Cryotherapy treats injured areas but also effects the whole body to achieve:

- General wellness
- Injury recovery & Pain relief
- Anti-ageing
- Inflammatory Condition Rehabilitation
- Sport Performance
1. INTRODUCTION

Cryotherapy is a revolutionary concept in healthcare to significantly reduce pain, create a potent anti-inflammatory response and harness the body’s potential to accelerate healing by up to 50%. Also referred to as cryostimulation, it is a treatment that involves the use of cryogenic temperatures ranging between -75˚ and -160˚C. Treatments typically do not exceed 3 minutes allowing the skin to rapidly cool down to approximately 5˚C. This brief barrage of the thermoreceptors just underneath the surface of the skin puts into action a cascade of physiological effects that are highly therapeutic.

The use of cryogenic temperatures was developed by Dr. Yamauchi in Japan in 1978 for the treatment of pain and inflammation in rheumatoid arthritis patients. Cryotherapy protocols have however since been further developed in Europe and America and is now an established treatment modality for injuries and a number of inflammatory mediated diseases.

Cryoliving, Cape Town is the first Cryotherapy facility in South Africa while this form of treatment is used extensively abroad. In Europe alone more than 400 whole body cryotherapy facilities exist, mainly in hospitals and around 12000 health professionals such as physiotherapists provide local cryotherapy for its profound results. In Poland, for instance, physiotherapists are required to have access to local cryotherapy equipment in order to practice within the National Healthcare Fund.

Whole body cryotherapy occurs in an open-top cryogenic sauna which fills with nitrogen vapour, while local cryotherapy involves the application of a stream of nitrogen or CO2 vapour to a more targeted musculoskeletal structure such as an arthritic joint or sports injury.

Both Whole body and local cryotherapy have been well researched offering empirical evidence for the effective adjunct treatment of many conditions.

2. ICING VERSUS CRYOTHERAPY

Cryotherapy in this context is often confused with cold application such as icing. The treatments offer significantly different and even contrasting results. Icing cools down skin and tissue and has a penetrating effect due to high contact surface. Icing, slows down cellular activities making it ideal for acute injuries but not for longer term use.

In contrast, cryogenic gas is completely dry and at a temperature -75˚ to -160˚ colder than icing, stimulates the thermoregulators in the outer layer of skin with no penetrating effects. The body responds by rapidly speeding up cellular activity in attempt to generate compensatory heat. Cryotherapy is thus indicated for the sub-acute to chronic phase of injury recovery (post 72 hours) because of its stimulatory effect on the body’s healing mechanisms.

Most of the benefits derived from cryotherapy are systemic in nature and are a result of the body’s thermoregulation responses to the cold exposure.
### 3. SUMMARY OF OBJECTIVE CHANGES IN BLOOD MARKERS IN RESPONSE TO CRYOTHERAPY

<table>
<thead>
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<th>Section</th>
<th>Changes</th>
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| **THE ANTI-INFLAMMATORY RESPONSE**          | • Increased anti-inflammatory cytokine interleukin IL-10  
• Decreases in pro-inflammatory interleukin IL-2 and chemokine IL-8  
• Decrease in intercellular adhesion molecule-1  
• Stabilisation of lysosomal enzymes  
• Decreased ESR  
• Decreased CRP  
• Decreased histamine levels  
• Decreased pro-inflammatory cytokine TNF-α |
| **THE HORMONAL RESPONSE**                   | • Increased Beta-endorphin release  
• Increased norepinephrine release  
• Increased adrenocorticotropic hormone (ACTH)  
• Increased pro-opiomelanocortin (POMC) |
| **THE NEUROMUSCULAR SYSTEM**                | • Decreased troponin 1  
• Decreased creatinine kinase |
| **REDUCED OXIDATIVE STRESS**                | • Studies have shown that following whole body cryotherapy the total anti-oxidative status (TAS) within the body is increased |
| **BONE HEALTH**                             | • Decreased serum osteocalcin  
• Increased carboxyterminal cross-linked telopeptide of type I collagen (ICTP)  
• Osteogenic effect on bone remodelling seen in elite rugby players. New bone formation was indicated by:  
• Increased OPG  
• Increased OPG/RANKL ratio |
4. PHYSIOLOGICAL RESPONSES TO CRYOTHERAPY

- Analgesic effect and pain signal adaptation
- Vasoconstriction and vasodilation
- Hormonal response
- Reduced oxidative stress
- Anti-inflammatory response
- Thermoregulation
- Increased metabolism

Physiological responses to cryotherapy

www.cryoliving.com | 3
4. PHYSIOLOGICAL RESPONSES TO CRYOTHERAPY

4.1. THERMOREGULATION

- Thermoreceptors just under the surface of the skin are stimulated
- Information is sent from these receptors to the hypothalamus in the brain which responds to maintain homeostasis

4.2. VASOCONSTRICTION AND VASODILATION

- The body protects its core temperature by redirecting blood flow from the periphery towards the core
- Vasodilation rebound occurs as the body tries to reheat itself
- Vessels and capillaries dilate by up to 4 times their normal diameter
- This results in a significant increase in blood flow to the extremities, enriching cells with oxygen and enzymes to a greater degree

4.3. ANALGESIC EFFECT AND PAIN SIGNAL ADAPTATION

- Cold exposure drastically reduces the body’s ability to communicate pain signals by reducing the nerve conduction velocity.
- Thermoreceptors are larger diameter, fast conducting nerve fibres whereas pain receptors are usually small diameter and slower conducting fibres, mass stimulation of thermoreceptors cause inhibition of the pain signals being processed in the CNS
- After multiple sessions, the body adapts its perception to pain stimuli by desensitization or deactivation of nociceptors due to inhibition within the central nervous system which results in reduced ability to detect pain stimuli
- Reduction of pain memory
- These adaptations alters how the body perceives pain stimuli, offering benefits in chronic pain management
4.4. ANTI-INFLAMMATORY RESPONSE

- White blood cells secrete small proteins called cytokines which are involved in cell signalling and thus affect the behaviour of other cells
- These proteins can be either pro-inflammatory or anti-inflammatory
- During whole body cryotherapy pro-inflammatory cytokines are decreased and anti-inflammatory cytokines are increased

4.5. INCREASED METABOLISM

- As part of the body’s metabolic reheating mechanisms (thermogenesis) additional calories are burnt
- Norepinephrine released during cryotherapy is also a powerful hormone in accelerating the body’s metabolic processes
- Repeated exposure may result in longer term increased metabolism as the body adapts by increasing the number of mitochondria in adipose tissue, creating more brown fat

4.6. HORMONAL RESPONSE

- Beta endorphins are released which is the body’s natural morphine, bringing about pain relief and a sense of euphoria
- Norepinephrine is released which is a potent natural anti-inflammatory hormone that occurs intrinsically within the body

4.7. REDUCED OXIDATIVE STRESS

- Studies have shown that following whole body cryotherapy the total anti-oxidative status within the body is increased
- The body achieves an improved ability to eliminate free radicals, neutralize toxins and repair cellular damage
- This process can be powerful in the treatment of conditions such as multiple sclerosis and osteoarthritis as well have the added benefit of a powerful anti-ageing effect
5. MEDICAL BENEFITS OF CRYOTHERAPY

- Decreases chronic pain
- Decreases chronic inflammation
- Reduces lymphoedema
- Improves anti-oxidative status in the body
- Improves peripheral circulation
- Improves post-operative recovery
- Improves muscular fatigue and spasm
- Decreases muscle spasm and spastic paresis
- Improves erectile dysfunction

6. APPLICATIONS

6.1. BENEFITS OF CRYOTHERAPY FOR RHEUMATOID ARTHRITIS PATIENTS:

Cryotherapy, both localised and whole body, has been used in the management of the disease since it was first described in Japan in 1978. It is a highly beneficial adjuvant therapy, with studies showing multiple benefits, not least of which is an improved ability to do physiotherapy, significantly improving the outcome of a course of treatment.

- Improvements in well-being
- Decreased swelling and oedema
- Decreased use of NSAIDS in up to 40% of patients
- Relief of symptoms
- Reduction in pain and restriction of movement
- Improved ability to do physiotherapy directly following a treatment
- Reduced disease activity
- Decreased inflammatory markers: Decreased pro-inflammatory cytokines TNF-α and interleukin IL-1
- Improvements can still be seen three to six months following a course of treatments

We are and have been documenting case studies of our patients at Cryoliving, below is a case study of a patient with an auto-immune condition.

CASE STUDY OF CRYOTHERAPY IN THE MANAGEMENT OF PAIN IN AN AUTO-IMMUNE CONDITION

This 31 year old female presented with a 4 year history of unexplained swelling in both lower limbs and sometimes the whole body, with a sensation of heaviness in both legs. Her condition is currently medically undiagnosed despite seeing a multitude of medical specialists. She has described lower back pain and pain in her left hip. She reports that cardiovascular exercise had the potential to aggravate her symptoms and is a keen runner. She has described regular “flare-ups” as often as every six weeks where her entire body swells up and is unable to get out of bed. During this time running or any form of cardiovascular exercise is impossible.

Following her course of 20 WBC treatments, swelling and heaviness in her legs has reduced by up to 50% with fewer “flare-ups” overall. Range of motion of her lumbar spine had improved by up to 40% with nil pain on lumbar flexion and pain in her left hip had almost completely abated. She is currently back to running and has since completed Two Oceans Marathon and the Cape Argus cycle Tour 2016.

This case demonstrates the efficacy of whole body cryotherapy in the treatment of inflammatory conditions, we must however stress that the treatment does have an accumulative effect and so a course of treatment as in the case of the above patient usually brings the most favourable results.
6.2. BENEFITS OF WBCT IN ANKYLOSING SPONDYLITIS

- Decreased inflammatory markers
- Decreased CRP
- Decreased immunoglobulins (IgG, IgA)
- Decreased seromucoid
- Significant improvements in spinal mobility
- Pain relief
- Improvements in sleep quality and quantity
- Reduced joint swelling
- Reduced morning stiffness
- Reduced medication intake
- Improvements in joint mobility
- Improvements last up to 6 months following a course of treatment.

PATIENT STORY (EXTRACT FROM POWER FROM THE COLD, PAPENFUSS 2012)

"I would now like to mention the case of one gentleman suffering from Bekhterev’s disease (ankylosing spondylitis) who was treated with whole body cryotherapy at the health centre in Bad Haering. The disease had really managed to depress him completely over the years in fact. When I met him for the first time and asked him what he wanted from the therapy, the modesty of his answer completely surprised me: "I just want to be able to turn my light on and off in my apartment again, I haven’t managed to be able to reach the light switch for a long time". This desire was already outdone after just a few days of intense cold application. When I met him again in the spring of the following year, he told me full of pride that two three week serial cold therapies had already recuperated him to the extent that in the preceding winter he was able for the first time in many years again to stand once again on his beloved skis, and indeed do so over a course of more than 150 kilometers!"

6.3. BENEFITS OF WBCT IN PSORIASIS

Results are most obvious in the skin with decreased itchiness and flaking within a few days. Results have been shown to last for 3-6 months after a course of treatments. Reduces inflammation in swollen joints in psoriatic arthritis.

6.4. BENEFITS OF WBCT IN MS

Generalised improvement in MS has been noted, and the overall therapeutic effects are attributed to the multi-component effect of WBCT: influencing the central nervous system, regulation of muscle activity, inhibition of inflammation, pain relief and the effects on the limbic system, with a positive effect on emotional wellbeing. Studies have demonstrated the following effects:

- Reduced fatigue
- Pain reduction (predominantly secondary pain arising from spinal posture and consequent joint strain)
- Improved quality of life
- Decreased muscle spasticity
- Improved muscle activity on a functional EDSS score
- Reduced nystagmus
- Improved body stability when standing
- Increased physical fitness using an exercise tolerance test
- Decreased inflammation.
6.5. BENEFITS OF WBCT IN FIBROMYALGIA

- Analgesic effects
- Reduction in the number of painful pressure points (Nestler EJ et al, 2002)
- Decreased intensity of local and generalized pain
- Reduction in muscle rigidity
- Improvement of fatigue
- Improved sleep
- Improvement in mood
- General improvement of state of wellbeing (Zagribelny Z et al 1999).

CASE STUDY OF CRYOTHERAPY FOR THE TREATMENT OF FIBROMYALGIA

This 50 year old female presented with a 5 year history of Fibromyalgia. She described pain in the neck, midback, lower back and anterior arms that ranged from 5-8 out of 10 on the visual analogue scale. She has described the inability to sleep through the night for approximately 5 years, often waking with pain. She is currently on Arcoxia which provides temporary relief. All blood tests and MRI scans to the cervical spine were NAD.

Following five sessions of local cryotherapy, which were done daily, the patient had noticed that she was sleeping through the night. By session ten the patient had described pain relief in all of the affected areas by up to 85%.

This case demonstrates the efficacy of local cryotherapy in the management of fibromyalgia.
6.6. BENEFITS OF WBCT IN THE MANAGEMENT OF BACK PAIN

- Increased ability to exercise and maintain mobility
- Reduction of pain
- Interruption in the development of pain memory
- Improvement of muscular spasm
- Decreased inflammation
- Increased oxygen and nutrient supply to the joints and disc cartilage.

CASE STUDY OF LOCAL CRYOTHERAPY FOR THE TREATMENT OF CERVICAL NERVE ROOT IMPINGEMENT.

This 69 year old chartered accountant presented with an 18 month history of severe neck pain and right arm radiculopathy due to degenerative disc disease and nerve root compression from C3-C7. He presented with pain, paraesthesia and numbness of the right arm, with severe localised pain over the right elbow and some weakness of grip strength of the right hand. He had come to see us after consulting various other health professionals and was reluctant to take the surgical route.

Following a course of 10 sessions of physiotherapy and local cryotherapy the patient’s symptoms have been very much improved, pain in the neck has felt 80% better. Pain, paraesthesia and numbness in the right arm has completed abated. Grip strength in the right hand has been restored. He has been discharged and has since visited the Great Wall of China!

This case demonstrates the efficacy of the combination of physiotherapy and local cryotherapy in the treatment of nerve root impingement pain and related symptoms.

These case studies are examples of a few of the many people that have benefited from whole body and local cryotherapy. Testimonials can be found on our website at www.cryoliving.com

6.7. BENEFITS OF WBCT IN INSOMNIA

- Insomnia tends to have anxiety and stress as an underlying feature and it is important to address the cause
- WBCT has been demonstrated to be of benefit as part of a behavioural-therapeutic programme, with improvement of sleep patterns seen after a week of therapy.
- It has the following benefits:
  - Helps restore disrupted homeostasis in central activity levels
  - Increases a general sense of wellbeing
  - Increases the body’s natural endorphins which help to reduce the symptoms of anxiety and depression
  - Pain relief.

6.8. BENEFITS OF WBCT FOR DEPRESSION AND ANXIETY

Depression is a debilitating mood disorder characterised by multiple emotional, behavioural and somatic symptoms. Numerous drug therapies exist to normalise neurotransmitters in the brain that are found to be abnormal in depression.

Benefits of WBCT in the management of depressive symptoms

Significant reduction in depressive symptoms as measured on the Hamilton’s depression rating scale and Hamilton’s anxiety-rating scale (Rymaszewska J, 2008)

- Significant reduction in anxiety symptoms
- Improvements in sleep
  - Less difficulty falling asleep
  - Improved quality of sleep
  - Reduction in "early waking"
6.9. BENEFITS OF CRYOTHERAPY FOR ASTHMA

Bronchial asthma is a chronic reactive airways disease, characterised by inflammation of the bronchial tubes. The result of the inflammation is tubes that constrict in response to certain stimuli and an increased production of sticky mucus. Common asthma symptoms are:

- Coughing (particularly at night and in the early morning)
- Chest tightness, pressure or pain
- Wheezing
- Shortness of breath

Management of asthma involves avoidance of the trigger causes (e.g. house dust mite or cats), preventative medications and medicines that open up the airways during an asthma attack. What about asthma that is triggered by cold?

Cold-induced asthma occurs when a reflexive mechanism is triggered in the airways following exposure to the cold. It is not a contra-indication for WBCT, although initial treatments will be conducted under medical supervision. Some initial research is showing that whilst cold air in the airways can trigger bronchoconstriction, skin exposure can in fact lead to an improvement in the bronchoconstriction due to the body’s compensatory mechanisms following a treatment. Care is taken to minimise inhalation of the cold gas and observations about an individual’s response will dictate whether further treatments are indicated or not.

WBCT in the management of bronchial asthma

- Improvement in FEV1 is seen following a treatment
- Short-term dilatation of the bronchi and bronchiole
- Relaxation of respiratory musculature
- Inhibition of chronic inflammatory processes.

6.10. BENEFITS OF CRYOTHERAPY FOR ATOPIC DERMATITIS

Atopic dermatitis (AD) is a chronic inflammatory skin disease characterised by dry and itchy skin. Treatments mostly target suppression of the immune system and symptom control.

Benefits of Cryotherapy in atopic dermatitis

- increased antioxidative capacity
- reduced conduction velocity of peripheral nerves
- reduced acetylcholine, one of the neurotransmitters in atopic pruritus, reducing the itching (Klimenko, 2008)
- increased anti-inflammatory cytokines.
6.11. BENEFITS OF CRYOTHERAPY IN OSTEOARTHRITIS

Whole body cryotherapy has the advantage of treating the whole body as it is rare that a single joint is affected. Its multiple mechanisms of action mean that WBCT treats several factors at once. The therapeutic effect lasts for several months following a course of treatments.

WBCT in management of osteoarthritis
- Improvements in nutrient and oxygen supply to the cartilage
- Delayed disease progression
- Reduction in inflammation
- Reduction in pain
- Interruption of development of pain memory
- WBCT allows for analgesic effect before exercise hence maintaining mobility
- Decreased swelling
- In the case of joint pain, WBCT induces a local cold therapy on the inflamed joint, reducing pain and inflammation, and allowing activation of the surrounding musculature. This prevents degeneration and muscle atrophy occurring. The higher joint mobility ensures a better oxygen and nutrient supply to the joint cartilage. Following repeated treatments, adaptations occur leading to overall functional improvement.

Localised cryotherapy in the management of osteoarthritis
- Reduced joint oedema and swelling
- Improvements in joint mobility: increased range of motion and reduced stiffness
- Pain reduction
- Decreased pain during examinations.

6.12. BENEFITS OF WBCT FOR BONE HEALTH

Results in postmenopausal women showed statistically significant changes in bone turnover markers indicating new bone formation.
- Decreased serum osteocalcin
- Increased carboxyterminal cross-linked telopeptide of type I collagen (ICTP)
- Osteogenic effect on bone remodelling seen in elite rugby players. New bone formation was indicated by:
  - Increased OPG
  - Increased OPG/RANKL ratio.

6.13. CARDIOVASCULAR CONDITIONING

WBC affects the function of the cardiovascular system with increases in preload measures and not afterload. Exposure to cryogenic temperatures results in:
- Decreased heart rate
- Increase in stroke volume
- Increase in stroke index
- Induced parasympathetic modulation is increased

Systolic and diastolic blood pressure and total peripheral resistance measures do not change significantly. (Zalewski P, 2014).
APPLICATIONS

6.14. BENEFITS OF WBCT FOR TENDONITIS AND INFLAMMATION OF TENDON INSERTIONS

Inflammation of tendons or degenerative connective tissue disorders e.g. tennis elbow, Achilles tendonitis and chronic heel pain responds well to cryotherapy.

• Improvements in nutrient and oxygen supply to the tendons
• Reduction in inflammation
• Reduction in pain
• Reduced associated muscle spasm.

6.15. BENEFITS OF WBCT IN STROKE AND CEREBRAL PALSY

Muscle spasticity responds well to WBCT and localised cryotherapy and plays an important role in muscle relaxation and pre-treatment before physiotherapy.

• Improvements in gait and walking
• Improved tolerance of physical therapy
• Mood improvement
• Decreased muscle tone and spasticity
• Reduction in chronic pain
• Increased spontaneous muscle activity.
7. COMPRESSION THERAPY

We use a device called the BOA Compression Device designed according to the Dr Emil Vodder technique, a world leader in lymphatic drainage. It stimulates blood and lymph circulation, quickens the process of waste elimination, detoxifies and improves oxygenation and nourishment of tissue. By providing graduated compression (strongest at the ankle and decreasing going up the body) the compression device helps venous and lymph return, decreases venous pressure, prevents venous stasis and deterioration of venous walls, strengthens lymphatic tissue and efficiently relieves aching and heavy legs by aiding the body in moving blood and lymph upward against the pull of gravity.

COMPRESSION THERAPY - MEDICAL APPLICATIONS

- Lymphoedema of various aetiology
- Poor circulation due to vascular insufficiency
- Swelling of the lower limbs of various aetiology
- Swelling of the upper limbs of various aetiology
- Post-operative management of swelling (oedema)
- Oedema of the upper limbs post mastectomy
- Rehabilitation after injuries and contusions
- Prevention of deep vein thrombosis and embolism
- Prevention of varicose veins
- Sports massage settings for sport/exercise recovery.
8. RESEARCH SUMMARY

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<th>Title</th>
<th>Research Focus</th>
<th>Abstract</th>
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<tr>
<td>Adhesive capsulitis of the shoulder</td>
<td>Adhesive Capsulitis</td>
<td>Objective: To compare 2 different treatment approaches, physical therapy modalities, and joint mobilization versus whole-body cryotherapy (WBC) combined with physical therapy modalities and joint mobilization, for symptoms of adhesive capsulitis (AC) of the shoulder. Participants: Patients with AC of the shoulder (n=23). Intervention: Patients were randomly assigned to 2 groups. The WBC group received physical therapy modalities, passive joint mobilization of the shoulder, and WBC, whereas the non-WBC group received only physical therapy modalities and passive joint mobilization of the shoulder. Main Outcome Measures: Visual analog scale (VAS), active range of motion (ROM) of flexion, abduction, internal and external rotation of the shoulder, and the American Shoulder and Elbow Surgeons Standardized Shoulder Assessment Form (ASSIST) were measured before and after the intervention. Results: A statistically significant difference between groups was found for the VAS, active ROM of flexion, abduction, internal rotation, and external rotation, and the ASSIST with greater improvements in the WBC group (P&lt;0.01). Overall, both groups showed significant improvement in all outcome measures and ROM measurements from pre to post at a level of P&lt;0.01. Conclusions: There is significant improvement with the addition of WBC to treatment interventions in this sample of patients. Archives of Physical Medicine and Rehabilitation 2013;94:16-21</td>
<td><a href="http://www.ncbi.nlm.nih.gov/pubmed/232824715">http://www.ncbi.nlm.nih.gov/pubmed/232824715</a></td>
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<td>Antioxidation in MS</td>
<td>Multiple Sclerosis</td>
<td>There is evidence that multiple sclerosis (MS) is not only characterized by immune mediated inflammatory reactions but also by neurodegenerative processes. Neutralization of oxidative stress and excitotoxicity might represent a therapeutic approach to provide neuroprotection in MS. The purpose of this study was to compare changes in total antioxidant status and activities of chosen antioxidant enzymes, such as: SOD, CAT in erythrocytes of patients with MS before and after using WBC with control group. Materials and methods: 32 patients with multiple sclerosis (ICD10-G35) and 20 healthy subjects were recruited for the study. The examined MS group (n=16) was treated with a series of 10 daily exposures in a cryogenic chamber (2-3 min, from -110°C to -110°C) and program of exercises. The control MS group (n=16) had only exercises. Plasma TAS as well as SOD and CAT activities in erythrocytes were measured. Results: The level of TAS in MS patients was distinctly reduced compared to healthy subjects. After two weeks of WBC treatment an increase of TAS in the whole examined group (P&lt;0.01) were observed in relation to control MS group. There was not increase of Cu/ZnSOD and CAT activities. Conclusion. Our results suggest positive antioxidant effects of WBC as a short-term adjuvant treatment for patients suffered due to MS. J. Med. Invest. 57 : 168-173, February, 2010</td>
<td><a href="http://www.ncbi.nlm.nih.gov/pubmed/20299758">http://www.ncbi.nlm.nih.gov/pubmed/20299758</a></td>
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<td>WBC in athletes</td>
<td>sport</td>
<td>Cold therapy is commonly used as a procedure to relieve pain symptoms, particularly in inflammatory diseases, injuries and overuse symptoms. A peculiar form of cold therapy (or stimulation) was proposed 30 years ago for the treatment of rheumatic diseases, the therapy, called whole-body cryotherapy (WBC), consists of exposure to very cold air that is maintained at -110°C to -140°C in special temperature-controlled cryochambers, generally for 2 minutes. WBC is used to relieve pain and inflammatory symptoms caused by numerous disorders, particularly those associated with rheumatic conditions, and is recommended for the treatment of arthritis, fibromyalgia and ankylosing spondylitis. In sports medicine, WBC has gained wider acceptance as a method to improve recovery from muscle injury. Unfortunately, there are few papers concerning the application of the treatment on athletes. The study of possible enhancement of recovery form injuries and possible modification of physiological parameters, taking into consideration the limits imposed by antidoping rules, is crucial for athletes and sports physicians for judging the real benefits and/or limits of WBC. According to the available literature, WBC is not harmful or detrimental in healthy subjects. The treatment does not enhance bone marrow production and could reduce the sport-induced haemolysis. WBC induces oxidative stress at cell level. Repeated treatments are apparently not able to induce cumulative effects; on the contrary, adaptive changes on antioxidant status are elicited – the adaptation is evident where WBC precedes or accompanies intense training. WBC is not characterized by modifications of immunological markers and leukocytes, and it seems to not be harmful to the immunological system. The WBC effect is probably linked to the modifications of immunological molecules having paracrine effects, and not to systemic immunological functions. In fact, there is an increase in anti-inflammatory cytokine interleukin (IL)-10, and a decrease in proinflammatory cytokines IL-2 and tumour necrosis IL-2. Moreover, the decrease in intercellular adhesion molecule-1 supported the anti-inflammatory response. Lysosomal membranes are stabilised by WBC, reducing potential negative effects on proteins of lysosomal enzymes. The cold stimulation shows positive effects on the muscular enzymes creatine kinase and lactate dehydrogenase, and it should be considered a procedure that facilitates athletes' recovery. Cardiac markers troponin I and high-sensitivity C-reactive protein, parameters linked to damage on myocardial tissue, but also to tissue repair, were unchanged, demonstrating that there was no damage, even minimal, in the heart during the treatment. N-Terminal pro B-type natriuretic peptide (NT-proBNP), a parameter linked to heart failure and ventricular power decrease, showed an increase, due to cold stress. However, the NT-proBNP concentrations observed after WBC were lower than those measured after a heavy training session, suggesting that the treatment limits the increase of the parameter that is typical of physical exercise. WBC did not stimulate the paraventricular nucleus ovalis of the hypothalamus, which has a negative feedback to the stress, shown by an increase of noradrenaline (norepinephrine). We conclude that WBC is not harmful and does not induce general or specific negative effects in athletes. The treatment does not induce modifications of biochemical and haematological parameters, which could be suspected in athletes who may be cheating. The published data are generally not controversial, but further studies are necessary to confirm the present observations.</td>
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<td>Bone remodeling biomarkers</td>
<td>Osteogenic effect</td>
<td>Whole body cryotherapy (WBC) consists of a brief exposure to extreme cold air (110°C) in a controlled chamber and is applied in sports medicine to improve recovery from musculoskeletal trauma. The aim of this study is to better define the beneficial effect of WBC on the musculoskeletal system of athletes, in particular on bone remodeling. Remodelling osteoimmunological biomarkers (PG, RANKL and RANK) were measured after WBC treatment in 10 male rugby players randomly selected from the Italian national team. OPG levels were increased significantly, supporting the view that WBC induces an osteogenic effect. Further studies evaluating the effect of WBC on bone metabolism are desirable.</td>
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<td>Clinical relevance of cryotherapy</td>
<td>General applications</td>
<td>Whole Body Cryotherapy (WBC) is a hypothermic application designed to reduce musculoskeletal pain and inflammation. WBC stimulates the sympathetic nervous system via alpha-adrenergic receptors, causing dramatic peripheral vasoconstriction. This induces adaptive changes correlated with effects of analgesia, reduction of inflammation, and increases in serum markers of tissue repair. Research conducted over the last two decades, primarily in Europe, has established therapeutic efficacy of WBC in a wide range of clinical conditions. The largest focus of research have been pain management and athletic performance. It has been shown to effectively reduce pain and swelling and improve physical performance. Due to the numerous adaptive physiological responses, WBC has also been studied as an adjunct treatment for atop dermatitis, cardiovascular health, depression and Multiple Sclerosis.</td>
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Whole-Body Cryotherapy Enhances Acute Recovery of Running Performance in Well-Trained Athletes

Purpose: To examine the effects of a whole-body cryotherapy protocol (3 min at −11°C) on acute recovery and oxidative stress in high-intensity intermittent exercise at submaximal intensities. Methods: Eleven endurance athletes were tested twice in a randomized crossover design. 5 x 8 min of high-intensity running (HR) were followed by one hour of passive rest at ~22°C, that either included 3 min of whole-body exposure to −11°C (WB), or a placebo intervention of 3 min wearing a 0.4°C body-cooling vest (VC). A ramp test protocol was performed before HR (R1) and after the one hour recovery period (R2). Time to exhaustion (TTE) was measured along with alterations in oxygen content of the m. vastus lateralis (TSI), oxygen consumption (VO2), capillary blood lactate (lac), heart rate (HR) and rating of perceived exertion (RPE) during submaximal and maximal running. Results: The difference in TTE between R1 and R2 was lower in the WB condition compared to PBO (p < 0.05, effect size d = 1.13). During R2 TTE was higher in WB compared to submaximal and maximal running (p = 0.01, d = 0.38–1.81). In addition, VO2, HR and RPE were lower at submaximal level R2 following WB compared to PBO condition (p = 0.04 – <0.01, d = 0.23–0.83). Conclusion: NBC improves acute recovery during high-intensity intermittent exercise in thermoneutral conditions. The improvements might be induced by enhanced oxygenation of the working muscles as well as a reduction in cardiovascular strain and increased work economy at submaximal intensities.

Cryogenic Physical Therapy

Introduction: Rheumatism has been treated using whole-body cryotherapy (WBCT) since the 1970s. The aim of this study was to assess the efficacy of WBCT as an experimental, adjunctive method of treating depressive and anxiety disorders. Materials and Methods: A control (n=34) and a study group (n=26), both consisting of outpatients 18–65 years old with depressive and anxiety disorder (DSM-10) and with standard psychopharmacotherapy. The study group was additionally treated with a series of 15 daily visits to a cryogenic chamber (-110°C). In addition, the study group and a control group were also followed by 14 days of continuous WBCT at home. Results: Depression and anxiety symptoms in the study group showed an improvement of at least 50% from baseline HDSS-17 scores in 34.6% of the study group and 2.9% of the control group and a decrease of at least 50% from the baseline HARS score in 46.2% of the study group and in none of the control group. Conclusions: These findings, despite such limitations as a small sample size, suggest a possible role for WBCT as a short-term adjunctive method for mood and anxiety disorders.

The effect of submaximal exercise preceded by single wbct on markers of oxidative stress and inflammation in blood of professional volleyball players

The aim of the study was to determine the effect of single whole-body cryotherapy (WBCT) session applied prior to submaximal exercise on the activity of antioxidant enzymes, the concentration of lipid peroxidation products, total antioxidative status, and the level of cytokines in blood of high-intensity intermittent exercise at submaximal environment. Methods: Eleven endurance athletes were tested twice in a randomized crossover design. 5 x 8 min of high-intensity running (HR) were followed by one hour of passive rest at ~22°C, that either included 3 min of whole-body exposure to −11°C (WB), or a placebo intervention of 3 min wearing a 0.4°C body-cooling vest (VC). A ramp test protocol was performed before HR (R1) and after the one hour recovery period (R2). Time to exhaustion (TTE) was measured along with alterations in oxygen content of the m. vastus lateralis (TSI), oxygen consumption (VO2), capillary blood lactate (lac), heart rate (HR) and rating of perceived exertion (RPE) during submaximal and maximal running. Results: The difference in TTE between R1 and R2 was lower in the WB condition compared to PBO (p < 0.05, effect size d = 1.13). During R2 TTE was higher in WB compared to submaximal and maximal running (p = 0.01, d = 0.38–1.81). In addition, VO2, HR and RPE were lower at submaximal level R2 following WB compared to PBO condition (p = 0.04 – <0.01, d = 0.23–0.83). Conclusion: NBC improves acute recovery during high-intensity intermittent exercise in thermoneutral conditions. The improvements might be induced by enhanced oxygenation of the working muscles as well as a reduction in cardiovascular strain and increased work economy at submaximal intensities.

Effect of WBCT on total antioxidative status enzymes in blood of MS patients

There is strong evidence that multiple sclerosis (MS) is characterized not only by immune mediated inflammatory reactions but also by neurodegenerative processes. Accumulated data indicate that oxidative stress (OS) plays a major role in this process. Generated in excess, reactive oxygen species (ROS) lead to oxidative stress and are involved in demyelination and axonal damage in MS. ROS generation may be inhibited partly by hypothermia, which is known as a potent putative neuroprotectant and may inhibit generating free radicals and oxidative stress. Whole-body cryotherapy (WBCT) treatment may improve both survival and neurological outcome in MS patients. The aim of the study was to determine the effects of WBCT on oxidative stress by the level of total antioxidative status (TAS) in plasma and the activity of antioxidant enzymes: superoxide dismutase (SOD) and catalase (CAT) in the erythrocytes from MS patients. Moreover, we measured the combined effects of WBCT and melatonin on TAS and activity of antioxidative enzymes in MS patients. Sixteen MS patients were treated with 3 cycles of 10 exposures in a cryogenic chamber (-110°C). The last cycle was accompanied by a 14-day-long supplementation of melatonin (10 mg daily). Healthy subjects as a control group had 1 cycle of WBCT. Our preliminary results for the first time showed that WBCT treatment of MS patients resulted in the increase of TAS but had no effects on activity of antioxidative enzymes: SOD and CAT. Supplementation of melatonin and the treatment along with WBCT significantly increased the activity of SOD and CAT in erythrocytes of MS patients.

WBCT increases parasympathetic outflow and decreases core body temp

The cardiovascular, autonomic and thermal response to whole-body cryostimulation exposure are not completely known. Thus the aim of this study was to evaluate objectively and noninvasively autonomic and thermal reactions observed after short exposure to very low temperatures. We examined 20 healthy men with mean age 30.1± 1.7 years. All subjects were comparable anthropometrically characterized to cryotherapeutically exposed. The subjects were exposed to −10°C for 3 min in a cryogenic chamber (3 min, approx. 120°C). The cardiovascular and autonomic parameters were measured noninvasively with Task Forces Monitor. The changes in core body temperature were determined with the Vital Senses telemetric measurement system. Results show that 3 min to cryotherapeutic temperature causes significant changes in autonomic balance which are induced by peripheral and central blood volume changes. Cryostimulation also induced changes in core body temperature, maximum drop of core temperature was observed 50– 60 min after the stimulation. Autonomic and thermal reactions to cryostimulation were observed up to 6 hours after the exposure and were not harmful for examined subjects.

Depression and anxiety

Psychological

Arm. The whole body cryotherapy (WBCT) is becoming a more popular adjunct method in rehabilitation and renewal. The objective was to evaluate influence of WBCT on depressive and anxiety symptoms. Materials and methods: A study group (n=26) was treated using a series of 15 daily visits to a cryogenic chamber (-11°C to 160°C) which lasted 2-3 minutes each. A control (n=34) group was similar to the study group as concerning diagnoses (anxiety and depressive disorders), age and gender. Both groups received standard out-patient psychopharmacotherapy. The Hamilton Depression Rating Scale and Hamilton Anxiety Rating Scale were used to evaluate the severity of symptoms before and after WBCT (3 weeks observation). The self-rating life satisfaction scale was used as well. Two efficacy measures were established: a significantly greater reduction of scales’ scores and mean scores lower at the endpoint in the study group than in the control group. Results. Both efficacy criteria were fulfilled for the depression scale in 12 of the 16 HDRS-II items except gastrointestinal and genitourinary symptoms, hypochondria, body mass and crisis. Concerning the HARS scale, in 11 of 14 anxiety items (except gastrointestinal and genitourinary symptoms and behav-ior) the mean reduction was significantly bigger and the mean final status was better in the experimental group in comparison to the control one. As for the life satisfaction scale, efficacy was shown as well. For the as for the life satisfaction scale, efficacy was shown as well. As for the life satisfaction scale, efficacy was shown as well. As for the life satisfaction scale, efficacy was shown as well. As for the life satisfaction scale, efficacy was shown as well.
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<td>WBC in inflammatory and non-inflammatory rheumatic diseases</td>
<td>Rheumatology</td>
<td>There are only a few studies looking at the analgesic effect of cold chamber exposures in patients suffering from fibromyalgia. However, in addition to the pain symptoms, patients with this syndrome also frequently suffer from an increased sensitivity to cold. Thus, the effect of cold chamber exposures (30 min) on the sensitivity to pain, thermal comfort and actual pain intensity was examined in 17 female patients with fibromyalgia (ACR criteria) and compared with a control group without applications. The measured parameters were pressure, heart rate, systolic and diastolic blood pressure, and skin temperature. The results showed that the WBC exposure was well tolerated and produced a statistically significant increase in pain threshold and decrease in the sensation of cold. The findings suggest that WBC could be used as a non-pharmacological treatment for patients with fibromyalgia and other chronic pain conditions.</td>
<td><a href="http://www.cryolec.es/wp-content/uploads/2014/02/COLD-CHAMBER-EXPOSURES-IN-CHRONIC-PAIN-SYNDROMES.pdf">http://www.cryolec.es/wp-content/uploads/2014/02/COLD-CHAMBER-EXPOSURES-IN-CHRONIC-PAIN-SYNDROMES.pdf</a></td>
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<td>Pain in the elderly</td>
<td>Pain Management</td>
<td>Objective: To evaluate the analgesic effects of hyperbaric CO2 cryotherapy in elderly inpatients. Methods: An open-label prospective study was conducted in a geriatric department with patients aged over 70 years with a range of pain characteristics. Each patient underwent a physical examination followed by hyperbaric CO2 cryotherapy sessions, whose spacing and number were determined by the discretion of the physiotherapist. Patients completed a 100 mm visual analog scale for pain severity before and after the sessions. Results: We included 51 patients, who were treated between May 2 and June 30, 2005. Mean age was 83.7 years, and the female-to-male ratio was 4:1. The patients had acute or chronic pain whose origin was usually musculoskeletal (88.2%), or neurogenic (11.8%). Pain scores decreased significantly after four sessions, from 52 mm to 33 mm (P&lt;0.001) in patients with acute pain and from 45 mm to 13 mm (P&lt;0.001) in those with chronic pain. Conclusion: Hyperbaric CO2 cryotherapy is an innovative tool that should be incorporated within the non-pharmacological armamentarium for achieving pain relief in older patients.</td>
<td><a href="http://www.ncbi.nlm.nih.gov/pubmed/17897861">http://www.ncbi.nlm.nih.gov/pubmed/17897861</a></td>
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<td>Changes in lipid profile in response to three different protocols of whole-body cryostimulation treatments</td>
<td>Lipid Profiles</td>
<td>Systemic cryostimulation is useful treatment, both in sport and medicine, during which human body is exposed to an extremely low, cryogenic temperature (below -100 °C). Although there exist some evidence of its beneficial effects in biological regeneration, so far it has not been unequivocally determined if the positive effect of repeated cryostimulations depends on their number in a series. The aim of this research was to estimate the influence of 6, 10 and 20 sessions of 3 min-long exposures to cryogenic temperature (-130 °C) on the lipid profile in physically active men. Sixty-nine healthy volunteers participated in the study. The blood samples were taken in the morning, before the first cryostimulation session, and the other mornings after we last one (5th, 10th, 20th). In serum specimens the concentration of total cholesterol (TC), HDL cholesterol and triglycerides were determined using enzymatic methods. LDL cholesterol level was calculated using Friedewald formula. The changes in lipid profile (LDL decrease with simultaneously HDL increase) occurred after at least 10 sessions of cryostimulation.</td>
<td><a href="http://www.ncbi.nlm.nih.gov/pubmed/23585654">http://www.ncbi.nlm.nih.gov/pubmed/23585654</a></td>
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<td>Thermal and hemodynamic response to whole-body cryostimulation in healthy subjects</td>
<td>Clinical safety</td>
<td>Whole-body cryotherapy (WBC) is an increasing applied cryotherapeutic method, that involves application of a cryotherapeutic factor to stimulate the body by the means of intense hypothermia of virtually the body’s entire area. This method is still not well recognized in Western Europe. However, in recent years its becoming increasingly popular in sports medicine and also in clinical application. Cryotherapeutic agents used in WBC are considered to be a strong stress stimulus which is associated with a variety of changes in functional parameters, particularly the cardiovascular and autonomic nervous systems. Since very few studies have been documented in this field on the hemodynamic alterations and their adaptation to repeated whole-body exposures, the purpose of this study was to evaluate the acute and chronic responses to WBC exposures in healthy, young adult men. Thirty healthy male volunteers participated. Each subject took part in 5 WBC exposures. None of the participants had been exposed to such conditions previously. The research was conducted with modern and reliable measurements techniques, which assessed complex hemodynamic reactions and skin temperature changes. All measurements were performed pre- and po-intervention. The data analysis was performed using the ANOVA method. The results showed that WBC resulted in a significant decrease in heart rate, systolic and diastolic blood pressure, and increase in stroke volume, total peripheral resistance and baroreceptors reflex sensitivity. These changes were observed just after WBC exposure. At stages WBC 3 and WBC 6 there was observed a significant drop in baroreceptors reflex sensitivity due to increased thermogenesis. In conclusion, the present findings suggest that WBC strongly stimulates the baroreceptor cardiac reflex in response to body fluid changes which sequentially modulate HR and BP control in supine and resting healthy subjects. The study was performed on randomized and homogenous group of young healthy subjects. Our findings are important for WBC safety determination in research and clinical studies.</td>
<td><a href="http://www.researchgate.net/publication/248384343_Heartratevariabilityinwomenexposedtoverycoldair.110.2014.02.0520">http://www.researchgate.net/publication/248384343_Heartratevariabilityinwomenexposedtoverycoldair.110.2014.02.0520</a></td>
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<td>Heart rate variability in woman exposed to WBC</td>
<td>Haematology</td>
<td>Heart rate monitoring was used to measure heart rate variability (HRV) at thermoneutral conditions (Ta 24°C) in healthy women resting in supine position before and after and acute and repeated (3 times a week during a 3-month period) whole-body cryotherapies (WBC), at 110°C. The observed acute cooling-related increase in heart rate variability (IHF) in the short term, and increase in power (IHF) in the long term, after 3 months of repeated WBC the increase in parasympathetic tone was attenuated, which may be interpreted as an adaptation of autonomic function. The repeated WBC exposures-related increase in resting low frequency power (LFP) of RR-intervals during the 3 months resembles the response observed related to exercise training.</td>
<td><a href="http://www.researchgate.net/publication/229303510_Acute_effect_of_a_single_whole-body_cryostimulation_on_parasympathetic_balance_in_blood_of_healthy_young_men">http://www.researchgate.net/publication/229303510_Acute_effect_of_a_single_whole-body_cryostimulation_on_parasympathetic_balance_in_blood_of_healthy_young_men</a></td>
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<td>Acute effect of a single whole-body cryostimulation on prooxidant-antioxidant balance in blood of healthy young men</td>
<td>Haematology</td>
<td>We have examined the prooxidant–antioxidant reaction to extremely low temperatures (-120 degrees C) during a one-time cryostimulation in 15 young, clinically healthy individuals. The total lipid peroxides as the total oxidative status (TOS) and the total antioxidative status (TAS) were measured in blood plasma collected in the morning of the day of cryostimulation, 30 min after the cryostimulation, and on the following morning. The level of stress expressed by total oxidative status in plasma, resulting from exposure to extremely low temperatures, was statistically significantly lowered 30 min after leaving the cryochamber than prior to the exposure. The next day, the TOS level still remained lower than the initial values. The TAS level decreased after leaving the cryochamber and remained elevated the following day.</td>
<td><a href="http://www.researchgate.net/publication/229303510_Acute_effect_of_a_single_whole-body_cryostimulation_on_parasympathetic_balance_in_blood_of_healthy_young_men">http://www.researchgate.net/publication/229303510_Acute_effect_of_a_single_whole-body_cryostimulation_on_parasympathetic_balance_in_blood_of_healthy_young_men</a></td>
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<td>The effect of whole-body cryostimulation on the activity of lysosomal enzymes in kayaker women after intense exercise</td>
<td>Sport recovery</td>
<td>In this study higher activity of certain lysosomal enzymes with concomitant lower α1-antitrypsin activity was revealed in serum of kayaker women after intense exercise without any external stimuli as compared with the exercise preceded by extreme cold application. Whole-body cryostimulation may have hematic, beneficial impacts on reduction of muscle damage. Conclusion: In studied group of kayaker women the common markers of muscle damage like creatine kinase remain unchanged and the stress hormone—cortisol shows only a decreasing tendency after the WBC. Nevertheless, we found significant changes in activity of lysosomal enzymes and activity of protease inhibitor, which are also accredited parameters of post-exercise changes in organism. Thus we propose that these proteins may be novel indicators of the effects of application of whole-body cryostimulation in sportmen.</td>
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<td>Five-Day Whole-Body Cryostimulation, Blood Inflammatory Markers, and Performance in High-Ranking Professional Tennis Players</td>
<td>Sport recovery</td>
<td>Context: Tournament season can provoke overarching syndrome in professional tennis players, which may lead to decreased performance. Thus appropriate recovery modalities are crucial for athletes in order to maintain high-level performance and avoid injuries. We hypothesized that whole-body cryostimulation could be applied to support the recovery process. Objective: To assess the effects of 5 days of whole-body cryostimulation combined with moderate-intensity training on immunologic, hormonal, and hematologic responses, resting metabolic rate, and tennis performance in a posttournamnet season. Design: Controlled laboratory study. Setting: National Olympic Sport Centre, Patras or Other Participants: Twelve high-ranking professional tennis players. Intervention(s): Participants followed a moderate-intensity training program. A subgroup was treated with the 5-day whole-body cryostimulation (120 BC) applied twice a day. The control subgroup participated in the training only. Main Outcome Measure(s): Pretreatment and posttreatment blood samples were collected and analyzed for tumor necrosis Cryostimulation is a general term used to describe localized cold therapy, water immersion, and ice-pack therapy as well as whole-body cryostimulation. It is a popular rehabilitation method because it limits secondary tissue damage and functions as a support for training programs. Whole-body cryostimulation relies on the exposure of a whole organism to an extremely low temperature (below 100°C) in a specific chamber for 2 to 3 minutes. This form of cryostimulation was first (h) reported in 1970s by Yamauchi et al. Due to its limited availability, whole-body cryostimulation is used rarely. However, it may accelerate the factor α, interleukin 6, testosterone, cortisol, and creatine kinase. Resting metabolic rate and performance of a tennis drill were also assessed. Results: Proinflammatory cytokine (tumor necrosis factor α) decreased and pleiotropic cytokine (interleukin 6) and cortisol increased in the group exposed to cryostimulation. In the same group, greater stroke effectiveness during the tennis drill and faster recovery were observed whether the treatment program or cryostimulation affected resting metabolic rate. Conclusion: Professional tennis players experienced an intensified inflammatory response after the completed tournament season, which may lead to overtraining. Applying whole-body cryostimulation in conjunction with moderate-intensity training was more effective for the recovery process than the training itself. The 5-day exposure to cryostimulation twice a day ameliorated the cytokine profile, resulting in a decrease in tumor necrosis factor α and an increase in interleukin 6.</td>
<td><a href="http://www.cryolifehealth.com/wordpress/wp-content/uploads/2014/12/influence-of-5-day-wbc-on-high-ranking-tennis-players.pdf">http://www.cryolifehealth.com/wordpress/wp-content/uploads/2014/12/influence-of-5-day-wbc-on-high-ranking-tennis-players.pdf</a></td>
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<td>Effects of Whole-Body Cryotherapy vs. Far-Infrared vs. Passive Modalities on Recovery from Exercise-Induced Muscle Damage in Highly Trained Runners</td>
<td>Sport recovery</td>
<td>Enhanced recovery following physical activity and exercise-induced muscle damage (EIMD) has become a priority for athletes. Consequently, a number of post-exercise recovery strategies are used, often without scientific evidence of their benefits. Within this framework, the purpose of this study was to test the efficacy of whole-body cryotherapy (WBC), far-infrared (FIR) or passive (PAS) modalities in hastening recovery with the 48 hours after a simulated trail running race in 3 non-adjoining weeks. 9 well-trained runners performed 3 repetitions of a simulated trail run on a motorized treadmill designed to induce muscle damage. Immediately (post), post 24 h, and post 48 h after exercise, all participants tested three different recovery modalities (WBC, FIR, PAS) in a random order over the three separate weeks. Markers of muscle damage (maximal isometric muscle strength, serum creatine kinase [CK] activity and perceived sensations: δ, pain, tiredness, well-being) were recorded before, immediately after (post), post 1 h, post 24 h, and post 48 h after exercise. In all testing sessions, the simulated 48 min trail run induced a similar, significant amount of muscle damage. Maximal muscle strength and CK activities were recovered after the first WBC session (post 1 h), while only FIR (post 24 h) and FIR, and was not attained through the PAS recovery modality. No differences in plasma CK activity were recorded between conditions. Three WBC sessions performed within the 48 hours after a damaging running exercise accelerate recovery from EIMD to a greater extent than FIR or PAS modalities.</td>
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<td>The effects of prolonged whole-body cryostimulation treatment with different amounts of sessions on chosen pro- and anti-inflammatory cytokines levels</td>
<td>Haematology</td>
<td>Cryostimulation is used in the early treatment of acute injuries (sprains, strains, fractures) yet only a few papers discuss the possible influence of whole-body cryostimulation on inflammation mechanisms or immunology. It is postulated that cold exposure can have an immunomodulating effect related to enhanced nonadrenergic response and can be connected with paracrine effects. The aim of this study was to examine the effect of different sequences of whole-body cryostimulations on the level of pro- and anti-inflammatory cytokines in healthy individuals. The research involved 45 healthy men divided into three groups. The groups were subjected to 5, 10 or 20, 3-minute long whole-body cryostimulations each day at -130 °C. Blood was collected for analysis before the treatments, after completion of the whole series, and 2 weeks after completion of the series, for the examination of any long-term effect. The analysis of results showed that in response to cryostimulation, the level of anti-inflammatory cytokines IL-6 and IL-10 increased while IL-1α cytokine level decreased. It seems that the most advantageous sequence was the series of 20 cryostimulations due to the longest lasting effects of stimulation after the completion of the whole series of treatments.</td>
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<td>Time-course of changes in inflammatory response after Whole-Body Cryotherapy multi exposures following severe exercises</td>
<td>Sport recovery</td>
<td>The objectives of the present investigation was to analyze the effect of two different recovery modalities on classical markers of exercise-induced muscle damage (EIMD) and inflammation obtained after a simulated trail running race. Endurance trained males (n=11) completed two experimental trials separated by 1 month in a randomized crossover design; one trial involved passive recovery (PAS), the other a specific whole body cryotherapy (WBC) for 96 h post-exercise (repeated each day). For each trial, subjects performed an 8 min running treadmill exercise followed by PAS or WBC. The interleukin (IL)-1, IL-6, IL-10 tumor necrosis factor alpha (TNF-α), protein C-reactive (CRP) and white blood cells count were measured at rest, immediately post-exercise, and at 24, 48, 72, 96 h after. A significant time effect was observed to characterize an inflammatory response (PAS vs. WBC) following the exercise bout in all condition. Interestingly, IL-10 (Post 1 h) and CRP (Post 24 h) levels decreased and IL-1α (Post 1 h) increased following WBC when compared to PAS. In WBC condition (Post 0,24h), TNF-α, IL-10 and IL-6 remained unchanged compared to PAS condition. Overall, the results indicated that the WBC was effective in reducing the inflammatory process. These results may be explained by vasoconstriction at muscular level, and both the decrease in cytokines activity pro-inflammatory, and increase in cytokines anti-inflammatory.</td>
<td><a href="http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3145670/">http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3145670/</a></td>
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Cryotherapy in Osteoporosis

Osteoporosis

Cryotherapy is use of temperature lower than -100 degrees C onto body surface, for 2-3 minutes, in aim to cause physiological reactions for cold and to use such adapting reactions. Organism's positive response to cryotherapy supports treatment of basic disease and facilitates kinesitherapy. Low temperature may be obtained by use of air flow cooled with liquid nitrogen; this could be applied either locally, over chosen part of the body, or generally, over the whole body, in cryosauna or in cryochamber. The most efficiently is applying cryotherapy twice a day, with at least 3 hours interval. Kinesitherapy is necessarily used after each cryotherapy session. Whole treatment takes 2 to 6 weeks, depending on patient's needs. Cryotherapy reduces pain and swellings, causes skeletal muscles relaxation and increase of their force, also, motion range in treated joints increases. Thus, cryotherapy seems to fulfill all necessary conditions for rehabilitation in osteoporosis. Cryotherapy represents numerous advantages: it takes short time for applying, being well tolerated by patient, also patient's status improves quickly. In addition, contraindications against cryotherapy are rare. All this makes cryotherapy a method for a broad use in prophylactics and treatment of osteoporosis.

Do sessions of cryostimulation have influence on white blood cell count, level of IL6, and total oxidative and antioxidative status in healthy men?

Haematology

The influence of extremely low temperatures on the human body and physiological reactions are not fully recognized. It has been postulated that cryostimulation could modify immunological reactions, leukocytes mobilization and levels of cytokines. The aim of this research was to estimate the influence of a ten sessions 3-min-long exposures to cryogenic temperatures (~130 degrees C) on the white blood cell (WBC) count, level of IL6 and the total oxidative and antioxidative status in 15 young, clinically healthy men. Blood samples were obtained in the morning before cryostimulation, again 30 min after treatment and the next day in the morning, both during the first and tenth session. The WBC count, level of IL6 and total lipid peroxides as the total oxidative status and the total antioxidative status (TAS), were measured. After completing a total of ten whole-body therapy sessions a significant increase in WBC count, especially lymphocytes and monocytes was noted. There was an increase in level of IL6 after first and the last cryostimulation the most pronounced after tenth session. On the contrary the TAS level decreased significant after the treatment. It was concluded that repeated expositions to extremely low temperatures use in cryostimulation have mobilization effect on immunological system.

The influence of whole body cryotherapy on mental health

Psychological

The paper presents a little known issue about the influence of whole-body cryotherapy on mental health. Changes in a health of patients' behaviour after passing the cryogenic chamber leads to an interesting hypothesis. Short exposition to extreme cold has doubtless a profitable influence on man's frame of mind. Immediately after passing the cryogenic chamber, apart from the well known analgetic effect, we detect changes in patients' mental condition such as improvement of mood, deep relaxation, freshness up, consolidation of return to normal state such as improvement of mood, deep relaxation, freshness up, consolidation, euphoria. This unusual state lasts for a long time after ending the cycle of cryotherapy. Different mechanisms of this effect are considered. New possibilities of this method have been presented. Durability of such an advantageous phenomenon are investigated in our research centre in Wrocław.


Rheumatology

Background: As yet, whole-body cryotherapy is especially used for the therapy of chronic inflammatory arthritis. An analgetic effect has been described in several studies. However, only few data exist concerning the long-term effects of this therapy. PATIENTS AND METHODS: A total of 60 patients with rheumatoid arthritis (n = 48), and ankylosing spondylitis (n = 12) were analyzed. Patients underwent treatment with whole-body cryotherapy twice a day. The average age was 56.7 +/- 10.3. The study group consisted of 48 female and twelve male patients. The average number of therapeutic treatments with cryotherapy was 15.6 +/- 6.37, the average follow-up 63.4 +/- 63.48 days. RESULTS: 13 patients (21.7%) discontinued treatment because of adverse effects. For patients with rheumatoid arthritis, DAS28 (Disease Activity Score) and VAS (visual analog scale) were determined. A significant reduction of both parameters was found (DAS 3.9 +/- 1.22 vs. 3.4 +/- 1.08, p < 0.01, VAS 5.4 +/- 16.62 vs. 37.7 +/- 19.13, p < 0.01). BASDAI (Bath Ankylosing Spondylitis Disease Activity Index) was analyzed for patients with ankylosing spondylitis, and also showed a significant reduction (4.4 +/- 1.91 vs. 3.1 +/- 1.34, p < 0.01). DISCUSSION: Thus, whole-body cryotherapy is an effective option in the concept of treatment of inflammatory rheumatic diseases. The relief of pain allows an intensification of physiotherapy. A significant reduction of pain over a period of 2 months could be shown.

Evaluation of effectiveness of whole-body cryotherapy in patients with tinnitus

Tinnitus

MATERIALS AND METHODS: The research was carried out in 120 patients (aged 20-65) with tinnitus, divided into two groups: I--80 patients treated by cryotherapy and II--40 patients non treated. There were: 73 women and 47 men. Among patients of group I: 39 reported bilateral tinnitus, 20 reported right tinnitus, 15 reported left tinnitus. Among patients of II group: 39 reported bilateral tinnitus, 20 reported right tinnitus, 15 reported left tinnitus. The patients underwent 10 procedures in two cycles with the weekend break. They were in cryochamber in temperature of -110 degrees C for 3 minutes. After cryotherapy they used kinesitherapy for 45 minutes. Intensity of tinnitus in 138 ears and changes in intensity of tinnitus in 91 ears. After treatment decrease of tinnitus in 4 patients, decrease in their intensity in 47 patients, maintenance of the ailment on the same level in 47 patients. Evaluations of effectiveness of cryotherapy was analyzed with: nonparametric Wilcoxon test (treatment vs. placebo). The level of significance was 0.05.

The impact of whole-body cryotherapy on parameters of spinal mobility in patients with Ankylosing Spondylitis

Ankylosing Spondylitis

Background. The aim of our study was to assess the impact of whole-body cryotherapy with subsequent kinesitherapy on spinal mobility parameters in patients with ankylosing spondylitis. Material and methods. We enrolled 32 men with ankylosing spondylitis in a clinical trial. The subjects were randomly divided into 2 groups consisting of 16 persons, with no significant differences in age, duration, or stage of disease, treated with a cycle of 10 whole-body cryotherapy procedures with subsequent kinesitherapy or kinesitherapy alone, respectively. Routine spinal mobility parameters were determined for all patients before and after the end of the therapeutic cycle. Results. Significant improvement of spinal mobility was observed in both groups of patients, but in patients undergoing whole-body cryotherapy with subsequent kinesitherapy the percentage change in the values of particular parameters were more distinct as compared to patients in whom kinesitherapy alone was used, mainly in respect to lumbar and thoracic spinal mobility. Conclusion. The use of whole-body cryotherapy as a component of comprehensive therapy in patients with ankylosing spondylitis produces a significant improvement in spinal mobility parameters as compared to patients in whom kinesitherapy alone is used.
The effect of whole-body cryostimulation on the prooxidant-antioxidant balance in blood of elite kayakers after training

**Sport Performance**

The effect of whole-body cryostimulation prior to kayak training on the prooxidant-antioxidant balance was evaluated and compared to the effect of a single cryo-ostimulation treatment in untrained men. The kayakers underwent a ten-day training cycle with pre-training whole-body cryostimulation for three min (temperature -120 to -140°C) and training without cryostimulation as a control. Blood samples were obtained before and after the sixth and the tenth day of training and from the untrained men before and 20 min after cryostimulation.

In the untrained cryostimulation induced an increase in the activity of superoxidase dismutase (SOD) by 36% (P < 0.001) and glutathione peroxidase (GSH) by 68% (P < 0.01) in the erythrocytes and an increase in the conjugated dienes (CD) in plasma by 36% (P < 0.05) and in the erythrocytes by 71% (P < 0.001). In the kayakers comparing the effect of whole-body cryostimulation, the level of CD in plasma was 46% (P < 0.001) and 49% (P < 0.001) lower in erythrocytes, and the concentration of thiobarbituric acid-reactive substances in plasma was 24% (P < 0.05) lower with pre-training cryo-ostimulation. After the sixth day of training with cryostimulation, SOD activity was also 47% (P < 0.01) lower, while GSH activity after the tenth day was reduced by more than 50% (P < 0.01) as compared to control training. Whole-body cryostimulation per se stimulates the generation of reactive oxygen species. Yet, the oxidative stress induced by kayak training was reduced by prior exposure to extremely low temperatures.

**Multiple Sclerosis patients**

Assessment of pelvic overload syndrome treated in whole-body cryotherapy

**Spinal Overload Syndrome**

Background. In pain syndromes involving the lumbo-sacral region, the pelvis, and the lower extremities, the mobility of the hip joint is disrupted by structural and functional changes in tissues, which also cause irritation of the ligaments and muscles of the pelvis. Dislocation of the pelvis with incorrect alignment of the sacroiliac bone leads to an oblique load on the lumbar vertebrae and muscle tension. In recent years whole-body cryotherapy has come to be more and more often applied in the comprehensive treatment of spinal overload syndrome, to reduce pain, relax skeletal mobility, and increase joint mobility. Material and method. The research was conducted in the SP ZOZ outpatient rehabilitation clinic in Zgorzelec, Poland, from December 2004 to March 2005. The study group consisted of 20 patients, 13 women (65%) and 7 men (35%), ranging in age from 23 to 77 years (mean age 47). Each of the subjects received whole-body cryotherapy in a 20-day cycle, once a day for 3 minutes at a temperature of -130 degrees C. The length of the pelvic muscles implicated in overload syndrome, the pain perception of the pelvic ligaments, the Pidelou test, and Patrick’s symptom were assessed before therapy was commenced and after its completion. Immediately after each session the patients received kinesitherapy under supervision of a physiotherapist, Magine exercises, post-isometric relaxation under kinesio-taping, and resistance exercise of the muscles and the intraspinal, ilio-sacral and ilio-lumbar ligaments, active movement of the lumbar spine in the non-painful direction, and neuromobilization using Butler’s method. This was supplemented by exercises on the ergometer in horizontal position. Results. Whole-body cryotherapy applied together with kinesitherapy was effective in reducing pressure pain in the ligaments (average 20%) and tension in significant pelvic muscles (average 30%). Conclusions. The cryotherapy and kinesitherapy combination applied to the treatment of spinal overload syndrome gives satisfactory clinical outcome.

Influence of Whole Body Cryotherapy on depressive symptoms

**Psychological**

Background. Cryotherapy has a long tradition in somatic medicine. Yet we know very little about its impact on patients with depressive symptoms and therefore there is a real need for research in this field. Objective: The study reported here was an initial approach to whole-body cryotherapy (WBCT) as a potential treatment modality for depression and was expected to provide rough data helping to design a future project with extended methodology, larger sample groups and longer follow-up. Methods: 23 Patients aged 37–70 years gave informed consent to participate in the study. Ten WBCT procedures (160 s - 160 deg C) were applied within 2 weeks. Participants were recruited from depressed day hospital patients. Antidepressive medication was not ceased. Symptoms were rated at the beginning and end of this intervention using the 21-item Hamilton Depression Rating Scale (HDRS). Changes in scores were analyzed in the group of patients for every item separately as well as for the sum of all items for each patient. Results: All the patients started with the same high baseline score. In the individual item, the overall score for all patients together was significantly lower after WBCT. This means that all symptoms, except for day–night mood fluctuations, were presumably positively influenced by cryotherapy. The HDRS sum-score for each patient after WBCT was lower than that of the baseline and reached statistical significance in a paired samples t-test. Every patient was therefore considerably relieved after WBCT. Conclusions: It appears that WBCT helps in alleviating depressive symptoms. Should this be confirmed in the extended study we are currently implementing, WBCT may become an auxiliary treatment in depression.
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<th>Title</th>
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<td>Cryotherapy decreases histamine levels in the blood of patients with rheumatoid arthritis</td>
<td>Rheumatology</td>
<td>Introduction: Conventional physiotherapy (electrotherapy, magnetic fields), kinesitherapy, and whole-body cryotherapy (plus kinesitherapy) are used to relieve pain and inflammation or to improve function in rheumatic diseases. The aim of this study was to investigate the effects of different physiotherapies and cryotherapy on biochemical blood parameters of patients with rheumatoid arthritis (RA) and osteoarthritis (OA). Materials and methods: Twenty patients with RA and 17 patients with OA received whole-body cryotherapy at -140 to -160°C for 2 to 3 min, once daily for 4 weeks. The second-on group of patients (24 with RA and 28 with OA) received conventional physiotherapy for 4 weeks. We measured the parameters of neutrophil activation (respiratory burst, calcitriol) and markers of cartilage metabolism [β-aminopyrrolehistidine (NTPP-Hase), ectonucleotide pyrophosphohydrolase (NTPPase)] twice: before and 3 months after cryotherapy or physiotherapy. Results: We showed, for the first time, that cryotherapy significantly reduced (P &lt; 0.001) histamine levels in the blood of patients with RA. The effect was long-lasting (for at least 3 months). The levels of blood histamine in patients with OA were not changed significantly. Cryo-therapy also downregulated the respiratory burst of PMNs and NTPPase activity and upregulated calcitriol levels and the activity of NTPPase. However, these changes were not statistically significant. In contrast, there were no significant changes in histamine levels or the other biochemical parameters measured in groups of patients treated solely with physiotherapy and kinesitherapy. Conclusion: It may be concluded that the beneficial clinical effects of cryotherapy in RA patients are in part due to the action on the production, release, or degradation of histamine.</td>
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<td>The influence of whole body cryotherapy followed by relaxing gymnastics on bone turnover and muscular function in elderly women</td>
<td>Osteoporosis</td>
<td>To prevent the osteoporosis by applying physiotherapy is important for avoiding fractures. Cryotherapy is an established method of physiotherapy, and is usually followed by relaxing gymnastics. The aim of the study was to assess the possible influence of whole body cryotherapy followed by relaxing gymnastics on bone turnover and muscular function in elderly women. The study was carried out on 62 elderly women (mean age 69.2 ± 4.5 yr). None had a past history of osteoporotic fracture. Osteoporosis was diagnosed in 14 of them, osteopenia in another 30, and normal BMD was shown in the remaining 18. The control group were 20 young healthy women. The subjects were exposed to whole body cryotherapy for 6 weeks, 5 times weekly (3 min session each time) in a cryochamber of a temperature between -110 and -150°C. Then, they performed relaxing gymnastics for 45 minutes. Serum osteocalcin (OC) and carboxyterminal cross-linked telopeptide of type I collagen (ICTP) were measured, and a functional assessment of back flexors and extensors by the isokinetic method was carried out at the beginning and at the end of the study. We observed a statistically significant decrease of OC (p &lt; 0.05) and an increase of ICTP (p &lt; 0.05) in serum in the entire group of elderly women following the physiotherapy course. Bone turnover markers in the control group increased, but only statistically significant changes were in ICTP (p &lt; 0.05). The functional muscle analysis revealed positive influence of physiotherapy and cryotherapy on back flexors and extensors activity (p &lt; 0.05). In conclusion, cryotherapy followed by relaxing gymnastics influences the bone turnover in elderly women. On the other hand, this form of physiotherapy induced positive changes in muscle function, in terms of back flexors and extensors activity.</td>
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<td>The Effect of Three Different (-125 degrees C) Whole Body Cryotherapy Exposure Durations on Elite Rugby League Players</td>
<td>Sport recovery</td>
<td>Background: Whole body cryotherapy (WBC) is the therapeutic application of extreme cold air for a short duration. Minimal evidence is available for determining optimal exposure time. Purpose: To explore whether the length of WBC exposure induces differential changes in inflammatory markers, tissue oxygenation, skin and core temperature, thermal sensation and comfort. Method: This study was a randomised cross over design with participants acting as their own control. Fourteen male professional first team super league rugby players were exposed to 1, 2, and 3 minutes of WBC at -125 degrees C in each series. Testing took place the day after a competitive rugby league fixture, each exposure separated by seven days. Results: No significant changes were found in the inflammatory cytokines interleukin six. Significant reductions (p &lt; 0.05) in deoxyhaemoglobin for gastrocnemius and vastus lateralis were found. In vastus lateralis significant reductions (p &lt; 0.05) in oxyhaemoglobin and tissue oxygenation index (p &lt; 0.05) were demonstrated. Significant reductions (p &lt; 0.05) in skin temperature were recorded. No significant changes were recorded in core temperature. Significant reductions (p &lt; 0.05) in thermal sensation and comfort were recorded. Conclusion: Three brief exposures to WBC separated by 1 week are not sufficient to induce physiological changes in IL-6 or core temperature. There are however significant changes in tissue deoxyhaemoglobin, deoxyhaemoglobin, tissue oxygenation index, skin temperature and thermal sensation. We conclude that a 2 minute WBC exposure was the optimum exposure length at temperatures of -125 degrees C and could be applied as the basis for future studies.</td>
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