

Cold water therapies: minimising risks.

Mike Tipton¹, Heather Massey¹, Ade Mayhew², Paddy Morgan².

¹- Extreme Environments Laboratory, SHES, University of Portsmouth, UK.

²- Surf Life Saving GB.

Corresponding author: Mike Tipton (michael.tipton@port.ac.uk)

Cold water immersion (CWI) is a “hot topic” at the moment. In many countries there has been an explosion in the number of individuals undertaking CWI for anecdotally claimed mental and physical health-related benefits (1). These immersions range from static immersions in home-based ice baths and cold showers, to open water swims and dips. Associated with this, in 2021 Her Majesty’s Coastguard (HMCG) in the UK reported a 52% increase in call-outs associated with swimming and dipping and, between 2018 and 2021, there was a 79% increase in open-water swimming deaths (34 to 61 deaths) in the UK (2).

For tropical animals like humans, immersion in cold water is stressful and carries a significant risk of respiratory, cardiovascular and, possibly, peripheral neurovascular injury. The most dangerous response associated with CWI is “Cold Shock” (3, 4). It is initiated by a rapid fall in skin temperature and includes gasping, hyperventilation, release of stress hormones, hypertension and arrhythmias. The loss of control of breathing can be a precursor to drowning, and the increased work required of the heart and circulation can result in cardiovascular pathologies. Cardiac arrhythmias are particularly common if cold immersion includes the face, breath holding and co-activation of the Cold shock (sympathetic autonomic nervous system response) and Diving response (parasympathetic autonomic nervous system response) – a combination of conflicting inputs to the heart termed “Autonomic Conflict” (4).

We encourage people to enjoy the water, but in a responsible way that maximises the potential benefits and minimises the risks. With this in mind, we offer some guidance for: those participating in CWI; those assessing participants for CWI; and those providing CWI experiences.

Advice for participants

When undertaking any significant physical challenge for the first time, a medical assessment is recommended (see next section).

Ideally, swimmers should use lifeguarded areas, or participate with experienced outdoor swimmers, coaches or lifeguards. Where there is no formal lifeguard supervision, the critical analysis of the body of water to be swum in falls to the participants. This pre-immersion step is vital, but requires knowledge and risk recognition skills. Additional mitigation measures include nominating a (trained) safety observer and agreeing on an emergency signal when a swimmer needs help (the international emergency signal is to wave one hand).

For visibility, swimmers should wear a bright swimming hat (e.g. fluorescent green, orange or “hot” pink) and use a tow float (with name and emergency number on it). It is sensible to adopt an incremental approach to CWI by starting mid-summer and wearing a wetsuit, at least initially. Wearing a wetsuit will not completely negate cold shock (3), but will reduce the rate of cooling (muscle and deep body) and increase buoyancy.

Cold water should be entered gradually; do not jump or dive in. Cold shock peaks in water between 10 and 15 °C, it is maximal in the first 30 seconds of CWI and then attenuates. Allow this response to subside before swimming or immersing the face, and avoid

prolonged breath holds (4, 5). Start with short immersions within your depth, only extend the swim duration if your stroke remains well co-ordinated with no muscle stiffness. Make immersions shorter (less than 10 minutes) in colder water to avoid incapacitation due to muscle cooling; this can occur with little warning. Those undertaking CWI should not base their time in the water on how cold they feel; this is dangerously unreliable, particularly for individuals who, as a result of repeated CWI, have a diminished response to immersion (cold habituated) (6).

If in difficulty in the water, float on your back moving your arms and legs as little as you need to stay at the surface of the water – practise this. Carry a “pea-less” whistle on the wrist, tow float or wetsuit leash so you can attract attention. On exit, dry and dress quickly in warm clothing with a windproof outer layer. Continued cooling occurs for approximately 30 minutes after exiting the water; avoid driving during this period.

Advice for clinicians assessing participants

For CWI this might include a routine pre-participation screening tool (e.g. PARmed-X or similar) (7), with additional considerations with respect to CWI, including: screening for risk of cardio-respiratory compromise; peripheral vascular disorders; immune response to cold; medications with pro-arrhythmic risk; or any other condition which would be negatively affected by profound autonomic nervous system activation (Table 1). A recent study suggests up to 43% of drownings are associated with pre-existing medical conditions (8). Pharmaceutical therapies, both acute and chronic, can alter an individual’s response to CWI and their perception of cold (4, 9). Long-QT syndrome, for example, is associated with fatal arrhythmias during immersion: it can be a pre-existing medical condition, or induced by pharmaceuticals e.g. Antihistamines (4, 9), and thus a screening 12-lead electrocardiogram (ECG) should be considered. The risks are not limited to prescribed medications; alcohol and recreational drugs are also associated with fatalities (9).

Concurrent stressors increase the risk of injury upon CWI and should be reduced where possible, or CWI avoided. Examples include: acute injury or illness; exhaustion; hypothermia/pre-cooling; and acute exacerbations of chronic medical conditions.

Advice for those providing open water “experiences”

The hazards associated with open water are dynamic, they include: tides, currents, wind, temperature, sea/river state, depth, debris and pollution. Understanding these varying hazards and their mitigation will reduce overall risk. Mitigation might include: criteria for cancellation of events; requirements for participant swimming ability, health and fitness; and immersion depth limits.

Supervising individuals should have location-specific knowledge, risk management and environmental assessment training. They should be able to recognise the signs of swim failure (10). Safe entry and exits should be identified, water should be pollution-free and good hygiene practices should be followed.

A pre-immersion briefing should be provided for swimmers (similar to that provided to scuba divers), this should include: review of risks; identification of entry and exit points;

Table 1. Medical screening for Cold Water Immersion*

| System | Risk factor |
|----------------|--|
| General | <ul style="list-style-type: none"> - Cold urticaria - Endocrine disorders with risk of sympathetic nervous system surges, or collapse/ altered consciousness e.g. Unstable diabetes, Pheochromocytoma |
| Respiratory | <ul style="list-style-type: none"> - Cold/Exercise induced or unstable Asthma/ Pulmonary disease - Acute exacerbation of lung disease or lung infection in recent months |
| Cardiovascular | <ul style="list-style-type: none"> - Family history of sudden or unexplained cardiac death - Hypertension - Cardiac Rhythm disturbances, inducible or latent - Structural cardiac disease - Ischaemic Heart Disease - Peripheral vascular disorders e.g. Raynaud's phenomenon - Pro-arrhythmic or QT prolonging medications |
| Nervous System | <ul style="list-style-type: none"> - Seizure disorders e.g. Epilepsy - Checks of sight and hearing - Peripheral nervous system disorders e.g. Guillain-Barré Syndrome |

*This list is not exclusive, individuals should be risk-assessed on a case by case basis.

instruction on what to do if unwell or in trouble, including following CWI. A post-immersion protocol should be established, including provision of a rewarm area, advice on rewarming and checks to ensure that participants are rewarmed before leaving.

Recommended first aid provision includes: responders trained in first aid, cardiopulmonary resuscitation (CPR), use of an Automatic External Defibrillator [AED] and the effects of CWI; first aid equipment (e.g. methods of drying and warming, access to an AED). An emergency action plan should be established and emergency procedures practiced (e.g. recovery from the water of an incapacitated individual). Stipulate: points of entry/exit for rescues; emergency services contacts and communications, access point for emergency service vehicles; and a grid reference for location.

The advice presented in this editorial is summarised in Figure 1.

Participant

- Get a medical check (Note: this might be via a questionnaire [7])
- Avoid concurrent stresses and medications
- Swim on a lifeguarded beach and with experienced others. Nominate a “safety” officer
- Analyse swimming location and weather/weather forecast
- Follow an incremental approach (e.g. start when water is warmest). Habituate to the cold
- Wear: a wetsuit (for buoyancy and thermal protection) if you want; a visible hat; a tow float
- Enter water gradually, allow cold shock to abate before swimming or face immersion
- Avoid prolonged breath holds
- Stay in your depth, limit exposures to 10 minutes in colder water
- Don’t rely on how you feel
- If in difficulty, float on your back
- On exiting the water wear warm clothing and a windproof outer. Rewarm before driving

Provider

- Understand the above and associated rationales. Brief the participants. Have participant information available (e.g. emergency contact numbers, information for emergency services).
- Utilise local knowledge
- Get relevant training in risk assessment & management, and environmental assessment
- Designate an observer with rescue training
- Risk assess location, weather forecast and other hydrodynamic variables
- Location: safe entry/exit points. Emergency service access
- Have post-immersion rewarm location and plan
- Provide first aid, CPR and AED cover throughout

Acknowledgements

We would like to thank Dr Chris Cuff, Dr Sarah Hollis and Sarah Walsh for reviewing the manuscript before submission.

References

1. Tipton MJ, Collier N, Massey H, Corbett J, Harper, M. (2017) Cold water immersion: kill or cure? *Experimental Physiology*. *Exp Physiol* 102.11: 1335–1355.
2. National Water Safety Forum. Water Incident Database (WAID)
<https://www.nationalwatersafety.org.uk/waid>.
3. Tipton MJ (1989) The initial responses to cold-water immersion in man. *Editorial Review, Clinical Science* 77: 581-588.
4. Shattock MJ, Tipton MJ. ‘Autonomic conflict’: a different way to die during cold water immersion? *J Physiol*. 2012, Jul 15;590(14):3219–30.
5. Tipton MJ. Sudden cardiac death during open water swimming. *British Journal of Sports Medicine*. 2013, 48(15):1134-5.
6. Tipton, MJ. Drifting into unconsciousness: Jason Zirganos and the mystery of undetected hypothermia. *British Journal of Sports Medicine*. 2019, 53: 1047
<http://dx.doi.org/10.1136/bjsports-2019-100646>.
7. Warburton DER, Jamnik VK, Bredin SSD, Gledhill N. The Physical Activity Readiness Questionnaire for Everyone (PAR-Q+) and Electronic Physical Activity Readiness Medical Examination (ePARmed-X+). *Health Fit J Can*. 2011;4(2):3–17.
8. Dunne CL, Sweet J, Clemens T. The link between medical conditions and fatal drownings in Canada: a 10-year cross-sectional analysis. *CMAJ*. 2022, May 9;194(18):E637–44.
9. Pajunen T, Vuori E, Vincenzi FF, Lillsunde P, Smith G, Lunetta P. Unintentional drowning: Role of medicinal drugs and alcohol. *BMC Public Health*. 2017, May 19;17(1):388.
10. Tipton MJ, Franks CM, Gennser M & Golden FStC. Immersion death and deterioration in swimming performance in cold water. 1999, *The Lancet* Vol 354, 21 Aug: 626-9.

LEGEND

Figure 1. Suggested actions for those considering undertaking or providing cold water immersions.

ADDITIONAL RESOURCES/MATERIAL

<https://www.worksafebc.com/en/resources/health-safety/articles/living-colour>

<https://www.nationalwatersafety.org.uk/advice-and-information/open-water-swimming>

<https://rnli.org/safety/choose-your-activity/open-water-swimming>

<https://thebluetits.co/dont-be-a-tit-be-a-bluetit-swim-safety-resources/>