Effectiveness of Cryotherapy on Acute Soft Tissue Injuries

Differences of Expert Opinions and Evidence Based Data
Comparison Netherlands to Germany | Isabelle Hildebrandt

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Preface

With the aim of becoming a fully trained Physiotherapist and graduating from the Hanzehogeschool in Groningen, I had to complete my graduation assignment, which was to write a Bachelor Thesis. The topic I could choose myself, as long as there was a relation to the field of Physiotherapy. To write about Cryotherapy I decided after finishing with my internships, which I did in a private practice in Germany, in a Rehabilitation Centre in Kenya and in a hospital in Germany. During that time I spent there I noticed the different opinions about Ice applications and started to question the evidence as well. To include a practical part in my thesis, I decided on developing and executing a questionnaire among therapist in Germany and the Netherlands about the current use of Cryotherapy on acute soft tissue injuries.

With this paper I will try to inform the reader about the most recent studies and reviews concerning the effectiveness of Cryotherapy, the opinions of active Physiotherapist towards this topic and possible differences among experts in using ice between Germany and the Netherlands.

Additionally, I would like to thank the Physiotherapists, who completed my questionnaire and made it possible for me to implement this in my thesis. As well I could not have written this paper without the patience, believe and encouragement of my friends and family.
Abstract

Background
It has been shown that there is insufficient data to establish evidence based guidelines concerning the use of Cryotherapy on acute soft tissue injuries.

Objective
With this thesis I will give an overview of the latest studies and reviews regarding Cryotherapy used in the management on acute soft tissue injuries. The current use of ice by Physiotherapists in private practice and their opinion about this form of treatment will be displayed through a questionnaire. Additionally a comparison is made between the experts’ opinion and evidence based data as well as between Therapists out of Germany and the Netherlands.

Method
A computerized literature search was done on seven databases for articles in English language from the past five years relating to Cryotherapy on acute soft tissue injuries. The questionnaire was formulated by me in English and German and distributed via email to several clinics in both countries.

Results
Seven clinical trails were used; one comparing different cooling agents, one comparing two different icing protocols, two identifying the effect of cold water immersion on muscle damage, one determining the effect of quantity of ice and contact area, one comparing Cryotherapy combined with compression to Cryotherapy alone on the Achilles tendon microcirculation and one evaluating the differences between two rehabilitation protocols on acute ankle sprains. Three out of four reviews concluded the evidences for the use of ice on acute soft tissue injuries; the other one determined the effect of ice on return to participation after injury. The questionnaire was send out twice (N = 150); the compliance rate was 22% (N = 33).

Conclusion
Differences between the evidence based data and the experts’ opinion regarding the use of Cryotherapy are present. There is as well a need for more high quality studies until the effects of ice are completely understood.

Keywords: Cryotherapy; Acute Soft Tissue Injury; Questionnaire; Expert Opinion
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Abbreviation Index

CK – Creatine Kinase
CI – Crushed Ice
CIVD – Cold Induced Vasodilation
CWI – Cold Water Immersion
DOMS – Delayed onset of Muscle Soreness
EMG - Electromyogram
FP – Frozen Peas
GP – Gel Pack
MVC – Maximum Voluntary Contraction
N – Number of Subjects used
NCV – Nerve Conduction Velocity
P – P-Value
PEDro – Physiotherapy Evidence Database
PRICE – Protection, Rest, Ice, Compression, Elevation
PTH – Pain Threshold
PTO – Pain Tolerance
RCT – Randomized Controlled Trail
ROM – Range of Motion
S – Standard Deviation
WI – Ice-water Immersion
1. Introduction
When it comes to dealing with acute soft tissue injuries as a Physiotherapist, Cryotherapy might be one of the most controversial treatment methods. This could be due to a lack of knowledge concerning the efficacy of ice therapy on acute injured patients.

Studies from the past five years have shown the effects of different cooling agents (Kennet et al., 2007), icing protocols (Bleakley et al., 2006) and cold water immersions on the human body (Bailey et al., 2007; Goodall & Howatson, 2008). The effect of quantity of ice and contact area (Janwantanakul, 2009) is known as well as the effectiveness of Cryotherapy on acute sprained ankles (Bleakley et al., 2006). Several reviews have concluded that there is a need for more high-quality trails until the outcome of Cryotherapy on acute soft tissue injuries is fully proven and understood (Bleakley et al., 2008; Hubbard & Denegar, 2004; Collins, 2008; Hubbard et al., 2004; Bleakley & McDonough, 2004).

Those Studies and reviews have shown the outcomes of different trails. One review has done a survey among Irish emergency physicians concerning the practical use of ice therapy on acute injuries (Collins, 2008), which showed that 73% are in favour of Cryotherapy. There was no study found which directly compared the practical use of Cryotherapy to the proven data.

Therefore, my hypothesis is that there are differences in the practical use of ice on acute soft tissue injuries and in what is proven by reviews and clinical trails. The aim of this thesis will be to clarify the differences between the use of cold treatments and the evidence based data. With help from a questionnaire, which will be done in the Netherlands and Germany a comparison between those two countries will be made as well.

1.1. Motivation
Cryotherapy is a field with many different opinions and point of views. I have experienced it during my internships which were integrated in my four year Study program.

The first clinical I did was in a private practice in Hamburg, Germany. During the 10 weeks I have worked there I had different discussions about ice therapy with my supervisor, who was not in favour of it. Already there I noticed that the effects of ice are not fully clear to everyone and that there might be a lack of clinical trails. My third internship I did in the military hospital in Hamburg, where I experienced that mainly ice was used for treating soft tissue injuries. There were as well opposite opinions about this by Doctors and Physiotherapists.
After my three placements I was thinking about a topic for my bachelor Thesis and remembered the various views of Cryotherapy. Followed by a week of superficial literature search about Cryotherapy I decided in favour of it. Throughout that time I noticed that there is a lack of recent studies and reviews, therefore I decided on developing a questionnaire to determine the recent use of Cryotherapy in private practice and to compare the opinions of different Therapists to the evidence based data. Herewith, I would like to create an overview of the facts about Cryotherapy, what is evidence based, and how it is used in practice in Germany and in the Netherlands.

1.2. Background Information

Cryotherapy is a term used for the application of ice for therapeutic purpose. It is a common treatment modality for acute soft tissue injuries and is mostly used to control pain, edema, and inflammation response. The following section will focus more on the physiological effects rather than on the application techniques.

In general, the first response of the human body to a drop of skin temperature is a decreased blood flow towards the cooled area, which is a result of different components. Immediately after the cooling agent is applied, thermoreceptors in the skin are activated to enhance vasoconstriction by reducing the release of histamine and prostaglandins. Smooth muscles in the walls of blood vessels are stimulated to constrict as a direct effect to the coldness. Additionally the blood viscosity is thought to increase followed by a reduction of the circulation, which minimizes the heat transfer. Due to those factors the blood flow is first decreased; however vasodilation may occur when the skin temperature drops lower than 10ºC. This is a phenomenon called cold-induced vasodilation (CIVD), which is know as a hunting response of the vessels. The founder Lewis recorded this in 1930 by placing an individual’s finger in an ice bath. Immediately the temperature from that finger decreased, but after 5 to 15 minutes the temperature raise due to vasodilation. This occurs to be due to the very low temperature, which paralyzes the smooth muscle contraction on the wall of the blood vessels. This reaction might take place to protect the tissue from damage due to long and excessive cooling (Cameron, 2009).

The reduction of pain through cooling the tissue can be explained with the gate control theory. Cold serves here as a counterirritant and rapidly arouses the pain and temperature sensations on the skin, which provides enough sensory input to block the conduction to the brain either partially or completely. Another explanation is that cold affects the
conduction velocity of both sensory and motor nerve fibers. It has been shown that cold decreases and stops the conduction of the A-Delta fibers, which raises the pain threshold (Alqafly & George, 2007).

The reduction of edema through Cryotherapy is associated with the vasoconstriction of the blood vessels, leading to a decreased circulation of the injured area. Therefore, the release of extravasation fluid into the surrounding tissue is reduced. This is promoted through the slowed cell metabolism and a minimized release of histamine (Cameron, 2009).

Additionally in the acute inflammation phase the slowed metabolism and chemical activity together with the reduction of oxygen release and blood flow are decreasing the risk of secondary injury. It takes place when secondary hypoxia and enzymatic activity cause harm to tissue bordering the injured area. Decreasing temperature might reduce the destructive enzyme activity and metabolism of the damaged tissue; hereby the healthy tissue might be preserved during the first 48 – 72 hours. After the inflammation phase of soft tissue injuries Cryotherapy could delay the healing process through the lessened metabolic processes. It has been shown that ice used in the first 48 hours of an acute soft tissue trauma is helpful in reducing pain, control edema and shortening the recovery time compared to different treatment modalities (Watson, 2008).

2. Method Section
In this section I will explain how the literature search was done and how the questionnaire came into existence. The results will be shown in the following chapter.

In the time from 23rd of November till the 6th of December 2009 a computer based literature search was done on the following databases: Cochrane, Directory of open Access Journals, Free medical Journals, Google Scholar, Pedro, Pubmed, and Science Direct. The Keywords which were used by using the Boolean logic (AND, OR) were Cryotherapy, Physiological effects, Effectiveness, Physical Therapy, Pain, Pain management, Inflammatory response, Healing process, Acute soft tissue injuries, Metabolism and Edema control. Inclusion criteria for the relevant articles were not to be older than five years, to be published in English language, not to aim on postsurgical recovery, and not to focus on hypothermia. In one case the author of a study protocol (Bleakley et al., 2009) was contacted in order to receive the abstract of the finished study. Furthermore, a hand search was done in the American Journal of Sports Medicine (2004 – 2009) and books (Electrotherapy, Therapeutic Modalities for Musculoskeletal Injuries, and Physical Agents in Rehabilitation) about
Cryotherapy on acute soft tissue injuries. There were no more relevant articles found in the journals, but significant information was found in the books about the physiological effects of ice on the human body.

In the next stage of selecting the appropriate articles the title and abstract were screened for the above mentioned eligibility criteria. If I was unable to include or exclude an article by just reading the abstract, the article was fully read. Once the articles (N = 12) were chosen, those were divided into Single-Subject Studies (N = 1), Crossover Studies (N = 2), Clinical Trails (N = 5) and Reviews (N = 4). The clinical trails (N = 5) were rated for methodological quality using the PEDro Scale (Table 1). The PEDro Scale consists of an 11 – Point criteria list and is used to rate the quality of Randomized-controlled trails. The 11 – Point checklist has a maximum score of 10 if all points are satisfied, there were no points given for criteria number one, because it measures the study’s external validity. All study characteristics and data were summarized into a table (Table 2). The Author, Objective, Method and Conclusion were recorded.

To find out the current use of Cryotherapy on acute soft tissue in private practice a questionnaire was done in the Netherlands and in Germany. The questionnaire was developed in different stages; first a mind map was made of what would like to be known, in the next stage questions were formulated. While formulating those it was clear that the answers should be given in advance, because the evaluation later on would be quicker and the answers could be directly compared with one another. After the first draft was done, I asked different people to have a look at it and let me know their opinion about it. During the final stage I made a few changes on the layout, took the suggestions of the others into account and translated the final version into German. The purpose of the opinion poll was to establish an overview of the current use of Cryotherapy in private practice. The questions were aiming on the type of cooling agent, duration of use, experiences and patients’ response to Cryotherapy, plus on the knowledge about the recent evidence based data of Cryotherapy. This questionnaire was distributed in two rounds via email to several clinics in the Netherlands (N = 75) and Germany (N = 75); the first round was done between the 20th of December 2009 and the 12th of January 2010, the second round was used as a form of reminder and was done on the 20th of January 2010. All of the data was gathered and analysed with Excel 2003 on the 22nd of January 2010. The overall compliance rate was 22%; out of 150 questionnaires, 33 were answered. 2 surveys had to be excluded, since the questions were not answered in a clear manner. The rest were sorted and the answers processed into Excel.
3. Results
In this section the gathered data will be displayed and summarised, I differentiated between the evidence based data and the expert opinions. A confrontation between Germany and the Netherlands is made in the discussion section later on.

3.1. The Evidence Proven Data

The articles which are used in this thesis were subdivided into four groups, Single-Group Study (N = 1), Crossover Studies (N = 2), Clinical Trails (N = 5) and Reviews (N = 4). The Key factors of each article are displayed in Table 2 and 3.

3.1.1. Single-Group Study

Algafly & George, 2007 showed the effects of local crushed ice applications on the ankle towards the nerve conduction velocity (NCV), pain threshold (PTH) and pain tolerance (PTO). 23 sports players were recruited and received an ice application on one ankle, the other side served as the control side. The NVC of the tibial nerve was measured by an electromyogram (EMG), the PTH and PTO was determined by a pressure algometer. The data were collected from both sides on the baseline, as well when the skin temperature was cooled down to 15ºC and 10ºC at the experimental side. It was shown that the NCV decreased and the PTH and PTO increased significantly on the experimental side; no changes were apparent on the control side. Those findings do not correspond with the gate control theory.

3.1.2. Crossover Studies

Janwantanakul, 2009 found out with repeated measures the effect of quantity of ice and contact area during 20 minute cooling period. 20 males volunteered to have an ice pack placed on their right thigh with an elastic bandage for compression for constant 20 minutes. Three ice packs measuring 18x23cm were containing 0.3, 0.6, and 0.8kg ice, and one pack measuring 20x25cm was containing 0.6kg of ice were used. Each participant got tested with all four ice packs, the recovery time in between was at least 24 hours. During the test the temperature was monitored at 1 minute intervals, this showed that the minimum temperature was reached after 8 to 9 minutes of cooling. The greatest cooling effect was reached with at least 0.6kg of ice in one pack; the cooling effect did not change by increasing the contact area.

Kennet et al., 2007 compared in his article the cooling efficiency of four different agents. Crushed Ice (CI), Gel Pack (GP), Frozen Peas (FP) and Ice-water immersion (WI) were tested on 9 healthy volunteers. The agent was applied to the right ankle for constant 20 minutes; each agent was tested on every participant. One measurement was taken in one session; between the sessions were at least 24 hours. The temperature of the skin
and agent were recorded with a thermal Imaging camera before the application, right afterwards and during a 30 minute re warming time. The application of the crushed Ice showed a significant greater cooling effect on the skin surface than the Gel Pack, and the Frozen Peas. The differences between the Crushed Ice and the Ice-water immersion were significant. Therefore are Crushed Ice and Ice-water immersion the most efficient cooling applications.

3.1.3. Clinical Trails

Bailey et al., 2007 measured in his randomized controlled Trail the effects of cold-water immersion on the indications of muscle damage following prolonged intermittent exercise. Twenty healthy males volunteered to take part in this study, whose average age 22.3 years with a standard deviation of 3.3 years was. They all completed a 90min. periodical shuttle run, which has been shown to lead to soreness and muscle damage. After this exercise, the group was randomly divided into two equal groups; a cold-water immersion group and a control group. The first group received a 10min. cold-water bath of their lower limbs (iliac crest was fully underwater) immediately after the exercise, the water temperature of 10°C was maintained by adding crushed ice. The second group did not receive any treatment and served as the control group. Muscle soreness was decreased in the intervention group at 1, 24, and 48 hours post-exercise. Muscular function and discharge of intracellular proteins were as well tested in both groups before exercises, during treatment and at regular intervals up to 7 days. The major results of this study were the reduced muscle soreness and muscle function up to 48 hours after exercise, and decreased serum myoglobin response 1 h after exercise.

Bleakley et al., 2006 aimed in this double-blind randomized controlled Trail on the differences of two icing protocols. 89 participants with a mild or moderate ankle sprain were randomly assigned into one of two treatment groups. One group used a standardized icing protocol using an ice pack (melting iced water in a plastic bag) constant for 20min. every two hours. The other group used the intermittent application form of placing the ice pack on the ankle for 10min., removing it, letting the ankle rest at room temperature for the next 10min. and reapplying the ice for 10minutes. This was repeated every two hours; both treatment groups continued their application forms for the first 72hours. As well both groups were introduced to a short exercises program, which should be preformed once a day for the first week. This program consisted out of ankle mobility, calf stretching and basic Proprioceptive exercises. At baseline and one, two, three, four, and six weeks after injury swelling, pain and the level of
function were recorded. Participants, who used the intermittent protocol, had significantly less ankle pain on activity in the first week than those who used the standardized protocol. After the first week were no significant differences between groups in terms of function, swelling, or pain at rest.

**Bleakley et al., 2009** preformed this double blind randomized controlled trial to compare the effectiveness of standard rehabilitation with an accelerated rehabilitation protocol after acute ankle sprain. 100 subjects with an acute ankle sprain grade 1 or 2 were randomly divided into two groups. One group received the standard PRICE rehabilitation and the other one this rehabilitation program including intermittent ice applications with early therapeutic exercises. After the first week both groups followed the standard rehabilitation program. Ankle function, pain, swelling and re-injury rate were recorded at the baseline and at weeks 1 to 4, the follow up assessment was carried out until week 16. In the first week there were significant differences between the groups favouring the exercise group concerning the ankle functions and level of activity. After the first week there were no more differences between the groups.

**Goodall & Howatson, 2008** aimed with this randomized controlled Trail on the efficacy of repeated cold-water immersion (CWI) in the recovery of muscle damage due to exercises. 18 sportive men were selected for this study and had to perform a bout of 100 drop jumps. After the exercises the group was divided into two equal groups, one received a seated 12 minute ice bath of the lower limbs (up to the iliac crest) in which the water temperature was maintained at 15°C by adding crushed ice, the other group served as the control group and remained seated whenever the other group had their ice bath. The intervention group received this ice bath immediately after the exercises and every 24h for the following three days. There were no significant differences between the groups concerning the recovery of exercises induced muscle damage.

**Knobloch et al., 2008** evaluated in his randomized controlled trail the discrepancies between Cryotherapy combined with compression and Cryotherapy alone on the Achilles tendon. 60 healthy volunteers were randomly allocated into two groups, one received Cryotherapy combined with compression and the other Cryotherapy alone. The agent was applied 3x10 minutes (3 times 10 minute application followed by 10 minutes of rest) on the ankle level covering the midportion of the Achilles tendon. The major outcomes of this study were that Cryotherapy with compression leads to a significantly stronger tendon oxygenation in the recovery period than Cryotherapy alone and that both groups
showed a significant improvement of the tendinous venous outflow. The capillary blood flow is decreased in all participants during the application, but during the recovery the group Cryotherapy combined with compression showed an increased capillary blood flow compared to the second group.

Table 1 displays shortly the score for each trail used in this paper, a detailed version can be found in the appendix.

<table>
<thead>
<tr>
<th>Study</th>
<th>PEDro</th>
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<tbody>
<tr>
<td>Bailey et al., 2007</td>
<td>4</td>
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<tr>
<td>Bleakley et al., 2006</td>
<td>7</td>
</tr>
<tr>
<td>Bleakley et al., 2009</td>
<td>9</td>
</tr>
<tr>
<td>Goodall &amp; Howatson, 2008</td>
<td>6</td>
</tr>
<tr>
<td>Knobloch et al., 2008</td>
<td>7</td>
</tr>
</tbody>
</table>

3.1.4. Reviews

Bleakley et al., 2004 determined in their systematic review of RCT's the use of ice in the treatment of acute soft tissue injuries. All RCT's up to April 2002, which focused on the recovery of humans from acute soft tissue injuries and using Cryotherapy, were included in this paper. The validity of the 22 included trails was measured by using the PEDro scale. The outcomes of the studies showed minor prove that ice combined with exercise is the most effective after injury. There was no sufficient outcome of studies, which assessed the effectiveness of ice on closed soft tissue injuries. The conclusion of this review is that there is a need of more high quality trails in order to establish evidence-based guidelines concerning ice as a treatment agent on acute soft tissue injuries.

Collins, 2007 focused with this review on concluding the evidence on the outcome of Cryotherapy used on acute soft tissue injuries. A comprehensive literature search was done up to 2006 on several databases, included were all human and animal trails as well as reviews, which focused on reduction of pain and swelling, improved function and reduced time to return to normal activity. The papers which were included in this article were six human trail, four animal trails and two systematic reviews. The conclusion of the human trails was that four out of six lacked in randomisation and blinding, the other two were well carried out, but only one showed statistical significance showing the benefits of cooling gel. The animal trails outcome was that modest cooling reduced swelling and excessive ice application is damaging the tissue. One of the reviews reports that Cryotherapy may accelerate the return to activity, the other one was inconclusive. This review shows that Cryotherapy applied right after the injury might have a positive effect on the treatment; however there is still insufficient data to prove this.
Hubbard et al., 2004 searched the English language literature in his systematic review for the effects of ice on the return to activity after a soft tissue injury. The search was carried out from 1976 to 2003 and aimed on RCT’s of Cryotherapy. The four used studies were assessed regarding validity with the PEDro scale; the score ranged from 2 to 4. Two of those article stated that using ice accelerates the return to activity after the sprain of an ankle, but the authors did not provide comprehensive statistical data of their results. The other articles did not show any statistical differences. The authors of this review concluded that there might be a positive effect of ice on the comeback of athletes to their activity, but to fully evaluate the effects of Cryotherapy further studies are required.

Hubbard & Denegar, 2004 defined in their review the clinical evidence base for the use of Cryotherapy. Eight databases were searched for RCT’s in English language, which had outcome measures including function, pain, swelling or range of motion. The same trails were assessed in this review as in the review of Bleakley et al., 2004. This review concludes that Cryotherapy might have a positive effect on decreasing pain, but until the proper effectiveness of Cryotherapy is known more clinical studies are needed.

Table 2: Summery of Systematic Reviews

<table>
<thead>
<tr>
<th>Author</th>
<th>Objective</th>
<th>Method</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bleakley et al., 2004</td>
<td>To determine the use of ice in the treatment of acute soft tissue injuries</td>
<td>Hand searches, citation tracking and computerized literature search up to April 2002 22 studies found (5 relating to soft tissue injuries, 17 relating to surgery)</td>
<td>Many more high quality studies are needed to establish evidence based guidelines</td>
</tr>
<tr>
<td>Collins, 2007</td>
<td>To conclude the evidence on the outcome of Cryotherapy used on acute soft tissue injuries</td>
<td>Comprehensive literature search was done up to 2006 on several databases All human and animal trails or systematic reviews which focused on reduction of pain and swelling, improved function and reduced time to return to normal activity were included</td>
<td>The evidence regarding that Cryotherapy improves clinical outcome of soft tissue injuries is insufficient</td>
</tr>
<tr>
<td>Hubbard et al., 2004</td>
<td>Research the effect of ice on return to participation after a soft tissue injury</td>
<td>English language literature was searched from 1976 – 2003 for RCT’s 4 articles were found</td>
<td>Cryotherapy used right after the injury may accelerate the return to participation</td>
</tr>
<tr>
<td>Hubbard &amp; Denegar, 2004</td>
<td>To determine the clinical evidence base for the use of Cryotherapy</td>
<td>8 Databases were searched for RCT’s in English language concerning the outcome measures function, pain, swelling or range of motion</td>
<td>With the focus on decreasing pain Cryotherapy might be helpful, although many more high quality trails are needed</td>
</tr>
<tr>
<td>Author</td>
<td>Objective</td>
<td>Method</td>
<td>Conclusion</td>
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<td>------------------------</td>
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<td>------------------------------------------------------------------------------------------------</td>
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<tr>
<td>Algaflly &amp; George, 2007</td>
<td>Measure the impact of ice application on the NVC, PTH and PTO</td>
<td>A within-subject experimental design N = 23 healthy sportsmen</td>
<td>Ice application can increase PTH and PTO, which can be linked to a decreased NVC</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Crushed ice was applied to one ankle, the other side served as the control side NVC, PTH and PTO was measured at a skin temperature of 15ºC and 10ºC on both sides</td>
<td></td>
</tr>
<tr>
<td>Bailey et al., 2007</td>
<td>Effects of cold-water immersion on muscle damage following a bout of prolonged intermittent exercise</td>
<td>Randomized Controlled Trail N = 20 males aged 22.3, S = 3.3</td>
<td>In the Cryotherapy group Soreness → reduced at 1, 24 and 48h (P &lt; 0.05)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two equal groups: One 10min. CWI after exercises, the other control group</td>
<td>Muscle function → lower at 24h and 48h after exercises Proteins → reduced serum myoglobin response</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tested before exercises, during treatment and at regular intervals up to 7 days on: Soreness, changes of muscular function and discharge of intracellular proteins</td>
<td>1h after exercise</td>
</tr>
<tr>
<td>Bleakley et al., 2006</td>
<td>Comparing two different icing protocols (intermittent and standard) on acute ankle pain</td>
<td>Double-blind Randomized Controlled Trail N = 44 sportsmen, N = 45 general public with mild/moderate ankle sprains</td>
<td>Intermittent application → less pain on activity (P &lt; 0.05) after one week</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standard application (n = 46) → 20min. Ice every two hours</td>
<td>No significant differences in function, swelling, or pain at rest</td>
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<tr>
<td></td>
<td></td>
<td>Intermittent application (n = 43) → 10min. Ice, 10min. rest, 10min. ice every two hours</td>
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<tr>
<td></td>
<td></td>
<td>Treatment continued over the first 72hours after injury</td>
<td></td>
</tr>
<tr>
<td>Bleakley et al., 2009</td>
<td>Effectiveness of standard rehabilitation with an accelerated rehabilitation protocol after acute ankle sprain</td>
<td>Double-blind Randomized Controlled Trial N = 100 with acute grade 1 or 2 ankle sprains</td>
<td>In the exercises group Activity level → significantly higher in terms of time spent walking (P &lt; 0.05), total step count (P &lt; 0.021) and cadence (P &lt; 0.047)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two equal groups: Standard PRICE rehabilitation, or accelerated rehabilitation incorporating intermittent ice applications with early therapeutic exercise over the first week</td>
<td>No differences between groups at any other time point</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tested at baseline and weeks 1-4 on ankle function, pain, swelling and re-injury rate</td>
<td></td>
</tr>
<tr>
<td>Goodall &amp; Howatson, 2008</td>
<td>Efficacy of repeated cold-water immersions in the recovery of exercise induced muscle damage</td>
<td>Randomized Controlled Trail N = 18 males aged 24, S = 5</td>
<td>CWI → no effect on Maximal Voluntary Contraction (MVC) of knee extensors, creatine kinase (CK), muscle soreness (DOMS), Range of Motion (ROM), and limb girth</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Two equal groups: One 12min. CWI post exercise and every 24hours for the following three days, the other control group</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Title</td>
<td>Methodology</td>
<td>Findings</td>
</tr>
<tr>
<td>-------</td>
<td>-------</td>
<td>-------------</td>
<td>----------</td>
</tr>
<tr>
<td>Janwantana kul, 2009</td>
<td>Effect of quantity of ice and contact area during 20-minute cooling period</td>
<td>Repeated Measures N = 20 males aged 21, S = 1.1 Ice packs: Three 18x23cm containing 0.3, 0.6, and 0.8kg, one 20x25cm containing 0.6kg ice Application: Right thigh with compression using an elastic bandage for 20 min. Temperature was monitored at 1 minute intervals</td>
<td>The lowest temperature was reached after 8-9 minutes cooling with at least 0.6kg of ice, the size of contact area did not alter the degree of cooling significantly</td>
</tr>
<tr>
<td>Kennet, 2007</td>
<td>Comparing 4 common Cryotherapy agents</td>
<td>Repeated Measures N = 9; 5 males and 4 females aged 24, S = 4.6 Cooling agents: Crushed Ice (CI), Gel Pack (GP), Frozen Peas (FP) and Ice-water immersion (WI) Application: 20 minutes to the right ankle, one measurement per session, between the session were at least 24 hours Temperature was measured before and after the application as well during a 30-minute rewarming period</td>
<td>CI and WI had the greatest cooling efficiency</td>
</tr>
<tr>
<td>Knobloch, 2008</td>
<td>Effect of combined Cryotherapy/Compression versus Cryotherapy alone on the Achilles tendon</td>
<td>Randomized Controlled Trail N = 60; 33 males and 27 females aged 33, S = 12 Two groups: Cryotherapy/Compression and Cryotherapy alone Application: Intermittent 3x10 min. covering the targeted midportion Achilles tendon</td>
<td>Combined Cryotherapy and compression is superior to Cryotherapy alone</td>
</tr>
</tbody>
</table>
3.2. Experts opinion

Here the results from the questionnaire will be summarized and shown in table 4. The question is written in the left column, the next column shows the answers of all the participants and the other two columns are showing the answers of the two different countries. The numbers are shown in percentage.

Table 4: Results from the questionnaire

<table>
<thead>
<tr>
<th>Question</th>
<th>Expert – Both Nations</th>
<th>Germany</th>
<th>Netherlands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using Cryotherapy</td>
<td>Yes 71%</td>
<td>Yes 53%</td>
<td>Yes 93%</td>
</tr>
<tr>
<td></td>
<td>No 29%</td>
<td>No 47%</td>
<td>No 7%</td>
</tr>
<tr>
<td>How often on acute soft tissue injuries</td>
<td>Often 55%</td>
<td>Often 56%</td>
<td>Often 54%</td>
</tr>
<tr>
<td></td>
<td>Rarely 45%</td>
<td>Rarely 44%</td>
<td>Rarely 46%</td>
</tr>
<tr>
<td>Which Agent</td>
<td>Ice Water 17%</td>
<td>Ice Water 36%</td>
<td>Ice Water</td>
</tr>
<tr>
<td></td>
<td>Crushed Ice 24%</td>
<td>Crushed Ice 21%</td>
<td>Crushed Ice 27%</td>
</tr>
<tr>
<td></td>
<td>Cold Pack 59%</td>
<td>Cold Pack 43%</td>
<td>Cold Pack 73%</td>
</tr>
<tr>
<td></td>
<td>None of them</td>
<td>None of them</td>
<td>None of them</td>
</tr>
<tr>
<td>Which mode</td>
<td>Intermittent 23%</td>
<td>Intermittent 56%</td>
<td>Intermittent</td>
</tr>
<tr>
<td></td>
<td>Constant 45%</td>
<td>Constant 22%</td>
<td>Constant 62%</td>
</tr>
<tr>
<td></td>
<td>Various 32%</td>
<td>Various 22%</td>
<td>Various 38%</td>
</tr>
<tr>
<td>Which duration</td>
<td>10 min. 45%</td>
<td>10min. 78%</td>
<td>10min. 23%</td>
</tr>
<tr>
<td></td>
<td>20 min. 36%</td>
<td>20min.</td>
<td>20min. 62%</td>
</tr>
<tr>
<td></td>
<td>Various 18%</td>
<td>Various 22%</td>
<td>Various 15%</td>
</tr>
<tr>
<td>Exercise after Ice</td>
<td>Yes 9%</td>
<td>Yes 11%</td>
<td>Yes 8%</td>
</tr>
<tr>
<td></td>
<td>No 55%</td>
<td>No 44%</td>
<td>No 62%</td>
</tr>
<tr>
<td></td>
<td>Various 36%</td>
<td>Various 44%</td>
<td>Various 31%</td>
</tr>
<tr>
<td>Beneficial for the patient</td>
<td>Yes 61%</td>
<td>Yes 53%</td>
<td>Yes 71%</td>
</tr>
<tr>
<td></td>
<td>No 16%</td>
<td>No 24%</td>
<td>No 7%</td>
</tr>
<tr>
<td></td>
<td>Not sure 23%</td>
<td>Not sure 24%</td>
<td>Not sure 22%</td>
</tr>
<tr>
<td>Reason for applying</td>
<td>Experience 58%</td>
<td>Experience 55%</td>
<td>Experience 60%</td>
</tr>
<tr>
<td></td>
<td>Common sense 8%</td>
<td>Common sense 9%</td>
<td>Common sense 7%</td>
</tr>
<tr>
<td></td>
<td>Clinical evidence 35%</td>
<td>Clinical evidence 36%</td>
<td>Clinical evidence 33%</td>
</tr>
<tr>
<td>Reason for not applying</td>
<td>Experience 56%</td>
<td>Experience 63%</td>
<td>Experience</td>
</tr>
<tr>
<td></td>
<td>Common Sense</td>
<td>Common sense</td>
<td>Common sense</td>
</tr>
<tr>
<td></td>
<td>Clinical evidence 44%</td>
<td>Clinical evidence 38%</td>
<td>Clinical evidence 100%</td>
</tr>
<tr>
<td>Question the evidence of Cryotherapy</td>
<td>Frequently 32%</td>
<td>Frequently 18%</td>
<td>Frequently 50%</td>
</tr>
<tr>
<td></td>
<td>Occasionally 65%</td>
<td>Occasionally 76%</td>
<td>Occasionally 50%</td>
</tr>
<tr>
<td></td>
<td>Never 3%</td>
<td>Never</td>
<td>Never</td>
</tr>
<tr>
<td>Reading literature regarding Ice in the past 4 years</td>
<td>Yes 58%</td>
<td>Yes 35%</td>
<td>Yes 86%</td>
</tr>
<tr>
<td></td>
<td>No 32%</td>
<td>No 53%</td>
<td>No 7%</td>
</tr>
<tr>
<td></td>
<td>Not sure 10%</td>
<td>Not sure 12%</td>
<td>Not sure 7%</td>
</tr>
</tbody>
</table>
4. Discussion
In this section first a comparison between the expert opinions and the evidence based data will be made, the second part will clarify the differences in the use of Cryotherapy between Physiotherapists in Germany and the Netherlands. The third part will discuss the limitations of this paper.

4.1. Evidence Based Data versus Expert Opinion

Taking a closer look at the overall outcome of the questionnaire and the evidence based data discrepancies are visible. The majority of asked therapists is using Cryotherapy on acute soft tissue injuries and is reading literature regarding ice, but favours the cold pack, which has been shown to be less effective in decreasing the skin temperature than crushed ice. Considering this, the question can be raised what literature they were reading. The Article of Kennet et al., was only published in English language in the Journal of Athletic Training. This could be the reason for not being read by the Therapists in Germany and the Netherlands. The language barrier is in my opinion the key factor for the conflicts in the results of the questionnaire. In addition the clinical evidences are questioned occasionally by most of the Therapists which is an indication that the experts are only reading literature in their native language.

My research was limited to English language articles and when the consulted Therapists only read German and Dutch articles, it showed that there is a lack of the latest information about Cryotherapy in other languages than English. Therefore, the Dutch and German physiotherapists should consider reading more international literature in order to provide the best care for their patients. Additionally experience is playing an important role while deciding whether to use ice or not, the experts are more convinced by their own know-how so far than from the researched data. Furthermore no guidelines were found, which state a clear protocol for the most effective use of cooling agents. The main consequence resulting from these factors is that Cryotherapy is not employed in the most efficient approach. If the experts were open to different techniques and willing to read more international literature, cold applications could be implemented more striking in the daily practice of treating acute soft tissue injuries.

4.2. Germany versus the Netherlands

Comparing the results of each country with another, it is obvious that Cryotherapy is used more frequently in the Netherlands than in Germany; as well literature concerning Ice is being read by the majority of the Dutch therapists. This reflects the two different educational systems from Germany and the
Netherlands. In order to become a Physiotherapist in the Netherlands you have to complete a three to four year study program at one of the Universities of applied science. The students will learn where to find articles, how to read and assess those. On top most of the used and read literature is in English, for this reason the Dutch students are familiar with the English physiotherapeutic terminology by the end of their study program.

In the German system the scientific part is neglected and the students there are following a three year more practical oriented study program at either a public or private Physiotherapy school. In order to achieve an international Bachelor degree the students have to follow an additional three year study program at one of the Universities for applied science in Germany. During those three years English literature and evidence based practice are slowly implemented in the study curriculum. Since it is not obligatory to have an academically degree for working in Germany, most of the German therapists are not trained in reading and evaluating research articles. On the other hand they are more hands-on orientated and are willing to experiment more with their patients, whereby it had been shown that the ice water and the crushed ice as cooling agents are more efficient than the cold pack in decreasing skin temperature. The most effective mode and duration of appliance are widely used among the German therapists, although the majority of them are not reading scientific literature. In both countries experience is the main reason for applying ice, the clinical evidence only plays a small role, which indicates again that there is a lack of knowledge about it amongst the therapists. Nevertheless, the patients’ reaction and response towards coldness is the most important indication for either treating an acute soft tissue with or without ice.

Amongst the therapists who are not favouring Cryotherapy, clinical evidence is the only reason for the ones in the Netherlands; this reflects the behaviour of being more scientifically orientated than practical. Since it seems that there is not enough literature supporting Cryotherapy in Dutch and the Physiotherapists in the Netherlands are mostly not reading articles concerning this subject written in English, those results are not surprising. For the German therapists who are not taking advantage of cold treatment, experience is the crucial criteria followed by clinical evidence. Those results are indicating a more practical approach than scientifically orientated like the Dutch.

The two following figures are showing a direct and graphical comparison of the two countries. The most relevant points were chosen; each nation can be identified by their dedicated flag.
4.3. Limitations of this paper

The articles used in this paper are not older than five years, which decreased the amount of studies to only eight. The majority of those studies had a low level of evidence and a small number of subjects. In only two studies the participants were actually injured (Bleakley et al., 2006, Bleakley et al., 2009), the other six studies used healthy subjects. Additionally, not more than two articles were found concerning the same objective and the articles are different study designs. The scoring of the trails was done by me; I am not a trained person and did this the first time. The chance that mistakes were made in the scoring is likely, as well there was no feedback given by a second viewer. I developed the questionnaire and
translated it into two languages (German and English); the responses from the Dutch experts might have been higher, if it was translated in Dutch. The compliance rate from the questionnaire was 22% and distributed via email, there was no personal contact involved and phone calls were not done either, which might have influenced the responses.

5. Conclusion
This paper provides an overview of the recent data concerning Cryotherapy on acute soft tissue injuries. The comparison between the evidence based data and the experts’ opinion, shows discrepancies, which confirms my hypothesis made in the beginning. Those differences are explained in detail in the Discussion section. My conclusion about the evidence based data is that Cryotherapy applied in the first 72 hours of an acute soft tissue injury is effective; the ideal agent is crushed ice in a waterproof plastic bag, which should be used for ten minutes followed by ten minutes of rest and then once more used for another ten minutes. This circle should be repeated every two hours. The majority of the questioned experts are in favour of the cold pack applied for constant ten minutes. These differences between the evidence based data and the currently practiced form of Cryotherapy prove a lack of international communication. The exchange of knowledge among one another needs improvement and the language barriers should be decreased in order to provide a consistent level of evidence based therapy. However, ice therapy is not fully understood and proven by now therefore a need for more high quality trails is present.
6. References


7. Appendix

7.1. Explanation and Purpose of this Questionnaire
7.2. The detailed PEDro Score of the trails
My name is Isabelle Hildebrandt and I am a fourth year physiotherapy student at the Hanzehogeschool in Groningen, Netherlands. In connection with my studies I am writing a bachelor Thesis on the effectiveness of Cryotherapy on acute soft tissue injuries. On the basis of this questionnaire I would like to determine the frequent use of Cryotherapy in private practice; the results will be anonymously implicated in my Thesis.

The filled out questionnaire can be send back to me via email (preferably) to Isabelle.Hildebrandt@hotmail.de or by mail to Isabelle Hildebrandt

Heymanslaan 7A

9714GE Groningen, Netherlands

Example of how to fill out the questionnaire:

Please mark the appropriate answer like it is shown below.

1. Do you use Cryotherapy to treat acute soft tissue injuries?
   - Yes
     - No → If answered No, please proceed with question 9 to 13.

On the following two pages you will find the actual questionnaire.
Questionnaire concerning the therapeutic use of Cryotherapy on Acute Soft Tissue Injuries

1. Do you use Cryotherapy to treat acute soft tissue injuries?
   - Yes
   - No → If answered No, please proceed with question 9 to 13.

2. How often do you use Cryotherapy to treat acute soft tissue injuries?
   - Often
   - Rarely
   - Never

3. Which Cryotherapy agent do you use the most in treating soft tissue injuries?
   - Cold Gel
   - Water Immersion
   - Crushed Ice
   - Cold Pack
   - None of the Mentioned

4. How do you apply Cryotherapy?
   - Intermittent
   - Constant
   - Various

5. Which duration do you choose when applying Cryotherapy?
   - 10 minutes
   - 20 minutes
   - 30 minutes
   - Longer than 30 minutes
   - Various

6. After applying a cooling agent do you proceed with exercise therapy?
   - Yes
   - No
   - Various
7. What are your patients’ responses to Cryotherapy?
   - Positive
   - Negative
   - Various

8. What are your experiences with cold treatment concerning...
   - Patients pain
     - Positive / Negative / Don’t have any
   - Edema control
     - Positive / Negative / Don’t have any
   - Level of function
     - Positive / Negative / Don’t have any
   - Healing process
     - Positive / Negative / Don’t have any

9. Do you think Ice therapy is beneficial for the patient?
   - Yes
   - No
   - Unsure

10. What is your reason for (not) applying cooling agents?
    - Experience
    - Common Sense
    - Clinical evidence

11. Do you question the clinical evidences of Cryotherapy?
    - Frequently
    - Occasionally
    - Never

12. Have you been reading literature supporting ice therapy over the past 4 years?
    - Yes
    - No
    - Unsure

13. Comments:
### 7.2. The detailed PEDro Score of the Trails

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Bailey et al., 2007</th>
<th>Bleakley et al., 2006</th>
<th>Bleakley et al., 2009</th>
<th>Goodall &amp; Howatson, 2008</th>
<th>Knobloch et al., 2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random allocation of subjects</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Concealed allocation</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Y</td>
</tr>
<tr>
<td>Groups were similar at baseline</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Blinding of Subjects</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Blinding of Therapists</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>Blinding of Assessors</td>
<td>N</td>
<td>Y</td>
<td>N</td>
<td>N</td>
<td>N</td>
</tr>
<tr>
<td>More than 85% compliance</td>
<td>N</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Intention to treat analysis</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Reported differences between Groups</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Point measures and measures of variability</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
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</tbody>
</table>