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Occupational Health
Clinics for Ontario
Workers Inc.



Cold Stress

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Cold Stress: What is it?

Stress is a means by which a person adapts to the environment

Cold stress is a response of the body to cold temperatures resulting from heat loss from a portion of the body, such as the feet, hands, limbs or head

Contact to too much cold is a threat to the body, both mentally and physically

Types of Heat Loss!

The body loses heat through various processes:

Radiation – Heat is lost to the environment due to a temperature gradient. There is a difference in air temperature and body temperature.



Conduction – Heat loss through direct touch with a cold object. Heat loss is the greatest when in direct contact with cold water (25 times more heat lost).

Convection – Heat is lost from the body to the surrounding air as air moves across a surface. This type of heat loss is dependent on air speed; with increased wind speed there is greater heat lost.

Evaporation – Loss of heat due to water changing from a liquid to a gas. In the human body this is accomplished through sweating and breathing. Evaporation of heat also causes the body to lose fluids, which can lead to dehydration.

What is Happening in your Body?



The body is always adapting to changes in temperature in the surrounding environment. The human body requires a constant core temperature of roughly 37°C. An individual is most comfortable when the surrounding temperature is between 18 and 22°C and the humidity is around 45%.

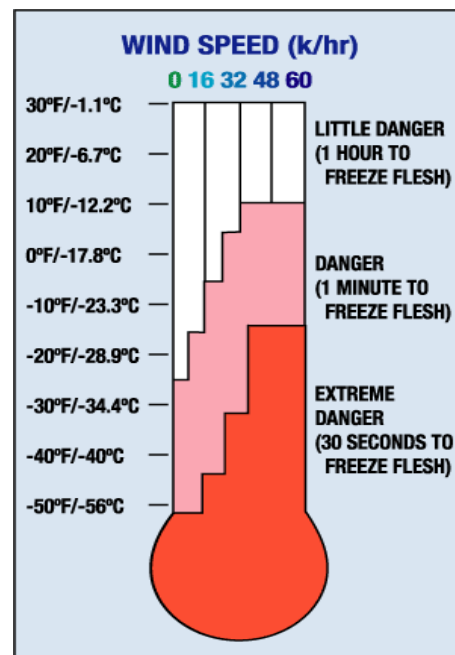
When the surrounding temperature drops below 18°C, body heat is lost. The body adjusts by decreasing the blood flow to the skin's surface area or by producing heat through muscle movement, such as shivering. Heat is produced on a cellular level as a result of metabolism. The process of metabolism converts food into energy through diverse biochemical methods within the body.

Cold Weather Challenges for Workers

- Air temperature
- Air movement (wind speed), feels colder as wind speed increases
 - Wind Chill is the felt effect of temperature and air movement
- Humidity (wetness of air)

Workers at risk:

- Outdoor workers, such as, construction workers, emergency response workers, transport workers, and fire fighters etc.
- Workers in refrigerated



Source: Adapted from
ACGIH, 1999

- warehouses
- Meat packaging and storage workers
- Outdoor recreation work

Importance to Employers

Why is it vital that employers ensure that their workers are safe from hazards of working in cold conditions?

Because the cold...

- Decreases efficiency of workers
- Decreases mental capacity
- Increases the number of accidents on the jobsite

Signs and symptoms of lower body temperature

- Constant shivering
- Blue lips and fingers
- Crazy and confused behavior
- Reduced mental alertness
- Poor coordination
- Poor decision-making



Risk factors for Cold Injuries

- Age – Older adults have decreased circulation
- Disease – Such as, Diabetes and heart disease or those that affect the circulatory system
- Injury – With blood loss or restriction in blood flow
- Previous cold injuries – Makes you prone to recurring injury
- Raynaud's phenomenon – Spasms of the blood vessels that results in reduced blood flow and discoloration of the affected area (white to blue to red)
- Consumption of alcohol – Decreases circulation, alters mental state

- Use of drugs or certain medications – Such as, narcotics, tranquilizers, antidepressants and blood pressure medication, decrease circulation to the skin
- Wet clothing – Draws heat away from the body into the air

Health effects



The chief effect of cold stress is the cooling of tissues that result in injuries to the exposed part. Injuries are classified into three groups including non-freezing, freezing and hypothermia. The toes, fingers, ears and nose are at the greatest risk for exposure because they do not have a major muscle group for heat production. Also in cold temperatures the body will reduce the blood flow to the extremities in order to keep the organs warm.

Non-Freezing



Chilblain is a mild cold injury caused by prolonged and repeated exposure to air temperatures above freezing (0°C - 16°C). The skin will appear red and swollen, and tingling and pain are present.

Trench foot is a “Wet cold disease” resulting from prolonged contact in a wet environment (0°C – 10°C) at lower temperatures. Symptoms include redness, swelling, pain itching and numbness.

Immersion foot occurs in persons whose feet have been wet for days or weeks. This injury affects the nerve and muscle tissues. Symptoms include tingling and numbness, itching,

pain, swelling of the extremities, and blisters. In severe cases gangrene may develop.

First Aid for Non Freezing Injuries

- Warm slowly to room temperature
- Elevate extremity to prevent swelling
- Air dry, if extremity becomes wet
- Do not constrict limb with clothing or blanket

Freezing



Frostnip is a mild form of a freezing injury, which occurs when ears, nose, cheeks, fingers or toes are open to the elements and the top layer of skin freezes. Symptoms include firm, cold, white areas on the affected area. After healing begins, peeling or blistering and hypersensitivity to cold temperatures occurs to the affected skin.

Frostbite – Caused by exposure to extreme cold temperatures and by contact with extremely cold objects. This occurs when tissue temperatures fall below the freezing point. Blood vessels can be severely damaged with impaired blood circulation in the affected tissue. Most commonly affected body parts are ears, face, fingers and toes. The skin will appear white and have a “wooden” feel to it.

- Mild – skin inflamed and slightly painful
- Severe – tissue damage without pain, burning or prickling sensations, blisters, gangrene may develop

First Aid for Freezing Injuries

- Seek medical help
- Move the victim to warm area



- Loosen tight clothing or jewelry that might restrict blood flow
- Loosely cover the affected area with sterile dressing
- Transport victim to emergency room
- DO NOT attempt to re-warm the affected area on site, may cause severe damage to the tissue
- DO NOT rub area or apply dry heat
- DO NOT allow the victim to drink alcohol or smoke

Hypothermia



This is a decrease in the core body heat, to the point where normal muscle and brain functions are impaired. This happens when the body cannot make as much heat as the amount being lost. Severe shivering occurs when the body's temperature falls below 35°C. It can happen in mild cool-wet climates, usually after hard physical work.

Stages of Hypothermia

Stage	Core Temperature	Signs & Symptoms
Mild Hypothermia	37.2-35°C (99 - 95°F)	Goose bumps, unable to perform complex tasks with hands, shivering can be mild to severe, hands numb
Moderate Hypothermia	35-32.2°C (95 - 90°F)	Violent shivering persists, difficulty speaking, sluggish thinking and movements, amnesia starts, unable to use hands, stumbles frequently, difficulty speaking, signs of depression
Severe	32.2-27.8°C	Shivering stops, exposed skin

Hypothermia	(90 - 82° F)	blue, unable to walk, confusion, incoherent/irrational behavior, rigid muscles, semiconscious, loss of awareness of others, pulse and respiration rate decrease, likely heart fibrillation
	27.8-23.9° C (82 - 75° F)	Unconscious, heart beat and breathing erratic, a pulse may not be palpable. Pulmonary edema, cardiac and respiratory failure, death. Death may occur before this temperature is reached.

First Aid for Hypothermia

- Seek medical help
- Remove wet clothing
- Give warm, sweet drinks, unless losing consciousness
- Quickly transport to emergency room
- Place the victim between blankets in order to raise the body heat slowly
- DO NOT re-warm the victim by rubbing the skin or placing them in hot water



Prevention from the adverse effects of cold

- Provide heat warming shelters
- Pace working to prevent sweating
- Rest periods in warm setting, using Threshold Limit Values (TLVs) warm-up schedule (Table 1)

- Change clothes to dry ones often
- New employees should become acclimatized and have protective clothing before starting a full work load
- **Education** – Research advises that workers and supervisors should be informed about symptoms of adverse effects of cold exposure, proper clothing habits, safe work practices and emergency procedures in case of cold injury
- **Acclimatization** is the body's ability to get used to the cold temperatures. It is easier for the body to adapt to hot environments rather than cold ones.

Table 1: TLVs Work/Warm-up Schedule for Four-Hour Shift

Air temperature - sunny sky		No noticeable wind		8 k/hr wind (5 mph)		16 k/hr wind (10 mph)		24 k/hr wind (15 mph)		32 k/hr wind (20 mph)	
°C(approx.)	°F(approx.)	Max work period	Number of breaks	Max work period	Number of breaks	Max work period	Number of breaks	Max work period	Number of breaks	Max work period	Number of breaks
-26° to -28°	-15° to -19°	normal breaks	1	normal breaks	1	75 min	2	55 min	3	40 min	4
-29° to -30°	-20° to -24°	normal breaks	1	75 min	2	55 min	3	40 min	4	30 min	5
-32° to -34°	-25° to -29°	75 min	2	55 min	3	40 min	4	30 min	5	Non-emergency work should cease	
-35° to -37°	-30° to -34°	55 min	3	40 min	4	30 min	5	Non-emergency work should cease			
-38° to -39°	-35° to -39°	40 min	4	30 min	5	Non-emergency work should cease					
-40° to -42°	-40° to -44°	30 min	5	Non-emergency work should cease							
-43° & below	-45° & below	Non-emergency work should cease									

*Source: Adapted from Threshold Limit Values and Biological Exposure Indices booklet: published by ACGIH, Cincinnati, Ohio, 2000 (For workers in dry clothing)

Clothing & Personal Protective Equipment

- Needed for work below 4° C



- Clothing should be worn in multiple layers, which provides better safety than a single “thick” garment
- The inner layer should be cotton to provide insulation and be able to draw moisture away from the skin to help keep it dry
- Extra layers should provide plenty of insulation for the weather conditions
- In wet conditions, the outer layer should be waterproof
- Wear a hat, fifty percent of body heat is lost through the head
- Clothing should be kept clean, since the dirt clogs the air cells in the fibers of clothing and destroys its insulating affect
- Clothing must be dry
- For work below -17°C thin polyester gloves should be worn under protective gloves
- Felt lined boots with rubber bottom and leather top with removable insoles (porous, allow feet to breath)
- Thick bulky wool socks, liner socks made from polypropylene are best (if cotton is used, change when wet)
- Face protection should be used in extremely cold temperatures, such as a balaclava or hard hat liner
- Eye protection for blowing snow and ice, high winds and sun glare

Safe Work Practices

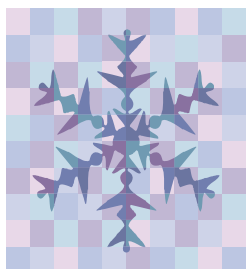
If shoveling snow, be careful to avoid over exertion, do not become damp with sweat

- Change out of wet clothing or footwear as soon as you can



- Do not touch cold objects with bare hands
- People who are taking certain medications (blood pressure, narcotics), older age, overweight, have allergies, smoke, or have poor blood flow are more prone to cold injuries and should take extra precautions
- Do not drink alcohol
- Avoid getting clothing or gloves wet with any liquid, such as, gasoline or cleaning fluids, due to evaporation
- For work below 25°C follow the work/warm-up schedule (take into account wind speed and air temperature)
- Always work in a buddy system, if you must work outdoors in cold conditions
- Avoid using vibrating tools
- Wear UV protected eyewear (snow glare)

The DO'S and DON'T'S of Cold Stress



DON'T

- DO NOT consume alcohol or drugs that may change blood flow
- DO NOT enter cold weather conditions after a recent shower or bath

DO

- Cover your hands, feet, face, and eyes
- Continue moving
- Dress in layers of loose, dry, protective clothing
- Take many breaks in warm places
- Eat properly to preserve heat and prevent dehydration

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Created 2005