

Cryotherapy Studies Overview

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1.1 Acta Biomedical Engineering vol. 1-1-2006, Whole body cryotherapy

Authors:	Podbielska, H. – Strek, W. – Mueller, G.J. – Bialy, D.
Location/Date:	Poland, 2006
Aim/Purpose:	To compare the effectiveness of the conducted cryotherapeutic treatments in relation to particular depression symptoms
Study Overview:	23 patients: 18 women and 5 men, aged 37-70, treated for depressive dysfunctions. Patients had ten cryotherapeutic treatments between the 14 th of May and the 31 st of July 2001. The cycle of treatments, which lasted two weeks for each patient, consisted of two series of five treatments carried out only on weekdays. Between the series there was a weekend break. Each time patient was in the chamber for 160s. The temperature applied in cryogenic chamber during the first treatment was -110 degrees Celsius and with the analysis of organism adaptation was gradually lowered to -150 centigrade in case of a last treatment.
Result/Effect:	improvement in sleep disorders, such symptoms as tardiness of thinking, activity, jactitation, general somatic symptoms (headaches and others) and the loss of body mass were changed in over 80%

1.2 Beneficial effects of whole body cryotherapy on sport haemolysis

Authors:	Banfi, G. – Melegati, G. – Barassi, A. – Melzi d'Eril, G., T.Serna
Location/Date:	Italy, 2009
Aim/Purpose:	To determine whether WBC had a positive effect on erythrocyte metabolism, particularly during the recovery from exertional damage.
Study Overview:	10 male athletes (mean age 26±2.5 years; mean body-mass index 27.5±2.3 kg/m ²) underwent once daily WBC treatment for five days (Monday, Tuesday, Wednesday, Friday, and Saturday) at the Olympic Rehabilitation Center of Spała (Poland). Wearing minimal clothing, the subjects were first exposed to very cold air (30 s at -60°C) then to extremely cold air (2 min at -110°C). They reported an improved sense of general well-being and no discomfort or disturbance.
Result/Effect:	Observed the increase of haptoglobin and an increase of MSCV after the treatment period. WBC reduces sports haemolysis, as judged from MSCV and haptoglobin data, supported from other haematological values, as well as the absence of mean corpuscular volume and reticulocytes increase. The treatment is useful to prevent the physiological impairments derived from sport haemolysis

1.3 Clinical assessment of whole body cryotherapy treatment outcomes in fibromyalgia

Authors:	Kuehne, J.
Location/Date:	USA, 2011
Aim/Purpose:	To study if cryotherapy may provide therapeutic benefit to patients with fibromyalgia
Study Overview:	A 27-year-old female with long standing history of fibromyalgia presented for a total of 25 whole body cryotherapy (wbc) treatments at -170 degrees Celsius.
Result/Effect:	The patient reported improved sleep and energy level within the first 3 treatments. Her mood also began to improve. After 5 treatments, the patient reported a significant decrease in her pain perception, as well as improved concentration. Assessment after 12 treatments showed decreased pain sensation to trigger point pressure. At the completion of 25 treatments the patient's symptoms had improved significantly.

1.4 Effect of whole body cryotherapy on the levels of some hormones in professional soccer players

Authors:	Korzonek-Szlacheta, I. – Wielkoszynski, T. – Stanek, A. – Swietochowska, E. – Karpe, J. – Sieron, A., T.Serna
Location/Date:	Poland

Aim/Purpose:	The study was undertaken to determine blood serum concentrations of selected steroid hormones (estradiol--E(2), testosterone--T, dehydroepiandrosterone sulfate--DHEA-S) and luteinizing hormone (LH) in professional footballers subjected to whole body cryotherapy.
Study Overview:	Twenty-two clinically healthy males, mean age 26.7 years, were studied. The subjects underwent ten sessions of whole body cryotherapy in Wroclaw-type chamber, with kinesitherapy following each session. Blood samples were collected before and two days after the treatment and the results were analyzed statistically.
Result/Effect:	WBC leads to a significant decrease in serum T and E(2), with no effect on LH and DHEAS levels. As a results of cryotherapy, the T/E(2) ratio was significant increased. The changes observed are probably due to cryotherapy-induced alternation in the blood supply to the skin and subcutaneous tissue, as well as to modulation of the activity of aromatase which is responsible for conversion of testosterone and androstenedione to estrogens.

1.5 Effect of whole body cryotherapy on uric acid concentration in plasma of multiple sclerosis patients

Authors:	Miller , E. – Kedziora, J.
Location/Date:	Poland, 2011
Aim/Purpose:	Effect of WBC on uric acid concentration in plasma of multiple sclerosis patients
Study Overview:	Sample consisted of 21 females and 11 males. Mean age was 47.6±13.5 years, mean weight BMI 20.1±9.7, mean enhanced disability status scale (EDSS) score was 4.3±1.8 and mean disease duration was 11.5±9.5 years.
Result/Effect:	Main anti-oxidant in human blood – uric acid which was distinctly higher after WBC. UA concentration in plasma of MS patients 4.0±0.57 mg/dl is lower than in healthy controls (5,1 ±0.3 mg/dl). After using 10 exposures of WBCT increase of UA concentration observed after WBCT treatment is higher in MS patients (5,6 ±0.74 mg/dl) than in controls subjects (5,5 ±0.48 mg/dl).

1.6 Effects of whole body cryotherapy on serum mediators of inflammation and serum muscle enzymes in athletes

Authors:	Banfi, G. – Melegati, G. – Barassi, A. – Doglieotti, G. – Melzi d’Eril, G. – Dugue, B. – M. Corsi, M.
Location/Date:	Italy, 2008
Aim/Purpose:	Effect of WBC on uric serum mediators of inflammation and serum muscle enzymes in athletes.
Study Overview:	Compared changes in immunological parameters (C3, IgA, IgM, IgG, C-reactive protein, PGE2), cytokines(IL-2, IL-8, IL-10), adhesion molecules (sICAM-1), and muscle enzymes (creatine kinase, lactatedehydrogenase) before and after WBC in 10 top-level Italian National team rugby players. The subjects underwent 5 sessions on alternate days once daily for 1 week. During the study period, the training workload was the same as that of the previous weeks.
Result/Effect:	Compared to baseline values, immunological parameters remained unchanged, while CK and LAD levels significantly decreased after treatment. No alterations in immunological function were observed but there is a decrease in pro-inflammatory cytokine/chemokine and an increase in anti-inflammatory cytokine.

1.7 Effects of Whole-Body Cryotherapy in the Management of Adhesive Capsulitis of the Shoulder

Authors:	Ma, SY. – Je, HD. – Jeong, JH. – Kim, HY. – Kim, HD
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Location/Date:	Republic of Korea, 2012
Aim/Purpose:	Effect of WBC on physical therapy and joint mobilization
Study Overview:	30 patients with adhesive capsulitis of the shoulder were randomly assigned to either a "WBC group," which received WBC in addition to physical therapy and passive joint mobilization of the shoulder, or a "non-WBC group," which received only physical therapy and passive joint mobilization.
Result/Effect:	The WBC group showed greater improvements on average than the non-WBC group. After 4 weeks of treatment patients showed significant improvements in range of motion, pain and shoulder function

1.8 Effects of whole-body cryotherapy on a total antioxidative status and activities of some antioxidative enzymes in blood of patients with multiple sclerosis preliminary study

Authors:	Miller, E. – Mrowicka, M. – Malinowska, K. – Zolynski, K. – Kedziora, J
Location/Date:	Poland, 2012
Aim/Purpose:	The purpose of this study was to compare changes in total antioxidative status and activities of chosen antioxidative enzymes, such as : SOD, CAT in erythrocytes of patients with MS before and after using WBCT with control group.
Study Overview:	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 -120 to -110) 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.
Result/Effect:	The level of TAS in MS patients was distinctly reduced compared to healthy subjects. After two weeks of WBCT treatment an increase of TAS in the whole examined group (p 0,01) were observed in relation to control MS group.

1.9 Effects of whole-body cryotherapy on delayed onset muscle soreness

Authors:	Šarabon, N. – Fonda, B.
Location/Date:	Slovenia, 2012
Aim/Purpose:	The purpose of this study was to examine the effects of whole-body cryotherapy (WBC) on biochemical, sensational and performance factors after damaging exercise.
Study Overview:	<p>Subjects (age 26.9 ± 3.8 years, height 184.5 ± 7.7 cm and weight 90.5 ± 3.8 kg) performed a damaging bout of exercise including drop jumps with emphasis on larger hip flexion and, explosive leg curl exercise and eccentric leg curl exercise. Subjects were randomly assigned into two groups. The experiment was performed in two separate occasions, where one group undertook the WBC in the first session, while the other group did not use any of the recovery modality. After ten weeks, in the next session, groups were changed and the second group performed the WBC, while the first group did not use any of the recovery modalities.</p> <p>The WBC group performed the WBC one hour after the damaging exercise and then at the same time of the day for the next six days. WBC consisted of three minute exposure to temperatures ranging from -140 to -195 °C in a cryo-cabin (model: space cabin; Criomed, Ltd, Kherson, Ukraine). Feet were protected with warm shoes, while hands and head were not exposed.</p> <p>Subjects were tested prior, and 1, 24, 48, 72, 96 and 120 hours after the damaging exercise. They had to assess their pain sensation in two conditions and perform three squat jumps, three counter movement jumps, three maximal voluntary contractions, three maximally explosive contractions, and two fast frequency leg stampings.</p>
Result/Effect:	The results clearly demonstrate that repeated WBC significantly enhanced recovery process

	from damaging exercise to a greater extent compared to control group.
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2.0 Effects of Whole-Body Cryotherapy vs. Far-Infrared vs. Passive Modalities on Recovery from Exercise-Induced Muscle Damage in Highly-Trained Runners

Authors:	Hauswirth, C. – Louis, J. – Bieuzen, F. – Pournot, H. – Fournier, J. – Filliard, J-R. – Brisswalter, J. , T.Serna
Location/Date:	France, 2011
Aim/Purpose:	The purpose of this study was to test the efficacy of whole body cryotherapy (WBC), far infrared (FIR) or passive (PAS) modalities in hastening muscular recovery within the 48 hours after a simulated trail running race.
Study Overview:	In 3 non-adjointing 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.
Result/Effect:	Maximal muscle strength and perceived sensations were recovered after the first WBC session (post 1 h). 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.

2.1 Impact of 10 sessions of whole body cryostimulation on aerobic and anaerobic capacity and on selected blood count parameters

Authors:	Dybek, T. – Szygula, R. – Klimek, A. – Tubek, S.
Location/Date:	Poland. 2011
Aim/Purpose:	The purpose of this study was to see the impact of 10 sessions of whole body cryostimulation on aerobic and anaerobic capacity and on selected blood count parameters
Study Overview:	The study group included 32 volunteers – 16 women and 16 men. The volunteers underwent 10 sessions of WBCT in a cryogenic chamber. Blood samples (RBC, WBC, PLT, HGB, HCT) were taken, and aerobic and anaerobic efficiency and lactate concentration in capillary blood were measured before the first session and one day after the last one.
Result/Effect:	Ten sessions of whole body cryostimulation did not affect aerobic and anaerobic capacity in the tested group, although it improved the blood count parameters.

2.2 Impact of different treatment of whole-body cryotherapy on circulatory parameters

Authors:	Bonomi, FG. – De Nardi, M. – Fappani, A. – Zani, V. – Bandi, G., T. Serna
Location/Date:	Italy, 2012
Aim/Purpose:	The aim of this study was to investigate the effects of different treatment of WBC on blood pressure (BP) and heart rate (HR) parameters in adult subjects characterized from non-pathological values of BP.
Study Overview:	Eighty subjects (36 females, 44 males, age range 19-80 years) submitted to 4-17 WBC applications for a total of 816 treatments were recruited. Immediately before and after each WBC application systolic and diastolic BP and HR were measured and recorded.
Result/Effect:	No significant differences were found in BP and HR ($p > 0.05$). WBC seems to be safe with respect to unwanted BP and HR alterations for adult patients.

2.3 Influence of the 10 session of the whole body cryostimulation on aerobic and anaerobic capacity

Authors:	T. Klimer, A. – Lubkowska, A. – Szygula, Z. – Chudecka, M. – Fraczek, T. Serna
Location/Date:	Poland, 2010
Aim/Purpose:	To determine the influence of WBC on aerobic and anaerobic capacities.
Study Overview:	30 subjects (fifteen males and fifteen females) undertook two ergocycle trials before and after the ten sessions of cryogenic chamber treatment. To assess baseline aerobic capacity, the progressive cycle ergometer test was applied. This allowed determination of maximal oxygen uptake and ventilatory thresholds. Twenty-second Wingate test was performed to assess baseline levels of anaerobic power.
Result/Effect:	There were no changes in aerobic capacity, in both females and males, after ten sessions of 3-minute-long exposures to cryogenic temperature (-130°C). Participation in the whole body cryostimulation caused an increase in maximal anaerobic power in males (from 11.1 to 11.9 $\text{W}\times\text{kg}^{-1}$; $P < 0.05$), but not in females. : It can be concluded that whole body cryostimulation can be beneficial, at least in males, for increasing anaerobic capacity in sport disciplines involving speed and strength.

2.4 Influence of whole body cryotherapy on depressive symptoms – preliminary report

Authors:	Rymaszewska, J. – Tulczynski, A. – Zagrobelny, Z. – Kiejna, A. – Hadrys, T.
Location/Date:	Poland, 2003
Aim/Purpose:	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.
Study Overview:	Twenty-three patients aged 37–70 years gave informed consent to participate in the study. Ten WBCT procedures (160 s, -150°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.
Result/Effect:	Almost for each individual HDRS 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-test. Every patient was therefore considerably relieved after WBCT.

2.5 Lung function after acute and repeated exposures to extremely cold air (-110°C) during whole-body cryotherapy

Authors:	Smolander, J. – Westerlund, T. – Uusitalo, A. – Dugue, B. – Oksa, J
Location/Date:	Finland, 2006
Aim/Purpose:	The aim was to examine the effects of WBC on lung function in healthy humans after acute and repeated exposures.
Study Overview:	Twenty-five healthy, non-smoking subjects participated in the study. They were exposed to WBC for 2 min three times per week for 12 weeks. The peak expiratory flow rate (PEF) and forced expiratory volume in 1 s (FEV1) were measured before and after (at 2 and 30 min) the

	first WBC, and then similarly at 4, 8 and 12 weeks. At all time points, after 30 min of the WBC the PEF values were slightly lower compared with values before the WBC, and the reductions reached statistical significance at 1 month ($5.1 \pm 1.2\%$), and at 3 months ($3.2 \pm 1.7\%$). After 30 min of the first WBC, the FEV1 was significantly reduced by $2.3 \pm 0.8\%$, but no other changes were observed during the study.
Result/Effect:	WBC induced minor bronchoconstriction in healthy humans instead of proposed bronchodilatation. The WBC seems not to be harmful for lung function, but should be used with caution in susceptible individuals.

2.6 Muscle, Skin and Core Temperature after -110 °C Cold Air and 8 °C Water Treatment

Authors:	Costello, J.T. – Culligan, K. – Selfe, J. – Donnelly, A.E.
Location/Date:	United Kingdom, 2012
Aim/Purpose:	The aim of this investigation was to elucidate the reductions in muscle, skin and core temperature following exposure to 2110uC whole body cryotherapy (WBC), and compare these to 8uC cold water immersion (CWI).
Study Overview:	Twenty active male subjects were randomly assigned to a 4-min exposure of WBC or CWI. A minimum of 7 days later subjects were exposed to the other treatment. Muscle temperature in the right vastus lateralis (n = 10); thigh skin (average, maximum and minimum) and rectal temperature (n = 10) were recorded before and 60 min after treatment.
Result/Effect:	The present study demonstrates that a single WBC exposure decreases muscle and core temperature to a similar level of those experienced after CWI. Although both treatments significantly reduced skin temperature, WBC elicited a greater decrease compared to CWI. These data may provide information to clinicians and researchers attempting to optimize WBC and CWI protocols in a clinical or sporting setting.

2.7 Superficial Heat and Cold

Authors:	Klein, M. - T.Serna
Location/Date:	USA, Ongoing
Aim/Purpose:	
Study Overview:	
Result/Effect:	

2.8 The effect of prolonged whole-body cryostimulation treatment with different amounts of sessions on chosen pro- and anti-inflammatory cytokines levels in healthy men

Authors:	Lubkowska , A. – Szygula, Z. – Chlubek, D. – Banfi, G.
Location/Date:	Italy, 2011
Aim/Purpose:	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.
Study Overview:	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 stimulations, after completion of the whole series, and 2 weeks after completion of the series, for the examination of any long-term effect.
Result/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-1 α 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.
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2.9 The effect of whole-body cryostimulation on lysosomal enzyme activity in kayakers during training

Authors:	Wozniak, A. – Wozniak, B. – Drewa, G. – Kierzenkowska, C-M. – Rakowski, A.
Location/Date:	Poland, 2007
Aim/Purpose:	Effects of WBC on lysosomal enzyme activity, acid phosphatase, arylsulphatase and cathepsin, as well as the creatine kinase and cortisol concentration in the serum of kayakers during training.
Study Overview:	The kayakers were subjected to a 10-day training cycle, in which training sessions were preceded by WBC at a temperature ranging from -120 to -140 degrees C. Blood samples were taken from the kayakers before the training and after the sixth and tenth day of training from untrained men before and after cryostimulation.
Result/Effect:	Results support that preceding training with WBC alleviates exertion stress by stabilization of lysosomal membranes.

3.0 The increase in systolic and diastolic blood pressure after exposure to cryogenic temperatures in normotensive men as a contraindication for whole-body cryostimulation

Authors:	Lubkowska, A. – Suska, M.
Location/Date:	Poland, Ongoing
Aim/Purpose:	Study was to evaluate changes in blood circulation induced by a single exposure to very low temperature during whole-body cryostimulation
Study Overview:	The study included 40 young men aged 22±0.7 years, average body weight 76.65±7.8 kg and height 175.5±7.2 cm. The participants were exposed to extremely low temperatures in a cryogenic chamber. Each session lasted for 3 min at -130 °C and was preceded by 30 s of adaptation in a vestibule at -60 °C. Blood pressure and heart rate were measured before entering the chamber, immediately after exiting, and 10 and 20 min after exiting.
Result/Effect:	Results showed a significant increase in systolic blood pressure after cryostimulation (by an average of 21 mmHg in comparison with the initial level before cryostimulation) and an increase in diastolic blood pressure after the cryostimulation (by 9 mmHg). The increase in systolic blood pressure was accompanied by a significant decrease in heart rate (by about 10 bpm).

3.1 The influence of single whole body cryostimulation treatment on the dynamics and the level of maximal anaerobic power

Authors:	T. Klimer, A. – Lubkowska, A. – Szygula, Z. – Fraczek, B. – Chudecka, M.
Location/Date:	Poland, 2011
Aim/Purpose:	The objective of this work was to determine the dynamics of maximal anaerobic power (MAP) of the lower limbs, following a single whole body cryostimulation treatment (WBC), in relation to the temperature of thigh muscles
Study Overview:	The subjects included 15 men and 15 women with an average age (±SD) of 21.6±1.2 years. To evaluate the level of anaerobic power, the Wingate test was applied. The subjects were submitted to 6 WBC treatments at -130°C once a day. After each session they performed a single Wingate test in the 15, 30, 45, 60, 75 and 90th min after leaving the cryogenic

	chamber. The order of the test was randomized. All Wingate tests were preceded by an evaluation of thigh surface temperature with the use of a thermovisual camera.
Result/Effect:	A single whole body cryostimulation may have a minor influence on short-term physical performance of supra-maximal intensity, but it leads to improvement of velocity during the start as evidenced by shorter time required to obtain MAP.

3.2 The physiological basis and clinical application of cryotherapy and thermotherapy for the pain practitioner.

Authors:	Nadler, S. – Weingand, K. – Kruse, R.
Location/Date:	USA, 2004
Aim/Purpose:	
Study Overview:	
Result/Effect:	Therapeutic modalities are commonly used in the treatment of various musculoskeletal disorders. A thorough understanding of the physiologic effects of these modalities within the peripheral and central nervous system especially in regards to the pain-spasm-pain cycle is important for any clinician dealing with musculoskeletal pain. Newer research has demonstrated the superior effects of continuous cryotherapy and thermotherapy in the treatment of pain as opposed to intermittent treatment. Pain physicians need to be aware of current research into therapeutic modalities, which may be utilized by their patients in therapy and at home.

3.3 Thermal responses during and after whole-body cryotherapy (-110 C)

Authors:	Westerlund, T. – Oksa, J. – Smolander, J. – Mikkelsen, M
Location/Date:	Finland, 2003
Aim/Purpose:	Study the effect of WBC on rectal and skin temperatures on healthy subjects
Study Overview:	The effect of whole-body cryotherapy (WBC) on rectal and skin temperatures was measured in healthy subjects before, during and after WBC exposure. WBC did not cause any significant change in rectal temperature. The lowest local skin temperatures were recorded in the forearm, 5.2 (2.8)C, and in the calf, 5.3 (3.0)C. WBC involves no risk for frostbites.
Result/Effect:	All skin temperatures recovered rapidly, analgesic effects of WBC only occur during a limited period after the exposure

3.4 Thermal, circulatory and neuromuscular responses to whole body cryotherapy

Authors:	Westerlund, T.
Location/Date:	Finland, 2009
Aim/Purpose:	To examine thermal (body temperature, thermal sensation and comfort ratings) circulatory (blood pressure, heart rate variability) and neuromuscular performance response to WBC.
Study Overview:	Altogether 66 healthy subjects were exposed to WBC for two minutes. The acute and long-term changes were examined, when the subjects were exposed to WBC three times a week during three months.
Result/Effect:	Increase of systolic and diastolic blood pressure, increase in cardiac parasympathetic modulation, signs of neuromuscular adaptation

3.5 Thermotherapy for treating rheumatoid arthritis (Review)

Authors:	Robinson, VA. – Brosseau, L. – Casimiro, L. – Judd, MG. – Shea, BJ. – Tugwell, P. – Wells, G.
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Location/Date:	USA, 2008
Aim/Purpose:	To evaluate the effectiveness of different thermotherapy applications on objective and subjective measures of disease activity in patients with RA.
Study Overview:	Seven studies (n=328 participants) met the inclusion criteria. The results of this systematic review of thermotherapy for RA found that there was no significant effect of hot and ice packs applications (Ivey 1994), cryotherapy (Rembe 1970) and faradic baths (Hawkes 1986) on objective measures of disease activity including joint swelling, pain, medication intake, range of motion (ROM), grip strength, hand function compared to a control (no treatment) or active therapy. There is no significant difference between wax and therapeutic ultrasound as well as between wax and faradic bath combined to ultrasound for all the outcomes measured after one, two or three week(s) of treatment (Hawkes 1986). There was no difference in patient preference for all types of thermotherapy. No harmful effects of thermotherapy were reported.
Result/Effect:	Superficial moist heat and cryotherapy can be used as palliative therapy. Paraffin wax baths combined with exercises can be recommended for beneficial short-term effects for arthritic hands. These conclusions are limited by methodological considerations such as the poor quality of trials.

3.6 Thermotherapy for treatment of osteoarthritis (Review)

Authors:	Brosseau, L. – Yonge, KA. – Robinson, V. – Marchand, S. – Judd, M. – Wells, G. – Tugwell, P.
Location/Date:	USA, 2008
Aim/Purpose:	To determine the effectiveness of thermotherapy in the treatment of OA of the knee. The outcomes of interest were relief of pain, reduction of edema, and improvement of flexion or range of motion (ROM) and function.
Study Overview:	Three randomized controlled trials, involving 179 patients, were included in this review. The included trials varied in terms of design, outcomes measured, cryotherapy or thermotherapy treatments and overall methodological quality. In one trial, administration of 20 minutes of ice massage, 5 days per week, for 3 weeks, compared to control demonstrated a clinically important benefit for knee OA on increasing quadriceps strength (29% relative difference). There was also a statistically significant improvement, but no clinical benefit in improving knee flexion ROM (8% relative difference) and functional status (11% relative difference). Another trial showed that cold packs decreased knee edema.
Result/Effect:	Ice massage compared to control had a statistically beneficial effect on ROM, function and knee strength. Cold packs decreased swelling. Hot packs had no beneficial effect on edema compared with placebo or cold application. Ice packs did not affect pain significantly, compared to control, in patients with OA. More well designed studies with a standardized protocol and adequate number of participants are needed to evaluate the effects of thermotherapy in the treatment of OA of the knee.

3.7 Time-Course of Changes in Inflammatory Response after Whole-Body Cryotherapy Multi Exposures following Severe Exercise

Authors:	Pournot, H. – Bieuzen, F. – Louis, J. – Fillard, J-R. – Barbiche, E. – Hausswirth, C.
Location/Date:	France, 2011
Aim/Purpose:	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.

Study Overview:	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 a 48 min running treadmill exercise followed by PAS or WBC. The Interleukin (IL) -1 (IL-1), IL-6, IL-10, tumor necrosis factor alpha (TNF-a), protein C-reactive (CRP) and white blood cells count were measured at rest, immediately post-exercise, and at 24, 48, 72, 96 h in post-exercise recovery. A significant time effect was observed to characterize an inflammatory state (Pre vs. Post) following the exercise bout in all conditions (p,0.05). Indeed, IL-1b (Post 1 h) and CRP (Post 24 h) levels decreased and IL-1ra (Post 1 h) increased following WBC when compared to PAS. In WBC condition (p,0.05), TNF-a, IL-10 and IL-6 remain unchanged compared to PAS condition.
Result/Effect:	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.

3.8 Topical Cryotherapy – Use for Relief of Pain and Spasticity

Authors:	Mead, S. – Knott, M.
Location/Date:	USA, YEAR
Aim/Purpose:	The purpose of this article is to indicate an alternative procedure – removal rather than addition of heat to the body.
Study Overview:	
Result/Effect:	Treatment by local or general chilling has advantages. It is more sedative than heat and at the same time is without its enervating effects. Usually more pain-relieving than heat, by the mechanism of transient peripheral nerve block. Far more relaxing effect on spasticity and rigidity than heat. Specifically indicated and heat is specifically contraindicated in acute trauma.

3.9 Translating whole-body cryotherapy into geriatric psychiatry—a proposed strategy for the prevention of Alzheimer’s disease

Authors:	Misiak, B. – Kiejna, A.
Location/Date:	Poland, 2012
Aim/Purpose:	
Study Overview:	
Result/Effect:	

4.0 Whole body cryotherapy as a novel adjuvant therapy for depression and anxiety

Authors:	Rymaszewska, J. – Ramsey, D.
Location/Date:	Poland, 2008
Aim/Purpose:	The objective was to evaluate influence of WBCT on depressive and anxiety symptoms.
Study Overview:	The study group (n=26) was treated using a series of 15 daily visits to a cryogenic chamber (-110 to -160 C) which lasted 2-3 minutes each. A control group (n=34) was similar to the study group as concerning diagnoses (anxiety and depressive disorders), age and gender. Both groups received standard out-patient psychopharmacotherapy.
Result/Effect:	Both efficacy criteria were fulfilled for the depression scale in 12 of the 16 HDRS items except gastrointestinal and genitourinary symptoms, hypochondria, body mass and criticism. Concerning the HARS scale, in 11 of 14 anxiety items (except gastrointestinal and genitourinary symptoms and behavior) 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 in 6 of the 11 items: physical and mental health, everyday activity, vocational activity, hobbies and general life satisfaction in the experimental group.
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4.1 Whole-Body Cryostimulation – Potential Treatment for Improving Antioxidant Capacity in Healthy Men – Significance of the Number of Sessions

Authors:	Lubowska, A. – Dolegowska, B. – Szygula, Z. 2012
Location/Date:	Poland, 2012
Aim/Purpose:	This research is aimed to evaluate the effect of a series of whole-body cryostimulations on the level of non-enzymatic antioxidants and the activity of antioxidant enzymes in healthy men.
Study Overview:	The study was carried out on 30 young and healthy men aged 27.866.1 years with average body mass index and peak oxygen consumption (46.3466.15 ml kg ⁻¹ min ⁻¹). The participants were daily exposed for 3 minutes to cryogenic temperatures (2130uC). Blood samples were obtained in the morning before cryostimulation, again 30 min after exposure and the following day in the morning, during the 1st, 10th and 20th session.
Result/Effect:	The obtained results indicate that cryogenic temperatures in repeated daily treatments result in changes in the peroxidant and antioxidant status. These changes seem to depend on the number of cryostimulations. After 20 daily treatments there was an increase in SOD, SOD:CAT ratio, a decrease in the concentration of reduced and oxidized glutathione and in the activity of GPx. It could be possible that differences in the activity of GSSG-R after 20 treatments depended on the body mass index of participants.

4.2 Whole-body cryostimulation and oxidative stress in rowers the preliminary results

Authors:	Wozniak, A. – Mila-Kierzenkowska, C. – Szpinda, M. – Chwalbinska-Moneta, J. – Augustynska, B. – Jurecka, A.
Location/Date:	Poland, 2011
Aim/Purpose:	The effect of whole-body cryostimulation (WBC) on the biomarkers of oxidative stress, lysosomal enzymes, creatine kinase and cortisol.
Study Overview:	The rowers underwent two 6-day training cycles: with pre-training daily WBC (temperature: from -125°C to -150°C) and without cryostimulation (control). Blood samples were taken before and after the third and sixth day of training.
Result/Effect:	The use of WBC prior to training may reduce the risk of oxidative stress and the extent of muscle fibre injuries provoked by intense exercise. The WBC seems to be an effective and safe method for limiting exercise-induced damage; thus it may be used in biological regeneration of sportsmen.

4.3 Whole-body cryostimulation in kayaker women a study of the effect of cryogenic temperatures on oxidative stress after the exercise

Authors:	Mila-Kierzenkowska, C. – Wozniak, A. – Wozniak, B. – Drewa, G. – Rakowski, A. – Jurecka, A. – Rajewski, R.
Location/Date:	Poland, 2009
Aim/Purpose:	The aim of this study was to determine the effect of whole-body cryostimulation on the activity of selected antioxidant enzymes and the concentration of lipid peroxidation products in kayaker women in the course of training.
Study Overview:	The study was performed on the group of 9 kayaker women, who underwent two training cycles: one typical ten-day training cycle and another ten-day cycle preceded by cryostimulation sessions twice a day. The activity of antioxidant enzymes was assayed in

	erythrocytes, while the concentration of lipid peroxidation products was measured both in erythrocytes and in blood plasma.
Result/Effect:	Whole-body cryostimulation improves the antioxidant capacity of organism exposed to intense exercise. Brief application of cryogenic temperatures is likely related to the activation of adaptive homeostatic mechanisms in accordance with the hormetic dose-response model.

4.4 Whole-body cryotherapy in athletes

Authors:	Banfi, G. – Lombardi, G. – Colombini, A. – Melegati, G.
Location/Date:	Italy, 2010
Aim/Purpose:	Study of possible enhancement of recovery from injuries and possible modification of physiological parameters
Study Overview:	<p>From 30 rugby players who underwent WBC treatment, 10 athletes from the Italian national team were randomly selected to be studied before and after a WBC treatment cycle performed at Spala, Poland. The treatment was applied once a day for 5 days; during this period, the athletes trained regularly and following the same protocol used during the previous weeks.</p> <p>The WBC effect on pro-oxidant-antioxidant balance was studied in 20 top-level kayakers from the Polish Olympic team and in 10 untrained men. The kayakers completed a 10-day programme with training sessions twice a day.</p> <p>WBC effects on lysosomal enzymes were studied in 21 kayakers from the Polish Olympic team compared with 10 untrained men. The athletes were submitted to a 10-day training cycle where training sessions were preceded by WBC treatment three times a day. Hormonal homeostasis was studied in 22 elite soccer players who completed ten WBC sessions accompanied by kinesitherapy following each WBC session. Blood was collected before and 2 days after the treatment. After the treatment, a significant decrease in the concentration of testosterone and estradiol was found, whereas dehydroepiandrosterone sulphate and luteinizing hormone were unchanged.</p>
Result/Effect:	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. It has a positive effects on muscular enzymes creatine kinase and lactate dehydrogenase

4.5 Whole-body cryotherapy in rehabilitation of patients with rheumatoid diseases – pilot study

Authors:	Metzger, D. – Zwingmann, C. – Protz, W. – Jackel, WH.
Location/Date:	Germany, 2000
Aim/Purpose:	The aim of the study was to test whether significant pain relief could be achieved by means of this cold therapy. Furthermore, we were interested in the practicability and acceptance of this new technique.
Study Overview:	The sample consisted of 120 consecutive patients (75% women, age: 30-67 yrs, M = 52.6 yrs). These patients were suffering from primary fibromyalgia (40.7%), rheumatoid arthritis (17.3%), chronic low back pain (16.4%), ankylosing spondylitis (10.9%), osteoarthritis (9.1%), secondary fibromyalgia (3.6%) and other autoimmune diseases (1.8%) (mean duration of symptoms: 4 yrs). The patients were treated 2.5 minutes on average in the main chamber (mean temperature: -105 degrees C).
Result/Effect:	According to the results of our study, there is evidence that the whole-body cold therapy

	generates important short-term effects and somewhat weaker effects over the treatment period as a whole. Short-term pain reduction facilitates intensive application of physiotherapy and Occupational Therapy. The treatment procedure is practicable, and all in all well tolerated. From the patients' point of view, whole-body cold therapy is an essential part of the rehabilitation program.
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4.6 Whole-body Cryotherapy on Proprioception and Muscle Damage

Authors:	Costello, JT. – Algar, LA. – Donnelly, AE.
Location/Date:	Ireland, 2011
Aim/Purpose:	The authors evaluated the immediate effects of WBC on proprioception (knee joint position sense and muscle force reproduction) and tympanic (ear) temperature as well as the effectiveness of WBC in the treatment of muscle soreness and function (maximal voluntary isometric contraction force, peak power output, muscle soreness questionnaire) following eccentric exercise damage.
Study Overview:	Thirty-six healthy college-aged participants were randomized to receive WBC (-60°C for 20 seconds, then -110°C for 3 minutes) or control interventions (15°C for 3 minutes and 20 seconds). Both groups received 2 treatments separated by 2 hours (based on standard procedures). All of the participants completed the assessments in a random order before treatment, 2 to 3 minutes after treatment, and 15 minutes later (some of the tests were done after the first exposure and others after the second exposure). A subset of 18 participants also performed 100 high-force maximal eccentric contractions of the left knee extensors 24 hours before their treatment. Among this subset, maximal contraction force, peak power output, and muscle soreness were assessed before, 24, 48, and 72 hours after treatment.
Result/Effect:	Overall the study suggests that WBC does not impair proprioception or isometric muscle force but when it is administered 24 hours after a eccentric muscle damaging protocol it is not effective at reducing muscle soreness (self-reported) or measures reflective of muscle damage (maximal contraction force, peak power output).