UNITED STATES MARINE CORPS
Field Medical Training Battalion
Camp Lejeune

FMST 1404

Manage Environmental Cold Injuries

TERMINAL LEARNING OBJECTIVES

1. Given a casualty in a combat environment and standard field medical equipment and supplies, **manage environmental cold injuries**, to prevent further injury or death. (FMST-HSS-1404)

ENABLING LEARNING OBJECTIVES

1. Without the aid of references, given a description or list, **identify the predisposing factors associated with cold injuries**, per the student handout. (FMST-HSS-1404a)
2. Without the aid of references, given a list of symptoms, **identify the types of cold injury**, per the student handout. (FMST-HSS-1404b)
3. Without the aid of references, given a list of symptoms, **identify the stages of hypothermia**, related to decreasing core temperature, per the student handout. (FMST-HSS-1404c)
4. Without the aid of references, given a description or list, **identify the proper treatment for cold injuries**, per the student handout. (FMST-HSS-1404d)
5. Without the aid of references, given a list, **identify preventive measures for cold injuries**, per the student handout. (FMST-HSS-1404e)
6. Without the aid of references, given a simulated cold casualty and standard field medical equipment and supplies, **manage environmental cold casualties**, per the student handout. (FMST-HSS-1404f)

1. 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. Pathologically, all cold injuries are similar. Trench foot, frostbite, and hypothermia are the cold injuries of greatest military significance.

2. 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. Refer to the lesson on dehydration for more information.

3. PREDISPOSING FACTORS

Host Factors

Previous Cold Injury

Persons with previous cold injury, especially recent injuries, are at higher risk for subsequent cold injury. Individuals more sensitive to the cold should take actions to protect themselves.

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**.**

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.

Psychological Factors

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. Combat anxiety, which produces immobility, disorganization, and carelessness, coupled with sweating and vasoconstriction in the extremities can predispose a Marine to cold injury. Try to develop a positive attitude toward the cold and the situation in general. Also, develop a degree of mental discipline to ensure unquestioning ability to follow orders.

Race/Geographic Origin

Military studies suggest that dark-skinned soldiers 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.

Nutrition

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

Other Injuries

Injuries resulting in significant blood loss or shock reduce effective circulation to extremities and predispose a patient to a cold injury. Injuries that make patients immobile also lead to cold injuries.

Drugs and Medications

Medications that cause vasoconstriction, increase urinary output, or produce sweating should be avoided. 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.

4. CONTRIBUTING FACTORS

Environmental Factors - weather and temperature are predominant factors and will modify the rate of body heat loss.

Temperature - freezing temperatures are not necessary for cold injury. Of the 428 cases of hypothermia in one year, 69 were in Florida.

Humidity - effects rate of freezing and nonfreezing injuries

Precipitation - increases rate of body heat loss

Wind - greatly accelerates 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.

5. **TYPES OF COLD INJURIES**

Chilblains (Pernio) - small skin lesions that are mild but uncomfortable inflammatory lesions on skin that is exposed to damp, nonfreezing ambient temperatures. The hands, ears, lower legs, and feet are involved most commonly. They are more likely to develop in those with poor peripheral circulation. Historically, it is not of major clinical significance to military operations.

Cause

Exposure to air temperatures just above freezing (more likely to occur in dry, cold areas with high humidity)

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

Snow Blindness - the burning of the conjunctiva and superficial cells of the cornea by ultraviolet light from exposure to bright reflections from snow.

Cause

Ultraviolet light - exposure to the sun's ultraviolet rays in conjunction with gray cloudy conditions, whiteout snow conditions, or bright sunny conditions in a snow covered environment.

Signs and Symptoms

Gritty sensation in the eyes
Pain
Increased lacrimation (tearing)
Photophobia
Blurred vision
Headache

Treatment

Prevent further ultraviolet exposure (sunglasses). If no sunglasses are available, patch affected eye.
Oral analgesics (NSAIDS, but do not put local analgesics into the eyes)
Do NOT put steroid medications into the eye
CASEVAC as the operational environment permits

Hypothermia - 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 or normal bodily functions. 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.

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.
Traumatic injuries - resuscitation with cold fluids or blood can lead to hypothermia.
Alcohol and drugs - alcohol is a vasodilator, and because of its anesthetic effects intoxicated subjects neither feel the cold nor respond to it appropriately.

Signs and Symptoms (Stages of Hypothermia)

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. There is a wide range of individual differences at which shivering starts and stops, but typically, shivering starts when the core temperature is 94° to 97° F (34.4°- 36° C) and continues until the core temperature is 84° to 88° F (29°- 31° C).

Mild Hypothermia - individual response to cold varies. In general, body temperatures from 93° to 97° F constitute mild hypothermia. In this temperature range, the casualty is in an excitation (responsive) stage. The casualty will usually remain conscious, however, they may start to exercise poor judgment or have irrational behavior. The body's natural defense mechanism, shivering, will eventually diminish. 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.

Moderate Hypothermia - moderate hypothermia occurs when the core temperature is between 86° and 92.9° F. Cognitive abilities become more difficult and the patient becomes stuporous and does not respond to painful stimuli. Shivering is replaced by progressive muscular rigidity. In the initial excitation phase, heart rate, blood pressure, and cardiac output all rise. With decreasing temperatures, these all decline. The patient in this stage is at risk for lethal cardiac dysrhythmias.

Severe Hypothermia - when the core temperature is below 86° 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!

Treatment

"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.

Maintain ABC's. If CPR is initiated, maintain extensive re-warming efforts to ensure circulation of warm blood to the body's core.
Move casualty to a warm shelter to prevent further heat loss
Remove wet clothing if situation allows

Loosen or remove constrictive clothing
Warm, moist air via boiling water or hot shower (inhalation is the fastest way to warm the core)
Sleeping bag re-warming (place patient in bag with 1 or 2 buddies)
Apply heating pads or packs (groin/armpits/neck)
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)

Frostbite - actual freezing of tissue fluids in the skin and subcutaneous tissues. Ice crystals form between and inside the cells with resulting tissue destruction (see figure 1). 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, they expand and cause 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.

Figure 1. Frostbite

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. The classification of frostbite injury is identical to burn injuries. There are four degrees on injury based on physical findings.

Signs and Symptoms

First-Degree Frostbite - a superficial injury limited to skin that has brief contact with cold air or metal.
Skin appears red progressing to white or yellowish plaque at site of injury
No blister or tissue loss
Skin has stinging and/or aching sensation progressing to numbness
Healing occurs in 7 – 10 days

Second-Degree Frostbite - involves all the epidermis and superficial dermis.
Initially appears similar to first-degree

Thawing is rapid, which results in superficial skin blister that has clear or milky fluid after several hours
Tissue surrounding injury is red and edematous
No permanent loss of tissue
Healing occurs in 3 to 4 weeks

Third-Degree Frostbite - involves the epidermis and dermis layers and frozen skin is stiff with restricted movement.

After tissue thaws, skin swells leaving blood-filled blister, indicating vascular trauma to deep tissue.
Skin loss occurs slowly leading to mummification and sloughing of tissue
Healing is slow

Fourth-Degree Frostbite - frozen tissue involves full thickness 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

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 of casualties with deeper frostbite includes:

Move to warm shelter and provide supportive care
Rapid immersion of affected area into warm water
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 cigarettes because of their vasoconstrictive properties
Do NOT use direct heat source greater than 102°F on the affected area
Do NOT allow the thawed part to refreeze (when the injured site freezes, thaws, and then refreezes, the second freezing causes a greater amount of severe thrombosis, vascular damage, and tissue loss)
CASEVAC ASAP

6. **PREVENTION MEASURES**

Education of troops and leaders is number one preventive measure.

Activity Levels

Activity should be maintained at a steady, constant rate.
Quick bursts of activity 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 measure:

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

O - Avoid ***O****VERHEATING*. 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 - ***L****AYER* 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 ***D****RY*. If clothing becomes wet so does the skin, which will promote cooling and frostbite. Change wet clothing at the first opportunity.

REFERENCES

Wilderness Medicine 5th Ed., 2007, Chapter 5
Naval Preventive Medicine Manual, P5010, Chapter 3
Pre-hospital Trauma Life Support, Military Edition 6th Ed, Chapter 16

Cold Injuries Review

1. Explain the effect age and rank have on an individual's chance for developing hypothermia.

2. Describe the symptoms for Chilblains.

3. List three signs or symptoms of Moderate Hypothermia.

4. Define the acronym C.O.L.D.