

Frostbite is a limb injury caused by freezing. In cold temperatures, the body constricts the blood vessels in the limbs to try to keep the core warm. Frostnip occurs before freezing, as skin of the fingers and hands may become red, then pale and numb. Warming the tissues correctly before freezing can prevent loss of tissue. If the cold exposure continues, frostbite can follow, and the injury can cause permanent damage or even finger loss.

During frostbite, the freezing of tissues leads to the creation of damaging ice crystals inside the body. First, the crystals form between cells. This can progress to ice forming inside the cells which causes further damage. First, the skin layers are affected. With more cold exposure, there can be damage to deeper tissues including bone. The longer the tissues are frozen, the higher chance of severe damage. When cooled, blood can thicken or clot. This damages the blood vessel lining. Rewarming too fast can also cause injury to the tissues.

Frostbite in hands 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. Problems can persist for months, even a lifetime, after frostbite. These may involve chronic pain and/or numbness, finger sweating, and skin or nail changes. The area may also be more sensitive to cold in the future and develop arthritis from the loss of good cartilage cells in the joints.

Causes

Frostbite happens when the fingers/hands are exposed to freezing conditions for too long. Lack of proper clothing, homelessness and cold exposure during military service are common risk factors. Some conditions may limit a person's ability to move away from exposures or make the fingers more vulnerable to damage from the cold. Examples are alcohol or drug abuse, diabetes, mental illness, poor nutrition or dehydration. Some studies have reported that children, people of African descent and smokers are more likely to suffer frostbite. Fingers damaged by prior frostbite are also at higher risk to new injury.

Signs and Symptoms

Before you suffer from frostbite, you will see symptoms of frostnip. The skin may become pale or waxy in color. This is due to blood vessel spasm. The fingers/hand typically become numb. With these early symptoms of frostnip, the damage is typically reversible.

When the skin actually freezes, it officially becomes

frostbite. The skin then becomes firm due to ice crystals forming in the skin. Swelling (edema) usually occurs when there is leakage of fluid from the damaged cells/vessels. If there is longer exposure, deeper tissues may also freeze, release toxins from dying cells into the body, and eventually stop functioning. Depending on the severity of your frostbite, you may also experience the following symptoms:

- **Blisters:** Clear or milky blisters are a sign of mild to moderate frostbite (Figure 1). Bloody or blue blisters are a sign of deeper, more severe injury (Figure 2). These blisters may form during the first 24 hours.
- **Black hard covering:** Those with more severe frostbite may see the area turn black (Figure 3), which means some tissue has died.



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



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

Figures 1-3 courtesy of James E. O'Malley, MD

When exposed to prolonged freezing conditions, the human body will lose its normal internal temperature and become unable to function. This is called hypothermia and can lead to death. Signs of hypothermia include the person becoming confused, clumsy and having a slow pulse.



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

Treatment

Treatment of frostbite starts by first treating the hypothermia. Treatment for hypothermia is primarily providing shelter from the cold exposure. Then the person can be changed into warm, dry clothing and given warm fluids by mouth. Treatment of hypothermia is lifesaving.

Many times, when frostbite occurs, it's not easy to get the individual to hospital quickly enough. The best course of action is to take the initial treatment step yourself before medical personnel can arrive or you can get to a hospital. This includes limiting exposure to further cold and protecting the frozen body part from more damage by wrapping in a warm/room temperature dry covering. Ibuprofen or aspirin can be given before transport to a medical facility. It is not recommended to put high heat on the damaged body part if you are able to get to a medical facility within 2 hours. Immediate high heat can further damage the numb fingers. Use of heaters, fire or car exhaust should not be tried. Rubbing the affected parts with snow or ice was briefly considered beneficial,

but studies now show it should not be done. These myths of treatment can cause additional damage. Do not allow the affected body part to thaw and refreeze before or during transport to medical care because the results are usually much worse.

Once under the supervision of a medical professional, the best treatment for frostbitten fingers/hands is to rewarm in a warm (98-102° F) water bath. This is done until the affected part has become red and soft (about 15-30+ minutes). During the rewarming process, at first there is actually more cellular injury. This is due to blood thrombosis (clotting) and damage to the blood vessel linings. The damage due to these 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 assessed fully until rewarming and reperfusion are complete.

When blisters form, treatment at a hospital is usually required and may last for weeks or longer. Sometimes, medications are used to open the blood vessels (vasodilation) or to break up blood clots. These are usually only used during the first 24-48 hours. Additional treatments of the healing fingers include whirlpool baths, elevation and medicine for inflammation. After frostbite, the fingers may be stiff, and hand therapy is used to help them move again. However, loss of full hand use may remain for the patient's lifetime. Severe frostbite that affects the deeper tissues can even lead to amputation.

Prevention is considered the best treatment for frostbite. Frostbite in hands, even after getting medical care, can result in problems for months or even for a lifetime.