Recovery Methods

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What is Recovery?
- Process by which the athletes physiological and psychological function is restored
- Recovery can result in an enhanced performance by increasing the adaptation to training
- Increase the quality and quantity of training
- Reduce the risk of developing overuse injuries

What recovery techniques do athletes use?
- Stretching
- Active recovery (warm-down)
- Nutrition
- Massage
- Hydrotherapy
- Compression
- Vibration
- Psychological means and sleep

Hydrotherapy and Cryotherapy

Effects of Cryotherapy?
Effects of Cryotherapy?

- ↑ Circulation
- ↑ Oedema
- ↑ Flexibility
- ↑ Inflammation

↓ muscle spasm
↓ muscle relaxation
↓ pain

Temperature changes within the various tissues

- Skin temperature
- Subcutaneous temperature
- Intramuscular temperature
- Joint temperature

**Table 1: Effect of various cooling methods on skin temperature**

<table>
<thead>
<tr>
<th>Reference</th>
<th>Method</th>
<th>Temperature (°C)</th>
<th>Time (min)</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abromson et al. (1985)</td>
<td>Water immersion</td>
<td>4</td>
<td>100</td>
<td>10.8°C</td>
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<tr>
<td>Abromson (1985)</td>
<td>Water immersion</td>
<td>4</td>
<td>50</td>
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<tr>
<td>Bäthe (1985)</td>
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<td>10</td>
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<tr>
<td>Knight et al. (1986)</td>
<td>Water immersion</td>
<td>1.5</td>
<td>40</td>
<td>10.5°C (finger)</td>
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<tr>
<td>Magni et al. (1979)</td>
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<td>7</td>
<td>30</td>
<td>10.5°C (finger)</td>
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<tr>
<td>Single (1978)</td>
<td>Ice massage</td>
<td>20</td>
<td>15</td>
<td>10.5°C</td>
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<td>Jönsson et al. (1987)</td>
<td>Ice massage</td>
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<td>10</td>
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<td>20</td>
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<td>Utschek et al. (1987)</td>
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<td>10</td>
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<td>Zeman (1986)</td>
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<td>5</td>
<td>20</td>
<td>10.5°C</td>
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<tr>
<td>Lee et al. (1976)</td>
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<td>15</td>
<td>10.5°C (finger)</td>
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<td>Berghard (1985)</td>
<td>Ice pack</td>
<td>100</td>
<td>3</td>
<td>10.5°C</td>
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<tr>
<td>Raa (1983)</td>
<td>Ice towel</td>
<td>7</td>
<td>10</td>
<td>10.5°C</td>
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<td>John (1987)</td>
<td>Refrigerant gel</td>
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<tr>
<td>Johnson &amp; Berghard (1985)</td>
<td>Spray</td>
<td>10-20 sec</td>
<td>10-15 (min)</td>
<td>10.5°C</td>
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</table>

**Table 2: Effect of various cooling methods on intramuscular temperature**

<table>
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<th>Method</th>
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<th>Time (min)</th>
<th>Result</th>
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<tr>
<td>Knight et al. (1986)</td>
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<td>40</td>
<td>11.0°C</td>
</tr>
<tr>
<td>Ming &amp; Weis (1983)</td>
<td>Water immersion</td>
<td>15.0-15</td>
<td></td>
<td></td>
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<td>20</td>
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<tr>
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<td>10</td>
<td>20</td>
<td>10.5°C</td>
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<td>10</td>
<td>20</td>
<td>10.5°C</td>
</tr>
<tr>
<td>Botte (1985)</td>
<td>Ice massage</td>
<td>10</td>
<td>15</td>
<td>10.5°C</td>
</tr>
<tr>
<td>Lennard &amp; Weis (1979)</td>
<td>Ice massage</td>
<td>2</td>
<td>10</td>
<td>10.5°C</td>
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<tr>
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<td>Ice massage</td>
<td>7</td>
<td>5</td>
<td>10.5°C</td>
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<tr>
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<td>Ice pack</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wing et al. (1984)</td>
<td>Ice pack</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Johnson &amp; Berghard (1985)</td>
<td>Ice pack</td>
<td>10-20 sec</td>
<td>10-15 (min)</td>
<td>10.5°C</td>
</tr>
</tbody>
</table>

**Skin – Intramuscular Temperature (IMT)**

- Intramuscular temperature (2.3 cm deep)
- Subcutaneous temperature
- Room temperature 23-22.2°C
Cryotherapy and blood flow

Clarke, Hellon & Lind (1958)
- Blood flow
- Pletysmography
- Limb blood flow
- No distinction between skin and muscle blood flow!

Materials & Methods
- n=15
- mean age: 20.5 yr
- Ice pack (-5°C) water bag (+32°C)
- Skin temperature
- Laser Doppler flowmeter

Procedure
- 15 min acclimatisation
- 5 min rest values
- 20 min application
- 20 min recovery period

Skin Blood Flow

During application
- first decrease (5th min 56% lower)
- already during application: increase

Following application
- peak volume 3 min post appl
- Cold-Induced Vasodilatation
- gradual decrease
Intramuscular blood flow

Tracer study $^{133}$Xe

- Distinction between skin blood flow and intramuscular blood flow
- Cold Induced Vasodilatation depends on tissue temperature
- Skin blood flow will increase intramuscular blood flow → vasoconstriction, probably no dilatation

Thorsson et al (1985)

Cryotherapy & Blood Flow

Contrast Therapy - Background

- Rationale - increase blood flow
- stimulate central nervous system
- Evidence - scientific
- anecdotal

Contrast Therapy - Methods

- 1 minute in spa
- 1 minute in plunge pool
- Repeat 7 times

NB: Spa at AIS 38°C.
Plunge pool at AIS 10-12°C

Cold Water Immersion

Ice Baths: a Great Way to Enhance Team Spirit!
What evidence do we have that recovery works?- Hydrotherapy

- Subjects: 11 AIS Professional Cyclists
- Purpose: What are the physiological effects of cold water immersion following cycling in the heat

40 min 11°C at 34.3°C: 41.2°F

40 min

RECOVERY PERIOD

Time (min)

0

40

80

What evidence do we have that recovery works?- Hydrotherapy

MEASURES:
- Trec, Tsk, heart rate
- Lactate, glucose, pH, chloride, potassium, bicarbonate, sodium, PO₂ and PCO₂
- Testosterone, cortisol, GH, PRL, A, NA, CK, CRP, IGF-1, IL-6
- Thermal scale, recovery questionnaire

What evidence do we have that recovery works?- Hydrotherapy

RESULTS - Effects of CWI
- Reduced heart rate
- Reduced core temperature
- Reduced skin temperature
- Enhanced perception of recovery
- No change in any other variable

What evidence do we have that recovery works?- Hydrotherapy

Effects of Cold Water Immersion (3 x 1min at 11°C) on Core Temperature in Male Cyclists (n=11)

Core
ICE

Recovery Time (min)

-5 0 5 10 15 20 25 30 35 40 45

36.5

37.0

37.5

38.0

38.5

39.0

39.5

40.0

Thermal Imaging Video

Following Cold Water Immersion

ICE

33.6°C

27.8°C

39.2°C
### What evidence do we have that recovery works? - Hydrotherapy

Examination of the effects of regular CWI on performance, adaptation and perceived recovery in AIS rowers
- 10 subjects (6F and 4M) pair-matched according to 2000m ergometer performance, gender and weight category (M)
- CWI (~11°C; 4 X per week), Placebo (sugar capsule)
- 1 week of baseline assessment (training volume, intensity, level of fatigue, perceived recovery, sleep quality and quantity)
- 4 weeks of assessment and treatment
- Pre and post 2000m ergometer assessments

<table>
<thead>
<tr>
<th>HYDROTHERAPY</th>
<th>ICE</th>
<th>CONTR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>-4.6%</td>
<td>-2.6%</td>
</tr>
<tr>
<td>VO₂</td>
<td>0.6%</td>
<td>0.1%</td>
</tr>
<tr>
<td>Time</td>
<td>-1.54%</td>
<td>-0.94%</td>
</tr>
<tr>
<td>Rating of Fatigue</td>
<td>0.4%</td>
<td>13.8%</td>
</tr>
<tr>
<td>Rating of Recovery</td>
<td>-3.8%</td>
<td>-11.8%</td>
</tr>
<tr>
<td>Amount of Sleep</td>
<td>3.3%</td>
<td>-9.0%</td>
</tr>
<tr>
<td>Quality of Sleep</td>
<td>17.3%</td>
<td>8.0%</td>
</tr>
</tbody>
</table>

Recommendation to AIS Rowing Coaches → CWI may be beneficial during intense training blocks to adaptation to training and increase performance.

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### The Effect of Contrast Water Therapy on Symptoms of Delayed Onset Muscle Soreness

**Joanna M. Vaile, Nicholas D. Gill, and Anthony J. Blazevich**

Department of Physiology, Australian Institute of Sport, Canberra, Australia; School of Sport and Exercise Sciences, University of Waikato, Hamilton, New Zealand; Department of Sport Sciences, Brunel University, England.

13 recreational athletes
- 2 trials randomised cross over (6 weeks apart)
- Eccentric leg press protocol 140% 1RM → DOMS CWT: [1min (ca 10°C) + 2 min 40-42°C] x 5min
- Jump Power, Squat force
- Muscle soreness, recovery score, thigh volume

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### Passive & Contrast Water Therapy

#### Peak isometric power

#### Squat Jump

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### Passive & Contrast Water Therapy

#### Creatine Kinase

#### Thigh Volume

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### DOMS

- Strength, Power, DOMS improved following CWT compared to Passive recovery.
Hydrotherapy & DOMS

Effect of hydrotherapy on the signs and symptoms of delayed onset muscle soreness


1. Cold water immersion (CWI: n = 12),
2. Hot water immersion (HWI: n = 11),
3. Contrast water therapy (CWT: n = 15)

Hydrotherapy & DOMS

DOMS-inducing leg press protocol followed by PAS or one of the hydrotherapy interventions for 14 min

Measures:
- Squat jump, Isometric squat, Perceived pain, Thigh girths
- Pre, immediately post, 24, 48 and 72 h post-exercise
- Recovery after eccentric exercise

Water immersion

- Pain improved following ContrastWT at 24, 48 and 72 h post-exercise.
- ColdWI and ContrastWT → effective in reducing the physiological and functional deficits associated with DOMS:
  → improved recovery of isometric force
  → dynamic power reduction in localised oedema.
- HotWI effective in the recovery of isometric force, ineffective for recovery of all other markers compared to PAS

Swelling and Pain

- Cold WI
- Hot WI
- Contrast WT

Change in Squat Jump
What evidence do we have that recovery works?

**Hydrotherapy**

- Warm up 15 mins @ 75% PPO
- 1) 10ºC
- 2) 15ºC
- 3) 20ºC
- 4) 20ºC +
- 5) Active recovery

± 5 mins seated in heat chamber

10 male subjects (70.7 ± 7.9 ml·kg⁻¹·min⁻¹); randomised, repeated measures design

![Diagram showing warm up, recovery strategy, and performance](image)

**Power output**

<table>
<thead>
<tr>
<th>Recovery condition</th>
<th>First exercise task</th>
<th>Second exercise task</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intermittent CWI in 10ºC</td>
<td>498 ± 48</td>
<td>495 ± 46</td>
</tr>
<tr>
<td>Intermittent CWI in 15ºC</td>
<td>498 ± 47</td>
<td>500 ± 46</td>
</tr>
<tr>
<td>Intermittent CWI in 20ºC</td>
<td>500 ± 44</td>
<td>495 ± 47</td>
</tr>
<tr>
<td>Continuous CWI in 20ºC</td>
<td>502 ± 47</td>
<td>492 ± 48</td>
</tr>
<tr>
<td>Active recovery</td>
<td>503 ± 42</td>
<td><strong>484 ± 38</strong></td>
</tr>
</tbody>
</table>

![Diagram showing power output](image)

**Body Temperature**

- Mean Body Temperature
- ACT
- 10ºC
- 15ºC
- 20ºC
- 20ºC +

![Diagram showing body temperature](image)

**Cold Water immersion Protocols**

- Were effective in:
  - reducing thermal strain
  - More effective than active recovery in:
  - maintaining subsequent high-intensity cycling performance
- No differences in total work between any of the cold water immersion protocols
- No differences in blood lactate concentration between interventions or exercise tasks.

![Diagram showing cold water immersion](image)

**Why might hydrotherapy work?**

- Decrease in core temperature
- Decrease inflammation - compression
- Decrease pain sensation/nerve conduction
- Increase blood flow?
- Influence on sleep latency

![Diagram showing why hydrotherapy works](image)
Is cold water immersion safe in extreme temperatures?

![Graph showing the effects of cold water immersion on core temperature in male cyclists.](image)

**Effects of Cold Water Immersion (3 x 1min @11°C) on Core Temperature in Male Cyclists (n=11)**

<table>
<thead>
<tr>
<th>Recovery Time (min)</th>
<th>28.5</th>
<th>30.5</th>
<th>32.5</th>
<th>34.5</th>
<th>36.5</th>
<th>38.5</th>
<th>40.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>28.5</td>
<td>30.5</td>
<td>32.5</td>
<td>34.5</td>
<td>36.5</td>
<td>38.5</td>
<td>40.5</td>
</tr>
<tr>
<td>Wall of 5°C</td>
<td>28.5</td>
<td>30.5</td>
<td>32.5</td>
<td>34.5</td>
<td>36.5</td>
<td>38.5</td>
<td>40.5</td>
</tr>
<tr>
<td>Wall of 1°C</td>
<td>28.5</td>
<td>30.5</td>
<td>32.5</td>
<td>34.5</td>
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<td>38.5</td>
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**Recovery Time (min)**

- ICE: 9
- Wall of 5°C: 9
- Wall of 1°C: 9

**Récupération - Football**

- The main findings of these studies:
  - No effect of the recovery methods used (football – futsall)
  - Players “liked” more electrostimulation and water cool-down recovery interventions
  - No main effect of recovery intervention on anaerobic performances

**Anaerobic performances**

<table>
<thead>
<tr>
<th>Exercise</th>
<th>Control</th>
<th>Wall of 5°C</th>
<th>Wall of 1°C</th>
</tr>
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<tbody>
<tr>
<td>Squat Jump</td>
<td>2.7</td>
<td>2.7</td>
<td>2.7</td>
</tr>
<tr>
<td>Counter movement</td>
<td>2.7</td>
<td>2.7</td>
<td>2.7</td>
</tr>
<tr>
<td>Bounce Jump</td>
<td>2.7</td>
<td>2.7</td>
<td>2.7</td>
</tr>
<tr>
<td>10m Sprint</td>
<td>2.7</td>
<td>2.7</td>
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**Effectiveness of Active Versus Passive Recovery Strategies After Futsal Games**

**Exercise:**
- AS Roma -19
- Squat Jump, Counter movement jump, Bounce Jumping, 10m sprint
- Rest – Land cooling down, water exercises, Electrostimulation

**Design:**
- Futsal games: more than one/wk
- 4 friendly games in 2 wks (3d interval)
- Recovery: seated rest; electrostimulation; ‘dry’ exec; water exec
- 10 players:
  - 23 ± 2yr
  - 176 ± 4.7cm
  - 73 ± 7kg
  - 52.2 ± 2.7 ml/kg/min

**Table 2:** Mean ± 95% CI of performances scores (countermovement jump, bouncing jump, and 10m sprint) recorded during the pregame, postgame, and structural stages.

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<td>10m Sprint</td>
<td>2.7</td>
<td>2.7</td>
<td>2.7</td>
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**Note:**
- *p < 0.05 is considered statistically significant.
- Effect sizes for main effect are shown in parentheses.

**Tessitore et al. 2008**
Female climbers

- Anthropometric and demographic data:
  - Age (years): 27.1 ± 8.9
  - Height (cm): 168.9 ± 6.4
  - Weight (kg): 55.4 ± 8.2
  - bmi :19.3 ± 1.9
  - % fat mass: 20.6 ± 5.2
  - Free fat mass (kg): 43.6 ± 4.6

Study Design

- Passive, electrostimulation, cycling, cold water immersion

Recovery in climbers

Active recovery & cold water immersion
- results climb 1 & 2 the same
- Passive & Electrostimulation
  - no effect

Recovery in climbers

Passive, electrostimulation, cycling, cold water immersion

Effect of local cooling

Varies depending on:
- temperature tissues
- depth measurement

Skin blood flow differs from muscle blood flow

IMT:
- delayed drop
- ‘after effect’

Ice Baths / Cryotherapy

- Ice baths: bath or bin filled with ice and water
- Cryotherapy is the most commonly used strategy for the treatment of acute soft tissue sports injuries
- Cryotherapy, including CWI may be an effective treatment to
  - Decrease skin, muscle and core temperatures
  - Reduce inflammation
  - Decrease pain
What happens when you do not get enough sleep?

- Decreased focus
- Cannot process rapidly changing information
- Persevere with strategies that are not working
- Choose high risk options
- Difficulty controlling mood and emotion
- Difficulty in determining why you are making errors
- Confusion remembering instructions, facts
- Loss of sequences of thoughts
- Physical problems such as headaches, stomach aches, sore joints etc

**SLEEP IS PROBABLY THE BEST RECOVERY STRATEGY**
WE HAVE: Physically and Mentally

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### Basics for Recovery

- Massage
  - Injury prevention
- Stretching/Warm-down
  - Injury prevention
  - Muscle relaxation
  - Reduce muscle soreness
- Nutrition Recovery
  - Replace carbohydrate, fluid and electrolytes
  - Repair the muscle-protein
  - Protect the immune system

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### Practical Aspects of Recovery

- Include Recovery as part of the training program
- ‘One-stop shop’/readily accessible facilities
- Athlete education sessions
- Portable devices and preparation for travel
Thank you