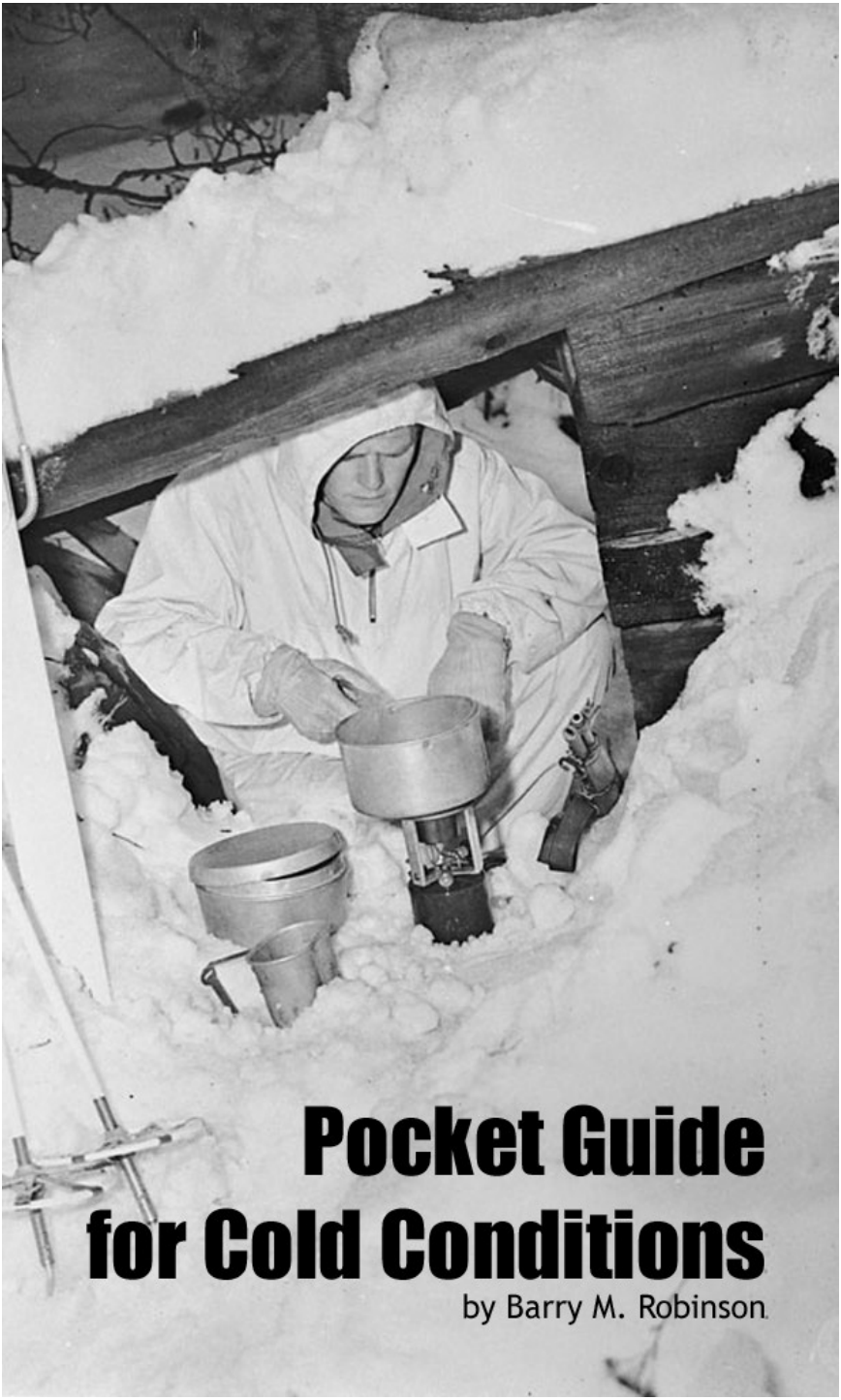

# Pocket Guide for Cold Conditions

by Barry M. Robinson

## Dressing for the Cold

Our goal in dressing is to keep our body at the optimum temperature for functioning and to reduce or eliminate temperature stresses. If our clothing allows too much heat to escape, we'll use up energy in generating heat to keep warm. If our clothing retains too much heat, we'll use up energy and body fluids in sweating. Either way, we'll be uncomfortable and won't be able to produce our best results either physically or mentally. Most military units that conduct cold weather operations use the mnemonic **COLD** to help soldiers remember how to use and care for their clothing in a cold environment. **COLD** stand for:

- **Clean** - keep your clothing clean
- **Overheating** - avoid overheating which causes sweating and a decrease in the insulation value of your clothing.
- **Layers** - Dress in layers for control of overheating and better mobility. Keep clothing loose.
- **Dry** - Stay dry to preserve insulation value of the clothing

### Fibres and fabrics

Fibres that make up fabrics can be either natural or synthetic (man-made); natural fibres do not offer any universal advantages. Synthetic fibres do offer an advantages in insulation especially in the cold since the structural qualities (length and cross sectional area) are not affected by moisture. The strength of the synthetic fibre is retained even when wet preventing the collapse and matting of insulation when wet. Down insulation is an excellent insulator when dry but turns into a soggy mass with very little insulation value when wet. Microfiber products such as Thinsulate® offer higher insulation values than conventional fibres and retains its insulation with up to 30% moisture content by weight. Non-absorbent synthetic fibres don't give the wearer the cold, damp sensation that cotton clothing does. Polypropylene fibre has a lower thermal conductivity than other fibres and along with other synthetic fibres is lighter in weight than cotton and wool. Mixtures of fibres have been found to perform well; underwear made from a fabric containing a mixture of 67% polyester with 33% cotton performed well in sweat buffering, the ability of clothing to transport water.

### Insulation and layering

Clothing insulates by trapping air between layers of cloth or among fibres. The efficiency of a particular thickness of insulation depends upon the surface area of all the fibres. In most cases (except for sleeping bags) an insulation thickness of 3cm provides maximum warmth if it is an efficient insulator (10-20% fibre and 80-90% air) and dry.

Layering is a clothing system that divides up the insulation into various layers instead of having one thick layer of insulation. This system has several advantages including: fine adjustment of the insulation value to account for ambient temperature and level of activity, donning or removal of water-resistant or water-proof layers as required, easier cleaning/exchange of soiled or damaged

layers. Clothing should be kept loose for better blood circulation and to trap more air for better insulation. Genital cold injury (frostbite) has been reported in joggers, skiers and mountaineers wearing tight trousers. Windproof clothing helps reduce heat loss through convection. Use draw cords to prevent clothing movement from pumping warm air out of or cold air into clothing.

Nuclear-Biological-Chemical (NBC) suits worn by military personnel may put soldiers at risk of cold injury due to sweat accumulation reducing insulation and from non-insulated gloves and footwear.

**Keeping dry**

Keeping dry preserves the insulation value of clothing; 10-20% by weight of moisture can cause a 50% reduction of the dry insulation value of clothing. Moisture barriers such as Gore-Tex® are called “breathable” since they keep out liquid water yet pass water vapour. However, the label “breathable” is misleading since these materials block the passage of oxygen and carbon dioxide, “breathable” applies to water vapour only. Don’t wrap your head or cover yourself too tightly with Gore-Tex® or similar materials, it will restrict the flow of oxygen to you. These barrier materials must also be kept clean to function properly. In extreme cold (below -40ºF (-40ºC)) Gore-Tex® becomes stiffer and noisy, most likely due to the freezing of water absorbed by the hydrophillic (attractive to water) coating.

**Footwear**

The feet are often a problem area in cold weather; they’re in contact with the ground so they lose heat through contact, the feet have a large number of sweat glands so they rapidly become damp, circulation from tight footwear can reduce heat transfer via blood to the feet and feet are the first part of the body to come into contact with snow, ground water etc. Wear proper footwear for the conditions, mukluk's in very cold conditions, wet weather combats in cold, wet conditions. Don't tie up boots tightly and brush off snow when entering a warm environment. Temperatures in deep snow can be quite a bit colder than the top layers of snow; one expedition on Mt. McKinley in Alaska measured a -16ºC air temperature and a -25.6ºC temperature in the deep snow.

**Sleeping bags**

Sleeping bags lose heat via convection and conduction. Convection is through circulating air that escapes through the head opening and other openings (zippers etc.) on the bag. Conduction occurs by compression of the insulation material underneath the sleeper’s body reducing the insulation value and transferring heat to the ground. When using sleeping bags in cold weather you should use sleeping bag liners to reduce the dirt transfer to the sleeping bag, an insulating mattress/water barrier should be placed between the ground and the sleeping bag and vapour hoods (made of Gore-Tex® and similar materials) should **not** be used with sleeping bags inside of tents. When not in use, sleeping bags should be stored loose (uncompressed) so the down insulation retains its loft. Keep the sleeping bags in large laundry or cloth bags.

Your heat production is lower when you're at rest so your insulation, the sleeping bag must retain more heat then the clothing you wear when you're active. Don't dry wet clothing in or on your sleeping bag, moisture transfer will reduce insulation and will make you uncomfortable.

When sleeping strip down to your minimum clothing, T-shirt and underwear; more clothing restricts movement and doesn't contribute to heat retention. Use the insulated hood provided with your sleeping bag (**Note:** This is not the same thing as the Gore-Tex® vapour hood mentioned earlier) or wear a hat to prevent heat loss from your head and don't pull your head inside the sleeping bag; carbon dioxide accumulation may make sleeping difficult. Your extremities may need a bit more insulation than your body since you're at rest during sleep and circulation will be lower than when you are active. A comfortable temperature for your body may be too cool for your hands and feet. Wearing socks and liner gloves may help you to sleep better by keeping your hands and feet warm.

**Wind Chill**

In still air, a layer of air near the body is warmed and forms a micro climate that makes the skin feel warmer. This layer of warm air is stripped away and you feel colder in windy conditions. Moisture in the skin is also evaporated by the wind cooling the skin even further. Wind chill is a numeric expression of this effect and is often given as an equivalent temperature. For example, if the outside

**Wind Chill Chart**

**October 2001 - based on data from Environment Canada**

| Wind Speed (km/hr) | What to look for | Temperature in Celsius degrees | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0 | -5 | -10 | -15 | -20 | -25 | -30 | -35 | -40 | -45 |
| 10 | Wind felt on face; leaves rustle; wind vanes begin to move. | -3 | -9 | -15 | -21 | -27 | -35 | -39 | -45 | -51 | -57 |
| 20 | Leaves and small twigs constantly moving; small flags extended. | -5 | -12 | -18 | -24 | -30 | -37 | -43 | -49 | -56 | -62 |
| 30 | Dust, leaves and loose paper lifted; large flags flap; small tree branches move. | -6 | -13 | -20 | -26 | -33 | -39 | -45 | -52 | -59 | -65 |
| 40 | Small trees begin to sway; large flags extend and flap. | -7 | -14 | -21 | -27 | -34 | -41 | -48 | -54 | -61 | -68 |
| 50 | Larger tree branches moving; whistling heard in power lines; large flags extend and flap more wildly. | -8 | -15 | -22 | -29 | -35 | -42 | -49 | -56 | -63 | -69 |
| 60 | Whole trees moving; resistance felt in walking against wind; large flags extend fully and flap only at end. | -9 | -16 | -23 | -30 | -36 | -43 | -50 | -57 | -64 | -71 |
| | | Wind Chill Index (Celsius) | | | | | | | | | |

temperature is -10ºC and a 35km/hr wind is blowing the wind chill (equivalent temperature) will be -20ºC. In other words the windy day at -10ºC will feel the same as a calm day at -20ºC.

## Cold Illness and Injuries: Treatment and Prevention

### Factors in cold illness and injury

#### Fatigue and nutrition

Fatigue and lack of proper nutrition increase the individual's susceptibility to cold illness and injury by disrupting the ability of the body to maintain thermal balance.

Proper nutrition in cold weather involves increasing the amount of carbohydrates to provide energy to heat the body. An amount of 5g to 8g of carbohydrate intake per kilogram of body mass per day has been suggested (example: a 60kg person should consume 300g to 480g of carbohydrates per day). Foods such as cereals, bananas and bread are high glycemic index food and enter the blood stream quickly. These should be eaten before exercise. Low glycemic index foods such as pasta enter the blood stream more slowly and should be taken after exercise. Eat small servings (50g carbohydrates with 10g of protein) spread out over the day.

A research expedition on the Lake Winnipeg Narrows headed by Gordon Giesbrecht from the University of Manitoba found that even with a daily diet of 4700 Cal members of the expedition lost between 11 and 19 pounds each (5kg to 8.6kg) over a period of 19 days. That diet represents over twice the energy intake of 2110 Cal required by a young man leading a sedentary life.

Dehydration in cold weather must be avoided by drinking plenty of water or even better a drink containing glucose and some electrolytes ($Cl^-$, $K^+$). Ideally water should be warm but not hot; hot water increases the time taken to empty the stomach and hence increases the time taken for the water to enter the circulatory system. Lack of water will make a person more susceptible to cold injury, it will increase the severity of cold injuries and it reduces the food intake. Restricted water rationing in cold environments has also been found to cause selective metabolism of fat and hence fat loss. This can be critical in a hypothermic casualty since depleted fat reserves reduce the ability of the body to combat hypothermia.

#### Physical conditioning

Physical conditioning will help guard against cold injury only if the individual is also well-fed and rested. Even individuals in excellent physical condition can suffer from cold injuries; four U.S. Army soldiers died of hypothermia during a training exercise at the U.S. Army Ranger school in Florida on February 15, 1995. Studies of U.S. Marines during winter training have shown a high level of conditioning seems to help prevent frostbite. The mechanism preventing frostbite may be improved blood flow to warm the extremities and a higher metabolic rate providing increased heat output.

**Alcohol, tobacco and caffeine**

Alcohol and tobacco both have detrimental effects on humans exposed to cold environments. Alcohol interferes with the ability to sense the cold and inhibits shivering. There is also the possibility that body heat might be lost more quickly due to vasodilation caused by alcohol use but there is debate over this. At higher blood alcohol levels the impairment of mental functions can lead to inappropriate behaviour and choices of clothing, putting the individual at greater risk of cold injury. A high percentage of civilian hypothermia victims and frostbite victims are intoxicated when found. Alcohol and strenuous physical exertion can produce hypoglycaemia (a drop in blood glucose levels) which leads to the impairment of the thermoregulation mechanism of the body and a drop in core temperature. The bottom line: don't drink before going out in the cold or soon after returning.

Tobacco, either smoked or smokeless, causes an increase in nicotine in the bloodstream. This nicotine gives rise to vasocontraction; a narrowing of the blood vessels going to the extremities. Reduction in blood flow leads to lower heat transfer and makes the hands and feet cooler, more susceptible to frostbite. Studies of U.S. Marines taking part in winter training shows a significant correlation between tobacco use and cold injury of the feet. The more you use tobacco, the greater risk you have for frostbite.

Caffeine use in cold environments may have beneficial effects. Caffeine alone will increase the metabolic rate by approximately 12% while at rest and increase 16% while exercising. A moderate intake of caffeine (caffeinated drinks) accompanied by proper nutrition appears to be safe.

**Hypothermia**

**What is hypothermia?**

Hypothermia is defined as a drop in core body temperature below 35ºC. The core of the body is the major internal organs such as the heart, liver, lungs, and brain. Core temperature is normally 37ºC. In reality we define hypothermia by its signs and symptoms since core temperature is difficult to take, especially the conditions in which hypothermia is a problem. Temperature ranges for various **levels** of hypothermia, mild to severe, vary among sources. Mild hypothermia is a core temperature between 34ºC and 35ºC, moderate hypothermia is a core temperature of 30ºC to 34ºC and severe hypothermia is below 30ºC. Presented here are the **types** of hypothermia.

**Superacute or Submersion Hypothermia**

This form of hypothermia is caused by total submersion in ice-cold water. Cooling is extremely rapid as heat leaves not only through the entire body surface but through the head as well. Cold water entering the lungs brings about rapid cooling of the core. Water in the lungs may result in fluid or electrolyte imbalances; salt water can cause a blood volume drop of up to 40% and freshwater can cause the blood volume to double resulting in ventricular fibrillation in up to 80% of cases.

**Acute or Immersion Hypothermia**

The most common causes of this type of hypothermia are falling into cold water or alcohol intoxication with a large proportion of the body surface exposed to the cold (usually with inappropriate dress). Trauma casualties in cold weather are also at risk since shock (due to the loss of circulating blood volume), reduced movement and contact with cold ground all help to cool the body rapidly. In any case, the heat production mechanisms of the body are overwhelmed and the body cools rapidly. The body still has plenty of energy reserves since the cooling has taken place over a short period of time. As the body tries to adapt to the cold (especially after immersion in water), fluid shifts from the extremities to the core, increasing the blood pressure which increases fluid output through the kidneys as urine (diuresis) resulting in a loss of fluids from the body. If the casualty is taken out of the environment quickly, rewarming will be spontaneous. At water temperatures below 20ºC the body will continue to cool until death occurs unless the casualty is removed from the water.

**Subacute or Exhaustion Hypothermia**

Most commonly found in endurance activities such as hiking and mountain climbing, the casualty has exhausted his or her energy reserves and begins cooling. This may take place during the activity or during rest periods. Cold in this case does not have to be as severe as for acute or superacute since the primary cause is the reduced ability of the body to create heat. Since energy reserves have been exhausted prior to hypothermia setting in spontaneous rewarming is not as likely compared with acute hypothermia.

**Chronic or Urban Hypothermia**

This takes place over longer periods of time, usually days or weeks, in cool to cold weather. Casualties tend to be the elderly or malnourished, living alone in an urban environment and often occurs indoors. Other groups that might suffer from this type of hypothermia are those with mental illness, alcohol and drug abusers, and refugees living under harsh conditions. Rewarming of the chronic hypothermia casualty MUST take place in an intensive care unit since mortality approaches 100% if proper facilities are not available.

**Signs and symptoms of hypothermia**

One of the first signs of hypothermia is a change in behaviour, a distant gaze, stumbling (“stumbling slobbers”) while walking, incoherent or slurred speech, and drowsiness; Royal Marines in the Falklands War were paired off and told to watch each other for symptoms.

To check for mental status, ask the person to count slowly backwards from one-hundred or some other mental task. You can also have the person try to walk a straight line for 10 meters; if they’re unable to walk a straight line they may be suffering from hypothermia, however altitude sickness, exhaustion, hypoglycemia (low blood sugar) and dehydration also cause a person to fail this test. Take these factors into account. If doubt exists, assume hypothermia.

The mechanism of injury is also another sign that you're dealing with hypothermia. A person who has just fallen into cold water, is wearing inappropriate clothing, or whose clothing is wet and cold is probably hypothermic or in danger of becoming hypothermic. **ALL TRAUMA CASUALTIES in a cold environment will probably have some degree of hypothermia due to shock, contact with cold ground and reduced heat generation.**

Depending upon the individual circumstances, shivering may or may not accompany hypothermia. In some cases, shivering may cease as the patient moves from mild to moderate or severe hypothermia or upon application of external heat. Extreme shivering, the kind that keeps the person from doing anything else, is a definite sign of hypothermia but again, THE ABSENCE OF SHIVERING DOES NOT PRECLUDE A DIAGNOSIS OF HYPOTHERMIA.

Other signs of hypothermia include; cold, pale skin (check for temperature by placing your hand in the armpit or stomach of the casualty) and rigidity of limbs (difficult to move arms or legs). In extreme cases, where the core temperature falls below 33ºC, patient may appear dead without pupillary reflexes, pulse or breathing.

**Prevention and treatment**

The key to the prevention of hypothermia is understanding the causes which are:

- increased heat loss
- decreased heat production
- impaired thermoregulation

Wear proper clothing to retain body heat and know how to adjust your clothing. Use a scarf and the draw cord on your jacket or parka to prevent heat leakage. Stay well-nourished, drink plenty of water often and rest often. Carry a foam "bum pad" to avoid sitting directly on wet, cold ground. Emergency bivouac equipment should be carried, along with dry clothing. If caught outside stay put and seek shelter instead of pressing on to your destination

Trauma casualties occurring in cold weather are at risk of hypothermia. External heat sources may be applied to the non-hypothermic minor trauma casualty to prevent hypothermia, provide comfort and reduce pain and anxiety. Trauma casualties must always be closely watched for signs of hypothermia. Even mild hypothermia can cause increased blood loss in patients.

In all cases of hypothermia the priority is to get the person out the cold environment. Do so gently as the heart is very susceptible to ventricular fibrilation when cold; in the field erecting a FAST, temporary shelter around the person may be the best bet. Wind and rain can cool a person quickly. Insulate the person from the ground with a foam mattress and keep them dry by placing a plastic sheet under them. Keep the person horizontal (place in the recovery position if possible) and do not allow the patient to exert themselves. Gently

remove any wet clothing, cutting it away with scissors if necessary, or if this is not possible use a towel or other cloth to GENTLY dry the person by patting up any water (don't rub the skin or jostle the patient). Quickly stabilize any injuries such as broken bones, open wounds etc. Wrap in warm blanket, then wrap in plastic, being careful not to cover the face. Put a warm head covering on the patient. Leave the blankets and plastic wrapped in such a a way so that the patient may be checked easily. If available give oxygen immediately. Do not apply external heat sources; do not try to artificially warm the person. One of the "treatments" often recommended is warming the person by body-to-body contact usually in a sleeping bag; DO NOT USE THIS METHOD. This method is useless at best and, in many cases, can be dangerous since it can actually reduce rewarming of the casualty by stopping shivering. In addition the heat transfer between two bodies is very inefficient due to vasoconstriction and the small proportion of body to body contact, and this treatment may unnecessarily delay transportation of the casualty to a proper medical facility. If the patient is only mildly hypothermic and is alert and conscious, warm fluids may be given (sweet drinks, avoid coffee and tea. Never give alcohol) if rescue or transport is delayed. Do not warm the casualty's hands or feet as this will reduce the stimulus for heat production so don't put gloves or socks on the casualty (but do protect the casualty's extremities from further cooling and don't purposely cool the extremities by exposing them to the environment).

In severe hypothermic casualties, both the breathing and heart rates may be slow and difficult to detect. Before beginning CPR (cardiopulmonary resuscitation) you must check carefully for breathing and a carotid pulse (the artery on either side of neck next to the trachea) for a full minute. Any hypothermic patient showing signs of movement must NOT be given CPR. Check frequently for a pulse and STOP CPR immediately if a pulse is detected

Deaths in hypothermia frequently occur after rescue during the rewarming phase; this is why rewarming in the field is discouraged. When moving the hypothermic patient, carry the patient horizontally and be extremely gentle. Move slowly, especially over rough ground since rough handling is a common cause of ventricular fibrilation in the hypothermic casualty. Protect the patient from the environment at all times (cold, wind, rain). Finally, do not give up. With hypothermic patients, "No one is dead until warm and dead."

**Treatment in remote areas**

If hypothermia occurs in remote areas many hours or days away from help, there is very little you can do aside from supportive care. Your main goals are: prevent further heat loss by keeping the casualty warm and dry, prevent ventricular fibrilation by keeping the casualty lying down and quiet (handle/move the casualty as little as possible), keep the hands and feet cool (not cold) since warm hands and feet reduce the stimulus for heat production, a conscious, lucid casualty can be given warm fluids and food The last point is important since hypothermia increases urine output (diuresis) with consequent loss of fluid and shivering increases the need for energy. If the casualty is NOT

shivering try placing warm (40ºC) bottles of water in or on the armpits, groin and neck to provide supplemental heat. Provide oxygen if available.

**Cold water rescue**

In Canada 50 people died as a direct result of hypothermia from cold water immersion in the year 1998. This represents approximately 12% of all drowning victims. An additional number of drowning victims probably had hypothermia as a contributing cause to drowning, especially in cases where the water was colder than 20ºC. Even in well-rested and healthy individuals with extensive swimming experience hypothermia can begin in as little as 3km of swimming in water at 11.7ºC.

Hypothermia is a consequence of immersion or submersion in cold water and hypothermia caused by cold water usually has the best prognosis since the casualty, if rescued quickly, still has plenty of metabolic energy reserves available for rewarming. However, cold water presents some unique risks which must be taken into account. First is hyperventilation (fast, shallow breathing) that may interfere with the ability to swim and increases the potential for panic. Cold water immersions frequently result in the casualty feeling hopeless or weak and not making any effort to stay afloat. Grip strength, manual dexterity and mental performance are all impaired by immersion cooling. Large fluid shifts caused by the cold, coupled with the pressure the water exerts on the body (hydrostatic pressure) may bring about cardiovascular collapse upon removal from water. If possible remove casualty from water in a horizontal position.

There are three types of rescue technique available, the choice being on what is available to the rescuer and the state of the casualty.

**Reach rescue**

The reach rescue is done from shore by extending an arm or other object to the casualty. Stay away from the water's edge to avoid being pulled in.

- lie in a prone position on the shore or lock hands with a second rescuer
- tell the casualty to remain calm. Important since struggling quickly reduces energy reserves available for rewarming after rescue and movement of cold water over the body increases the speed of temperature drop.
- if you can't reach casualty with your arm use a branch, rifle or rifle sling, rucksack or some other object to reach. Tell the casualty to take hold.
- slowly pull the casualty back to shore being careful not to jerk the casualty and lose their grip

**Throw rescue**

The throw rescue is done with a line and is for casualties that cannot be reached by the reach rescue method. It involves a line attached to a throwing device that

will float. In an emergency an air matress, sleeping pad, waterproof stuff sack, empty canteen or water bottle can be used as a throwing device

- make two or three trial throws without throwing the rescue device.
- throw the rescue line past the casualty's head and then slowly draw the line back toward the casualty. Instruct the person to grab the rescue device
- slowly pull the person back to shore

**Active in-water rescue**

This is potentially the most dangerous for the rescuer since he/she may become a hypothermic casualty. Cold weather clothing can easily become waterlogged and make movement difficult. Some sort of flotation device must always be used and another rescuer must be available and remain on shore.

- remove all loose clothing and shoes
- enter the water carefully, never dive in as this could result in injury especially in unfamiliar, shallow water
- approach casualty with flotation device between the rescuer and the casualty
- place flotation device against casualty's cheek and instruct casualty to grab it. Never establish direct physical contact with the casualty unless the casualty is unconscious.
- when flotation device has been grasped, return slowly to shore while reassuring the casualty

**Frostbite**

**What is frostbite?**

Frostbite is the freezing of tissues, the severity of which is dependent upon the temperature gradient between the skin and the environment and the duration of the exposure. Tissues freeze at a lower temperature than does water. During frostbite, ice crystals form first outside the cell (extracellular) dehydrating the cells. As frostbite progresses, ice crystals form inside the cells (intracellular) destroying the cells. Upon warming the second phase of frostbite begins; progressive thrombosis (blood clots form) and progressive ischemia (reduced blood flow to the frostbitten area). This reduced blood flow is the mechanism that causes the longer term complications and tissue loss associated with frostbite injury.

The first symptoms of frostbite are numbness and coldness in the affected parts, the skin may also appear pale and mottled with a yellowish or bluish tinge. Muscles in the affected part may not work properly. Extreme pain follows which can continue for anywhere from several days to several weeks after rewarming.

Continuing damage occurs from cycles of thawing and refreezing. Dry human skin can cool to -10.9ºC before it freezes; an effect known as supercooling. If the

skin becomes wet it will freeze at -5.4ºC, the water on the skin initiating crystalization of the extracellular water. Cold skin has a reduced blood flow resulting in faster cooling; total surface blood flow in a warm person will be from 200 to 500 mL/minute, at 14ºC ambient temperature this flow will drop to 20 to 50 mL/minute.

The extremities, hands and feet, account for about 90% of all frostbite injuries; in a study of U.S. Marines the hands were the primary site for frostbite injuries in other studies hands accounted for 46% of the injuries, the lower extremities 56% (**Note:** Percentages add up to more than 100% because in some casualties more than one area was frostbitten). Other areas include the head; here the ears suffer the most with 58% of frostbite, the nose with 22% and the rest of the face, mainly the cheeks with the remaining 20%.

**Prevention and treatment**

The most important preventative measure is to keep areas of skin exposed to the cold to a minimum; this is especially important in windy conditions. You should have both an insulation layer and a layer to cut the wind. Keep your arms and legs moving, this helps return blood from the extremities and brings in fresh, warm blood. Don't smoke; nicotine in the blood causes vasoconstriction or narrowing of the blood vessels and results in a reduced flow of blood and a reduced warming of the extremities. If you're going to be in a remote area your tetanus immunity should be current (check with your physician).

Socks, boots, gloves and mitts should all fit properly without tightness, binding or pressure points. Avoid wrinkles in socks and insoles. Carry extra socks and liner gloves. Keep toenails and fingernails trimmed. Don't touch cold metal objects (rifles, tent poles, cameras) with bare hands.

Frostbite is a risk factor in the use of vehicular transport, either conventional or recreational. In a survey of frostbite in the Canadian Prairies over a 12 year period, 30% of the frostbite cases involved some type of vehicle (vehicular failure 15%, motor vehicle accident 9%, snowmobiles 6%). Motor vehicles can transport you much farther than you can walk and in most cases also have heating systems which encourage under dressing.

Frostbite has also been caused by inattentive use of a cold compress on an injured foot (frozen potatoes applied to the foot for 40 minutes caused severe frostbite). When using cold compresses, wrap the compress in a towel and use an application time of less than 30 minutes; use a time less than 10 minutes if the area treated has little subcutaneous fat or muscle or is a region of superficial nerves. Check the injured site often.

Don't use facial creams or lotions, Finnish researchers have found that creams and lotions, even white petrolatum jelly (Vaseline), can increase the rate of cooling of facial skin. Don't wet your skin; try to reduce or eliminate washing during cold weather activities or limit washing and shaving to bedtime so your skin can lose the excess moisture and regain oil during sleep. If you have chapped lips, it's most likely okay to apply protectant to your lips to reduce drying. Try a non water-based protectant.

Mild or superficial frostbite can be treated by placing the affected part next to warm skin after removing any wet gloves or clothing. This will rapidly rewarm the part.

Field treatment of severe or deep frostbite involves protecting the site from mechanical injury, no field rewarming of the site should be attempted in severe or deep frostbite as this will cause further tissue damage without proper medical management. Remove wet clothing, gently pad and splint the site IN POSITION, if necessary, to prevent movement. DO NOT RUB THE SKIN, it will make matters worse, water may be carefully and gently patted off. Cover area with insulation so it doesn't continue to freeze; do not warm with external heat; warming with body heat is okay and most likely unavoidable. Transport to medical facilities as soon as possible.

**Treatment in remote areas**

If a severe or deep frostbite injury occurs in a remote area where rescue will be delayed for more than 4 hours some treatment may be done in the field as a last ditch effort to prevent major tissue loss. You should realize that treatment done in the field will be suboptimal from a medical standpoint and that treatment will drastically reduce the mobility of your casualty and team. A rewarmed casualty **MUST** be kept from refreezing.

Current protocols suggest rewarming the affected areas in warm water at 37ºC to 40ºC for 20 to 30 minutes. It is important to have the temperature of the water correct, too hot can cause thermal (burn) damage to already damaged skin, too low reduces tissue survival. Since you probably won't have an accurate thermometer in the field, here is how to get the correct water temperature. You'll need a measuring cup and an insulated container with a large capacity for use as a warming bath. Cool water with ice or snow to freezing point (where ice or snow melt very slowly) then remove excess ice or snow from water. Mix in the insulated container 4 parts boiling water to 6 parts cold water, stir well, this will give you approximately 40ºC water which should be warm when you feel it with your wrist. A small amount of antibacterial agent, povidone-iodine, may be added to the water if you have it. Remove rings or other jewelry from the frostbitten part. Immerse the frostbitten part in the water until it becomes red/purple in appearance and has a pliable texture. Add small amounts of hot water during the rewarming to keep the water warm; add the hot water very slowly, carefully and with stirring to avoid burning. Active motion of the part by the casualty during rewarming is okay but do not help the casualty move the part and do not massage the part.

**DO NOT ATTEMPT TO REWARM WITH RADIANT HEAT OR OTHER DRY HEAT**. Rewarming with dry heat will have disastrous consequences, most frostbite injuries are numb and severe injury will occur with dry heat.

After rewarming, the part should be splinted, padded and elevated. Toes or fingers may be kept gently separated with gauze or cotton. KEEP THE PART WARM, REFREEZING AFTER REWARMING WILL BE CATASTROPHIC.

DO NOT WALK ON FEET AFTER REWARMING. Warn the casualty that the frostbitten part may become discoloured, blistered, swollen and have an alarming grisly appearance; this is the normal progression of frostbite. If available, give 400mg of ibuprofen every 12 hours. Keep the casualty well hydrated and fed.

**Other cold injuries and illnesses**

**Trenchfoot (immersion foot)**

Swelling of foot with skin mottling and pain in early stages. If not taken care of at an early stage, gangrene may set in and in extreme cases amputation may be necessary. Caused by long immersion, days to weeks, in cold water. Treatment for mild cases of trenchfoot is removal from cold environment, gentle drying and airing of feet (remove socks and boots).

**Chilblains (pernio or cold sores)**

Itchy, red lesions due to exposure to above freezing cold and damp. Dry the area, use gentle rewarming, apply a dry dressing (gauze or Telfa) over the site and elevate if possible to reduce swelling. Do not apply any topical medications (creams, ointments etc.) to the area.

**Raynaud's syndrome**

Raynaud's syndrome or phenomenon is an intermittent spasm of the blood vessels of the fingers which may be caused or made worse by exposure to cold or by emotion or both. The syndrome is most common in young women who make up some 60% to 90% of the reported cases. Fingers are initially cold, pale and numb becoming swollen and red with throbbing pain. Small, painful ulcers may appear on the finger tips. Usually, attacks of Raynaud's syndrome last from a few minutes to several hours. Treatment is protection of the part from cold and avoid smoking (nicotine constricts blood vessels in the extremities). If symptoms persist, seek medical attention.

**Cold-induced uricaria**

Uricaria is another name for hives usually caused by an allergic reaction to the cold. Cold induced uricaria occurs during either continuous cold exposure or upon warming skin that has been exposed to the cold. Signs and symptoms include redness, itching, wheals and edema (swelling) of the affected area and fatigue, headache, difficult or laboured breathing and a rapid heartbeat. The cause is unknown but it appears to be affected by the rate of cooling rather than the absolute temperature.

You can test for sensitivity to cold-induced uricaria by placing an ice cube on your forearm between the wrist and elbow with the palm up. Leave the ice cube in position for four minutes. If a large, itchy wheal forms after 10 to 20 minutes at room temperature then you are probably at risk for cold-induced uricaria.

Treatment of cold-induced uricaria involves moving to a warmer location; the symptoms should disappear within one hour of leaving the cold.

**Cold-induced asthma**

Cold air can cause wheezing, chest tightness and other symptoms associated with asthma. Usually occurs in those with asthma or bronchitis, especially those susceptible to exercise-induced asthma. Cold induced asthma may also affect from 3% to 10% of normally non-asthmatic people. Treatment is removal from the cold environment. Give oxygen if available.

If you have asthma consult with your physician about drugs that can be taken prior to cold exposure. A 15 to 20 minute warm-up exercise before exertion can help to reduce symptoms as can good physical conditioning. If possible, use a face mask to warm air in very cold weather.

**Rhinitis (skier's nose)**

Runny nose or increased secretion of mucus upon exposure to cold air. There really isn't too much you can do about this condition without seeing your physician. There are several drugs available by prescription (example: atropine sulfate) which may help. If your nasal passages tend to become dry and irritated, try applying a thin coating of petrolatum jelly to the inside of the nose.

**Danger: Carbon monoxide poisoning**

Carbon monoxide poisoning is not caused by the cold but is a problem in cold weather due to the use of fuel burning heaters. The burning of wood and charcoal or any fossil fuel, gasoline, kerosene, natural gas, propane or mixtures of these, can produce carbon monoxide. Carbon monoxide causes more deaths than all other poisons combined. The Centers for Disease Control and Prevention (CDC) report over 1500 deaths per year from carbon monoxide.

Hemoglobin, an iron-based compound in red blood cells, binds with oxygen and makes it possible for blood to carry oxygen from the lungs to the rest of the cells in the body. When carbon monoxide is inhaled, the hemoglobin binds with it instead of oxygen. Less oxygen is available, having been displaced by the carbon monoxide, which starves the body of oxygen. Small concentrations of carbon monoxide can replace large amounts of oxygen.

Symptoms of carbon monoxide poisoning are: dizziness, headache, nausea and vomiting. At higher concentrations or longer exposures the casualty becomes unstable on their feet, has blurred vision and disorientation and their pulse and breathing rates are faster. Eventually coma, seizures and death result.

In the initial stages carbon monoxide poisoning may be mistaken for the flu. In the field warning signs are several people in the same tent complaining of headache, dizziness or nausea, especially in the morning. Carbon monoxide is heavier than air and will settle in low spots and near the floor of the tent. At night, tents are closed up more tightly with less movement to stir up the gas.

Prevention of carbon monoxide poisoning is the best course of action; don't use stoves, heaters, lanterns that burn fuel in enclosed spaces. Keep vehicles and exhausts away from sleeping and living areas, don't sleep in running vehicles especially in the field; snow, dirt and vegetation can block and redirect exhaust

fumes back into the vehicle. Watch for symptoms of carbon monoxide poisoning, the onset of flu-like symptoms especially several in a group is cause for concern.

First aid treatment is simple. Remove casualty to open air, provide oxygen if available and transport to medical facilities. It's important to get medical help even in mild cases because of delayed effects of the poisoning which may show up anywhere from days to weeks later.



**Cover photograph**: Unidentified Forceman of the First Special Service Force preparing rations in an improvised shelter during cold weather survival training, Blossburg, Montana, United States, January 1943. **Credit:** U.S. Signal Corps / Library and Archives Canada / PA-183752 **Copyright:** Expired