Handbook in Winter Service – Cold Weather Injuries

Adopted for use by the Norwegian Armed Forces

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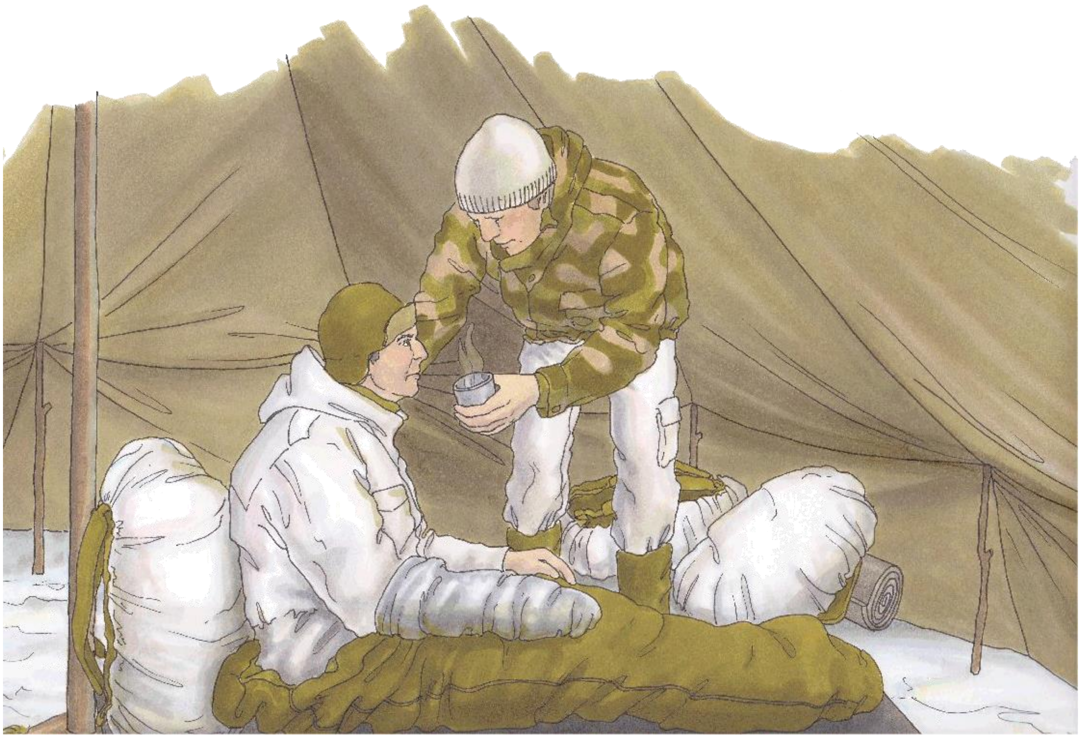

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Contents

1 Introduction

1.1 Foreword
This manual supersedes UD 6-81-4 Instruction in Winter Service – Winter Injuries.
The term 'cold weather injuries' has replaced 'winter injuries' because the injuries concerned are related to cold weather and not necessarily the winter season. For the purposes of this manual, 'cold weather injuries' means hypothermia, frostbite, non-freezing cold injuries and falls into cold water. Sunburn, snow blindness, carbon monoxide poisoning and hazards linked to the use of fossil fuels are also included because these are indirect cold weather injuries, which are more likely to occur in cold weather.
In this manual, the hypothermia classifications have been updated in accordance with the guidelines issued by the Norwegian Armed Forces Medical Services (FSAN, 2017).
Cold weather injuries represent a challenge for all branches of the Norwegian Armed Forces, and relevant and appropriate training of personnel is an absolute necessity in order to prevent injuries and impaired combat capability.

1.2 Purpose and aims
Winter and cold weather present additional challenges for military units. Both officers and enlisted personnel must remain vigilant in order to prevent injuries and maintain their combat capability. Body temperature must be maintained with the aid of appropriate clothing, activity, shelter, full utilisation of food and drink, and the least possible loss of body energy.
All cold weather injuries can be avoided. Such injuries can be very challenging to treat and may, in the worst-case scenario, result in varying degrees of invalidity. There is probably no area of pathology where the statement "prevention is better than cure" is more apposite.
The aim of this manual is to explain the body's protection mechanisms against hypothermia, the impact of our surroundings and how we can protect ourselves against impaired performance and injury. The preventive measures that are specified are the result of many years of experience of winter service, as well as experiences collated from reports on incidents which have resulted in cold weather injuries.
The manual can be used as a reference work for both officers and the enlisted ranks. It should form the starting point for the training and leadership of soldiers, alongside the Norwegian School of Winter Warfare's master lessons. This manual should be viewed in context with booklet UD 6-81-2 Personal clothing, as well as booklet UD 6-81-3 Provisioning, which identify important measures relating to the prevention of cold weather injuries.

2 Physiology

2.1 General
The internal temperature of the human body is precisely regulated at a more or less constant level, regardless of fluctuations in external temperature. Normal body temperature, as measured in the body core, is approx. 37°C (98,6°F) . To maintain the body's normal functions, this temperature must be kept constant (natural variation +/– 0.7°C). If the body's temperature moves outside this range, the fundamental chemical processes taking place in the cells which generate heat will gradually be weakened and eventually cease altogether. This means that anyone who has hypothermia or a fever will no longer be able to regulate their heat production in the same way as a healthy person. However, the temperature of the skin varies greatly relative to the temperature of the surroundings. When wearing clothing in an environment at normal room temperature, the average skin temperature is 32–35°C (89,6-95°F), which is considered to be comfortable for humans. In other words, there is a "tropical micro-climate" next to the skin. Temperature regulation depends on physiology and behaviour.

2.2 Physiological temperature regulation

2.2.1 General

Physiological temperature regulation is controlled by the hypothalamus in the brain, independently of any influence from the will (autonomy), and impacts:

Heat production:

- basal heat production
- additional heat production

Heat loss:

- circulatory regulation
- sweat production

2.2.2 Heat production

2.2.2.1 Metabolism

Heat production in the human body is the result of chemical energy-releasing processes which take place in the cells. This heat production is also referred to as metabolism and takes place constantly. The conversion rate in these chemical processes can be increased by, for example, physical activity and muscle work, but a human adult at rest will continually give off approx. 100 W of heat.

2.2.2.2 Basal heat production

Basal heat production is the underlying heat production which is constantly taking place in the cells. The process involves sugar, amino acids or fatty acids being converted to high-energy compounds, during which heat is released and carbon dioxide is produced as a by-product. The intake of protein-rich food, such as meat or fish, increases heat production by up to 25% for a few hours after consumption.

2.2.2.3 Additional heat production

Additional heat production can be influenced through food, controlled physical actions or uncontrolled actions, such as shivering. Muscle work increases the metabolic rate and thereby heat production, as the cells are forced to increase their conversion rate. Heat production is highest during physical activity. Moving the large muscle groups in the body is the most effective way of achieving heat production.

During moderate physical activity, the body needs approx. 3,000 kcal/day. When carrying a heavy pack and moving on skis during the winter, the body's calorie requirement can rise to over 5,000 kcal/day. If the body's temperature drops below 37°C (98,6°F), mild shivering will begin, which can be consciously suppressed for a short period of time. At a body temperature of below 36°C (96,8°F), the shivering will become more violent and inhibit the ability to move or speak. This cannot be suppressed. During shivering, heat production is increased by a factor of 2 to 5, but prolonged shivering can drain the body's energy reserve and cause the person concerned to become exhausted.

Overview of the body's heat production during various types of activity	
Rest	100 W
Shivering	200–500 W
Moderately heavy work	400 W
Heavy work	600–800 W
Burst of extreme effort	1000 W (only possible very briefly)

2.2.3 Distribution of body heat

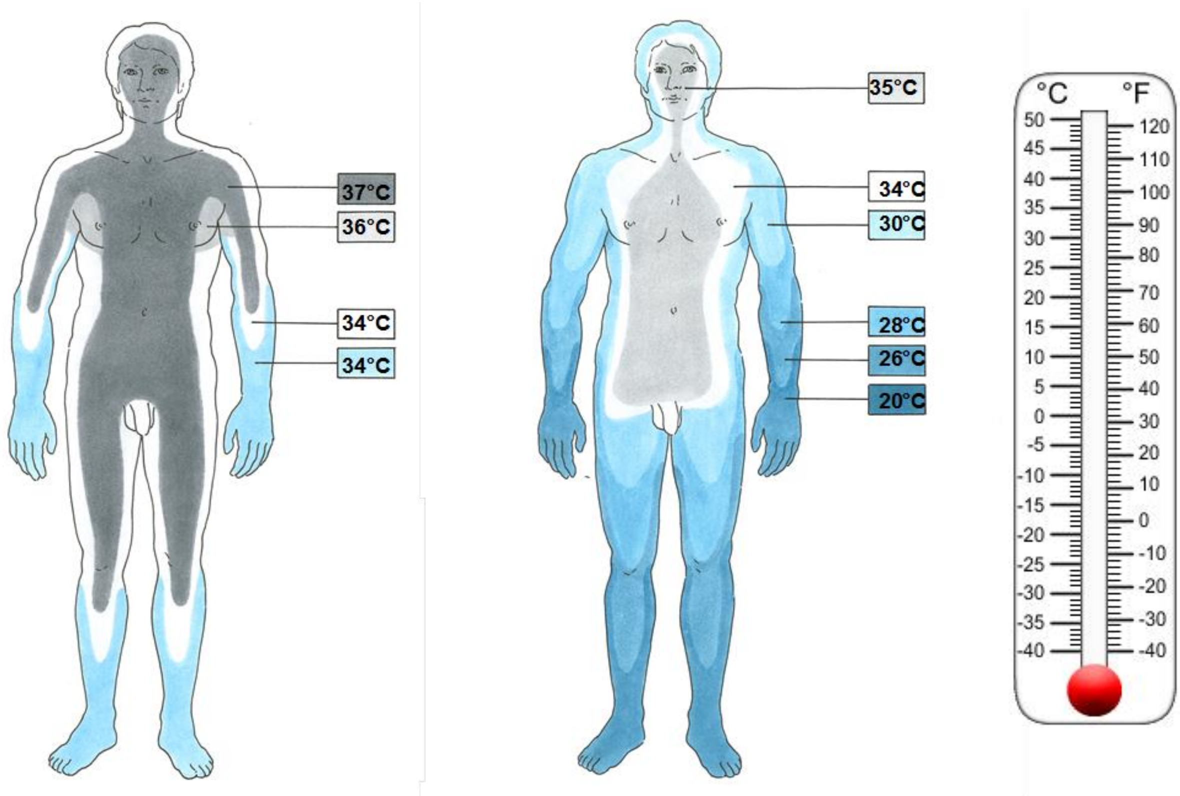


Figure 1: Distribution of body heat

Figure 1 shows that the body regulates its temperature so as to protect core functions in the vital organs, while extremities, such as hands and feet, receive a lot less heat. The figure shows that if a person's core temperature drops by 2ºC, they will experience a temperature drop of 8ºC in their hands and feet.

The temperature of the body is partly regulated by the flow of blood to the skin. If the body is warm, the blood vessels will open up, enabling warm blood to flow out to the extremities. This blood flow can increase by up to a factor of 10 compared with the normal situation. When the core temperature drops, the body will do the opposite, by closing the blood vessels in order to protect the body's core functions. This will lead to a rapid drop in the temperature of the hands and feet. A drop in the core temperature therefore increases the risk of cold-related injuries in the hands and feet.

The body regulates the blood supply to extremities exposed to the cold by periodically opening the superficial blood vessels in the skin (cold-induced vasodilation or CIVD, also known as the 'hunting response'). This reflex helps to limit cold injuries to the skin. The reflex will gradually disappear as the core temperature drops, and will cease altogether when the person becomes hypothermic, i.e. their body temperature drops below 35ºC (95°F). Mental stress will also help to reduce this effect.

2.2.4 Heat loss from the body

Heat loss from the body into the surroundings largely takes place in four different ways: radiation, convection, conduction and evaporation (Figure 2):

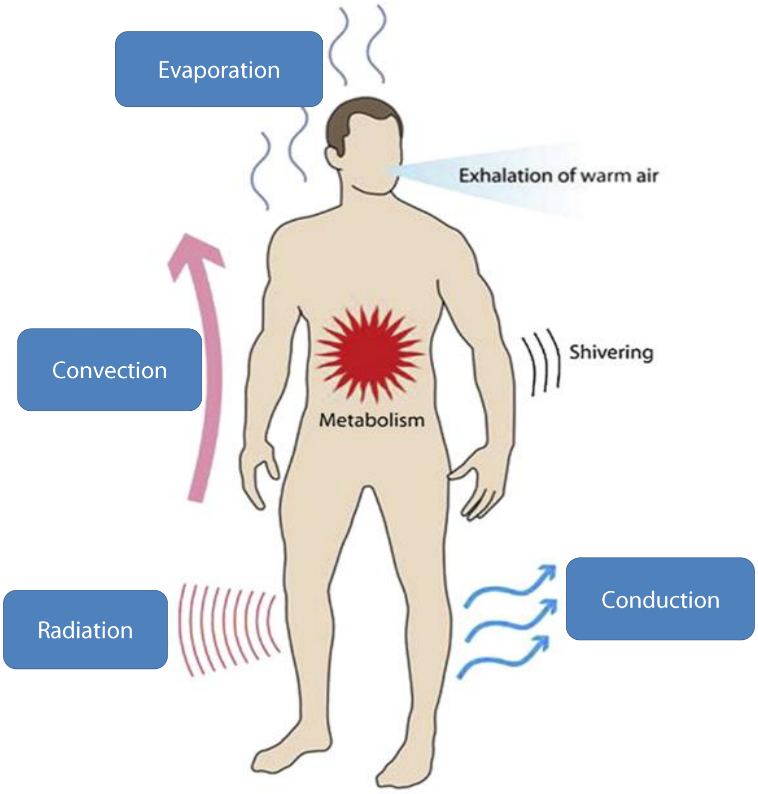


Figure 2: The body's heat loss and heat production

2.2.4.1 Radiation

When a naked person is at rest in a room with a temperate indoor temperature, approx. 60% of their total heat loss will occur through thermal radiation. This heat loss is regulated and greatly reduced by clothing. Thermal radiation is determined by the surface temperature; radiation loss decreases as the skin temperature drops.

2.2.4.2 Convection (heat flow)

The heated layer of air next to the skin dissipates and is replaced by cold air. This is particularly noticeable when you are exposed to a strong cold wind.

2.2.4.3 Conduction (thermal conduction)

Thermal conduction is affected by what the body is in contact with. For example, cold shoe soles and a poor sleeping mat can 'steal' heat from the body. Water conducts heat 26 times faster than air. You can therefore quickly become cold when you are wet.

2.2.4.4 Evaporation

Heat loss also occurs when the sweat on skin and in clothing evaporates. It takes approx. 0.6 kWh to evaporate 1 litre of water. During physical activity, evaporation is the most important factor (accounting for more than 50% of the heat loss).

The evaporation of moisture on the skin and in clothing extracts energy and cools the skin.

Heat loss through the respiratory passages (respiratory heat loss) occurs through the constant heating of cold air which is drawn down into the lungs, and through the loss of water vapour. This heat loss is estimated to account for approx. 5% of the total heat loss and is accompanied by fluid loss of approx. 300 ml/day.

In Arctic regions with dry and severe cold, heat loss via the respiratory passages is considerable and can account for as much as 20% or so of the body's total heat loss during hard physical activity.

Total heat loss is the sum of radiation, convection, conduction and evaporation.

2.2.5 The body's regulation of its own temperature

In order to maintain a stable body temperature, heat loss to the surroundings is precisely controlled with the aid of circulatory regulation and the regulation of sweat evaporation.

2.2.5.1 Circulatory regulation

Blood flow through the skin and subcutaneous tissue determines the thermal conductivity of the skin. Regulation takes place largely through the opening and closing of the arteriovenous anastomoses (connecting vessels between the arteries and veins). Under the influence of cold, the blood vessels in the skin contract, blood flow is reduced, skin temperature drops and skin insulation increases. Under the influence of heat, the vessels expand, blood flow increases, skin temperature rises and skin insulation decreases. Circulatory regulation, which is a precise process, is most effective in the arms and legs.

2.2.5.2 Regulation of sweat evaporation

During the evaporation of 1 litre of sweat, approx. 540 kcal of heat is given off by the body to the surroundings. This is essential in order for the sweat to evaporate. If it drips off the body, it is considered to constitute fluid and salt loss, rather than heat loss. The sweating mechanism is effective, but it is a less precise regulating mechanism than circulatory regulation.

2.3 Temperature regulation through behaviour and the importance of mental adaptation

2.3.1 General

Humans can adapt to a colder climate primarily through prevention and behavioural change. Preventive measures, such as clothing and physical activity, are by far the most important. Physiological changes in the organism, which contribute to thermal equilibrium in connection with cold, are minimal and secondary. Brown fat provides protection against cold, but is only present in adults in limited quantities and is not a significant factor in practice. The insulation created through the raising of hair is insignificant, and the only effective physiological response to maintain temperature is shivering.

2.3.2 Adaptation and training

Adaptation and training as regards cold have been key points in the Norwegian Armed Forces' training programme for soldiers. Recent research has shown that people have differing abilities to cope with or 'withstand' the cold. However, human adaptation is largely a cognitive or mental adaptation. To some extent, therefore, it is possible to train the mind as regards the perception of being cold.

However, the ability of tissue to endure cold cannot be improved by training in cold surroundings. This applies to both core temperature and the local effects of cold. It has been shown that repeated exposure to cold, resulting in a drop in core temperature, contributes to a faster drop in temperature the next time the body is exposed to severe cold. Similarly, it has also been shown that local skin temperatures on fingers and toes drop more rapidly upon repeated exposure to cold. As the fingers and toes become colder, pain signals are suppressed and sensitivity to cold is reduced.

It is therefore not possible to train body tissue to become better at tolerating cold. On the contrary, exposing the body to cold, particularly peripheral/local cooling, actually increases the risk of injury instead. The drop in skin temperature occurs more rapidly, the person's ability to feel the cold is reduced.

2.3.3 Clothing

In order for clothing to be effective, it is necessary to be aware of the parts of the body, which are most vulnerable to heat loss. A high proportion of the body's heat is released via an uncovered head and neck.

Cooling of the head will accelerate the heat loss occurring in the core and cause the body to cool more rapidly. This is caused by complicated regulation mechanisms, rather than an inability to reduce blood flow in the scalp.

The head, face and neck are important parts of the body, both as regards getting rid of heat (exposed head and open neck) and in the maintenance of body temperature (hat, scarf and balaclava).

> Body temperature can be better maintained through the wearing of appropriate headgear.

3 Vital needs

3.1 Water

Water is essential for the normal chemical balance of the body and for the normal functioning of vital organs. During the winter, water intake should amount to at least 2 1/2 litres per day in order to prevent dehydration. This is additional to the water which enters the body through food.

During physical activity, the body needs more fluids, and water should be consumed regularly to ensure that the body has sufficient time to absorb the water. 1 litre per hour or approx. 100–200 ml every 10 minutes is ideal. If you drink large quantities of water in a short period of time, a lot will be excreted by the body without any benefit.

3.2 Fluid balance in the body

The human organism consists of approx. 65% water (Figure 3). The kidneys extract waste products from the metabolism and regulate the excretion of water and waste substances from the body, so that the relative composition and volume of interstitial fluid remain constant. If the water deficit becomes too great (> 2 litres), this can disrupt the body's functions. Water loss of approx. 12% of body weight can be life-threatening.

When there is too little water in the body, this condition is referred to as 'dehydration'. Dehydration increases the risk of cold weather injuries because people who are dehydrated have:

- reduced ability to regulate their temperature
- less resistance to cold
- reduced physical work capacity

Figure 3: The body's water content

During the winter, fluid loss from the body can be substantial. Physical activity can cause us to sweat many litres of water a day. We also continually lose fluids through the skin and via the respiratory organs, even when stationary or asleep. Evaporation is significant, amounting to approx. half a litre of water per day. Even mild cooling can have a disruptive effect on the kidneys and increase the excretion of water via the urine.
Caffeine has a mild diuretic effect. Coffee and tea contain so little caffeine that is not possible to become dehydrated by consuming either coffee or tea in normal quantities. Nevertheless, people who are not used to drinking beverages which contain caffeine, and who have therefore not developed a caffeine tolerance, should limit their intake.

Even though we lose a lot of fluid in cold weather, we do not become correspondingly thirsty. A change in the colour of urine from pale yellow to dark yellow, orange or brown is a sign of dehydration. Visible signs of this are headaches, general malaise, irritability, constipation and increasingly impaired consciousness. It is therefore important to ensure that the body takes in enough fluids during the winter.

The body needs fluids on a regular basis. It is important not to become dehydrated.

3.3 Food and nutrition

Personnel wearing appropriate clothing do not generally need a higher calorie intake than normal because of cold. The need to increase calorie intake occurs during physical activity, e.g. when moving around in snow carrying heavy equipment on foot, skis or snowshoes (increases from 3,000 kcal to over 5,000 kcal per day). Hot food and drinks give energy and provide an important heat supplement. In cold surroundings, the body temperature is maintained at a higher level through the night if you eat something before resting.

3.4 Sleep

Sleep is the best form of rest. In order to maintain normal activity levels, both physical and mental, over extended periods of time, we should have at least six hours of continuous sleep per day in calm and quiet surroundings. Sleep deprivation particularly affects mental acuity, such as reaction time, ability to learn or perform complicated tasks, alertness, etc. During operations lasting around a week, the performance of personnel getting less than 3–4 hours of sleep per day will deteriorate dramatically.

A healthy and reasonably well-rested person will wake long before their body temperature drops below the limit for hypothermia. People suffering from sleep deprivation and exhaustion can more easily ignore the body's signals concerning the risks of cold weather injuries.

Military exercises with planned sleep restrictions should therefore be avoided during cold weather periods.

4 Cold tolerance

The ability of the body to tolerate cold varies considerably from individual to individual, and is affected by many factors, both physical and mental.

4.1 Acclimatisation

Acclimatisation is remaining in cold surroundings for a prolonged period of time. Acclimatisation can be divided into physiological and psychological adaptation.

Physiological adaptation can consist of changes in the burning of calories or fat, changes in the nervous system, greater muscle tension, changes in hormonal responses and/or cell changes, as well as a greater ability to shiver. An effect of approx. 70% can be achieved after 10 days of acclimatisation, and full effect is believed to be achieved after approx. 30 days. However, the medical preventive effect of physiological acclimatisation is limited.

Psychological acclimatisation can involve becoming better able to cope with exposure to cold by perceiving it as less unpleasant. Psychological acclimatisation takes approximately 2–3 days and results in people becoming accustomed to lower temperatures. Greater mental tolerance of low temperatures can thus improve performance, but it has the drawback that it predisposes people to cold weather injuries, through a belief that they are capable of tolerating more than they are actually able to.

4.2 Age

Given the age limits that apply within the Norwegian Armed Forces, age is not a significant factor. Younger people are more resistant, while older people tend to be more vulnerable to cold weather injuries. This is because people over 60 have poorer thermoregulation as a result of the normal ageing process. They sweat less, shiver less and have poorer circulatory regulation and a slower metabolism than young people.

4.3 Geographic and ethnic origin

Ethnicity refers to people who have a common origin and share a particular culture.

Biology describes races as genetically different populations, where all the individuals in each population have common genetic or observable characteristics. It has been observed that different ethnicities have differing tendencies to develop certain diseases (e.g. raised blood pressure) and differing tolerances to cold. Studies indicate wide differences in cold tolerance between people of different ethnicity. For example, African-Americans are four times more likely to suffer a cold weather injury compared with their Caucasian colleagues in the US Army(Degroot, Castellani, Williams & Amoroso, 2003). In the British Army, African-Americans are 30 times more likely to develop a cold weather injury than their Caucasian colleagues(Burgess & Macfarlane, 2009). One explanation for this may be that African-Americans lack previous experience of cold weather.

4.4 Circadian rhythm

Temperature regulation changes during the night. Humans have daily rhythms (known as circadian rhythms), which regulate alertness, performance, body temperature and many hormones. Temperature regulation decreases during the night. Body temperature is at its lowest around 5am and highest at around 5pm. Core temperature varies by approx. 1°C between its highest and lowest points during the day. Normal core temperature is 37°C (98,6°F). If this decreases by 1°C, the body temperature will be very close to the limit for when a person is considered to be hypothermic, which is 35°C. In other words, the body can tolerate less cold loss at night or in the early morning than during the day and evening. Training activities which involve getting wet, followed by low-intensity activity, should therefore not be scheduled at night or in the early morning. An example is a mud run from 3am to 5am followed by shooting range practice from 5am to 7am.

4.5 Nutritional condition

Undernourishment and hunger greatly reduce cold tolerance, as does a lack of water (dehydration). Lack of nourishment will result in reduced heat production by the body.

Military exercises with planned dietary restrictions should therefore be avoided during cold weather periods.

4.6 Gender

Gender has previously been seen as a factor which affects cold tolerance, with women being considered to tolerate less cold than men.

Today, the divergences are instead explained by individual differences, both between and within the genders, such as body shape, muscle mass and fat distribution; see section 4.7 Body shape.

4.7 Body shape

The relative surface area of the skin (body surface area per kg of body mass) is larger for a slightly built person than for a well-built person. This means that a short, thin person will become colder more easily. At the same time, a larger muscle mass will increase volume relative to surface area and lead to more heat production. Fat cells do not produce heat in the same way as muscle cells, but fat has some insulating properties. It is therefore an advantage to have some body fat, as this fat will retain the heat that muscles and organs produce and provide insulation against the cold.

4.8 Physical endurance

Good physical fitness is a major factor in determining tolerance to cold. A high level of physical fitness means that the body does not have to work as hard, sweats less and has more mental energy. A large muscle mass also enables increased heat production linked to external work or shivering. This reduces the risk of developing cold-related injuries.

4.9 Physical activity

Intense physical activity leads to a high rate of sweat production. The evaporation of sweat moisture leads to heat loss from the body. The presence of moisture in clothing greatly reduces its insulating properties. The risk of hypothermia increases when a person is stationary. This is due to the reduction in heat production. Arms and legs are particularly vulnerable, and work should therefore ideally be performed at a steady and even tempo, in order to avoid sweating in cold weather and maintain cold tolerance for as long as possible.

4.10 Alcohol and tobacco

Alcohol causes the circulation of blood in the skin and subcutaneous tissue to increase, and thereby increases heat loss. Heat loss can lead to a reduction in core temperature. The ability to shiver is reduced, judgement is impaired, and the risk of hypothermia and other cold-related injuries increases considerably.

Tobacco contains nicotine, which greatly reduces the diameter of the blood vessels, causing blood circulation to decrease. The temperature of the skin on the fingers is reduced by a few degrees for a few minutes after nicotine is consumed. Consuming chewing tobacco is almost ten times as potent as inhaling cigarette smoke. The intake of nicotine can therefore increase the risk of frostbite injuries.

4.11 Medicines

Some medications affect blood circulation and sweating. Seek advice from a doctor if you take medicines regularly.

4.12 Previous cold weather injuries

Previous frostbite and cold injuries considerably increase the risk of further injury developing in the same part of the body. A previous injury will reduce sensitivity to the cold, impairing a person's natural ability to detect that they are at risk. Damaged circulatory regulation will also reduce the flow of heat to the skin. The hunting reflex (CIVD) will also not be as effective in areas which have previously suffered cold weather injuries.

4.13 Illness and injury

Illness and injury are particularly dangerous factors during the winter, as such conditions can cause soldiers to remain stationary longer than would otherwise be the case, and quickly develop cold weather injuries. Injury/illness will also increase the body's energy needs, which in turn can increase the risk of cold weather injuries if the person concerned does not get enough nourishment.

Many illnesses impair or significantly interfere with temperature regulation. Blood loss or circulatory failure following injury reduces the blood supply to the arms and legs, and makes the person more likely to develop frostbite and other cold injuries.

Skin with burn injuries is very vulnerable to frostbite because the functioning of the nerves in these areas is impaired.

Previous injuries, wounds and scar tissue have poor blood circulation and are therefore more vulnerable to frostbite and other cold injuries.

4.14 Wind

Wind is a factor which has a major impact on heat loss when it encounters naked skin. In virtually static air, a boundary layer of air forms, which remains stationary. Because air is a poor conductor of heat (good insulator), this boundary layer will act as an insulating layer. If a wind is blowing, the air next to the skin will be blown away and the boundary layer will be reduced in thickness, causing an increase in heat loss to the surroundings. Wind therefore accelerates cooling (at temperatures below skin temperature). However, clothing can greatly reduce the effects of wind (*wind chill*). Figure 4 shows the perceived temperature depending on wind strength.

The table below shows how the effect of cold on bare skin increases as wind speed rises.
It shows the perceived skin temperature at different temperatures with different wind effects.
The combination of moderate cold and wind can be more dangerous than severe cold and calm weather.

Air temperature C

Wind speed m/s	... -10 C							-11 ... -28 C						-29 ... -39 C			
0	**10**	**7**	**4**	**1**	**-2**	**-5**	**-8**	**-11**	**-14**	**-17**	**-20**	**-23**	**-26**	**-29**	**-32**	**-35**	
2	9.2	5.7	2.2	-1.3	-4.8	-8.3	-12	-15	-19	-22	-26	-29	-33	-36	-40	-43	
3	8.5	4.9	1.3	-2.3	-5.9	-9.5	-13	-17	-20	-24	-28	-31	-35	-38	-42	-46	
4	8	4.3	0.6	-3.1	-6.8	-10	-14	-18	-22	-25	-29	-33	-36	-40	-44	-47	
5	7.6	3.8	0.1	-3.7	-7.4	-11	-15	-19	-23	-26	-30	-34	-38	-41	-45	-49	
6	7.2	3.4	-0.4	-4.2	-8	-12	-16	-19	-23	-27	-31	-35	-39	-42	-46	-50	
7	6.9	3.1	-0.8	-4.6	-8.5	-12	-16	-20	-24	-28	-32	-36	-39	-43	-47	-51	
8	6.7	2.8	-1.1	-5	-8.9	-13	-17	-21	-25	-29	-32	-36	-40	-44	-48	-52	
9	6.4	2.5	-1.5	-5.4	-9.3	-13	-17	-21	-25	-30	-33	-37	-41	-45	-49	-53	
10	6.2	2.2	-1.8	-5.7	-9.7	-14	-18	-22	-26	-30	-34	-38	-42	-46	-50	-53	Fresh Breeze
11	6	2	-2	-6	-10	-14	-18	-22	-26	-30	-34	-38	-42	-46	-50	-54	
12	5.8	1.8	-2.3	-6.3	-10	-14	-18	-23	-27	-31	-35	-39	-43	-47	-51	-55	
13	5.6	1.6	-2.5	-6.6	-11	-15	-19	-23	-27	-31	-35	-39	-43	-47	-51	-55	
14	5.5	1.4	-2.7	-6.8	-11	-15	-19	-23	-27	-31	-35	-40	-44	-48	-52	-56	
15	5.3	1.2	-2.9	-7	-11	-15	-19	-24	-28	-32	-36	-40	-44	-48	-52	-56	
16	5.2	1	-3.1	-7.2	-11	-16	-20	-24	-28	-32	-36	-40	-45	-49	-53	-57	
17	5	0.9	-3.3	-7.5	-12	-16	-20	-24	-28	-32	-37	-41	-45	-49	-53	-57	
18	4.9	0.7	-3.5	-7.6	-12	-16	-20	-24	-29	-33	-37	-41	-45	-50	-54	-58	
19	4.8	0.6	-3.6	-7.8	-12	-16	-20	-25	-29	-33	-37	-42	-46	-50	-54	-58	
20	4.7	0.4	-3.8	-8	-12	-17	-21	-25	-29	-33	-38	-42	-46	-50	-55	-59	
21	4.5	0.3	-3.9	-8.2	-12	-17	-21	-25	-29	-34	-38	-42	-46	-51	-55	-59	
22	4.4	0.2	-4.1	-8.3	-13	-17	-21	-25	-30	-34	-38	-42	-47	-51	-55	-60	Strong Gale

Figure 4: Wind chill effect

Effective temperature °C *(°F)*	Degree of risk	Effect on the body	Good advice
0°C to –10°C *(32°F to 14°F)*	Low	Mild discomfort	Dress according to the conditions
–11°C to –25°C *(15°F to –13°F)*	Moderate	Uncomfortable. Bare skin feels cold. Risk of hypothermia in the event of prolonged periods without appropriate protection.	Dress warmly. Windproof outer garments are important. Remember to cover your head, neck and hands.
–26°C to –45°C *(–14°F to –49°F)*	High	Risk of frostbite: check your fingers, toes and face (particularly the nose and ears) for signs of numbness and white discolouration (frostbite). Risk of hypothermia in the event of prolonged periods without protection.	Dress warmly, preferably with several layers of windproof fabric. Cover all bare skin, remember face and hands. Keep moving.
–46°C to –59°C *(–50°F to –74°F)*	Extreme	Bare skin can freeze within minutes: frequently check your face, arms and legs for numbness and white discolouration. High	Be careful! Dress warmly, with several layers of windproof outer garments. Cover

		risk of hypothermia in the event of prolonged periods spent outdoors.	all bare skin. Limit time spent outdoors to short periods, and be prepared to seek shelter. Keep moving at all times.
–60°C and colder *(–75°F and colder)*	Extreme	Outdoor conditions are lethal: bare skin can freeze in less than two minutes.	Limit time spent outdoors to a minimum.

People have different tolerances to cold. There must therefore be some room to make individual adjustments to clothing.

5 Risk assessment

5.1 General

Risk assessments are a useful tool for both preventing and alleviating frostbite and other cold injuries. Experience suggests that a number of factors are normally involved when a unit suffers cold weather injuries. The ability to identify hazards at an early stage in the planning process and maintain a high degree of flexibility during the actual execution of an operation will often enable injuries to be avoided.

5.2 Experience

Summary of factors from units which have experienced cold weather injuries in the past:

- absence of hot food during the previous 14 hours, and not enough to drink
- challenging weather conditions with severe cold (below –10°C (50°F)) and strong winds
- little or no time for breaks
- unclear leader roles or absence of leadership
- verbal assurances should have been replaced by physical checks and inspections
- lack of supervising of soldiers
- lack of establishment and follow-up of buddy checks
- combination of damp and cold (e.g. operations on water)
- inadequately prepared equipment (shoes too narrow, holes and defects)
- ambitions set too high for the exercise relative to the level of training
- continuous periods of more than 24 hours spent outdoors without a heat source

An appropriate and thorough risk assessment will enable many of these factors to be identified and eliminated. Risk assessments carried out prior to exercises using a 5-step model will enable hazards linked to cold weather injuries to be identified. Based on this, a series of essential measures should be drawn up and implemented both before and during the exercise (ref. UD-2-1 Risk assessment).

During the planning process, it is important to identify and implement a range of preventive measures to prevent cold weather injuries within the unit. This should be clearly stated in the risk assessment.

When executing the plan, it is important that the necessary procedures that have been established are followed up. This includes implementing and reinforcing checks at low levels within the unit. It is important that commanders make their officers aware of the time-critical assessment. Those with leadership responsibilities should have established cut-off criteria with regard to cold weather injuries, taking into account the activity that is being carried out.

It is important to ensure that those with leadership responsibilities at a low level are prepared and possess the requisite knowledge to assess situations during the actual exercise and in the event of unexpected hazards. This is extremely important because the outcome of early symptoms and stages of hypothermia, cold-related injuries and frostbite can rapidly deteriorate if immediate action is not taken on site.

5.3 Example of risk assessment of cold weather injuries

Assignment/task: **Norwegian Winter Course 2010 – Exercise BIRKEBEINER**	Date: **19–27 January 2010**
Carried out by: Norwegian School of Winter Warfare	Side: 1 of 12

No.	Main activity:	Hazard:	Reason:	C.[1]	P.:[2]	R.:[3]	Action:	A,F[4]	Residual risk:	Remarks[5]:
	FROSTBITE/COLD-RELATED INJURIES	Team members are exposed to localised frostbite injuries in exposed body parts while marching.	Natural: Wind chill factor and general severe cold increases the risk of local frostbite injuries occurring. Human: Inadequate clothing. Inadequate use of clothing. The unit ignores signs of local frostbite injuries and fails to take immediate action/ buddy help.	4	2	8	Focus on procedures for buddy checks Carry out SIBIR at least once a day and as necessary depending on the situation Essential training linked to correct use of clothing before and during the exercise Training concerning immediate action in the event of local frostbite injuries prior to the exercise. Including: buddy service and rapid bivouacking. Wear gloves/mittens, etc. to avoid direct skin contact with metal. Check shoe sizes before the start of the exercise			Equipment: Mask, glasses/goggles.
	FROSTBITE/COLD-RELATED INJURIES		Personnel allow metal to come into direct contact with their skin.	3	3	9	Cover all skin, wear mittens Face mask for cold weather and glasses/goggles			
			Personnel wear shoes that are too small for them.	4	4	16	Dry clothing at every opportunity			
			Bare skin.	4	2	8				
			Wet clothing.	3	3	9				
			Poor hygiene.	4	2	8				
	HYPOTHERMIA	Team members do not maintain adequate combat capability and become dehydrated and exhausted while marching.	Natural: Factors which could have an impact: severe cold, difficult marching conditions, wind, etc. Human: Poor reconditioning linked to fluid,	3	2	6	Skin to skin Monitor hygiene in connection with implementation of SIBIR Logging of previous frostbite injuries before STARTEX. Strong focus on fluids and nutrient supply in bivouac and during marching. Provide reassurance that			Individuals have sufficient capacity to

[1] Consequence: 1-critical, 2-severe, 3-moderate, 4-minor, 5-insignificant
[2] Probability: 1-probable, 2-possible, 3-could happen, 4-not very probable, 5-improbable
[3] Consequence * probability
[4] Responsibility and deadline
[5] For example: need for clarification from superior, more facts, need to prepare a specific ORM for the main activity, etc.

			nutrition, hygiene and sleep. At a general level, the unit does not have enough time to maintain its own combat capability. The unit continues to march despite clear signs that some individuals are becoming exhausted.				everyone can speak up about any issues This is particularly important under challenging weather conditions. Optimise the route of the march with regard to avoiding natural obstacles, steep descents, areas with deep loose snow, etc. Dry clothing General warming of the patient Establish procedures concerning hot food and drink			carry 2 litres of fluids, of which 1 litre in a Thermos flask. Individuals are physically fit and have tried their own skiing equipment over time before. STARTEX.

6 Hypothermia

6.1 General

Hypothermia (Dietrichs, 2019) is defined as cooling of the body's core temperature to below 35°C (95°F).

Hypothermia greatly affects most of the body’s physiological processes. For example, the body’s ability to control internal bleeding (coagulation regulation) is roughly halved, even in the case of mild hypothermia. The risk of arrhythmia and cardiac arrest is also very serious in connection with hypothermia.

Hypothermia is a hazard which is often accorded insufficient weight. In Norway, such injuries can occur all year round due to the country’s location and topography:

- Mountains and mountain plateaux during the summer: A damp climate with rain, wind and air temperatures of between +10 and 0°C (50 and 32°F) leads to a risk of hypothermia if clothing is inadequate.
- Mountain ranges and plateaux during the winter: Hypothermia most frequently occurs among personnel who are poorly clothed, have poor equipment and are exhausted. Wind greatly increases the risk of hypothermia.
- Injured persons lying out in the open, waiting for help are particularly vulnerable to hypothermia. Even in warm weather, heat loss can be considerable when personnel are lying in wet clothing on a damp surface and are also injured.
- Cold water: The water temperature must be 35°C (95°F) in order for the environment to be thermoneutral for a stationary naked person (thermoneutrality is where a person needs to neither shiver nor sweat in order to maintain a stable body temperature). Such water temperatures are unrealistic even in tropical waters. The corresponding air temperature is approx. 30°C (86°F).

6.2 Stages of hypothermia.

6.2.1 General

Hypothermia was previously classified as ***mild***, ***moderate*** and ***severe***, with core temperature being the parameter used to distinguish between these categories.
There were a number of practical problems linked to the traditional subdivision. The most obvious of these is that it required a knowledge of core temperature, measurements of which are rarely available in the field. Most measurement methods in the field (ear canal temperature, armpit temperature and rectal temperature) will provide an inaccurate indication of the temperature in the core of the body. The other problem is that it is difficult to remember the distinctions between the various stages.

The Norwegian Armed Forces has therefore decided to classify hypothermia according to an international standard and in accordance with new national recommendations (NKT-Traume, 2017). In the event of an injury, determining the severity of hypothermia in accordance with the new recommendations will enable the appropriate level of treatment within the civilian health service to be determined.
The subdivision of hypothermia is shown in the table below:

Level	Consciousness	Shivering	Breathing	Estimated core temperature
1 - Mild	Conscious	Yes	Yes	35–32°C (95-89,5°F)
2 – Moderate	Drowsy	No	Yes	32–28 °C (89.5-82.5°F)
3 - Severe	Unconscious	No	Yes	28–24 °C (82.5-75°F)
4 - Deep	Unconscious	No	No	< 24 °C (< 75°F)

By combining the clinical findings (**shivering, consciousness and respiration**), medical personnel can obtain a good indication of the severity of the patient's hypothermia. The column on the right (core temperature) is included in order to give an idea of the anticipated core temperature. This subdivision is also easier for first aiders to follow, as they do not have any equipment available to help with diagnosing the patient. Here, the treatment provider will only have to relate to the clinical findings. These findings must be reported as part of "*Signs and Symptoms*" in the MIST report when the patient is passed back up the medical chain. The lowest core temperature ever measured in anyone who has survived hypothermia is 13.7°C (56,66°F).

Core temperature measurements should normally be taken by specially trained personnel. Measurements must only be taken once the patient has been stabilised in a warm environment or is being transported for final treatment. This assumes that a special thermometer is available (ordinary fever thermometers do not show temperatures below 34°C (93,2°F)) and that the measurement is taken deep inside the rectum. Measurements of skin or ear temperature are of no relevance in the context of hypothermia. See

regarding what is expected of the various levels within field medical training.

6.2.2 Stage I – Mild (35–32°C, 95-89,5°F)

The person is conscious, breathing and shivering. Shivering is at its least intense at around 35°C. Intense shivering is a good finding. If the patient is given dry clothing and insulated from their surroundings, it is likely that their body temperature will return to normal without any further intervention.

The skin will feel cold and appear pale. Fine motor skills are impaired first. Movements then become clumsy and the musculature stiff. Rapid respiration and a high pulse indicate that the body temperature has not dropped to a dangerous level. When the core temperature drops below 35°C, shivering, respiration frequency and heart frequency will gradually decrease. In the transition between Stage I and Stage II, the patient will occasionally experience a paradoxical feeling of being hot and want to undress. This is often cited, but is actually rare in practice.

6.2.3 Stage II – Moderate (32–28°C, 89.5-82.5°F)

At 32°C, the patient will normally be drowsy. Shivering has decreased considerably. Breathing frequency is reduced and respiration shallower. The pulse is slower. At around 30°C, all shivering will have ceased in practice and the muscles will be stiff. In the temperature range 28–30°C, the heart is unstable, and arrhythmia is common (the heart beats irregularly). The heart is particularly prone to developing spontaneous fibrillations (ventricular fibrillations) at a core temperature of around 28°C.

6.2.4 Stage III – Severe (28–24°C, 82.5-75°F)

The patient is unconscious and all shivering has ceased. Breathing frequency may be reduced to a few breaths per minute. The skin is cold. The pulse is so slow and weak that training is needed to detect it. It is easy to believe that the person is dead if you do not have the necessary experience in appropriate patient examination.

6.2.5 Stage IV – Deep (<24°C, <75°F)

There are no signs of life. The patient is not breathing. It will not be possible to determine whether the patient will survive until they have been taken to a hospital.

6.3 Treatment

6.3.1 Conscious patients who are shivering:

- Remove wet clothing, replace with clothing with good insulating properties.
- If it is not possible to insulate the patient satisfactorily in the field, try to create a moisture barrier outside the wet clothes, e.g. waste bags wrapped tightly around wet clothing before the patient is taken to warm surroundings.
- The moisture barrier must be tight.
- As soon as practicable, insulate the patient to prevent further heat loss. For example, use a sleeping mat, clothing, sleeping bag, "*Hypothermia prevention management kit*" (HPMK), plastic bubble wrap (poor insulation), bivouac.
- An outer wind barrier is preferable, particularly if a helicopter is to be used to transport the patient. Example: survival suit or other emergency bivouac.
- All hypothermic patients should be actively warmed, but conscious patients who are shivering may be permitted to move themselves (under supervision) in order to normalise their body temperature or enable evacuation. Warming should take place gradually.
- When a hypothermic patient is warmed up, cold blood from the arms and feet will return to the core circulation and cause a temporary drop in body temperature (afterdrop).
- Be aware of the risk of frostbite.
- Warming through the body heat of another person is no more effective than shivering.
- Care must be taken with open heat sources, as the patient will be particularly vulnerable to burns due to their impaired pain sensation.

6.3.2 Unconscious and/or deeply hypothermic patients:

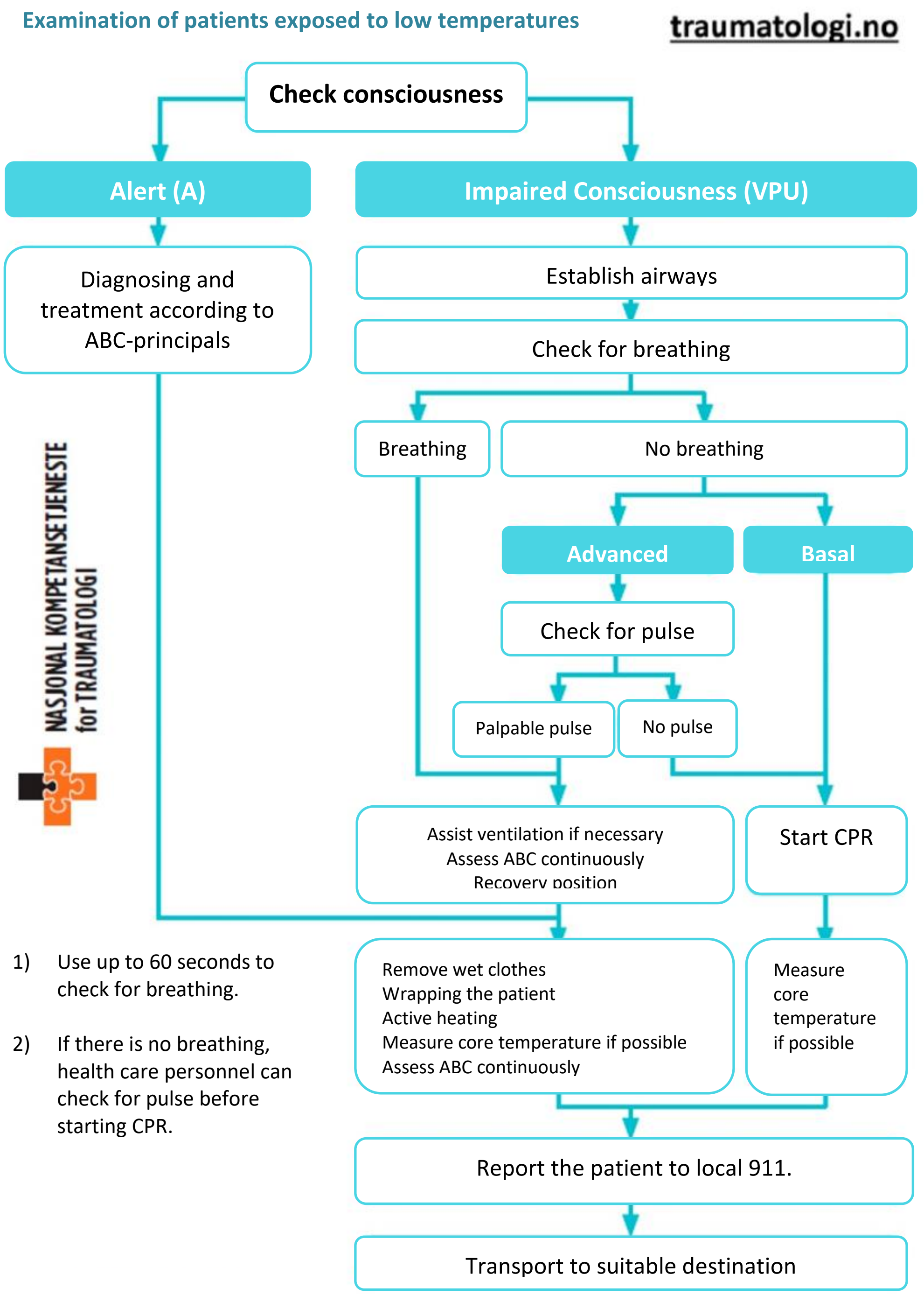
- As above. Patients who are not shivering or who are hardly shivering must be actively warmed.
- Using the HPMK is an easy and effective method for both ensuring heat conservation and applying external warming.
- Indications for rehydration are the subject of some debate and are not easy to identify if no obvious fluid or blood loss has occurred. A reduction in the pumping capacity of the heart is normally the most important factor behind the low blood pressure, rather than lack of fluids.
- All movement must take place carefully; be particularly careful when sitting/lifting the patient up. Hypothermic patients are much less able to regulate their blood pressure, and the careless handling of a patient can trigger a life-threatening drop in blood pressure, heart fibrillations and even cardiac arrest. Transport the patient horizontally if possible.
- Be aware of the possibility of burn injuries from heating elements.
- Be aware of a possible drop in blood pressure during warming. You should therefore attempt to obtain two large peripheral venous catheters (14–16G). If certified: Consider IO (intraosseous needle). In consultation with a doctor, consider a fluid infusion of 300–500 ml Ringer's solution to maintain systolic BP > 90 mmHg during the warming phase. Only use warmed fluids!

- Medevac by helicopter should be given particular priority if the terrain is difficult, if evacuation would be prolonged or if the evacuation platform provides poor shock absorption.

> The prevention of hypothermia is based on insulation (dry/warm clothing) and protection from the weather.
> The treatment of hypothermia is based on the removal of wet clothing (e.g. moisture barrier) and the supply of warmth.

FAGLIG GRUNNLAG FOR PREHOSPITALE PROSEDYRER

Utarbeidet: 2016-19-01
Revidert: 2017-12-04 (Ref DL 2017/028745-008)



Forsvarets sanitet

Figure 5: Examination of patient exposed to cold

(NKT-Traume, 2017)

6.3.3 Evacuation

- Following the administration of first aid, the patient should wherever possible be taken in a heated, enclosed means of transport to their final place of treatment. It is important to avoid further cooling while the patient is being transported. The patient must always be kept lying in recovery position.
- Use a patient warming device and blankets.
- If conditions permit, patients with mild hypothermia can receive final treatment in a heated tent or building. The patient must be continually monitored by trained personnel. In the case of moderate hypothermia, warming must be carried out with care until the necessary medical resources become available. Even during warming up from mild hypothermia, a drop in core temperature can be caused by "afterdrop" when the blood from peripheral areas (feet/arms) returns to circulation as a result of the increase in core temperature and the dilation of previously contracted vascular connections when the core temperature rises above 35ºC.

> In case of moderate, severe and deep hypothermia, final treatment must be provided at a hospital.

6.4 Prevention of hypothermia

6.4.1 Clothing

The task of clothing is to help us maintain the correct body temperature. Clothing must provide insulation against the cold and protect against wind and rain. It must also allow ventilation, so that condensation from the body can escape, as it is easier for the body to stay warm when it is dry.

It is important to be able to adjust clothing according to the conditions and current activity level. We therefore put together clothing according to the multilayer principle, i.e. thin layers of clothing, so that individual garments can be put on and taken off according to the prevailing conditions.

Several thin layers of clothing also provide more insulating layers, and therefore better heat insulation, than a single thick layer of clothing.

Clothing must enable the body to regulate its temperature by undoing and doing up fasteners at the wrists, ankles, neck, front and waist. If clothing is to have the desired effect, it must be loose and allow ventilation. Trousers, which is tight around the waist and clothing, which is compressed by belts or straps do not permit ventilation.

Woollen underwear affords better insulation than underwear made from other fabrics, particularly when wet. Nevertheless, it is extremely important to stay as dry as possible during the winter. This also applies to gloves/mittens and footwear.

See also the booklet *UD 6-81-2 Personal clothing (HVS, 2009)*.

6.4.2 Procedures

In addition to ensuring that clothing is adjusted to suit the prevailing conditions, it is important that units have good procedures in place for winter service.

Among the general procedures for movement during the winter, marching procedures such as the *50/10 principle* and *technical rest* are well-established, and make it easier for personnel to adjust their clothing and equipment. Anyone who has experienced becoming too warm while on the move will understand that it is a good idea to start off a little cold in order to avoid unnecessary sweating.

Similarly, experience shows that it is always important to have a set of dry underwear available. Evaporation from the body is inevitable, and clothing will often become wet no matter how suitable and well-adjusted it is. However, when resting, you must be dry in order to avoid freezing. For that reason, you must have some dry clothing ready to put on. Under field conditions, it can be difficult to dry wet clothing during periods of rest. In such cases, the wet clothing must be put back on again before resuming work.

Wet clothing must be dried as well as possible at every opportunity, and shoes and other clothing must be prevented from freezing during rest periods. It is important that leaders have a conscious attitude towards the procedures that apply to their unit and when they should be implemented.

7 Frostbite

7.1 General

Frostbite are local injuries, caused by cold (freezing). Frostbite occurs when ice crystals are formed which puncture and burst cells in the body, causing the cells to die. The ice crystals are formed at temperatures below -0.55ºC (31,01ºF).

Frostbite occurs as a result of two mechanisms: the direct effect of cold and frost on the body's tissues, and the secondary injuries which occur when the tissue warms up again. The warming process often leads to fluid accumulation around the injury site after the injury has thawed. Thus, injuries predominantly occur when the blood supply to frostbite-damaged tissue is restored.

Frostbite can occur locally even if the core temperature is normal. However, there is a greater risk of such injuries when the core temperature is low, as the body's protection mechanisms against localised frostbite cease to function at core temperatures below 35ºC.

The development of frostbite is characterised by the blood vessels in the exposed area contracting when the skin is cooled, and the skin becomes pale. The maximum effect of this blood flow regulation occurs at a skin temperature of approx. 15°C. If further cooling takes place, the skin begins a cyclical variation with periodic opening of the blood vessels. The response peaks at a skin temperature of 10°C, and causes the skin to temporarily turn a reddish colour. If cooling continues, the skin will start to feel numb. When the skin temperature is close to freezing point, the skin will turn white because blood circulation has ceased.

Around 90% of frostbite injuries occur in the hands (fingers) and feet (toes)(Figure 6). Small cylindrical body parts, such as the fingers, lose heat rapidly because they have a large surface area relative to their volume. Wearing mittens instead of gloves reduces the overall surface area, making it easier to keep the hands warm.

The male genitals can be vulnerable to frostbite during physical training if the clothing being worn is too thin.

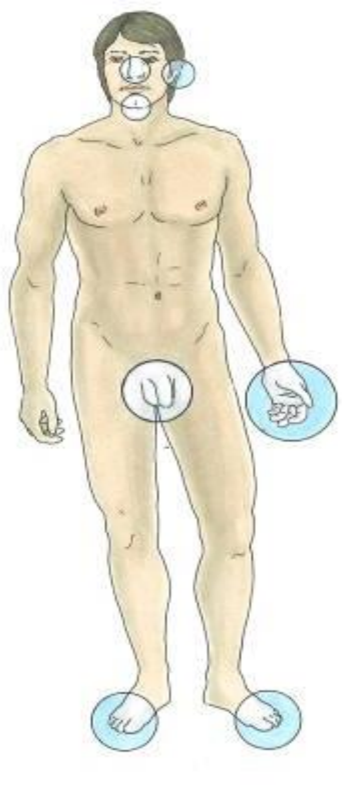


Figure 6: Areas vulnerable to frostbite

7.2 Classification of frostbite injuries

Frostbite injuries are divided into two main groups:

- superficial (the skin can be moved over the damaged area)
- deep (wax-like, hard and immovable skin)

The difference relates to the depth and therefore the severity of the injury. Both types will cause permanent damage to tissue. Both superficial and deep frostbite injuries are divided into two subgroups, see Figure 7

Severity		Symptoms and findings	Type of injury
Superficial frostbite	**Level 1**	Reddish skin, numbness, prickling sensation (“stinging”), white spots (“chilblains”)	Partially intradermal frostbite
	Level 2	Pronounced hyperaemia, blisters containing clear liquid, superficial erosions, severe pain (gradual reduction in pain sensation)	Full dermal frostbite
Deep frostbite	**Level 3**	Blisters containing bloody liquid, blue/white discolouration of the skin, necrosis, considerable reduction in pain sensation	Damage down into the subcutaneous tissue
	Level 4	Bright red/blue-black discolouration, subcutaneous skin solid, full-thickness oedema, tissue necrosis, loss of pain sensation	Damage to muscles and bone

Figure 7: Levels of severity

7.3 Superficial frostbite

7.3.1 Symptoms

The very mildest level of local frostbite is reversible and rarely results in long-term sequelae. This stage often passes without the person being aware that they were even in the process of developing frostbite. However, the classic stinging sensation is a sign that a person was close to developing mild, localised frostbite. This must be considered to be harmless, and if the skin which is exposed to cold is cared for appropriately, intense redness/erythema will develop as a sign that the skin is repairing the damage.
When the skin freezes, ice crystals are formed, primarily in interstitial fluid between the skin cells (Figure 9). The skin is now numb and has white spots which can be moved relative to the subcutaneous layer. Prolonged cold can cause white spots to form on the skin, which occur relatively frequently at skin temperatures of *around* 0°C. Such frostbite injuries cause occasional moderate pain and a prickling sensation in the skin, which disappears when the sensation of cold and discomfort ceases. “White spots” first become apparent on the nose, cheeks, ears (Figure 12) and fingers. This is a precursor to the freezing of tissue (Figure 8).

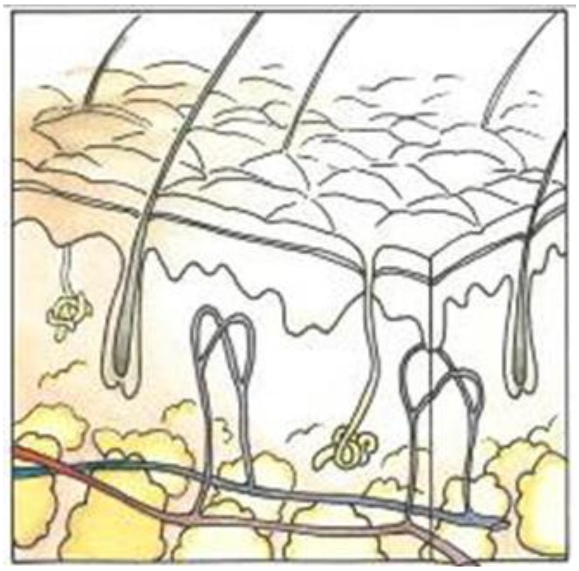


Figure 9: Deep frostbite

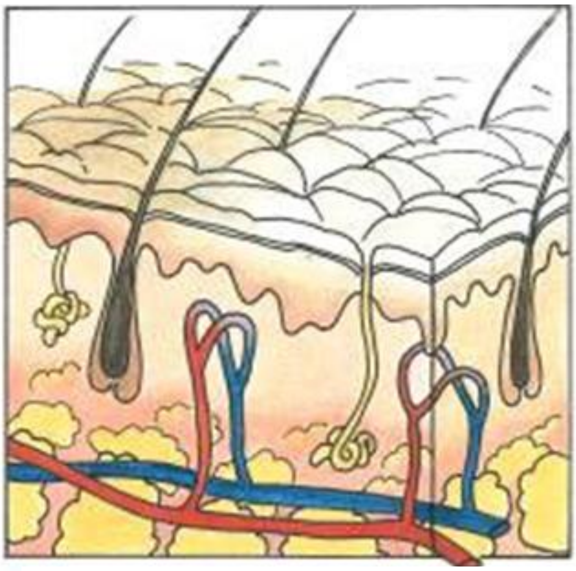


Figure 9: Superficial frostbite

It is at this stage that fellow soldiers, through the buddy-check, can help to limit an injury by making the sufferer aware of the symptoms and preventing any further exposure to cold.
If exposure to cold persists, the development of ice crystals will cause fluid to seep out from the tissue and into the superficial layers of the skin. This will give rise to blisters which may contain clear liquid and/or dark/bloody liquid.

Superficial frostbite injuries are divided into two stages:

1) White skin (Figure 11 and Figure 12) which is warmed up and recovers within no more than 15 minutes. The skin is red, rather than white, after the administration of first aid.
2) An injury which extends further down into the skin will have typical oedemas or blisters which contain clear liquid after they have thawed (Figure10). The presence of clear liquid in blisters is generally a sign of a less severe injury than if the liquid is coloured/mixed with blood. In some contexts, blisters containing dark liquid are classified as a sign of a third-degree injury of the underlying tissue.

Figure10: Level 2 frostbite, after thawing

Figure 11: Level 1 frostbite

Figure 12: Level 1 frostbite, white spots

7.3.2 Treatment/first aid

Localised superficial frostbite must be treated at the scene, preferably under sheltered conditions. Placing warm skin against the injured area is a very effective method; place a palm against the nose, ear, cheek and chin. Do NOT rub the skin. Place frozen fingers or hands under the armpits. Place toes and feet on the stomach of another person (see the figures below).

Figure 16: Hands on the patient's own stomach and feet on the stomach of a buddy

Figure 15: Hands under the armpits

Figure 13: Palms of the hands against the cheeks and nose

Figure 14: Palms of the hands against the cheeks and ears

Give the patient a hot drink and get them into warm, dry clothing. After warming, the area must be covered with clothing, as frostbitten skin has a very poor resistance to any further cooling.

If the frostbitten body part cannot be warmed up within 10-15 minutes, the soldier must be evacuated/taken to a heated tent or building as soon as possible. This can help in the acute situation and, with a concern to the possibility of future and permanent injuries warming/thawing is vital for subsequent healing of the injury.

Final treatment of superficial frostbite:

Warming in a water bath at 38–40°C (100-104°F) for 15–30 minutes, perhaps longer, and preferably until the tissue is vital and red/violet in colour (may require painkillers). Further water bath treatment will depend on the response and the extent of the injury.

Superficial frostbite is best treated skin against skin.

Anti-inflammatory medicines have a beneficial effect, not only because they provide pain relief, but also because they counter the development of oedema, which will aggravate the injury. A good medicine to use is Ibuprofen (Ibumetin/Ibux), 400–600 mg 3–4 times daily for the first 4–5 days; other anti-inflammatory medicines may also be used.

Do not allow frostbitten body parts to come too close to heat sources, as frostbite patients have reduced pain sensation and can suffer burn injuries very easily.

In the case of extensive superficial frostbite, treatment at a hospital is necessary. 'Extensive' means that the injury covers an area which is larger than can be warmed with one hand.

7.4 Deep frostbite

7.4.1 Symptoms

Deep frostbite extends deeper than the skin, down to the subcutaneous tissue and musculature. The frostbitten part is white, hard and numb. Skin and musculature over bone cannot be moved. The hardness is caused by the tissue freezing to ice in the exposed areas.

7.4.2 Treatment/first aid

Deep frostbite requires specialist treatment at a hospital and should not be treated under field conditions. A soldier with deep frostbite who has not been thawed out can be treated more easily than a solider with deep frostbite where thawing has started (Figure 18).

The injured area must be well-wrapped to prevent the frostbite from developing further (Figure 17). The patient must be wrapped in warm, dry clothing (preferably with wool next to the body) and blankets to maintain normal body temperature and retain/normalise core temperature. Where possible, a hot drink should be given if the patient is fully conscious.

Figure 18: First aid in the event of deep frostbite. NB: The right hand is wrapped and insulated in order to prevent thawing.

Figure 17: Deep frostbite after thawing.

If necessary, the patient may be permitted to walk on a frozen foot, but as soon as the foot begins to warm up, the patient must be considered a stretcher patient. Thawed deep frostbite injuries are very vulnerable to further frostbite, and any repeat frostbite injury will considerably aggravate the damage already caused to the area of the body concerned. The patient must therefore be evacuated to a place where they can receive final treatment.

Deep frostbite is often accompanied by secondary injuries. Secondary injuries can include relatively mild sequelae, such as reduced cold tolerance. In severe cases, deep frostbite can also give rise to permanent pain conditions or the loss of fingers/toes due to gangrene.

> In the event of doubt as to whether an injury is superficial or deep, it must be treated as a deep injury.

8 Prevention of frostbite

"... all local cold injuries should be regarded as preventable during peacetime in the military non-combat situation ..."(Rosén, Eltvik, Arvesen & Stranden, 1991)

For a military unit, preventing frostbite injuries will be vital to the success of its mission. During the first winter of the Korean War in 1950 (Cutter, 2015), US troops became aware of the importance of prevention. No fewer than 5,000 US soldiers suffered severe frostbite, which in turn greatly reduced the combat capability of the units to which they belonged.

8.1 Hygiene

Good hygiene will not prevent frostbite, but it can keep soldiers healthy and therefore combat-ready. The *Hygiene* section has been included in order to stress that good hygiene can be practised even at low temperatures and even if supplies of clean water are limited.

Everyone has a responsibility to look after themselves generally and their health in particular. During the winter, more frequent checks are needed to ensure that hygiene measures are being followed.

Wash armpits, feet and crotch areas more than once a week. Washing or bathing in snow can be a reasonable substitute for washing with water when the conditions permit. Be aware of the possible risk of frostbite to the feet when bathing in snow, in addition to any parts of the body which have previously suffered cold-related injuries. Carry out local assessments which take account of temperature, wind, rest time, liquid and nutritional state and evidence of exhaustion amongst the soldiers before starting any activities such as snow-bathing.

8.2 The skin

Washing or shaving during the 24 hours prior to prolonged exposure to severe cold is not recommended. Water and soap remove the natural layer of fat on the surface of the skin, which helps to regulate the body's heat loss through its insulating properties.

The hands and face should be massaged before going out into severe cold in order to get the blood circulation going. Once outside: Make faces and use chewing gum to maintain blood circulation/flow in the face.

Regularly turn the face away from the wind in order to reduce exposure. Tacking against the wind can also help to vary the side of the face which is exposed.

Prevent winter injuries by regularly carrying out buddy checks to ensure that no white spots are developing.

Beards and moustaches help to insulate the skin to some extent.

Research shows that cold cream provides little or no protection against the cold (Lehmuskallio, 1999) and that in some cases it can have the opposite effect. The use of cold cream is therefore not recommended by the Norwegian Armed Forces.

Greasy, non-aqueous cream can be used on the fingers and lips to prevent dry skin and cracking.

8.3 The feet

Feet should be kept clean, dry and warm. Once their feet start to get cold, it can be difficult for a person to stay warm, even when wearing warm clothing.

Boots must be sufficiently large to allow space for the toes to move. Shoes 1-2 sizes larger than those used during the summer are recommended. This will leave room for a couple of pairs of socks and insulating pockets of air.

The use of overboots is recommended during the winter.

The use of a moisture barrier on the feet is an alternative method for keeping the feet warm. This will generally cause you to sweat a lot, making staying dry and maintaining hygiene very important in order to avoid problems.

8.4 The hands

The hands are often more vulnerable to frostbite as they have to operate weapons and other equipment. Metal objects must not be touched with bare skin, as metal conducts cold very well; mittens/contact gloves must therefore always be worn. When mittens are not in use, they should be placed against the body.
Gloves/mittens must also be adjusted according to the level of activity in order to prevent the build-up of moisture. Soldiers must be given the opportunity to practise a wide range of skills wearing mittens.
The temperature of the hands and feet is regulated by the body's core temperature. It is therefore vital to ensure that you have sufficient clothing covering the body.

8.5 Earrings and piercings

Earrings and piercings conduct cold and should therefore not be worn.

8.6 Clothing (see UD 6-81-2 Personal clothing)

The most important factor as regards clothing under winter conditions is to actively adjust and regulate clothing to ensure that it is adapted to the level of activity. This will make it possible to stay warm at all times, while avoiding becoming damp as a result of sweat.
Today, netting underwear is used next to the body to create a layer of insulating air. This is followed by a layer of wool. It is better to wear many thin layers of clothing than a few thick ones. A windproof layer should be worn outermost.
The field uniform has provision for ventilation under the armpits, on the hips, in the crotch area, on the chest and around the wrists and neck.
Suspenders are better than belts, as they allow better air circulation. It can be challenging to maintain self-discipline when drying wet clothing is either difficult or impossible. It is mentally demanding to put wet clothing back on before starting work, but this approach does enable a set of underwear to be kept dry. By maintaining discipline within the unit as regards preventive measures and precautions, the body temperature can be kept at a stable level:

- Adjust the tempo during marching so that heat loss and heat production are balanced
- Always put on dry clothing when you stop.
- Rest in dry clothing. Work in “wet” clothing.

8.7 Handling weapons and contact with metal in the cold

Contact with metal in the cold can quickly lead to frostbite. The hands and face are particularly vulnerable. When shooting in the cold, it can be a good idea to place a piece of cloth between the weapon and the face. A good example here is to wear a balaclava and face mask during shooting. The handling of weapons in the cold while wearing windproof mittens requires training. This should therefore be incorporated as an aspect in training!

8.8 Toilet hygiene

'Toilet hygiene' means the measures that are implemented to ensure that soldiers use the toilet facilities that are provided in the field, in order to avoid problems which can arise by not going to the toilet when necessary.

Latrines must be organised so that soldiers do not consider this to be problematic. Tents and thermal blankets can be used to provide privacy and shelter from wind and the weather. Toilet facilities must be provided for both men and women. Not going to the toilet sufficiently often can lead to constipation and/or illness.

8.9 Control measures and leadership

SIBERIA is one of the unit leader's most important tools for preventing and detecting frostbite. SIBERIA is a visual inspection of a soldier's extremities and general physical condition with the aim of preventing and detecting any early stages of cold weather injuries.

Some general tips for SIBERIA, which can be used as a checklist in the field are presented below:

- The inspection should be carried out by the unit's most experienced personnel
- The inspection should take place in the form of an informal chat in order to encourage soldiers to speak up
- Touch the skin and feel whether it is cold or damp
- Look out for cuts, blisters/chafing and strain injuries
- Feel the skin directly with your bare hands/fingers
- Check exposed areas such as the face, fingers and toes particularly carefully
- Check whether boots are dry; if they are wet, this is an indication of the condition of the soldier's feet (two pairs of socks are recommended for warmth and to prevent blisters)
- Self-inspections and verbal feedback are not sufficient.

Before setting off on an exercise, a thorough SIBERIA should be carried out on all unit personnel in order to ascertain their normal condition as a reference for subsequent inspections. The results should be written down in a log. It can be a good idea to carry out this inspection several weeks before setting out, in order to allow time for measures to be implemented.

> The prevention of cold weather injuries will largely be a question of leadership. The preventive measures implemented by the unit must be known to everyone, and checks must be carried out to ensure that they are being followed.

9 Non-freezing cold injuries (NFCI)

9.1 General

It is particularly important to distinguish NFCI from frostbite. The most marked difference is that frostbite occurs at temperatures below –0.55°C, i.e. through the formation of ice crystals in the tissue. This is not the case with NFCI.

NFCI are local cooling injuries which occur at temperatures above 0°C.

NFCI can also occur at temperatures as high as +20°C. NFCI normally occur at temperatures of around 8–12°C, generally in damp environments over many hours (Figure 20).

NFCI are caused by tissue remaining at a low temperature over time, which causes prolonged disruption to the microcirculation. This leads to local changes in the body's metabolism and the release of substances which are toxic to tissue, causing tissue damage of various kinds due to changes in the function of the nerve pathways. This often reduces tolerance to cold, causes a loss of feeling (sensitivity disorders) and results in persistent/long-term pain. Resistance to cold is also impaired, and the risk of further injury is increased.

The condition generally affects the feet, but it can also occur in the hands on rare occasions. This type of injury often occurs symmetrically, i.e. it occurs on both sides simultaneously. The rate of development of the injury increases as the temperature of the body part drops, particularly if the skin is exposed to pressure injuries. Nicotine increases the risk of such injuries and aggravates the injury.

9.2 Symptoms

The following symptoms are common in connection with NFCI:

- numbness, prickling sensation in the skin
- loss of feeling, reduced sensitivity in the skin
- loss of vibration sensation, deep reflexes affected
- pale skin colour, slow filling of capillaries
- localised swelling/oedema in the area
- impaired ability to feel different temperatures, particularly the cold
- pain, but this does not usually arise until a few days later
- gait disorders, unsteady gait caused by numb feet

It can be difficult to detect mild forms of NFCI (Figure 21). The symptoms often only consist of numb toes. Pain in the toes will often not arise until several days later (Figure 19).

9.3 Treatment/first aid

Figure 21: Cold injury

Figure 20: Military service in a wet and cold climate

Figure 20: Incipient cold injury

- Remove the patient from the cold/damp environment immediately
- It is important that any further exposure to cold ceases as soon as possible, as any shortening of the cold exposure improves the prognosis
- Carefully warm the patient at room temperature, ideally a high room temperature of around 26–28°C
- The patient must not be immersed in water due to their impaired pain sensation and the potential for them to burn themselves on a heat source

- Give them a hot drink; help to maintain a warm core temperature
- Avoid massaging or mechanically stimulating the tissue
- Elevate the legs or arms of the injured person to reduce swelling (oedema); be aware that this may cause pain
- The patient may need painkillers during treatment and warming
- Avoid all use of nicotine.

9.4 Prevention

- Dry boots and socks
- Avoid boots/shoes which are too narrow
- Wear woollen gloves or mittens if combat gloves are not sufficient, particularly in the spring and autumn, when it is often damp and cold but the temperature is above 0°C
- Drink plenty of liquids/avoid dehydration
- Change socks frequently
- Rest/sleep with dry feet
- Rub the feet vigorously at least once a day.
- If the patient has cold feet, action must be taken quickly. Many people believe that it is acceptable to have slightly cold feet, but this can quickly lead to injury.

> Be particularly aware of cold injuries when the terrain is very damp or wet. There will be a greater risk of cold injuries in sleet when the temperature is around 0°C (32°F), or during snowmelt in the spring.

10 Immersion in cold water

10.1 Heat loss in water

The body will lose heat in water at a temperature of less than 35°C. The heat loss will accelerate as the water temperature drops. The table below shows that will happen when a person is immersed in water at different water temperatures.

Temperature (°C)	Temperature (°F)	Time to exhaustion	Time to death
27	80,5	unlimited	unlimited
21–27	70 - 80	3–12 hours	3 hours to unlimited
16–21	60 - 70	2–7 hours	2–40 hours
10–16	50 - 60	1–2 hours	1–6 hours
4–10	40 - 50	30–60 minutes	1–3 hours
0–4	32 - 40	25 minutes	30–90 minutes
0	32	less than 15 minutes	15–45 minutes

The reason why the body cools so rapidly in water is that water conducts heat around 25 times faster than air. Being in water causes the insulating layer of air present in clothing to be lost. Nevertheless, it has been shown that clothed people cope with being in water better than people who are naked, as water flows in between the various clothing layers and is then heated by the body. It is therefore recommended not to remove any clothing or footwear after falling into water. It is important that you remain as stationary as possible in order to try to maintain your body temperature. Waterproof clothing outermost on the body is an advantage because it reduces the circulation of water to some extent.
In theory, it is better to adopt the "foetal position", but this is impossible to maintain over time in practice because it quickly becomes uncomfortable.

In cold water everyone will gradually become less and less able to move. In practice, this will eventually be fatal for most people. Victims can no longer keep their head above water and start to inhale water into their lungs, and eventually drown. It normally takes quite a long time before the heart stops due to hypothermia. This is why life-vests are so important for everyone moving about on the water.
A person who is rescued and taken ashore after falling into water will be further cooled by rain, snow and wind. They should therefore be taken to a sheltered location immediately. Remove wet clothing before it freezes to ice. Change into dry clothing. Monitor the soldier for symptoms of hypothermia and administer first aid as necessary. Even though it feels unpleasant to come out of the water if the wind/rain is severe, it will always be better than remaining in the water. In water, the person will soon drown, while on land, it will take a long time for them to become so cold that their circulation stops.

10.2 Immersion

Immersion is defined as being submerged in water as far as the shoulders. In the event of immersion, there are four clear stages which either individually or collectively can lead to death. These stages are:

- cold shock
- impaired swimming ability
- hypothermia
- rescue shock (*Post Rescue Collapse* - circulatory collapse either at the moment of rescue or up to several hours after rescue)

However, this depends on external influences and a number of individual factors:

Individual factors:
- age
- nutritional condition
- endurance
- physical activity
- sleep deprivation
- illness
- alcohol and tobacco

External influences:
- temperature
- wind
- air humidity

10.3 Cold shock

Cold shock is a response which is triggered immediately after a person falls into cold water. An immediate gasp response is triggered (the person is unable to suppress a deep inhalation), which in itself can lead to drowning if the person is temporarily kept underwater by, for example, equipment or the ice that they have fallen through. This is followed by a brief period (typically lasting a minute) of rapid breathing, a fast pulse and intense shivering.

10.4 Impaired swimming ability

Cooling of the nerves and musculature combined with reduced blood flow impairs fine motor skills. This makes it difficult to use emergency equipment, such as a life raft. Swimming movements become clumsy and swimming ineffective. Even good swimmers will become unable to swim in cold water after a relatively short period of time. This period of impaired swimming ability is the main cause of death amongst people who die during the first half hour after falling into the water.

10.5 Hypothermia

In cold water (< 7°C,), a poorly insulated person will become hypothermic within 30 minutes. When the body's core temperature drops below 35°C, the effects of hypothermia on rational thought/action and muscle strength will be so pronounced that these factors in themselves can cause death. Nevertheless, it will take time for the core temperature to drop by so much that circulation stops. See also Chapter 6 concerning hypothermia.

10.6 Rescue shock

This is a collective term for complications which can arise following rescue. *Post Rescue Collapse* includes the following circumstances:

- Circulatory arrest upon recovery from the water or transport. This is caused by the cardiovascular system being unable to regulate blood pressure and blood circulation in the normal way. The risk is particularly great if a hypothermic person is raised up into the vertical position. Their blood will then accumulate in their legs and not circulate back to the heart.
- Circulatory arrest after being brought ashore and taken to a warm environment. A number of factors come into play here, but prolonged temperature drop ("afterdrop") is an important one. The body's core temperature can continue to drop by up to 2°C (3.6°F) after the patient has been taken into a warm environment. Some of this temperature drop is unavoidable (cold musculature and subcutaneous tissue continue to cool the core), but careless warming can accelerate the drop in temperature by causing large amounts of cold blood from the legs and arms to return to the body's core.
- Pulmonary oedema ("secondary drowning") People who have come close to drowning can develop pulmonary oedema, a condition where the lungs become filled with fluid from the blood vessels after they have been brought ashore. The condition can develop several hours after the person has been recovered from the water.

10.7 Action following a fall into cold water

- Recover the soldier from the water as quickly as possible.
- Change to dry clothing.
- If no dry clothes are available, wrap the soldier well in order to prevent heat loss (NB: This solution should be used only in an emergency; the soldier will expend a lot of heat warming the water in his or her clothes).
- Activate the large muscle groups.
- Seek shelter and take the soldier to a warm room (well heated).
- Exercise caution when actively warming soldiers who have partially lost consciousness.
- If the soldier is unconscious, but breathing unaided: give oxygen if available.

11 Avalanche accidents

11.1 General

Avalanche accidents always entail a risk of cold weather injuries. Reference is also made to UD 6-81-9 Rescue following avalanche accidents (HVS, 2011).

12 Operations in coastal regions

Operating in coastal regions entails a number of additional challenges compared with inland climates. First and foremost, salt water creates a number of challenges which must be considered.

Clothing which has become damp with salt water can become "saturated" with salt crystals which absorb and retain moisture. If this happens, action should be taken to remove the salt from the clothing. If possible, rinse the clothes in fresh water or alternatively wash them in snow and brush them down. Clothing with a waterproof membrane makes good outerwear, as the membrane does not retain a lot of moisture. However, it should be noted that salt water reduces the performance of membranous clothing. This increase in moisture increases heat loss from the body, and dramatically increases the risk of hypothermia.

Boots quickly become wet and full of salt water. Rubber boots with removable felt/woven woollen inner boots are recommended. Boots with a membrane are not recommended, as they tend to retain more moisture. In addition, the salt will reduce the performance of the membrane.

Salt water has a lower freezing point than fresh water, which can increase the risk of frostbite.

13 Other injuries

The term 'other injuries' covers what are known as indirect cold weather injuries: *sunburn, snow blindness, carbon monoxide poisoning and injuries caused by handling fossil fuels in cold weather*. This is because these conditions often arise when it is cold. For example, snow reflects ultraviolet (UV) radiation from the sun, causing sunburn or snow blindness, while low temperatures lead to the extensive use of stoves in tents, increasing the risk of carbon monoxide poisoning.

13.1 Sunburn

Sunburn is due to a directly harmful effect on the skin cells caused by the UV rays in sunlight. The amount of UV light to which a person is exposed increases the higher the sun is in the sky and the higher the person is above sea level (lower atmospheric pressure).

UV radiation also increases as a result of the increased reflection of light from the surroundings, e.g. from snow and water. The degree of skin reaction depends on the intensity and duration of the radiation to which the person is exposed. The skin initially responds by becoming redder several hours after the start of exposure to solar radiation. Blisters may also form if the radiation is severe. The skin becomes intensely painful. Peeling of the skin begins after 1–2 days. The skin that remains after peeling is very vulnerable to further burning. Pigments in the skin cells are the body's defence mechanism against the sun's rays. Pigment production increases when the body is exposed to incoming solar radiation. Tolerance to UV radiation can therefore be increased through gradual exposure to the sun's rays. An increase in the risk of skin cancer has been demonstrated in the event of excessive sunbathing without appropriate protection.

We can protect our skin against radiation by wearing clothing (e.g. a handkerchief in front of the face), by staying in the shade as much as possible or by applying sun cream which reduces the effect of the UV rays. Sunburnt skin must be covered to prevent further exposure to solar radiation. The skin must be kept dry in order to prevention infection. In the event of intense itching or severe swelling, it may be necessary to use medication (antihistamine medicine and steroid cream). Consultation with a doctor is therefore recommended. The patient will often be put out of action and need treatment. The condition will normally pass by itself within a couple of days if protected from further sunlight.

13.2 Snow blindness

Snow blindness occurs because the eyes are unable to cope with the effects of the UV rays in sunlight.

When we traverse a snow-covered surface, the rays from the snow crystals and UV rays are reflected back. The rays are not blocked to any great degree by clouds, mist and snowy weather, and can cause inflammation in the outer part of the eye (cornea). The symptoms of snow blindness often develop several hours after exposure to light, and can become apparent as severe stinging or itching in the eyes, as if they had sand in them. Exposure of the eyes to light aggravates the discomfort. The condition is uncomfortable, but not dangerous. Exposing the eyes to UV radiation over time can increase the risk of developing cataracts.

This can be prevented by wearing sunglasses/protective glasses/skiing goggles in the high mountains during the winter. The colour of the glasses has no effect on the protection that is afforded, but it is more pleasant to use coloured glass. Dark glass prevents squinting and strained musculature, and can help to reduce or prevent head and neck ache.

It is very important that the glasses cover the eyes and do not let in a lot of light around the sides. Wearing sunglasses without UV protection may be counter-productive and actually allow more harmful UV rays to enter the eye. Sunglasses must therefore be CE-approved, which means that they are certified as providing good protection against UV.

If necessary, sunglasses can be improvised by cutting eye slits in a paper disc or piece of wood as shown in Figure 23. It is also possible to use a handkerchief and create small holes for the eyes (Figure 22).

Figure 22: Improvised sunglasses made from a handkerchief

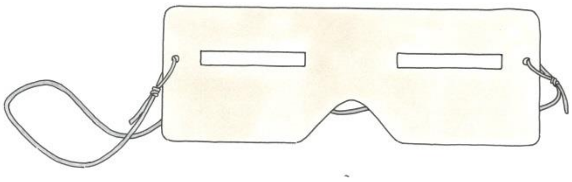


Figure 23: Improvised sunglasses made from a piece of paper/wood

13.3 Carbon monoxide poisoning

13.3.1 General

Carbon monoxide (CO) is a very poisonous and dangerous gas. It is odourless, colourless and tasteless. Even though carbon monoxide has no smell or taste, other exhaust gases associated with it can indicate an abnormal situation. CO is slightly heavier than air, with the result that, in poorly ventilated areas, concentrations of the gas will be higher at ground level than near the roof of the tent.

There is a risk of carbon monoxide poisoning when carbon compounds (paraffin, propane, etc.) are burned without an adequate supply of air, or when combustion is incomplete for other reasons, e.g. when melting snow.

Possible sources of carbon monoxide within the Norwegian Armed Forces are: cooking appliances, vehicle engines and diesel generators.

Poisoning is caused by the carbon monoxide blocking the uptake of oxygen by the blood, resulting in a form of internal suffocation. The first signs of carbon monoxide poisoning are a mild headache and nausea.

The headache and nausea can increase in severity, but carbon monoxide poisoning often develops without the victims even noticing any symptoms beforehand. Poisoning can be effectively prevented by good ventilation.

Particular care should be taken when placing a kettle on a stove. When melting snow and cooking over time, people are exposed to high concentrations of CO, both because the snow keeps the temperature of the kettle low and because people are exposed to the gas over a prolonged period of time.

Good ventilation during cooking/snow melting is vital. Be particularly aware of ice- and snow-covered tents. The use of heat sources is not permitted in snow caves because of the risk of high carbon monoxide concentrations and the possibility of glazing of the snow cave wall. A wax candle which starts to flutter or goes out is a warning sign that CO levels are high.

The circulation of air tends to be less in modern tents made from plastic materials. It is important that air vents are kept open at all times, and that good ventilation is ensured when melting snow or cooking in the tent.

The half-life of CO is long, which can result in its accumulation in the blood over time if a person is exposed to high concentrations for several days in a row.

13.3.2 Symptoms

- headache, dizziness, nausea, vomiting, visual impairment, high pulse and shortness of breath
- reduced consciousness, respiratory arrest

Remember that the effects of carbon monoxide poisoning occur BEFORE the symptoms become apparent. The symptoms are mild and few in number.

13.3.3 Treatment

- Take the patient out into fresh air.
- MARCH
- administer oxygen as soon as practicable

In the event of any suspected case of CO poisoning with severe symptoms, the patient must be taken for medical treatment. The diagnosis is not easy, and symptoms can continue to develop after exposure has ceased.

> In the event of symptoms of carbon monoxide poisoning, the patient must be taken out into fresh air as soon as possible!

13.4 Hazards associated with the handling of fossil fuels (petrol, diesel, F-34)

Petrol, diesel and F-34 have many properties in cold weather which it is important to be aware of. This also applies to many related products, such as paraffin, white spirit, barbecue lighter fluid, lamp oil, etc.

These products remain liquid even at extremely low temperatures. Because liquids conduct heat away from the body much faster than air, it is easy to imagine the heat loss that will occur if you stick your finger into a liquid fuel which is at a temperature of –30°C. These substances also evaporate more rapidly than water. This results in greater heat loss than in the case of water. Clothing that has been splashed with such fuels will feel colder than clothing that has been splashed with water, and it will steal a lot of heat from the body through evaporation.

During the winter, the air is dry and the skin can rapidly dry out and become cracked. These substances have fat-soluble properties and will remove the protective layer of fat on the skin. This increases the risk of skin problems and cold weather injuries. Many of these liquids can also irritate the skin. Prolonged exposure, e.g. if you spill F-34 on your trousers and do not remove it or change your clothes, can result in chemical burns, which can be very painful.

Fossil fuels also have a harmful effect on the gastrointestinal system if you ingest any. If provisions become soiled with fuel products, it can result in diarrhoea or, in the worst case, more serious symptoms of poisoning such as nausea, vomiting or nervous system disorders.

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15 Entry into force

This document enters into force on 2020-10-01. UD 6-81-4 Instruction in Winter Service – Winter Injuries of 01/01/2011 shall lapse as of the same date.