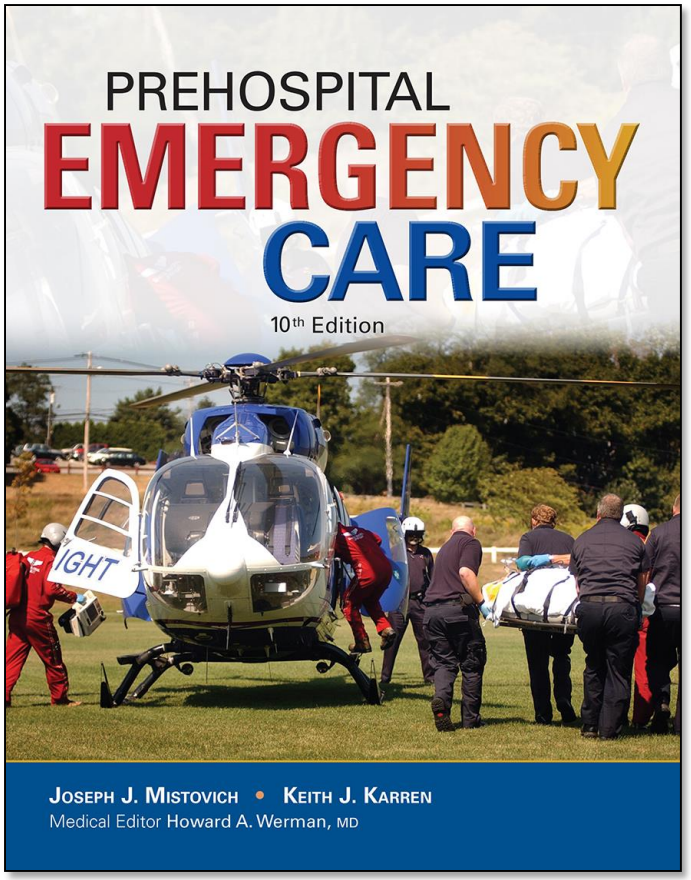
PREHOSPITAL EMERGENCY CARE

TENTH EDITION



CHAPTER 24

Part I
Environmental Emergencies

Learning Readiness

- EMS Education Standards, text p. 676

Learning Readiness Objectives

- Please refer to page 676 of your text to view the objectives for this chapter.

Learning Readiness Key Terms

- Please refer to page 677 of your text to view the key terms for this chapter.

Setting the Stage

- Overview of Lesson Topics
  - Heat and Cold Emergencies
  - Exposure to Cold
  - Exposure to Heat

Case Study Introduction

EMTs Seth Ebers and Steve Holly can feel the cold and wind, despite their heavy winter gear, as they head toward the center of an empty field, where a police officer and bystanders are surrounding someone on the ground.

Case Study Introduction

"I'm glad you're here," says one of the bystanders. "This is Stan. We hadn't seen him since last night and we found him here this morning on our way to get breakfast. He's freezing cold!"

Case Study

- How should the EMTs organize their priorities in managing this patient?
- What findings should they anticipate in this patient?
- What is the emergency care of this patient?

Introduction

- Environmental emergencies
  - Disruptions in the body physiology in response to elements in the patient's natural surroundings.
  - Elements include the climate, altitude, lightning, and contact with insects or animals.

Heat and Cold Emergencies

- Temperature regulation
  - Body mechanisms normally keep the temperature at 98.6° F (37° C).
  - Thermoreceptors send information to the hypothalamus.
  - The hypothalamus sends signals to bring about adjustments to maintain the body temperature.

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Heat and Cold Emergencies

- Temperature regulation
  - Heat is exchanged with the environment via a thermal gradient in which warmer temperatures move toward cooler temperatures.
  - The body responds by increasing or decreasing the amount of heat produced or lost from the body.

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Heat and Cold Emergencies

- Temperature regulation
  - Cellular damage occurs when there are significant changes in body temperature.
  - Heat is produced by metabolism; the body increases the metabolic rate when too much heat is lost from the body.

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Heat and Cold Emergencies

- Temperature regulation
  - Heat is conserved through vasoconstriction.
  - Heat is lost through vasodilation, increased blood flow to the skin, increased sweating, and increased respiration.

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Heat and Cold Emergencies

- When heat loss exceeds heat gain, hypothermia results.
- When heat gained exceeds heat lost, hyperthermia results.

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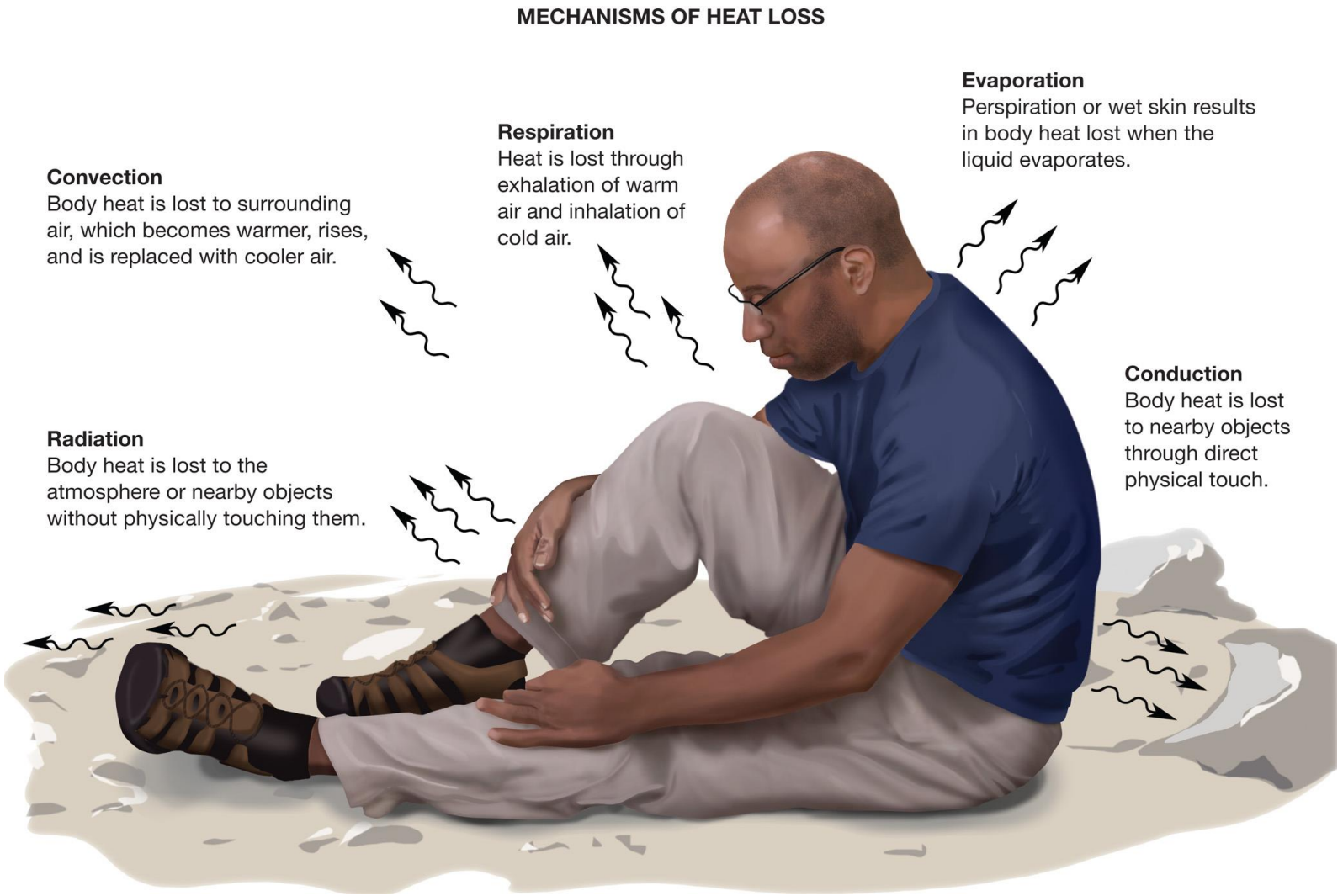
The illustration shows a situation in which a wet, poorly dressed climber has taken shelter in a crevasse or among cold, wet rocks.



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Heat and Cold Emergencies

- Take actions to reduce patients' heat loss.
- Wind increases heat loss by convection; wind chill increases the risk of hypothermia.

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Wind-chill index.

WIND-CHILL INDEX

WIND SPEED (MPH)	WHAT THE THERMOMETER READS (degrees °F)											
	50	40	30	20	10	0	–10	–20	–30	–40	–50	–60
	WHAT IT EQUALS IN ITS EFFECT ON EXPOSED FLESH											
CALM	50	40	30	20	10	0	–10	–20	–30	–40	–50	–60
5	48	37	27	16	6	–5	–15	–26	–36	–47	–57	–68
10	40	28	16	4	–9	–21	–33	–46	–58	–70	–83	–95
15	36	22	9	–5	–18	–36	–45	–58	–72	–85	–99	–112
20	32	18	4	–10	–25	–39	–53	–67	–82	–96	–110	–121
25	30	16	0	–15	–29	–44	–59	–74	–88	–104	–118	–133
30	28	13	–2	–18	–33	–48	–63	–79	–94	–109	–125	–140
35	27	11	–4	–20	–35	–49	–67	–82	–98	–113	–129	–145
40	26	10	–6	–21	–37	–53	–69	–85	–100	–116	–132	–148
	Little danger if properly clothed				Danger of freezing exposed flesh			Great danger of freezing exposed flesh				

Source: U.S. Army

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Heat and Cold Emergencies

- Exposure to water increases heat loss by conduction and evaporation.
- High relative humidity reduces heat loss by evaporation.

Exposure to Cold

- Generalized hypothermia
  - Thermoregulation ability is lost when the body temperature reaches 95° F.
  - Coma occurs at 79° F.
  - Mortality is as high as 87%.

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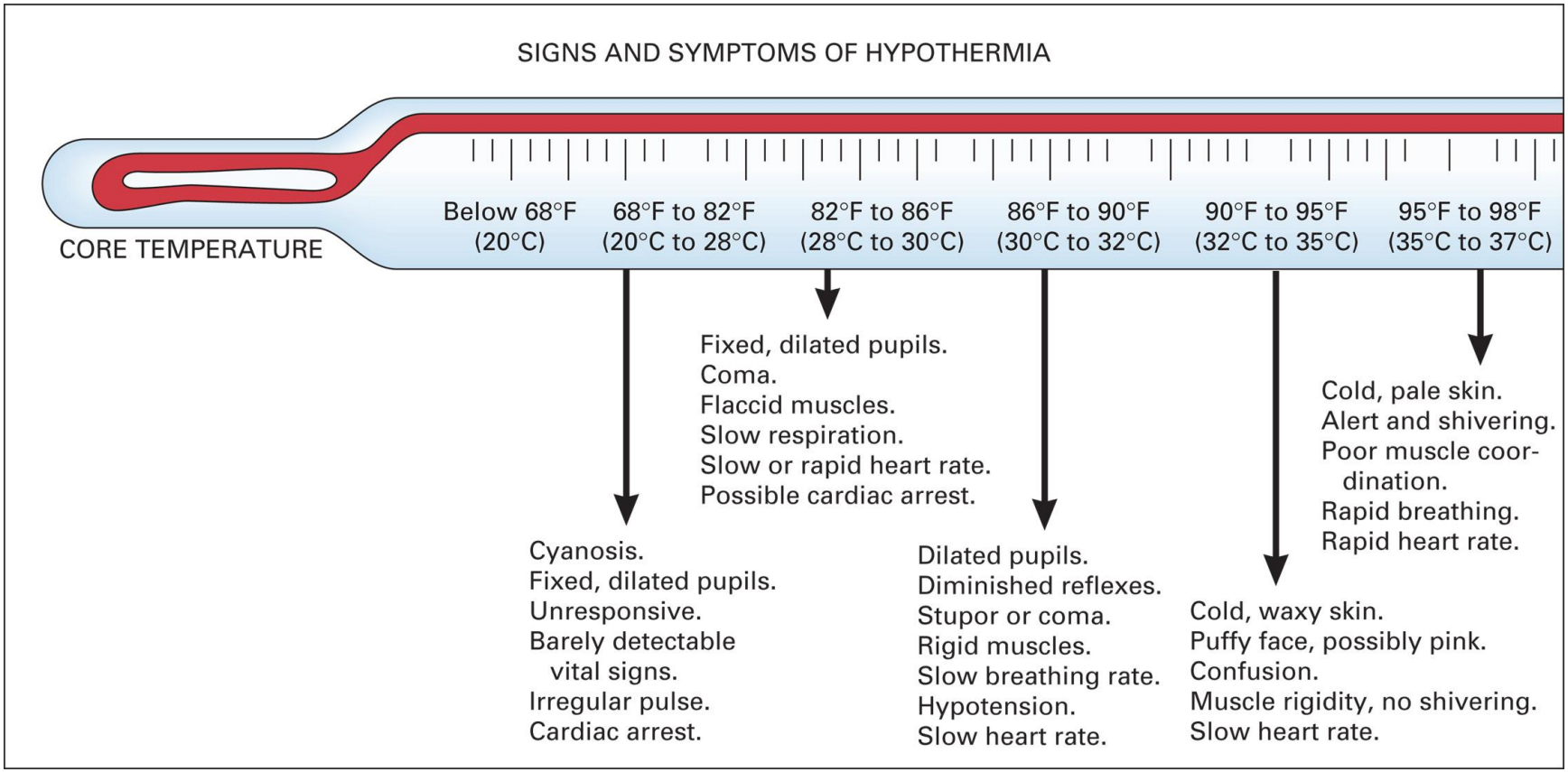
Signs and symptoms of a sinking core temperature.



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Exposure to Cold

- Factors that predispose to hypothermia
  - Ambient temperature, wind chill, moisture
  - Extremes of age
  - Medical conditions
  - Alcohol, drugs, poisons
  - Duration of exposure
  - Clothing
  - Activity level

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Hypothermia can occur in cold or merely cool environments. All of the persons in these photographs are subject to possible hypothermia: (a) a person dressed too lightly for outdoor activity on a very cold day, (Photo a: © Corbis) (b) a person sleeping outdoors on a cool surface in cool weather.

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TABLE 24-1 Stages of Hypothermia

Stage	Core Temperature Range
Mild	35°C to 33°C
	95°F to 91.4°F
Moderate	32°C to 29°C
	89.6°F to 85.2°F
Severe	28°C to 22°C
	82.4°F to 71.6°F
Profound	20°C to 9°C
	68°F to 48.2°F

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Exposure to Cold

- Immersion hypothermia
  - Heat loss occurs 25 to 30 times faster in water than in air.
  - Death can occur in minutes in water temperatures as high as 50° F.

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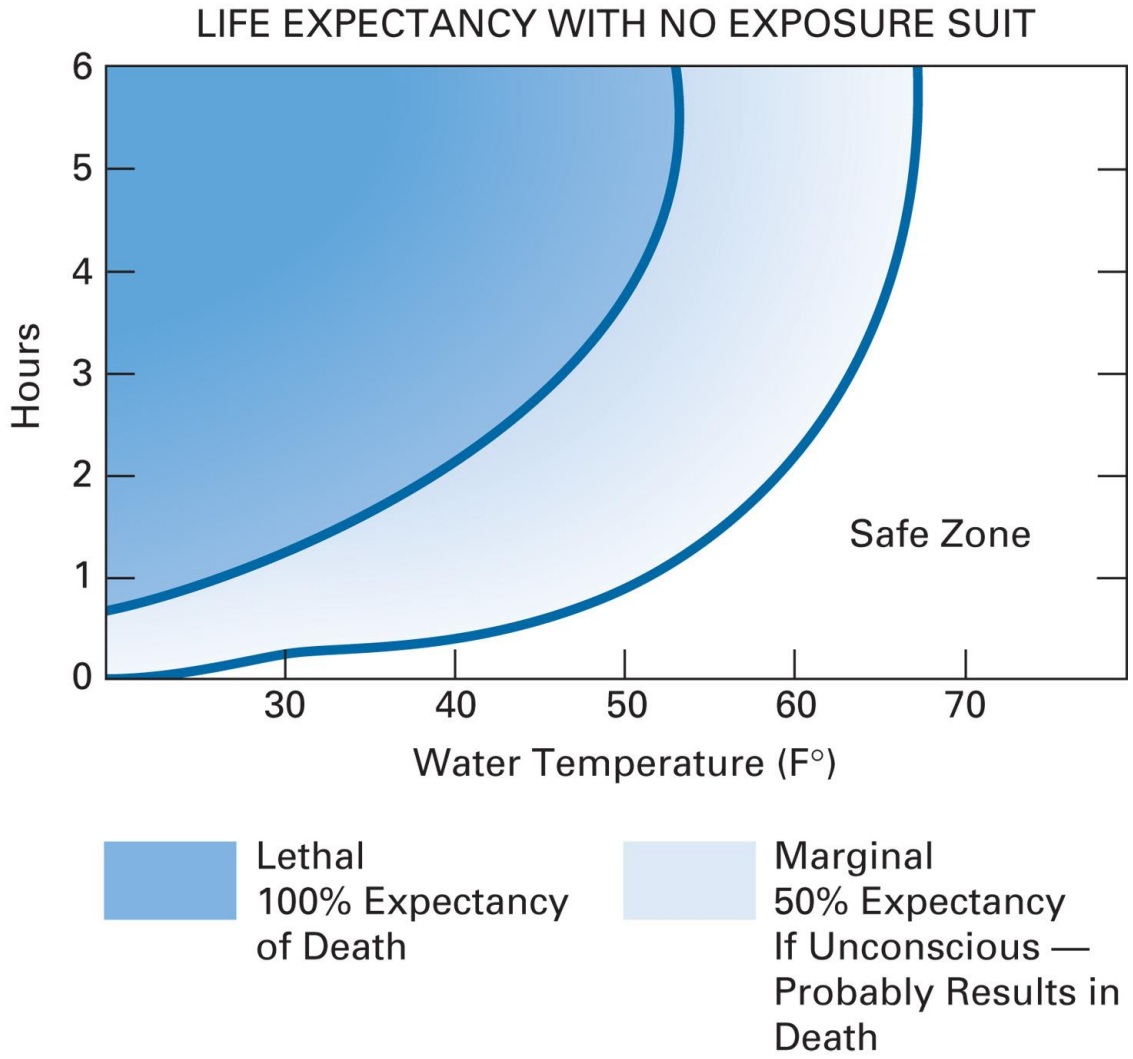
Effects of water temperature on survival in coldwater immersion.



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Exposure to Cold

- Urban hypothermia
  - Illness, medication, and age predispose patients to hypothermia.
  - External hypothermia occurs because of inadequate access to shelter.
  - Internal hypothermia occurs because of inadequate heating of the home.

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Exposure to Cold

- Myxedema coma
  - Thyroid hormone maintains a normal metabolic rate.
  - Myxedema coma is a complication of chronic hypothyroidism.
  - The core temperature may be as low as 75° F.

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Exposure to Cold

- Local cold injury
  - Local cold injury occurs when ice crystals form between the cells of the skin.
  - Tends to occur on the hands, feet, ears, nose, and cheeks

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Exposure to Cold

- Factors that predispose to local cold injury
  - Any kind of trauma
  - Extremes of age
  - Tight footwear
  - Use of alcohol

continued on next slide

Exposure to Cold

- Factors that predispose to local cold injury
  - Wet clothing
  - High altitudes
  - Loss of blood
  - Arteriosclerosis

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Local cold injuries may progress from early or superficial to late or deep.

STAGES OF LOCAL COLD INJURY

EARLY OR SUPERFICIAL COLD INJURY
usually involves the tips of the ears, the nose, the cheek bones, the tips of the toes or fingers, and the chin. The patient is usually unaware of the injury. As exposure time lengthens or temperature drops, the patient will lose feeling and sensation in the affected area. The skin remains soft but cold to the touch, and normal skin color does not return after palpation. As the area rewarms, the patient may report a tingling sensation.

LATE OR DEEP COLD INJURY
involves both the skin and tissue beneath it. The skin itself is white and waxy with a firm to completely solid, frozen feeling. Swelling and blisters filled with clear or straw-colored fluid may be present. As the area thaws, it may become blotchy or mottled, with colors from white to purple to grayish-blue. Deep cold injury is an extreme emergency and can result in permanent tissue loss.

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In late or deep cold injury, the skin may appear white and waxy and feel firm to solidly frozen. Swelling and blisters may be present.

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As a late or deep cold injury thaws, it may become blotchy or mottled and colored from white to purple to grayish blue.

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Exposure to Cold

- Assessment-based approach
  - Scene safety
    - Ensure your own safety.
    - Look for clues to how the environment has affected the patient.
      - Mechanisms of heat loss
      - Predisposing factors

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Exposure to Cold

- Assessment-based approach
  - Primary assessment
    - General impression—Are there risk factors for or indications of hypothermia?
    - Assess the mental status.
    - Assess and maintain the airway.

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Exposure to Cold

- Assessment-based approach
  - Primary assessment
    - Respirations slow, and eventually stop in hypothermia; be prepared to provide positive pressure ventilation.
    - Maintain oxygenation; use warmed, humidified oxygen, if possible.

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Exposure to Cold

- Assessment-based approach
  - Primary assessment
    - Check the pulse carefully; if it is completely absent, begin chest compressions, followed by ventilation.
    - A hypothermic patient is a high priority for transport.

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Exposure to Cold

- Assessment-based approach
  - Secondary assessment
    - Place the patient in a warm environment.
    - Obtain a medical history.
      - Current and past history
      - Predisposing factors for hypothermia

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Exposure to Cold

- Assessment-based approach
  - Secondary assessment
    - Perform a physical exam.
      - Signs of trauma
      - Signs of hypothermia
    - Obtain baseline vital signs.
    - Obtain a temperature, if possible.

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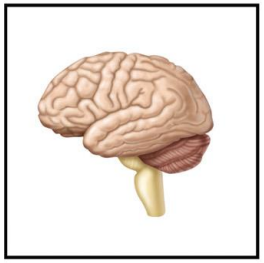
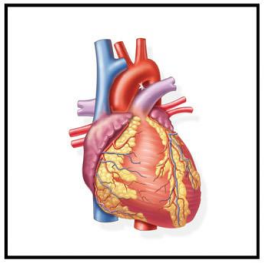
Signs and symptoms of hypothermia.

SIGNS AND SYMPTOMS OF HYPOTHERMIA



Decreasing mental status
- Amnesia, memory lapses, and incoherence
- Mood changes
- Impaired judgment
- Reduced ability to communicate
- Dizziness
- Vague, slow, slurred, or thick speech
- Drowsiness progressing even to unresponsiveness

Decreasing motor and sensory function
- Stiffness, rigidity
- Lack of coordination
- Exhaustion
- Shivering at first, little or no shivering later
- Loss of sensation



Changing vital signs
- Breathing rapid at first; shallow, slow later; absent near end
- Pulse rapid at first; slow and barely palpable later; irregular or absent near end
- Skin red in early stages, changing to pale, to cyanotic, to gray, waxen, and hard; cold to the touch
- Slowly responding pupils
- Low to absent blood pressure

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TABLE 24-2 Stages of Hypothermia and Associated Physiologic Changes

Stage	Core Temperature Range	Physiological Changes
Mild	35°C to 33°C 95°F to 91.4°F	• Maximum shivering (early) • Metabolic rate increases • Amnesia and difficulty in speaking develop • Blood pressure remains normal • Ataxia and apathy develop
Moderate	32°C to 29°C 89.6°F to 85.2°F	• Stupor develops • Oxygen consumption decreases by 25% • Shivering ceases • Cardiac dysrhythmias develop • Inability to maintain a body core temperature independent of the ambient temperature (poikilothermia) • Heart rate and cardiac output reduced by 1/3 and progressively decrease as body core temperature declines • Insulin becomes ineffective • Progressive decrease in consciousness • Pupils dilate
Severe	28°C to 22°C 82.4°F to 71.6°F	• Susceptible to ventricular fibrillation • Oxygen consumption decreases by 50% (early) to 75% (late) • Heart rate decreases by 50% • Reflexes and voluntary motion are lost • Cerebral blood flow decreases by 2/3 • Cardiac output declines by 55% • Pulmonary edema may develop • Significant hypotension • No corneal reflexes
Profound	20°C to 9°C 68°F to 48.2°F	• Heart rate declines by 80% (early) and deteriorates to pulselessness

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Exposure to Cold

- Emergency medical care
  - Basic principles
    - Prevent further heat loss.
    - Rewarm the patient as quickly and safely as possible.
    - Be alert for complications.

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Exposure to Cold

- Emergency medical care
  - Remove the patient from the environment and prevent further heat loss.
    - Remove wet clothing.
    - Dry the patient.
    - Use blankets; insulate from cold surfaces.

continued on next slide

Exposure to Cold

- Emergency medical care
  - Remove the patient from the environment and prevent further heat loss.
    - Protect from the wind.
    - Use warm, humidified oxygen, if possible.

continued on next slide

Exposure to Cold

- Emergency medical care
  - Handle the patient gently.
    - Rough handling may cause cardiac dysrhythmia.
    - Do not allow the patient to exert himself.

continued on next slide

Exposure to Cold

- Emergency medical care
  - Maintain adequate oxygenation.
    - Maintain an SpO_2 of 94% or greater.
    - Do not aggressively ventilate or hyperventilate.
    - Use warmed, humidified oxygen if possible.

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Exposure to Cold

- Emergency medical care
  - For cardiac arrest:
    - Initiate CPR.
    - Apply the AED.
    - Additional shocks may be indicated for persistent ventricular tachycardia or ventricular fibrillation.
    - Survival after prolonged hypothermia has been reported.
    - Follow protocols.

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Exposure to Cold

- Emergency medical care
  - Active rewarming for moderate to severe hypothermia.
    - Warm blanks.
    - Heat packs in the groin and armpits, and on the chest.
    - Heat the patient compartment of the ambulance.

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Exposure to Cold

- Emergency medical care
  - Active rewarming for moderate to severe hypothermia.
    - Do not increase the temperature >1° F per hour.
    - Do not apply heat to the extremities.

continued on next slide

One way to actively warm the patient is to place heat packs in the groin, in the armpits, and on the chest. Insulate the packs to prevent burns.

continued on next slide

Exposure to Cold

- Emergency medical care
  - Passive rewarming for all hypothermic patients
    - Use blankets.
    - Heat the patient compartment of the ambulance.

continued on next slide

Passive rewarming includes wrapping the patient in blankets and turning up the heat in the patient compartment.

continued on next slide

Exposure to Cold

- Emergency medical care
  - Do not allow consumption of tobacco, coffee, or alcohol.
  - Do not rub or massage the arms or legs.
  - Transport as quickly as possible.

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Exposure to Cold

- Emergency medical care for immersion hypothermia
  - Instruct a patient in the water to make the least effort needed to stay afloat.
  - Remove the patient from the water in horizontal position.
  - Remove wet clothing.

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Exposure to Cold

- Signs and symptoms of early local cold injury
  - Blanching of the skin
  - Loss of sensation
  - Tissue is soft to palpation
  - Tingling during rewarming

continued on next slide

Exposure to Cold

- Signs and symptoms of late local cold injury
  - White, waxy skin
  - Firm to frozen feeling on palpation
  - Swelling
  - Blisters
  - If thawing has occurred, skin is mottled or cyanotic.

continued on next slide

Exposure to Cold

- Emergency medical care for local cold injury
  - Never allow the tissue to thaw if there is any possibility of refreezing.
  - Follow medical direction.

continued on next slide

Exposure to Cold

- Emergency medical care for local cold injury
  - Remove the patient from the cold environment.
  - Do not initiate thawing if there is a chance of refreezing.

continued on next slide

Exposure to Cold

- Emergency medical care for local cold injury
  - Maintain oxygenation (SpO2 94% or higher).
  - Prevent further injury to the affected part.

continued on next slide

Exposure to Cold

- For early or superficial injury:
  - Remove jewelry and wet or restrictive clothing.
  - Immobilize and elevate the affected part.
  - Cover affected skin with dressings.
  - Do not rub or massage the area.
  - Do not re-expose skin to the cold.

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Exposure to Cold

- For late or deep injury:
  - Remove jewelry and wet or restrictive clothing.
  - Cover affected skin with dressings.
  - Do not break blisters or apply topical medications.

continued on next slide

Exposure to Cold

- For late or deep injury:
  - Do not rub or massage the area.
  - Do not apply direct heat.
  - Do not allow the patient to walk on the extremity.

continued on next slide

Exposure to Cold

- Rewarming may be necessary for long or delayed transport.
  - Follow protocol; contact medical direction.
  - Rapid rewarming is preferred.
  - Rewarming is painful.

continued on next slide

Exposure to Cold

- Rapid rewarming steps
  - Immerse the affected part in a warm water bath just above body temperature (104° F).
  - Keep the water temperature constant.
  - Stir the water to keep heat evenly distributed.
  - Keep the tissue in the water until it is soft and color and sensation return.

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Thaw the affected area rapidly in water just above body temperature (100° F–110° F).

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Exposure to Cold

- Rapid rewarming steps
  - After thawing, dress with dry, sterile dressings; place dressings between the fingers and toes.
  - Elevate the extremity.
  - Protect against refreezing.
  - Transport as soon as possible.

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Exposure to Cold

- Reassessment
  - Reassess all patients with cold emergencies.
  - Monitor the mental status, airway, and breathing.
  - Begin CPR if the pulse disappears; apply the AED.
  - Assess affected areas.
  - Vital signs every 5 minutes

Click on the mechanism of heat loss that is increased with increased wind speeds.

A. Evaporation

B. Conduction

C. Radiation

D. Convection

Exposure to Heat

- Hyperthermia is caused by increase in the body's heat production or inability to eliminate the heat produced.
- Various stages of hyperthermia are heat cramps, heat exhaustion, and heat stroke.

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Exposure to Heat

- Heat cramps
  - Muscle spasms related to electrolyte imbalance in the body
  - The large flexor groups are usually affected.

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Exposure to Heat

- Heat exhaustion
  - A mild state of shock
    - Vasodilation leads to blood pooling beneath the skin.
    - In extreme cases organs are not well perfused.
    - Prolonged and profuse results in salt and water loss.

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Exposure to Heat

- Heat exhaustion
  - Patients present with dizziness or fatigue, normal body temperature and diaphoresis.

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Exposure to Heat

- Heat stroke
  - Thermoregulation fails; the body is unable to cool itself.
  - High body temperature damages brain cells.
  - Mortality ranges from 20% to 80%.

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Exposure to Heat

- Heat stroke
  - May be classic (nonexertional) or exertional
  - Patient has altered mental status and can present with hot skin that may either be dry or moist.

continued on next slide

Exposure to Heat

- Factors that predispose to heat emergencies
  - Climate
  - Exercise, strenuous activity
  - Extremes of age
  - Pre-existing illnesses
  - Drugs and medications
  - Lack of acclimation

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Exercise and strenuous activity can cause the loss of more than one liter of sweat per hour. (© Michal Heron)

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The risk of illness is increased when heat and humidity produce dangerous conditions. Lower temperatures with high humidity can also cause the body's temperature to rise.

NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

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Exposure to Heat

- Assessment-based approach
  - Scene size-up
    - Protect yourself from overexposure to heat.
    - Check the surroundings for clues to heat exposure or exertion.
    - Look for medications and drugs.

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Exposure to Heat

- Assessment-based approach
  - Primary assessment
    - Form a general impression.
    - Assess the mental status.
    - Assess the airway and breathing.

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Exposure to Heat

- Assessment-based approach
  - Primary assessment
    - Maintain oxygenation.
    - Check the pulse and skin.
    - A patient with altered mental status and hot skin is a high-priority patient.

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Exposure to Heat

- Assessment-based approach
  - Secondary assessment
    - Move the patient to a cool environment.
    - Obtain a history.
      - Medications
      - Oral intake
      - Events leading up to the situation
    - Physical exam
    - Vital signs

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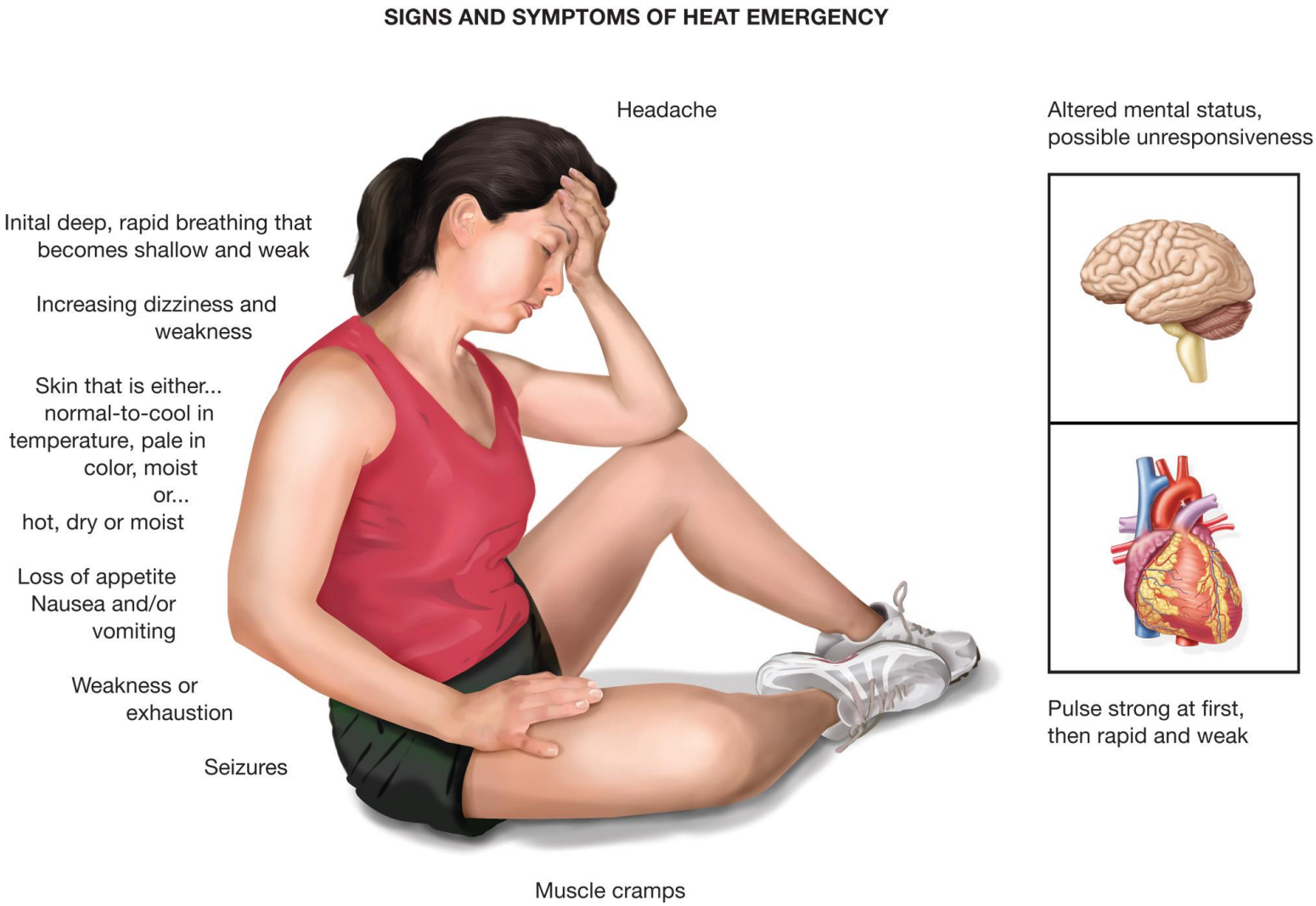
Signs and symptoms of a serious heat emergency.



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Exposure to Heat

- Emergency care for patients with moist, pale, normal-to-cool skin
  - Move the patient to a cool place.
  - Maintain adequate oxygenation.
  - Remove heavy clothing.
  - Cool the patient.

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If the skin is moist, pale, and normal to cool, place the patient in a cool environment, mist with water or apply cold, wet compresses, and fan to promote cooling.

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Exposure to Heat

- Emergency care for patients with moist, pale, normal-to-cool skin
  - Place the patient supine; consider elevating the feet. Use lateral recumbent position if the patient is nauseated or vomiting.
  - If the patient is alert and not nauseated, give cool water to drink.

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Exposure to Heat

- Emergency care for patients with moist, pale, normal-to-cool skin
  - Give nothing by mouth if the patient has altered mental status or is vomiting.
  - Make a transport decision.

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Exposure to Heat

- Transport the patient with moist, pale, normal-to-cool skin when he:
  - Has altered mental status
  - Is vomiting, nauseated, or refuses fluids
  - Has a history of medical problems
  - Has a core temperature >100° F
  - Temperature is increasing
  - Does not respond to treatment

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Exposure to Heat

- Emergency medical care for a patient with hot skin that is moist or dry
  - This is a dire emergency; cooling is the highest priority except airway, breathing, and circulation.

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Exposure to Heat

- Emergency medical care for a patient with hot skin that is moist or dry
  - Remove the patient from the hot environment.
  - Remove as much of the patient's clothing as possible.
  - Maintain adequate oxygenation.

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Exposure to Heat

- Emergency medical care for a patient with hot skin that is moist or dry
  - Begin immediate cooling.
    - Pour tepid water over the patient.
    - Cold packs in the groin and armpits, at each side of the neck, and behind the knees.
    - Fan aggressively.
    - Keep the skin wet.

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If the skin is hot and dry or moist, promote cooling by applying cold packs to the groin, neck, armpits, and backs of knees; fanning the patient; and spraying or pouring tepid water over the patient's body. Then wrap in a wet sheet and continue fanning.

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Exposure to Heat

- Emergency medical care for a patient with hot skin that is moist or dry
  - Be prepared for complications, such as seizures and aspiration.
  - Transport immediately, continuing cooling methods.

continued on next slide

Exposure to Heat

- Emergency medical care for heat cramps
  - Remove the patient from the hot environment.
  - Consult medical direction about giving sips of low-concentration salt water or a commercial product.

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Exposure to Heat

- Emergency medical care for heat cramps
  - Apply moist towels to the forehead and cramped muscles; try to stretch the muscles involved.
  - Educate the patient about the event and advise avoiding exertion for 12 hours.

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Exposure to Heat

- Reassessment of patients with heat emergencies
  - Mental status
  - Airway
  - Breathing
  - Circulation
  - Vital signs (every 5 minutes)
  - Treatment

Case Study Conclusion

The EMTs quickly determine that Stan is unresponsive, but that respirations and pulse are present. They immobilize Stan on a long backboard, with cervical collar in place, and move him into the ambulance before further assessment or treatment.

Once in the ambulance, Steve reassesses the airway and breathing, and decides to insert a nasopharyngeal airway and assist ventilations. At the same time, Seth removes Stan's wet clothing and covers him with blankets.

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Case Study Conclusion

Seth puts the heat in the ambulance on high and continues a physical exam. He finds a hematoma on Stan's head, as well as abrasions on his hands, suggesting there may be injury in addition to cold exposure.

Without further delay, the EMTs begin transport, with Steve managing the airway and ventilations, and monitoring the patient's pulse.

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Case Study Conclusion

At the hospital, it is determined that Stan's core temperature is 89° F. Rewarming measures are implemented, as a thorough examination is performed. Although Stan's blood alcohol level is elevated, his injuries appear to be minor. The nursing staff continues to monitor Stan carefully for complications of hypothermia and rewarming.

Lesson Summary

- The body's thermoregulation mechanisms normally keep the body temperature at 98.6° F.
- When heat loss exceeds heat production, hypothermia results.
- When heat gain exceeds heat loss, hyperthermia results.

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Lesson Summary

- Cold-related emergencies include generalized hypothermia and local cold injuries.
- Heat-related emergencies include heat cramps, heat exhaustion, and heat stroke.