UNITED STATES MARINE CORPS

FIELD MEDICAL TRAINING BATTALION
Camp Lejeune, NC 28542-0042

FMST 102

Manage Environmental Cold Injuries

TERMINAL LEARNING OBJECTIVES

1. Given a casualty and materials, treat environmental injuries to prevent further injury or death. (HSS-MED-2004)

ENABLING LEARNING OBJECTIVES

1. Without the aid of reference, given a description or list, **identify signs and symptoms of cold injuries, select contributing factors, and define treatment measures and symptoms of deterioration**, within 80% accuracy, per the Prehospital Trauma Life Support Manual, Current Military Edition. (HSS-MED-2004a)

2. Without the aid of reference, given a description or list, **identify the deterioration of cold, heat, and environmental injuries and how to seek a higher level of care**, within 80% accuracy per the Prehospital Trauma Life Support Manual, Current Military Edition. (HSS-MED-2004d)

OVERVIEW

Throughout history the most celebrated and extreme reports of cold related injuries have been in the field of military endeavors. From Hannibal losing half of his 46,000-man army crossing the Pyrenean Alps to frostbite and hypothermia, and the tens of thousands of cases of trench foot during World War I, we have learned much. Mild to severe cold weather conditions caused 13,970 unintentional hypothermia related deaths in the US between 1978 and 1998, with 6,857 of these deaths occurring in persons 65 years of age or older. When adjusted for age, death from hypothermia occurred approximately 2.5 times more often in men than women.

Cold injury is defined as tissue injury produced by exposure to cold. Cold itself is not the only factor in determining whether injury will occur. Duration of exposure, humidity, wind, altitude, clothing, medical conditions, behavior, and individual variability all contribute to the injury. Cold injuries can occur at nonfreezing and freezing temperatures. Trench foot, frostbite and hypothermia are the cold injuries of greatest military significance.

1. RISK FACTORS

Fatigue

Slow metabolic rate and inability to increase physical activity puts poorly conditioned personnel at increased risk. Mental and physical fatigue may cause apathy, leading to neglect of cold weather protection principles.

Age/Rank

Most cold injuries are suffered by military personnel from 17-25 years of age. The exact reason is unknown although these troops are generally “front line” troops who experience more exposure and are generally less experienced dealing with the cold. Decreased incidence of cold injury among higher ranks is a reflection of a combination of experience, less exposure and receptivity to training.

Nutrition

Poor nutrition or incomplete meals contribute to cold injury. During cold weather operations, encourage personnel to eat well-balanced meals (Meals Ready to Eat (MRE) or cold weather rations).

Discipline, Training, Experience

Well-trained and disciplined personnel are better able to care for themselves through personal hygiene, care of the feet, changing clothing and other simple, effective preventive measures. Personality and motivation are significant in determining adaptability. In intense cold, such as -25° F, the mind, as well as the body, is adversely affected. An individual becomes numb and indifferent to nonessential tasks. Essential tasks require more time to complete and are more difficult to accomplish. Lack of cold weather experience can greatly increase susceptibility.

Race/Geographic Origin

Military studies suggest that dark-skinned individuals and those from warmer regions are more susceptible to cold injuries. This relationship in race and cold is related to the greater susceptibility of pigmented cells to freeze compared with non-pigmented cells. However, with proper training and experience, a Sailor or Marine can compensate or overcome this predisposition.

Dehydration

Dehydration occurs very easily in the cold, particularly with increased physical activity. As with exposure to heat, adherence to proper fluid hydration while working in cold environments is necessary to minimize dehydration and the associated physical fatigue and cognitive changes. (*See lesson on Dehydration Casualties)*

Medication

Medications that cause vasoconstriction, increase urinary output or produce sweating should be avoided. Examples of medication: antihistamines, decongestants, diuretics, blood pressure medications.

Tobacco/Caffeine/Alcohol

Tobacco and caffeine products (tea/coffee) cause vasoconstriction and poor circulation. Alcohol is a vasodilator, and because of its anesthetic effects, intoxicated subjects neither feel the cold nor respond to it appropriately.

Environmental Factors

Weather and temperature are predominant factors that will modify the rate of body heat loss. Freezing temperatures are not necessary for cold injury. Humidity affects the rate of freezing and nonfreezing injuries. Precipitation and wind also greatly accelerate body heat loss.

Activity

Too much or too little activity may cause or contribute to cold injuries. Over activity creates large amounts of heat loss through rapid and deep breathing, and perspiration trapped in clothing reduces its insulating value. Conversely, immobility causes decreased heat production with resultant cooling in the extremities.

2. **TYPES OF COLD INJURIES**

Chilblains (Pernio)

Small skin lesions that are itchy, tender and appear as red or purple bumps which occur on the extensor skin surface of the finger or any exposed skin surface (e.g. ears, face) from chronic cold exposure.

Cause - Cold causes constriction of the small arteries and veins in the skin and re-warming results in leakage of blood into the tissues and swelling of the skin.

Signs and Symptoms

- Usually occur several hours after exposure to cold
- Appear as nodular plaques (patches on the skin)
- Intense pruritus (itching)
- Burning paresthesia (numbness)

Treatment

- Supportive in nature
- Gradually re-warm the exposed area at room temperature
- Wash and dry the affected area
- Apply a dry, soft sterile bandage
- Symptoms usually subside with elimination of cold

Solar Keratitis (Snow Blindness)

Cause - Ultraviolet burns to the skin and eyes from exposure to dry air or bright reflections from the snow. Corneal burns can occur within an hour but do not become apparent for 6 to 12 hours.

Signs and Symptoms

- Excessive tearing
- Pain
- Redness
- Swollen eye lids
- Photophobia
- Headache
- Gritty sensation in the eyes
- Blurred vision

Treatment

- Prevent further ultraviolet exposure (sunglasses). If no sunglasses are available, patch affected eye.
- Topical ophthalmic anesthetic drops to provide symptomatic relief.

Frostbite

Defined as the actual freezing of tissue fluids in the skin and subcutaneous tissues. Ice crystals form between and inside the cells with resulting tissue destruction. The most susceptible body parts are those areas farthest from the body's core, such as the hands, fingers, feet, toes and male genitalia.

Cause - Tissue does not freeze at 32°F because cells contain electrolytes that prevent tissue from freezing until skin temperature reaches approximately 28°F. When the tissue does freeze, ice crystals form and causes damage to surrounding tissue.

Depending upon wind velocity and air temperature, the exposure time necessary to produce frostbite varies from a few minutes to several hours.

Classification and Signs and Symptoms of Frostbite - frostbite is classified by depth of injury and clinical presentation. The degree of cold injury, just like burn injuries, in many cases will not be known for at least 24 to 72 hours. There are four degrees on injury based on physical findings.

First-Degree frostbite - an epidermal injury limited to skin that has brief contact with cold air or metal.

- Skin appears white or yellowish plaque at site of injury
- No blister or tissue loss
- Skin thaws quickly, feels numb and appears red with surrounding edema
- Healing occurs in 7 – 10 days

Second-Degree frostbite - involves all the epidermis and superficial dermis.

- Initially appears similar to first-degree however frozen tissues are deeper
- Tissue feels stiff to the touch, but gives way to pressure
- Thawing is rapid, results in superficial skin blister that has clear or milky fluid after several hours
- Surrounded by erythema and edema
- No permanent loss of tissue
- Healing occurs in 3 to 4 weeks

Third-Degree frostbite - involves the epidermis and dermis layers.

- Frozen skin is stiff with restricted mobility
- After tissue thaws, skin swells leaving blood-filled blister, indicating vascular trauma to deep tissue (hemorrhagic bulla)
- Skin loss occurs slowly leading to mummification and sloughing of tissue
- Healing is slow

Fourth-Degree frostbite – involves full thickness frozen tissue completely through dermis with muscle and bone involvement.

- No mobility to frozen tissue and only passive movement when thawed
- Poor skin perfusion
- Blisters and edema do NOT develop; will see early signs of necrotic tissue
- Slow mummification process will occur along with sloughing of tissue and auto-amputation of nonviable tissue.

Treatment (Superficial Frostbite) - Casualties with first and second-degree frostbite should be placed with the affected area against a warm body surface, such as covering the casualty's ears with warm hands or placing affected fingers into armpits or groin region.

Treatment (Deep Frostbite) - Management of casualties with third and fourth-degree frostbite includes:

- Move to warm shelter and provide supportive care

- If prolonged transport (1-2 hours) thaw in warm water bath at a temp no greater than 102°F. If re-freezing is a concern, do not thaw.
- Cover with loose, dry sterile dressing that is non-compressive and non-adherent
- Do NOT allow casualty to walk on affected feet
- Fingers and toes should be separated and protected with sterile cotton gauze
- Do NOT drain blisters in the field
- Provide pain meds as needed
- Start IV and give 250 mL bolus of warm saline to treat dehydration and reduce blood viscosity
- Do NOT give alcohol or tobacco products
- Do NOT use direct heat source greater than 102°F on the affected area
- Do NOT allow the thawed part to refreeze.
- TACEVAC ASAP

3. STAGES OF HYPOTHERMIA

Hypothermia

A condition in which the core body temperature is below 95°F. Hypothermia renders a casualty unable to generate sufficient heat production to return to homeostasis. Hypothermia can occur in environments with temperatures well above freezing. Inadequate clothing and physical exhaustion contribute to the loss of body heat and the development of hypothermia.

Hypothermia, acidosis, and coagulopathy constitute the **"triad of death"** in trauma patients. The mortality in combat casualties with hypothermia is double that of normothermic casualties with similar injuries. Hypothermia occurs regardless of the ambient temperature; hypothermia can, and does, occur in both hot and cold climates.

Causes

- Prolonged exposure to cold and/or wet conditions
- Inadequate clothing/protection
- Dehydration and/or inadequate nutrition
- Poor physical condition; slow metabolic rate and inability to increase physical activity puts the poorly conditioned at increased risk.
- Resuscitation with cold fluids or blood after traumatic injuries

Mild Hypothermia

Individual response to cold varies. In general, body temperatures above 89.6° to below 95° F constitute mild hypothermia. In this temperature range, the casualty is in an excitation (responsive) stage. The casualty will be shivering and usually show signs of altered LOC such as confusion, slurred speech, altered gait and clumsiness. The body will attempt to retain and generate heat by increasing heart rate, blood pressure and cardiac output. The respiratory rate will increase, which, in the long run, only cools the body more by breathing in cold air and losing moisture through respirations.

Shivering - body's main mechanism to generate heat. Shivering increases the metabolic rate by increasing muscle tension, which leads to repeated bouts of muscular contraction and relaxation.

Moderate Hypothermia

Moderate hypothermia occurs when the core temperature is between 82.4° and 89.6° F. The patient will probably not complain of feeling cold, shivering will be absent and the LOC will be greatly decreased. Paradoxical undressing may be observed before the patient loses consciousness. The patient in this stage is at risk for lethal cardiac dysrhythmias.

Severe Hypothermia

When the core temperature is below 82.4° F, the patient is in severe hypothermia. The casualty will be unconscious with no response to pain. Vital signs will be barely detectable or non-detectable. Without immediate and intensive treatment, this patient will die!

4. TREATMENT OF HYPOTHERMIA

"A patient is not dead until they are warm and dead." This phrase was created after many patients survived prolonged hypothermic events and received CPR in the field. No matter what your initial impression of the casualty in the field, do NOT withhold basic or advanced life support until core temperature has returned to normal.

- Move casualty to a warm shelter to prevent further heat loss
- Remove wet clothing if situation allows
- Loosen or remove constrictive clothing
- Cover patient's head and body with warm blankets or sleeping bags
- Administer warmed oxygen if available
- Warm water bath (water temperature between 100°F and 108°F)
- Hot, sweet drinks (if conscious)
- Monitor vital signs. Observe for cardiac abnormalities
- Monitor core temperature rectally
- Warm IV solutions (Pre-warm solution in warm water or between MRE heaters)
- TACEVAC

5. PREVENTION MEASURES

Education

- Education of troops and leaders is the number one preventive measure.
- Because of the difficulty, time and energy required to actively re-warm casualties, significant attention should be paid to preventing hypothermia from occurring in the first place.

Activity Levels

- Activity should be maintained at a steady, constant rate.
- Quick bursts of activity and long periods of inactivity should be avoided.

Buddy System

- Train personnel to observe each other for symptoms.
- Train personnel to re-warm extremities (fingers/toes) by holding (not rubbing) their buddy's hands/feet.

Personal Measures

- The Marine Corps uses the acronym "**COLD**" to describe the cold weather protection principles and preventive measures:

  C - Keep clothing ***CLEAN*** and free of oil and dirt. Oily and dirty clothing quickly loses its insulating effectiveness.

  O - Avoid ***OVERHEATING***. There are more heat exhaustion cases in a cold environment because of overdressing for the type of work performed. Overdressing and over-exertion cause an increase in body heat production and decrease heat dissipation. As the body temperature increases, there is a corresponding increase in perspiration, which causes saturation of clothes with sweat. Both conditions lead to cold injuries.

  L - ***LAYER*** correctly. Clothes should be loose to trap air between the layers, which produces the insulating effect necessary for survival in the cold. Tight and constricting clothing produces cold injuries. There can be as many as seven layers of clothing used to protect personnel in a cold environment.

  D - Keep clothing ***DRY***. If clothing becomes wet so does the skin, which will promote cooling and frostbite. Change wet clothing at the first opportunity.

6. **DETERIORATION OF CASUALTIES WITH COLD INJURIES**

Worsening temperature readings, unconsciousness, or semi-consciousness after treatment is a deterioration of the casualty and evacuation measures must be in place to get the casualty to a higher level of care immediately.

REFERENCES

Advanced Trauma Life Support (ATLS). American College of Surgeons: Current Edition
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First Aid
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Prevention and Management of Cold-Weather Injuries