Frostbite

Frostbite is an injury caused by exposure to freezing temperatures. Before freezing, skin of the fingers and hands may become red, then pale and numb. This is due to the body's attempt to keep the major organs warm by constricting the blood vessels in the limbs. In this way, the body sacrifices blood flow to the limbs to keep warmth where it is needed. These first changes are called frostnip. If the affected parts are warmed before the tissue freeze, there is usually no loss of tissue. If the cold exposure continues, frostbite can follow.

During frostbite, the freezing of tissues leads to the formation of ice crystals. The ice crystals can cause damage in multiple ways. First, the crystals form between cells. This can progress to ice forming inside the cells which causes further damage. Initially, the skin layers are affected. With more cold exposure, the deeper tissues including bone can be damaged. The cells begin to lose water along with other changes. The longer the tissues are frozen, the higher chance of permanent damage. There is additional injury to the tissues when the frozen tissue is rewarmed. This is caused by a combination of blood sludging, or coagulating, and damage to the lining of blood vessels.

Frostbite can be mild-to-severe and requires treatment, often in a hospital. When the injury is significant enough, amputation may be required even after the best treatments. It is common to have problems for months, even a lifetime, after frostbite. These may involve permanent pain and/or numbness, loss of feeling, excessive sweating, skin and nail changes, cold sensitivity, and arthritis.

Causes

Frostbite can happen when the fingers/hands are not protected enough and are exposed to freezing temperatures. Lack of proper clothing, alcohol or drug abuse, diabetes, mental illness, homelessness, becoming dehydrated, poor nutrition, and cold exposure during military service are common contributing factors. Children, people of African descent, people with previous frostbite, and smokers are more likely to suffer frostbite. Frostbite is more likely to occur when people become stranded from accidents or vehicle breakdown and do not have access to warm surroundings or proper gear.

Signs and Symptoms

The first symptoms of frostnip may be mistaken for frostbite. The skin may become pale/white or waxy in color. This is due to blood vessel spasm. The fingers/ hand becomes numb. When the skin actually freezes, it becomes firm or even hard due to ice crystals forming in the skin. If there is longer exposure to the freezing temperatures, the deeper tissues may also freeze.

Treatment

When there is exposure to freezing temperatures, the body as a whole may lose its normal internal temperature. As the body's temperature drops, called hypothermia, there is greater health risk, and this can even result in death. The person may become confused, clumsy, and have a slow pulse. First, an exposed person should be protected in a shelter, provided with warm dry clothing, and given warm fluids by mouth. Treatment of hypothermia is necessary before treating frostbite (The treatment of moderate hypothermia requires hospitalization and will not be discussed here).

Because most cases of frostbite occur unexpectedly, there are frequently no medical or emergency facilities available at the time of frostbite. Therefore, it is important to limit the exposure to further cold and protect the frozen part from further damage. Ibuprofen or aspirin can be given before transport to a medical facility. When transport to a medical facility is possible within 2 hours, it is recommended that no warming of the frozen part be attempted "in the field". Use of heaters, fire or car exhaust should not be tried. Rubbing the affected parts with snow or ice should not be done. These can cause additional damage. Partial or slow thawing of frozen tissues is not the best treatment. If there is refreezing before or during transport to medical care, the results are usually much worse.

The best treatment for frostbitten fingers/hands is rapid rewarming in a warm (98-102° F) water bath until the affected part has become red and soft (about 15-30+ minutes). During the rewarming process, there is additional cellular injury due to blood thrombosis (clotting) and damage to the blood vessel linings. The damage due to these additional changes is called reperfusion injury. The damage caused during this part of treatment can be worse than what happens during the freezing of cells.

Pain during rewarming may require narcotics. The degree of the frostbite injury usually cannot be determined until there has been rewarming. Depending on the severity of the frostbite, blisters may form during the first 24 hours. Clear/milky blisters are a sign of mild/moderate frostbite (Figure 1). Blisters with blood or blue color are a sign of deeper, more severe injury (Figure 2). When blisters form, hospitalization is usually required and may last for weeks or longer. Swelling (edema) usually



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frostbite, some tissue may die, forming a black hard covering (Figure 3). When severe frostbite affects the deeper tissues, amputation is often necessary.

Because frostbite, even after the best treatment, can result in problems for months or even for a lifetime, prevention is considered the best treatment.



Figure 1 - Clear/milky blisters are a sign of mild/moderate frostbite

Photos courtesy of James E. O'Malley, MD

Figure 2 - Blisters with blood or blue color are a sign of deeper, more severe injury due to frostbite

Figure 3 - A black, hard covering is a sign of severe frostbite when tissue has died

