Preventing and Managing Hypothermia and Frostbite Injury

Injuries due to cold weather are common among children and athletes who are involved in exercises and sports that are usually played in extremely cold conditions. Frostbite is defined as a direct freezing injury to the peripheral tissues and occurs when the skin temperature drops below -0.5 C. Common sites of frostbite including the nose, ears, fingers, and toes. These regions of the human body are far from the body’s core and are more likely to undergo vasoconstriction if they become too cold. Hypothermia can be defined as a drop in the core body temperature below 35 C. In this article, we will discuss the prevention and management of hypothermia and frostbite injury.

Overview

Hypothermia can occur when there is more total body heat loss than the normal
physiologic heat production.

Classification

They are broadly classified into:

Freezing injuries that entail injuries due to temperatures below the freezing point. They include injuries such as frostbite that is more common on the nose, ears, fingers, and toes. These regions of the human body are far from the body’s core and are more likely to undergo vasoconstriction if they become too cold.

Non-freezing injuries that occur at an ambient temperature above freezing point.

Hypothermia can be further classified as mild, moderate and severe:

- Mild hypothermia: Temperature between 32 and 35°C.
- Moderate hypothermia: Temperature between 28 and 32°C.
- Severe hypothermia: Temperature below 28°C.

Epidemiology of Hypothermia and Frostbite Injury

The true incidence of frostbite injury is unknown; however, a recent study has reported an incidence of 20% or more of those involved in skiing and other cold-weather-related sports. In fact, frostbite injury was reported as the most common type of cold injuries.

The incidence of frostbite in mountaineers is around 366 per 1000.

The main risk factor for frostbite injury is inappropriate clothing and a lack of knowledge on how to deal with the cold extreme weather. Certain underlying medical conditions, such as the history of the peripheral vascular disease or Raynaud’s phenomenon predispose the person to an increased risk of frostbite injury.

The same risk factors for frostbite injury can also predispose the person to hypothermia. Immersion in cold-water is a possible cause of hypothermia. A combination of cold, wet, and windy weather is associated with a higher risk of hypothermia and frostbite compared to cold weather alone.
Risk factors

Factors that increase the risk of experiencing cold injuries include climatic changes into cold weather conditions, poor protection such as light clothing, prolonged exposure, immobility, extremes of ages, cerebral impairment such as alcohol intoxication, peripheral vascular disease, and previous cold injury.

Pathophysiology of Hypothermia and Frostbite Injury

Vasoconstriction develops in response to cold exposure. Peripheral vasoconstriction occurs when the mean body temperature drops below 34°C. In the initial response to freezing weather, vasoconstriction is usually interrupted by vasodilation to protect the peripheral tissues from ischemic injury and maintain blood flow and skin temperature. As the core body temperature further drops, vasodilation response decreases and the risk of frostbite increases.

Shivering occurs as a protective mechanism to increase the metabolic heat production; therefore, shivering is an involuntary response to cold temperatures. Maximum shivering occurs at a skin temperature of 17 to 20°C which corresponds to a core temperature of 32 to 35°C.

Clinical Presentation of Hypothermia and Frostbite Injury

Hypothermia is classified into mild, moderate, and severe according to the core body temperature. Mild hypothermia is characterized by a core body temperature of 32 to 35°C. People who have mild hypothermia develop shivering, social withdrawal, and behavioral changes.

Moderate hypothermia develops if the person does not remove him or herself from the cold environment. Moderate hypothermia is characterized by a core body temperature between 28 and 32°C. Pupils become dilated, and cardiac arrhythmias might occur at this.
Frostbite is a severe form of injury that may present in any of the following stages:

- **Stage 1** involves the superficial areas of the skin and thus presents with hyperemia and itching.
- **Stage 2** frostbites are characterized by blisters and desquamation.
- **Stage 3** frostbites are characterized by ulceration and involvement of the skin and subcutaneous tissue.
- **Fourth degree** frostbites involve a deeper injury of the connective tissues and bone leading to gangrenous limbs.

Frostbite injury occurs more commonly in the nose, ears, fingers, and toes. Contact frostbite occurs when there is contact between the skin and cold metals, gasoline, stove fuel, ice packs, or alcohol. The severity of frostbite is dependent upon the temperature, duration of exposure, and the amount and depth of the frozen tissue.

<table>
<thead>
<tr>
<th>Frostbite</th>
<th>Characterization</th>
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<tr>
<td>First-degree</td>
<td>Numbness, erythema, development of a white or a yellow plaque on the skin</td>
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<tr>
<td>Second-degree</td>
<td>Superficial blisters, erythema, edema</td>
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<tr>
<td>Third-degree</td>
<td>Hemorrhagic blisters, which is suggestive of deeper tissue injury, tissue loss</td>
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<tr>
<td>Fourth-degree</td>
<td>Necrosis of the dermis and muscle in addition to bone necrosis</td>
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Prevention of Cold Injury

Before we discuss the management of frostbite and hypothermia, it is essential to emphasize the **importance of preventing cold injury** in the first place. For the adequate prevention of cold injury, one needs to understand the pathophysiology of the several types of cold injuries. In general, frostbite or hypothermia develops when heat loss exceeds heat production.

Understanding the weather conditions, wind chill, water temperatures, and planning water activities can help in preventing cold injury by minimizing exposure.

It is essential to alert others about extreme weather changes before they happen so that one can prepare. When temperatures drop below –20°C, it is recommended to avoid racing activities and other outdoor sports. **Proper clothing is important** as it can act as a layer of insulation between the body and the cold environment. It is recommended to put clothes in layers rather than wearing one heavy coat as this has been proven to provide better insulation and gives the person better control depending on the severity of the cold weather.

The inner layer should wick moisture away from the body. Wool can retain heat even when wet; therefore, it is a good clothing material for people expecting to be exposed to cold, wet and windy weather. Wearing mittens can protect the hands from frostbite and is recommended over gloves.
Clothing should be well-fitted to minimize heat loss; however, too tight footwear might impair blood flow to the foot and increase the risk of frostbite injury.

**Other preventive methods:**

1. Following weather forecasts and avoiding exposure to extremely cold environments.
2. Keeping warm during cold weather using loose fitting and warm clothes, avoid excessive sweating in cold weather and keep your body dry.
3. Avoid intoxication while you are out in the cold.
4. Early management of cold injuries by re-warming, rubbing the cold places and call for help in time.
5. Use life jackets while swimming or exploring water bodies.
6. In case of drowning, only swim if close to safety to conserve energy but instead huddle with others in a circle.

**Treatment of Cold Injuries**

The first step in the management of a frostbite injury is to **remove wet clothing and to move the patient to a warm and dry environment**. You should avoid rubbing the frozen tissue in an attempt to warm it. You should instruct the patient to put his or her hand under his or her arm in the axilla region as that region tends to be the warmest in our body. This is usually done in the pre-hospital setting.

Rapid re-warming can be achieved by immersing the cold extremity in a warm water bath at the temperature of 37 to 39°C. One should avoid fires and stoves as they can burn the fingers and toes. Once the fingers and toes become purple to red in color and soft to touch, one can stop the re-warming process.

Patients in cardiac arrest because of severe hypothermia should receive cardiopulmonary resuscitation regardless of their temperature. Internal re-warming should be initiated. **Defibrillation** should be attempted if the patient is in ventricular fibrillation.

If the first defibrillation attempt fails to restore a normal cardiac rhythm, further defibrillation should be delayed until the core body temperature is raised to 30 to 32°C.

Hypothermia might provide a protective effect for the brain and other organs; therefore, it is recommended to continue cardiopulmonary resuscitation until the core body temperature is raised to normal or near normal.

**References**


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