HOT AND COLD
Therapy in rehabilitation includes modalities such as whirlpool immersion (above), cold compression, and more.
Theromotherapy is an umbrella term for the therapeutic application of heat or cold. In physical rehabilitation, heat and cold are used as superficial therapeutic agents in the treatment of soft tissue and musculoskeletal injuries to facilitate the ultimate therapeutic modality of exercise.1

**MAIN ROLE OF THERMOTHERAPY IN PHYSICAL REHABILITATION**

Physical rehabilitation includes returning patients to a maximum quality of life and function using a combination of physical, electrical, and thermal treatment. Superficial thermal modalities are often among the first measures used in a rehabilitation treatment plan. The role of thermotherapy is to reduce inflammation, mitigate adverse secondary inflammatory effects, and reduce associated pain before and/or after exercise. When used appropriately, thermotherapy allows the patient to achieve higher-quality exercise before, during, and after the rehabilitation session.2,3

**ACUTE AND CHRONIC INFLAMMATION**

When choosing a superficial thermal modality, it is important to understand the stage of tissue

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**FIGURE 1.** Canine patient with acute inflammation after tibial plateau leveling osteotomy.
inflammation being treated. Inflammation is vital in the protection and healing of the body, but if left untreated, it can lead to long-term detrimental effects on tissues and organs. The 2 stages of inflammation are acute and chronic (BOX 1). Both types can cause pain and can greatly affect a patient’s ability to participate in exercises that involve any range of motion, thus negating the main goal of improved quality of life and function.

Acute inflammation occurs after injury and is followed by an immediate release of chemical mediators that trigger changes in microcirculation, alerting the immune system to send more white blood cells and fluid (blood flow) to the affected area. This response causes impaired circulation and secondary muscle spasm resulting in redness, swelling, edema, and pain (FIGURE 1). The acute inflammatory period can last several days, then overlap with subacute inflammation, which can last 2 to 6 weeks before the inflammation becomes chronic.

Chronic inflammation is a slow, long-term, or prolonged period of inflammation lasting for months to years and has little physiological survival advantage if left untreated. In chronic inflammation, the increase in white blood cells and vascular fluid triggered during acute inflammation continues beyond the expected healing time and starts to cause deleterious tissue changes (FIGURE 2). Neutrophils start to be replaced by increased numbers of primary inflammatory cells (macrophages, lymphocytes, and plasma cells), which contribute to further breakdown of healthy tissue and reparative abilities, resulting in permanent damage and ongoing pain to tissues and/or organs.

**PHYSIOLOGIC RESPONSES TO THERMOTHERAPY**

Cold therapy (cryotherapy) and heat therapy each have different effects on the body (BOXES 2 AND 3). By stimulating peripheral nerve receptors, heat and cold alter tissue temperatures, leading to the modification of local circulation and promoting positive biochemical reactions in the tissues. Effects of heat and cold range from changes in blood flow, tissue metabolism, inflammatory properties, and connective tissue properties.

Tissues are affected by thermotherapy in 3 main ways: changes in blood flow, reduction of pain, and changes in tissue metabolism. All 3 effects are interrelated.

**Blood Flow Changes**

Changes in blood flow are caused by vasoconstriction or vasodilation and affect tissue healing. Vasoconstriction, which occurs during cryotherapy, reduces hemorrhage and edema formation during the acute inflammation period. Vasodilation, which occurs during heat therapy, supports tissues during subacute and chronic phases of inflammation by helping remove tissue metabolites and increasing the metabolic rate,
leading to accelerated tissue healing and protection. These changes in blood flow start a chain reaction in the tissues, leading to reduction of pain and changes in tissue metabolism.1-3

Pain Reduction
Thermotherapy reduces pain primarily through what is described as the gate control theory of pain. The pain pathway involves 3 different neuronal paths, starting with stimulation of sensory nociceptors (a type of pain receptor located in the skin, muscles, joints, bones, and viscera), continuing with pain transmission to the dorsal horn of the spinal cord (DHSC), and ending in the brain. The gate control theory essentially explains how this pathway can be “blocked” by 2 or more types of receptors.

In the case of thermotherapy, the receptors involved in the pain pathway are nociceptors, thermoreceptors, and mechanoreceptors. The type of receptor used to “close the gate” depends on the superficial thermal modality used. For example, a painful stimulus (e.g., inflammation from injury) causes nociceptors to transmit a pain signal to the DHSC via both unmyelinated and thinly myelinated neurons (C fibers and A-δ fibers, respectively). Once in the DHSC, the pain signal synapses with a second neuronal pathway leading to the brainstem and then again to the final pathway, on its way to the cerebrum. Application of heat or cold stimulates thermoreceptors and/or mechanoreceptors (touch receptors, such as highly myelinated A-β fibers), which use a different neuronal pathway that also sends signals through the DHSC on its way to the brain. These signals stimulate interneurons that then send inhibitory substances, such as γ-aminobutyric acid (GABA), into the synapse and block nociceptive signals on the way to the brain, thus helping to close the gate.3,8,9

Cryotherapy uses the gate control theory of pain by overstimulating cold receptors, relieving pressure on the nociceptors through vasoconstriction, and decreasing nerve conduction velocity through a decrease in temperature.1-3 All 3 of these effects initiate pain control in the DHSC and reduce transmission of pain signals to the brain.1,3 Cryotherapy thus increases pain threshold and tolerance, allowing for a potential decrease in analgesic medications.1

The gate control theory of pain can also help explain pain management during local application of heat. Local heat therapy increases nerve conduction velocity, but the clinical implications of these effects are not well understood. In the gate control theory, the heat receptors specifically target and increase activation of large, non-nociceptive A-β fibers to block the transmission of pain signals carried by the A-δ and C fibers to the brain.1

BOX 2

Examples of Continued Effects of Cryotherapy1-3,7

- Vasoconstriction/edema formation
- Reduced tissue metabolism
- Decreased sensory and motor nerve conduction velocities
- Reduced muscle spasm/tissue extensibility
- Decreased histamine release
- Increased connective tissue stiffness
- Increased temporary muscle viscosity
- Increased activation threshold of tissue nociceptors

BOX 3

Examples of Continued Effects of Heat Therapy1,3

- Vasodilation
- Increased oxygen uptake/transport
- Accelerated tissue healing
- Increased activity of destructive enzymes such as collagenase
- Increased catabolic rate
- Decreased muscle spasm
- Decreased pain
- Increased capillary pressure and permeability
- Leukocyte migration into heated area
- Increased local metabolism
- Muscle relaxation
- Increased tissue elasticity, extensibility, and range of motion
Tissue Changes

Tissue metabolism refers to the balance of anabolic (building up) and catabolic (breaking down) activity of cells carrying energy and oxygen to the tissues. 10 Cryotherapy decreases the rate of metabolic effects, slowing the delivery of inflammatory mediators and reducing the release of histamine, thereby resulting in less tissue damage. 2, 3 When heat therapy is applied to the skin, cutaneous thermoreceptors release chemical mediators (histamine, prostaglandins, and bradykinin), which cause an increase in catabolic rate, capillary permeability, and lymph and blood flow (vasodilation). 1

Heat therapy has the important physiologic benefit of decreasing tissue stiffness or contracture. Heating of local tissue decreases muscle spindle activity and relieves muscles of ischemia, a condition resulting from inadequate blood supply caused by chronic muscle contraction. Relieving ischemia results in reduced muscle spasm, an increase in tissue extensibility, and muscle relaxation. This local effect is important for veterinary nurses performing manual therapy techniques such as passive range of motion or therapeutic massage because it relaxes the muscles, allowing the therapist to gain a greater stretch of the patient’s muscles with less force and less risk of tissue damage. Applying heat before exercise also helps the patient retain improvements in joint range of motion even after the tissue has cooled. 1

DECIDING WHICH MODALITY TO USE

Once the physiology behind the effects of thermotherapy is understood, the application of thermotherapy may be explored. Superficial thermal modalities have an array of uses and multiple application methods. There are 3 main questions to ask when deciding whether cold or heat would benefit a specific patient:

- What condition is being treated (e.g., injury, surgery)?
- What is the expected healing timeframe of the injury, surgery, or condition?
- Does the patient have any secondary comorbidities associated with this injury, surgery, or condition?

The condition being treated, where it is located, and when it occurred will determine where and what kind of treatment is needed. Therefore, “what and where” questions are important to ask the clinician as they give insight into the patient’s condition and what has been done or is being done to treat it. This information is pivotal in choosing which superficial thermal modality to use and how to best facilitate the application to achieve the optimum effect. During the acute inflammatory period, cryotherapy is indicated; in the subacute or chronic inflammatory period, thermotherapy is indicated (BOX 4). Cryotherapeutic modalities may also be used after exercise to mitigate adverse secondary effects and reduce acute pain and inflammation. 1, 3

As a general rule, cryotherapy should only be used during the first 24 to 72 hours after acute injury or when acute inflammation is present. Heat therapy modalities should only be used during subacute and chronic periods of inflammation (e.g., no earlier than 48 hours after an injury) or when pain due to stiffness or contracture is present. 1, 3

As a safety precaution, veterinary nurses should always ask the owner and/or clinician if there are any secondary conditions. As with any modality used in rehabilitation, there are concerns and contraindications associated with cold and heat therapies. Even though treatment is local, the patient’s entire history, including secondary conditions, should be known in order to decrease the risk of adverse reactions to thermotherapeutic treatments.
PRECAUTIONS AND CONTRAINDICATIONS OF THERMOTHERAPY

Cryotherapy
Precautions and contraindications of cryotherapy include potential causes of altered thermal perception, such as frostbite or a history of frostbite, generalized vascular compromise, an inadequate thermoregulatory system (e.g., very young or old patients), and decreased or absent sensation due to anesthesia, neuropathy, or other causes. The level of tissue sensation should be checked prior to applying cryotherapy, and special precautions should be taken to avoid areas with redness, burns, scabs, or wounds, as cold perception may be altered in these locations.

The area of application should be clean, and when treating a postsurgical site, a protective barrier such as a thin towel should be placed between the skin and the cryotherapy agent to avoid infection. After 5 minutes of cryotherapy application, the patient’s skin should be checked for areas of redness or blanching to ensure no damage is being sustained.

The therapist should pay special consideration to the baseline temperature of small, very young, or older patients and patients coming directly out of surgery before cryotherapy applications. These patients may not be able to receive cryotherapy for a full 10- to 20-minute application period or may already be hypothermic due to anesthesia/surgery. If hypothermic from surgery, it is recommended to wait until the patient’s baseline temperature has stabilized before applying cryotherapy. If the patient is small, very young, or old, the therapist should continue to check the patient throughout the treatment for indicators of hypothermia, as these patients may have a harder time thermoregulating.

Heat Therapy
Heat therapy applied too early in the inflammation period or healing process may result in increased inflammation that can be detrimental to the tissues, promote enzymatic activity detrimental to cartilage (collagenase and gelatinase), and increase local tissue metabolism. Special precautions should be taken during local application of heat in patients with bleeding disorders due to heat’s ability to vasodilate. Other conditions that may be contraindications for heat therapy include pregnancy, acute inflammation period, fever, cardiac insufficiency (e.g., older patients with decreased cardiovascular and respiratory reserves), malignancy, and poor body heat regulation.

The patient’s skin should be closely monitored during heat therapy by checking for damage every few minutes, and a barrier should be used between the thermal modality and skin to avoid burns. An electric heating pad should never be placed over or under a patient, especially if the patient is sedated or anesthetized or has reduced superficial skin sensation, as it increases the risk of burns.

APPLICATION OF THERMOTHERAPY

Equipment used to apply superficial thermal modalities

FIGURE 3. Crushed ice pack with a potty pad to be used as a protective layer for skin during cold therapy.

FIGURE 4. Example of a hot or cold gel pack.
comes in a variety of shapes, sizes, and types (BOX 5). Heat and cold packs are very convenient treatment options that are usually readily available, easy to use, and safe (FIGURE 4).2 When deciding which application medium to use, the size of the patient, the location being treated, and patient tolerance of treatment must be considered for the best therapeutic outcome.7

Application methods are chosen based on stage of tissue healing, size of tissue area, depth of penetration desired, and physiologic goals. As desired therapeutic goals are reached, changes in modality may be necessary. For example, cryotherapy can be used during the acute inflammatory period in a patient that is recovering postoperatively from a tibial plateau leveling osteotomy. After 48 to 72 hours, the proliferative subacute and chronic inflammatory period begins, which changes the status of the tissue’s healing process, making heat therapy the modality of choice. With each application of cryotherapy or heat therapy, it is important that the patient be thoroughly reevaluated at predetermined intervals as the tissue status changes.1

Local Cryotherapy
Cold packs can be manipulated to fit different parts of the patient, are reusable, and come in a variety of sizes.3,7 Their application causes positive local tissue changes with minimal side effects to the surrounding tissues, and their effects can reach tissue depths of approximately 1 to 2 cm depending on the duration of treatment and application method.3

Cold packs are easily made with items that many clinics have on hand, such as crushed ice placed in a plastic bag (FIGURE 5), frozen gel packs, and water-alcohol slushies. For ice massages, water can be frozen into paper or plastic cups. Special reusable cups are also commercially available and have the benefit of being thicker than paper cups, making the pack less cold in the therapist’s hand and slowing the rate of ice melting during application.

Treatment time for cold pack application is typically 10 to 20 minutes starting directly after injury or surgery; this application may be repeated every 2 to 4 hours throughout the acute pain and inflammation period, typically up to 72 hours. The application of a cryotherapy pack should never exceed 30 minutes, as local hypothermia can damage tissues and cause unwanted local vasodilation and edema formation.1,3 Ice massage treatment time, however, is typically only 5 to 10 minutes. The treatment area becomes slightly pink and numb much more quickly compared with...
cold pack application, and the direct pressure and massaging action of the ice cup alter local blood flow to reach increased tissue depths, increasing the risk of tissue damage if applied for prolonged periods.

Cold compression units are ideal for treatment during the acute stage of postoperative healing to help minimize pain and swelling. These units usually consist of an inflatable wrap with either a cold pack or cold water circulating inside, along with a pump regulating the amount of pressure during treatment (FIGURE 6). The temperature of the water circulating through the wrap can be set between 35°F and 50°F (2°C to 10°C), with varied treatment cycle times to choose from in programmed settings. Commercial compression units typically have specifically designed wraps to fit animals and programmable settings for the patient or condition and require a moderate financial investment.¹,³,⁵

**Local Heat Therapy**
Therapeutic heat packs can be made by soaking a towel with warm water and placing it in a plastic bag; microwaving a fabric bag containing dry rice, cracked corn, or beans; or microwaving gel packs. Treatment time for heat pack therapy is generally between 15 and 20 minutes with a maximum treatment time of 30 minutes, depending on the severity of injury, location, and stage of tissue healing being treated. Heat packs work best when applied before or during other physical exercises such as joint range of motion exercises, stretching, or massage. Heat therapy should only be applied during the subacute and chronic inflammatory phases, and no earlier than 48 hours after injury or a surgical procedure.¹,³

**Immersion Therapy**
Water baths and whirlpools are also a great way to achieve the positive effects of heat and cold therapy beyond local tissue application. Unlike cold and heat packs that produce local tissue changes, water baths and whirlpool therapy can affect large parts of or the whole body through immersion.

During cold water immersion, the patient stands with only the affected limb or target tissue in the water. This
type of cooling results in the greatest decrease in tissue temperature. The typical water temperature ranges from 35°F to 60°F (2°C to 16°C), and the duration of treatment is 10 to 20 minutes. Cold immersion therapy may be difficult to implement depending on patient compliance and should not be performed if the patient has any wounds, as it may increase the risk of infection or delay healing.  

Warm water therapy is a great way to apply superficial heating to tissues. Warm water whirlpools are specifically helpful for their hydrostatic pressure effects on immersed tissues, causing an increase in lymphatic and venous flow that may result in decreased edema and promote the removal of lactic acid produced during exercise. Whirlpools can also be beneficial for patients with chronic inflammation such as osteoarthritis, as multiple areas of the body can be treated simultaneously (FIGURE 7). The temperature of the water is usually between 80°F and 95°F (27°C and 35°C), while treatment time varies depending on patient size, condition being treated, and expected therapeutic outcome. Whirlpool therapy can decrease blood pressure, increase heart rate via vasodilation, and potentially cause an increase in overall core body temperature (when large portions of the body are submerged); therefore, appropriate precautions should be taken for individual patients.

CLIENT EDUCATION

Client education is arguably one of the most important jobs a veterinary nurse has as an advocate for the patient to ensure it stays safe and healthy during prescribed home treatments. It is important to talk with the client about which modality to apply, how to use it, how long to use it, and why that modality was chosen. Descriptions of different precautions and how to evaluate the pet for indicators of pain will help prevent accidents and injury during home treatment sessions. Sending the client home with written information is important, as they may forget what has been explained during discharge. In some instances, videos may be preferred, depending on the client’s learning style. Ensuring the client has a complete understanding of the modality and its treatment increases compliance, which will help promote further healing and better quality of life at home for the pet.

CONCLUSION

Superficial thermal modalities are some of the most easily accessible, safe, and important therapies in a veterinary nurse’s toolbox. Each therapeutic modality has different physiologic effects on tissue and can greatly contribute to pain management when applied correctly. Understanding thermotherapeutic effects on tissues, when and how thermotherapy can be utilized, treatment times, and what precautions need to be taken during application are all part of achieving an optimal outcome for the patient. TVN

References
Superficial Thermal Modalities: Heat and Cold Therapy Effects and Uses

TOPIC OVERVIEW
This article provides an overview of thermotherapy modalities, including what they are, how they affect tissues, and how to choose an appropriate modality to treat a specific patient in various stages of tissue healing.

LEARNING OBJECTIVES
Upon completion of this article, readers will understand what thermotherapy is, how thermotherapeutic modalities affect body tissues, what the therapeutic benefits and contraindications of thermotherapeutic modalities are, and how and when to apply the correct modality in a clinical setting.

1. During what stage(s) of inflammation should heat be applied?
   a. Subacute
   b. Acute
   c. Chronic
   d. a and c

2. True or False: Both heat and cold therapies help with pain reduction.
   a. True
   b. False

3. Cryotherapy has what type(s) of effect on blood flow?
   a. Vasoconstriction
   b. Vasodilation
   c. No effect
   d. a and b

4. What is the typical length of time cryotherapy (cold packs) should be applied?
   a. 10 minutes
   b. 10 to 20 minutes
   c. 20 to 30 minutes
   d. 30-plus minutes

5. Benefits of heat therapy include all except
   a. Decreased stiffness
   b. Increased vasodilation
   c. Decreased oxygen uptake
   d. Decreased muscle spasm

6. Cryotherapy is contraindicated in patients with
   a. Acute inflammation
   b. Pain due to inflammation
   c. Decreased or absent sensation
   d. All of the above

7. Heat therapy can be safely applied to a patient using
   a. Heated gel pack
   b. Warm water baths
   c. Warmed towels in plastic bags
   d. All of the above

8. Warm whirlpool therapy is specifically helpful in patients with edema because of
   a. Hydrostatic pressure
   b. Buoyancy
   c. Cohesion of water molecules
   d. Temperature of water

9. The primary way thermotherapy modalities help relieve pain is explained by
   a. Numbing of the skin
   b. The gate control theory
   c. Superficial and peripheral nerves
   d. Wolf’s law

10. Client education about the use of superficial thermal modalities at home is important because
    a. It improves their pet’s quality of life
    b. It can improve the quality of physical rehabilitation exercises
    c. It helps facilitate better healing times
    d. All of the above