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PREVENTION, TREATMENT, AND MANAGEMENT OF COLD WEATHER INJURIES

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HEADQUARTERS, DEPARTMENT OF THE ARMY

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CHAPTER 7

COLD WEATHER-RELATED PROBLEMS

7–1. Carbon monoxide poisoning

a. CO is a poisonous gas which cannot be seen or smelled. CO binds to red blood cells more readily than oxygen so less oxygen is available to vital organs and tissues. It is contained in the exhaust from stoves and vehicles. CO can build up in closed spaces that are poorly ventilated. Early signs of CO poisoning are headache, confusion, dizziness, and drowsiness. Persons found unconscious in a closed shelter or vehicle may be victims of CO poisoning, especially if the lips and skin are bright red.

b. CO poisoning can be prevented by maintaining adequate ventilation. Shelters should not be airtight. Soldiers should not remain stationary in idling vehicles for long periods. Under no circumstances should anyone sleep in an idling vehicle. Occupants of idling vehicles should ensure that exhaust pipes are not blocked by snowbanks, and the windows of the vehicle are slightly opened.

c. Use of a CO detector in shelters is highly recommended. These detectors can provide an early warning to occupants that CO levels are elevated and countermeasures need to be taken to reduce the risk of CO poisoning.

d. Treatment.

(1) Move to fresh air immediately.

(2) Seek medical aid promptly.

(3) Provide mouth-to-mouth resuscitation if victim is not breathing.

(4) Administer 100% oxygen until the patient is symptom-free, usually about 4-5 hours. Serial neurologic exams should be performed to assess progress, and to detect the signs of developing cerebral edema.

(5) Consider hyperbaric oxygen therapy (HBO) therapy when the patient has a carboxyhemoglobin level of more than 25-30%, there is evidence of cardiac involvement, severe acidosis, transient or prolonged unconsciousness, neurological impairment, abnormal neuropsychiatric testing, or the patient is ≥ 36 years in age.

7–2. Cold urticaria

a. Cold urticaria is a disorder characterized by the rapid onset of itching, redness and swelling of the skin within minutes after exposure to a cold stimulus. It is probably the most common form of urticaria (hives). In extreme cases, anaphylactic shock may occur. This condition can begin at any age, affects both men and women, and is most prevalent in young adults (18-25 years old).

b. There are two forms of the disorder: essential (acquired) cold urticaria and familial (hereditary) cold urticaria. The symptoms of the acquired form become obvious in two to five minutes after exposure to the triggering substance or situation, while it takes 24-48 hours for symptoms of familial cold urticaria to appear. Also, symptoms tend to last longer with the familial form, typically about 24 hours although they may remain for as long as 48 hours. With the acquired form, symptoms tend to last for 1-2 hours.

c. Diagnosis of cold urticaria is made by placing a thin plastic bag with a freshly-melted ice cube on the skin, producing a wheal.

d. Management of cold urticaria includes:
(1) Patient education on the risks of systemic reactions.
(2) Prescribing an antihistamine for prophylactic use, if indicated.
(3) Prescribing epinephrine pen if life-threatening anaphylactic reaction is possible.

7–3. Cold-induced bronchoconstriction/asthma/respiratory illness

a. Cold weather leads to a host of possible complications for the respiratory system. Problems include bronchospasm, nasal discharge, and upper respiratory tract infections. Allergy-prone Soldiers are most susceptible to bronchospasm during heavy exercise (exercise-induced bronchospasm (EIB)) in very cold air and must be watched carefully. Bronchospasm can also be caused by fumes from fuel-fired heaters. Proper ventilation and maintenance of these heaters is crucial as pollutants are also a trigger for EIB. Use of a nasal spray consisting of water or sterile saline solution relieves the dryness and discomfort from breathing heated air.

b. EIB has an incidence rate of ~4-20% in the general population and 11-50% in elite athletes. Cold exposure has been implicated as a trigger for bronchoconstriction and asthma-like symptoms. Cold-weather athletes have an increased prevalence of EIB (23% of Olympic winter athletes) with cross-country skiers reportedly having an incidence rate of 33-50%. The incidence rate of EIB in Soldiers stationed in cold-weather areas is not known. Additionally, women are reported to have higher rates of EIB than men.

c. Healthy Soldiers can experience an increase in respiratory passage secretions and decreased mucociliary clearance when breathing very cold air during exercise, and any associated airway congestion may impair pulmonary mechanics and ventilation during exercise.

d. Crowding and poor ventilation in tents and other shelters increase dissemination of respiratory infections. Influenza vaccination is an essential preventive measure. Medical officers should perform aggressive surveillance, particularly for streptococcal infection. Early intervention with appropriate treatment and infection control can curtail the spread of respiratory infection. Control measures include appropriate pre-deployment immunization and prophylaxis, early detection of respiratory infection by examination and culture, head-to-toe sleeping in tents, and adequate ventilation.

7–4. Snow blindness (solar keratitis) and sunburn

a. Snow blindness and sunburn are caused by exposure of unprotected eyes and skin to ultraviolet (UV) radiation. The threat of snow blindness and sunburn depends on the intensity of sunlight, not the air temperature. Snow, ice, and lightly-colored objects reflect the sun's rays, increasing the risk of injury.

b. Snow blindness results when solar radiation "sunburns" unprotected eyes, primarily from reflected UV light. Symptoms begin 4-10 hours after exposure and range from a "gritty" sensation to severe pain, blurred vision, uncontrolled blinking, headache, eye-watering, photophobia, and blepharospasm. Symptoms last < 48 hours, or several days if severe. Injury can be compounded by corneal swelling, which results from altitude-and wind-related hypoxia and corneal evaporative drying, with hypoxia worsened by contact lens use. A fluorescein eye stain test can locate corneal injuries.

c. The use of protective eyewear or goggles that block > 95% of UV radiation will help to prevent snow blindness. Sideshields or deeply-wrapped lens designs should be used. Soft contact lenses which block UV-light are protective. If sunglasses are not available, opaque eye covering (for example, tape-covered eyeglasses) with narrow horizontal slits provide adequate field-expedient eye protection. Brimmed hats also offer some protection.

d. For treatment, have the Soldier close the eyes and rest until pain eases. In a first step, cool gently through the closed eyelid. In a next step use oral analgesics (for example, acetaminophen, up to 1000 mg, four times a day). If available, administer a topical lubricant (for example, antioxidant artificial tears), and apply non-steroidal anti-inflammatory eye-drops (for example, diclofenac 0.1%). Topical anesthetics slow corneal recovery and should not be used outside emergency situations (for example, descent from high-altitude). Consider topical antibiotics in severe cases to prevent infection. Cycloplegic eye-drops (cyclopentolate 1%) may relieve pain but impair vision.

e. Sunburn to the skin increases heat loss during cold exposure, increasing susceptibility to hypothermia. It also leads to uncomfortable/painful feelings that decrease Soldier performance. Sunburn can be prevented by using a sunscreen that contains para-aminobenzoic acid (PABA) of at least a 15 sun protection factor (SPF). For cold weather, an alcohol-free sunscreen lotion should be used that blocks both UVA (longer wavelength, associated with skin aging) and UVB (shorter wavelength, associated with skin burning) rays.

7–5. Altitude sickness

a. High-altitude environments are typically cold. In personnel not acclimatized to altitude, hypoxia can cause pathologic conditions that are distinct in their symptoms. These conditions include acute mountain sickness (AMS), high-altitude pulmonary edema (HAPE), and high-altitude cerebral edema (HACE).

(1) AMS occurs in Soldiers from low altitude (< 3,937 feet (< 1,200 m)) who ascend rapidly to high altitude (> 8,202 feet (> 2,500 m)) or from high to higher altitude and remain there for several hours or more. AMS is caused by the decreased amount of oxygen available to the body in the low-pressure atmosphere at high altitude. The pathophysiology of AMS is thought to be the result of mild cerebral edema and subsequent brain swelling. Although not life-threatening, AMS is the most common altitude illness, and its symptoms, when severe, can degrade physical and mental performance such that large numbers of troops may be completely incapacitated in their first few days at altitude. In a few Soldiers, AMS can progress to life threatening HACE or HAPE, both of which require evacuation.

(2) HAPE is a non-cardiogenic, potentially fatal accumulation of fluid in the lungs, which occurs in Soldiers that rapidly ascend from low (< 1,200 m) to high altitude (> 2,500 m) or from high to higher altitude and stay there for a few days or more. It also occurs in long-term high altitude residents who reascend rapidly to high altitude following a stay at low altitude lasting several weeks. The edema is caused by the combination of hypoxia induced pulmonary vasoconstriction and increase in permeability of the pulmonary capillary endothelium. The end result is overflow of fluid from the bloodstream into the lungs, hindering the normal exchange of gases between the lungs and circulating blood. Untreated, HAPE can be rapidly fatal (6-12 hours) and is the most common cause of death among the altitude illness syndromes. It is often preceded by AMS and is frequently seen in individuals with HACE, but most cases of HAPE occur without concomitant HACE. Although the incidence of HAPE is relatively low, its impact on military units can be significant because of the serious prognosis and need for rapid evacuation.

(3) HACE is a potentially fatal accumulation of fluid in brain tissue that occurs in Soldiers who rapidly ascend from low (< 3,937 feet) to high altitude (> 8,202 feet) or from high to higher altitude and stay there for a few days or more. The pathophysiology of HACE is thought to involve a hypoxia-induced vasogenic edema, in which protein-rich fluid spreads into the extracellular space through a compromised blood-brain barrier, or cytotoxic edema, in which intracellular fluid accumulates in neurons and neuroglia, or a combination of both. HACE is the

more severe end of the spectrum of altitude-induced edema in the brain with subclinical cerebral edema manifested as AMS at the other end. HACE can have a significant impact on military units operating at high altitude due to its serious prognosis and the need for rapid evacuation.

b. Altitude acclimatization is the most effective way to prevent these injuries (see TB MED 505 (2010) for the proper methods to acclimatize to altitude and reduce the risk of high-altitude injuries).

7–6. Musculoskeletal injury

There is an increased susceptibility to falls, broken bones, sprains, and strains due to frozen ground and ice. Proper footwear and education about this hazardous environment are essential.

APPENDIX B

Cold Weather Deployment Tips

B–1. Prevention categories

Preventing cold weather injuries depends on several factors including prior cold weather experience; proper use of clothing, equipment, and supplies; and appropriate planning for all operational scenarios. In addition to implementing these measures, Soldiers must be carefully observed for signs of distress in the cold and monitored for development of peripheral cold injuries and hypothermia. Clothing, shelter, nutrition, and rest/work cycles must be adjusted according to observations.

B–2. Weak link rule

When the first cold casualty occurs, assess the status of the whole unit.

B–3. Prior cold weather experience

a. Classroom training is not sufficient preparation for cold weather deployment; Soldiers must learn to work in the cold before deployment to cold regions.

b. Training exercises in cold weather should initially be conducted for short periods under very controlled conditions, and progressively increase in duration and intensity to several days of mission-related tasks under supervision.

c. Training sessions should be designed to provide practical experience under cold conditions, including proper use of cold weather clothing during both work and rest periods; efficient shelter construction (with external heat source); meal preparation; and use of other mission-related equipment which may function differently in the cold. Soldiers must be able to complete these tasks efficiently even when cold and fatigued.

d. Soldiers with prior cold weather experience dress effectively to avoid overheating and excessive cooling, be more efficient at conducting tasks in the cold, and have a better understanding of their own performance in the cold.

e. Leaders gain a better understanding of the capabilities of the unit and the function of equipment in the cold.

B–4. Clothing, equipment, and supplies

Soldiers must have access to the proper cold weather clothing, including items such as balaclavas, gaiters, goggles, gloves/mittens, and cold weather boots. Layering principles must be followed for the clothing to be effective. This requires training and experience. Clothing must be kept clean and dry. Several changes of socks are necessary to keep feet dry and reduce the risk of trench foot. Equipment and supplies used in cold weather must be tested in a cold environment and must be usable by Soldiers with reduced manual dexterity due to wearing gloves. Some equipment may require special tools for assembly or use in the cold so that Soldiers will not have to take off their gloves.

B–5. Operational planning

Everything takes longer in a cold environment, and this may be exacerbated by fatigued Soldiers, poor weather conditions, and exposure that is worse than expected. The weather, unit fitness, work/rest cycles, shelter, and nutrition need to be considered during planning.

a. Weather.

(1) A reliable source for evaluating cold stress is necessary. Any weather monitoring devices relied on must be tested in extreme cold environments to ensure proper functioning.

(2) Weather patterns may change abruptly; therefore, planning must include contingencies for greater-than-expected exposure, particularly if Soldiers are immobile or could get wet.

(3) Precipitation and water immersion greatly increase the risk of cold injury. Careful planning to avoid these conditions and provide emergency evacuation/rewarming are imperative.

b. Unit fitness.

(1) Cold weather operations may be more physically demanding, due to heavier loads (for example, more clothing), walking in snow or heavier boots, and mountainous terrain.

(2) Tired Soldiers are more prone to injury and are less efficient at preparing shelter and meals which could increase their exposure and risk of injury.

c. Work/Rest cycles.

(1) The concept of work/rest cycles can be implemented to avoid overheating and sweating in Soldiers who are physically active, and to avoid excessive cooling in Soldiers who are immobile.

(2) Sweat accumulation can lead to damp or wet clothing and increase body cooling. Soldiers who have worked hard and have damp clothing should change into dry clothing as soon as possible.

(3) Immobile Soldiers must be aware of extremity cooling. Placing extra insulation on the ground will limit conductive heat loss. Even small movements (stamping feet, swinging arms) will provide some internal heat.

(4) Both wind and solar load affect body temperature and should be used to advantage. For example, an immobile Soldier located out of the wind and exposed to the sun will be much warmer than one who is in the shade and exposed to wind.

d. Shelter.

(1) Adequate shelter is imperative so that Soldiers are able to rewarm and dry their clothing.

(2) Soldiers should be able to erect shelters in adverse conditions while wearing gloves.

(3) Safety guidelines for use of external heat sources must be followed.

e. Nutrition.

(1) Fluid intake is greatest at mealtime. Providing time for meals will ensure proper hydration as well as energy intake.

(2) Warm meals are important for improving morale and will help rewarm Soldiers who feel cold but are not yet hypothermic.

(3) Tired Soldiers may skip meals to avoid having to prepare stoves and heat water, but this practice will make them more susceptible to cold injury and further fatigue.

(4) Extra precautions are necessary to prevent water supplies from freezing in cold weather.

(5) Hydration of Soldiers can be monitored by noting the color and volume of urine. Dark yellow urine and infrequent urination indicate fluid intake should increase.

B–6. First aid for cold injuries

a. Early signs of hypothermia include shivering, withdrawal, and “the umbles” (stumbles, mumbles, fumbles, grumbles). Early intervention is imperative to take advantage of the heat generated from shivering. Remove wet clothing and increase dry insulation. Move the Soldier

to a heated shelter. Provide warm food or fluid to conscious Soldiers. Soldiers who are hypothermic and not shivering must be immediately evacuated.

b. Soldiers must be encouraged to take early action to rewarm cold extremities. Removal of wet socks or gloves is imperative. Dry, loose insulation will retain heat best. Swinging the arms or stomping the feet can increase blood flow to those regions. Increasing core temperature by exercise is most effective.

c. Extremities can be rewarmed in warm water (100-104 °F), but if frostbite is suspected, the extremity must be rewarmed only if refreezing will not occur.

d. Ensure Soldiers have adequate food and fluid intake, rest, and dry clothing.