CANADIAN AIRBORNE REGIMENT
FROSTBITE
Annex to Paratroop Medicine

Introduction

Cold injury occurs sporadically in the civilian population, but is of primary concern in the military service. It has been recognised as a problem of military importance since the days of Alexander of Macedonia. Napoleon's famous surgeon, Barron Larrey, classically described the role which cold injury played in the defeat of Napoleon's Army in Poland in 1812. It was of considerable military significance in World War II, in aerial battles, in the Battle of Ardennes Forest during December 1944 and at the Chosin Reservoir during the Korean conflict in 1951. Among United States troops, there were approximately 92,000 cases of cold injury during World War II and more than 9,000 during the Korean War. During the exercise Acid Test III in Alaska, the Canadian Airborne Regiment suffered 66 cases of frostbite early in December 1970.

A follow-up of 100 Korean cold injury casualties revealed that both after four and thirteen years, there was excessive sweating, pain, cold feet, numbness, abnormal colour and damage to the joints.

In this study of the cold injuries we will limit ourselves to the frostbite injuries putting aside the chilblains (exposure to temperature above freezing associated with humidity), the immersion foot (caused by exposure to water temperatures usually below 50°F), the trench foot (which results from exposure to cold temperatures just above freezing point to 50°F, often in damp environments) and hypothermia (result of cold exposure causing loss of body warmth and loss of contact with the environment).

Factors in frostbite

Cold is the specific agent in cold injury and is the immediate cause of tissue damage. A variety of environmental and host factors influence the incidence, type and severity of the injury. Weather is a predominant influence in the causation of cold injury. Low temperatures and low relative humidity favour frostbite, whereas higher temperatures together with moisture are usually associated with trench foot.

Wind chill is considered to be one of the important factors in the production of cold injuries. Wind velocity greatly increases wind chill. For example: a temperature of 38°F with a wind velocity of 10 miles an hour has the same effect on exposed flesh as a temperature of 0°F at a wind velocity of 1 mile per hour.

Increasing tissue heat loss is a most important factor in cold injury. The movement of cold air removes the warm layer of insulating air from around the exposed parts. When water or metal replaces air as the medium surrounding cold exposed parts, cold injury is more apt to occur than when air is the medium, since water and metal conduct heat better than does air. Persons with wet feet develop injury at considerably higher temperatures than those exposed in cold, dry air. Contact of the skin with cold metal can produce almost instantaneous freezing of tissue.

Conditions which decrease the internal heat supply include those which mechanically obstruct blood flow to the extremities, such as constrictive clothing or other pressure producing objects. Tight and stiff clothing is especially harmful if individuals must remain in cramped position in a confined space.
Frostbite

Physiology of frostbite

Cold injures the tissues of the human body by 2 ways. The first one is by direct action on the tissues and the second in damaging the blood vessels which nourish those tissues.

The exposure to cold causes a vasoconstriction (narrowing in diameter) of the arterioles (small caliber arteries) and small arteries. The mechanism contributes to local tissue anoxia (lack of oxygen). When the patient is moved to a warmer environment thawing (defrosting) occurs first along the course of the blood vessels. Vasodilation (expansion in diameter) of the blood vessels subsequently occurs with an outpouring of a protein-rich fluid through the walls of the capillary vessels (smallest blood vessels) causing occlusion of the blood vessels, swelling, and a stop in flow and tissue necrosis (damage).

Parts affected in frostbite

In order of common occurrence we find the following: Nose. Ears. Cheeks. Forehead. Wrists. Toes. Fingers.

Symptoms and consequences of frostbite

As a general rule patients who develop frostbite do so without being aware of it. They may have a symptom of uncomfortable coldness but subsequently with continued heat loss there is anaesthesia (loss of feeling) of the affected part.

Superficial frostbite most commonly seen about the ears usually is associated with a stinging sensation but this is not frequently noted in frostbite of the limbs. The part is usually without feeling, the patient complaining the limb feels like a stump or a block of wood. The first physical symptom (which is seen) is reddening of the skin which later becomes pale or waxy-white.

First degree frostbite

Symptoms. Slight degree in feeling in the form of numbness.

Slight discoloration (white) at the extremities of toes and heels.

The skin is red hot and dry after warming. The swelling begins within 3 hours and may persist for 10 days or more if the patient is ambulatory (continues to walk). If the patient is kept on bed rest the oedema (swelling) may subside within 10 days.

Desquamation (loss) of the superficial layer of the skin begins within 5 to 10 days after injury and may continue as long as a month.

This condition is reversible (return to normal) upon moving, which will restore circulation or rewarming until the feeling is completely restored.

In these cases, exposures to sub-zero temperatures should be of short duration followed by massaging of the extremities.

Recurrence of freezing is probable, therefore, one should keep a close look for the first 24 hours.

Consequences. The toes may remain cyanotic (bluish colour due to impaired circulation). Severe loss of feeling may appear within 3 to 13 days after rewarming. Many patients develop hyperhydrosis (abnormal sweating) and coldness of the injured part.
and this may persist for many months—most frequently patients having suffered from first degree frostbite will notice an increased sensitivity in the affected part. As far as the Canadian Airborne Regiment is concerned we suffered 49 cases of first degree frostbite in December 1970.

**Second degree frostbite**

*Symptoms.* There is an important decrease or absence of feeling of a toe, or all toes, or of the heel.

- The skin is of a greyish or greenish colour.
- The pain is rapidly present following the first attempt of rewarming.
- This condition is not reversible without tissue damage.

The red hot dry skin and swelling are the early manifestations. The swelling disappears within 3 to 5 days after rewarming. However, within 12 to 24 hours after rewarming the superficial vesicles (blisters) appear.

- Those blisters should not be ruptured, those patients should not walk and must be evacuated as soon as possible for further treatment.

*Consequences.* The blebs (ampoule, cloche) dry within 12 to 24 days after rewarming and form black eschars (patches of death tissue) and may cause some impairment of movement of the part. These black eschars gradually desquamate (fall off) revealing intact skin which is soft, thin and poorly keratized (protected by corn) and easily damageable.

Late consequences of this injury are throbbing and aching pain and usually appear within 20 days after the injury. Abnormal sweating appears within the second or third week after injury.

Patient may never totally recover from this injury and for years to come remain very sensitive to frostbite if exposed to cold. The Canadian Airborne Regiment suffered 16 cases of second degree frostbite in December 1970.

**Third degree frostbite**

*Symptoms.* Complete absence of feeling of the extremity.

- Pain at the limit of the freezing area.
- Grey or black discolouration of skin due to dead tissues.
- Hard and solid consistency of the skin.
- Tissues injured have reached the irreversible stage of death.

The injury involves the full skin thickness and extends to the tissue below the skin. The blebs in this case are smaller, less tense and may bleed. Like in the second degree an eschar is formed that is black, hard and dry and when this eschar finally desquamates, it leaves an ulcer which will be eventually covered by skin if there is not an infection.

*Consequences.* Average healing of this injury is 68 to 70 days. Late sequelae (consequences) of this injury are burning, aching, throbbing and shooting pains beginning within two weeks and usually lasting to five weeks.

Hyperhydrosis (abnormal sweating) and cyanosis usually appears within the fourth and tenth weeks. The Canadian Airborne Regiment in 1970 suffered 1 case of third degree frostbite.
Fourth degree frostbite

It is the destruction of the entire thickness of the part injured by cold including bones. The part of the body involved is anaesthetic (frozen)—swelling may be present, vesicles (blebs) are small, scattered and hemorrhagic. The tissues remain deeply cyanosed (with impaired circulation) after rewarming.

The injured part becomes progressively black, dry and mummified over a period of approximately 20 days. The line of demarcation becomes apparent on the average of 36 days and extends down to the bones between 60 and 80 days after injury. If this is left alone you will have an auto-amputation (the injured part falls by itself).

The Canadian Airborne Regiment in 1970 had no cases of fourth degree frostbite.

Protection against frostbite

Prior to parachuting, aboard the aircraft wear only the necessary clothing to be comfortable. When the order is given to get dressed avoid loss of energy and sweating in trying to beat your neighbour in speed. Until the last minute aboard the aircraft allow your clothing to be ventilated.

If you have to work during a few hours while recovering equipment, temporary shelter should be provided.

Don’t put the front strapping on your snowshoes too tight so your toes-circulation will not be impaired. Do not reach the stage when you cannot feel your toes, work on them as soon as possible, as you get the first tingling sensation.

Keep your whole body active, this will bring new warm blood to your extremities, simply beating your feet is not enough. You must keep the whole body warm, especially if you have been sweating.

If you know you are more susceptible than others to cold, be more careful than others. Do not be afraid to put your parka hood and your best mitts on even if you think you can get away without them.

The buddy system to check your face is still in use in the Canadian Airborne Regiment.

Avoid impairment of circulation to your hands and feet by contraptions holding your sleeves and pants. Keep your clothing clean and dry, when it is wet or moist change them, don’t wait for bedtime.

Avoid overheating by regular ventilation of your clothing. Wear clothing loose and in layers—it takes only one layer deficient to damage your whole clothing protective system.

Make the maximum use of your rations. They replace the energy you have lost during the day and help you to prepare yourselves for the next day.

Treatment of frostbite

The first treatment of frostbite resides in the prevention.

All frozen parts that have been rethawed in the field should be protected against further cold injury and the patient treated as a litter case. All clothing items such as boots, gloves, socks and shoes should be removed, if adequate protection from further cold exposure can be achieved.
If the injured parts are still frozen when first seen they should be rapidly rewarmed by immersion in water at 100° to 104° F (with Phischex added) and with agitation of the water to hasten the warming (such as the whirlpool bath). General body warmth should be maintained and sleep and rest should be encouraged.

A booster of tetanus toxoid should be given to those not previously immunized. Smoking is prohibited. Prophylactic (for protection of infection) antibiotics should not be used.

The vesicles (blebs) should be protected and kept intact if possible—once ruptured it is usually desirable for complete debridement (remove death tissue) of the bleb. Protective dry dressings should be placed between the toes or fingers with sterile cotton to prevent maceration.

The patient is placed on bed rest with the part elevated using foot cradles and sterile sheets. Analgesics are usually required in the early post thaw period only. The patient should be placed on a normal nutritional diet. All lesions should be exposed to air or sterile sheets at normal room temperature. All frostbites when possible should be X-rayed.

Avoid pressure point during the evacuation.

Conclusion

This paper was prepared primarily to make every man in the Canadian Airborne Regiment aware of the problem of Frostbite. Frostbite should not be only the concern of the Unit Aid Station but every officer, Non-Commissioned Officer and Man of this Regiment. In many instances, medical terms have been used and explained so everyone could understand them.

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