# Cold & Heat Therapy, by Patrick Herbots, DVM

COLD & HEAT THERAPY
EFFECTS

A. Vasoconstriction
B. Hypo metabolism
C. Decreased nerve conduction velocity
D. Anti-inflammatory effect + analgesia
E. Influences swelling
F. Cold decreases muscle-spindle sensitivity to stretch thereby reducing muscle spasm.
G. Increased collagen stiffness

INDICATIONS

A. Musculoskeletal trauma
B. Pre/post operatively
C. Pain secondary to muscle spasm
D. Limitations to motion secondary to pain and oedema

CONTRA-INDICATIONS

A. Cold hypersensitivity
B. Decreased sensation. The animal with this condition may be at risk of tissue damage as it may be unable to sense discomfort
C. Previous frost bite to the tissues
D. Over an area of compromised circulation

GENERAL CONSIDERATIONS

A TIME OF APPLICATION
B LENGTH OF APPLICATION
C ANATOMICAL SITE
D CONDITION OF THE TISSUE
E COMPRESSION

DIFFERENT MODALITIES TO USE

- COLD WATER HOSE
- TUB, WHIRLPOOL, TURBULATED BOOT
- COMMERCIAL COLD PACKS
- ICED TOWEL, GEL WRAPS
- ICE MASSAGE
- HOME MADE ICE PACKS
- CONTINUOUS COOLING

## EFFECTS CONTRIBUTED TO COLD TREATMENT

### LOCAL VASOCONSTRICTION

It is generally assumed that cryotherapy causes small blood vessels on the body surface to constrict. This effect may help reduce haemorrhage and oedema. Controls bleeding and reduces the release of chemical mediators.

### LOCAL VASODILATATION

Following initial vasoconstriction, vasodilatation occurs (HUNTING REACTION). This appears to be a protective mechanism to maintain viability of body tissues at low temperatures. If cold treatment cools local tissues to 18°C for long enough to interfere with sympathetic nerve conduction, vasodilatation may occur. When tissue temperature falls below 18°C, the initial reduction of blood flow is followed by a compensatory increase in blood flow. This appears to be due to dilation of muscle blood vessels. Reflex vasodilatation was not recognized after 30 min of cold therapy at 4°C, when applied to the equine metacarpus ( T Turner)

The Hunting reaction occurs at intramuscular temperatures of 7 to 10°C.

### HYPOMETABOLISM

Decreased local cellular metabolism can minimize the damage caused by tissue hypoxia The decrease in inflammatory response seen after cold application is enhanced due to decreased tissue metabolism, which limits secondary tissue damage due to hypoxia. For example, enzymatic activity in the knee joints of human patients with rheumatoid arthritis increases 4 times with an increase in temperature from a normal 33°C to 36°C. studies have shown that metabolic enzyme activity is decreased by about 50% when the temperature is lowered by 10°C.

Immersion in a water bath of 18°C for 30 min, in one study found on the human forearm, delivers an intramuscular temperature of 27°C.- the ideal for maintaining maximal muscle tension. At higher temperatures, rapid accumulation of metabolites brings on fatigue. Below an intramuscular temperature of 27°C, decrements in neuromuscular transmission and an increase in muscle viscosity result in reduced performance.

DECREASED NERVE CONDUCTION VELOCITY has been documented as a result of cold application. This is thought to contribute to the reported analgesic effects of cold. Cold impairs the conduction of afferent sensory input resulting in pain reduction.

### PAIN-ANALGESIA

Painful inflammation often inhibits normal neuromuscular function and can result in decreased tissue extensibility, range of motion and strength.

The decrease in nerve conduction velocity appears to be proportional to the decrease in tissue temperature. The application of cold also appears to act as a counter irritant

producing a shower of nerve impulses that makes receptors momentarily refractory to pain impulses + interference with the gait control pain mechanism or release of endorphins. Patients who previously had felt pain relief from rheumatoid arthritis of the knee through the use of cold packs, found that they no longer felt pain-free after administration of naloxone. This indicated that endorphins play a role in cold-mediated pain relief.

One study found only a 3 min duration of analgesia after ice massage. Analgesia occurs at surface temperatures of 10 to 15°C.

## ANTI-INFLAMMATORY EFFECTS

It is believed that cold reduces inflammation by inhibiting histamine, neutrophil activation, collagenase activity and synovial leucocytes. When tissue insult occurs, there is an immediate chemical reaction produced by the injured cells, release of histamine, bradykinin and prostaglandines. Early in the process, water, dissolved electrolytes and protein leak from the damaged capillaries. Later, leukocytes migrate through the capillary to remove damaged tissue or kill bacteria. During this process, large amounts of fluid and protein can leak into intercellular spaces, forming edema.

## EDEMA

Management of initial swelling and control of deleterious effects on neuromuscular function is important in minimizing recovery time from soft tissue injury.

The combined effects of muscle activity and cold can reduce edema.

Increased swelling was shown with the application of cold for treatment. Increased subcutaneous swelling may be due to the fact that cutaneous veins and arteries appear to react differently to cold, with veins staying constricted at lower temperatures. It should be noted that many clinical studies related to the use of cold in humans do not indicate increased swelling following application of cold, perhaps because first aid combines cold with compression and elevation. Most of the conditions in which cold is employed as therapy in the horse also use bandaging as an adjunct to treatment and swelling after the application of cold is not reported. Each time the application of cold therapy is followed by a compression wrap, to eliminate further edema formation.

## REDUCED MUSCLE SPASM

Cold decreases activity of the muscle spindle, which in turn decreases muscle spasticity. Motor performance is affected by temperature with a critical temperature being around 18°C. Brief surface treatments have little effect in cooling interior temperatures. Some papers reported a period of 25 min before intramuscular tissue dropped 1°C. On the other hand, intramuscular temperature continued to fall for up to 10 min after the application of cold has been discontinued. Joints cool more slowly than muscles.

## INCREASED COLLAGEN STIFFNESS

The use of cryotherapy is considered contraindicated in humans prior to exercise because the increased collagen stiffness results in a decrease in muscle flexibility.

GENERAL CONSIDERATIONS

- If cold therapy is recommended, begin the initial application as soon as possible. The first 24-48 hrs are key.
- Repeat cold therapy every 4-6 hrs within the first day.
- Apply ice for approximately 15-30 min at a time until heat, swelling and pain are reduced.
- Cold application for more than 30 min can have detrimental effects, including neuronal and cellular damage.
- APPLICATION OF ANY ICE PACK SHOULD BE OVER A LAYER OF FABRIC TO PROTECT THE SKIN AND THE ICE PACK SHOULD BE COVERED WITH A WET TOWEL FOR INSULATION. Ice which is applied at a temperature of 0°C, has the potential to injure tissue. Use a damp cloth or sheet cotton as a buffer, between the ice pack and the horse's skin, to protect the tissue and dissipate the cold.
- Chemically activated cold packs may require more layers of fabric to buffer the skin and prevent frostbite.
- Be careful, not to bandage the leg too tightly or create any pressure points If possible, place a compressive bandage on the area between treatments, to prolong the benefits and help reduce swelling.
- Use a thermometer to check skin temperature during application.
- Get veterinary help if the lameness lasts longer than 1 day without significant improvement.

TIME OF APPLICATION

Cryotherapy initiated on the day of injury (day0) allowed for an earlier resumption of full activities than did cryotherapy begun at day 2.

The authors suggest that we should not drop the core temperature of the tissues below 15°C.

LENGTH OF APPLICATION

Optimum duration of cold therapy is from 20 to 30 min.

Investigators using scintigraphs ( bone scans) were able to show that the topical application of ice for 20 min, decreased skeletal blood flow in the human knee by an average of 19.3% and soft tissue blood flow by 25.8%.

One study found decreased blood flow during the 25 min of cold application and for 25 min after removal of the ice packs.

The effect of cooling down tissues will be different, depending from to location and underlying tissues to be cooled. (Muscle/Canon bone/tendons).

ANATOMICAL SITE, WHERE THE PACK IS APPLIED

This relates to the vascularity of the targeted tissue. As a general rule , the skin cools first, followed by the subcutaneous tissue. Both cool before joint and muscle, with the former cooling more slowly than the latter and the effects of cold being less pronounced in either muscle or joint than in the skin or subcutaneous tissues, although they tend to persist longer. Most studies indicate that muscle temperature continues to drop after the cooling modality has been removed.

THE CONDITION OF THE TISSUE

Temperatures in sheep thighs did not fall as much after trauma as they did in pre-trauma experiments.

THERAPEUTIC COLD

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1 S Hamilton, Canine rehabilitation: An overview of physical modalities, The North Am Vet Conf, 2003, 46-49
2 TA Turner, Effects of topical therapeutic modalities on skin circulation in the horse, World Eq Vet Rev, 2000, 5:12, 26-29 + AAEP, 1991
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5 M Porter, Using cold therapy, The horse, 1998, July, 69-74
6 AJ Kaneps, Tissue temperature response to hot and cold therapy in the metacarpal region of a horse. AAEP proc, 2000, 46, 208-213
7 KA Hassan, Investigation of the effects of local cryotherapy on intra-articular temperature and experimentally induced synovitis in horses. AESM, 2001, Sep, 70-72
8 R Petrov, Influence of topical cold therapy on equine superficial digital flexor tendon core temperature and cell viability. AESM, 2001, Sep, 68-69

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(1) Patients treated with cold (whirlpool baths or ice packs applied 1 to 3 times daily; 15 minutes each till 36 hrs after traumatic injury), returned earlier to pre-injury activities an average of 8 days sooner than those who were treated with heat. It was found that early cryotherapy allowed patients to return to full activities sooner than late cryotherapy or early heat treatments.

(2) Thermographic control of skin temperature, 10 horses, Cold was applied with a nylon-covered gel wrap ( Dickau Eq Ther Wrap), cooled to 4°C and circumferentially applied to the metacarpal region, for 30 min. Paired t-test.:

The mean difference in temp between treated/untreated leg was 6°at t=0, the heat in the hoof also decreased 1-2°. The metacarpus remained 4.75° colder after 1hour

(6) Ice water immersion resulted in the greatest changes in tissue temperature when compared to three other thermal treatment modalities. The temperature of warm water of a hose should be closely regulated to 40-45°C using a thermometer in the warm stream. Tissue temperatures for ice water immersion and warm water hose therapy stabilized after 10 min. Commercial hot and cold packs were convenient to use, but had relatively lower changes in tissue temperatures than ice water immersion or warm water hose treatments.

Methods: Thermistor probes were implanted subcutaneously and between the superficial and deep digital flexor tendons of the metacarpal region of a limb.

*1 Ice water in a therapy boot 8lbs of ice mixed with 3 gal of cold water, 30 min,
*2 Hot water from a hose, T° regulated 42-45°C, 15 min,
*3 Commercial hot pack, 30 min,
*4 Commercial cold pack, 30 min

(7) The results of this study suggest that there is little difference in the efficacy of currently available methods for application of topical cold therapy applied to the equine carpal articulation. Materials: Crushed ice, Laminated antifreeze pouches-frozen to -20°C, Compression bandage with circulating ice-water (Ice-Horse), A 2-copartment recirculating antifreeze system (COOLsystem)

(8) In vivo: Results indicated that after 1 hour of continuous cooling, the SDFT core temperature was lowered by an average of 21.7°C, and reached a mean minimum temperature of 10.5°C+/- 3.47
In vitro: Tenocytes exposed to a one-hour cooling period at 10°C: cell viability was not significantly affected s a result of cooling.

COMPRESSION may be combined with cold to enhance its effectiveness. Compression should be applied in a distal to proximal direction. It is recommended that the animal not be left alone during this or any treatment. It may also enhance the risk of hypothermic injury if applied injudiciously. Pressure increases the efficiency of cold delivery.

DIFFERENT MODALITIES

HOSE

Cold water directed through a hose is a time-consuming and relatively ineffective method for applying cryotherapy. The water temperature is uncontrolled and might not be cold enough for the deep cooling necessary to affect the structures most often involved in sports injuries. Wet cold is thought to be more effective than using cold in a dry form.

WHIRLPOOL BOOT

Cold water immersion causes a profound decrease in tissue temperature. Crushed ice can be added to the water to increase the cold effect of the therapy. A thermometer would be useful for monitoring the temperature applied by these methods, so as to prevent tissue injury. Water immersion is the most effective of the cryotherapies. It would appear that ice-water whirlpool boots are the most effective equine cryotherapy device for the lower leg. Immersion in a water bath of 18°C for 30 min, in one study found on the human forearm, delivers an intramuscular temperature of 27°C.

COMMERCIAL COLD PACKS are malleable packs that will conform to various body parts and are stored in the freezer. The commercial cold packs seem to be the least efficient in skin cooling. Some of them are too stiff and do not conform to the horse's leg.

ICED TOWELS, GEL WRAPS

Clean towels soaked in a bucked of ice water. As the towels are applied, and begin to warm, they are replaced for a treatment time of 20 min. Intensive application of ice towels have cooled muscle 7°C at a depth of 3cm in 20 min.

Numerous products are available composed of gels that can be cooled in the refrigerator or freezer and than applied directly to the horse's limb. Although convenient, one study found that the standardized application of melting ice cooled better than did either of these methods.

ICE MASSAGE uses a block or cube of ice to be massaged over the affected tissue site for 510 min. This is an intense cold and may be uncomfortable for the animal. This is a quick way to apply therapeutic cold to small areas. A Styrofoam cup filled with water can be placed in a freezer and be peeled of before use.

Ice massage is roughly as effective, due to the pumping effect of the massage, achieving a 15.9°C drop at 2 cm in 5 min.

REFRIGERANT GEL, pre-cooled at -18°C, gave an 11°C drop in 30 min at a depth of 2 to 3 cm.

HOME MADE ICE PACKS can be prepared inexpensively and stored in a freezer.

Two parts of water to one part Isopropyl alcohol are mixed and placed into double layered freezer zip locking bags. The alcohol prevents the solution from freezing solid, keeping the pack malleable so it can conform to irregular shaped body parts.

Crushed ice placed into a zip-locking bag may also be used. Treatment time 20 min. Air spaces around the ice cubes prevent uniform cooling of the tissues.

Crushed ice and water in a plastic bag has the advantage of being able to mold to limb contours. Crushed ice appears to be more effective at cooling than do ice cubes. The colder the ice, the greater the cooling effect but the greater the potential to cause surface tissue injury.

The greater the area covered with cold, the more profound the temperature decrease. Ice packs have achieved a 14.4 drop at 3.2 cm in 45 Min.

CONTINOUS COLD THERAPY All the previous methods lose effectiveness as they are warmed by the heat of the limb. Second is that when ice is used at 0°C, there is a potential risk for tissue injury. Continuous cold application offers the additional advantage of controlling the vasoconstriction/ vasodilatation cycle that occurs with intermittent applications of cold. Continuous cold therapy from 7 to 10°C reduces pain, decreases analgesic intake and decreases swelling.

(Petrov) study to determine the cooling rate of cooling the Superf digital flex tendon (SDFT), during a 60 min application of a cooling splint ( COOLSystems) = a compression splint with circulating antifreeze. Skin surface T° was measured and one inserted into the SDFT.

CONSIDERATIONS

- When stretching is the treatment goal, stretching should begin during or immediately after heating as the effect is short lived.
- Typical treatment time is 20 min
- Depending on the heat source, one or several towels are placed between the hot pack and skin to prevent burning.
- It is recommended that anyone applying heat to animals know, first hand, what the heating experience is like, as they are then better able to gauge the animal's response.
- Typical recommendations for heat therapy are to delay application until at least 48 hrs after injury
- When using any heating modality, it is important to understand the depth of penetration of the heat produced. There is little change in skeletal muscle blood flow with superficial heating agents. Because of this, superficial heating agents should be combined with exercise to provide a deep heating effect. Only ultrasound has the ability to penetrate through the skin to the deeper structures such as joints, bursa, tendons and muscles.

SOURCES

- HYDROCOLLATOR HOT PACKS; These cotton packs contain a gel that absorbs heated water and becomes soft, these packs can become very hot 5060°C, so they must be wrapped in towels before application. By soaking the sleeve before inserting the heat pack, moist heat is provided. It has been shown that dry heat can raise surface temperatures to a greater degree, but moist heat can penetrate to a slightly deeper level of tissue.
  At least one layer of heavy toweling should be used between these packs and the animal and another layer should be used to cover the pack to delay its cooling.
- NYLON-COVERED GEL WRAP
  (TA Turner) The wrap was heated to 40°C and applied circumferentially to the metacarpal region and was left in place for 30 min. The gel wrap tended to decrease in temperature over the 30 min application. This decrease was averaged 6°C. The heat-treated leg was 5°C warmer than the control leg. The heat application also increased the hoof temperature by 1.7°C. The metacarpal region rapidly cooled and the difference between tr/untr legs at 15 min after gel wrap removal was 2.7°C. At 30 min: 2.8°C.
- SINGLE LEG WHIRLPOOLS A iodine concentrate added to the water will reduce the possibility of transmitting infections and aid in cleansing abraded skin. Of course, the horse should be as clean as possible and the whirlpool boot should be disinfected before use. A thermometer to monitor water temperature is essential for safety and effectiveness of hydrotherapy. The water temperature should be between 40-45°C. If a tank is used, it must be plastic or rubber, never metal, to avoid shock hazard. The motor should be grounded and protected with a ground fault interrupter at the wall plug. The danger of shock from ungrounded metal whirlpools is great.
  For muscle soreness, try adding two cups of EPSOM Salts to a bucked of warm water. Soak towels in the water, wring them out and place them on the sore area.

The magnesium in EPSOM salts is an excellent muscle relaxant and sedative for the nervous system.

- MICROWAVEABLE HOT PACKS
- INSTANT HEATING PACKS
- ULTRASOUND FOR DEEP HEATING. Therapeutic ultrasound can be used to increase tissue temperature at depths ranging from 3-5 cm, without overheating the skin and superficial tissues. Sound waves create rapid oscillations that disrupt collagenous fibers and increase cell metabolism. Ultrasound combined with stretching exercises can elongate contracted fascia and reduce the restrictive effects of scar tissue.
    - (TA Turner) The horses were clipped between the carpus and the fetlock, moving strokes for 10 min, over the flexor tendon region. 0.5 ; 1.0 ; 1. 5W/cm2. 0.5 W/cm2: within 45min there was a temperature increase which peaked at l hr and cooled to no difference at 2hrs. 1.0W/cm2: Peak at 45min.
    - (U Smolenski) Knee, 0.6 W/cm2, 6 min, dynamic, 6.4cm2 us head, continuous or pulsated.
    - (D Levine) 1.OW/cm2, 1.5W/cm2, for 10 min over 10 cm2, US head = 5 cm2 Needle thermistors below the skin surface at depths of 1, 2, 3 cm Results: 1 W/cm2: T° rise/ lcm = 3°C , 2cm = 2.3°C, 3 cm= 1.6°C 1.5 4.6 3.6 2.4 Tissue temperatures returned to baseline within 10 min after treatment.
    - (JE Steiss) ultrasound treatment applied through an intact coat considerably warmed the coat with loss of thermal effects in underlying tissues. So, coat can impede successful use of ultrasound treatment of dogs.
    - In the few cases where the MAGNET-treated limb temperature was greater than the placebo temperature rise, the difference was not statistically significant.

SUPERFICIAL HEAT

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(1) AA Worster, Effects of external thermal manipulation on laminar temperature and perfusion scintigraphy of the equine digit, New Zealand J, 2000, 48, 111- 116
(2)TA Turner, Effects of topical therapeutic modalities on skin circulation in the horse, World Eq Vet Rev, 2000, 5:12, 26-29 + AAEP, 1991
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(4)U Smolenski, Gewebetemperatureanderungen unter application von Ultrashall und Kurzwelle in der Gelenkregion, Z.Physiother, 1989, 41, 269-273
(5)D Levine, D Millis, Effects of 3.3-MHz ultrasound on caudal thigh muscle temperature in dogs, Vet surg, 2001, 30, 170-174
(6)JE Steiss, Effect of coat on rate of temperature increase in muscle during ultrasound treatment in dogs, AJVR, 1999, 60:1, 76-80

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- (1) The foot to be treated was either bathed in ice water at a temperature of 4°C, or hot water at 47°C, for 30 min. Each foot was immersed to a depth of one cm proximal to the level of the coronary band.

EFFECTS

A. Increases tissue temperature up to 3cm of depth.
B. Increase metabolism of target tissues.
C. Increases blood flow to the area, improving oxygenation and toxin removal.
D. Increases tissue extensibility, thus decreasing joint stiffness and facilitating elongation of tendons if applied during stretching exercises.
E. Decreases pain sensation.
F. An increase in cutaneous blood flow will promote wound healing.

Used in the subacute and chronic phases of healing, moist heat can improve circulation thereby increasing local metabolism, resulting in improved oxygenation and toxin removal. Tissue extensibility can be improved as a result of local heating; heat is an excellent precursor to stretching.

The thermal effects of superficial heat reaches a depth of up to 3cm. If heating of tissues deeper than 3cm is indicated, therapeutic ultrasound should be considered, as it can affect tissues up to a 5 cm depth.