Clinical question.

# 603
Does cooling of musculoskeletal injury improve outcome?
And if so, what is the optimal method of cooling?
Is this question addressing an intervention/therapy, prognosis or diagnosis: Intervention/therapy.
Sate if this is a proposed new topic or revision of existing worksheet: Revision

Conflict of interest specific to this question
Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet?
No conflict of interest

Search strategy (including electronic databases searched).

PubMed
#1 (“athletic injuries” or “soft tissue injuries”) and (“cryotherapy” or “cooling”) and (“pain” or “swelling” or “outcome” or “return to participation”)
   Limits: Humans, English, Japanese
   37 hits
#2 "athletic injuries" and (“cryotherapy” or "cooling")
   Limits: English, Japanese
   85 hits
#3 "soft tissue injuries" and ("cooling" or "cryotherapy") and "outcome"
   Limits: English, Japanese
   8 hits
#4 (“cooling” or “cryotherapy”) and (“method” or “modality”) and “skin temperature"
   Limits: Humans, Clinical Trial, Meta-analysis, Randomized Controlled Trial, English, Japanese
   34 hits
Janana Centra Revuo Medicina
#5 2003-2008 (“cryotherapy” or “icing”) and (“upper limb” or “lower limb”)
   16 articles

Hand search and reference tracking was also done.
• **State inclusion and exclusion criteria**
Inclusion criteria: clinical trials, complication, side effect
Exclusion criteria: exercise-induced muscle damage (EIMD), bone injury, postoperative use, treatment by athletic trainers and physiotherapist, in-hospital treatment, severe soft tissue injury (such as Morel-Lavallee lesion), review.

• **Number of articles/sources meeting criteria for further review:**
20 studies met criteria for further review. Of these 1 was LOE1, five were LOE2 and remaining 14 were LOE5.

### Summary of evidence

#### Evidence Supporting Clinical Question

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Outcomes – Please define outcomes for this question, place them after letters below and use letters to identify studies which evaluate this outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of evidence</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

**Outcomes**

*Italics = Animal studies*

A – pain, B – swelling, C – function, D – temperature, E – complication, F – other outcomes
# Evidence Neutral to Clinical question

<table>
<thead>
<tr>
<th>Level of evidence</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Outcomes</th>
</tr>
</thead>
</table>
| 1                 |      |      |      | **Dykstra 2009 D**  
|                   |      |      |      | **Graham 2000 E**  
|                   |      |      |      | **Kanlayanaphotoporn 2005 D**  
|                   |      |      |      | **Kennet 2007 D**  
|                   |      |      |      | **Merrick 2003 D**  
|                   |      |      |      | **Moeller 1997 E**  
|                   |      |      |      | **Palmieri 2006 D,E**  |
| 2                 |      | Airaksinen 2003 A F | | **Bassett 1992, E**  
|                   |      |      |      | **Chesterton 2002 C**  |
| 3                 |      | Laba 1989 A,B,C  
|                   |      | Sloan 1989 B,C | | **Bleakley 2004 F**  
|                   |      |      |      | **Cote 1988 C**  
|                   |      |      |      | **Hubbard 2004 C**  |
| 4                 |      |      |      | **Level of evidence**  
|                   |      |      |      | 1  
|                   |      |      |      | 2  
|                   |      |      |      | 3  
|                   |      |      |      | 4  
|                   |      |      |      | 5  |
| 5                 |      |      |      | **Outcomes** |
|                   |      |      |      | A – pain, B – swelling, C – function, D – temperature, E – complication, F – other outcomes  |
|                   |      |      |      | **Italics = Animal studies**  


DISCUSSION: Cryotherapy is one of the most commonly applied treatment in the management of acute musculoskeletal injuries. Various cooling procedures have been widely used by physician, athletic trainer, physical therapist and layman. Its use must be supported by strong research evidence. Two questions were addressed. One is “Does cooling of musculoskeletal injury improve outcome?” and the other is “If so, what is the optimal method of cooling?” As for the first question, measurements of outcomes included reducing pain, swelling, edema and duration of disability. There is weak evidence which support cryotherapy improve outcome after acute musculoskeletal injury (Ayata 2007, Basur 1976, Hoccut 1982) and mechanism of cryotherapy is proposed by animal experiment (Deal 2002). 6 articles (Airaksinen 2003, Bleakley 2004, Cote 1988, Hubbard 2004, Laba 1989, Sloan 1989) were neutral and no opposing evidence was found. Strong evidence which supports “Immediate cooling of acute musculoskeletal injuries in patients without preexisting musculoskeletal pathology improve outcome” is still lacking because of the difficulty of study design and no study was found which demonstrated the effects of “immediate” cryotherapy for “fresh” and “acute” musculoskeletal injuries in truly randomised controlled design. As for second question “What is the optimal method of cooling?”, two questions can be generated. “What is the optimal material for cryotherapy” and “How long is the optimal time for cryotherapy”. There is good evidence that support ice is the optimal material in cryotherapy as measured by decrease in temperatures of tissues (Dykstra 2009, Kanlayanaphoteporn 2005, Kennet 2007, Merrick 2003). These studies constantly showed modality (ice in water) that undergoes a phase change seem to be more effective in lowering tissue temperature. Frozen peas was shown to be more effective as cryotherapy than flexible frozen gel packs in one fair study (Chesterton 2002). As for duration of cryotherapy, there is good evidence (Graham 2000, Moeller 1976) and fair evidence (Bassett 1992) that support cryotherapy should not exceed 20 minutes. These three studies reported total of 8 cases of complications with cryotherapy and time of cooling exceeded 20 minutes in 5 cases (20-60 minutes). In remaining 3 cases, nerve injuries (all recovered spontaneously) occurred with 15-20 minutes of cooling. Caution should be paid when applying ice to areas where subcutaneous fat layer is thin and peripheral nerves run (Bassett 1992). One good study (Bleakley 2006) showed that intermittent application group (ice application for 10 minutes, then 10 minutes rest without ice, and again ice application for 10 minutes) might as effective in reducing pain as standard ice application for 20 minutes. As for safety of cryotherapy, a good evidence (Palmieri 2006) showed that 20 minutes cryotherapy applied to the ankle did not alter core
temperature in adult volunteers.

Acknowledgements:

Citation List


LOE2. Fair. Neutral. Ice Power was a newly developed cold-forming gel consisted of 3.5% menthol and 8% ethanol. 5 g of Ice Power was applied four times a day for 14 days on the painful injured area. This gel has no physical cooling effect and the study did not assess whether the cold gel actually lowered the physical temperature of tissues under treatment. Menthol elicits a cooling sensation by activating a menthol receptor and this may explain the effect of Ice Power as a transducer of cold stimuli in the somatosensory system (Nature 2002) as authors speculated. Ice Power was a new commercial product but conflict of interest of authors was not stated.


LOE5. Fair. Supporting. This study is the only study that examined immediate effect of icing for acute soft tissue injury and showed cooling is effective compared to no cooling in collegiate volleyball players with jumper's knee (according to Blazina classification stage 2). 16 players with jumper's knee were randomly assigned to either “icing” or “no icing”.


LOE5. Fair. Neutral. Cooling time of six cases of nerve injury were: each for 30-45 min (ice bag) and 20-30 min (ice), two for 60 min (both ice), and two for 15-20 min (both ice). Authors concluded that 20 minutes appears to be the critical time period. The thickness of the overlying subcutaneous fat was proposed as the risk factor of nerve injury in cryotherapy with ice.

LOE2. Poor. Supporting. No randomization. Score was categorized using subjective degree of pain and circumferential measurements of the ankle. Although there was a significant difference between the two groups, the recovery percentage came closer on the 14th day. Summary: To compare the effect of cooling and no cooling in patients with recent ankle sprain. Materials and method: Sixty patients with ankle sprain were divided into two equal groups. The material used in this study is a gel ("Cryogel") enclosed in a soft plastic bag. The advantage of using this pack is that it lowers the temperature of the skin to 50° F (10°C) within 10 minutes and keeps it between 68° F and 86° F for another three hours. One group of patients had cooling treatment for the first 48 hours, and then bandaging, whilst the other group had only bandaging. All patients were evaluated after 2, 7, 14 days, and score (numerical scoring of signs and symptoms in table 1) was given at each visit. Results: Of those treated by cooling, 42.1% showed recovery on the 2nd day and 84.2% by the 7th day of follow-up, compared with 29.1% and 60.6% respectively in patients who had bandaging only. Conclusions: This study confirms the view that early reduction of edema in ankle sprain reduces the period of disability.


LOE5. Poor. Neutral. 22 references which were selected as RCT in this study were first checked with inclusion and exclusion criteria in this worksheet. 19 out of 22 studies were excluded (17 postoperative, 2 off-topic). Remaining three studies were all included in this citation list (Sloan 1989, Laba 1989, Cote 1988).


LOE1. Good. Supporting. Patients with mild/moderate ankle sprains within the preceding 48 hrs were studied. Participant flow and retention were clearly shown
Randomisation was done by independent researcher using computer software. The primary investigator, who remained blinded to group assignment until completion of data collection and analysis, carried out subject recruitment. Three secondary researchers assigned subjects to either the standard or intermittent group. All treatments were self-administered. Verbal explanation and written instructions were given. Patient compliance was monitored using a treatment diary and the degree of compliance in both groups was good: mean (SEM) number of ice treatments over the first 72 hours was 5.7 (0.41) in the standard group and 5.5 (0.42) in the intermittent group. 19 were lost and full datasets obtained from 70. Compliant if patients applied ice at least once each day over the first 72 hours. None of them were considered protocol violators (intention to treat analysis). A randomised controlled pilot study was used to determine sample size and recruitment targets. The power analysis and calculations showed (assuming 80% power and a 0.05 alpha value) a minimum number of 40 subjects. The design is high quality. As for the result, only difference was observed on ankle pain on activity at one week (less pain in intermittent group) and there were no differences in pain at rest, swelling and function. This study shows that shorter, intermittent applications of ice may enhance the analgesic effect of ice after acute ankle sprain.


LOE5. Fair. Neutral. The frozen peas also produced a continuous fall in mean skin temperature over 20 minutes, whereas a plateau in mean skin temperature after 10 minutes was noted in pack. Some limitations. The use of a small convenience sample of healthy subjects restricts the external validity. This was not blinded to the participants or the examiner. The role of subcutaneous fat as an insulator may have influenced the heat conduction between an individual’s skin and subcutaneous tissue.


LOE5. Poor. Neutral. This study was done in postacute phase of injury and intention of treatment was rehabilitation. Process of random allocation of the subjects is unclear and there was no control.

LOE5. Good. Supportive. Good study design and well documented experimental description. In this study, changes in vascular permeability were measured after 6 hours following treatment. The result of this animal study demonstrates that short term (20 minutes) cryotherapy soon after acute soft tissue injury (15 minutes) prevent edema formation until 6 hours after the therapy. The mechanism of this result cannot be explained by direct physical cooling effect of ice, instead the reduction in edema in injured skeletal muscle following cryotherapy could be due to reduction in leukocyte rolling and adhesion in the microvasculature.


LOE5. Good. Neutral. All ice packs were made by placing the ice into 22 x 40 cm polyethylene bags removing excess air. Cube-ice packs were made by placing 2000 mL of cubed ice into the bag. Crushed-ice packs were made by placing 2000 mL of crushed ice into the bag. Wetted-ice packs were made by placing 2000 mL of cubed ice and 300 ml of room-temperature water into the bag. Surface and intramuscular temperatures were measured both during treatment phase (20 min) and recovery phase (after the removal of ice, 120 min). Changes in surface temperature showed rapid recovery after the removal of any type of ice, whereas intramuscular temperatures showed very slow recovery and remained below 32°C until 120 min in groups of wetted ice and crushed ice.


A case of severe frostbite injury to the right foot is presented. This was caused by the inappropriate application of a bag of frozen chips to the foot in an attempt to ease non-specific pain. No specific acute traumatic injury was identified. As the patient was a teacher of physical education, the pain had initially been assumed to originate from a minor musculoskeletal injury. Full recovery ensued after surgical excision of necrotic tissue and split skin grafting. The danger of inappropriate overenthusiastic use of ice packs or other frozen material to treat soft tissue injuries is emphasised. The need for education to prevent similar future injuries is discussed.
LOG5. Good. Neutral. This case report described the potential danger of overutilization of cryotherapy and pointed out the need for education to prevent complication. The cooling time of this case is 40 minutes.


LOE2. Poor. Supporting. 53 patients were initially entered and 37 completed the study. 16 were excluded because of inadequate follow-up or because adhesive tape wrapping was used without cryotherapy. This study compared cryotherapy versus heat therapy and did not include control (without cryotherapy). Cryotherapy in the study is defined as either use of an ice whirlpool between 40-50°F for 12-30 minutes 1-3 times/day or application of an ice pack on the injured area for 15-20 minutes 1-3 times/day. After the cryotherapy, the injured ankles were wrapped with adhesive bandage. Three treatment methods were applied: Day 0, treatment was started and adhesive or Ace wrapping was applied within one hour of the injury. One mode of therapy was continued for at least three days. Day1, treatments was started and adhesive or Ace wrapping was applied between 1 to 36 hours after injury. The chosen treatment was continued at least three days. Day 2, treatment and adhesive of Ace wrapping was not used for at least 36 hours (usually 48 hours) after the injury. Patients were then asked to indicate when (after how many days) they were able to perform the following tasks without pain – walking, climbing stairs, and running and jumping. This study measured how long did it take for patients to do tasks without pain using patient’s subjective recall. No other measurements were done. No data how they allocated patients to treatments.


LOE5. Poor. Neutral. 3 of 4 articles which were selected as RCT in this study were all reviewed (Basur 1976, Hocct 1982, Laba 1989) in this worksheet. Remaining 1 article was excluded according to exclusion criteria.

LOE5. Good. Neutral.


LOE5. Good. Neutral. The ability of CI and WI to undergo phase change appears to enhance efficiency of heat energy transfer and enables consistent agent temperature throughout application. In this study, changes in surface skin temperatures were measured but that of intramuscular did not.


LOE2. Poor. Neutral. Coin toss is the method of randomization. The treatment was not blinded to authors. Patients injured their ankles within the previous 2 days. A standard treatment programme includes ultrasonic therapy and exercise and support after application of an ice-pack in “ice” group. As authors are physiotherapist, this standard treatment could have done as rehabilitation.


LOE5. Good. Neutral. Flex-i-Cold was chosen because it is a frozen gel pack and does not change state physically. This study showed that ice-based modalities go through a change of physical state from solid to liquid and as a result absorb more heat than modalities like frozen gel pack which doesn’t go phase change. They measured temperature changes at the depth of 1 cm and 2 cm of subadipose tissue and showed that degree of temperature decreases were more mild at 2 cm than at 1 cm. This fact explains the risk of nerve injury in cryotherapy in patients with less fat in injured area.


LOE5. Good. Neutral.

LOE5. Good. Neutral. Core temperature was measured by using the CorTemp 2000 Wireless Core Body Temperature Monitoring System and CorTemp disposable temperature sensor. Subjects ingested the core temperature pill at 11:00 pm on the day before experiment. Typical 20-minute cryotherapy treatment did not decrease core body temperature in healthy adults.


LOE2. Poor. Neutral. Experiment group received immediate physiotherapy, consisting of the application of a cooling anklet, inflated to 30 mmHg for 30 min, together with elevation of the ankle. Control group received dummy physiotherapy consisting of the application of a non-inflated anklet without elevation. The anklet was a freon-cooled device (skin temperature 15-20 degree C). A soft tissue swelling index which was calculated using X-P and ankle movement were measured and no significant difference was found.