HYPOTHERMIA

DEFINITION: **Hypothermia** is defined as a core body temperature below 35° C (95° F). Because many standard medical thermometers do not read below 34.4° C (94° F), clinical hypothermia can be easily overlooked. Most clinically significant episodes of hypothermia result from a fall in core body temperature due to injury, immersion in cold water, or prolonged exposure to a cold environment. The very young and the very old are the most susceptible to hypothermia. Infants lose the same amount of heat per unit of body surface area as adults but cannot produce as much heat as adults. Infants also have a larger body surface area relative to total body mass than adults. Older individuals have a lower metabolic rate than the young, making it difficult for them to maintain a normal body temperature when subjected to an ambient temperature below 18° C (64.4° F).

Alcohol ingestion increases the risk of hypothermia by causing cutaneous vasodilation, impairment of the shivering mechanism, hypothalamic dysfunction, and a lack of awareness of the environment. Other medical conditions commonly associated with the development of hypothermia include drug ingestion (especially barbiturates or phenothiazines), diabetes (especially in the presence of **hypoglycemia**), hypothyroidism, hypopituitarism, hypoadrenalism, anorexia nervosa, **head injury**, and **sepsis**. Immersion in cold water, as in near drowning, can cool the body temperature much more rapidly than exposure to cold air because the thermal conductivity of water is 32 times greater than that of air. Hypothermia can occur in previously healthy individuals (such as cross-country skiers or hikers) who become injured and are exposed to the cold for prolonged periods of time.

CLINICAL FEATURES: The most important clinical effort of a lowered core body temperature is a gradual and progressive decline in basal metabolic rate and oxygen consumption. Mild hypothermia (above 30° C (86° F)) results in shivering, loss of fine motor coordination, and lethargy. Below 30° C (86° F) the pupils are usually dilated and there is hyporeflexia. Reflex vasoconstriction helps to preserve the core temperature, but makes detection of the pulse and blood pressure difficult. The hypothermic patient may appear clinically dead, but may still be viable with proper diagnosis and aggressive

management. Fully successful clinical recovery has occurred in a patient with an initial core temperature as low as 17° C (62.6° F). The only way to establish the potential viability of the hypothermic patient is to attempt resuscitation and active rewarming.

Hemodynamically, mild hypothermia causes a rise in pulse rate, blood pressure, peripheral vascular resistance, central venous pressure, and cardiac output. Moderate to severe hypothermia, below 30° C (86° F), causes bradycardia, arrhythmia's (atrial fibrillation is common, but virtually any atrial, junctional, or ventricular arrhythmia can occur), hypotension, and a fall in cardiac output. The risk of **ventricular fibrillation** or **asystole**, the usual final event leading to death, increases as the temperature drops below 28° C (82.4° F).

Oxygenation and acid-base balance are altered by hypothermia. Mild hypothermia initially causes hyperventilation. As the core temperature decreases, there is respiratory depression with anoxia and carbon dioxide retention. A combined respiratory and metabolic acidosis may occur due to hypoventilation, carbon dioxide retention, reduced hepatic metabolism of organic acid due to decreased perfusion of the liver, poor peripheral perfusion, and increased lactic acid production from poor perfusion of skeletal muscle and shivering.

GENERAL PRINCIPLES OF TREATMENT: Early recognition of hypothermia is essential. Health care providers in the field and in the emergency department must maintain a high index of suspicion in any patient with an altered level of consciousness who has been subjected to even a modestly cool environment. A thermometer capable of registering a temperature of 30° C (86° F) or less is essential.

Because the cold heart is irritable and susceptible to serious arrhythmia, care should be taken to move the patient gently during transportation or during transfer of the patient from a litter to a hospital bed. The patient should be monitored continuously, and equipment for resuscitation (including a defibrillator) should be immediately available. The hypothermic heart is usually unresponsive to cardioactive drugs, pacemaker stimulation, and

defibrillation. Nonessential interventions should generally be avoided until the core temperature is increased above 30° C (86° F). However, indicated and necessary procedures should not be withheld. For example, **endotracheal intubation** of the severely hypothermic patient may be needed to protect the airway, to correct hypoxemia and hypercarbia, and to deliver warm humidified oxygen. There is little evidence that intubation is likely to precipitate ventricular fibrillation in this setting as long as the patient is adequately ventilated (usually with a **bag valve mask** device) and the respiratory acidois corrected by hyperventilation prior to attempting intubation.

The effect of most drugs is diminished during hypothermia. Metabolism of drugs is usually reduced, causing accumulation in the body and potential toxicity during rewarming, if repeated doses have been administered. Nonessential drugs should generally be avoided until the temperature is corrected to above 30° C (86° F). Indicated and necessary drugs should not be withheld, although they may need to be administered in reduced doses, at less frequent intervals, or both. Hypoglycemia should be treated with glucose. Hyperglycemia during hypothermia will often correct spontaneously with rewarming. Volume depletion should be corrected.

FIELD MANAGEMENT: Once hypothermia is suspected, every effort should be made to minimize further heat loss, to begin the rewarming process, and to cautiously transport the patient. If possible, wet garments should be removed and replaced with dry (preferably warm) garments. Blankets and/or an insulated sleeping bag may be used to retain body heat. A normothermic rescuer may be alongside the victim underneath the covers to assist in rewarming. If available, airway rewarming with warmed humidified **oxygen** should be used because it can improve the patient’s heat balance.

HYPOTHERMIA-INDUCED CARDIAC ARREST: Treatment of a patient in cardiac arrest due to hypothermia is different from the treatment of a normothermic patient in cardiac arrest. The most common cardiac rhythms in hypothermia induced arrest are ventricular fibrillation and asystole. However, the fibrillating hypothermic heart is often resistant to defibrillation until the core temperature is raised and the temperature at which the heart will respond to defibrillation varies. In general, defibrillation should be attempted as soon as possible. If

unsuccessful, CPR should be continued and aggressive attempts should be made to rapidly rewarm the patient's core temperature. Periodically the core temperature increases when using a combination of techniques with repeated attempts at defibrillation. The patient should be intubated as soon as possible and should be ventilated with warmed humidified oxygen.

HOW LONG SHOULD ATTEMPTS AT RESUSCITATION BE CONTINUED? In general, children or young adults who develop cardiac arrest due to a sudden severe drop in core temperature (as in cold water immersion) should be treated aggressively, since survival without neurological impairment may be possible. A common problem is how to manage the unwitnessed cardiac arrest victim who is found in a cool or cold environment. The victim could have arrested due to hypothermia or the cold body temperature could be due to death. The clinical maxim that patients who appear dead after prolonged exposure to cold temperature should not be considered dead until they have been restored to near normal core temperature and remain unresponsive to resuscitation cannot be applied literally in all cases. Instead, the decision to terminate resuscitation must be individualized by the physician in charge based on the unique circumstances of each incident.