World Water Safety

INTERNATIONAL LIFE SAVING FEDERATION

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MEDICAL POSITION STATEMENT - MPS 12

COLD WATER IMMERSION

NOTE: This statement is intended for those lifeguards, acting in a professional or volunteer capacity, who are trained in the techniques of water rescue and resuscitation and who assume a duty to safeguard members of the public at aquatic sites. They may be called lifeguards, lifesavers or both. This statement is not directed at members of the public trained in water safety and rescue techniques, but without a duty to respond, who may also be known, in some areas of the world, as lifesavers.

BACKGROUND

Cold water removes heat from the body 25 times faster than cold air. The immediate effects of sudden immersion (head out of the water) in cold water (<15°C, 59°F) can be a debilitating, short duration (approximately 2 – 3 min), reflex response called *cold shock*. This response includes life-threatening respiratory and cardiovascular effects. The respiratory effect involves quick onset (<30 seconds) uncontrollable rapid breathing, which impairs breath holding and facilitates aspiration of water (which can lead to drowning). This rapid breathing can be so extreme that it causes a reduction in blood flow within the brain resulting in loss of consciousness (Mantoni *et al* 2007). The cardiovascular response involves an immediate constriction (closure) of the blood vessels near the surface of the body, an increase in heart rate, and a surge in blood pressure. These factors, mediated by the sympathetic arm of the autonomic nervous system, may lead to incapacitation from a cardiovascular accident, e.g. a heart attack, stroke, and/or death from drowning following aspiration (Golden & Tipton 2002). If the face is exposed to cold water (i.e. during submersion – head under the water) the *"Dive reflex"* is initiated. This involves a slowing of the heart rate (bradycardia) and breath holding (Wolf, 1964). The majority of this response is mediated by the parasympathetic arm of the autonomic nervous system. A sudden submersion in cold water may simultaneously stimulate these strongly opposing responses (known as Autonomic Conflict) resulting in disruption of the electrical system of the heart – and potentially cardiac arrest. (Shattock and Tipton, 2012)

If sudden immersion in cold water does not cause death immediately, the related effects will impair swimming ability. Research has shown that even strong swimmers can experience difficulty and drown within minutes of cold-water immersion unless they are habituated to cold (Golden & Hardcastle 1982). These initial responses occur long before body temperature

begins to fall and are believed to be responsible for the majority of sudden cold-water immersion deaths.

After about three minutes, the initial effects of sudden cold-water immersion decline. Thereafter, in those whose airway is out of the water, who can still breathe, progressive whole body cooling occurs leading to a gradual fall in deep body temperature – *hypothermia*. Before a significant level of hypothermia develops, however, there is a progressive cooling of the muscles and joints in the exposed limbs through shivering and stiffening. This impairs locomotion and thus swimming performance (Tipton et al. 1999), which is likely to lead to drowning before a life-threatening level of hypothermia develops, unless the victim is wearing a lifejacket or personal floatation device (PFD) capable of keeping the airway out of the water. This impairment of locomotion also impedes the victim's ability to assist in the rescue effort.

If the victim is wearing an appropriate lifejacket drowning is prevented but without timely rescue hypothermia will eventually lead to loss of consciousness and cardiac arrest (Golden 1973). Time to death in such victims will be influenced by body insulation (thickness of clothing worn and the amount of body fat, with men generally having less than women), age (young and elderly fair less well), sea state (breaking waves increase the chances of water aspiration), and time to rescue. A swimmer who has consumed alcohol will succumb to the effects of hypothermia more rapidly (Haight & Keatinge 1973).

When called upon to search for a victim who has been submerged (head and airway below the surface) in cold water there are inherent risks to the rescuer. These risks must be balanced against the probability of a successful outcome for the victim. A recent systematic review suggested submersion (head underwater) durations of less than 10 minutes were associated with a very high chance of a favourable outcome; submersion longer than 25minutes being associated with a low chance of a favourable outcome (Perkins et al., 2015).

The same systematic review found no linear correlation between survival and water temperature, age and salinity of water. Tipton and Golden (2011) however illustrate from their retrospective analysis of case reports from the literature that a young age and freshwater submersion were favourable characteristics for survival. They also demonstrated a stepped relationship with water temperature with an increase in the possible survival times up to 78 minutes below 6 degrees centigrade. Extending the period of search and rescue may be appropriate in "icy-cold" water as the window of survival is prolonged. This potential increase in survival time underwater must be balanced against the risk to the rescuers attempting protracted rescue attempts in cold hazardous conditions. Some guidelines suggest a review of the risk versus likelihood of survival to be performed at 30 minutes intervals up to a maximum search time of 90 minutes (Deakin et al*.,* 2015;CFOA, 2014; Tipton and Golden, 2011). An objective temperature for "icy-cold" being cited as 6 degrees centigrade.

This suggestion for deciding how long to search assumes the rescuers are trained in submerged search and rescue; have appropriate equipment (including personal protective clothing); and the risk posed by the environment is not excessive. Timing begins on arrival of a member of the professional rescue/ ambulance response (this removes any potential time error from the eye-witness accounts by family or witnesses of the event). If there is a possibility of an air pocket, e.g. submerged car, the risk assessment must consider the casualty immersed (head out, airway potential clear) and not submerged.

Post immersion

Post rescue, victims may be profoundly hypothermic. An increasingly available option is re-warming via extra-corporeal circuits (Wanscher, 2012). These machines are part of advanced emergency care and work by taking blood from the victim; add in oxygen, remove carbon dioxide, warm to prescribed temperature and re-circulate to the body. The availability of such a service is variable in different regions of the world, and even within individual countries.

One very rare complication of contact with cold water is *cold urticaria*. This condition is an allergy-like reaction to contact with cold water, as well as other sources of cold (Bentley 1993). Within minutes, the skin may become itchy, red, and swollen. Fainting, very low blood pressure, and shock-like symptoms can present. Symptoms may be severe enough to be managed as anaphylaxis.

STATEMENT

1. Prevention is the best cure. Do not attempt to swim in cold water unless habituated to it or wearing suitable protective garments, such as a wetsuit or survival suit. If at risk of immersion take precautions against becoming immersed, such as by use of a safety line. If in a boat, wear suitable clothing and an approved lifejacket with sufficient buoyancy to keep your airway clear of the water even when unconscious. Lifejackets fitted with *splash guards* are recommended. If immersed, reach for any flotation available, though maintaining your grip may be difficult due to lack of coordination and weakness caused by the cold.

2. Various methods of body positioning, previously recommended to help reduce heat-loss in the cold-water immersion victim, are now believed to have an insignificant benefit. However, if two or more persons find themselves in distress in cold water, they should attempt to remain in close proximity for moral support and to aid in rescue. Excessive movement in the early phase of immersion will increase heat loss.

3. All immersion victims should be quickly rescued. Those victims who have been in cold water for a considerable time, and whose airways are not being threatened by wave splash, should be rescued in a near horizontal attitude, if possible, to prevent a potentially adverse fall in blood pressure (Golden et al. 1991). Those whose airways are threatened should be rescued by the quickest method regardless of body attitude.

4. Victims who are not in need of resuscitation should have wet clothing removed and replaced with dry clothing, if available. They should then be enclosed in a sleeping bag, or otherwise insulated in blankets or the like, making sure that their airways are clear and supported. Conscious shivering survivors will generally re-warm themselves reasonably quickly with such treatment, but the process can be accelerated by immersion in a bath of warm (up to 40^{o}C) water. When recovered, they should be removed from the bath before they start to sweat, usually as their pulse begins to increase.

5. In the case of unconsciousness or apparent cardiac arrest, the airway should be cleared and appropriate procedures should be employed according to regional CPR protocols. It may be difficult to assess form signs of life in an unconscious victim of hypothermia. Commence CPR or use an automated device according to local protocols: consider the safety of the rescuers, the ability to continue to hospital and appropriate transport e.g. Helicopter. Since drowning victims are typically starved of oxygen, pay particular attention to oxygenation and ventilation of their lungs. Arrange rapid transfer to hospital and use oxygen, if available. Consider transport to a facility with extra corporeal

membrane oxygenation.

6. In those who are apparently dead, avoid a hasty diagnosis. The maxim "no one is dead until they are warm and dead" is appropriate provided you are not too remote from medical support. Follow resuscitation protocols and arrange rapid transport to hospital. People, especially small children, who have been submerged for up to an hour in ice-cold water have been successfully resuscitated

7. In the rescue of submerged (head under) casualties balance the risk of continued search against the likelihood of any form of positive outcome. If the water temperature is greater than 6^{o}C and there is a risk for rescuers or limiting resources (lifeguards taken out of duty to search) limit searches for a victim to 30 minutes. If colder than 6^{o}C this time may be extended to 90 minutes.

8. Persons who have any abnormal breathing or difficulty or who have experienced serious hypothermia, even if successfully revived, should always be sent to hospital to be checked for pulmonary complications (Modell 1971).

9. In cases of apparent cold water urticaria, removal from the source of cold is essential. Treatment is similar to that for any allergic reaction, with priority being given to maintaining breathing and circulation. Antihistamines may be effective (Bentley 1993; Mathelier-Fusade 1998). Severe symptoms, suggestive of anaphylaxis should be managed with an adrenaline pen if available.

LEVEL OF EVIDENCE

This document is based on expert consensus.

POTENTIAL CONFLICT OF INTEREST STATEMENT

None of the participants in the consensus process leading to this position statement has a conflict of interest with the stakeholder industry, technology, persons or organisations that are identified and/or impacted by the position statement

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APPROVAL

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