<table>
<thead>
<tr>
<th><strong>Clinical question.</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>General: &quot;Does heat applied to a musculoskeletal injury improve outcome? And if so, what is the optimal method of applying heat?&quot;</td>
</tr>
<tr>
<td>PICO Format: In individuals with musculoskeletal injury (P) does heat application (I) as opposed to no treatment (C) improve tissue healing? In individuals with musculoskeletal injury (P) which type of heat application (I) compared to other methods is more effective (C) and improves healing better (O)?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Is this question addressing an intervention/therapy, prognosis or diagnosis?</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention/therapy</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>State if this is a proposed new topic or revision of existing worksheet:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>New</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Conflict of interest specific to this question</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Do any of the authors listed above have conflict of interest disclosures relevant to this worksheet? <strong>Yes, Intellectual interest</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Search strategy (including electronic databases searched).</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>EMBASE, MEDLINE, PUBMED, Cochrane Library, DARE, and TRIP: “muscle” OR “musculoskeletal” AND “thermotheapy” OR “heat” AND “therapy” as text words in the free search field.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>State inclusion and exclusion criteria</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inclusion items: All modes of thermotherapy which increases local musculoskeletal tissue temperature, special populations with orthopedic injury were considered. The special populations found include were rheumatoid arthritis patients.</td>
</tr>
<tr>
<td>Exclusion items: pulsed (non-thermal) ultrasound, equipment validation/reliability studies</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Number of articles/sources meeting criteria for further review:</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>60 studies met the criteria for further review. Of these forty-six were LOE1, one was LOE2, five were LOE4, and three were LOE5.</td>
</tr>
</tbody>
</table>
## Summary of evidence

### Evidence Supporting Clinical Question

| Good | Evidence Supporting Clinical Question | Enwemeka, 1990A  
Karnes, 2002A  
Piedade, 2008A |
|------|--------------------------------------|------------------|
| Fair | Chastain, 1978I  
Michlovitz, 2004BI  
Nadler, 2002B  
Nadler, 2003BEG  
Nadler, 2003BEG | Lehamann, 1993AC  
Giombini, 2001AB  
Giombini, 2006B  
Klaiman, 1998B |
| Poor | Ogilvie-Harris, 1995B | |

<table>
<thead>
<tr>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
</table>

### Level of evidence

- **A** = Increase in healing rate
- **B** = Decrease in pain/soreness
- **C** = Increase in blood flow
- **D** = Increase in tissue temperature
- **E** = Increase tissue extensibility/range of motion
- **F** = Evidence does not support or refute application of heat
- **G** = Improved self-reported activities of daily living/Functional indexes
- **H** = Increases strength
- **I** = Reduced Edema

*Italics = Animal studies*
## Evidence Neutral to Clinical question

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>------</td>
<td>-----------------</td>
<td>-----------------</td>
<td>-------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------------------------</td>
<td>-------------</td>
<td>-----------</td>
</tr>
<tr>
<td>French, 2006F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Evidence Opposing Clinical Question

<table>
<thead>
<tr>
<th>Poor</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evidence Opposing Clinical Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>A = Increase in healing rate</td>
</tr>
<tr>
<td>B = Decrease in pain/soreness</td>
</tr>
<tr>
<td>C = Increase in blood flow</td>
</tr>
<tr>
<td>D = Increase in tissue temperature</td>
</tr>
<tr>
<td>E = Increase tissue extensibility/range of motion</td>
</tr>
<tr>
<td>F = Evidence does not support or refute application of heat</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Evidence Opposing Clinical Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>G = Improved self-reported activities of daily living/Functional indexes</td>
</tr>
<tr>
<td>H = Increases strength</td>
</tr>
<tr>
<td>I = Reduced Edema</td>
</tr>
</tbody>
</table>

**Italics = Animal studies**
REVIEWER’S FINAL COMMENTS AND ASSESSMENT OF BENEFIT / RISK:

There is limited evidence; particularly a lack of randomized control trials to support that thermotherapy (heat application) improves tissue healing in humans. Most evidence regarding heat application is regarding thermotherapy devices that are beyond the scope of a layperson. A single randomized control trial study using physically active individuals with musculoskeletal injury, demonstrated that a deep heat via 434 MHz microwaves with superficial cooling thermotherapy device, which is limited to trained clinicians, can improve healing.\(^{18}\) The remaining supporting evidence is based on animal model studies.\(^{15,25,46}\)

There is evidence that various types of thermotherapy increases: tissue temperature at both superficial (<2 cm below skin)\(^{14}\) and deep tissue levels (>3 cm below skin)\(^{5}\), tissue extensibility/joint range of motion\(^{6,11,28,30,37,45,24}\), and blood flow\(^{31,39}\), while decreasing pain.\(^{1,2,3,4,17,18,19,22,24,26,27,36,38,40,42,43,44,52,53}\) The exact relationship of these outcomes to improved tissue healing has not been established at this time. In addition, many of the methods of heat application studied are not available to the layperson.

Limited evidence exists regarding the risks associated with heat application for musculoskeletal injury. The application of heat to individuals with mild to moderate ankle sprains during subacute injury phase increased edema, which is thought to prolong return to daily activities. Since healing does not follow the same time course in all musculoskeletal tissue, the layperson would need to identify the victim’s phase of healing to safely apply heat. Determining the victim’s musculoskeletal healing phase may be difficult for the layperson.

Therefore, based on the limited evidence available, there is weak support that thermotherapy may improve tissue healing. More human subject, randomized control trials are needed with tissue healing as an outcome measure. Without a clear understanding if thermotherapy improves healing, it is difficult to determine if one type of thermotherapy is more effective than another.

Acknowledgements:

Citation List


   LOE: 1
   Good
   Neutral
   Funding: Research Support, Non-U.S. Gov't


   LOE: 1
   Good
   Neutral
   Funding: Research Support, Non-U.S. Gov't


   LOE: 1
   Good
   Neutral
   Funding: Research Support, Non-U.S. Gov't


   LOE: 1

Consensus Development Conference
Meta-Analysis
Research Support, Non-U.S. Gov't
Review
United States
Physical therapy


LOE: 1
Fair
Neutral


LOE: 1
Fair
Neutral


LOE: 1
Fair
Neutral


LOE: 1
Fair
Neutral


LOE: 1
Fair
Supporting


LOE: 1
Fair
Neutral


LOE: 1

LOE: 1
Fair
Neutral
Funding: Research Support, Non-U.S. Gov't Research Support, U.S. Gov't, P.H.S.


LOE: 1
Fair
Neutral
Funding: Research Support, Non-U.S. Gov't


LOE: 5 (animal study)
Good
Supporting
Funding: Research Support, Non-U.S. Gov't Research Support, U.S. Gov't, Non-P.H.S.


LOE: 1
Poor
Neutral


LOE: 4
Fair
Supporting


LOE: 1
Fair
Neutral.


LOE: 4
Fair
Supporting


LOE: 1
Fair
Neutral


   LOE: 1
   Fair
   Neutral


   LOE: 1
   Fair
   Neutral


   LOE: 1
   Fair
   Opposing
   Funding: Research Support, U.S. Gov't, Non-P.H.S.


   LOE: 1
   Good
   Neutral


   LOE: 5 (animal study)
   Good
   Supporting
   Funding: Research Support, Non-U.S. Gov't


   LOE: 1
   Fair
   Neutral
   Funding: Research Support, Non-U.S. Gov't


   LOE: 4
   Fair
   Supporting


   LOE: 1
   Fair
   Neutral

LOE: 4
Fair
Neutral


LOE: 1
Fair
Neutral


LOE: 2
Fair
Supporting
Funding: Research Support, U.S. Gov't, Non-P.H.S.


LOE: 2
Fair
Neutral


LOE: 1
Fair
Neutral


LOE: 1
Fair
Opposing


LOE: 1
Fair
Neutral


LOE: 1
Fair
Neutral
Funding: Research Support, Non-U.S. Gov't


LOE: 5 (animal study)
Good
Supporting


LOE: 1
Fair
Neutral


LOE: 4
Good
Supporting.


LOE: 4
Fair
Neutral
Funding: Research Support, U.S. Gov't, Non-P.H.S.


LOE: 1
Good
Neutral


LOE: 1
Fair
Neutral


LOE: 1
Fair
Neutral

LOE: 1
Fair
Neutral
Funding: Research Support, Non-U.S. Gov't


LOE: 1
Fair
Neutral


LOE: 1
Fair
Neutral


LOE: 1
Fair
Neutral


LOE: 1
Fair
Neutral


LOE: 1
Good
Neutral