take the patient. You may be sent directly to a hyperbaric trauma care center.
5. Keep the patient warm.
6. Position the patient either supine or on either side (Figure 31-5). Continue to monitor the patient. You may have to reposition the patient to ensure an open airway.

The Diver Alert Network (DAN) was formed to assist rescuers with the care of underwater diving-accident patients. The staff, which is available on a twenty-four-hour basis, can be reached by phoning the emergency contact number 1-919-684-9111. Collect calls will be accepted for actual emergencies. DAN can give you or your dispatcher information on assessment and care and how to transfer the patient to a hyperbaric trauma care center. (A hyperbaric trauma care center is one that has a special pressure chamber for treatment of such conditions.) For nonemergency medical information, call 1-919-684-2948.

NOTE: *The well-trained scuba diver makes use of a preplanned dive chart. The dive chart, if it is available, may provide you with useful information concerning the nature and duration of the dive. This chart must be transported with the patient.*

Water Rescues

The following is the order of procedures for a water rescue (Figure 31-6), most of which can be performed short of going into the water: reach, throw and tow, row, and go.

- **Reach.** When the patient is responsive and close to shore or poolside, try to reach him by holding out an object for him to grab. Then pull him from the water. Make sure your position is secure. Line (rope) is considered the best choice. If no line is available, use a branch, fishing rod, oar, stick, or other such object—even a towel, blanket, or article of clothing. If no object is available or you have only one opportunity to grab the person (e.g., in strong currents), position yourself flat on your stomach and extend your hand or leg to the patient. (This is not recommended for the nonswimmer.) Again, make certain that you are working from a secure position.
- **Throw and tow.** If the person is conscious and alert but too far away for you to reach and pull from the water, throw an object that will float (Figure 31-7). A personal flotation device (PFD or lifejacket) or ring buoy (life preserver) works best. Other buoyant objects include foam cushions, logs, plastic picnic containers, surfboards, flatboards, large beach balls, and plastic toys. Two empty, capped, plastic milk jugs can keep an adult afloat for hours. Inflatable splints can be used if there is nothing at the scene that will float.

  Once the conscious patient has a flotation device, try to find a way to tow him to shore. From a safe position, throw the patient a line or another flotation device attached to a line. If you are a good swimmer and you know how to judge the water, wade out no

FIGURE 31-6 First try to reach and pull the patient from the water. If that fails, throw him anything that will float and tow him from the water. If that fails, row to the patient.

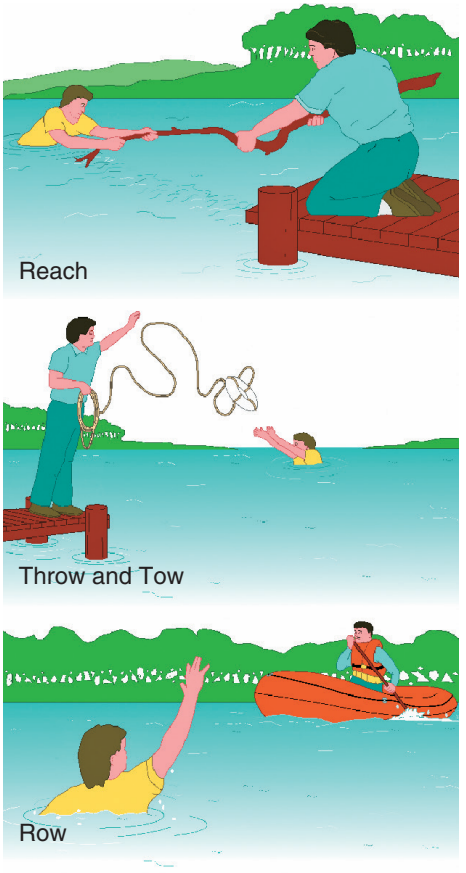


FIGURE 31-7 Throw the patient any object that will float.

deeper than waist high, wear a personal flotation device, and have a safety line that is secured on shore.

- **Row.** When the patient is too far from shore to allow for throwing and towing or is unresponsive, you may be able to row a boat to the patient. However, do not attempt to row to the patient if you cannot swim. Even if you are a good swimmer, wearing a personal flotation device is required while you are in the boat.

  If the patient is conscious, tell him to grab an oar or the stern (rear end) of the boat. You must exercise great care when helping the patient into the boat. This is even trickier when you are in a canoe. If the canoe tips over, stay with it and hold on to its bottom and side. Most canoes will stay afloat.
- **Go.** As a last resort, when all other means have failed, you can go into the water and swim to the patient. However, you must be a good swimmer, trained in water rescue and lifesaving. Untrained rescuers can become patients themselves.

Decision Point

- What is the safest way to rescue the patient—considering safety for both the EMT and the patient.

Ice Rescues

Every winter people fall through ice while skating or attempting to cross an ice-covered body of water. Often the scene becomes a multiple-rescue problem as other individuals

FIGURE 31-8 Safe ice rescues require proper equipment.

fall through the ice while trying to reach the patient. The number-one rule in ice rescue is to protect yourself. Formal ice rescue training is available. In addition, you should wear a cold-water submersion suit and personal flotation device during any ice rescue attempt (Figure 31-8).

There are several ways in which you can reach a patient who has fallen through ice:

- You can throw a flotation device to the patient.
- You can toss a rope in which a loop has been formed to the patient. The patient can put the loop around his body so he can be pulled onto the ice and away from the danger area.
- You can use a small, flat-bottomed aluminum boat for an ice rescue. It can be pushed stern (rear end) first by other rescuers and pulled to safety by a rope secured to the bow (front end). The primary rescuer will remain dry and safe if the ice breaks. The patient can be pulled from the water or allowed to grasp the side of the boat, although he may be unable to grasp or to hold on for long.
- A ladder is an effective tool often used in ice rescue. It can be laid flat and pushed to the patient then pulled back by an attached rope. The ladder also can serve as a surface on which a rescuer can spread out his weight if he must go onto the ice to reach the patient. The ladder should have a line that can be secured by a rescuer in a safe position. Any rescuer on the ladder should have a safety line.

Remember that the patient may not be able to do much to help in the rescue process. In just a matter of minutes, hypothermia may interfere with his mental and physical capabilities.

Whenever possible, do not work alone when trying to perform an ice rescue. If you must work alone, do not walk out onto the ice. Never go onto ice that is rapidly breaking. Never enter the water through a hole in the ice to find the patient. Your best course of action will be to work with others from a safe ice surface or the shore. When there is no other choice, you and your fellow rescuers can elect to form a human chain to reach the patient. However, this is not the safest method to employ, even when all the rescuers are wearing personal flotation devices and using safety lines.

Expect to find injuries to most patients who have fallen through the ice. Treat for hypothermia according to local protocols and treat for any injuries. Transport all patients who have fallen through ice.

Bites and Stings

Insect Bites and Stings

CORE CONCEPT
Signs, symptoms, and treatment for bites and stings

Insect stings, spider bites, and scorpion stings are typical sources of injected poisons, or ***toxins***—substances produced by animals or plants that are poisonous to humans. (***Venom*** is a term for a toxin produced by some animals such as snakes, spiders, and certain marine life forms.) Commonly seen insect stings are those of wasps, hornets, bees, and ants. Insect stings and bites are rarely dangerous. However, 5 percent of the U.S. population will have an allergic reaction to them, which may result in shock. Those who are hypersensitive develop severe anaphylactic shock that is quickly life threatening (see the chapter "Allergic Reaction").

toxins
substances produced by animals or plants that are poisonous to humans.

venom
a toxin (poison) produced by certain animals such as snakes, spiders, and some marine life forms.

Although all spiders are venomous, most species cannot get their fangs through human skin. The black widow spider and the brown recluse, or fiddleback, spider (Figure 31-9) are two that can, and their bites can produce medical emergencies. Almost all brown recluse spider bites are painless, and patients seldom recall being bitten. The characteristic lesion appears in only 10 percent of cases and only after up to 12 hours (Figure 31-10). EMTs are seldom called to respond to a brown recluse bite. However, black widow bites cause a more immediate reaction.

Scorpion stings are common in the Southwest United States. They do not ordinarily cause deaths, but one rare species (*Centruroides exilcauda*) is dangerous to humans and can cause serious medical problems in children, including respiratory failure.

Bites and stings belong in the class of injected poisons discussed in the chapter "Poisoning and Overdose Emergencies."

FIGURE 31-9 (A) Black widow spider. (B) Brown recluse spider. *(Both photos: Centers for Disease Control/Paula Smith)*

(A)

(B)

FIGURE 31-10 Brown recluse spider bite. *(Centers for Disease Control)*

PATIENT ASSESSMENT

Insect Bites and Stings

Gather information from the patient, bystanders, and the scene. Find out whatever you can about the insect or other possible source of the envenomation. The following are common signs and symptoms of injected envenomation:

- Altered states of awareness
- Noticeable stings or bites on the skin
- Puncture marks (especially note the fingers, forearms, toes, and legs)
- Blotchy (mottled) skin
- Localized pain or itching
- Numbness in a limb or body part
- Burning sensations at the site followed by pain spreading throughout the limb
- Redness
- Swelling or blistering at the site
- Weakness or collapse
- Difficult breathing and abnormal pulse rate
- Headache and dizziness
- Chills
- Fever
- Nausea and vomiting
- Muscle cramps, chest tightening, joint pains
- Excessive saliva formation, profuse sweating
- Anaphylaxis

NOTE: *Look for medical identification devices that identify persons sensitive to certain stings or bites. Some patients sensitive to stings or bites carry medication to help prevent anaphylactic shock. This situation is described in the "Allergic Reaction" chapter.*

PATIENT CARE

Insect Bites and Stings

As an EMT, you are not expected to be able to identify insects and spiders. Proper identification of these organisms is best left to experts. If the patient's problem was caused by a creature that is known locally and is not normally dangerous (such as a bee, wasp, or puss caterpillar), your major concern regarding the patient will be anaphylactic shock. If anaphylactic shock does not develop, care is usually simple.

If the cause of the bite or sting is unknown or the organism is unknown, a physician should see the patient. Call medical direction or take the patient to a medical facility, and let experts decide on the proper treatment for the patient. If possible, transport the stinging object or organism in a sealed container, taking care not to handle it without proper protection, even if it is dead. If you can accomplish this safely, you may save precious minutes needed to identify the toxin.

To provide emergency care for injected toxins:

1. Treat for shock, even if the patient does not present any of the signs of shock.
2. Call medical direction. Skip this only if the organism is known and your EMS system has a specific protocol for care.
3. To remove the stinger or venom sac, the traditional advice was to scrape the site with a blade or a card and to avoid pulling with tweezers (it was thought using tweezers might squeeze more venom into the wound). However, research indicates that how you remove the stinger or venom sac is far less important than doing so quickly. The venom sac is actually hard, not floppy, so squeezing venom into the wound is very difficult.
4. Remove jewelry from the patient's affected limb in case the limb swells, which would make removal more difficult later.
5. If local protocols permit and if the wound is on an extremity (not a joint), place constricting bands above and below the sting or bite site. This is done to slow the spread of venom in the lymphatic vessels and superficial veins. The band should be made of ¾-inch- to 1½-inch-wide soft rubber or other wide soft material. It should be placed about 2 inches from the wound. The band must be loose enough to slide a finger under it. It should not cut off circulation.
6. Keep the limb immobilized and the patient still to prevent distribution of the venom to other parts of the body.

NOTE: *Some EMS systems recommend placing a cold compress on the wound. However, most EMS systems do not use cold for any injected toxin. Follow your local protocols.*

Snakebites

Snakebites require special care but are usually not life threatening. Nearly fifty thousand people in the United States are bitten by snakes each year. Although more than eight thousand of these cases involve venomous snakes, on the average fewer than ten deaths each year are reported from snakebites. (In the United States, more people die each year from bee and wasp stings than from snakebites.) The signs and symptoms of snakebite envenomation may take several hours to appear. If death does result, it is usually not a rapidly occurring event unless anaphylactic shock develops. Most patients who die survive at least two days.

In the United States, there are two types of native venomous snakes—pit vipers (including rattlesnakes, copperheads, and water moccasins) and coral snakes (Figure 31-11). Up to 25 percent of pit viper bites and 50 percent of coral bites are "dry bites" without venom injection. However, the venomous bite from a diamondback rattler or coral snake is considered very serious. Since each person reacts differently to a snakebite, you should consider the bite from any known venomous snake or any unidentified snake to be a serious emergency. Staying calm and keeping the patient calm and at rest are critical.

NOTE: *Native snakes are not the only kind of venomous animals you may encounter. A number of people have decided to keep venomous reptiles even though it is illegal to do so in most areas. So even if you live in an area where there are no venomous snakes, you may encounter a patient who has sustained a bite from one.*

PATIENT ASSESSMENT

Snakebite

Unless you are dealing with a known species of snake that is not considered venomous, consider all snakebites to be from venomous snakes. The patient or bystanders may say the snake was not venomous, but they could be mistaken. The signs and symptoms of snakebite may include the following:

- Noticeable bite on the skin, which may appear as nothing more than a discoloration
- Pain and swelling in the area of the bite, which may be slow to develop, taking from thirty minutes to several hours

FIGURE 31-11 The pit vipers include (A) cottonmouth, (B) rattlesnake, and (C) copperhead. The coral snake (D) is also venomous. *(Photo A: Centers for Disease Control/Edward J. Wozniak, DVM, PhD; Photo B: Centers for Disease Control/Edward J. Wozniak, DVM, PhD; Photo C: Centers for Disease Control/James Gathany; Photo D: U.S. Fish and Wildlife Service/Luther C. Goldman)*

(A)

(B)

(C)

(D)

- Rapid pulse and labored breathing
- Progressive general weakness
- Vision problems (dim or blurred)
- Nausea and vomiting
- Seizures
- Drowsiness or unconsciousness

If the dead or captured snake is at the scene, your role as an EMT is not to identify the snake but to place it in a sealed container and transport it along with the patient. Arrange for separate transport of a live specimen. Do not transport a live snake in the ambulance.

If you see the live, uncaptured snake, take great care, or you may be its next victim. When possible, note its size and coloration. Getting close enough to look for details of the eyes or for a pit between the eye and mouth is foolish. The way you classify a snake, whether it is dead or alive, will probably have little to do with your subsequent care of the patient. The medical facility staff will arrange to have an expert classify a captured or dead specimen, and they have protocols to determine patient care if the snake has not been captured. Unless you are an expert in capturing snakes, do not try to catch the snake. *Never delay care and transport to capture the snake.*

PATIENT CARE

Snakebite

Emergency care of a patient with snakebite includes:

1. Call medical direction to determine the best receiving facility where antivenom will be most readily available to treat the patient. Rapid transport and the administration of antivenom are the most effective interventions for the treatment of life-threatening snakebite injuries.
2. Treat for shock and conserve body heat. Keep the patient calm.
3. Locate the fang marks. There may be only one fang mark.
4. Remove any rings, bracelets, or other constricting items on the bitten extremity.
5. Keep any bitten extremities immobilized—the application of a splint will help. Do not elevate the limb above the level of the heart.
6. Transport the patient, carefully monitoring vital signs.

NOTE: *Do not place an ice bag or cold pack on the bite unless you are directed to do so by a physician or local protocols. Do not cut into the bite and suction or squeeze the bite site. Never suck the venom from the wound using your mouth. Instead, use a suction cup. However, suctioning is seldom done.*

Research indicates that the use of a *pressure immobilization bandage* may be the most effective technique to slow the spread of venom after a snakebite. This technique involves immediately wrapping the bitten extremity with an elastic (ACE-type) bandage and immobilizing the wrapped extremity with a rigid splint or a sling on the upper extremity. The wrap should be only as snug as if you were wrapping a sprained ankle.

The purpose of the pressure immobilization bandage is to restrict the flow of lymph, not of blood. The wrap should be snug but not tight enough to cut off circulation. Monitor for a pulse at the wrist or ankle. Check to be certain that tissue swelling does not cause the constricting bands to become too tight.

Poisoning from Marine Life

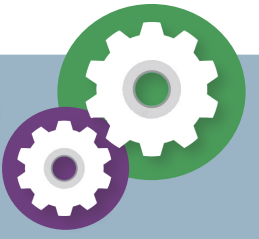
Poisoning from marine life forms can occur in a variety of ways—from eating improperly prepared seafood or poisonous organisms to receiving stings and punctures from aquatic life forms. Patients who have ingested spoiled, contaminated, or infested seafood may develop a condition that resembles anaphylactic shock. Therefore, they should receive the same care as any patient in anaphylactic shock. During care, you must be prepared in case the patient vomits. Most patients will show the signs of food poisoning. The care for seafood poisoning is the same as for all other food poisonings.

It is extremely rare for someone in the United States to eat a poisonous variety of marine life since creatures such as puffer fish and paralytic shellfish are not readily available. For all cases of suspected poisoning due to ingestion, call your on-line medical direction or the poison control center as local protocols direct you. Be prepared for the patient to display vomiting, convulsions, and respiratory arrest.

Venomous marine life forms producing sting injuries include the jellyfish, the sea nettle, the Portuguese man-of-war, coral, the sea anemone, and the hydra. For most victims, the sting produces pain with few complications. Some patients may show allergic reactions and possibly develop anaphylactic shock. These cases require the same care as rendered for any case of anaphylactic shock. Stings to the face, especially those near or on the lip or eye, require a physician's attention. Rinsing the affected area with vinegar will reduce the pain of the sting. However, be careful not to let vinegar get into the patient's mouth or eyes. Once the site has been rinsed with vinegar to inactivate the venom, immersion of the site in hot but nonscalding water (maximum temperature 45°C or 113°F) may further reduce the pain.

Puncture wounds can occur when someone steps on or grabs a stingray, sea urchin, spiny catfish, or other form of spiny marine animal. Although it is true that soaking the wound in nonscalding hot water for 30 to 90 minutes will break down the venom, you should not delay transport. Puncture wounds must be treated by a physician, and the patient may need a tetanus inoculation. Remember, the patient could react to the venom by developing anaphylactic shock.

Critical Decision Making



Safety First

Environmental emergencies provide a variety of situations in which an EMT must act. Some patients need to be cooled; others, warmed. However, before you even get to treat the patient, you must make some safety decisions. Consider the following situations, and identify the safety hazards:

1. You are taking a walk while on vacation. You hear a sound from the water and see that several hundred feet out in the water a person is struggling to stay afloat.
2. You are ice skating with the family and hear screaming. Someone has fallen through the ice. A group of people have gathered around the hole, peering downward.
3. You are on a hiking path and hear screaming. A hiker has been bitten by a snake. He is in pain and holding his leg. He is sitting by an outcropping of rocks.

Chapter Review

Key Facts and Concepts

- Patients suffering from exposure to heat or cold must be removed from the harmful environment as quickly and as safely as possible.
- Generalized cold injuries involve cooling of the entire body, also referred to as hypothermia. Treatment decisions are based on whether that patient has a normal or altered mental status.
- Patients who have hypothermia with an altered mental status are considered to have severe hypothermia.
- Local cold injury involves an isolated part or parts of the body. It has also been referred to as frostbite. Early local injury sites may be rewarmed gently. Late local injury involves freezing of tissue. You should transport rather than rewarm the patient unless transport is significantly delayed or you are advised by medical direction.
- Hyperthermia is a heat emergency. Its severity is determined by skin temperature. Skin that is normal to cool is considered less severe than skin that is hot to the touch. All heat-emergency patients should be removed from the heat and cooled. Altered mental status in the setting of hyperthermia indicates a life-threatening emergency.
- Follow local protocols in reference to rewarming or cooling procedures.
- Immediate resuscitation of the water-related emergency patient may require quick and persistent intervention. Always assure your own safety before attempting any sort of rescue.
- For injection or ingestion of the venoms of insects, spiders, snakes, and marine life, call medical direction and follow your local protocols.

Key Decisions

- Is the scene safe from heat, cold, and venomous creatures?
- How can I safely get the patient from the water?
- Hypothermia: Does the patient have an altered mental status?
- Hyperthermia: Is the patient's skin temperature cool to normal or hot?

Chapter Glossary

active rewarming application of an external heat source to rewarm the body of a hypothermic patient.

air embolism gas bubble in the bloodstream. The plural is air emboli. The more accurate term is *arterial gas embolism (AGE)*.

central rewarming application of heat to the lateral chest, neck, armpits, and groin of a hypothermic patient.

conduction the transfer of heat from one material to another through direct contact.

convection carrying away of heat by currents of air, water, or other gases or liquids.

decompression sickness a condition resulting from nitrogen trapped in the body's tissues, caused by coming up too quickly from a deep, prolonged dive. A symptom of decompression sickness is "the bends," or deep pain in the muscles and joints.

drowning the process of experiencing respiratory impairment from submersion/immersion in liquid, which may result in death, morbidity (illness or other adverse effects), or no morbidity.

evaporation the change from liquid to gas. When the body perspires or gets wet, evaporation of the perspiration or other liquid into the air has a cooling effect on the body.

hyperthermia (HI-per-THURM-e-ah) an increase in body temperature above normal, which is a life-threatening condition in its extreme.

hypothermia (HI-po-THURM-e-ah) generalized cooling that reduces body temperature below normal, which is a life-threatening condition in its extreme.

local cooling cooling or freezing of particular (local) parts of the body.

passive rewarming covering a hypothermic patient and taking other steps to prevent further heat loss and help the body rewarm itself.

radiation sending out energy, such as heat, in waves into space.

respiration breathing. During respiration, body heat is lost as warm air is exhaled from the body.

toxins substances produced by animals or plants that are poisonous to humans.

venom a toxin (poison) produced by certain animals such as snakes, spiders, and some marine life forms.

water chill chilling caused by conduction of heat from the body when the body or clothing is wet.

wind chill chilling caused by convection of heat from the body in the presence of air currents.

Preparation for Your Examination and Practice

Short Answer

1. When is it appropriate to treat a cold emergency with active rewarming, and when should you perform passive rewarming?
2. List five situations in which a patient may be suffering from hypothermia along with another, more obvious medical condition or injury.
3. Name the signs and symptoms of a late or deep localized cold injury.
4. Describe the management of a patient suffering from heat emergency who has moist, pale, and cool skin.
5. Describe the management of a patient suffering from a heat emergency who has hot, dry skin.
6. Describe the proper care for a patient suffering from snakebite.

Thinking and Linking

Think back to the chapters titled "Introduction to Emergency Medical Care," "The Well-Being of the EMT," and "Communication and Documentation." Link information from those chapters to information from this chapter as you consider the following situation:

- You respond to a snakebite. There, you find a patient and witnesses who describe a snake to you in great detail. Where would you find information on what type of snake this was, if it was venomous, and how to treat the patient? What would you do if the snake were still present?

Think back to the chapters "Introduction to Emergency Medical Care," "The Well-Being of the EMT," and "Lifting and Moving Patients." Link information from those chapters to information from this chapter as you consider the following situation:

- You have a patient who is experiencing hypothermia, is half a mile into the woods, and is not accessible by ambulance. Do you have clothing available that would protect you and your crew/team from hypothermia during the trip in and out? If you will be an EMT in a warm climate, change the situation. It is hot and humid. A hiker has experienced a heat emergency. Can you and your crew/team get the patient out without experiencing a heat emergency yourselves? In either case what transport device(s) and resources would you use to remove the patient from the woods?

Critical Thinking Exercises

Some environmental emergencies are dangerous for both the patient and the EMT. The purpose of this exercise will be to consider options for patient care in several such circumstances.

1. Your hypothermia patient has an altered mental status. How does this affect your care for the patient? What if you were several hours by snowmobile from the nearest road?
2. What is the underlying pathophysiology that makes hot skin more serious than having cool skin in a heat emergency? What are the implications of hot skin for the care you provide?
3. You are with your family at a local lake. You observe a boat capsize near the middle of the lake and can hear screams from the scene. You are a marginal swimmer. Several civilians begin swimming out to the site. Apply the concepts learned in the Scene Size-Up chapter to this scene.

Pathophysiology to Practice

The following questions are designed to assist you in gathering relevant clinical information and making accurate decisions in the field.

1. Why is an altered mental status a major factor in determining whether to actively or passively rewarm a hypothermia patient?
2. Explain why skin temperature (cool or warm versus hot) is a major factor in determining whether to aggressively cool a patient.

Street Scenes

It's very cold out, and it's been snowing for hours. Shortly after sundown, you get dispatched for an "unknown man down" call in a downtown area where homeless people often sleep outdoors. As you pull up to the scene, you are met by a police officer who tells you that the man sitting by the heater grate in the sidewalk was going to be taken to the shelter "but something didn't seem right." You get the first-in bag and approach the patient. You ask his name, and he says, "Frank." You ask for a last name, but he doesn't respond.

"Well, Frank, what's going on?" He just stares. "Do you have any pain?" Again, no response. He just sits with his arms folded over his chest and appears to be shivering. "Frank, we think you need to go to the hospital to get checked out."

"What?" he whispers. You ask the patient if he can stand up, but his response is unintelligible. You get the cot and load for transport. The police officer asks you what's wrong, and you tell him that you think the patient might be hypothermic.

Street Scene Questions

1. What concerns might you have for this patient?
2. What assessment needs to be performed?
3. Should you rewarm this patient? If so, when should you start?

When you get into the ambulance, you repeat your primary assessment, checking the patient's breathing closely and looking for any external bleeding. Again you ask the patient if he knows where he is, but he responds with only groans. You notice that his clothing is wet, so you turn up the heat in the patient compartment, take off his wet jacket and shirt, and wrap him in more blankets. He is still shivering. You take a set of vital signs and determine his blood pressure is 90/60, pulse is 120, respiration rate is 28 and shallow, and skin is flushed. When you feel the abdomen with the back of your hand, it feels cool. You do not smell any alcohol on the patient, and when you check distal pulses, motor function, and sensation, you find that he can move all extremities but it is difficult and seems painful. His pupils respond to light but appear sluggish. You decide to administer oxygen by nonrebreather mask. You also decide not to actively rewarm the patient but keep him wrapped in blankets, covering his head and keeping the heater turned up.

Street Scene Questions

4. How often should you take vital signs?
5. When moving the patient out of the ambulance and onto the hospital stretcher, what precautions should you take?

You decide to take another set of vital signs after 5 minutes because you think that this patient could be at risk for respiratory arrest or sudden cardiac death. You make sure the AED and the respiratory equipment are close at hand. His vital signs are about the same. You call the hospital, give your report, and advise an ETA of about 5 minutes.

When you get there, you remind your partner that this patient needs to be handled gently. You get another blanket from the emergency department before you make the move. The patient seems to be warming up, and you don't want to put him at any additional risk. When you get into the emergency department, you smoothly move the patient to the stretcher and give the prehospital care report. As you are leaving, Frank looks at you and says, "Thanks. You're nice."