The Dangers of Cold Water Immersion

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Cold water is deadlier than you think

Protect yourself from the shock of cold water by always wearing a lifejacket.

coldwaterkills.com

Dangers of Cold Water Immersion
• Lightly clothed, non-exercising humans in 0°C water.
• After <5 min of immersion skin temp dropped to <10°C.
• Took 30 min for deep body temp to drop below 35.5°C.
• Hypothermia is defined as drop in deep body temperature below 35°C (RCPL, 1966).
• People can die quickly in cold water, less than 10m from shore (Home Office, 1977).

4 Stages of Cold Water Immersion

1. Initial immersion (Cold Shock Response).
2. Short term immersion (Swim Failure).
3. Long term immersion (Hypothermia).
Cold Shock Response (CSR)

• Sudden death in cold water not due to hypothermia.
• Series of physiological responses termed the CSR believed to cause the majority of drowning deaths (Tipton 1989).
• Triggered by a rapid fall in skin temperature (Keatinge and Nadel, 1965; Goode et al., 1975; Cooper et al., 1976)
CSR Responses

• 4 responses to sudden cold water immersion (Tipton, 1989):
  - A large involuntary gasp.
  - Hyperventilation.
  - Significant increase in heart rate.
  - Constricting of blood vessels.

• First two responses are greatest threat to survival.
• Large involuntary gasp can be as much as 3L over 1.2 seconds (Goode et al., 1975).
• Hyperventilation can be 5x resting values (Hayward and Eckerson, 1984).
• Make it hard to hold your breath in water – increased risk of drowning.
• Cardiovascular components may be fatal with pre-existing heart conditions (Tipton, 1989).
Causes of CSR

• Rapid cooling of the skin – causes thermoreceptors to fire (Goode et al, 1975).
• Superficially located; body fat does not reduce response.
• Greatest CSR is seen when the torso is cooled (Burke and Mekjavic, 1991).
Cold Shock Response Video
Short Term Immersion (Swim Failure)

• As skin temp falls, so does muscle, joints, and nerve temps.
• Minimum criteria: 15°C for local skin temperature, nerve temperature of 20°C, and a muscle temperature of 28°C (Heus et al. 1995).
• Exposure of either forearms or hands to cold found to significantly reduce maximum grip strength within 2 minutes (Tipton and Vincent 1988) – MV Estonia incident.
• CSR makes coordinating breathing with swimming motions.
  - More upright posture and inefficient swimming.
• Shivering occurs concurrently with swimming motions.
  - Constriction of blood vessels deprives muscles of blood.
  - Numbing effects reduces coordination.
• Even “good” swimmers will experience swim failure in 10°C water (Tipton et al., 1999).
• When around cold water, even close to shore, always wear a lifejacket or PFD.
Hypothermia

Post Rescue Collapse

• Not a completely understood phenomenon.
• Thought that 20% of immersion deaths happen just before, during, or after rescue.
• Long believed to be due to *after drop* but disproven by Golden and Hervery (1981).
• Likely due to changes in blood volume and stress placed on the cardiac system.
• If recovering someone from the water, best to take them out in a horizontal position.
CSR Reduction

• Max CSR is observed in 10°C water.
  - Lower temps do not produce increased CSR; just feel colder.

• Can habituate to CSR – 6, 3 min immersions in 15°C water (Tipton et al., 1998).
  - Significantly lower CSR in follow up 10°C immersions.
  - Lasts up to 6 months.

• Possibly explains why some people can swim in cold water without severe effects (e.g. English channel swimmers; Polar Bear club.)
Exercise and Staying Warm

• Has been recommended not to exercise in water.
  - Reduced peripheral insulation due to blood perfusion.
• Recent work by Farevik et al. (2010) shows that moderate leg exercise in insulated immersion dry suits can increase deep body temperature during immersions.
• People performed leg cycling motions; deep body temp increased over 3h immersion.
• Had a positive effect on subjective perception of thermal comfort.
Manual Dexterity

• Manual dexterity can be lost quickly in cold water (“Lobster Claw”).

• Recent work by MacKinnon and Mallam (2011) showed that still able to perform the required survival tasks in under 2 min, after a 2 min barehanded immersion.

• Prolonged exposure can make it extremely difficult to help in your own rescue (e.g. can’t grab a rope thrown to you).

• Instead of griping the rope, roll both hands over the rope in the water to tangle it over your arms.

• Then, put your hands together (as if praying), and move both hands in a circular motion so that the rope wraps around your wrists.
Undergarments

• Immersion suits are tested with a defined clothing ensemble.
  - Underwear (short sleeved, short legged).
  - Shirt (long sleeved).
  - Trousers (not woolen).
  - Wool socks.

• Immersion suit`s insulation level (clo value) measured with this ensemble.

• Altering the underclothing will increase or decrease insulation level.
• Specific conditions for human test subjects:

“Each subject shall have had a normal night’s sleep the night before the test, a well-balanced meal 1 to 5 h before the test, and no alcoholic beverages 24h prior to the test” (CAN-CGSB 65.16-2005 section 6.22.2.1.1).

• Low blood sugar and alcohol can decrease the intensity of the shivering response – faster rate of fall in deep body temp (Golden and Tipton, 2002).

• Important to eat normally, be well rested, and abstain from alcohol.
Summary

• CSR thought to be responsible for deaths upon sudden immersion in cold water.
• Swim failure will occur – important to wear lifejackets around open water.
• Can take at least 30min for hypothermia to develop.
• Pre-exposure to cold water can lessen CSR.
• Exercising in insulated, immersion dry suits can help maintain a stable deep body temperature.
• Wearing warmer, layered clothing than what the suit was tested in will provide more thermal protection.
Recommended Further Reading and Watching

Dr. Frank Golden and Professor Michael Tipton—
*Essentials of Sea Survival.*

Dr. Christopher Brooks –
*Survival in Cold Waters: Staying Alive.*
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Dr. Gordon Giesbrecht -
*Cold Water Boot Camp.*
http://www.coldwaterbootcamp.com
References


Discussion

Thank-you