Chapter 27

COLD & HYPOTHERMIA

Fig 27.1

A diver is usually immersed in water which is considerably colder than the normal body temperature of 37°C. Unfortunately, water is particularly efficient at removing body heat, having a conduction capacity 25 times that of air and a specific heat (the amount of heat necessary to raise a given volume by a certain temperature) 1000 times that of air.

Without insulation, a diver will lose body heat much faster in water than in air at the same temperature. This can cause **hypothermia**, a harmful drop in body temperature to below 35°C.

The body can reduce temperature loss by generating heat through metabolism, exercise and shivering, and by restricting blood flow to the skin. The rate of heat loss also depends on factors such as the temperature of the water, the thickness of body fat, presence a wetsuit or other insulation, and the posture of the diver.

Recognition of the early clinical features of hypothermia may convince a diver to leave the water before a serious problem arises.

CLINICAL FEATURES

All divers will have experienced the early features of cold — numbness, blueness or pallor of the skin (especially in peripheral areas such as the fingers, toes and earlobes), clumsiness and shivering.

If the body temperature falls by about 2°C, loss of co-ordination and uncontrollable shivering may impair the ability to swim and render the performance of finely coordinated movements (like manipulating equipment and assisting buddies) impossible.

After a body temperature drop of 3–4°C, the diver may become weak, apathetic, confused and helpless. Drowning is a real possibility at this stage. A body temperature less than about 30°C results in unconsciousness. This may be confused with other causes of unconsciousness in divers. Often the diver appears to just lose consciousness without other obvious clinical manifestations.

A victim who is unconscious from severe hypothermia may have a very slow respiratory rate, and a barely detectable pulse, and may appear dead to the inexperienced observer. It is important to not assume the worst in this situation. He may even have fixed dilated pupils and still be resuscitated. Do not presume that he is dead, unless he is warm and dead.

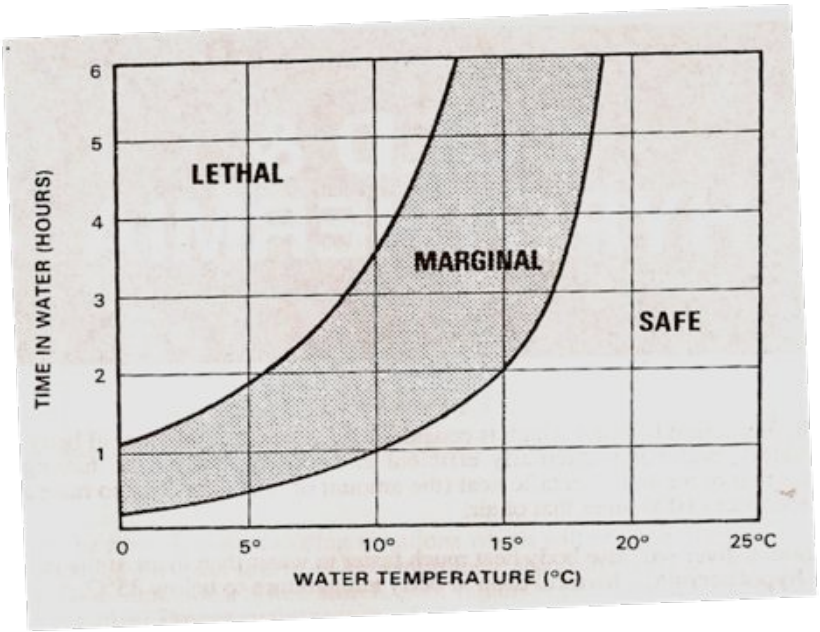

Fig. 27.2

This graph gives an indication of approximate survival times of an uninsulated human in water of various temperatures. These figures are overestimates – a diver would be severely incapacitated well before he reached the limits of survival. It is obvious that survival times of less than one hour can be expected without insulation in water temperatures found in many countries.

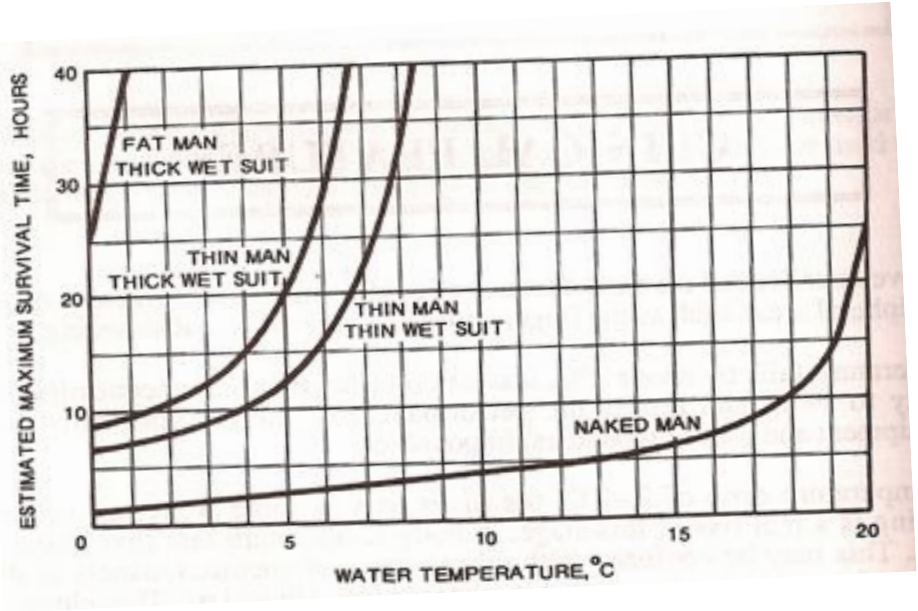

Fig. 27.3
Graph illustrating survival times in varying water temperatures for divers

FIRST AID TREATMENT

If required, the basic life support (**BLS**) first aid management principles take precedence (see Chapter 42). Removal from further danger is followed by assessment and treatment. It is recommended that expired air resuscitation (**EAR**) and external cardiac compression (**ECC)** be performed at half the normal rate in cases of hypothermia because body metabolism is slowed. However, unless the rescuer is confident that hypothermia is the sole cause of the victim's collapse, the usual resuscitation techniques and rates are probably indicated.

The diver must be handled gently. Both active and passive movements are to be avoided, as these tend to trigger serious or lethal cardiac arrhythmias. While the patient is hypothermic, ensure that he remains horizontal, as the vertical position can cause death. Always clear the airway, check for any evidence of heartbeat or respiration, and begin resuscitation as necessary.

The aim of management is to keep the victim alive, while returning the body temperature to normal. The usual methods of treating the diver include **wind-proofing**, **insulation** and **active warming**.

Fig. 27.4

If medical or hospital facilities are available, many other treatments are more effective than the first-aid and warm water immersion regimes, mentioned below. The immersion treatment is probably only indicated for those victims who have sudden or severe hypothermia.

Wind-proofing is essential. Unless the diver is protected from the wind and the wet, he will continue to lose heat. Usually it is best to dry the victim and clothe him, but under some exposed situations it may be necessary to leave his wet suit on and cover it with other materials, to supply insulation. If a wet suit has to be removed, it is preferable to cut it off.

Wet weather gear used alone, without a heat source, may help with insulation but may not be very effective as they do not generate heat and the victim's heat output is very slow. Wrapping in a **blankets**, **plastic** (garbage bag)**, tarpaulin** or even **newspaper**, may also help with insulation by reducing air flow over clothes, wet suit or skin. A reflective **survival blanket** over clothes and normal blankets may aid in wind-proofing and insulation.

Facilities to warm a diver are usually limited at a dive site and improvisation may be required. **Wrapping the victim in blankets with other divers** may be one way of transferring body heat to a mildly hypothermic diver. Warm diver buddies, especially of the opposite sex, may be sought by some unscrupulous divers who only pretend to be hypothermic.

The **engine room of larger vessels** is often warm enough to be of value in the management of hypothermia and engine cooling water may be a source of warm water in an emergency. Treatment can be suspended when the patient's body temperature reaches 37^{0}C, or he starts to sweat.

Although **alcohol** produces a warm inner glow, it actually worsens hypothermia by increasing blood flow to the skin, accelerating heat loss. It should not be given to hypothermic patients. Stimulating drinks such as tea and coffee should also be avoided. Warm water, glucose or electrolyte drinks may be given to fully conscious patients.

Re-warming is most simply achieved by **immersing the victim in a warm bath at a temperature of 37–38**^{0}C**.** A warm shower is a less efficient alternative and certainly not with the patient standing. A pleasantly warm bath or shower is approximately the right temperature. Warm packs or hot water bottles over the axilla, groin and abdomen may help – but avoid scalding.

It is possible that oxygen administration may be of value, especially if warmed or if used in a re-breathing system. The latter will reduce heat loss by re-breathing warm humidified gas.

Massage, alcohol or stimulant drinks (coffee), heat packs direct onto the skin and exposure to intense sources of heat (such as radiators), are all best avoided.

PREVENTION

Alcohol and other drugs may predispose to hypothermia by dilating peripheral blood vessels and losing heat by conduction into the water.

Diving in cold water is the commonest cause, but even in tropical waters loss of body temperature during a dive is likely if the diver is not effectively insulated.

The most popular and convenient insulator is the **wet suit** (see Chapter 5). Air bubbles enclosed in synthetic rubber provide an insulating barrier between the diver and the water without the need for the suit to be waterproof – hence the term "wet suit". They are available in various thicknesses depending on the expected water temperature. Wet suits have the disadvantage of compression of the air cells at depth, which reduces their insulation and causes inconvenient changes in buoyancy.

This problem is reduced in professional diving operations by the use of a "**dry suit**" which uses air as the insulating material. Other variations include electrical, chemical or hot water warming procedures, or even an inflatable air pocket enclosed in a wetsuit.

When immersed and in a survival situation, heat loss in an uninsulated person can be minimised by floating in the H.E.L.P position, a curled-up posture ("foetal" position) with the knees near the chest and the arms by the side, so covering the body areas which lose heat the most (axilla and groin). This can obviously be done only if the diver has a flotation aid. Huddling together with other survivors may be of value. Restriction of movement will also minimise heat loss.

To reduce heat loss, it is best not to swim more than a short distance, as although swimming generates some metabolic heat, this is more than offset by heat lost into the water during movement.

Divers should abort dives once they start feeling cold, and should ensure adequate time on the surface, in a protected and warm environment, before returning to dive. Hours are needed to regain the deep core body temperature. Sweating is a good sign that hypothermia no longer is a problem.

OTHER REACTIONS TO COLD

There are a variety of other problems which can eventuate from cold exposure. These include the following:

❑ Reflex Responses.

Exposure to cold can produce a number of adverse effects on the function of the heart and lungs. These reactions can kill a swimmer/diver on entering the water and can cause a problem before he develops hypothermia It can cause arrhythmias and interference with the coronary artery blood flow – with possible angina or myocardial infarction. It can also have reflex effects on the lung function, causing the diver to inhale excessively, causing aspiration of sea water, resistance to breathing, electrolyte changes, etc. Another problem is that a diver may respond to the cold stimulus with intense contraction of the blood vessels, causing a rise in blood pressure and a “stroke”.

Usually these changes are not noticed by the average diver and are of more interest to the diving physician investigating unusual diving accidents. (See Chapter 35)

❑ Muscular cramps

Cold exposure increases the likelihood of muscular cramps, especially in the legs (feet, calves), aggravated by finning.

❑ Cold Urticaria.

Some rare divers are particularly sensitive to the inhalation of cold air (due to the drop in pressure across the first and second stages of the regulator). This can cause difficulty in breathing as the cold air irritates the respiratory passages, producing an asthma-like syndrome. Cold water exposure on the skin can also produce an allergy-like effect, with a skin reaction similar to hives (urticaria). It can lead to generalised effects on blood vessels and blood pressure (shock), and it is important that the diver ceases to expose himself to cold, and obtains medical advice.

❑ Sinus and Ear Pain.

Exposure to cold seems to produce a reflex pain in susceptible divers, similar to the "ice cream headache". The site of pain may be related to an over-sensitive area of the skin being stimulated by the cold. Similar symptoms may develop during skiing or surface swimming in cold water.

If the external ear is affected, then ear plugs can be worn for surface swimming and fenestrated ear plugs for diving. Alternately a hood can be used with a small aperture over the ears. This will reduce the cold stimulus effect by retaining the water warmed to body temperature. Others instill oil or wax to reduce this effect.

Occasionally this disorder has been confused with barotrauma of descent, as it tends to occur within a few minutes of immersion, while the diver is descending.