Chapter 18

THERMAL INJURIES

Because of the range of environmental condition within which sports take place, various temperature-related health emergencies occur each year, some result in death. Most, if not all, of these deaths could be prevented if coaches, athletes, and administrators consider environmental conditions prior to allowing an event to take place.

Normal metabolism can be maintained during a narrow range of body **core temperatures**, ranging from between 98.0°F to 98.6°F when measured orally. Heat is a byproduct of metabolism, and exercise increases the metabolic rate, resulting in an elevation of body temperature to 104°F. The excess heat must be eliminated from the body or the body's temperature can rise to dangerous levels in a short period. Thermoregulation is the process by which the body rids itself of excess heat.

Excess heat can be lost through **radiation**, **conduction**, **convection**, and evaporation. For most exercise on dry land, evaporation is the most efficient method of eliminating excess body heat. The relative humidity determines how effectively the body can evaporate heat from skin during exercise. When the relative humidity is high, heat-related problems are more likely because the sweat on an athlete's skin is less able to evaporate into the surrounding air.

It takes about 1 to 6 weeks for an athlete's body to adjust to a major change in temperature (**acclimatization**). Time Out 18.1 lists the body's physiologic responses that occur with acclimatization. Physically fit people tend to acclimatize faster; adolescents, obese individuals, and people with certain metabolic disorders take longer to adjust to environmental temperature change.

With proper acclimatization, the sweating mechanism can yield 1.5 to 2.5 liters of sweat per hour, with a heat loss of at least 10 times the normal rate. Under hot conditions, athletes need to consume 4 to 10 liters of fluids per day to avoid dehydration. Food contains some fluid and is considered part of this calculation. When the climate is hot and humid, athletes should avoid exercising during the hottest times of the day and be encouraged to drink water frequently. A minimum of 10 fluid ounces every 10 to 20 minutes is recommended. Athletes may lose 2% to 6% of body weight during exercise. Such losses can impair performance significantly. Acclimatization does *not* decrease the body's need for water; fluid needs increase as sweating increases.

I. Exertional Heat Illnesses. Dehydration is the least severe form of exertional heat illnesses.

A. Dehydration. The effects of minimal **dehydration** (less than 2% body weight loss) will not compromise performance or health. When the loss of body weight exceeds 2% as a result of dehydration, performance and thermoregulation can be affected negatively.

1. The signs and symptoms of dehydration include dry mouth, thirst, irritability or crankiness, headache, seemingly bored or disinterested, dizziness, cramps, excessive fatigue, and loss of ability to perform as well as usual.

2. Athletes suffering from dehydration should be removed from participation and moved to a cool location.

a. Rehydrate the athlete with either water or a sports drink, preferably at a temperature between 50°F and 59°F.

1) If the athlete has lost less than 2% of his or her body weight and the symptoms are relieved with rehydration, he or she may return to participation.

2) If the athlete's symptoms persist after rehydration, seek medical attention.

B. Heat Cramps. **Heat cramps** generally develop within exercising muscles, i.e., the leg muscles of runners or shoulder muscles of swimmers. The physiology of heat cramps is unclear but thought to occur as a result of water and mineral loss caused by sweating.

1. The signs and symptoms of heat cramps include severe muscle cramps in the arms or legs that are not related to muscle strain, abdominal muscle cramps, and profuse sweating.

2. Management includes immediate cessation of exercise, consumption of fluids (water or sports drinks), and static stretching of involved muscles.

C. Heat Exhaustion. **Heat exhaustion** involves generalized fatigue that occurs during exercise, when excess sweating has occurred and the lost body fluid has not been replaced. Although heat exhaustion is not life threatening, it can lead to heatstroke, which is a true medical emergency. Coaches should monitor athletes constantly for the signs and symptoms of heat exhaustion when they practice or compete in high heat and/or high humidity.

1. Signs and symptoms include moist, clammy skin; profuse sweating; general muscle fatigue and/or cramps, nausea or related GI distress; dizziness and occasionally loss of consciousness; headache; increased respiration rate and rapid pulse; and body temperatures ranging from 97°F to 104°F.

2. Management includes immediate cessation of exercise; if the athlete is not nauseous, give fluids, preferably cool water or a commercial sports drink; move the athlete to a cool place and have the athlete assume a supine position, with legs elevated 8 to 12 inches; loosen clothing and cool the athlete with wet towels or ice packs; and if not fully recovered with 30 minutes, refer the athlete to a medical facility.

a. Do not allow the athlete to return to participation for the remainder of that day.

D. Heat Stroke. **Heat stroke** involves the body's inability to cool itself. As a result, extreme elevations in body temperature occur, sometimes exceeding 106°F. There are two types of heat stroke.

1. The classic form of heat stroke occurs among non-athletes and is generally seen in obese, chronically ill, elderly, or diabetic people. Exertional heat stroke is seen in athletes when they exercise in warm and/or humid conditions. Exertional heat stroke usually results from excessive fluid losses due to heavy sweating and lack of evaporative cooling. Heat stroke is a true medical emergency and must be treated accordingly.

    a. Signs and symptoms include sweating, which may or may not be present; hot, dry skin or clammy skin if sweat is present; mental confusion and possible loss of consciousness; GI distress, including nausea and vomiting; motor disturbances and loss of coordination; rapid and strong pulse; and rectal temperature of higher than 104°F.

    b. Heat stroke can permanently damage the central nervous system (**CNS**) as well

as other systems. Death can result if the body temperature is not controlled quickly.

c. To manage cases of heat stroke, if EMS personnel, an athletic trainer, or a physician is present, immediately cool the athlete by cold water immersion. The goal is to return core body temperature (measured rectally) to 101°F to 102°F.

1) This is best accomplished by removing the athlete's clothing and equipment and placing him or her into a tub of cold water (35°F to 58°F).

2) Summon EMS personnel if they are not already on site.

3) If cold water immersion is not possible, move the athlete to a cool, humidity-controlled environment.

4) Wrap the athlete in wet sheets or towels or place cold packs in areas with abundant blood flow such as the armpits, groin, neck, or head.

5) Treat for shock and monitor body temperature; do not allow temperature to drop below 102°F.

6) Keep the athlete in a semi-seated position.

E. Prevention of Exertional Heat Illnesses. Heat-related illness causing death among athletes is totally preventable. All personnel involved with the supervision of young athletes should review the NATA's position statement "Fluid Replacement for Athletes" and make every effort to incorporate the Association's recommendations (see Appendix 3). To prevent heat-related disorders, coaches and parents should have the athlete follow these practices:

1. Use a weight chart to monitor the athlete's weight. Body weight should be recorded each day, before and after practice/competition throughout the season.

a. To determine how much fluid the athlete needs to consume after practice/competition, calculate **24 ounces of fluid should be consumed for each pound of weight loss**. Post-exercise rehydration should take place within 4 to 6 hours after the practice/competition.

2. Two to three hours before an activity, the athlete should consume 17 to 20 ounces of fluids and an additional 7 to 10 ounces, 10 to 20 minutes prior to the activity.

3. While participating in warm and humid environments, the athlete should consume 7 to 10 ounces of fluids every 10 to 20 minutes.

4. Avoid heavy exertion during time of extreme environmental conditions, especially when the temperature is above 95°F and the humidity is high.

5. Wear loose clothing, and avoid darkly-colored clothing and helmets because they can facilitate heat buildup.

6. Improve fitness levels and allow time for acclimatization, which normally requires weeks.

7. Avoid factors that increase the risk of heatstroke (refer to Table 18.2 on page 265).

II. Cold-Related Health Problems. Exposure to cold can result in several conditions, including hypothermia.

A. Hypothermia. If the body loses heat too rapidly and the core temperature drops below normal, **hypothermia** can result. Mild hypothermia begins to occur when the body temperature drops to 95°F. Athletes with the greatest risk of hypothermia are those who are extremely lean and participate in outdoor aerobic events. A combination of wind and moisture can result in rapid heat loss, even when environmental temperatures are well above freezing.

1. To prevent hypothermia, the hypothalamus induces shivering (skeletal muscle contractions that generate heat). Shivering ceases if body temperature drops around 87° F to 90° F. Without shivering, the body begins to cool uncontrollably.

2. Signs and symptoms of mild hypothermia include shivering, loss of motor control, slurred speech, confusion, and memory loss. In severe cases, shivering will cease and muscles will become stiff, giving the appearance of rigor mortis. The athlete's skin color will be blue and his or her respiration and pulse will decrease. The athlete will be semiconscious or unconscious.

3. Management of mild hypothermia includes moving the athlete to a source of heat and out of the cold environment; removing any wet clothing; wrapping the athlete in warm, dry clothing or blankets; and using electric blanket or hot packs around the head and neck, armpits, groin, and chest.

4. In severe cases (body temperature below 90° F.), the athlete should be transported immediately to a medical care facility.

a. Do not attempt to rewarm the athlete but prevent further heat loss by moving the athlete to a warm environment and gently removing cold, wet clothing.

b. Treat the athlete gently because of the risk of cardiac-related problems associated with hypothermia.

c. Monitor vital signs and be prepared to administer CPR.

5. To prevent hypothermia, the athlete should

a. Assess the risk by using a wind-chill chart (refer to Table 18.3 on page 267).

b. Do not embark on long outdoor activities alone. Tell someone where you are going and when you plan to return.

c. Learn to recognize early warning signs of hypothermia, especially uncontrolled shivering and loss of motor control.

d. Dress with appropriate cold weather clothing. New synthetic materials wick body moisture away from the skin surface while retaining body heat. Try to keep your hands, head, and feet protected with extra insulation.

e. Maintain proper hydration and keep sufficient calories in your system to generate body heat. Avoid using drugs such as alcohol that creates the feeling of warmth but actually contributes to heat loss.

f. Personnel rendering first aid to a hypothermia victim should know how to assess body core temperature rectally. Oral thermometers are of little value in such situations.

B. Frostbite and Frostnip. Exposure to extreme cold can result in skin-related problems. **Frostbite** is "freezing of tissues from excessive exposure to cold." Initially symptoms of frostbite are feeling burning or pain, followed by progressive loss of sensation. **Frostnip** is less severe and involves freezing only the outer layers of skin. Both conditions can occur when body areas such as the nose, ears, fingers and feet are exposed to below freezing temperatures.

1. Skin temperatures must be between 28ºF to 21ºF for tissues to freeze. Medical evidence suggests that the most severe damage occurs when frozen tissues are thawed and then refrozen.

2. During activities in extreme cold conditions and wind chills, athletes should be instructed to be vigilant regarding early warning signs of frostbite.

3. The National Safety Council has published criteria for the treatment of frostbite and frostnip (refer to Time Out 18.2 on page 268). Tissue freezing may be superficial or deep freezing depending on the duration and extent of the exposure.

a. Signs and symptoms of superficial freezing include grayish yellow or white skin color; pain that may occur initially and later subsides; the affected part feels very cold and numb; there may be a tingling, stinging, or aching sensation; the skin surface feels hard and crusty, and underlying tissue will be soft when depressed.

b. Signs and symptoms of deep freezing are the affected part will feel hard, solid, and cannot be depressed; blisters appear 12 to 36 hours after exposure; the affected part is cold with pale waxy skin; and the painful area stops hurting.

C. Cold Urticaria. **Cold uticaria** is a localized skin reaction to cold, characterized by **edema** and severe itching. Normally involves skin areas exposed to cold or not well protected by clothing. Exact mechanism is not known, but the condition appears to be a type of allergic reaction to cold temperatures. Individuals with mononucleosis, syphilis, chicken pox and hepatitis are more susceptible. Those taking drugs such as penicillin and oral contraceptives also demonstrate a higher incidence.

1. Symptoms of cold urticaria tend to be self-limiting, typically resolving within a few hours after rewarming of affected areas.

2. Medical referral may be warranted if symptoms repeatedly recur; treatment may include drugs such as antihistamines to control the associated edema and itching.