Pre-Lecture

I. You are the Provider

Time: 10 minutes
Small Group Activity/Discussion

Purpose

This activity is designed to help introduce your students to the content of this chapter.

Instructor Directions

1. Direct students to read the "You are the Provider" scenario found throughout Chapter 35.
2. You may wish to assign students to a partner or a group. Direct them to review the discussion questions at the end of the scenario and prepare a response to each question. Facilitate a class dialogue centered on the discussion questions.
3. You may also assign this as an activity and ask students to hand in their comments on a separate piece of paper.

Lecture

I. Introduction

Time: 5 minutes
Slides: 2, 3
Lecture

A. Overview

1. Definition
   a. Medical conditions caused or worsened by the weather, terrain, or unique atmospheric conditions (high altitude or underwater)
   b. Directly cause harm or complicate treatment and transport considerations
2. Risk factors
   a. Generic
   b. Very young and old
   c. Conditions (diabetes, cardiac disease, restrictive lung disease, thyroid disease, and psychiatric illnesses)
   d. Overall health and fitness status and ability to acclimatize

II. Homeostasis and Body Temperature

Time: 10 minutes
Slides: 4–9
Lecture

A. Overview

1. Homeostasis
   a. Body processes that balance the supply and demand of the body's needs
2. Thermoregulation
   a. Heat production and excretion
   b. Thermosensitive neurons in the anterior hypothalamus
   c. The human body stubbornly defends a constant core temperature of approximately 98.6ºF (37ºC).
   d. Metabolic reactions of the body proceed at their optimal level at this temperature.

B. Thermoregulatory Mechanisms

1. Hypothalamus
   a. Body's main thermoregulatory center
   b. Thermogenic (heat-generating) tissues mediated by the sympathetic nervous system
   c. Thermolytic (heat-liberating) tissues mediated by the parasympathetic nervous system
2. Heat production
   a. At rest, chiefly by the metabolism of nutrients with the subsequent liberation of primarily water and carbon dioxide
   b. Basal metabolic rate (BMR): liver and skeletal muscles are the major contributors; minimal caloric energy requirement to sit on the couch all day.
   c. Exertion affects the metabolic rate.
   d. If the environmental temperature is higher than body temperature, the body can absorb heat from outside.

C. Physiologic Responses to Heat and Cold

1. Thermolysis
   a. Release of stored heat and energy from the body
   b. Body's reaction to its daily production of heat energy and to hot environmental conditions
   c. An increase in core temperature causes the hypothalamus to send signals via efferent pathways in the parasympathetic nervous system, causing vasodilation and sweating.
   d. Vasodilation causes an increase in heart rate moving warm blood from the core to the peripheral vessels for cooling.
   e. Radiation: transfer of heat via electromagnetic waves
   f. Conduction: transfer of heat from a hotter object to a cooler object by direct physical contact
   g. Convection: loss of heat when moving air picks up heat and carries it away
   h. Evaporation: conversion of a liquid to a gas that liberates 1 kcal per 1.7 mL of sweat
   i. Requires a thermal gradient between the body and its surroundings

j. The only way the body can dissipate heat when the ambient temperature approaches body temperature is by the evaporation of sweat.

2. Thermogenesis
   a. Production of heat and energy for the body
   b. Main method of dealing with cold stressors
   c. Skin is the body's thermostat in a cold environment.
   d. The sympathetic nervous system can increase muscle tone and initiate shivering in the short term and increase thyroid levels in the long term.
   e. The hypothalamus shunts blood to the core.
   f. Sweating decreases

D. You are the Provider

Slide: 10

Lecture/Discussion

1. Present the case study provided on the slide:
   a. At 3 AM on a very cold December night, you are dispatched to a local college campus for reports of two drunk teenage students who may have alcohol poisoning.
   b. When you arrive at the college dorm, one 19-year-old female and one 19-year-old male are seated on a futon, wrapped in a light blanket. They are pale and visibly shivering. When you get near them, you do not smell any alcohol.
   c. *Do you automatically make the assumption that the teens are drunk from the roommates' description and their initial appearance?*

III. Heat Illness

Time: 35 minutes

Slides: 11–33

Lecture

A. Overview

1. Increase in core body temperature
   a. Due to inadequate thermolysis
   b. Inability to get rid of the heat buildup in the body (hot and humid conditions)
   c. General state of health, clothing, mobility, age, preexisting illnesses, and certain medications add to problems.

B. Risk Factors for Heat Illness

1. See Table 35-2: Factors That Predispose to Heat Illness.
2. Older people are at a particular risk.
   a. Do not adjust as well to the heat
   b. Perspire less
   c. Acclimatize more slowly
   d. Feel thirst less readily
   e. Decreased mobility

   f. More likely to have chronic conditions
   g. More apt to be taking medications that disrupt the body's mechanisms for dissipating heat
3. Infants and young children exposed to a hot environment
   a. Proportionately higher metabolic heat production
   b. CBT that rises faster during dehydration
   c. Do not dissipate heat as well
4. Athletes and military recruits engaging in heavy exertion in hot conditions
5. See Table 35-3: Comparing Conditions Resulting from Heat Stress.

C. Heat Cramps

1. Acute involuntary muscle pains
   a. Usually in the lower extremities, the abdomen, or both
   b. Occur because of profuse sweating and subsequent sodium losses in sweat
   c. Three factors: salt depletion, dehydration, and muscle fatigue
   d. Most often afflict people in good physical condition
2. Usually start suddenly during strenuous and/or prolonged physical activity
   a. May be mild
   b. Severe incapacitating pain in the extremities and abdomen
   c. Pulse is rapid, skin is pale and moist, and temperature is normal.
3. Treatment
   a. Move the patient to a cool environment.
   b. If the patient is not nauseated, give one or two glasses of a salt-containing solution.
   c. If the patient is too nauseated to take liquids by mouth, insert an IV catheter and infuse normal saline rapidly.
   d. Do not massage the cramping muscles.
   e. As the salt balance is restored, the symptoms will abate.

D. Heat Syncope

1. Orthostatic syncopal episode
   a. Typically occurs in nonacclimated people
   b. Can occur with prolonged standing or when standing suddenly from a sitting or lying position
   c. Peripheral vasodilation is thought to be the cause.
   d. Treatment involves placing the patient in a supine position and replacing fluid deficits.

E. Heat Exhaustion

1. Clinical syndrome
   a. Milder form of heat illnesses
   b. Volume depletion and heat stress
2. Two forms

a. Water-depleted: primarily in geriatric patients owing to immobility, medications that contribute to dehydration, and decreased thirst sensitivity and in active younger workers and athletes who do not adequately replace fluids in a hot environment
b. Sodium-depleted: may take hours or days to develop; results from huge sodium losses from sweating but replacing only free water, not sodium

3. Exertional hyponatremia
   a. Prolonged exertion in a hot environment coupled with excessive hypotonic fluid intake
   b. Leads to nausea, vomiting, weight gain, and, in severe cases, mental status changes, cerebral edema, and seizures
4. Symptoms
   a. Headache, fatigue, dizziness, nausea, vomiting, and, sometimes, abdominal cramping
   b. Patient is usually sweating profusely.
   c. Skin is pale and clammy.
   d. Fast and shallow respirations
   e. Tachypnea may produce symptoms of hyperventilation: carpopedal spasm, perioral numbness, and a low end-tidal carbon dioxide level.
   f. Decreased blood pressure
   g. If the patient reports brown urine, suspect rhabdomyolysis (destruction of muscle tissue leading to a release of potassium and myoglobin).
5. "Summer flu"
   a. Misdiagnosed
   b. If untreated may progress to heat stroke
   c. Treatment aimed at removing the patient from exposure to heat and repairing the derangement in fluid and electrolyte balance
   d. Move the patient to a cool environment; remove excess clothing, and place supine with legs elevated.
   e. If the patient's temperature is elevated, sponge, spray, or drip the patient with tepid water and fan gently to make him or her comfortable.
   f. Consider specially designed cooling chairs for hand and forearm immersion in cold water for rehabilitation at fire scenes, mass gatherings, and endurance sports.
   g. Oral hydration with sports drinks may be appropriate. If nausea and vomiting are present, start a normal saline IV and draw blood for electrolyte determinations.
   h. If exertional hyonatremia is suspected, do not give fluids by mouth.
   i. Monitor cardiac rhythm, vital signs, temperature, and end-tidal carbon dioxide.
   j. If you cannot determine whether the patient has heat exhaustion or heat stroke, treat for heat stroke.

F. Heat Stroke

1. Least common but most deadly
   a. Caused by a severe disturbance in the body's thermoregulation
   b. Profound emergency
   c. Two findings: core temperature more than 104ºF (40ºC) and altered mental status
2. Two syndromes

a. Classic (passive heat stroke): usually occurs during heat waves; patients with chronic illnesses are particularly susceptible; high environmental temperatures initially elicit thermolysis, but the CBT eventually soars.
b. Exertional: typically an illness of young and fit people exercising in hot and humid conditions; generate heat without any means of excreting that heat

3. The clinical picture of heat stroke
   a. Both types present with similar signs and symptoms.
   b. Patients will not be able to give a coherent history (confused, delirious, or comatose).
   c. Earliest signs are changes in behavior (irritability, combativeness, and signs the patient is hallucinating).
   d. Older patients may present with signs resembling those of a suspected stroke.
   e. Central nervous system disturbances (tremors, seizures, constricted pupils, and decerebrate or decorticate posturing)
   f. The diagnostic vital sign is a markedly elevated temperature.
   g. Hyperdynamic state: tachycardia, hyperventilation with an end-tidal carbon dioxide of less than 20 mm Hg, and lowered peripheral vascular resistance
   h. Characterized by some degree of dehydration
   i. Diagnosis is easy to miss.
4. Fever and conditions that mimic heat stroke
   a. History may suggest infectious causes.
   b. Fever signals that the body is fighting an infection by inhibiting reproduction of harmful toxins.
   c. Pyrogens: proteins secreted by infective organisms and the body's immune system
   d. Anticholinergic poisoning presents with an elevated temperature (dilated pupils instead of constricted pupils).
   e. Neuroleptic malignant syndrome (NMS): caused by antipsychotic and some antiemetic medications; presents with hyperthermia, muscular rigidity, altered mental status, and a hyperdynamic state
   f. Malignant hyperthermia: can occur as a result of common anesthesia medications and presents similarly to NMS
5. Treatment of heat stroke
   a. If you are unsure about what is causing the elevated temperature, the prudent step is to treat for heat stroke.
   b. Aims at removing the patient from the environment and promoting rapid cooling
   c. Ice water body immersion and evaporate cooling by spraying tepid water over the patient
   d. Ice packs on the neck, groin, and axillae can augment the evaporative method.
   e. Evaluate the ABCs, administer supplemental oxygen, and be prepared to intubate.
   f. Move the patient to a cool environment, and strip the patient to underclothing. Monitor the rectal temperature every 10 minutes.
   g. Cool as rapidly as possible by the most expeditious means available.
   h. Start an IV line, give normal saline, and check the blood glucose level.
   i. Monitor cardiac rhythm, and remember rhabdomyolysis can occur with resultant hyperkalemia.

j. Be prepared to treat seizures with common antiseizure medicines.

G. Prevention of Heat Illness

1. Measures of prevention
   a. Paramedics working in hot climates should have appropriate summer uniforms.
   b. If you are standing by at a post or street location, park the ambulance in the shade and make sure the air conditioning works.
   c. Increase your daily intake of fluid. Do not rely on thirst to gauge your need.
   d. Install or carry a portable fan in the ambulance to improve convection, supplement the air conditioning, and treat patients with heat illness.
   e. Carry a portable cooler or an onboard refrigerator for hot weather. Stock it with sports drinks or other salt-containing drinks for patients and the ambulance crew.
   f. Review the Heat Index (Figure 35-8).
   g. Conduct community-based programs aimed at high-risk populations.
2. Be alert for early symptoms.
   a. Headache, nausea, cramps, and dizziness

H. You are the Provider (continued)

Slide: 34

Lecture/Discussion

1. Continue reading the case study provided on the slide:
   a. Even before you begin evaluating your patient, you check the outside temperature. The weather line said 34 degrees outside, not factoring in wind chill.
   b. You begin your questioning and exam of the male patient while your partner begins with the female patient. He is slow to respond, but states that he does not remember how long they were outside.
   c. You smell no alcohol while you are close to him. He doesn't remember drinking or taking any kind of drugs. He doesn't remember the last time he ate.
   d. *Is your field diagnosis leaning towards an intoxicated teen with possible alcohol poisoning? What other scenarios may be more likely?*
   e. *Before taking regular vitals, what should you consider taking first that may be of significant importance?*

IV. Local Cold Injury

Time: 15 minutes

Slides: 35–43

Lecture

A. Overview

1. Most injuries are localized to the extremities or exposed parts of the body.
   a. Tips of the ears, nose, upper cheek, and tips of the fingers or toes
2. Frostbite
   a. Ischemic injury
   b. Classified as superficial or deep depending on whether tissue loss occurs

c. Frostnip: mild form of frostbite; comes on slowly and generally is not painful; easily treated by placing a warm hand firmly over the chilled nose or ear
d. Windmilling: rapidly making a large circle with your hand, starting with your hand next to your side, raising it backward and up until you are reaching straight up, and moving it rapidly down frontward; forces blood into the cold hand

3. Deeper degrees of frostbite
   a. Occur only in ambient temperatures well below the freezing point
   b. Water within cells turns into ice crystals.

B. Risk Factors for Frostbite

1. Predispose for frostbite
   a. Going out on a cold, windy day without earmuffs, mittens, a scarf, or a hat
   b. Impeding the circulation to the extremities
   c. Going out in the cold when tired, dehydrated, or hungry
   d. Coming in direct contact with cold objects
   e. Not staying hydrated
   f. Allowing oneself to become thoroughly chilled

C. Superficial Frostbite

1. Most common symptoms
   a. Altered sensation (numbness, tingling, or burning)
   b. Skin typically appears white and waxy.
   c. Skin is firm to palpation, but the underlying tissues remain soft.
   d. Once thawing occurs, the injured area turns cyanotic (hot, stinging sensation).
   e. Capillary leakage produces edema in the frostbitten area.
2. Prehospital treatment
   a. Differs significantly from that of deep frostbite (important to distinguish between the two)
   b. If the tissues beneath the skin are soft when you press down on the skin surface, the frostbite is probably superficial.
   c. Combination of dressing, rest, food, and limiting exposure to the cold
   d. Get the patient out of the cold.
   e. Rewarm the injured part with body heat.
   f. Do not rub or massage the frostbitten area.
   g. Cover blisters with a dry, sterile dressing.
   h. Transport the patient to the hospital.

D. Deep Frostbite

1. Usually involves the hands or feet
   a. Looks white, yellow-white, or mottled blue-white
   b. Hard, cold, and without sensation
   c. Major tissue damage from thawing (especially gradual thawing)
   d. Partial refreezing of melted water may occur (larger ice crystals)

e. As thawing occurs, the injured area turns purple and becomes excruciatingly painful.
f. Gangrene: permanent cell death; may set in within a few days, requiring amputation

2. Prehospital treatment depends on two factors
   a. Whether the injured extremity has been partially or completely thawed before you arrive
   b. How far the patient is from the hospital
   c. If the extremity is still frozen when you find the patient, leave it frozen until the patient reaches the hospital (rapid rewarming is extremely difficult to carry out properly in the field).
   d. If you are within an hour's drive of a medical facility, leave the frozen extremity frozen; pad the injured extremity to protect the tissues from further trauma; do not massage the extremity; transport without delay.
   e. If the extremity is partially thawed or if transport will be delayed, contact medical control to discuss field rewarming.
   f. Rewarm the injured extremity before transport (water bath heated between 95ºF and 104ºF; immerse the injured extremity gently (10 to 30 minutes). Once complete, dry the extremity and apply sterile dressings very gently.

E. Trench Foot

1. Prolonged exposure to cool, wet conditions
   a. Can occur at temperatures as high as 60ºF
   b. Conduction: wet feet lose heat 25 times faster than dry feet
   c. Prevention: keeping the feet dry and warm

V. Hypothermia

Time: 25 minutes
Slides: 44–59
Lecture

A. Overview

1. Decrease in CBT starting at 95ºF
   a. Caused by inadequate thermogenesis and/or excess environmental cold stress
   b. Any temperature below the body's temperature can result in hypothermia.
   c. See Table 35-5: Factors Contributing to Thermoregulation and Hypothermia.

B. Risk Factors for Hypothermia

1. Body factors
   a. Increased thermolysis
   b. Decreased thermogenesis
   c. Impaired thermoregulation
2. Issues leading to its development
   a. Cold temperatures
   b. Fatigue

c. Improper gear for adverse conditions
d. Wetness
e. Dehydration
f. Malnutrition
g. Length of exposure
h. Intensity of weather conditions

3. Alcohol
   a. Most common cause of heat loss in urban settings
   b. Impairs shivering thermogenesis
   c. Promotes cutaneous vasodilation
   d. Liver disease creates inadequate glycogen stores and subnormal nutritional status.
   e. Impairs judgment (inappropriate behavior in cold conditions)
4. Older people
   a. Often cannot generate heat effectively
   b. Reduced muscle mass and a diminished shivering response
   c. Atrophy of subcutaneous fat reduces insulation against heat loss.
   d. Medications may interfere with vasoconstriction.
   e. Hypothyroidism and malnutrition
5. Trauma
   a. Hypotension and hypovolemia can interfere with normal thermoregulation.
   b. CNS trauma prevents shivering response.
   c. Leads to coagulation problems

C. The Clinical Picture of Hypothermia

1. Public awareness campaign
   a. Watch for "umbles": stumbles, mumbles, fumbles, and grumbles.
   b. Indicators of how cold affects the cerebral and cognitive functioning of patients in the early stages of hypothermia
2. Clinical definitions
   a. Mild hypothermia: CBT greater than 90ºF
   b. Below this is severe hypothermia.
   c. In the early stages CBT is more than 95ºF; body may compensate.
3. Classifications
   a. Acute: occurs rapidly
   b. Subacute: short time
   c. Chronic: occurs over a period of days
   d. Primary: caused by cold exposures
   e. Secondary: due to problems such as severe sepsis
4. Mild hypothermia
   a. Shivering is in full force.
   b. Umbles are noticeable.

c. Initial symptoms are vague.

5. Net effect
   a. Slow things down.
   b. Most dramatically apparent in the CNS (thinking, feeling, speaking)
   c. Apathetic and impaired reasoning ability; speech is slow and may be slurred; coordination is impaired; the gait is ataxic.
6. Cardiovascular system
   a. Blood shunted to the core
   b. Initially interpreted as an increase in blood volume (stimulate the kidneys to produce more urine).
   c. Cooling of tissues induces a flow of water from the intravascular to the extravascular spaces.
   d. Increased viscosity of the blood, impairing circulation and producing hypovolemia
   e. Cold initially speeds up the heart, then slows the rate and disrupts the electric conduction system.
   f. At CBT of 90ºF: cardiac dysrhythmias (atrial fibrillation)
   g. Osborn wave if shivering does not obscure the tracing
   h. Ventricular fibrillation at around 82.4ºF
7. Respiration
   a. Initially speeds up
   b. Later slows, leading to a decrease in minute volume
   c. Tracheobronchial secretions increase and bronchospasm may occur.
   d. At 90ºF: hypoventilation is profound, protective airway reflexes decline, and oxygen consumption decreases by about half.
8. Muscular system
   a. Slows down in response to cold
   b. Initial muscular reaction is shivering (generates heat but makes skilled movements difficult).
   c. Shivering ceases when the CBT falls below 91ºF.
   d. Cold muscles become progressively weaker and stiffer.
9. Metabolism
   a. Shivering depletes the body of glucose (hypoglycemia).
   b. Insulin levels fall, body switches to metabolism of fat.
   c. The liver's metabolism of drugs is slowed; effects of the drugs last much longer.

D. Treatment of Hypothermia

1. General care
   a. Aimed at preventing further heat loss and rewarming
   b. Victim should be stripped of wet clothes and insulated from further heat loss.
   c. See Figure 35-15 Prehospital hypothermia treatment algorithm.
2. Breathing patients with a pulse
   a. Mild hypothermia cases: 93.2ºF

b. Treatment: passive rewarming (removing wet clothing, drying skin, moving the patient into a warmed ambulance, and using warm blankets)
c. Promote heat generation by feeding the patient, giving warm fluids, and getting the person to move about.

3. Moderate hypothermia cases: 86ºF to 93.2ºF
   a. Treatment: passive rewarming and active external rewarming of the truncal areas (heating blankets or radiant heat from hot packs in the groin, neck, and axillae, forced hot air, and warmed IV fluids)
   b. Commercial warming devices
   c. Afterdrop: continued lowering of CBT after the patient is removed from the cold (more common in chronic hypothermia and frostbite)
4. Severe hypothermia cases: less than 86ºF
   a. Active internal rewarming sequence used to treat severe hypothermia is accomplished in-hospital.
5. Patients with no pulse or not breathing
   a. Cases of hypothermia less than 86ºF: continue CPR, attempt a single defibrillation for V-fib/V-tach, establish IV access, withhold IV medications, and transport.
   b. Cases of hypothermia greater than 86ºF: continue CPR, and administer IV medications as indicated by the electrocardiographic rhythm, repeat defibrillation, and transport.

E. Withholding and Cessation of Resuscitative Efforts

1. In the field
   a. Patients with obvious lethal traumatic injuries or those so frozen as to block the airway or chest compression efforts are generally dead.
   b. If submersion preceded the arrest, successful resuscitation is unlikely (possible exception of immersion in icy waters).
   c. Trauma and alcohol and drug overdoses can hamper resuscitation efforts.

F. You are the Provider (continued)

Slide: 60

Lecture/Discussion

1. Continue reading the case study provided on the slide:
   a. The male patient you are treating has a core body temperature of 93 degrees. He is alert and oriented x 2 (person, place). He has not become any less confused.
   b. Your patient needs immediate rewarming. What would be the best way to accomplish this?

VI. Drowning or Submersion

Time: 15 minutes

Slides: 61–69

Lecture

A. Overview

1. Second leading cause of injury-related death among children younger than 15
    a. Numbers are declining.
2. Definition
    a. At one point 33 different definitions existed.
    b. Process of experiencing respiratory impairment from submersion/immersion in liquid
    c. Liquid–air interface occurs at the airway's entrance.
    d. Continuum progresses from breath holding, to laryngospasm, to the accumulation of carbon dioxide and the inability to oxygenate the lungs, to subsequent respiratory and cardiac arrest.
    e. Victim can be resuscitated at any point along the continuum.
    f. See Table 35-7: Risk Factors for Drowning and Submersion.

B. Pathophysiology of Drowning and Submersion

1. Sequence
    a. Breath holding depends on the victim's state of health and fitness, his or her level of panic, and the water temperature.
    b. Water enters the mouth and nose, coughing and gasping, significant amounts of water swallowed.
    c. A small amount of water is aspirated into the posterior pharynx and perhaps the trachea, which sets off spasms of the laryngeal muscles that seal off and protect the airway.
    d. Laryngospasm leads to asphyxia and the patient may lose consciousness. (If the patient dies during this phase it is "dry drowning.")
    e. Water begins to enter the lungs ("wet drowning").
    f. Decompensation stage as the victim gasps for air and inhales more water.

C. Response to Drowning and Submersion Incidents

1. Resuscitation
    a. In general, same as any other patient in respiratory or cardiac arrest.
    b. First, you must reach the victim (specialized training in water rescue).
    c. Treatment steps follow the usual sequence of ABCs (establishing the airway, cervical spine precautions, ventilation assistance, supplementary oxygen, suction if necessary, high-quality CPR, prevent vomiting).
    d. Maintain some positive pressure at the end of exhalation (positive end-expiratory pressure).
    e. If an endotracheal tube has been inserted, insert a nasogastric tube to decompress the stomach.
    f. Patients prone to bronchospasm from irritation of the airway
    g. Do not give up on the victim of submersion.
    h. See Table 35-8 Management of Drowning and Submersion.

D. Postresuscitation Complications

1. Common complications
    a. Adult respiratory distress syndrome, chemical or bacterial pneumonitis, and renal failure

b. Can occur hours to days after submersion

VII. Diving Injuries

Time: 45 minutes
Slides: 70–97
Lecture

A. Overview

1. Diving
   a. 5 million recreational scuba divers in the US
   b. Others dive for commercial and military purposes.
   c. 200,000 Americans receive scuba instruction each year.
2. Modes of diving
   a. Scuba diving: self-contained underwater breathing apparatus
   b. Breath-holding diving: requires no equipment (occasionally a snorkel)
   c. Surface-tended diving: air is piped to the diver through a tube from the surface
   d. Saturation diving: the diver remains at depth for prolonged periods

B. Pressure Effects: Physical Principles

1. Pressure
   a. Force per unit area
   b. The weight of air at sea level is expressed at 14.7 pounds per square inch (psi), as 760 mm Hg, or as 1 atmospheric absolute (ATA).
   c. Atmospheric absolute is used most commonly in diving medicine.
   d. Water is much denser than air; relatively small changes in depth produce large changes in pressure.
   e. Every 33 feet of seawater (fsw), the pressure increases 1 ATA.
   f. The majority of scuba diving is done at depths between 60 and 120 fsw.
2. Human body
   a. Composed primarily of water
   b. Not compressible
   c. Not significantly affected by pressure changes experienced in descent or ascent through water
   d. Gas-filled organs are compressible.
   e. Nitrogen: inert gas; fat soluble; exists safely as gas nuclei in body tissues and is found in 79% of the air we breathe; produces nitrogen narcosis in humans at a depth of 100 fsw; causes decompression sickness on ascent
   f. Boyle's law: at a constant temperature, the volume of a gas is inversely proportioned to its pressure; as a diver descends (the pressure goes up) gas volume is reduced; as a diver ascends (the pressure goes down) gas volume increases.
   g. Dalton's law: pressures are exerted by mixtures of different gases; each gas in a mixture exerts the same partial pressure that it would exert if it were alone in the

same volume, and the total pressure of a mixture of gases is the sum of the partial pressures of all gases in the mixture.

h. Henry's law: the amount of gas dissolved in a liquid is directly proportional to the partial pressure of the gas above the liquid.

C. Diving History

1. Obtain as many details about the dive and onset of symptoms as possible.
   a. Onset of symptoms (during ascent or descent)
   b. Type of diving and the type of equipment used
   c. Type of tank used (compressed air or a Nitrox system with distinctive yellow and green stripes on the tank)
   d. Site of diving and water temperature
   e. Number of dives made during the past 72 hours, along with the depth, bottom time, and surface interval for each. Was a dive computer used?
   f. Were safety stops used?
   g. Were there any attempts at in-water decompression?
   h. Dive complications, if any
   i. Predive and postdive activities

D. Injuries During Descent

1. Barotrauma
   a. "Squeeze"
   b. Major problem encountered during descent
   c. Pressure imbalance between gas-filled spaces inside the body and the external atmosphere
   d. Two mechanisms: compression of gases within body spaces during descent or expansion of gases within those spaces during ascent
   e. Can affect any gas-filled space in the body (sinuses, inner and middle ears, and teeth)
   f. See Table 35-9: Diving Injuries.
2. Scuba diving
   a. Theoretically protected from barotraumas by breathing compressed air (match pressure of the surrounding environment)
   b. As long as air-filled cavities of the body can equilibrate freely, they will not implode, unless there is an obstruction.
3. Complications
   a. Blockage in the Eustachian tube (connects the middle ear with the nasopharynx)
   b. If the diver cannot equalize ear pressures with a Valsalva maneuver
   c. Pressure in the middle ear cannot be equalized with that of the outside of water.
   d. "Middle ear squeeze" syndrome develops with severe ear pain.
   e. If the tympanic membrane ruptures, nausea, vomiting, and vertigo may occur (colder waters).
   f. At depth, this reaction may cause panic, rapid ascent, and ascent problems.
   g. Treatment: loose dressing for ear bleeding (some patients may require IV antiemetics or sedatives)

E. Injuries at Depth

1. Nitrogen narcosis
    a. State of altered mental status caused by breathing compressed air at depth
    b. Nitrogen is not used for metabolism, it dilutes the concentration of oxygen.
    c. Problem may occur when a diver descends to 99 ft (ambient pressure is 4 ATA); inspired air pressure must be the same.
    d. Divers should not use compressed air for dives greater than 120 ft.
    e. Signs and symptoms: euphoric feeling, inappropriate behavior at depth, lack of concern for safety, apparent stupidity or inappropriate laughter, and tingling of lips, gums, and legs
    f. Only way to counteract the narcotic effect of nitrogen is to lower the nitrogen partial pressure through controlled ascent or by using a Nitrox system.

F. Injuries During Ascent

1. Barotrauma
    a. As the diver ascends, the ambient pressure decreases and gases expand.
    b. Trained to exhale constantly as they are ascending to vent air from their lungs
    c. Decongestants before diving: air may become trapped in the sinuses and ears
    d. Difficulty with equipment and panic (hold their breath) resulting in pulmonary overpressurization syndrome ("burst lung")
    e. Can cause pneumothorax, mediastinal and subcutaneous emphysema, alveolar hemorrhage, and a lethal arterial gas embolism (AGE)
    f. Relative pressure and volume changes are greater near the surface of water; a small overpressurization can rupture alveoli.
    g. Signs and symptoms depend on where the air escaping from the lungs ends up.
    h. Most commonly air leaks into the mediastinum and beneath the skin (mediastinal and subcutaneous emphysema); sensation of fullness in the throat, pain on swallowing, dyspnea, or substernal chest pain; patient may be hoarse or have a brassy quality to the voice.
    i. Most dangerous possible consequence of POPS is AGE (second only to drowning as a cause of death among divers).
    j. Clinical picture of AGE dramatic; symptoms appear within seconds or minutes after surfacing; may experience weakness or paralysis of one or more of the extremities, seizure activity, or unresponsiveness; variety of neurologic symptoms (paresthesias, visual disturbances, deafness, and changes in mental status).
    k. Prehospital treatment depends on whether the patient has an AGE; those without an AGE will be managed symptomatically in the hospital. Pneumothorax may require needle decompression or a chest tube. If AGE is present or suspected, transport to a hyperbaric chamber facility as soon as possible.
    l. See Table 35-10 Treatment of Suspected AGE.
2. Decompression sickness
    a. Broad range of signs and symptoms caused by nitrogen bubbles in blood and tissues coming out of solution during ascent
    b. Damage in two ways: interfering mechanically with tissue perfusion and triggering chemical changes within the body

c. The ensuing multisystem disorder can potentially affect almost every organ in the body.
d. As a diver descends, increased quantities of nitrogen and oxygen become dissolved in the blood and are carried to the tissues.
e. As a diver ascends, the reverse occurs, and nitrogen begins to diffuse out of tissues. If the ascent is slow enough, the amount of nitrogen will equilibrate with that in the alveoli. If the ascent takes place more rapidly than nitrogen can be removed, the diver's tissues will begin to bubble.
f. Presence of a patent foramen ovale (congenital defect)
g. Other risk factors for DCS include obesity, dehydration, fatigue, and flying within 12 to 14 hours of diving.
h. Type I refers to mild forms that involve only the skin, lymphatic system, and musculoskeletal system (joint pain is the most common symptom).
i. Type II includes all the other organs and is regarded as more serious.
j. Difficult to distinguish between DCS and AGE in the field
k. Symptoms produced by air embolism usually reflect cerebral dysfunction, whereas the spinal cord is more likely to be involved in decompression sickness (a loss of consciousness points to AGE).
l. Management in either case is supportive.
m. See Table 35-11 Treatment of Decompression Sickness.

3. Other gas-related problems
   a. Tanks with various mixtures to prevent DCS are more likely to experience oxygen toxicity (dizziness, lack of coordination, confusion, twitching or paresthesia symptoms, and underwater seizures).
   b. Contaminated air in a scuba tank (carbon monoxide and carbon dioxide)

G. Shallow Water Blackout

1. May be seen anywhere
   a. Most frequently seen among adolescent boys competing to see who can remain the longest underwater
2. Treatment
   a. Same as for any other case of drowning

H. Getting Help for Diving Injuries

1. Divers Alert Network (DAN)
   a. 24-hour emergency consultation service: (919) 684-8111
   b. Duke University Medical Center, Durham, North Carolina
   c. Physician experienced in diving medicine who can assist with diagnosis, provide advice for early management of the accident with diagnosis, provide advice for early management of the accident, and supervise referral to an appropriate recompression chamber

I. You are the Provider (continued)

Slide: 98

Lecture/Discussion

1. Continue reading the case study provided on the slide:
    a. 15 minutes after passive rewarming has begun, the patient's core body temperature is not rising as quickly as it should.
    b. *What are two obvious clues you've noticed that could be interfering with his body's ability to bring up his core temperature?*

VIII. Altitude Illness

Time: 15 minutes
Slides: 99–107
Lecture

A. Overview

1. Caused by the effects of hypobaric hypoxia on the CNS and pulmonary system
    a. Unacclimatized people ascending to altitude
    b. Acute mountain sickness (AMS)
    c. High-altitude cerebral edema (HACE) and high-altitude pulmonary edema (HAPE)
    d. Typically in people who rapidly ascend to heights above 8,000' (can occur at altitudes as low as 6,500')
    e. Symptoms usually occur within 6 to 10 hours.
2. Hypoxia
    a. Low atmospheric pressures
    b. Partial pressure of oxygen in the atmosphere decreases with increasing altitude but remains a constant 21% of the earth's barometric pressure.
    c. Barometric pressure varies according to how far north (typically lower in winter).

B. Risk Factors for Altitude Illness

1. Predisposed to altitude illness
    a. History of AMS (slow ascents and use of prophylactic medicines are recommended)
    b. Normal residence below 3,000'
    c. Physical exertion
    d. Presence of chronic obstructive pulmonary disease
    e. Sleeping above 8,000'
    f. Physical fitness is not a factor.
    g. Older people may be less likely to develop such an illness.
    h. Hypoxic ventilatory drive

C. The Clinical Picture of Altitude Illness

1. Definitions
    a. Acute mountain sickness (AMS): headache plus at least one of the following: fatigue or weakness, gastrointestinal symptoms (nausea, vomiting, or loss of appetite), dizziness or lightheadedness, or difficulty sleeping
    b. High-altitude pulmonary edema (HAPE): At least two of the following symptoms: dyspnea at rest, cough, weakness or decreased exercise performance, or chest

tightness or congestion. Also, at least two of the following signs: central cyanosis, audible rales or wheezing in at least one lung field, tachypnea, or tachycardia

c. High-altitude cerebral edema (HACE): requires the presence of a change in mental status and/or ataxia in a person with AMS or the presence of mental status changes and ataxia in a person without AMS

2. Other conditions can mimic AMS.
   a. Emergence of symptoms three or more days after being at higher elevations, a lack of a headache, or the failure of descent to improve signs or symptoms points to other causes.

D. Pathophysiology of Altitude Illness

1. Hypoxia
   a. Main culprit behind the pathophysiologic responses observed in altitude illness
   b. Exact mechanism remains poorly understood.
   c. Believed to initiate a complex series of reactions that result in overperfusion to the brain and lungs, with resultant increases in capillary pressures, leakage, and then cerebral and pulmonary edema

E. Management and Prevention of Altitude Illness

1. Mainstay of management
   a. Oxygen, descent, and evacuation
2. Prevention
   a. Best accomplished via acclimatization, slower ascents, and, occasionally, the use of acetazolamide
   b. See Table 35-12 Management and Prevention of Altitude Illnesses.

F. You are the Provider Summary

Slide: 108

Lecture/Discussion

1. Continue reading the case study provided on the slide:
   a. Passive rewarming in the ambulance while en route to the hospital is the best course of action for a patient with mild to moderate hypothermia. You will treat other issues if they arise. Be aware of the problems associated with hypothermia.
   b. When you make another call later that night, you drop by to see how your previous patient is doing. After 3 1/2 hours, his core body temperature is near normal. He is much more alert and oriented.

G. Summary

1. Heat illness
2. Local cold injury
3. Hypothermia
4. Drowning or submersion
5. Diving injuries
6. Altitude illness

Post-Lecture

I. Prep Kit Activities

Time: 55 minutes

Note: This section contains various student-centered end-of-chapter activities designed as enhancement to instructor's preparation. As time permits, these activities may be presented in class. They are also designed to be used as outside homework/activities.

A. Assessment in Action

Time: 20 minutes

Individual/Small Group Activity/Discussion

Purpose

This activity is designed to assist students in gaining a further understanding of the chapter content. This activity allows students an opportunity to analyze an emergency care scenario, develop responses, and integrate what they have learned.

Instructor Directions

1. Direct students to read the "Assessment in Action" scenario located in the Prep Kit at the end of Chapter 35.
2. Direct students to read and individually answer the quiz questions at the end of the scenario. Facilitate a class review and dialogue of the answers, allowing students to correct responses as may be needed. Use the quiz question answers noted below to assist in building this review.
3. You may also wish to assign these as individual activities and ask students to turn in their comments on a separate piece of paper.

Answers to Multiple-Choice Questions

You are dispatched to the senior citizens complex for an unconscious person. When you arrive on scene and enter the apartment, you find the patient lying on the floor. This is the fourth day of a heat wave and the patient did not have her air conditioning unit on. The patient's heart rate is 120 beats/min; her respiratory rate is 36 breaths/min.

1. What do you suspect is wrong with this patient?
   A. Heat exhaustion
   B. Heat cramps
   C. Heat stroke
   D. Frostbite

Answer: C. Heat stroke is the least common of these, but the most deadly. It is caused by a severe disturbance in thermoregulation and is a profound emergency with mortality rates as high as 10% in treated patients and 30% to 80% in untreated patients.

2. What are the two types heat stroke?

A. Classic heat stroke and exertional heat stroke
B. Thermolysis and thermoregulation
C. Orthostatic hypotension and classic hypotension
D. Classic heat stroke and orthostatic hypotension

Answer: A. Classic heat stroke usually occurs during heat waves and is most likely to strike the very old, the young, and bedridden people. Exertional heat stroke is typically an illness of young and fit people, usually athletes or military recruits exercising in hot and humid conditions.

3. A clinical syndrome thought to represent a milder form of heat illness and on a continuum leading to heat stroke is:

A. heat cramps.
B. classical heat stroke.
C. hyponatremia.
D. heat exhaustion.

Answer: D. There are two forms of heat exhaustion: water-depleted and sodium-depleted. Water-depleted heat exhaustion occurs primarily in geriatric people owing to immobility and medications that contribute to dehydration (diuretics). Sodium-depleted heat exhaustion may take hours or days to occur and is the result of huge sodium losses from sweating but replacing only free water, not sodium.

4. A condition closely related to sodium-depleted heat exhaustion is:

A. classic heat stroke.
B. exertional heat stroke.
C. exertional hyponatremia.
D. heat exhaustion.

Answer: C. Exertional hyponatremia and sodium-depleted heat exhaustion have a common thread of prolonged exertion in hot environments coupled with excessive hypotonic fluid intake leading to nausea, vomiting, and, in severe cases, mental status changes and seizures.

5. Medical conditions caused or worsened by the weather, terrain, or unique atmospheric conditions such as high altitude or underwater are called:

A. hypothermia.
B. hyperthermia.
C. weather-related emergencies.
D. environmental emergencies.

Answer: D. Most EMS providers would recognize the obvious problems of a child who has fallen into an icy lake. The challenge is recognizing environmental emergencies in the unusual settings of endurance sport events and mass gatherings and in acutely confused older patients.

6. Which of the following terms refers to the body processes that balance the supply and demand of the body's needs?

   A. Homeostasis
   B. Thermoregulation
   C. Hypothalamus
   D. Body temperature

Answer: A. An example of this concept is thermoregulation. Ensuring the balance between heat production and heat excretion is the job of the master thermostat in the anterior hypothalamus.

7. The body's reaction to its daily production of heat energy and to hot environmental conditions is:

   A. thermogenesis.
   B. thermolysis.
   C. hypothermia.
   D. hyperthermia.

Answer: B. Thermolysis is the release of stored heat and energy from the body. An increase in core temperature causes the hypothalamus to send out signals via efferent pathways in the parasympathetic nervous system, causing vasodilation and sweating.

8. When warmed blood from the core and overheated muscles heads for the peripherally dilated cutaneous vessels, the four major means of cooling it are:

   A. thermogenesis, thermolysis, hypothermia, and hyperthermia.
   B. radiation, conduction, convection, and evaporation.
   C. hypothermia, radiation, conduction, and hyperthermia.
   D. conduction, convection, evaporation, and thermogenesis.

Answer: B. The mechanisms require a thermal gradient between the body and its surroundings, that is, the mechanisms work only so long as the skin surface temperature is higher than that of the outside environment.

Challenging Questions

You are treating a severely hypothermic middle-aged male who is in cardiac arrest. The man was found in a wilderness area after being lost for 12 hours. The ambient temperature is 28°F. CPR is in progress and the patient has been successfully intubated. Medical control orders you to attempt defibrillation one time if indicated, withhold all cardiac medications, and rapidly transport the patient to the closest appropriate facility.

1. What affect would repeated defibrillation attempts have on this patient?

Rationale: The patient who is in V-fib most likely will not respond to defibrillation until his core is slowly warmed up. Medical direction may allow the paramedic to try once to defibrillate the patient as long as the interruption in CPR is kept to a minimum. It is likely that the defibrillation will not be effective if it does not work with the first shock, and

therefore all other attempts will merely interrupt compression and potentially delay transport to a facility that has the ability to warm the patient from the core out.

2. Why should medication therapy be withheld in cardiac arrest patients with severe hypothermia?

Rationale: The medications that are carried on a typical paramedic unit do not work in the hypothermic temperature ranges, and therefore should not be used until the core of the patient is properly warmed up. If the patient is loaded with medications such as vasopressors (epinephrine and vasopressin), the medications will not work and may potentially all "kick in" at once when the patient is warmed, causing a dangerously high dose.

B. Points to Ponder

Time: 20 minutes
Individual/Small Group Activity/Discussion

This activity addresses the affective objectives of the chapter, allowing you to help students probe the more difficult situations that they face. Use this as an opportunity to allow them to express differences of opinion and approach, while directing them to be thorough and decisive in their answers. Encourage challenges.

Purpose

To allow students an opportunity to apply critical thinking analysis to a given case study.

Instructor Directions

1. Direct students to read the "Points to Ponder" scenario found in the Prep Kit at the end of Chapter 35.
2. You may wish to assign students to a partner or a group and direct them to review the discussion question at the end of the scenario and prepare a response. Facilitate a class dialogue centered on the discussion point.
3. You may also ask students to complete this activity on their own and hand in their comments on a separate piece of paper.
4. Personally review the scenario and discussion question based on your experience and knowledge as an emergency care professional. Develop your own key points for guiding this discussion.

Scenario

You are dispatched for a man down outside. When you arrive, you find a man lying on the ground responsive to painful stimuli only. It is the middle of winter and is very cold. The patient is wearing only a light jacket and regular clothes. You immediately put the patient in the ambulance and begin assessing him. You turn the heat up in the back of the ambulance. The patient is extremely cold to the touch. His heart rate is 50 beats/min, blood pressure is 100/60 mm Hg, and respiratory rate is 12 breaths/min. You are unable to obtain a pulse oximetry reading.

What are your main concerns for this patient?

Issues

Understand the Pathophysiology of Environmental Emergencies, Understand the Treatment Modalities for Hypothermia, Understand How Young and Old People Are at Risk for Hypothermia.

Discussion

Hypothermia is defined as a decrease in CBT starting at 95°F due to inadequate thermogenesis and/or excessive environmental cold stress. You need to be able to recognize that any temperature below the body's temperature can result in hypothermia. An older person cannot generate heat as well because of reduced muscle mass and a diminished shivering response. Medications commonly prescribed to older people may interfere with vasoconstriction. The treatment of moderate hypothermia is active external rewarming, which involves the use of a variety of means to directly warm the patient's skin, including heating blankets or radiant heat blocks in the groin, neck, and axillae, forced hot air, and warmed IV fluids. You must administer a 500-mL bolus of fluid (unless contraindicated) to counter the hypovolemia common in hypothermia.

II. Lesson Review

Time: 10 minutes

Discussion

Note: Facilitate the review of this lesson's major topics using the review questions as direct questions or overhead transparencies. Answers are found throughout this lesson plan. Each question includes a reference to the slide where the information is covered.

1. Describe the physiologic responses of the body to heat. (Lecture II-B)
2. Discuss the two classical forms of heat exhaustion. (Lecture III-E)
3. Discuss the two findings used by experts to make a differential diagnosis for heat stroke. (Lecture III-E)
4. List the signs and symptoms of superficial and deep frostbite. (Lecture IV-C, D)
5. List the effects of hypothermia on different body systems. (Lecture V-C)
6. Discuss the management of drowning and submersion injuries. (Lecture VI-C)
7. Define barotraumas, identify the two common mechanisms, and give examples of areas of the body affected by barotraumas. (Lecture VII-D)
8. Discuss the classification of decompression sickness (DCS). (Lecture VII-F)
9. Discuss the signs and symptoms of oxygen toxicity. (Lecture VII-F)
10. List the types of altitude illnesses and the symptoms associated with each. (Lecture VIII-C)

III. Assignments

Time: 5 minutes

Lecture

1. Review all materials from this lesson and be prepared for a lesson quiz to be administered (date to be determined by instructor).
2. Read Chapter 36: *Infectious and Communicable Diseases* for the next class session.

