The Therapeutic Use of Local Heat and Cold

SUMMARY
Thermotherapy and cryotherapy are often valuable in the treatment of pain, inflammation and muscle spasm. Safe use of available modalities depends on specific knowledge of their contraindications. The choice of method requires an understanding of the physiological effects of heat and cold. The choice of any individual thermal modality depends on several factors including size of the area to be treated, ease of application, affordability, duration of application and depth of penetration. (Can Fam Physician 1986; 32:1110-1114.)

Key words: choice of thermal modality, cryotherapy, thermotherapy

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Thermotherapy and cryotherapy are often prescribed in the treatment of various musculoskeletal and neurological conditions presenting to primary care physicians. Often the indications and contraindications for their prescription are not well appreciated. The following article reviews the rationale for use of local heat and cold, based on their physiological effects and physical properties.

Indications for Thermotherapy and Cryotherapy

The commonest indications for use of therapeutic heat and cold include relief of pain, stiffness, muscle spasm and inflammation, as well as other conditions listed in Table 1. Both agents will often produce a similar clinical effect, although they may do so through different physiological mechanisms described below.

Relief of pain, muscle spasm and inflammation
The genesis of pain is often multifactorial and may include accumulation of toxic metabolites, muscle spasm, inflammation and psychological factors. The use of local heat (thermotherapy) may provide relief of pain and painful muscle spasm by acceleration of metabolic processes whereby the concentration of pain-inducing toxic metabolites is reduced. This is accomplished primarily by an increase in local circulation. Acceleration of the inflammatory response to resolution may initially exacerbate discomfort, but will shorten the time course to resolution of suppurative inflammation (e.g., abscess). Thermotherapy is generally soothing and psychologically relaxing, thereby favorably modifying emotional response to pain and further reducing painful muscle spasm.

Local cooling (cryotherapy) is often more effective in providing pain re-

<p>| TABLE 1 |</p>
<table>
<thead>
<tr>
<th>Indications for Thermotherapy and Cryotherapy</th>
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<tr>
<td>1. Relief of pain.</td>
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<tr>
<td>2. Relief of muscle spasm.</td>
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<tr>
<td>3. Acceleration of inflammatory response (heat).</td>
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<tr>
<td>4. Reduction in inflammation (cold).</td>
</tr>
<tr>
<td>5. Relief of stiffness (heat).</td>
</tr>
<tr>
<td>7. Temporary reduction in spasticity.</td>
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lie, especially in acute conditions. It acts primarily by decreasing metabolic activity and thus leads to a reduction in inflammatory response, as well as to a decrease in nociceptor excitability, nerve conduction velocity, and muscle contractility, which serves to decrease painful muscle spasm. Depth of penetration is greater with cold than with most forms of heat. Thus cold is better able to exert its physiologic effects at the painful site. Further, the volume that can be cooled is greater, and the duration of effect is more prolonged.

Application of both heat and cold have also been purported to provide pain relief by blocking transmission of pain impulses (Gait Theory).

**Relief of stiffness**

Synovial fluid viscosity is known to decrease with increasing temperature. It has been postulated that the subjective symptom of joint stiffness may be related to increased synovial fluid viscosity. Relief of joint stiffness may be provided with thermotherapy by a reduction in synovial fluid viscosity. Cryotherapy is not recommended for treatment of joint stiffness as the opposite physiologic effect is produced.

**Contractures**

The treatment of contractures may be facilitated by application of local heat, which increases tissue distensibility to allow stretching exercises to be performed more effectively and with less discomfort. From a practical point of view, however, it is often difficult to heat the contracted tissue effectively with currently available thermal modalities unless it is a small structure such as a collateral ligament of a finger. Ultrasound is able to penetrate to deeper contracted tissues, but only a limited treatment field is possible. Thus it may not be practical, for example, to heat contracted tissues about the hip as a multiple field technique would be required.

By contrast, local cooling reduces tissue distensibility and would therefore tend to make stretching exercises more difficult. This disadvantage is outweighed, however, by the superior analgesic effect which often improves patient tolerance for stretching.

**Spasticity**

Reduction in spasticity resulting from upper motor neurone disorders may be obtained with application of local heat or cold, in the former instance through psychological relaxation and more effectively in the latter through reduction in muscle spindle activity and muscle contractility. It must be emphasized that the reduction in spasticity is temporary. The major use of modalities in this instance is to facilitate range of movement and stretching exercises.

**Local Heating Modalities**

There are numerous heating modalities available. These act by conduction of heat (e.g., hot water bottle, heating pad, hot pack, paraffin wax) or by conversion to heat of electrical (short-wave, microwave) or sound (ultrasound) energy. Heat may also be provided by the combined effects of conduction and convection in a whirlpool or therapeutic pool. The choice of modality depends on various factors presented in Table 2.

**Size of area to be treated**

For those modalities requiring direct skin contact (i.e., hot water bottle, heating pad, hot pack, paraffin wax, ultrasound) the area that can be heated depends on the size of heating surface provided by the modality. Application of short-wave diathermy requires placement of the body part to be treated within an electromagnetic field. The size of the field can be adjusted to heat areas varying from the size of a wallet to a whole limb. Microwave diathermy can be used to heat areas varying from the size of a silver dollar to an 8½ inch by 11 inch page. Ultrasound has a small applicator head (2.5 cm. square) allowing for treatment of small areas only, where complete skin contact is possible, unless applied under water. Paraffin wax and infrared are the most useful modalities for heating body parts with irregular contours (e.g., hands and feet).

**Ease of application**

In a treatment centre, paraffin wax is the most involved modality to apply as it is messy, requires the use of insulating gloves, is tedious to remove, and is the least hygienic. However, it provides the best method for heating hands and feet, as it contours well to irregular surfaces.

Short-wave diathermy requires tuning the circuit to ensure that the part to be heated is within the electromagnetic field. Once the circuit is tuned, the patient must remain immobilized in that field for 15 to 20 minutes. Movement by the patient will alter the field and thus could result in a burn and/or loss of heating effect.

Application of ultrasound requires the use of an acoustic coupler (either gel or water) as well as direct application by the therapist. However, the short duration of application (2–10

### TABLE 2

Factors Determining Choice of Thermal Modality

<table>
<thead>
<tr>
<th>Size of Area to be Treated</th>
<th>Hot Water Bottle</th>
<th>Heating Pad</th>
<th>Hot Pack</th>
<th>Infrared</th>
<th>Paraffin Wax</th>
<th>Shortwave Microwave Diathermy</th>
<th>Ultrasound</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ease of Application</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>A. In a treatment centre</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>B. Use at home</td>
<td>NA</td>
<td>NA</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Affordability</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Duration of Application</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
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<td>+++</td>
<td>+</td>
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<tr>
<td>Depth of Penetration</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<td>+</td>
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</tbody>
</table>

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minutes) and its deep-heating capability make this modality valuable for the treatment of such conditions as tennis elbow (epicondylitis), plantar fasciitis, and suprascapular and bicipital tendinitis. 5, 8, 14.

The remainder of available modalities are relatively simple to use. Infrared is the easiest, but difficulty may be encountered in providing a uniform concentration of heat.

For home use, heating pads, hot water bottles and infrared lamps are easy and convenient. Hydrocollator packs (hot packs) and paraffin wax require longer preparation time. Shortwave, microwave and ultrasound are impractical for home use.

Affordability

Home use of certain modalities will be limited not only by the difficulty in application, but also by cost.

Justification for use of more expensive modalities in a treatment centre (e.g., short-wave or microwave diathermy) cannot be found in terms of providing a superior physiologic effect, although these modalities may provide greater psychological benefit. Ultrasound is also an expensive modality, but its value as a true deep heating agent justifies the cost.

Duration of application

All heating modalities except ultrasound are applied for 20 to 30 minutes in order to achieve the desired physiologic effect. Ultrasound requires an application of only two to ten minutes in view of the short time required to reach the therapeutic temperature.

Depth of penetration

Ultrasound is superior to other heating modalities in that it is currently the only true deep-heating agent capable of providing a temperature rise in structures below the superficial musculature. The value of ultrasound is somewhat limited, however, because of its small area of heating. It is the only modality, for example, that can heat the hip joint effectively, but it would be impractical to use for this purpose because of the size of the joint. Several other modalities can be heated to similar depths, but unfortunately, not without first burning the skin. There are devices which combine microwave diathermy with su-
perforal skin cooling and which will allow a greater depth and volume of heating, but these are still experimental.8

Safety of Thermal Modalities

All heating modalities are potentially dangerous and may inflict serious burns even with careful application, as the precise intensity of heat cannot be measured. Ultrasound is the only modality for which it is possible to measure intensity of output, but serious deep burns may still result from improper application unless the applicator head is moved continuously to prevent development of standing waves. Short-wave and microwave may cause electrical burns if large metallic implants are present within the treatment field.

Home use of heating pads is potentially dangerous should the patient fall asleep during application. A timer is recommended to minimize this risk.

Contraindications to Thermotherapy5, 7, 8, 11, 14

Contraindications to local thermotherapy are presented in Table 3. These are divided into general contraindications to use of heat and contraindications specific to individual modalities.

Most general contraindications are based on concern about possible burns. Infants, patients with profound sensory impairment or patients who are unable to sense increased temperature or respond to it appropriately are at increased risk, as patient feedback is the only method of monitoring intensity. Patients with impaired peripheral circulation cannot increase blood flow sufficiently to accommodate the increased metabolic demands imposed by local heating, and this inability leads to ischemia. In addition, lack of increased blood flow to carry heat away renders the patient more susceptible to burns.

Heating a fresh hemotoma (in the first 24–48 hours) is also contraindicated, as this will result in vasodilation which may cause increased bleeding. After this initial period, heating modalities may be useful in hastening resolution of the hemotoma.9

In cases of non-inflammatory edema (e.g., lymphedema) fluid-laden tissues are more susceptible to burns. In addition, an increase in hydrostatic pressure due to vasodilation may serve to aggravate edema. Traditionally, applying heat over a tumor has been contraindicated, as this has been thought to accelerate tumor growth. Recent research, however, has suggested the value of increasing temperature of tumor cells to facilitate tumor kill by chemotherapy or radiotherapy, as well as to retard growth of temperature-sensitive tumors.1

Short-wave and microwave diathermy are contraindicated in patients with pacemakers, as these modalities may interfere with pacemaker function. As previously stated, short-wave and microwave may cause electrical burns if large metallic implants are present within the treatment field. Ultrasound is not contraindicated in the presence of metallic implants because of the physical nature of the interaction

TABLE 3
Contraindications for Thermotherapy

<table>
<thead>
<tr>
<th>General Contraindications</th>
<th>Specific Contraindications</th>
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</thead>
<tbody>
<tr>
<td>1. Patient unable to respond to impounding burn.</td>
<td>Shortwave and Microwave Diathermy</td>
</tr>
<tr>
<td>3. Ischemia.</td>
<td>5. Eyes or gonads in treatment field (microwave only).</td>
</tr>
<tr>
<td>4. Fresh hemotoma in treatment field.</td>
<td>Ultrasound</td>
</tr>
<tr>
<td>5. Non-inflammatory edema.</td>
<td>1. Eyes or gonads in treatment field.</td>
</tr>
<tr>
<td></td>
<td>4. Pregnant uterus in treatment field.</td>
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</tbody>
</table>

IDARAC*  
PRESCRIBING INFORMATION (fluctofenaline 200 mg tablets. THERAPEUTIC CLASSIFICATION: Analgesic. INDICATIONS: IDARAC (fluctofenaline) is indicated for short-term use in acute pain of mild and moderate severity. CONTRAINdications: IDARAC (fluctofenaline) is contraindicated in patients with peptic ulcer or any other active inflammatory disease of the gastro-intestinal tract and in patients who have demonstrated a hypersensitivity to the drug. WARNINGS: USE IN PREGNANCY: The use of IDARAC (fluctofenaline) may cause increased fluid-laden areas of childbearing potential requires that the likely benefit of the drug be weighed against the possible risk to the mother and fetus. Use of the drug in women who are nursing is not recommended USE IN CHILDREN: The safety and efficacy of IDARAC in children have not been established and therefore is not recommended. The safety and efficacy of long-term use of IDARAC have not been established. PREcautions: IDARAC (fluctofenaline) should be used with caution in patients with impaired renal function. In clinical trials with IDARAC, dysuria without apparent changes in renal function was reported. It has not been established whether it is related to dose or duration of drug administration. Patients taking anticoagulant medication may be given IDARAC with caution. Alterations in prothrombin time have been observed only in clinical trials where the administration of IDARAC was extended beyond two weeks. IDARAC should be used with caution in patients with a history of peptic ulcer or other gastrointestinal lesions. ADVERSE REACTIONS: The most commonly occurring side effects reported during IDARAC therapy were: CENTRAL NERVOUS SYSTEM: Drowsiness, dizziness, headache, insomnia, nervousness, irritability. GASTROINTESTINAL SYSTEM: Nausea, diarrhea, abdominal pain or discomfort, heartburn, constipation, abnormal liver function, gastro-intestinal bleeding. UROGENITAL SYSTEM: Dysuria, burning micturition, polyuria, strong smelling urine, urethritis and cystitis. ALLERGIC-TYPE REACTIONS: Maculopapular rash, hives, urticaria. Redness and itching of the face and neck. SYMPTOMS AND TREATMENT OF OVERDOSE: No cases of overdose have been reported with IDARAC (fluctofenaline). In a case of overdose standard procedures to evacuate gastric contents, maintain urinary output and provide general supportive care should be employed. DOSAGE AND ADMINISTRATION: The usual adult dose of IDARAC (fluctofenaline) is 1 to 3 tablets (200 to 400 mg), 3 to 4 times per day as required. The maximum recommended daily dose is 900 mg. IDARAC is recommended for short-term management of acute pain. The tablets should be taken with a glass of water. IDARAC is not recommended for use in children. AVAILABILITY: Each tablet of IDARAC contains 200 mg of fluctofenaline. Tablets are biconvex, cylindrical, yellowish-white, scored on one side with D57 above the breakline and a distinctive logo on the reverse side. IDARAC is available in bottles of 100 tablets. Store at room temperature, protected from light. IDARAC is a Schedule F (prescription) drug. Product monograph upon request.
fungal cells is primarily *Malassezia furfur*. The mode of action of ciclopirox olamine is thought to involve the inhibition of cellular DNA replication by binding to DNA topoisomerase II. This agent is useful in the treatment of tinea versicolor, although it is not effective against *Candida albicans*.

### Pharmacological Classification

**Topical antifungal agent**

**Action**

Ciclopirox (ciclopirox olamine) is a synthetic broad-spectrum antifungal agent. Ciclopirox olamine inhibits growth of pathogenic dermatophytes, yeasts, and *Malassezia furfur*. Ciclopirox olamine exhibits fungicidal activity in vitro against isolates of *Trichophyton rubrum*, *Trichophyton mentagrophytes*, *Epidermophyton floccosum*, *Microsporum canis*, and *Candida albicans*.

The mode of action of ciclopirox olamine was studied using mouse ear infections. It is presumed that ciclopirox olamine-mediated growth inhibition or death of fungal cells is primarily caused by in vitro cellular blockages of some essential substrates and/or ions and that such effects are brought about through blockage of uptake and/or metabolism. No data on mechanism of action are available for dermatophytes.

### Indications

Ciclopirox (ciclopirox olamine) is used as a topical antifungal agent. It is effective against *Malassezia furfur* and is indicated for the treatment of tinea versicolor.

### Precautions

Skin sensitization occurs, and discontinuation of ciclopirox olamine and other appropriate therapy is recommended. Use in Pregnancy: Reproductive studies have been performed in the mouse, rat, and rabbit. No adverse effects on reproduction have been observed. Use in Children: Safety and effectiveness in children below the age of 10 years have not been established.

### Contraindications

Hypersensitivity to the product is an absolute contraindication. Ciclopirox olamine is not recommended for use in patients with a history of allergic reactions to compounds containing ciclopirox olamine.

### Dosage and Administration

Gently massage sufficient Loprox (ciclopirox olamine) Cream 1% on the affected and surrounding skin areas twice daily, in the morning and evening, for a maximum of 4 weeks. Clinical improvement with relief of pruritus and other symptoms usually occurs within the first week of treatment. If a patient showed no clinical improvement after two weeks of treatment with Loprox (ciclopirox olamine) Cream 1%, the diagnosis should be redetermined. Patients with tinea versicolor usually exhibit clinical and mycological clearing after two weeks of treatment.

### Supply

Loprox (ciclopirox olamine) Cream 1% is supplied in 15 and 30 g tubes. Store at room temperature (below 25°C). Product Monograph available on request.

### References