

COLD-WATER SURVIVAL

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Cold-water survival is dependent on avoidance of both drowning and hypothermia and upon the many factors related to these risks (1,2):

1. The ability to swim
2. The ability to keep one's head out of water (even without flotation aids)
3. The ability to avoid panic
4. The sea-state
5. The availability and type of personal flotation device
6. The availability of a life raft
7. The availability of other floating objects to increase one's buoyancy (e.g. a capsized boat, etc.)
8. The water temperature
9. The physical characteristics of the survivor
10. The type of protective clothing worn against immersion hypothermia
11. The behavior of the survivor in the water
12. The availability of signalling devices (e.g. whistles, flares, strobe-lights, radios and mirrors)
13. The proximity of rescue personnel

Drowning is the most immediate survival problem following water entry. To maintain airway freeboard and to avoid drowning, a survivor must possess the physical skills and psychological aptitude to combat the effects of wave action. Although a personal flotation device assists in maintenance of airway freeboard, waves can still submerge a survivor's head, even in moderate sea-states (3). A survivor can reduce his risk of drowning in rough seas by increasing effective airway freeboard by partially exiting the water (e.g., clinging to an overturned vessel or other debris floating in the water), or by climbing totally out of the water into a life raft or onto a capsized vessel. In both these environments, the survivor may still have to cope with the effects of cold wind, spray, and waves.

Sudden immersion in cold water is accompanied by cardiorespiratory reflexes which can potentiate the risk of drowning. The abrupt release of sympathetic catecholamines potentiates the risk of incapacitating cardiac dysrhythmias in susceptible individuals or of myocardial infarction or cerebrovascular accident in persons with arterial disease or hypertension (4). Sudden immersion in cold water initiates a reflex gasp and hyperventilation (5), which significantly shorten breath-holding time. This reflex can have severe consequences for survivors attempting an underwater egress from a submerged vehicle, capsized vessel or aircraft, or for survivors simply trying to maintain airway freeboard in rough water.

If a victim of cold-water immersion can avoid drowning during the initial few minutes following water entry, then prevention of hypothermia becomes an important problem. Survival time in cold water, based on the pathophysiological effects of decreasing core temperature, is not a precise calculation. The large individual variation among survivors in morphology, state of health and fitness, combined with many exogenous variables affecting cooling rate (e.g., clothing, water temperature, sea-state, flotation, and behavior) preclude exact survival time predictions. However, sufficient experimental data and case-history findings exist to allow generalizations. At a core temperature of 34 C, there is a significant deleterious effect on manual dexterity and "useful function" in cold water (6,7). If a survivor is trying to combat rough seas, this level of dysfunction may potentiate drowning. At a core temperature of

30 C, unconsciousness is probable (8). Even if a survivor is wearing a self-righting flotation device, designed to maintain airway freeboard in an unconscious person, drowning is probable at this core temperature in all but the calmest sea-states. Finally, at a core temperature of 25 C, cardiac arrest is probable. Of these three temperatures, 30 C is the most practical for defining limits of survival in cold water.

For immersion hypothermia, the most important variables affecting cooling rates are:

1. Water temperature
2. Survivor's percentage body fat
3. Type of protective clothing worn by the survivor
4. Sea-state
5. Survivor's behavior in the water
6. Amount of the survivor's body immersed in the water

A large number of studies over the past few decades have evaluated the relationship of different types of protective clothing to heat loss and cooling rates (9,10). Nearly all of these have been conducted in calm water or laboratory settings. Most have shown that in calm water, intact, "dry" insulated garments provide better protection than do "wet" insulated garments; and well-insulated garments provide significantly better protection than do poorly insulated garments. In rough seas, a survivor's cooling rate may be affected by swimming to maintain airway freeboard, passive body movements caused by waves, flushing of cold water through "wet" suits, and leakage of cold water into "dry" suits. Recent studies have demonstrated: 1) significantly faster cooling rates for human volunteers wearing "wet" protective garments in rough water or moving water than for persons in calm water (11); 2) higher energy expenditure and faster cooling rates for subjects in a wave-tank than for subjects in calm water (12).

All of the above factors make survival times in cold water highly variable: as short as a few minutes for drowning victims to many days for well-protected survivors with adequate buoyancy.

References

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