

# Management of Heat Induced Illness

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## Introduction

As the occupational health and safety advisor on board, it is important for you to remember that even in the North Sea heat can be a hazard to crew members. They will often be exposed to the sun for long periods of time whilst working in heavy duty PPE, hard hat, glasses, overalls and boots. You should therefore be able to recognise and manage the relevant heat induced injuries.

- Heat stroke
- Heat cramps
- Heat exhaustion

### Temperature Regulation of the Human Body

The human body has the remarkable capacity for regulating its core temperature somewhere between 98°F (36.5°C) and 100°F (37.5°C) when the ambient temperature is between approximately 68°F (20°C) and 130°F (54.5°C) according to Guyton. This presumes a nude body and dry air.

The external heat transfer mechanisms are radiation, conduction and convection and evaporation of perspiration. The process is far more than the passive operation of these heat transfer mechanisms, however. The body takes a very active role in temperature regulation.

The temperature of the body is regulated by neural feedback mechanisms which operate primarily through the hypothalamus. The hypothalamus contains not only the control mechanisms, but also the key temperature sensors. Under control of these mechanisms, sweating begins almost precisely at a skin temperature of 37°C and increases rapidly as the skin temperature rises above this value. The heat production of the body under these conditions remains almost constant as the skin temperature rises. If the skin temperature drops below 37°C a variety of responses are initiated to conserve the heat in the body and to increase heat production. These include:

- Vasoconstriction to decrease the flow of heat to the skin.
- Cessation of sweating.
- Shivering to increase heat production in the muscles.
- Secretion of norepinephrine, epinephrine, and thyroxine to increase heat production
- In lower animals, the erection of the hairs and fur to increase insulation.

Before you read any further try the exercise below:

Think about what the core temperature value or range (in °C) would be for the below:

- Normal body temperature
- Hypothermia
- Hyperthermia
- Excessive exercise
- The core temperature at which death will result from Hypothermia

## 1. Definition

The biological processes of the body produce heat and are themselves sensitive to temperature changes. Under normal conditions the body or core temperature remains more or less constant. If the core temperature rises excessively, then the biological processes will be disturbed, proteins may be denatured (have their natural qualities altered) and death may occur.

**Note:** Clinically Hyperthermia exists when the body's temperature has risen to 39 °C or above.

In healthy people the temperature of the body is maintained at or close to 37 °C by a balancing process of physiological and environmental adaptations.

## 2. Thermal Regulation

The body is able to lose heat by the following processes, the first two are far the most important:

- Evaporative loss through sweating
- Radiation
- Conduction

**Question A:** How much energy in kcal/h do you think you expend on the following types of work?

Sedentary:

Light:

Moderate:

Heavy:

## 3. Thermal Stress Factors

These are external influences which increase an individual's heat load. They include:

- Environmental factors
- Personal factors

### Environmental Factors

- Solar radiation. That is, exposure of the body to the heating effects of the sun
- A surrounding air temperature of 37°C will prevent heat loss and lead to overheating of the body
- Sweat evaporation ceases when the relative humidity exceeds 75%

**Question B:** What is the importance of relative humidity to thermal regulation?

### Personal Factors

#### Clothing

- May prevent heat loss by radiation
- May also trap moist air around an individual's body thus reducing the potential for heat loss by evaporation

#### Exercise

- Physical work generates heat
- Excessive workloads may produce heat at a greater rate than the body can lose it, thus causing the body to overheat.

#### General Health

Maximal sweat production results in the loss of approximately one litre of fluid per hour. Inadequate fluid replacement or an existing state of dehydration produced by diarrhoea/vomiting/blood loss through trauma/plasma loss through burns/etc will all reduce the rate of sweat production and hence reduce evaporative heat loss.

## 4. Pathophysiology

The pathological effects of heat stress are seen when either:

- The thermoregulatory system of the body is overwhelmed
- The body's responses to heat place a strain on the body systems which then fail under the extra pressure. For example, a cardiac arrest.

Under heat stress the body will shunt blood to the skin to maximise heat loss by radiation. The cutaneous vasodilation leads to an increase in cardiac output which can stress the myocardium. When vasodilation is marked, there may be a loss of response to sympathetic stimulation, so blood pools in the peripheries, this can lead to hypotension.

The diversion of blood to the peripheries shunts blood away from the vital centres of the brain and kidneys; this can then lead to cerebral hypoxia. If this is coupled with an abnormally high temperature of blood circulating the central nervous system, this is likely to lead to a progressive deterioration in cerebral functioning.

Evaporated sweat loss leads to the loss of water and electrolyte – in particular, sodium (Na<sup>+</sup>). With inadequate fluid replacement, the body may become not only dehydrated but also incur an electrolyte imbalance.

Once the thermoregulatory systems begin to fail, the core temperature will begin to rise and the risk of heat induced injury will increase. The rise in core may be rapid and it can rise to 41° or above within 15 minutes of thermoregulatory failure.

**Note:** It is important for you to realise that these effects describe the range through which a patient's condition may deteriorate, often rapidly in serious cases.

## 5. Heat Induced Injuries

There are three types of heat induced injury that you should be familiar with: heat cramps, heat exhaustion and heat stroke. The effects that each of these conditions has on the body is described in more detail in the next sections.

### Heat Cramps

#### Description

This state is characterised by cramping muscular pains usually in the calf or hamstring muscles, they are forceful and very painful. They seem to relate to heat, exercise and poor fitness rather than salt imbalance as was once thought.

#### Signs & Symptoms

The symptoms usually come on suddenly during vigorous physical activity. The skin remains pale and moist. The conscious level remains unimpaired.

#### Rectal Temperature

Normal 37°C

#### Ongoing Management

Drinking water is all that is required. Physical activity should be restricted for at least 12 hours, with attention to ensuring adequate hydration.

### Heat Exhaustion

#### Description

Caused by excessive sweating which leads to dehydration and salt loss.

#### Signs & Symptoms

Your patient will present complaining of intense thirst, weakness and headaches. They may complain of dizziness, fatigue, anorexia, nausea or vomiting. Signs include rapid pulse and rapid breathing. The skin could present clammy, pale, with sweating. They also may appear disorientated, agitated and/ or even psychotic.

#### Rectal Temperature

May be moderately elevated only.

#### Initial Management

Allow your patient to lie down in a cool area and remove clothing. Sponge the patient's body with tepid water and cool with a fan to assist heat loss.

### **Ongoing Management**

Oral rehydration therapy might prove effective but if your patient is too ill to take oral fluids then you must cannulate them and give IV fluids but only after taking guidance from your Topside Doctor. Your patient should remain on bed rest until they are fully recovered. Remember if this does not happen within a reasonably short period of time then you must consider medevac and admission to hospital for further management.

## **Heat Stroke**

### **Description**

Heat stroke is defined as a core temperature of 40°C or above. Onset can be rapid once the body's cooling mechanisms are overcome. Heat can no longer be lost from the body and so the core temperature rises at a rapid rate. The metabolic changes that occur as a result of this are catastrophic and the condition is an acute medical emergency.

### **Signs & Symptoms**

The patient may complain of headaches, dizziness, disorientation and nausea, however the onset of unconsciousness, sometimes accompanied by a seizure, may be the first sign. Other signs include altered consciousness level, dilated pupils, tachycardia with a bounding pulse, raised blood pressure and hot, flushed, dry skin.

### **Rectal Temperature**

Elevated – 40°C or above.

### **Initial Management**

Remember first aid measures and maintain the ABC, remove the patient urgently to a cool area, establish cooling measures, which may include:

- Gradual immersion into a cold shower
- Ice packs to the groin and axillae
- Placing the patient into a cool airflow, fanning etc.

### **Ongoing Management**

Intravenous fluid replacement is vital, although you should also encourage the conscious patient to take sips of some oral rehydration fluid but you must be aware of the risk of vomiting. While you maintain and monitor the vital signs you must also discuss the need for urgent medevac with your Topside Doctor.

## 6. Acclimatisation

Individuals can reduce their vulnerability to heat induced injury by a combination of physiological and psychological adaptive mechanisms. This is known as acclimatisation.

Crewmembers who arrive from a cool environment to work in a hot environment should and must be encouraged to pace their level of physical activity, building it up over a period of 14 days. Physical activity should be reduced or curtailed when the environmental temperature is at its highest, for example, midday. This requirement might necessitate rescheduling of work patterns and may be unpopular with project managers and senior management.

Remember the quote below:

‘Only mad dogs and Englishmen go out in the midday sun’ - Noel Coward, 1931

### Key Points:

**Note:** An individual’s perceived need of fluid lags behind the physiological needs. Therefore, it is important that you encourage workers to increase their intake of fluids in hot conditions.

- Once the thermoregulatory system is overwhelmed, the core temperature rise may be rapid, rising to 40°C within 15 minutes
- Acclimatisation reduces the vulnerability of the individual to heat induced injury.
- Maintenance of the ABC, urgent cooling methods, intravenous therapy and Medevac are mandatory in heat stroke.
- Heat induced injury from heat cramps to heat stroke, may result if the body’s mechanisms to dissipate an excessive heat load are overwhelmed
- In healthy people, the body maintains a core temperature of 37°C by processes that balance heat loss and heat gain.







## Answers:

**Question A:** How much energy in kcal/h do you think you expend on the following types of work?

Sedentary: 100

Light: 100-200

Moderate: 200-350

Heavy: 350-500

**Question B:** If the air already contains a lot of water vapour, that is a high relative humidity value, then the body will not be able to sweat much. This means the body's cooling system stops working and heat exhaustion or heat stroke may result.