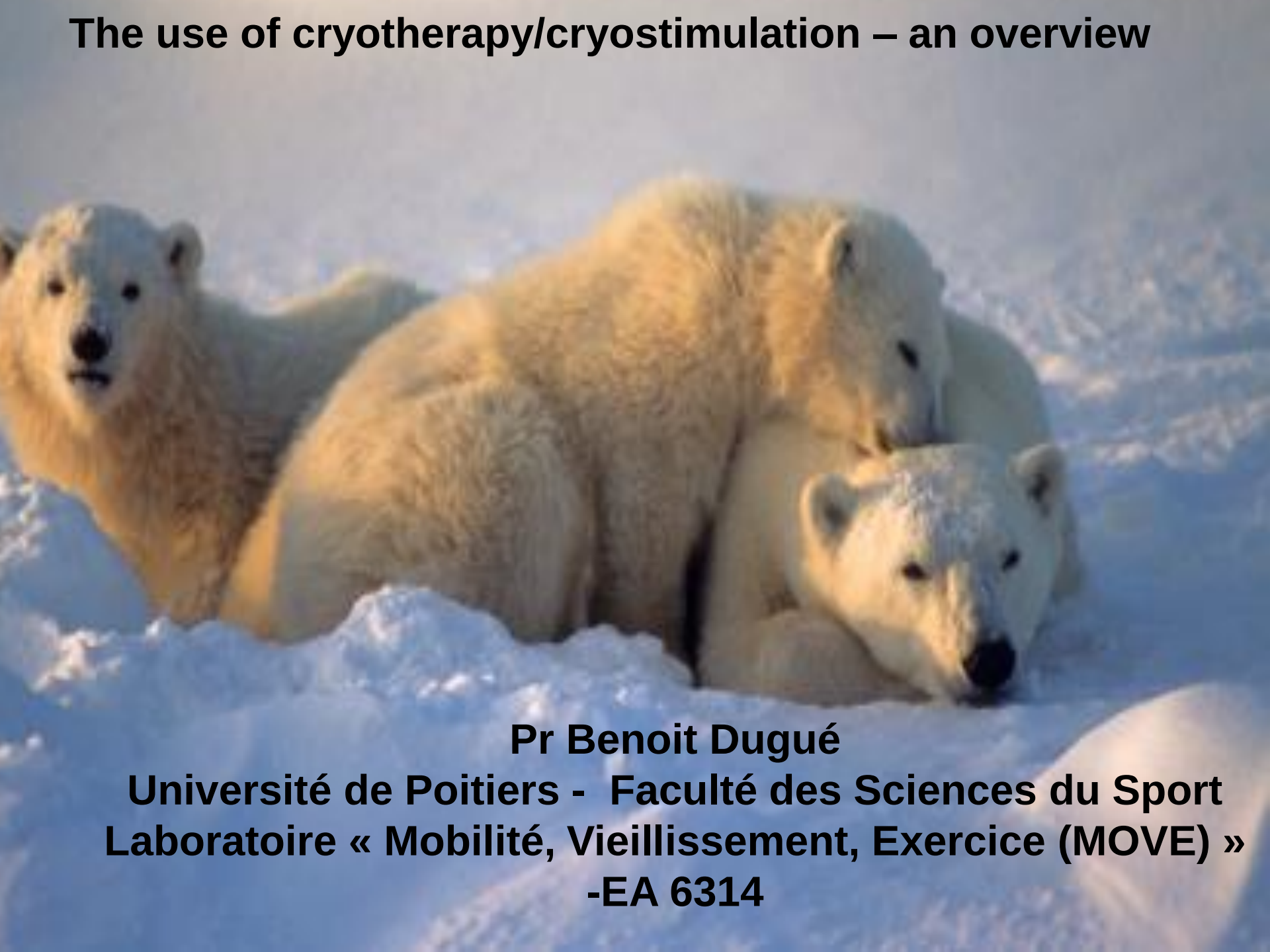
The use of cryotherapy/cryostimulation – an overview



Pr Benoit Dugué
Université de Poitiers - Faculté des Sciences du Sport
Laboratoire « Mobilité, Vieillissement, Exercice (MOVE) »
-EA 6314

Introduction

Cryotherapy/cryostimulation

Cryotherapy/cryostimulation and exercise

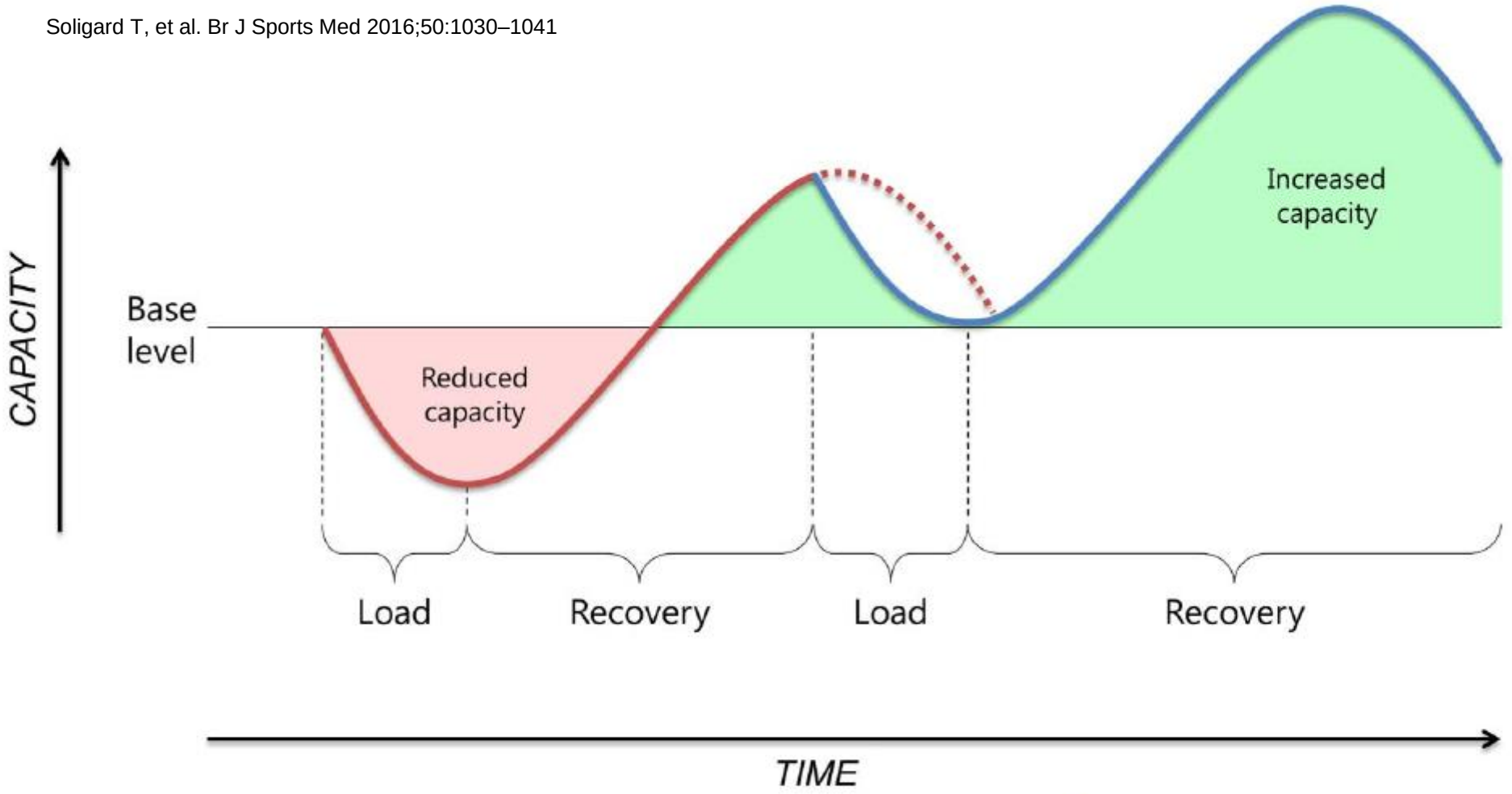
Introduction

RECOVERY AND RECOVERY AFTER EXERCISE

=

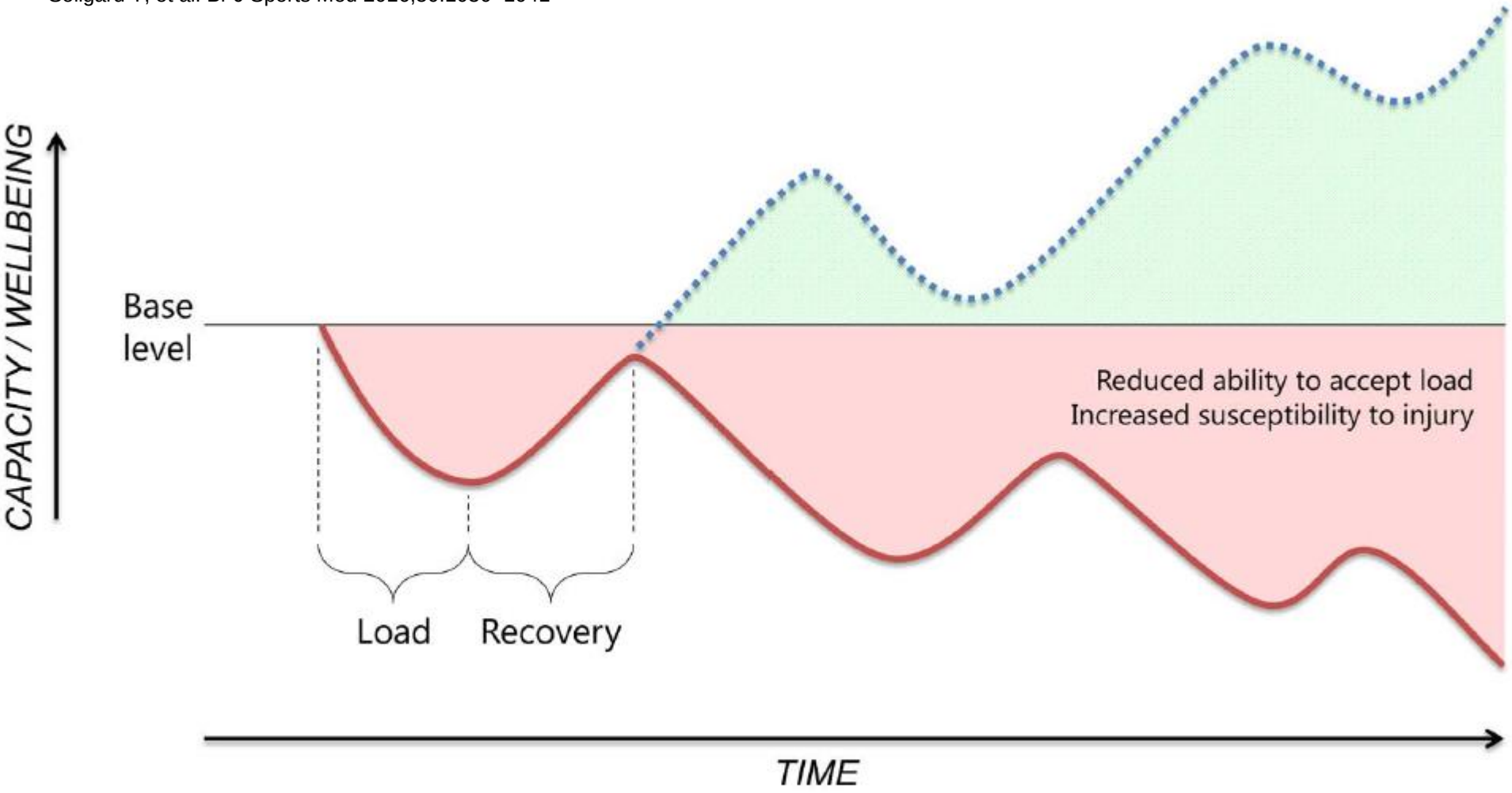
KEY OF SUCCESS

Soligard T, et al. Br J Sports Med 2016;50:1030–1041



Adaptations through cycles of loading and recovery

Soligard T, et al. Br J Sports Med 2016;50:1030–1041



Maladaptations through cycles of excessive loading and/or inadequete recovery

Recovery

- Recovery time
- Hydration, Rehydration, Nutrition, Sleep
- Techniques used for faster recovery
  - Active recovery
  - Massages
  - Stretching
  - Electrostimulation
  - Thermal contrast therapy
  - Cold baths
  - Cold vests
  - Cryotherapy/ Cryostimulation (cryo chambers or cabins)

Key aspects

- Different kinds of whole body cryotherapy (WBC) or cryostimulation
- Why to use WBC
- Feelings after exposure
- Cold and physiological adaptations
- Peculiar problems to deal with whole body cryotherapy investigations
- What do we know about whole body cryotherapy
- Mechanisms

Key aspects

- Different kinds of whole body cryotherapy (WBC) or cryostimulation
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- What do we know about whole body cryotherapy
- Mechanisms

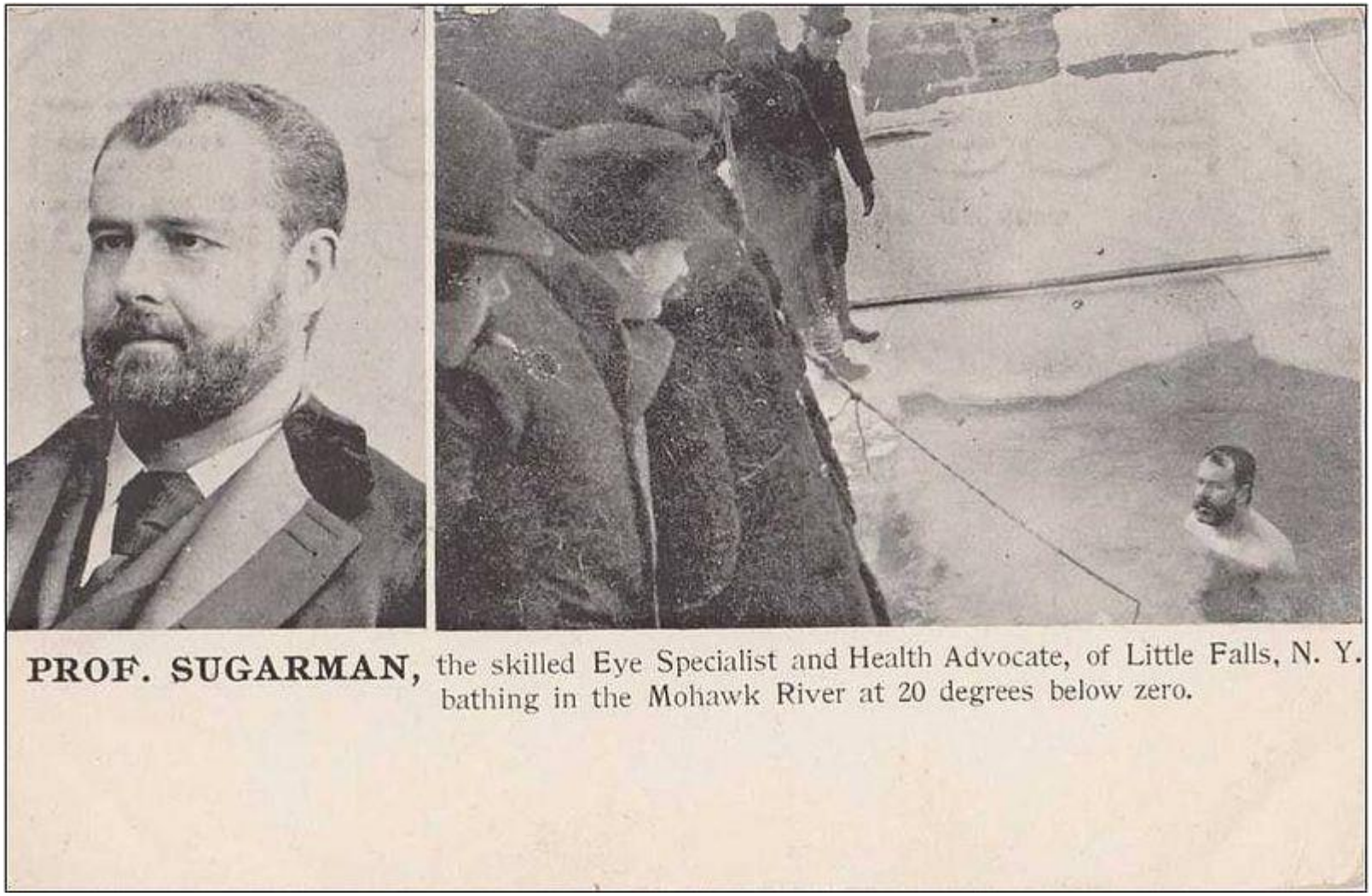
Cold and Medicine

Rhazès (Perse, IX century)

Hordeola treatment with a refrigerated blade

WHOLE BODY CRYOTHERAPY – INDIVIDUAL SETTING

WHOLE BODY CRYOTHERAPY – NATURAL SETTING



PROF. SUGARMAN, the skilled Eye Specialist and Health Advocate, of Little Falls, N. Y. bathing in the Mohawk River at 20 degrees below zero.


2013

WHOLE BODY CRYOTHERAPY – NATURAL SETTING

WHOLE BODY CRYOTHERAPY – NATURAL SETTING

WHOLE BODY CRYOTHERAPY – NATURAL SETTING

WHOLE BODY CRYOTHERAPY – NATURAL SETTING


SLUSH

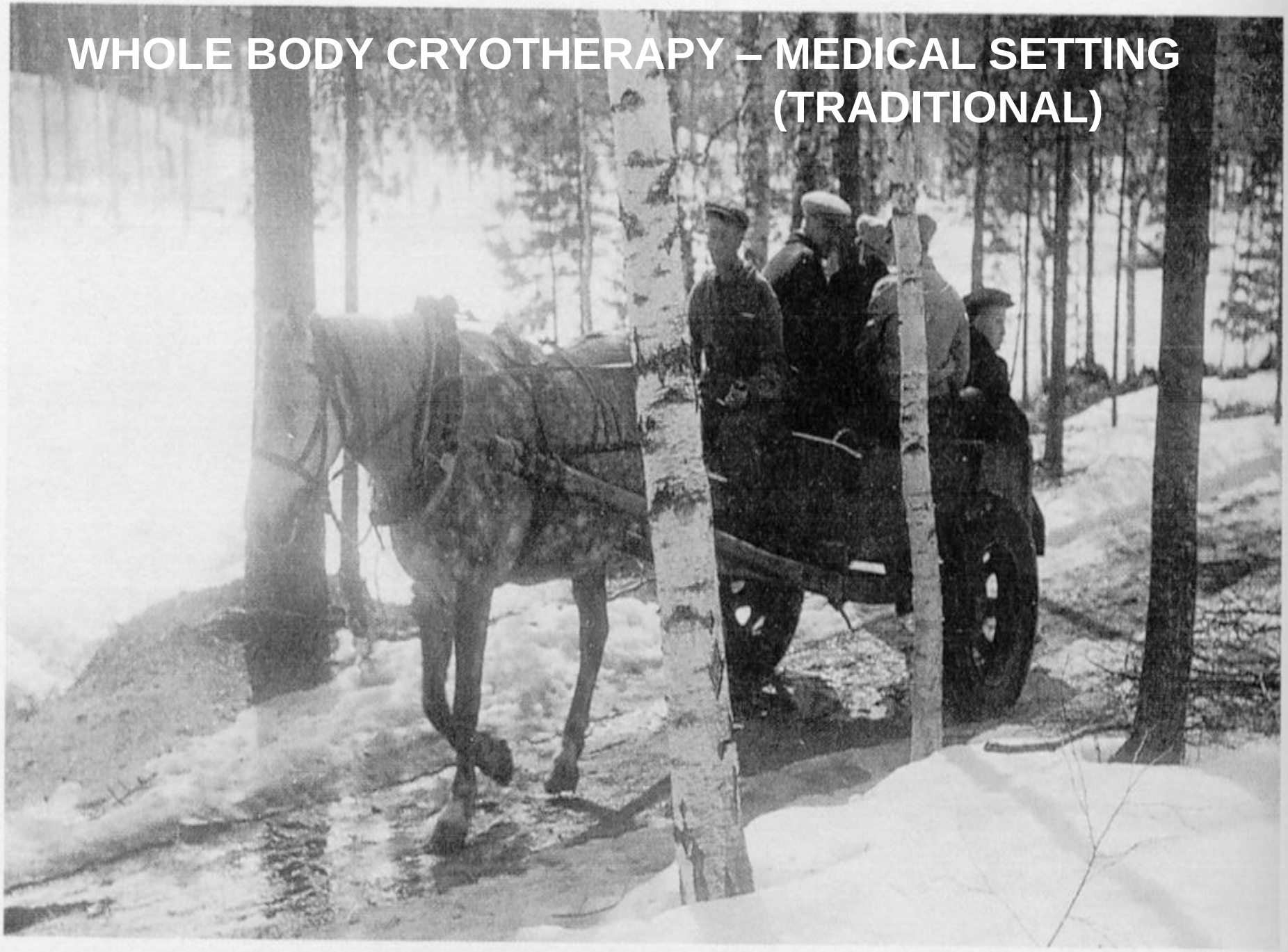
WHOLE BODY CRYOTHERAPY – NATURAL SETTING

WHOLE BODY CRYOTHERAPY – NATURAL? SETTING

WHOLE BODY CRYOTHERAPY – Sport context

WHOLE BODY CRYOTHERAPY– Halloween

WHOLE BODY CRYOTHERAPY – MEDICAL SETTING (TRADITIONAL)



WHOLE BODY CRYOTHERAPY – MEDICAL SETTING (MODERN)

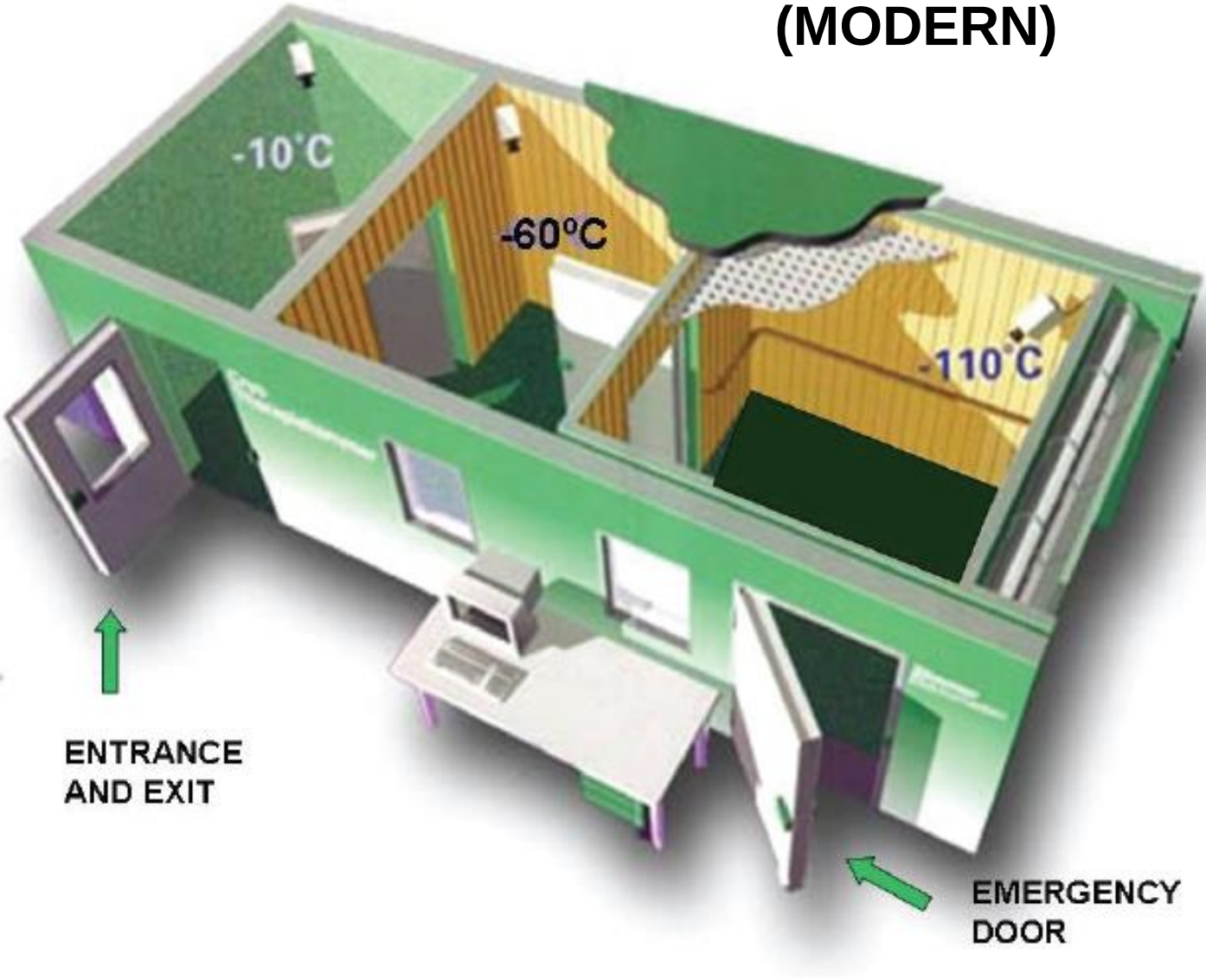


Fig. 1. Whole-body cryotherapy.

WHOLE BODY CRYOTHERAPY – MEDICAL SETTING (MODERN)

- 110 °C

WHOLE BODY CRYOTHERAPY – MEDICAL SETTING (MODERN)

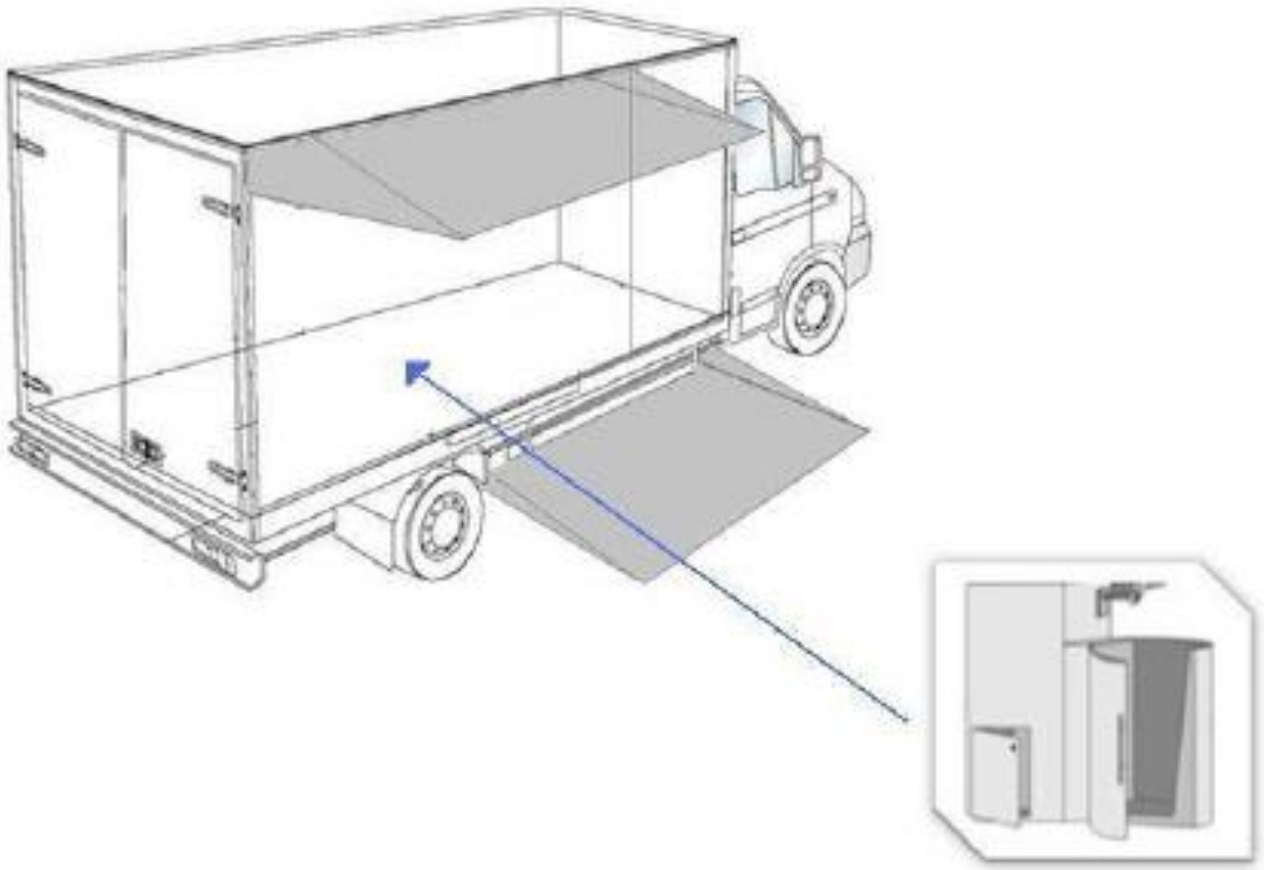
- 110 °C

WHOLE BODY CRYOTHERAPY – MEDICAL SETTING (MODERN)

- 160 to -180 °C

WHOLE BODY CRYOTHERAPY – MEDICAL SETTING + SPORT CONTEXT

- 160 to -180 °C



Société Cryantal & FDJ/ F Grappe

WHOLE BODY CRYOTHERAPY – MEDICAL SETTING + SPORT CONTEXT

- 160 to -180 °C

Technologies: cryogenics versus mechanical refrigeration

Direct injection of LN2

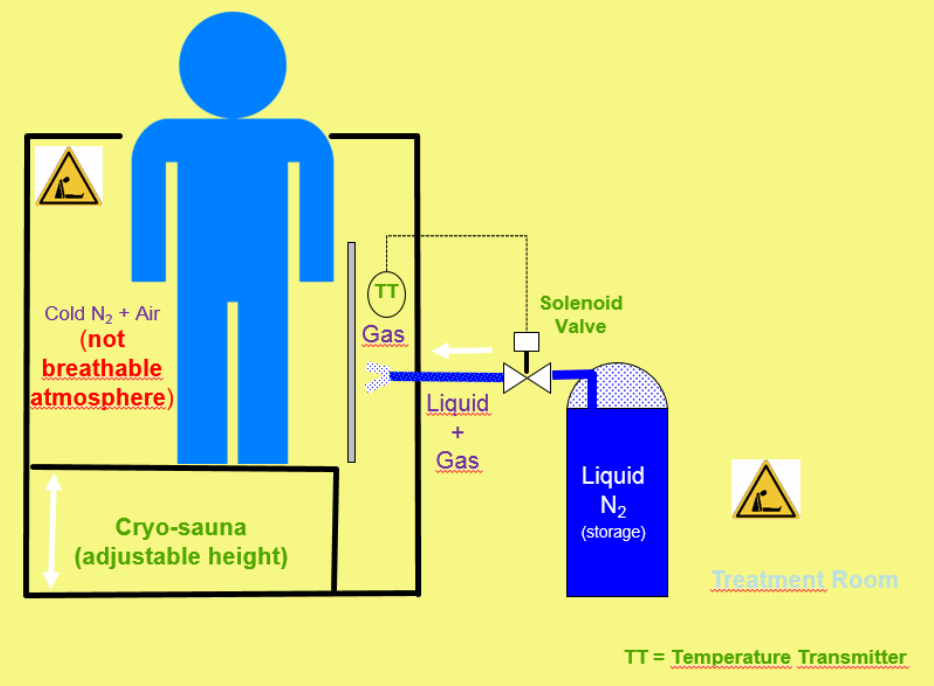


Figure 1 – Cryo-sauna: Principle with liquid N2 / Direct injection / Partial BC / Individual (JP Bernard – Air Liquid; IIR information note 2019)

Indirect injection of LN2 in two stages (with heat exchangers)

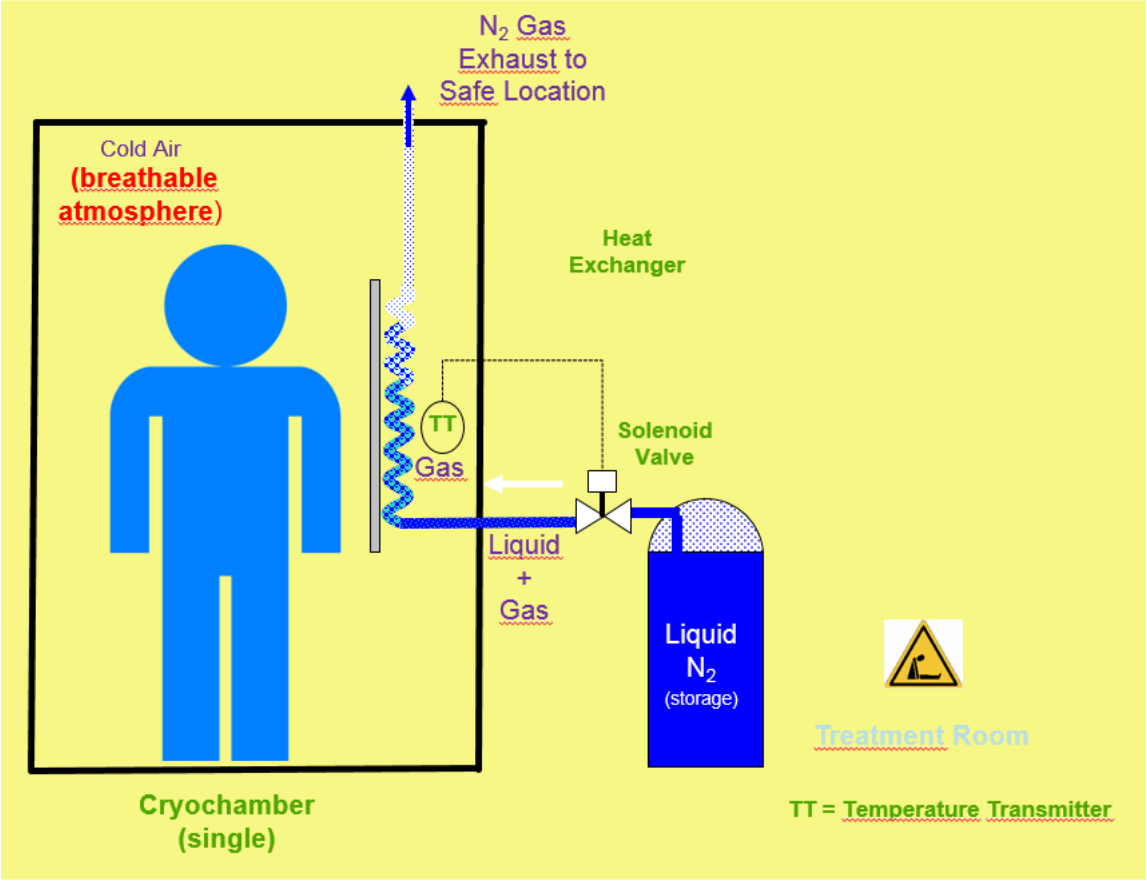


Figure 2 - Cryochamber: Principle with liquid N2 / Indirect injection / Whole BC / Individual or Collective

(JP Bernard – Air Liquid; IIR information note 2019)

Indirect injection of LN2 in two stages (with heat exchangers)

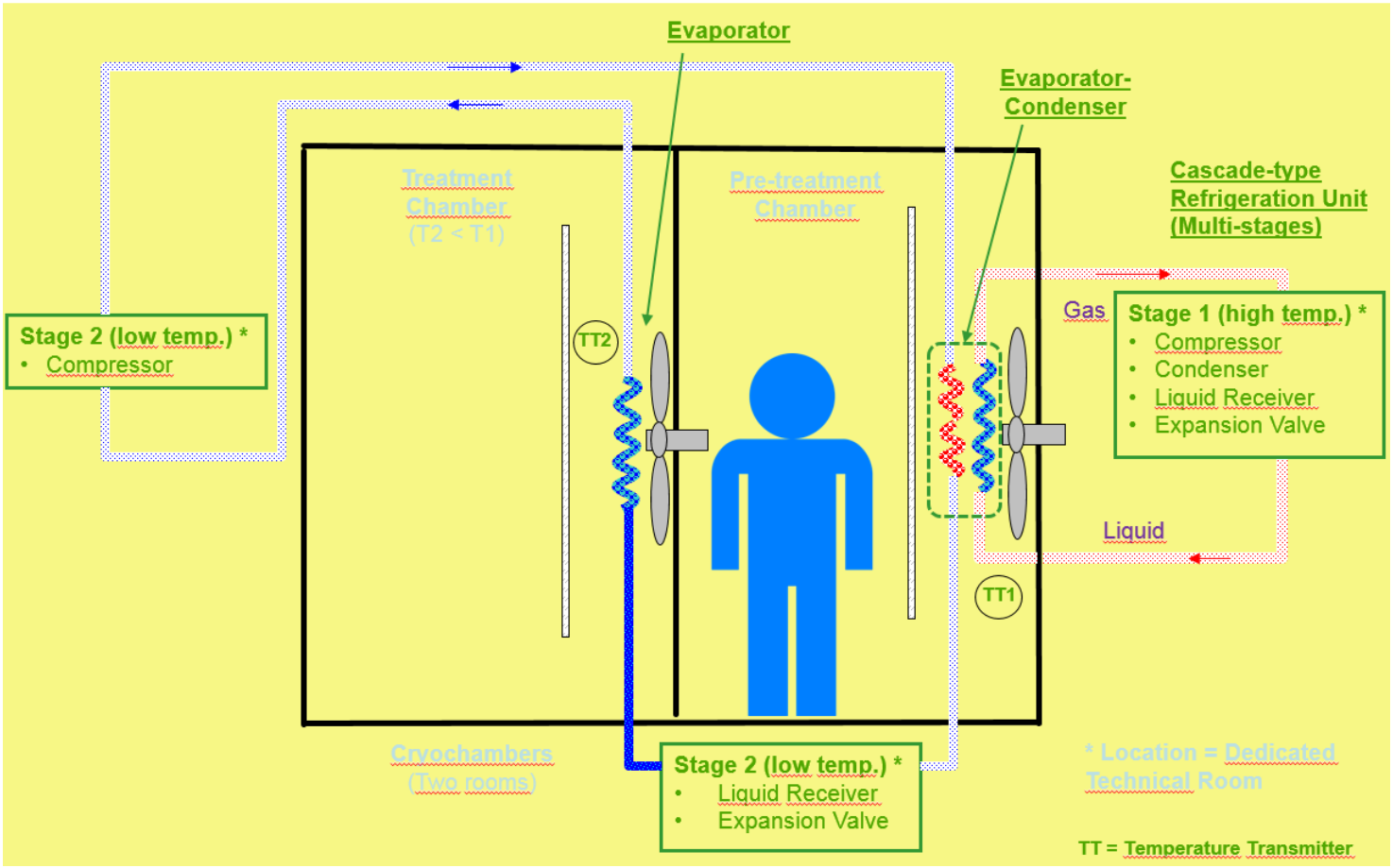


Figure 3 - Cryochambers: Principle with Mechanical Refrigeration / Whole BC / Collective

(JP Bernard – Air Liquid; IIR information note 2019)

Journal of Thermal Biology 65 (2017) 138–144

Contents lists available at ScienceDirect

Journal of Thermal Biology

journal homepage: www.elsevier.com/locate/jtherbio

Validation of a new whole-body cryotherapy chamber based on forced convection

Romain Bouzigon[a,d,*], Ahlem Arfaoui[b], Frédéric Grappe[a], Gilles Ravier[a], Benoit Jarlot[b], Benoit Dugue[c]

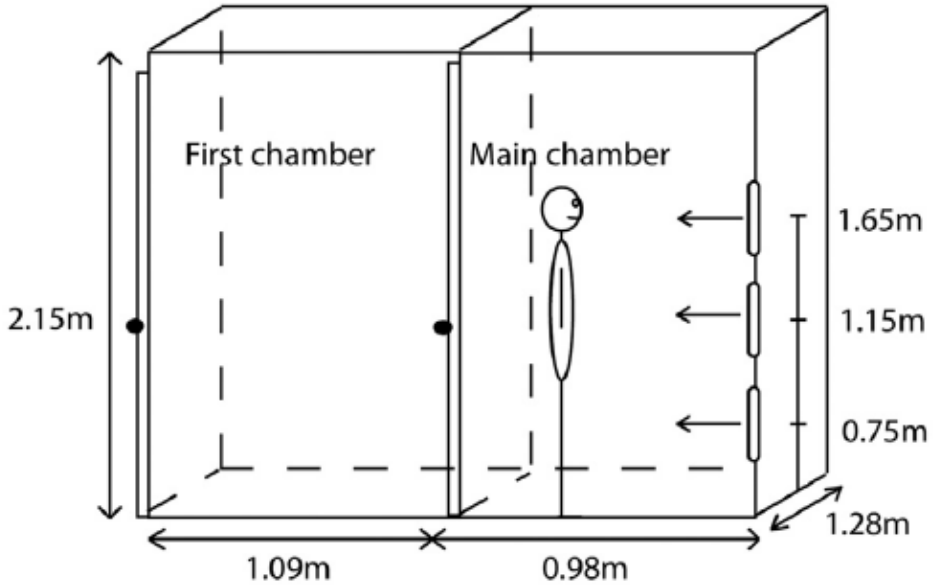


Fig. 1. Cold chamber drawing showing the position of the three fans in the main chamber. The wind velocities at 1.65, 1.15, 0.75 m were at 3.7, 1.9, 1.5 m s^{-1}, respectively.

Key aspects

- Different kinds of whole body cryotherapy (WBC) or cryostimulation
- Why to use WBC
- Feelings after exposure
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- What do we know about whole body cryotherapy
- Mechanisms

Beliefs of possible effects

- Improved cold tolerance
- Better mood
- Better sleep quality
- Improved coping with stress situations
- Reduced pains and aches
- Fewer respiratory infections
- Better health status and quality of life

J Smolander 2002

Cold therapy (cryotherapy) may be used in

- Rheumatic diseases
- Fibromyalgia
- Arthrosis
- Back disorders
- Psoriasis
- Depression
- Spasticity diseases (MS)
- Sports injuries
- Recovery from exercise

J Smolander 2002

Clin Rheumatol (2013) 32:1337–1345
DOI 10.1007/s10067-013-2280-9

ORIGINAL ARTICLE

Effects of 15 consecutive cryotherapy sessions on the clinical output of fibromyalgic patients

Lorenzo Bettoni · Felice Giulio Bonomi · Viviana Zani · Luigia Manisco · Annamaria Indelicato · Patrizia Lanteri · Giuseppe Banfi · Giovanni Lombardi

100 patients (20-70 years)

50 no medication change

50 no medication change + whole body cryotherapy

15 sessions; 3-min at -110°C
5 times per week

Whole body cryotherapy => Balance between pro and anti inflammatory mediators

Unbalanced pro / anti inflammatory mediators => Pain+++

The Aging Male

http://informahealthcare.com/tam
ISSN: 1368-5538 (print), 1473-0790 (electronic)

Aging Male, Early Online: 1–6
 DOI: 10.3109/13685538.2013.863860

informa
healthcare

ORIGINAL ARTICLE

Effect of cryotherapy on the lumbar spine in elderly men with back pain

Czesław Giemza[1], Magdalena Matczak-Giemza[2], Bożena Ostrowska[1], Ewa Bieć[1], and Mirosław Doliński[3]

WBC
(3 min at -120°C, 5x/week, 3 weeks)
+
physical exercises
(45 min at gym, 5x per week, 3 weeks)

vs.

only physical exercises

Psychology, Health & Medicine, 2014
Vol. 19, No. 1, 40–46, http://dx.doi.org/10.1080/13548506.2013.780130

Routledge
Taylor & Francis Group

Mental state and quality of life after 10 session whole-body cryotherapy

Joanna Szczepańska-Gieracha[a], Paulina Borsuk[a], Malwina Pawik[a]* and Joanna Rymaszewska[a,b]

55 subjects (43 females; 12 men) ; 20 to 70 years

34 patients with spinal pain syndromes

21 patients with peripheral joints disease

No controls

10 sessions
1 to 3 min at -100°C (?)

RESULTS: +++ well being
+++ mood
+ quality of live

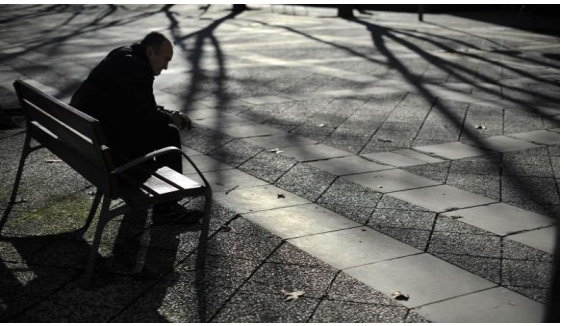
Arch. Immunol. Ther. Exp., 2008, **56**, 63–68
PL ISSN 0004-069X

DOI 10.1007/s00005-008-0006-5

Whole-body cryotherapy as adjunct treatment of depressive and anxiety disorders

Joanna Rymaszewska, David Ramsey and Sylwia Chładzińska-Kiejna

Department of Psychiatry, Wrocław Medical University, Wrocław, Poland



34 patients + medication (GR1)

26 patients + medication + cryotherapy (GR2)

15 sessions, 3 weeks
2 to 3 min at -160°C or at -110°C

for the scores obtained with Hamilton's depression scale

2.9% for GR1

Scandinavian Journal of Clinical & Laboratory Investigation, 2013; 73: 635–640

Long-term effects of whole body cryostimulation on uric acid concentration in plasma of secondary progressive multiple sclerosis patients

ELŻBIETA MILLER[1,2], JOANNA SALUK[3], AGNIESZKA MOREL[3] & BARBARA WACHOWICZ[3]

22 MS patients; 48.6 years

22 healthy controls

10 sessions

3 min at -110°C to -160°C

RESULTS:

++ Uric Acid concentration in plasma of MS patients

Positive changes in disability status scale

Conclusions

WBCT may be used as adjuvant therapy as it improves functional status of SPMS patients.

significant effect after 10 exposures

effect kept one and three months later

Hindawi Publishing Corporation
BioMed Research International
Volume 2015, Article ID 404259, 11 pages
http://dx.doi.org/10.1155/2015/404259

Clinical Study

Can Whole-Body Cryotherapy with Subsequent Kinesiotherapy Procedures in Closed Type Cryogenic Chamber Improve BASDAI, BASFI, and Some Spine Mobility Parameters and Decrease Pain Intensity in Patients with Ankylosing Spondylitis?

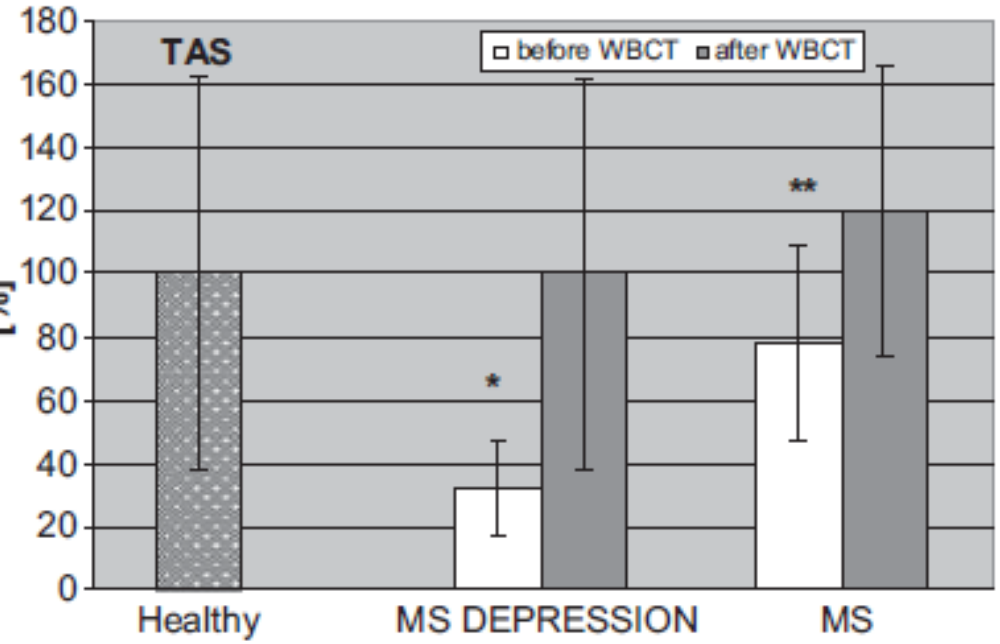
« … we observed on average about twice better results than in the group treated only by kinesiotherapy … »

The World Journal of Biological Psychiatry, 2010; Early Online, 1–5

ORIGINAL INVESTIGATION

Effects of whole-body cryotherapy on a total antioxidative status and activities of antioxidative enzymes in blood of depressive multiple sclerosis patients

ELŻBIETA MILLER[1], MAŁGORZATA MROWICKA[2], KATARZYNA MALINOWSKA[2], JERZY MROWICKI[2], JOANNA SALUK-JUSZCZAK[3] & JÓZEF KĘDZIORA[4]



Effect of whole body cryotherapy (WBCT) on total antioxidative status (TAS) level in plasma from multiple sclerosis (MS) patients with and without depression.

Acta Neurol Scand 2016: 134: 420–426 DOI: 10.1111/ane.12557

ACTA NEUROLOGICA SCANDINAVICA

Whole-body cryostimulation (cryotherapy) provides benefits for fatigue and functional status in multiple sclerosis patients. A case–control study

E. Miller[1,2], J. Kostka[1], T. Włodarczyk[3], B. Dugué[4]

[1]Department of Physical Medicine, Medical University of Lodz, Lodz, Poland; [2]Neurorehabilitation Ward, III General Hospital in Lodz, Lodz, Poland; [3]Ophthalmology Department, Warminski Hospital, Bydgoszcz, Poland; [4]Laboratoire "Mobilité Vieillissement Exercice", Faculty of Sport Sciences, University of Poitiers, Poitiers, France

… especially for those who are the most tired

Table 2 Influence of whole-body cryostimulation (WBC) on functional capacities in groups of fatigued MS patients with high fatigue (HF) and low fatigue (LF) levels

	HF			LF		
	Before	After	Changes	Before	After	Changes
EDSS (0–10 points)	5.1 ± 0.7	4.8 ± 0.7***	−0.3 ± 0.3^{S} (0.2–0.4)	5.2 ± 1.1	5.0 ± 1.1***	−0.2 ± 0.3^{S} (0.1–0.3)
MSIS-29-PHYS (0–100 points)	46.8 ± 2.8	44.9 ± 2.9***	−1.9 ± 1.4^{L} (1.4–2.3)^{a,b}	45.9 ± 3.2	45.2 ± 3.0***	−0.7 ± 0.7^{S} (0.2–1.1)
MSIS-29-PSYCH (0–100 points)	42.1 ± 2.7	39.8 ± 2.0***	−2.3 ± 1.9^{L} (1.8–2.8)^{a,b}	42.2 ± 2.6	41.3 ± 2.7***	−0.9 ± 1.0^{S} (0.4–1.4)
RMA1 (0–13 points)	7.9 ± 2.2	9.2 ± 2.0***	1.3 ± 1.0^{L} (0.9–1.5)^{a,b}	8.5 ± 2.1	9.0 ± 1.9**	0.5 ± 0.7^{M} (0.2 −0.8)
RMA2 (0–10 points)	6.7 ± 2.4	7.9 ± 2.1***	1.3 ± 1.4^{M} (0.8–1.6)	7.3 ± 1.6	8.1 ± 1.5***	0.8 ± 0.7^{M} (0.4–1.3)
RMA3 (0–15 points)	9.1 ± 1.7	11.2 ± 1.5***	2.1 ± 1.1^{L} (1.7–2.6)^{a,b}	8.2 ± 1.3	9.0 ± 1.7***	0.8 ± 0.9^{M} (0.3–1.1)
FSS (9–63 points)	49.3 ± 1.1	46.6 ± 1.3***	−2.7 ± 1.6^{L} (2.1–3.3)	39.3 ± 1.4	37.1 ± 1.5***	−2.3 ± 1.3^{L} (1.7–2.8)

Cryobiology 71 (2015) 398–404

Contents lists available at ScienceDirect

Cryobiology

journal homepage: www.elsevier.com/locate/ycryo

The whole body cryostimulation modifies irisin concentration and reduces inflammation in middle aged, obese men

Katarzyna Dulian [a], Radosław Laskowski [b], Tomasz Grzywacz [c], Sylwester Kujach [b], Damian J. Flis [d], Mirosław Smaruj [e], Ewa Ziemann [f, *]

n = 12 ; 38 ± 9 ans ; BMI > 30 kg/m^2

10 times, 3 min at -110°C

Decrease in low-grade inflammation (- - CRP)
++ irisin (=> higher oxidation in adipocyte lipids?)

Hindawi Publishing Corporation
Oxidative Medicine and Cellular Longevity
Volume 2015, Article ID 803197, 13 pages
http://dx.doi.org/10.1155/2015/803197

Hindawi

Research Article

Body Composition, Lipid Profile, Adipokine Concentration, and Antioxidant Capacity Changes during Interventions to Treat Overweight with Exercise Programme and Whole-Body Cryostimulation

Anna Lubkowska,[1,2] Wioleta Dudzińska,[2] Iwona Bryczkowska,[1] and Barbara Dołęgowska[3]

n = 30 ; 39 ± 9 ans ; BMI= 30 + 9 kg/m^2

20 times, 3 min at -110°C during 6 mois

+

Physical activity: 45min 3x semaines sur 6 mois

… Very little impact

J. Phys. Ther. Sci. 28: 1552–1555, 2016

The Journal of Physical Therapy Science

Original Article

Repeated cryostimulation improves position sense and simple reaction time

Czesław Giemza[1)a], Ewa Bieć[1)a], Bożena Ostrowska[1)], Bogusława Piechaczek[1)], Georg Sitny[1)], Michał Kuczyński[2)*]

The Improvement of Memory Deficits After Whole-body Cryotherapy – The First Report

Authors: Rymaszewska, Joanna; Urbańska, Katarzyna M; Szcześniak, Dorota; Stańczykiewicz, Bartłomiej; Tryp Elżbieta; Zabłocka, Agnieszka

Source: Cryoletters, Volume 39, Number 3, May 2018, pp. 190-195(6)
Publisher: Cryoletters

< previous article | view table of contents | next article > | ADD TO FAV

Abstract | References | Citations | Supplementary Data | Article Media | Metrics | Suggestions

BACKGROUND: Mild Cognitive Impairments (MCI) and dementia are still incurable. The Whole-Body Cryoth (WBC) - short, cyclic exposure to extremely low temperatures - has proven anti-inflammatory and anti-oxid effects. It can also induce hormonal, lipid and neural changes. **OBJECTIVE:** To evaluate the WBC effect on cognitive functioning and blood parameters of MCI patients. **MATERIALS AND METHODS:** Participants with undertook 10 WBC sessions. Cognitive functions and depressive symptoms were assessed before the first session, after the last session and 2 weeks later. Whole blood samples were collected. **RESULTS:** The cogni functioning improved after 10 WBC sessions (p<0.05), especially memory processes. WBC caused a signific (p<0.05) increase of NO plasma level, BDNF concentration (p<0.05) and reduction of IL-6 (p<0.05). The mod relationship between NO and cognitive functioning was noticed after WBC. **CONCLUSION:** The preliminary results of the first study evaluating WBC on memory deficits suggest that WBC may be useful as a support therapy of MCI.

Keywords: MEMORY IMPROVEMENT; MILD COGNITIVE IMPAIRMENT; SUPPORTIVE THERAPY; WHOLE-BODY CRYOTHERAPY

European Journal of Sport Science, 2018
https://doi.org/10.1080/17461391.2018.1551937

ORIGINAL ARTICLE

3-min whole body cryotherapy/cryostimulation after training in the evening improves sleep quality in physically active men

WAFA DOUZI[1], OLIVIER DUPUY[1], MAXENCE TANNEAU[1], GEOFFROY BOUCARD[2], ROMAIN BOUZIGON[3], & BENOIT DUGUÉ [1]

[1]*Laboratoire Mobilité Vieillissement Exercice (MOVE)-EA6314, Faculty of Sport Sciences, University of Poitiers, Poitiers, France;* [2]*Centre de Recherches sur la Cognition et l'Apprentissage (UMR7295), Université de Poitiers and Université François-Rabelais de Tours, Poitiers, France &* [3]*Laboratoire C3S (EA 4660), Unité de Promotion, de Formation et de Recherche (UPFR) des Sports, Université de Franche Comté, Besançon, France*

Douzi *et al. BMC Res Notes* (2019) 12:141
https://doi.org/10.1186/s13104-019-4172-9

BMC Research Notes

RESEARCH NOTE Open Access

Partial-body cryostimulation after training improves sleep quality in professional soccer players

Wafa Douzi[1], Olivier Dupuy[1], Dimitri Theurot[1], Geoffroy Boucard[2] and Benoit Dugué[1*]

Key aspects

- Different kinds of whole body cryotherapy (WBC) or cryostimulation
- Why to use WBC
- Feelings after exposure
- Cold and physiological adaptations
- Peculiar problems to deal with whole body cryotherapy investigations
- What do we know about whole body cryotherapy
- Mecanisms

Comfortable?

Thermal sensation

What is your general thermal sensation now?

4 very hot

3 hot

2 warm

1 slightly warm

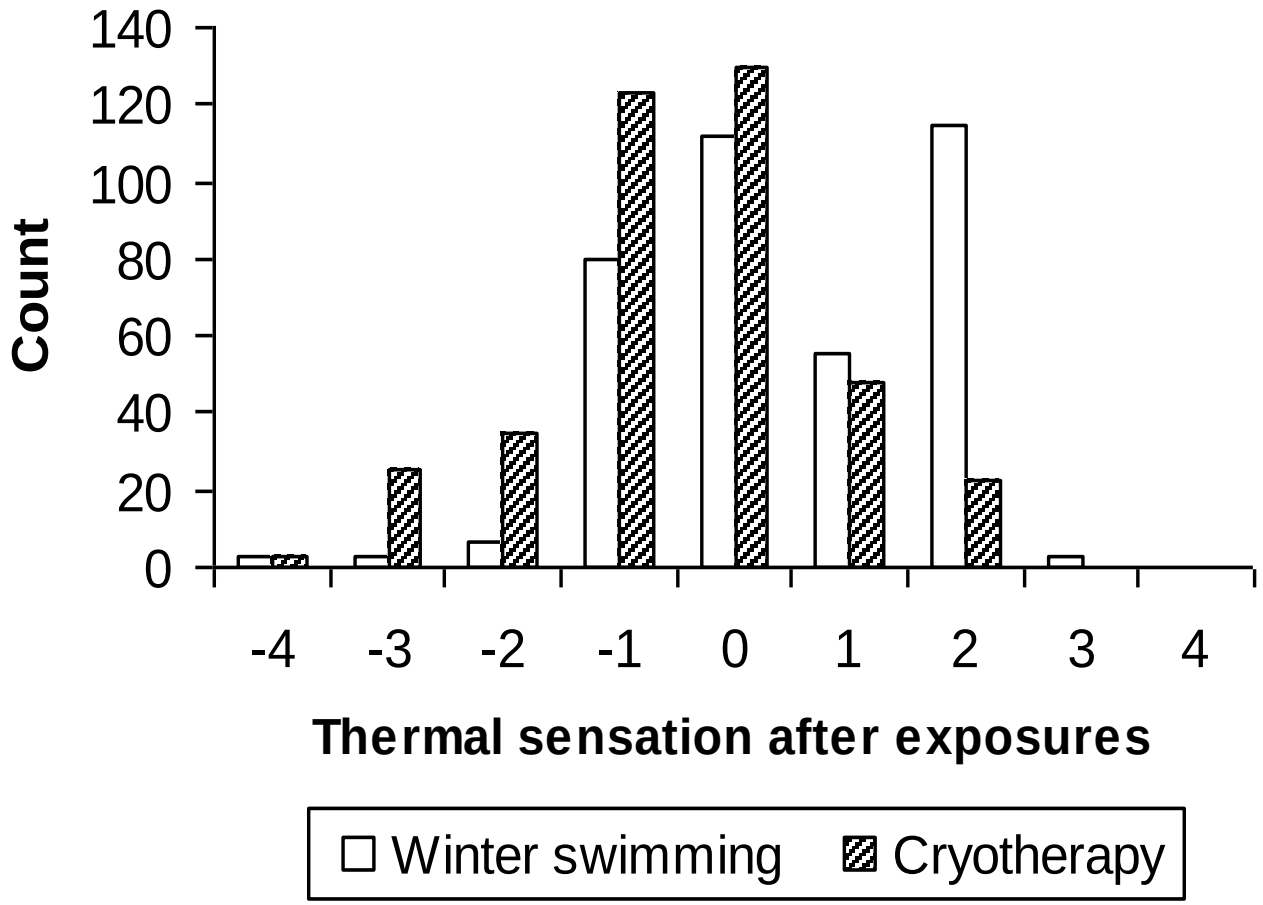
0 neutral

-1 slightly cool

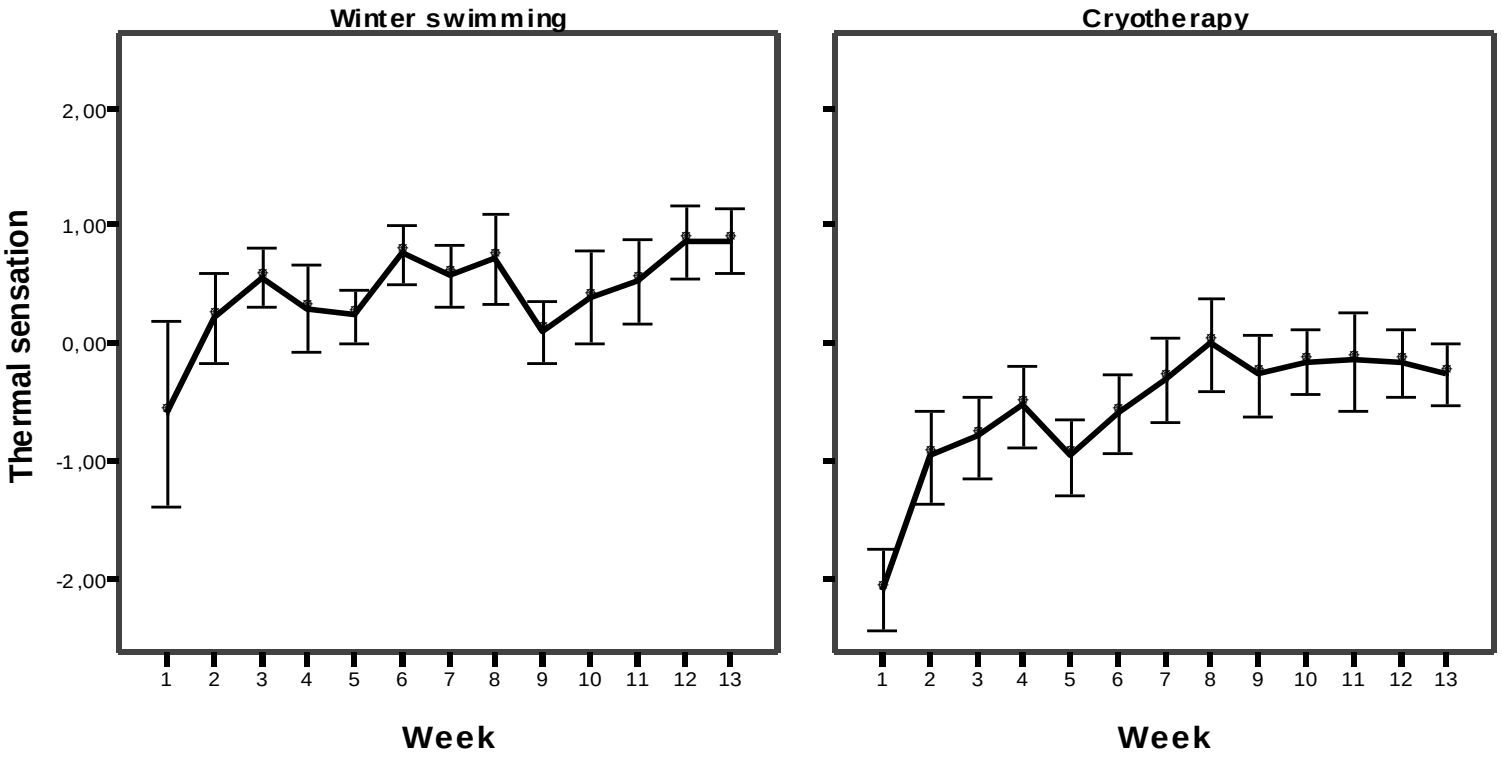
-2 cool

-3 cold

-4 very cold



T Westerlund



T Westerlund

Key aspects

- Different kinds of whole body cryotherapy (WBC) or cryostimulation
- Why to use WBC
- Feelings after exposure
- Cold exposure and physiological adaptations
- Peculiar problems to deal with whole body cryotherapy investigations
- What do we know about whole body cryotherapy
- Mecanisms

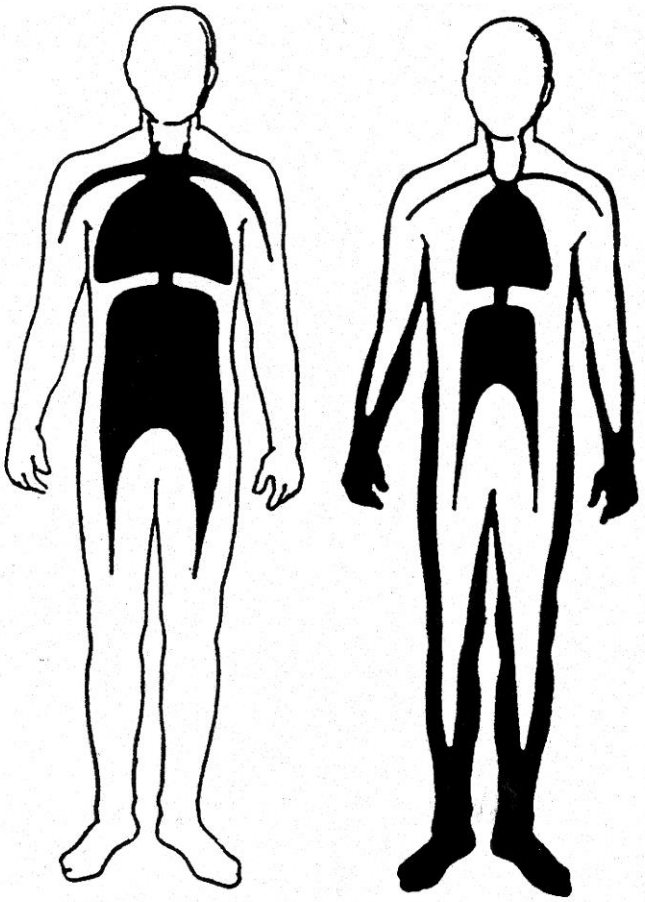
Human thermoregulation

- optimum for humans in air 27 °C and 33 °C in water
- control of thermoregulation
  - receptors in skin and internal organs
  - hypothalamic integrator in brain
- heat production and heat loss:
  - sweating /evaporation
  - control of peripheral circulation
  - heat production/shivering

Sudden exposure to cold causes

- constriction of blood vessels in skin
- increased blood pressure
- increased work for heart
- shivering starts
- increased breathing rate and heart rate
- reduced plasma volume
- increased concentration of e.g. cholesterol
- platelet adhesion increases
- release of stress hormones, especially noradrenaline
- Cold-induced analgesia

COLD WARM



Sudden exposure to cold causes

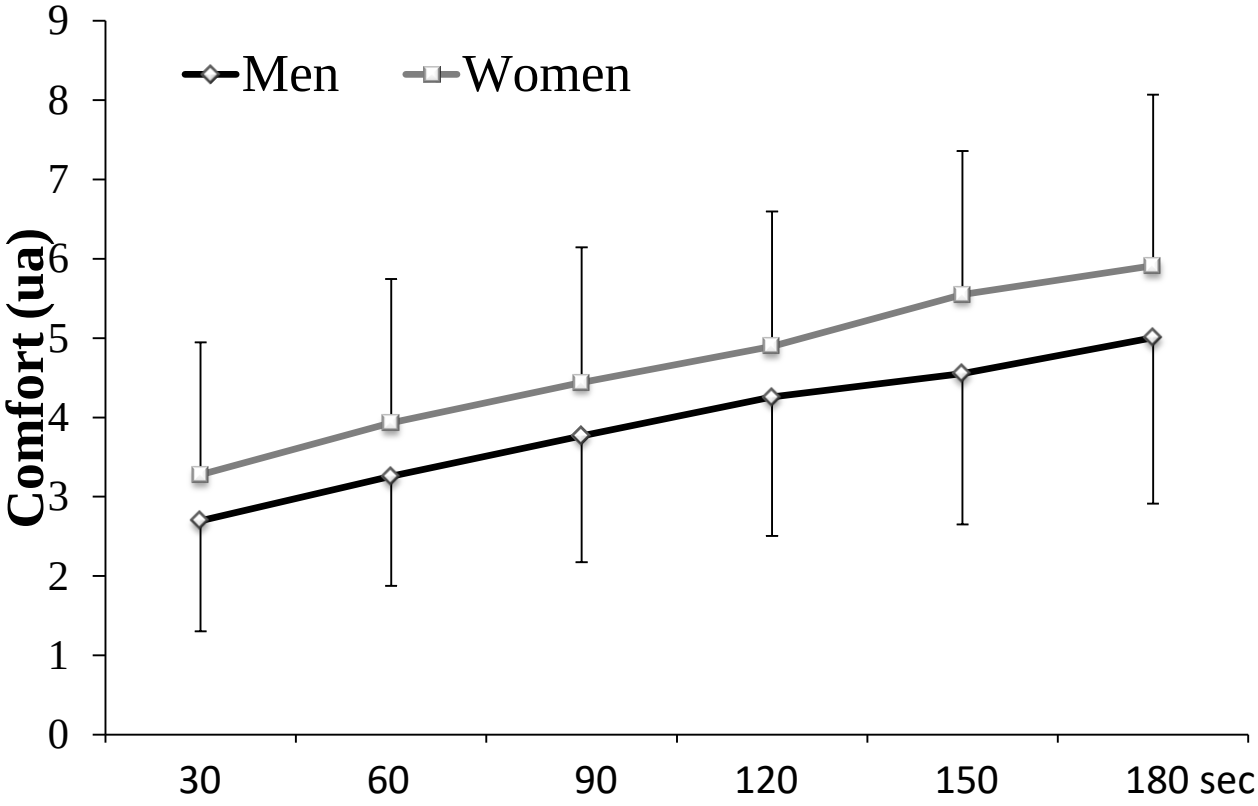
- constriction of blood vessels in skin
- increased blood pressure
- increased work for heart
- shivering starts
- increased breathing rate and heart rate (??)
- reduced plasma volume
- increased concentration of e.g. cholesterol
- platelet adhesion increases
- release of stress hormones, especially noradrenaline

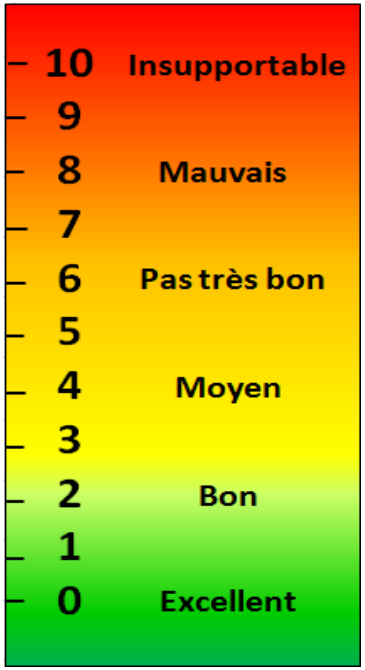
Role of individual factors

- body size or BSA/mass-ratio
- fatness
- physical fitness
- gender
- age
- state of cold adaptation
- health status

Role of individual factors

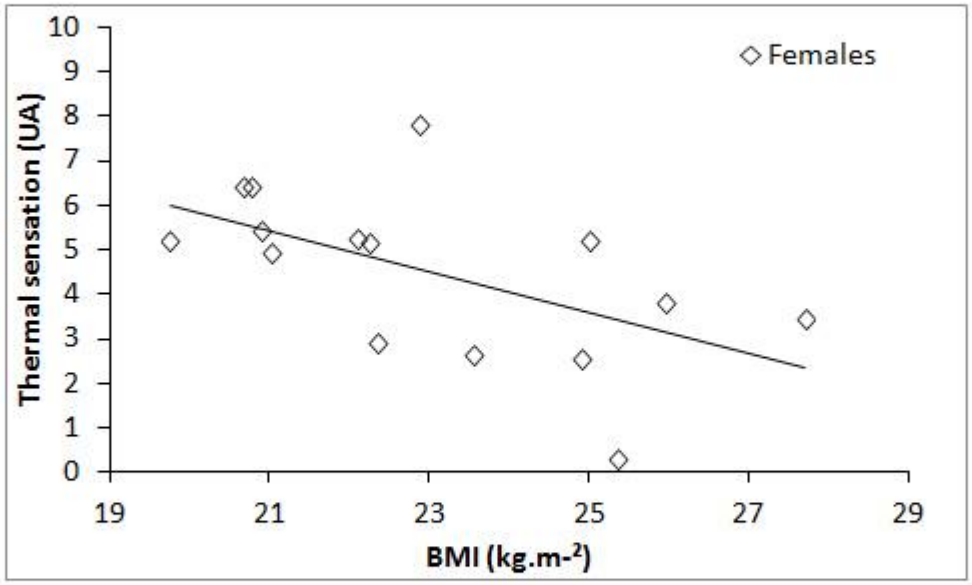
Male/female





Thermic comfort changes during 3-min exposure at -110°C (n=47 high level athletes).

Bouzigon et al., J Hum Kinetics, 2018


Females
Thermal sensation (UA)
BMI (kg.m-2)
10
9
8
7
6
5
4
3
2
1
0
19
21
23
25
27
29

Role of individual factors

- body size or BSA/mass-ratio
- fatness
- physical fitness
- gender
- age
- health status
- state of cold adaptation

Role of individual factors

Age

Elderly subjects + cold exposure (vs younger subjects):

- Less reactive to cold sensations
- Larger heat loss
- Lower vascular reactivity
- Sympathetic dysfonction (slower)

  ? lower alpha-adrenoceptrice response
- Lower increase in metabolism
- Larger increase in systolic + diastolic pressure

Role of individual factors

- body size or BSA/mass-ratio
- fatness
- physical fitness
- gender
- age
- health status
- state of cold adaptation
- mood

Habituation ('get used to')

- psychological response
- relatively fast
- response to cold is less intense
- less discomfort
- shivering starts at a lower internal temperature
- lower rise in heart rate, blood pressure, and breathing

Whole-body adaptation

Adaptive changes observed already in a week

Types of adaptation:

- hypothermic (reduced internal temperature)
- insulative (reduced skin circulation)
- metabolic (brown fat, betareceptors)
- different combinations

Key aspects

- Different kinds of whole body cryotherapy (WBC) or cryostimulation
- Why to use WBC
- Feelings after exposure
- Cold and physiological adaptations
- Peculiar problems to deal with WBC investigations
- What do we know about whole body cryotherapy
- Mecanisms

Peculiar problems to deal with WBC investigations

- No possibility for double-blind studies
- Homogeneity for Groups of volunteers
- number of volunteers
- Selection Biais

=> many studies with limited number of subjects, problems with standardization of procedure,

Control groups often missing

=> Results at variance

WHAT IS POSSIBLE?

META- ANALYSIS

Whole-body cryotherapy (extreme cold air exposure) for preventing and treating muscle soreness after exercise in adults (Review)

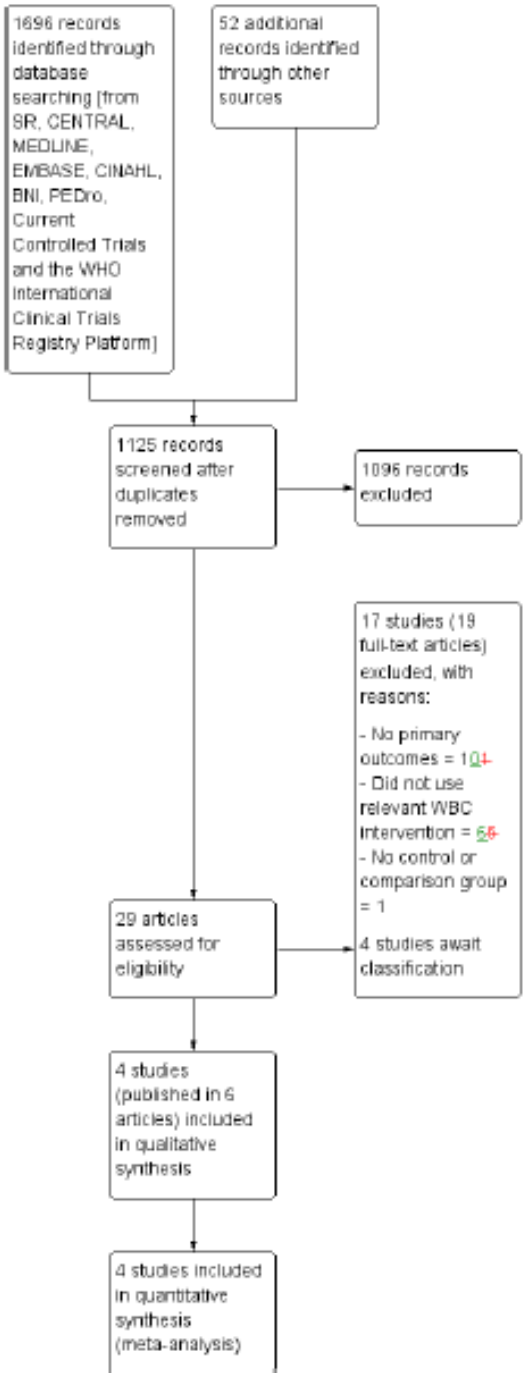
Costello JT, Baker PRA, Minett GM, Bieuzen F, Stewart IB, Bleakley C

Cochrane Database of Systematic Reviews 2015, Issue 9.

Authors' conclusions

There is insufficient evidence to determine whether whole-body cryotherapy (WBC) reduces self-reported muscle soreness, or improves subjective recovery, after exercise compared with passive rest or no WBC in physically active young adult males. There is no evidence on the use of this intervention in females or elite athletes. The lack of evidence on adverse events is important given that the exposure to extreme temperature presents a potential hazard. Further high-quality, well-reported research in this area is required and must provide detailed reporting of adverse events.

Figure 2. Study flow diagram



SYSTEMATIC REVIEW ARTICLE
Front. Physiol., 26 April 2018 | https://doi.org/10.3389/fphys.2018.00403

An Evidence-Based Approach for Choosing Post-exercise Recovery Techniques to Reduce Markers of Muscle Damage, Soreness, Fatigue, and Inflammation: A Systematic Review With Meta-Analysis

Olivier Dupuy*, Wafa Douzi, Dimitri Theurot, Laurent Bosquet and Benoit Dugué

Table 1: Effects of techniques of recovery on the kinetics of DOMS and perceived fatigue

	Subjects (n)	Experimental group (n)	SMD	IC	I^2
DOMS	**1188**	**106**	**-0.78**	**-0.94;-0.61**	**56.62**
Active recovery	90	8	-0.94	-1.61;-0.28	*
Stretching	67	5	0.15	0.00 ; 0.29	
Massage	158	14	-2.26	-3.05 ;-1.47	*
Massage + Stretching			N/A		
Compression Garments	160	16	-0.92	-1.34 ;-0.50	*
Electrostimulation	94	8	-0.28	-0.59; 0.03	
Immersion	379	34	-0.47	-0.77;-0.18	*
Contrast water therapy	144	12	-0.40	-0.73 ;-0.07	*
Cryotherapy/cryostimulation	72	6	-0.53	-1.04 ;-0.03	*
Hyperbaric therapy	24	3	0.55	-0.12 ; 1.22	
Perceived Fatigue	**266**	**27**	**-1.40**	**-1,92 ;-0,89**	**32,65**
Active recovery	33	4	0.64	-0.43; 1.70	
Stretching	30	1	-0.21	-1.04 ; 0.62	
Massage	64	7	-2.55	-3.49 ;-1.62	*
Massage + stretching	9	1	-4.34	-7.20 ;-1.47	*
Compression Garments	28	3	-0.88	-1.34 ;-0.50	*
Electrostimulation	11	1	-0.28	-0,59; 0,03;	
Immersion	75	8	-1.16	-1.94 ;-0.39	*
Contrast water therapy	16	2	-0.04	-0.86; 0.79;	
Cryotherapy/cryostimulation			NA		
Hyperbaric therapy			NA		

Abbrevation : SMD: Standardized mean differences; IC: interval of confidence ; NA : not available ; * significant ; - mean a decrease and + an increase in DOMS and perceived fatigue after the recovery strategy

An evidence-based approach to choose the recovery you need: a systematic review with meta-analysis.

Olivier Dupuy, Wafa Douzi, Dimitri Theurot, Laurent Bosquet, Benoit Dugué

Frontiers in Physiology 2018

Key aspects

- Different kinds of whole body cryotherapy (WBC) or cryostimulation
- Why to use WBC
- Feelings after exposure
- Cold and physiological adaptations
- Peculiar problems to deal with whole body cryotherapy investigations
- **What do we know about whole body cryotherapy**
- Mechanisms

COLD EXPOSURE AFTER EXERCISE

+++ SYMPATHETIC SYSTEM & RELEASE OF NORADRENALIN

SIGNIFICANT IMPACT CONCERNING PAIN

VASOCONSTRICTION:

=> --- BLOOD IN MUSCLE

=> ---CELL PERMEABILITY/LEAKING

=> --- FLUID DIFFUSION IN INTERSTIAL SPACE

=> --- INFLAMMATION

LOWER MUSCLE TEMPERATURE

=> --- ENZYME ACTIVITY

=> --- METABOLISM

=> --- SECONDARY DEGRADATION AFTER HYPOXIA

One meta-analysis in the context of pathology

EXPERT REVIEWS

Cryotherapy in inflammatory rheumatic diseases: a systematic review

Expert Rev. Clin. Immunol. 10(2), 000–000 (2014)

Guillot X, Tordi N, Mourot L, Demougeot C, Dugué B, Prati C, Wendling D: Cryotherapy in inflammatory rheumatic diseases: a systematic review. Expert Review of Clinical Immunology 2014; 10: 281-294

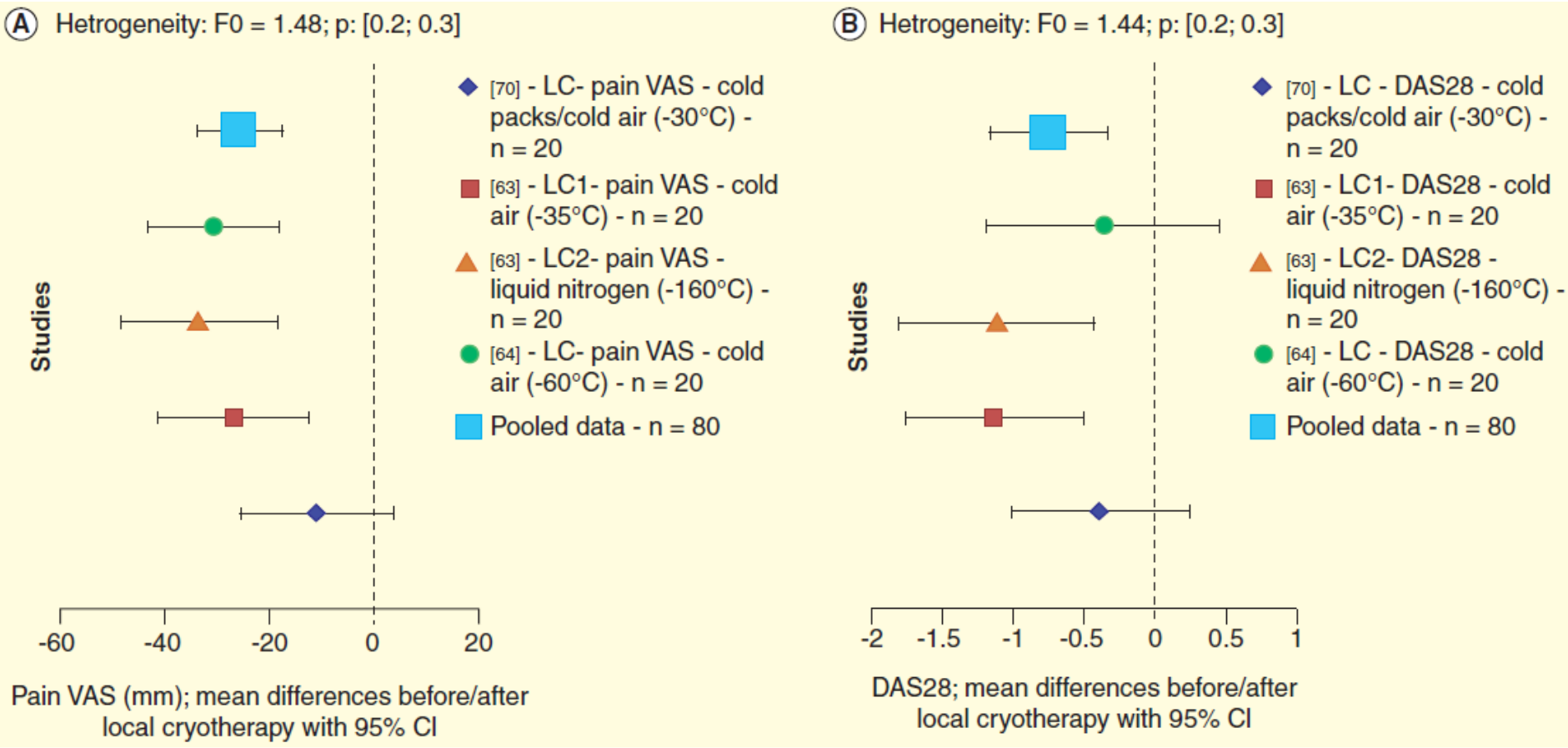


Figure 2. Effects of local cryotherapy on pain VAS **(A)** and DAS28 **(B)**.

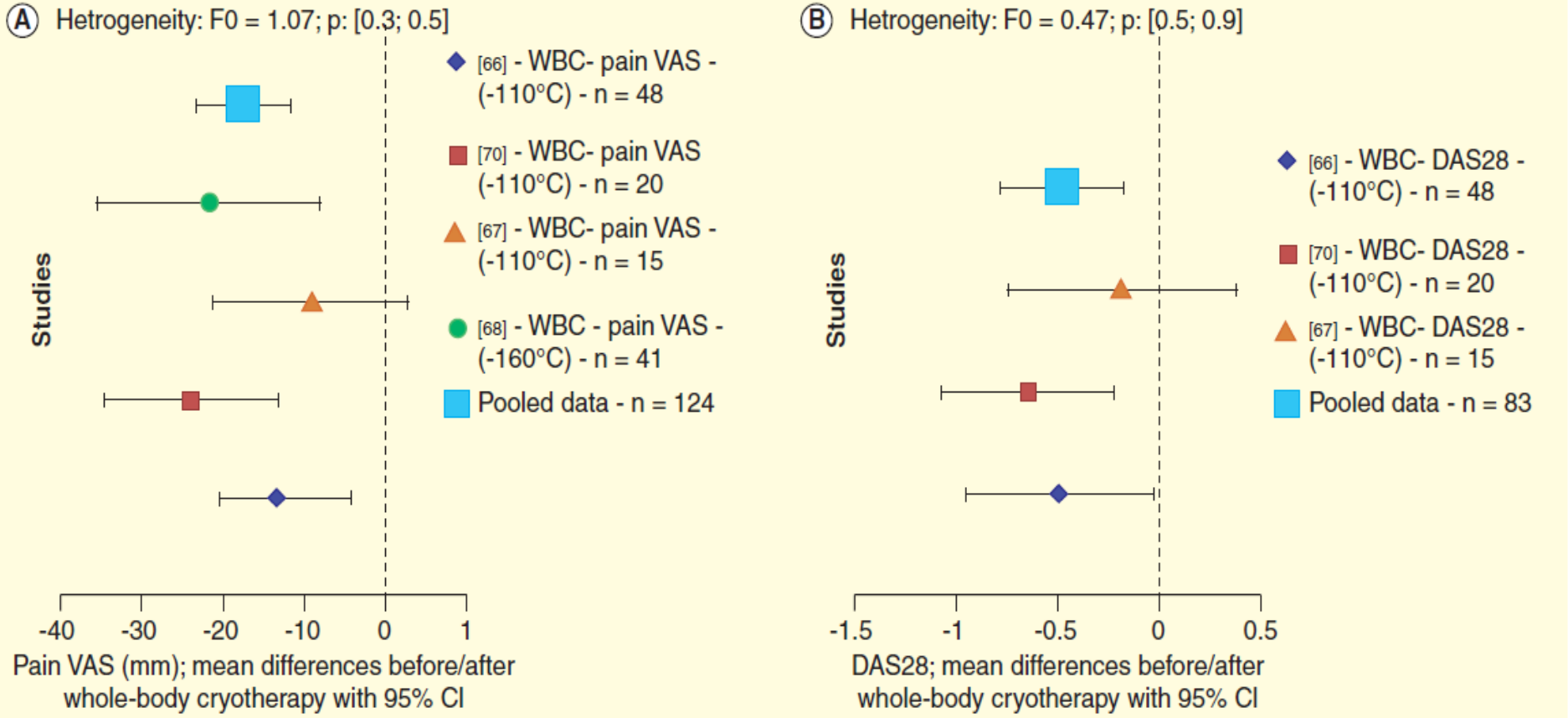


Figure 3. Effects of whole-body cryotherapy on pain VAS **(A)** and DAS28 **(B)**. Mean differences in pain VAS (mm) or DAS28 before/after LC or WBC are represented for each of the six studies included in the meta-analysis [63,64,66–68,70], with 95% confidence intervals. Heterogeneity was also tested using Fisher's test (F0 and p-values are shown on the graphs). Design of the studies: RCT [70], controlled trials [63,64], parallel cryotherapy treatment groups [67,68] and noncontrolled study [66].
DAS28: 28-joint disease Activity Score (composite score including patient VAS for disease activity, acute-phase reactant (ESR or CRP), tender joint count and swollen joint score); LC: Local Cryotherapy; n: Number of patients;

Conclusions

Local and whole body cryotherapy could be included in RA therapeutic strategies as an adjunct therapy with potential corticosteroid and non steroidal anti-inflammatory drug dose-sparing effects.

However, techniques and protocols should be more precisely defined in randomised controlled trials with stronger methodology

Biomed Res Int. 2015;2015:409174. doi: 10.1155/2015/409174. Epub 2015 Oct 21.

Effects of Whole-Body Cryotherapy in Comparison with Other Physical Modalities Used with Kinesitherapy in Rheumatoid Arthritis.

Gizińska M[1], Rutkowski R[1], Romanowski W[2], Lewandowski J[3], Straburzyńska-Lupa A[4].

Abstract

Whole-body cryotherapy (WBC) has been frequently used to supplement the rehabilitation of patients with rheumatoid arthritis (RA). The aim of this study was to compare the effect of WBC and traditional rehabilitation (TR) on clinical parameters and systemic levels of IL-6, TNF-α in patients with RA. The study group comprised 25 patients who were subjected to WBC (-110 °C) and 19 patients who underwent a traditional rehabilitation program. Some clinical variables and levels of interleukin-6 (IL-6) and tumor necrosis factor-α (TNF-α) were used to assess the outcomes. After therapy both groups exhibited similar improvement in pain, disease activity, fatigue, time of walking, and the number of steps over a distance of 50 m. Only significantly better results were observed in HAQ in TR group ($p < 0.05$). However, similar significant reduction in IL-6 and TNF-α level was observed. **The results showed positive effects of a 2-week rehabilitation program for patients with RA regardless of the kind of the applied physical procedure.**

Disabil Rehabil. 2016 Jun;38(11):1034-40

Complex rehabilitation and the clinical condition of working rheumatoid arthritis patients: does cryotherapy always overtop traditional rehabilitation?

Księżopolska-Orłowska K, Pacholec A, Jędryka-Góral A, Bugajska J, Sadura-Sieklucka T, Kowalik K, Pawłowska-Cyprysiak K, Łastowiecka-Moras E.

64 females RA
32 traditional rehab + exercice
32 cryo +exercise

YES !

3 weeks

Larger impact of the cryotherapy 3 months after the rehab (functional tests , Pain “Global Health Index)

Cryotherapy decreases synovial Doppler activity and pain in knee arthritis: a randomized-controlled trial

Xavier Guillot[1,2], Nicolas Tordi[2], Clément Prati[1,2], Frank Verhoeven[1], Lionel Pazart[3], and Daniel Wendling[1,4].

Joint Bone Spine 2017

N=30

Table 3. Effets taille inter-classes de la cryothérapie locale sur le score Doppler sur 24 heures.

Comparaison au score initial	Glace	CO2	Global (Glace+CO2)
Après cryothérapie 1	-0.73 [-1.1;-0.36]	-0.51 [-0.99;-0.03]	-1 [-1.33;-0.67]
2 minutes	-0.73 [-1.02;-0.44]	-0.25 [-0.73;0.23]	-0.48 [-0.81;-0.15]
2 heures	-0.96 [-1.35;-0.57]	-0.02 [-0.5;0.46]	-0.24 [-0.58;0.1]
8 heures	-0.73 [-1.08;-0.38]	-0.47 [-0.97;0.03]	-0.48 [-0.83;-0.13]
Après cryothérapie 2	-0.73 [-1.06;-0.4]	-0.93 [-1.38;-0.48]	-0.48 [-0.81;-0.15]
24 heures	-0.73 [-1.06;-0.4]	-0.7 [-1.18;-0.22]	-1 [-1.23;-0.77]

Medical Hypotheses 79 (2012) 56–58

Contents lists available at SciVerse ScienceDirect

Medical Hypotheses

journal homepage: www.elsevier.com/locate/mehy

Translating whole-body cryotherapy into geriatric psychiatry – A proposed strategy for the prevention of Alzheimer's disease

Blazej Misiak*, Andrzej Kiejna

Vascular alterations+ oxidative stress + inflammation
=> AD developpement

Whole body cryotherapy =>
--- inflammation
--- oxidative stress
--- vascular alterations

Whole body cryotherapy should be evaluated in the context of AD + MCI

Subjects at risks

- serious hypertension
- serious cardiopathies
- cold allergy
- Raynaud syndroma
- drepanocytose
- cryoglobulinemia
- claustrophobia
- skin problems, frostbites
- severe hypothyroid disease

Accidents are rare but they exist

Cold burn injury after treatment at whole-body cryotherapy facility

Mackenzie O'Connor, BS, Jordan V. Wang, MD, MBE, MBA, and Anthony A. Gaspari, MD

Fig 1. Cold burn injury after WBC.

JAAD Case Reports 2019;5:29-30.

McGee K, Turkewitz J. Death of Woman in Tank at a Nevada Cryotherapy Center Raises Questions About Safety. New York Times. 2017.

Carrard J, Lambert AC, Genne D. Transient global amnesia following a whole-body cryotherapy session. BMJ Case Rep. 2017.

Camara-Lemarroy CR, Azpiri-Lopez JR, Vazquez-Dıaz LA, Galarza-Delgado DA. Abdominal aortic dissection and cold-intolerance after whole-body cryotherapy: a case report. Clin J Sport Med. 2017;27(5):e67-e68.

Quesada-Cortes A, Campos-Mu~noz L, Dıaz-Dıaz RM, Casado-Jimenez M. Cold panniculitis. Dermatol Clin. 2008; 26(4):485-489.

Problem of anoxia in Cryo-sauna with the direct injection of vaporised liquid N2 which makes the atmosphere in the cabin not breathable. The head is of course not exposed but the unbreathable atmosphere is only few centimeters below the chin level.

MAIN CONCLUSIONS

- **EFFICIENCY: ALMOST OK**

-**MECHANISMS: ALMOST OK ?**

- **SAFETY:**
  - **OK FOR HEALTHY SUBJECTS**
  - **PATIENTS?**

MANY QUESTIONS + NEED OF MORE DATA

In cold, we trust

Cryotherapy: cure or kill ?

Cryotherapy: Are we freezing the benefits of exercise?

Cold water immersion
vs
Partial body cryotherapy
vs
Whole body cryotherapy

Temperature ?

Exposure duration?

Stimulation frequency?

Dose/Reponses?

Positive aspects of inflammation or Oxydative Stress ?

Temperature?

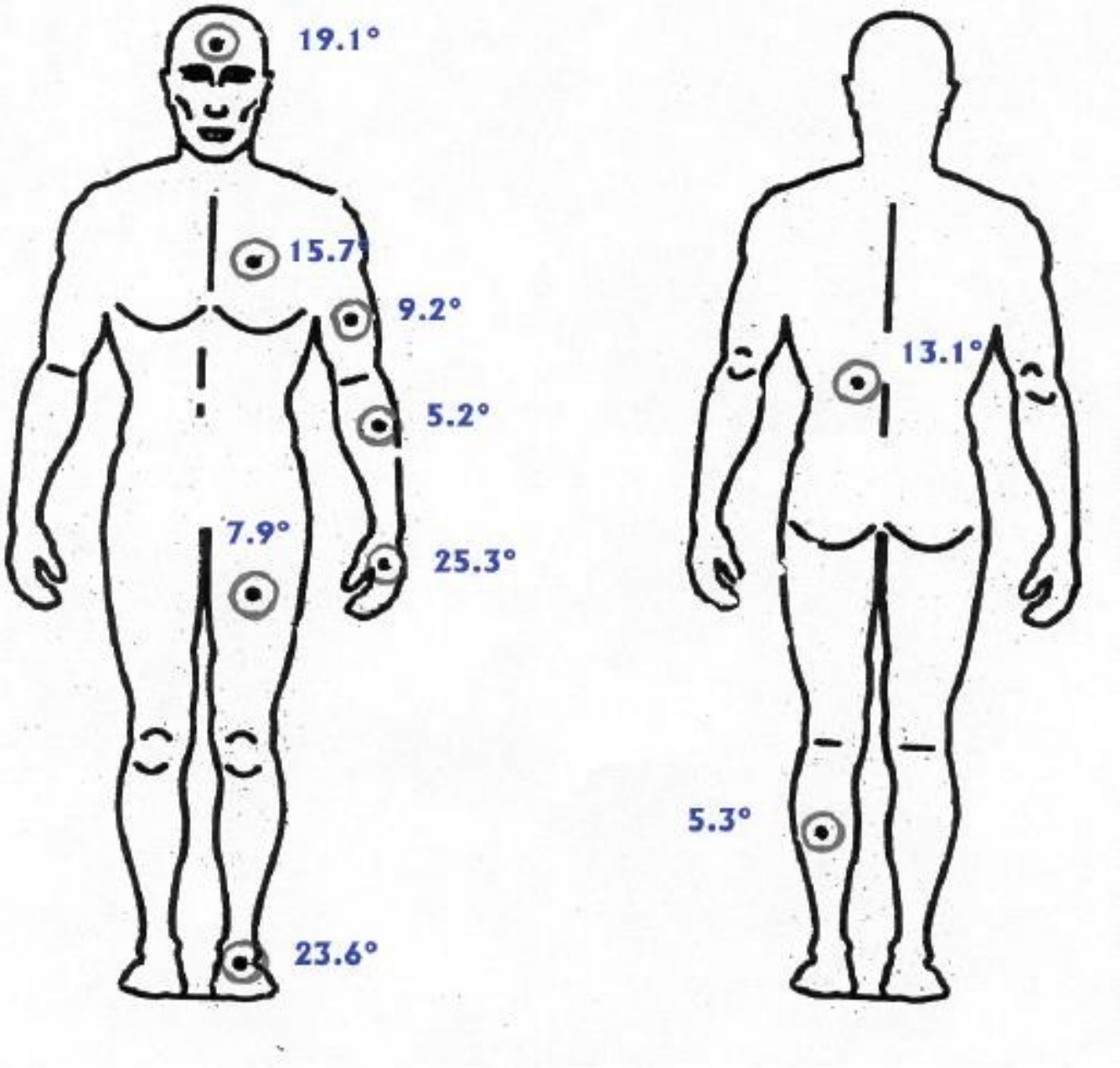
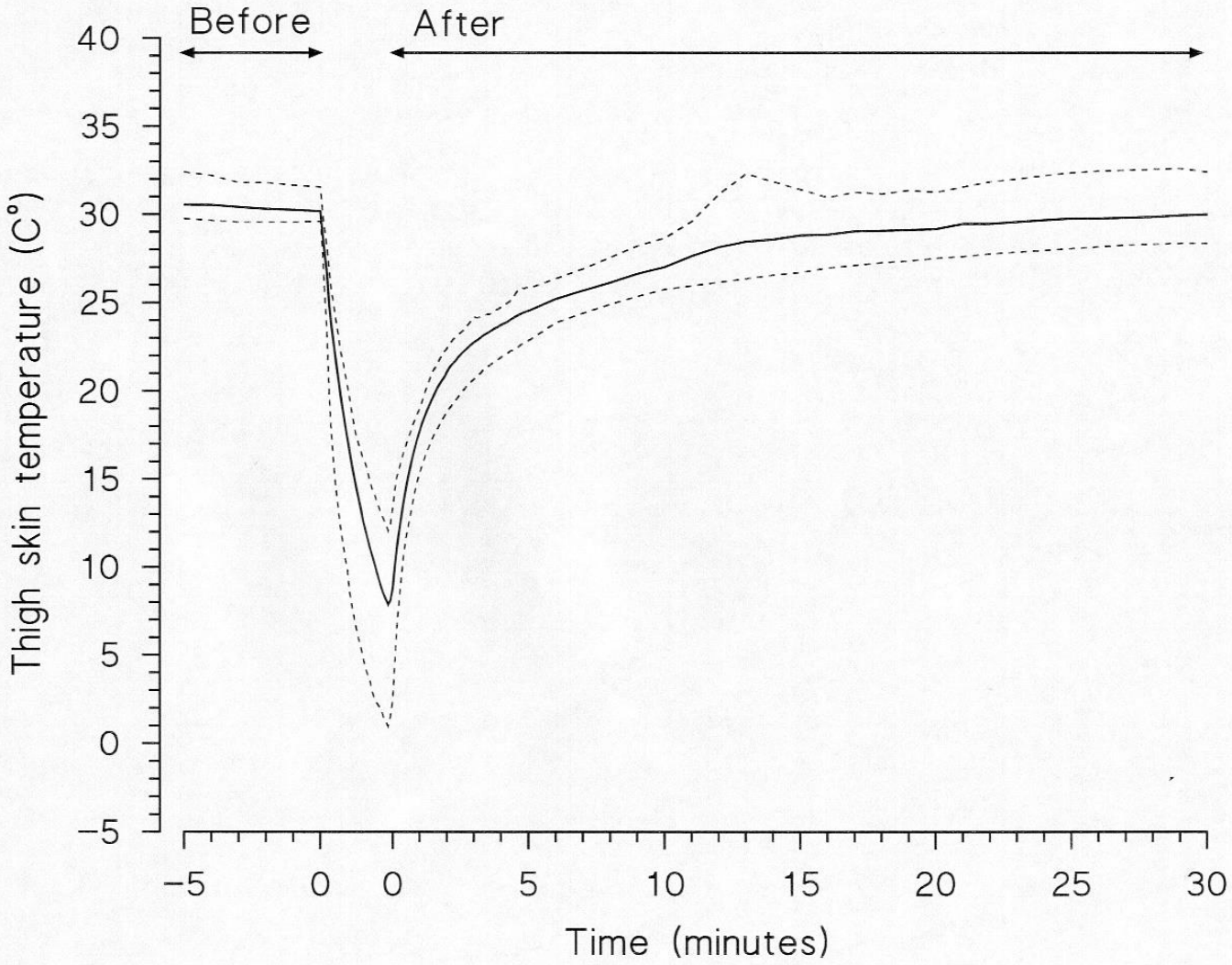


Fig. 2. The lowest skin temperatures (°C) during −110 °C.


Before
After
40
35
30
25
20
15
10
5
0
−5
Thigh skin temperature (C°)
−5
0
0
5
10
15
20
25
30
Time (minutes)

Session number?

10

20?

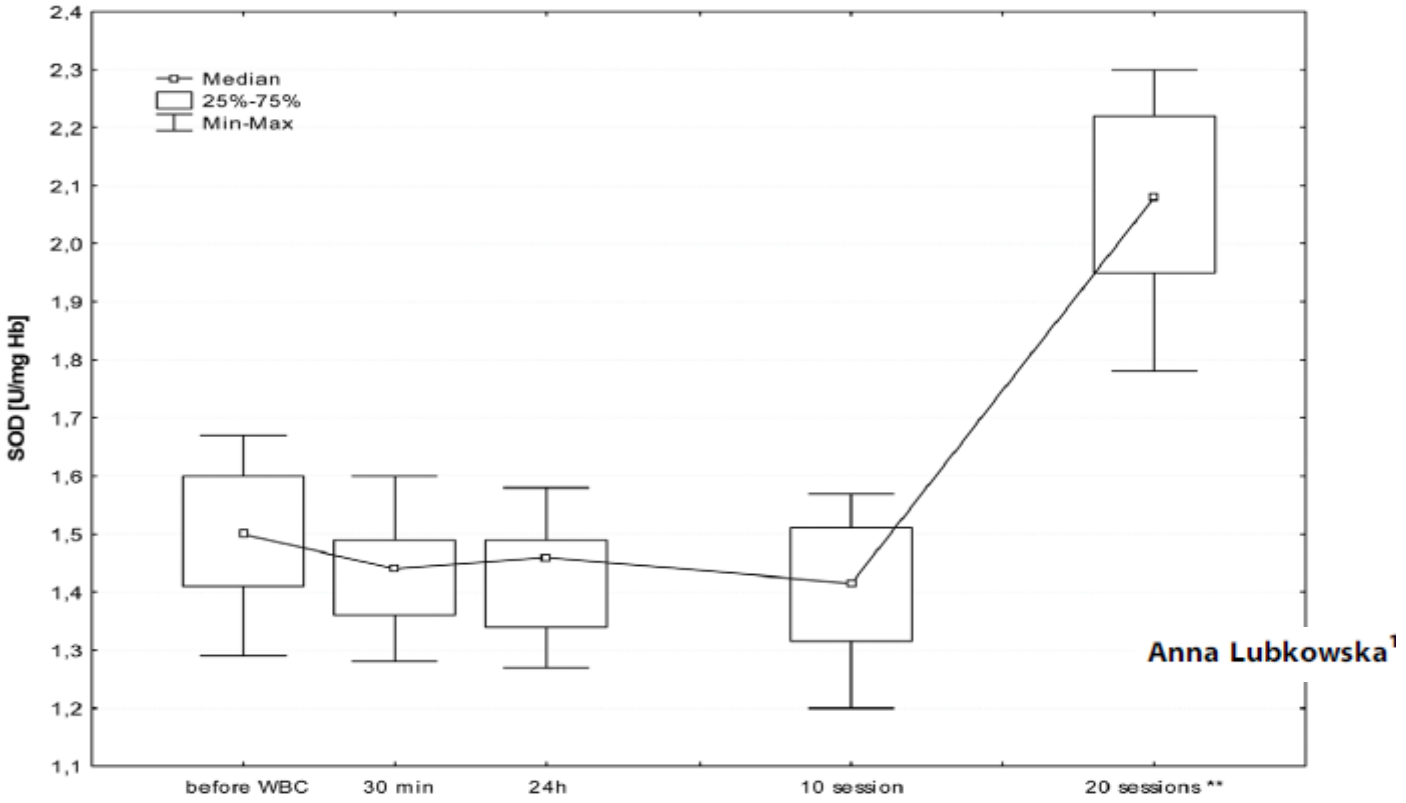
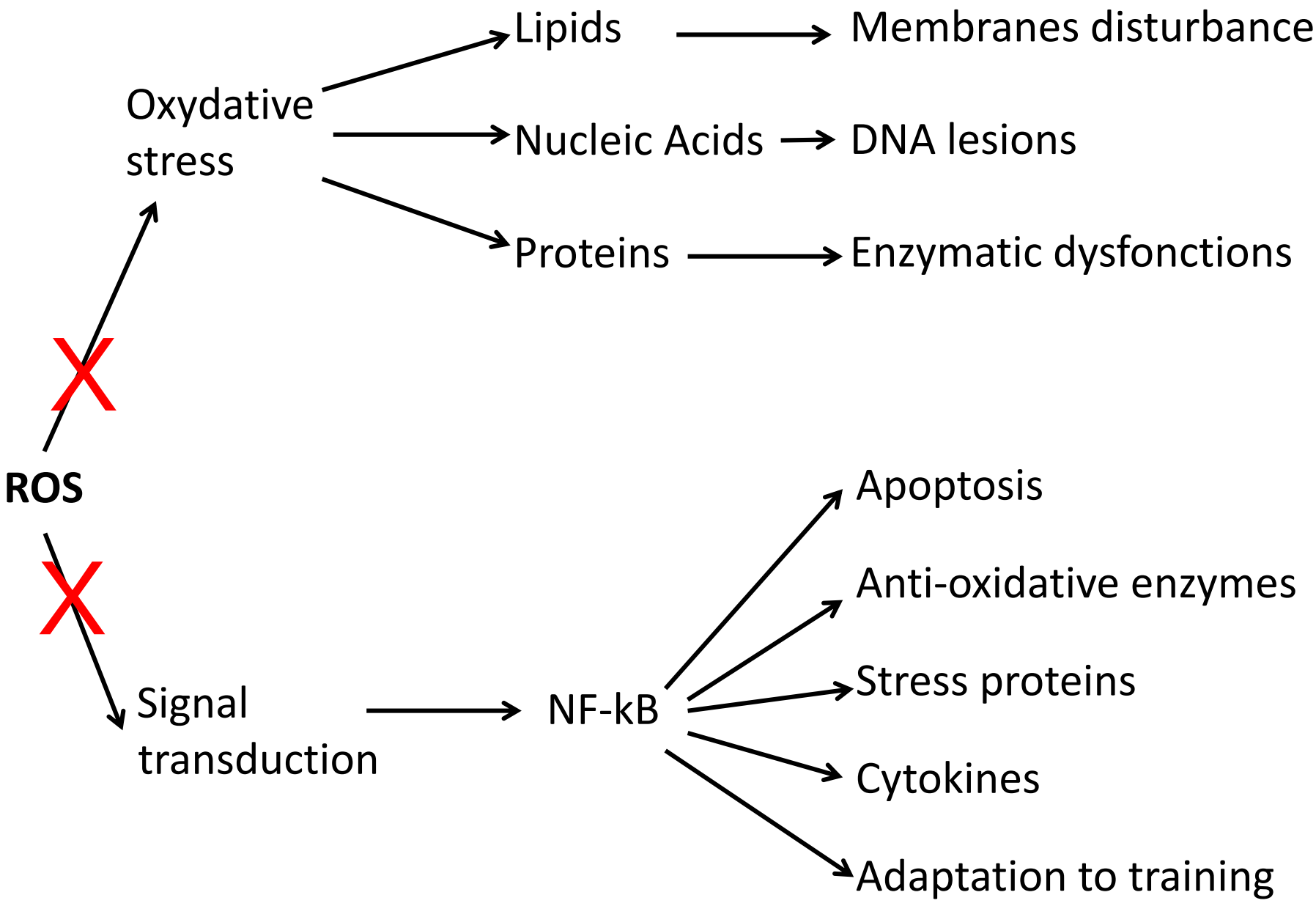


Figure 1. Changes in superoxide dismutase (SOD) activity in erythrocytes before and during following sessions of WBC. Legend Figure 1: Median and 25%–75% confidence interval; **p≤0.01 statistically significant vs. before WBC; before WBC - A: before the first cryostimulation, after overnight fasting; 30 min - B: 30 min after the first cryostimulation; 24 h – C: 24 hours after the first cryostimulation, after overnight fasting; 10 session – F: 24 hours after the10th cryostimulation, after overnight fasting; 20 session – I: 24 hours after the 20th cryostimulation, after overnight fasting.
doi:10.1371/journal.pone.0046352.g001

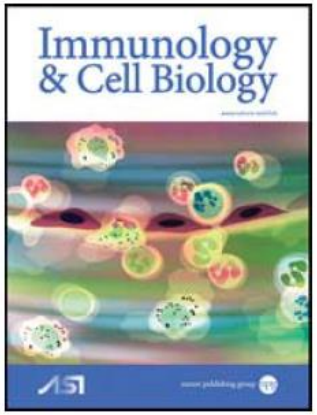
Cellular responses to reactive oxygen species (ROS)



Similar way of thinking with

inflammation after exercise

Accepted Article Preview: Published ahead of advance online publication



Inflammation during skeletal muscle regeneration and tissue remodeling—application to exercise-induced muscle damage management

Bénédicte Chazaud

Inflammation is a complex process which both mounting and resolution phases are required for tissue repair/recovery of muscle function.

Cold => lower inflammation => longer recovery

However, a strategy would be to boost the anti-inflammatory phase at the time of resolution of inflammation.

Difficult to monitor as this event occurs intramuscularly.

Contents lists available at ScienceDirect

Cytokine

journal homepage: www.elsevier.com/locate/cytokine

Whole-body cryotherapy (−110 °C) following high-intensity intermittent exercise does not alter hormonal, inflammatory or muscle damage biomarkers in trained males

Malte Krueger[a,b,*], Joseph T. Costello[c], Silvia Achtzehn[a,b], Karl-Heinrich Dittmar[d], Joachim Mester[b]

+

OR

+

PERSPECTIVE ARTICLE
Front. Physiol., 06 August 2019 | https://doi.org/10.3389/fphys.2019.01007

Whole-Body Cryotherapy: Potential to Enhance Athlete Preparation for Competition?

 Emily M. Partridge[1*], Julie Cooke[1,2],  Andrew McKune[1,2,3,4] and  David B. Pyne[1]

[1]Research Institute for Sport and Exercise Science, University of Canberra, Bruce, ACT, Australia
[2]Faculty of Health, University of Canberra, Bruce, ACT, Australia
[3]Collaborative Research in Bioactives and Biomarkers (CRIBB) Group, University of Canberra, Bruce, ACT, Australia
[4]Discipline of Biokinetics, Exercise and Leisure Sciences, School of Health Sciences, University of KwaZulu-Natal, Durban, South Africa

COMPLEX SITUATIONS

WHAT SHOULD WE DO?

PhD thesis - Romain Bouzigon:
LA CRYOSTIMULATION CORPS ENTIER COMME AIDE À LA RÉCUPÉRATION APRÈS EXERCICE(S) PHYSIQUE(S) ÉPUISANT(S). ETUDE DES IMPACTS BIOLOGIQUES, PHYSIOLOGIQUES ET PSYCHOLOGIQUES ET APPLICATIONS DANS LE CONTEXTE DE LA PERFORMANCE SPORTIVE.
Université de Franche Comté, 10 décembre 2016

PhD thesis - Xavier Guillot:
CRYOTHERAPIE ET RHUMATISMES INFLAMMATOIRES
Université de Franche Comté, 22 décembre 2016

PhD thesis - Wafa Douzi
UTILISATION DU FROID A DES FINS D'AMELIORATION DE LA RECUPERATION APRES UNE ACTIVITE PHYSIQUE DANS LE CONTEXTE SPORTIF, DE LA REHABILITATION ET DANS LE CONTEXTE DU TRAVAIL EN ENVIRONEMENT EXTREME
Université de Poitiers, September 28, 2018

PhD thesis – Dimitri Theurot
In progres
Université de Poitiers

The International Institute of Refrigeration Working Group on Whole body cryotherapy will help in promoting networking

THANK YOU FOR YOUR ATTENTION

YOU ARE COOL