Cold Water Immersion

Contents

Objectives

- Define and state the classes of Hypothermia
- Determine which factors should be considered when looking at the effects of cold on the human body
- Describe your management strategy for different classes of Hypothermia

Introduction

Anyone falling overboard into the North Sea is very likely to suffer from Immersion as well as Hypothermia. These are two very separate conditions, each one requiring its own specific management. In practice you could have to deal with both conditions simultaneously, with this in mind we will deal with each condition separately, but the management of these conditions will be combined.

The work of Golden, Harvey, and Tipton of the institute of Naval Medicine, Gosport, Hampshire, has been used in the preparation of this module.

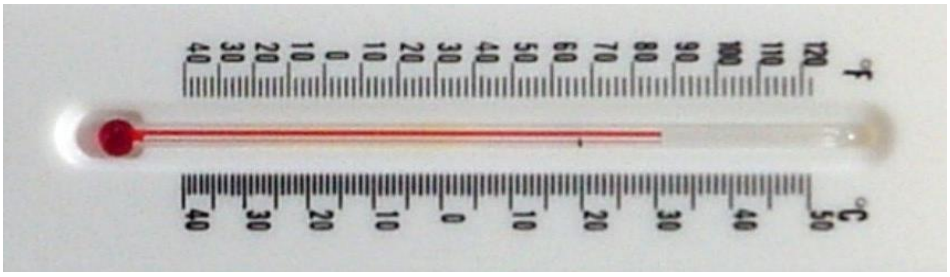
Preparation

Although a great deal of research has been carried out in this field there will be limited reading material readily available to you, therefore there is no pre reading material required prior to commencement of this module.

Warm Up

Take a look at the thermometer below, and then mark the temperature / temperature range for the following (you will be able to check your answers are you work through the unit):

- Normal temperature
- Hypothermia
- The temperature below which death from Hypothermia is inevitable



1. Definition

Humans are temperature animals who must maintain a temperature within a very small range to sustain life. The body can compensate for small variations by increasing blood flow to the surface and sweating to cool the body when it heats up, and shivering if the temperature drops to warm the body up.

Hypothermia means a lowering of the body or body's core temperature below that which is considered normal, the normal being 37°c in a healthy person.

Clinically, hypothermia exists when the body's core temperature drops to 35°c or below.

Note: All core temperatures should be taken rectally.

2. Classification

There are three classes of Hypothermia summarised below.

Class of Hypothermia	Core Temperature °C
Mild	35 - 34
Moderate	33 - 31
Severe	< 30

3.The effects of cold on the body

Temperature Changes

As the body cools the first sensation that occurs is that of feeling cold. The body's reaction is to start shivering; this can raise the body's temperature by 1°C. Combined with shivering there are other bodily reactions like "vasoconstriction".

After a short while the effects of shivering and vasoconstriction fade, and the body temperature starts to fall once again. The various effects of the cold on the body are described in the table below:

Core Temperature °C	Effects
36	Distinct feeling of cold, skin may become pale, waxy, and numb. Weakness and fatigue might ensue.
35	Clinical hypothermia, intense uncontrolled shivering commences, patient remains alert however movement become uncoordinated.
34	Mild confusion, introversion, disorientation, increased pulse and respiration, signs of losing interest in the surroundings.
33	Semi consciousness, shivering ceases and is replaced by muscular rigidity. Drowning will now occur without a buoyancy aid. Speech becomes slurred and strange behaviour might occur, breathing becomes slower and shallower.
33 - 30	Drifting in and out of consciousness.
< 30	Bradycardia followed by arrhythmias of any type but atrial fibrillation and ventricular arrhythmias most common, may be little or no pulse, breathing, and patient may appear dead.
26 - 25	From 26°c and below there is little chance of recovery. Death invariably occurs at 25°c.

Cooling Rates

The rate that the body cools itself depends on factors, such as:

- The amount of fat that the body carries
- The temperature of the water that the body is immersed in
- The layers of clothing worn, such a PPE, Immersion suits etc

The amount of clothing worn and the body's fat content act as insulators and so will reduce heat loss. The chart below gives you some idea of the body's cooling time when a person is dressed in normal clothing and immersed in water at 10°C:

Time to cool (hours)	Core Temperature °C
1.5 - 2	35 - 34
2 - 3	33 - 29
3 – 3.5	< 29

Question A: You may have heard of 'tog' or 'clo' in relation to bedding or some types of clothing. Have a go at finding out what these ratings mean. Check your answers at the end of this manual.

4. Immersion

Drowning Definition 2002

The process of experiencing respiratory Impairment from submersion/immersion in a liquid. There are only three outcomes:

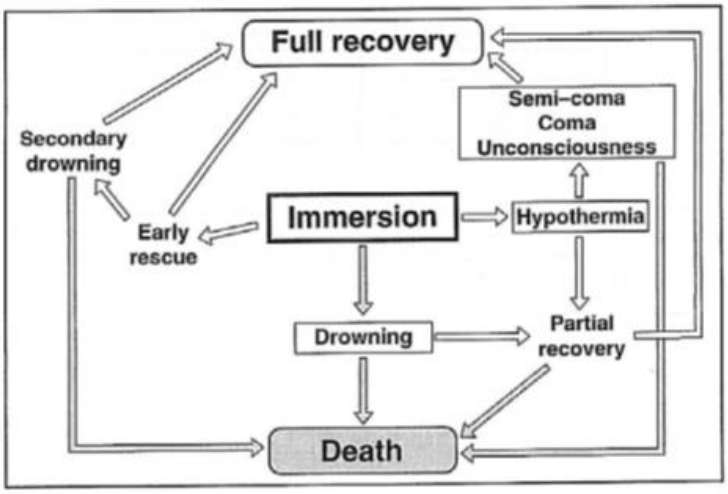
1. Death
2. No Morbidity
3. Morbidity

In an uninterrupted course of events, the process of drowning can be divided into the following temporal sequence:

- Struggle to keep the airway clear of the water.
- Initial submersion and breathe holding.
- Aspiration of water
- Unconsciousness
- Cardio-respiratory arrest
- Death – inability to revive.

} Physiology & Perception

Immersion might follow a simple course of drowning followed then by death. However, as the chart below shows, immersion may also result in a full recovery by the casualty. It might also be complicated by hypothermia or secondary drowning.



Effects which may result from immersion that you should be aware of:
It is possible to drown without inhaling water into the lungs. It is a well-known fact that 20 to 25% of immersion victims show less than 150ml of water in their lungs. The cause of death is Laryngeal spasm – dry drowning. When water below 15°C enters the throat, the epiglottis clamps shut and goes into spasm. As long as water remains over the epiglottis, the spasm is maintained.

Secondary drowning occurs from 24 – 96 hrs after initial recovery from the water. The presence of matter in the water such as algae, zoo plankton, sand in suspension, and surface contaminants such as oil, cause a local reaction within the lungs – pneumonitis. The lungs flood with exudate and the alveolar exchange is reduced leading to hypoxia and death, if untreated.
This same condition/effect can occur due to any insult to the lungs, in particular, smoke inhalation. Please remember any casualty suffering from either immersion or smoke inhalation must be Medevacked when it is safe to do so.

Cold Shock

	Heart Rate Beats p/m	Breathing Rate Breath's p/m	Breathing Volume Litres/min
Pre-immersion	90	12	16
1st Min Immersion	156	66	114
5th Minute Immersion	108	23	67

Lethal aspiration = Sea Water 22ml.kg (Approx 1.5 litre) / Fresh Water 44ml.kg

Aspirating 2.2ml.kg reduces PA02 from 13 - 8kPa (100-60mmHg)

Aspirating 2.5ml.kg increases pulmonary shunt from 10 – 75%

Complications

There are two important factors which can complicate the management of an immersion injury.

- After-drop, this is associated with hypothermia
- The effects of water on the body

After-drop

This is a phenomenon that occurs with any 'body' that generates its own heat within an insulating shell. As the body cools, the core temperature falls at a slower rate than that of the outer shell. Then when the re heating takes place, the core temperature still lags behind that of the shell therefore cooling persists. The core temperature often falls by as much as 1 – 2 °C in the first hour following rescue – this is after drop.

If the core temperature at rescue is within 2°C of 28°C, after drop can reduce it to a critical level and the injured persons heart might start to fibrillate.

After-drop does take time to occur and this cannot explain the sudden collapse of some recorded rescues. A possible explanation for this following some recorded cases of post – rescue collapse is:

- A drastic drop in blood pressure
- Associated hypoxia
- A reduction in circulatory blood volume due in part to pooling of blood in paralysed, dilated peripheral veins

The effects of water on the body

Water has a density similar to that of the human body. Therefore a body immersed in water become weightless and the resulting effect of gravity on the system is reduced. The pressure exerted by water increases with depth, and for a body floating vertically in water, there will be a pressure gradient exerted on it.

Research shows that the blood in the lower limbs is forced upwards, increasing the volume of blood returning to the heart and, therefore the cardiac output. This increase is also added to by the effects of the peripheral shutdown caused by the cold. Although this increased cardiac output and venous return is initially beneficial, it is ultimately perceived by the body as an excess of fluid.

This excess is removed in the usual way by increasing the urine output; the volume involved can exceed 350 ml per hour, and can result in hypovolemia and severe shock.

It is very important for the Medic to remember this next part when dealing with an initial rescue from the water. On recovery from the water, the hydrostatic pressure on the lower limbs is removed, and in vertical lifting, the blood drops suddenly to pool in the legs. This mimic's the effects of a sudden loss of a litre or more of blood from the system, further worsening the hypovolaemia. This in turn will lead to cerebral and myocardial hypoxia. The myocardial ischemia which results may lead to irreversible ventricular fibrillation.

How would this affect Helicopter rescues?

The outcome of research has resulted in the rescue services adopting a method of retrieval using a double helicopter strop allowing a horizontal lift.

The effects of a cool wind blowing over a warm body can cool it dramatically. In cold weather the effects of wind speed must be considered, along with the air temperature. The wind chill temperature for various wind speeds can be seen in the chart below:

5. System of management

Remember this Old Norwegian saying and keep it imprinted in your memory:

"No one is dead until they are warm and dead"

A severely hypothermic patient may have no apparent pulse, BP or be breathing but they may still be successfully resuscitated with the correct management.

The management of immersion casualties depends on their core temperature and is summarised in the table below. The only way of measuring the body's core temperature is by using a low grade reading rectal thermometer.

Management following immersion

Mild & Moderate Hypothermia – Temperature 35-31°C

- Remove wet clothing
- Prevent further heat loss with blankets and dry clothing
- Active re-warming with hot drinks
- Medivac

Mild & Moderate Hypothermia – Temperature <30°C

Estimated Windchill Temperature

Wind speed		Ambient Temp (°C)										
m/s	km/h	10	8	6	4	2	0	-2	-4	-6	-8	-10
2.8	10	8.6	6.2	3.9	1.5	-0.9	-3.3	-5.7	-8.1	-10.5	-12.9	-15.3
5.6	20	7.4	4.9	2.3	-0.2	-2.7	-5.2	-7.8	-10.3	-12.8	-15.3	-17.9
8.3	30	6.6	4.0	1.4	-1.3	-3.9	-6.5	-9.1	-11.7	-14.3	-16.9	-19.5
11.1	40	6.0	3.3	0.6	-2.0	-4.7	-7.4	-10.1	-12.7	-15.4	-18.1	-20.8
13.9	50	5.5	2.8	0.0	-2.7	-5.4	-8.1	-10.9	-13.6	-16.3	-19.0	-21.8
16.7	60	5.1	2.3	-0.5	-3.2	-6.0	-8.8	-11.5	-14.3	-17.1	-19.9	-22.6
19.4	70	4.7	1.9	-0.9	-3.7	-6.5	-9.3	-12.1	-14.9	-17.7	-20.5	-23.4
22.2	80	4.4	1.6	-1.3	-4.1	-7.0	-9.8	-12.6	-15.5	-18.3	-21.2	-24.0
25.0	90	4.1	1.3	-1.6	-4.5	-7.4	-10.2	-13.1	-16.0	-18.9	-21.7	-24.6
27.8	100	3.9	1.0	-1.9	-4.8	-7.7	-10.6	-13.5	-16.4	-19.3	-22.2	-25.1

Based on formula for the North American Windchill index, as per Wikipedia (http://en.wikipedia.org/wiki/Wind_chill) as at 27 May 2011, 11:33 UTC

- Remove wet clothing
- Use rescuers body heat as well as blankets
- Exhaled air near nose and mouth
- No active re-warming
- CPR
- Oxygen
- Medivac

Mild Hypothermia

As the medic offshore you should prevent further heat loss. Keep the casualty horizontal at all times, and raise the legs as you would for shock. Remove all wet clothing and pat the skin dry, do not rub skin vigorously taking great care as cold skin is easily damaged.

Remember the effects of wind chill, especially on someone who is still soaked. A foil blanket only prevents heat loss; it will not warm the injured person up. Once the casualty is dry and in warm clothing and blankets it will then be a useful idea to use a foil blanket, placing it over the others to prevent heat escape.
As soon as possible start warming from the inside by giving hot drinks.
Remember the use of a bath for re-warming patients is no longer an accepted practice; rapid re warning has been associated with Cardiac Arrhythmias.

Moderate Hypothermia

Once again it is important to remove wet clothing and cover the patient with blankets. You can apply mild heat to the head, neck, chest, armpits, and groin using wrapped thermal pads, hot water bottles or warm towels. Give warm sweetened drinks if the patient is conscious and able to swallow.

Severe Hypothermia

Remove injured person/crewmember from the cold and wet environment and use whatever means that are available to reduce a further drop in temperature.

- Remove wet clothing
- Replace with dry clothing and or blankets
- Use the rescuers body heat, skin to skin is the best contact (there are some who would argue this practice is not a good idea if the person doing the warming is the medic or only other person to hand) as they might put themselves at risk. There is also a gender issue.
- Use exhaled warm air near the patients nose and mouth

- Avoid active external warming to prevent metabolic release

Remember to avoid unnecessary movement to reduce the risk of precipitating cardiac arrhythmia.

Only commence CPR if the patient is in full cardiac arrest and has no evidence of a carotid pulse after a two-minute check. Please refer to July 2021-updated UK and European resus council guidelines.

Baseline measurements of rectal temperature, pulse and blood pressure are essential as soon as possible.

Note: "It may be difficult to detect a pulse as extreme Bradycardia could be present in these circumstances. A pulse should be observed for a full two minutes at least, before deciding it is absent."

General Considerations

As for any case of shock, give Oxygen at the highest concentration possible for all immersion casualties as soon as possible.

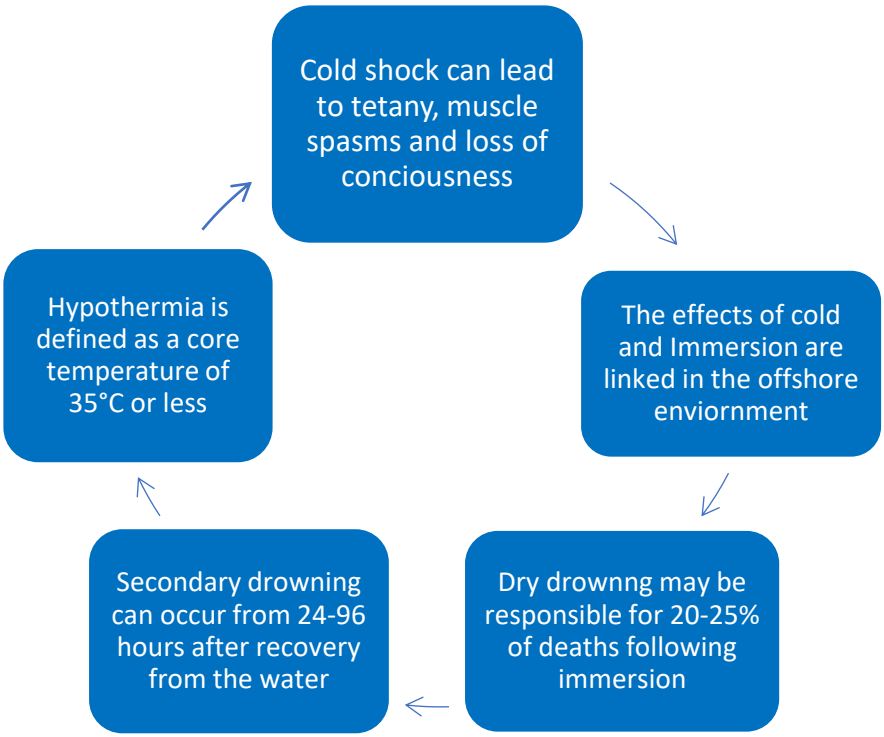
At this point it is worth mentioning that you should think initial fist aid (complete a secondary survey), check for any other injuries. For example you might not know why they fell overboard and remember falls from height into the sea can cause extensive injuries which might complicate management. For example a person with fractured ribs resulting from the fall might have difficulty in breathing due to the pain.

Pain control using intramuscular injections should be avoided due to peripheral shutdown, which will impair absorption of the drug. Entonox (50% oxygen 50% nitrous oxide mixture) is preferred in these situations, as it also provides an additional 50% oxygen.

Another pain relief medication currently being used offshore in place of Entonox/Nitrous oxide, is Penthox where the patient inhales the pain medication as if smoking. Termed the Green whistle.

“Be aware that the person you are treating might be a diver in which case you must not use Entonox at any cost”

Finally, all immersion victims must be Medivaced for further care due to the risk of secondary drowning. If they are a diver then care must be taken to fly them below 2000 metres and you must discus first with a Diving Doctor.



Questions

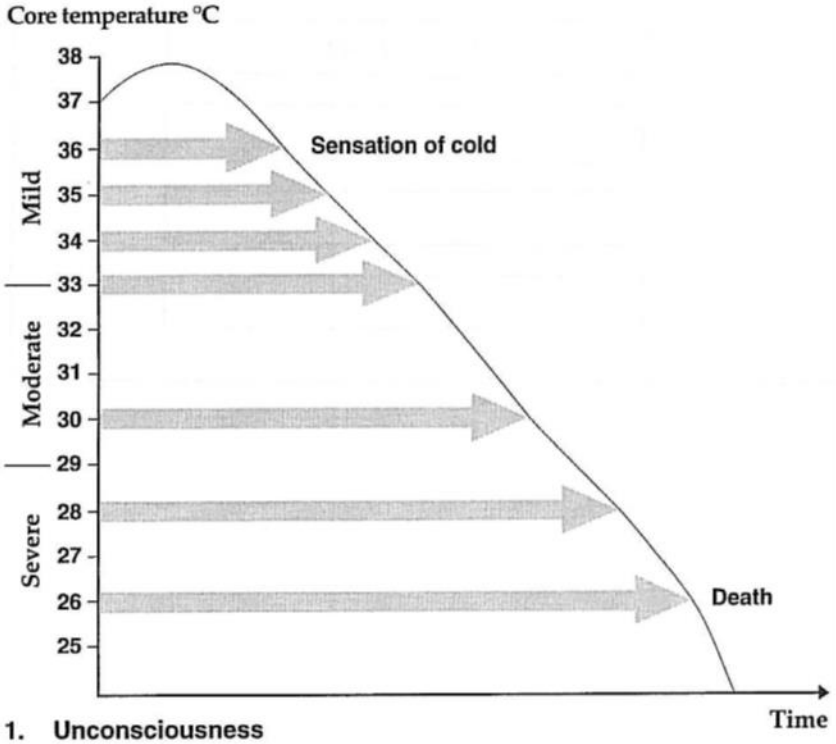
Question 1: Complete the following definition of Hypothermia:

Hypothermia exists when the bodies ……. Temperature has ……. to …….°C or ……

Question 2: Which one of the below is not a class of Hypothermia?

Mild / Moderate / Partial / Severe

Question 3: Using the list below complete this chart of the effects on a person in the water at 10°C. Put the effects in order of falling core temperature.



1. Unconsciousness
2. Ventricular fibrillation
3. Hypothermia, intense shivering
4. Muscle rigidity, semi–consciousness, difficulty breathing
5. Confusion, disorientation, introversion

Question 4: Take a look at the list below of management techniques. Use them to put together the three different strategies for mild, moderate and severe hypothermia. Remember you can use some of the techniques more than once. Write the technique in the relevant box in the order you would use it; the first one has been done for you.

Mild Hypothermia	Moderate Hypothermia	Severe Hypothermia
1. Prevent further heat loss		

Management techniques:

- Prevent further heat loss
- Remove wet clothing
- Medivac
- Pat skin dry
- Hot drinks
- Skin-to skin Warmth
- CPR
- Warm bed

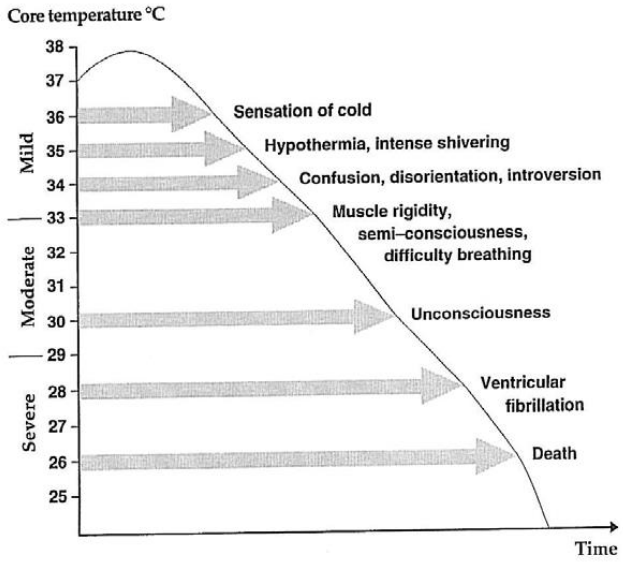
Questions for your tutor

Answers:

Question A: You will probably know that duvets and some items of protective clothing use these measures. In both cases the ratings give an indication of how warm the item will keep the body.

One 'clo' = the thermal insulation required to keep a sedentary person comfortable at 21°C

One 'tog' = 0.645 clo.



Question 1: Hypothermia exists when the body's **core** temperature has **fallen** to **35°C** or **below**

Question 2: Partial is not a class of Hypothermia

Question 3:

Question 4:

Mild Hypothermia	Moderate Hypothermia	Severe Hypothermia
1. Prevent further heat loss with blankets and dry clothing 2. Remove wet clothing 3. Active re warming with hot drinks 4. Medevac	1. Prevent further heat loss with blankets and dry clothing 2. Remove wet clothing 3. Active re warming with hot drinks 4. Medevac	1. Remove wet clothing 2. Use rescuers body heat as well as blankets 3. Exhale air close to nose and mouth 4. No active re-warming 5. CPR 6. Oxygen 7. Medevac