# ICE THERAPY (CRYOTHERAPY)

**Lyn Paul Taylor, A.A., B.A., M.A., R.P.T.**

(**Editing Assistant and Computer Consultant: Joanna Soon, B.S.**)

Ice therapy (***cryotherapy***) is the therapeutic use of ***locally applied coolants*** to affect various physiological processes through the cooling of soft tissues. Cooling occurs when heat is ***removed*** or lost from an object through ***conduction*** of heat from one mass to another, or through ***evaporation***. Conduction occurs when heat is transferred from a warm body to a colder body by ***direct contact*** between their surface molecules. The slow moving molecules of the cold body speed up by ***absorbing*** energy from the faster moving molecules of the warm body, thereby becoming warmer, while, conversely, the faster moving molecules of the warm body ***slow down*** as they lose energy and become cooler. Conduction occurs when a cool mass (like ice) is applied continuously to the skin, or when a body part is ***immersed*** in cold water. As the body or body part cools, the ice or cold water heats up.

Cryotherapy has historically been used to provide ***pain relief***, ***reduce fever***, ***slow the damage of thermal burns***, ***control bleeding***, and prevent or ***reduce edema*** caused by soft tissue trauma. Cryotherapy has also been shown to be useful for the ***reduction*** of extrafusal and intrafusal ***muscle spasm***, ***neuromuscular hypertonicity***, and ***spasticity***. Cryotherapy may additionally be used to elevate the pain threshold and slow ***destructive enzyme action*** that occurs in some joint diseases.

The cooling of bodily tissue is governed by **two** basic physiological principles: ***(1) the cooling effect on the soft tissue by an ice massage or ice pack will decrease as the depth of the tissue increases; (2) the time required for cooling to be effective will vary according to the type of tissue being cooled (the speed of cooling underlying tissues will decrease as the amount of insulating fat increases)***.

As cooling decreases tissue temperatures, the ***sensory nerves*** in the skin are provoked to fire continuously until ***physiologically exhausted***. Usually this causes the subject to predictably experience a sequence of sensations including ***aching***, ***burning***, and finally ***numbness*** (though exceptions will be found). Numbness or ***temporary local anesthesia*** occurs as the sensory nerves are exhausted and, coincidentally, when the normal ***erythema*** of the skin reaches its zenith.

Deeper nerves (below the epidermis) may also be affected by cooling. Muscle cooling has been shown to affect the ***afferent nerves*** arising from the ***muscle spindle*** flower-spray and annulospiral sensory nerve endings. Their rate of discharge decreases as the temperature of muscle tissue decreases. As the temperature drops, the sensitivity of the muscle spindle initially ***increases*** (a minimal stretch is required for a spindle response at 30°C), but as the temperature decreases further, the spindle's sensitivity ***decreases*** (requiring a bigger stretch to elicit a muscle spindle response). Some evidence has suggested that cooling may affect a decrease in the ***rate of muscle spindle discharge*** by causing membrane ***hyper polarization*** with a lowering of ***potassium*** concentration. Cooling may also affect the ***speed of impulse*** of the ***gamma efferents*** to the muscle spindle by decreasing ***gamma biasing*** of the muscle spindle ***intrafusal muscle fiber***, thereby ***depressing*** membrane activity and the ***stretch reflex***. This occurs in the muscle after 10 minutes of cooling with a ***crushed ice pack*** (if the muscle isn't too deep).

Cooling of the exteroceptors of the skin has been shown to increase the amplitude of the ***H response*** (a phasic stretch reflex induced by electrical stimulation), largely ***by-passing*** the muscle spindle, by increasing or ***facilitating*** alpha motor neuron excitability. As the temperature drops toward 5°C, there are decreases in the amplitude and frequencies of the motor ***endplate potentials*** combined with increases in their duration. If cooling is sufficient to drive the muscle tissue temperature at the ***neuromuscular junction*** down to 5°C, ***blockage*** of the junction has been shown to occur.

The effects of cooling on ***peripheral nerves*** are primarily dependent on ***myelination and fiber diameter***. All nerve fibers are generally affected by cooling. The smaller medullated fibers are affected first, then the large medullated, and finally the non-medullated. The smaller gamma efferent fibers are more sensitive to cold (their frequency slowing more quickly and to a greater extent) than are the ***alpha efferents***. ***Motor nerve conduction velocity*** decreases linearly at a rate of between 1.84 and 2.4 meters per second per degree (centigrade), as the temperature drops from 36 to 23°C. ***Proprioceptive sensory fibers*** (and others important for motor learning) are relatively insensitive to cooling since they are large diameter myelinated fibers.

Additionally, cooling has been shown to affect the various vascular structures at all levels to the extent of causing an initial ***reflex vasoconstriction*** to occur. It is unclear what specifically causes vasoconstriction, but various reasons have been suggested. One theory is that vasoconstriction occurs in tissues in which the cold induces an increase in the firing of ***sympathetic nerve fibers*** within the tissues cooled. Another theory postulates that vasoconstriction occurs from the cooling of tissues by directly affecting the ***blood vessels*** themselves.

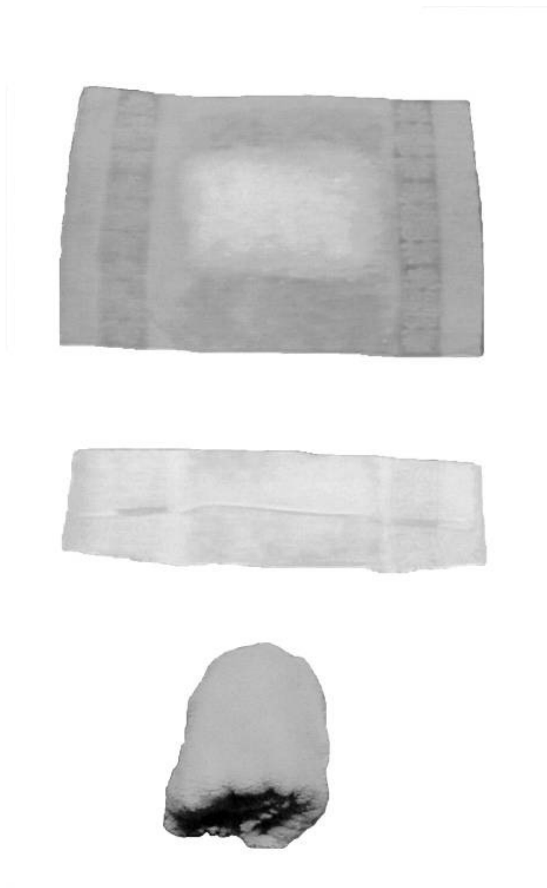
Whatever the specific mechanism may be, vasoconstriction has been shown to ***reduce*** blood flow in tissues cooled to 18°C. As cooling continues, however, and the tissue temperature reaches 2°C, ***vasodilation*** occurs in a physiological attempt to ***increase*** blood flow and thereby prevent tissue damage. This phenomenon is called the ***Hunting Reaction***.

Cryotherapy is most commonly applied as ice packs or ice bags (frozen hydro-collators or commercial ice packs).

An ***ice bag*** may be created by putting ice in a plastic bag or by freezing a moistened hydro collator. Commercially prepared chemical-ice packs or bags are also available. A ***damp towel*** should be wrapped around the ice bag to ***prevent*** any part of it from directly touching the unprotected skin. The towel-covered bag or commercial pack is then placed over the treatment site. Ice bags or commercial packs are not as cold as the ***crushed-ice pack***, and should remain in place for 30 minutes or until sensory analgesia (temporary local anesthesia) of the skin is produced.

**Application:**

- Spread out a towel on a flat surface.
- Arrange a one-inch thick layer of crushed-ice (enough to cover the treatment site) in the middle of the towel.
- Fold the long edges of the towel to overlap one another and the ice.
- Roll up the ends of the towel toward one another to make handling easy.



Making an ice pack

- Before applying to the treatment site, moisten the side of the ice pack that will touch the skin with water.
- Unroll the ice pack in place over the treatment site.

- In common use (for the normal subject who is not allergic to cold), the crushed-ice pack should ***not*** be left in place longer than ***10 to 12 minutes*** or but can be removed earlier if local anesthesia has occurred.

***Cryotherapy*** has been shown to be extremely valuable when applied in combination with other modalities. Ice packing, for example, may be used together with heat in the form of ***contrast packs*** to ***increase capillary bed circulation*** and to reduce joint stiffness. The hot pack should last for 10 minutes followed by a three-minute ice pack. The heat should then be reapplied for four minutes followed by another three-minute ice pack; this process should be repeated for a total treatment time of 30 minutes.

Research has demonstrated that the cooling of a joint results in vasoconstriction and a ***decrease*** in interarticular temperature. This has the effect of ***slowing*** enzyme action and its destructive action. It has also been demonstrated that cryotherapy applied over the area of an over-stretched ligament may ***increase*** edematous swelling in the general area but decreases the edema around the injured ligament.

Cryotherapy has been shown to have a rather dramatic effect on soft tissues because of the physiological responses it provokes. As a result, it has become a valuable tool for the treatment of various physical dysfunctions.

**Precautions:**

Adverse effects of ice packing are rare, but some of the symptoms that may be associated with ***abnormally high histamine production*** triggered by cooling include ***cold urticaria***, ***erythema***, ***itching***, ***sweating***, and ***shortness of breath***. More severe symptoms may develop including ***syncope***, ***tachycardia***, ***extra systoles***, ***dysphagia***, ***abdominal cramping*** or ***diarrhea***. These symptoms may occur during therapy or soon after, but they have been known to appear several hours later.

***Cold hemolysins*** and ***agglutinins*** produced in abnormal amounts in response to tissue cooling may produce significant ***anemia***, ***malaise***, ***chills***, ***fever***, ***paroxysmal cold hemoglobinuria of the kidney***, or the dermal symptoms of ***cold urticaria*** or ***ulcerations***.

Abnormally ***high cryoglobulin*** production in response to cooling may produce ***chills*** and ***fever*** and may adversely affect vision and hearing (***blindness or deafness*** in the extreme). It may cause ***conjunctival hemorrhages*** and ***epistaxis***, ***anemia*** with ***fibrinogenopenia***, ***elevated sedimentation rates***, and ***abnormal numbers of cryoglobulin inclusion cells***. Other symptoms include ***itching***, ***purpura***, ***cold urticaria***, ***ulcerations*** and necrosis, ***dyspnea***, ***stomatitis***, ***melena***, and ***bleeding of the gums***.

Cryotherapy may be **contraindicated** for open wounds. The use of a cryotherapeutic application should be based on the extent, nature, depth of the wound, and the ***chances of contamination***. Advantages must be weighed against the risks. For example, there is little risk and a great deal of benefit to be gained by cooling a freshly contused area, in spite of the presence of a shallow wound. It may be helpful in slowing or stopping bleeding if a ***dry sterilized ice bag*** is used or if the treatment site is protected from the touch of any water (a plastic bag may be helpful). However, cryotherapeutic applications may further damage involved tissues if the wound is deep or the ***vasocirculation*** in the area is ***impaired*** through application.

### *References:*


A.E. Grant, "Massage with Ice (Cryokinetics) in the Treatment of Painful Conditions of the Musculoskeletal System," *Arch Phys Med & Reh*, vol. 45, May 1964. Pp. 233-238

L.R. Haldovich, W.J. Personius, H.P. Clamann, R.A. Newton, "Effect of Fluori-Methane Spray on Passive Hip Flexion," *Physical Therapy*, 61:2, February 1981. Pp. 185-190

D.J. Johnson, S. Moore, J. Moore, R.A. Oliver, "Effect of Cold Submersion on Intramuscular Temperature of the Gastrocnemius Muscle," *Physical Therapy*, 59:10, October 1979. Pp. 1238-1242

M.A. Kowal, "Review of Physiological Effects of Cryotherapy," *JOSPT*, 5:2, September/October, 1983. Pp. 66-73

J.F. Lehmann, *Therapeutic Heat and Cold*, Williams and Wilkins, Baltimore, Md., 1982. Pp. 563-602

S. Michlovitz, S.L. Wolf (Ed.), *Thermal Agents in Rehabilitation*, F.A. Davis, Philadelphia, Pa., 1986. Pp. 73-97, 263-275, 277-294

F.B. Moor, S.C. Peterson, E.M. Manwell, M.F. Noble and G. Muench, *Manual of Hydrotherapy and Massage*, Pacific Press Publishing Association, Mountain View, Ca., 1964.

A.J. Murphy, "The Physiological Effects of Cold Application," *Physical Therapy Review*, 40:2, 1960. Pp. 112-115

R.A. Newton, "Effects of Vapocoolants on Passive Hip Flexion in Healthy Subjects," *Physical Therapy*, 65:7, July 1985. Pp. 1034-1036

C.F. Simpson, "Heat, Cold, or Both," *American J Nursing*, February 1983. Pp. 270-272

L.P. Taylor, T. Hui, *The Taylor Technique of Soft Tissue Management, Inflammation: Evaluation & Treatment,* 2002. Pp. 34-43