CHAPTER 14

EMERGENCIES DUE TO TEMPERATURE CHANGE

As a first aider there is a good chance that you will be called to deal with an emergency due to changes in the core temperature of a casualty's body. The core temperature of the human body is maintained at about 37.6°C and changes of three degrees either lower or higher can seriously affect the health of a casualty.

MAINTENANCE OF A CORE BODY TEMPERATURE

The temperature of the human body varies depending on what part of the body we are talking about. For this reason the body is divided into two parts; the peripheral, consisting of the skin and muscles, and the core, which consists of the brain, heart, lungs, liver, kidneys and the other organs of the abdomen. When looking at the effects of environmental temperature upon the human body we need to consider both parts.

The temperature of the peripheral part of the body, especially the skin, is not constant. It is through the skin that heat is lost from the body. Thus on the skin the temperature will vary from close to 37°C in the groin and axillae to near the environmental temperature in the hands and feet.

Temperature within the core of the body however is almost constant, at around 37.6°C. Any large fluctuations in this temperature will result in problems. These problems occur because to function the cells of the body require complex chemical reactions and these can only occur within a limited temperature range around 37.6°C. Thus the core temperature of the body is maintained at this level with only a slight variation (±5°C) in a 24 hour cycle with the temperature being lower at about 4.00am and higher at about 6.00pm.

Body heat is created by cell metabolism, the chemical activity we have already mentioned above. Cell metabolism produces about 292.6KJ of energy (heat) per hour and the controlled loss of this heat is what maintains the core temperature of the body.

To maintain a constant core temperature of 37.6°C the body has to carefully regulate heat production and loss and anything which interferes with this will result in temperature imbalance. Thus if more than 292.6KJ of body heat is lost per hour the casualty will become cold (hypothermic). If heat is prevented from leaving the body the core temperature will rise about 1°C every hour leading to death within four to five hours.

Heat loss from the body is slowed by gaining heat from the environment by eating hot food, sitting in the sun or in front of a fire, and through the wearing of clothing which insulates the body from the environment by trapping and warming air in the fibres close to the skin. If the body needs to lose excess heat then we move away from sources of environmental heat or we take off clothing.

The body also regulates its heat loss by altering the temperature of the skin. When the skin itself is hot it fills with warm blood which cools before going back to the heart and core organs. Thus the rate of heat loss from the body increases. When the environment becomes very cold the blood vessels in the skin contract and little blood can enter the skin and this reduces the speed of heat loss. This is why on a cold day the skin is pale and blue from lack of blood and a hot day it is flushed and warm.
These four processes act on the skin. A much lesser heat loss is produced through the lungs where heat is lost during respiration. Very small amounts of heat are lost via passing urine and faeces.

TYPES OF TEMPERATURE EMERGENCY

The types of temperature emergencies you will encounter are hyperthermia (high body temperature), and hypothermia (low body temperature). The cause of these conditions are either illness or injury, and exposure to environmental temperature

The most common type of problem you will encounter is altered temperature due to illness or injury, so we will deal with this subject first.

INFANTILE CONVULSIONS (FEBRILE CONVULSION)

The most common medical problem involving temperature change is infantile convulsions. Infantile convulsions are fits caused by high temperature in young children, usually the result of a cold, flu or other infection combined with too much clothing and a warm environment.

Infantile convulsion is very dramatic and frightening for parents and it is necessary to carefully reassure them while you treat the child. Most parents of children who suffer infantile convulsions are quite capable of dealing with the problem once they are aware of its causes and treatment. Thus it is usually the first fit that you will see and this is why the parents will be so distressed. Therefore calm down the parents, especially the mother. Her emotional distress is very easily communicated to the child and getting the mother calm allows the child to be more easily treated.

PROVISIONAL DIAGNOSIS OF INFANTILE CONVULSION

HISTORY:

a. Story of illness (Cold, flu, cutting teeth) or infection
b. Child is heavily dressed
c. The home is well heated
d. Child began fitting

SIGNS:

a. Child can be seen to convulse - arching of back
b. Veins on head and neck are distended
c. Child is obviously distressed
d. Skin is hot

SYMPTOMS:

a. Impossible to obtain
**TREATMENT OF INFANTILE CONVULSION**

1. Approach incident
2. Reassure and relax parents
3. Get mother to remove child’s clothing
4. Have mother and father sponge the child with cool water
5. Fan child
6. Continue until convulsions cease and child is seen to shiver
7. Dry child and dress lightly
8. Ensure parents understand that child should be kept cool
9. Call a doctor or have parents take child to a hospital.
10. If the child is over 12 months Children’s Paracetamol can be administered.

**HIGH TEMPERATURE (FEVER) DUE TO ILLNESS**

Nearly everyone has experienced an episode of fever or high temperature due to an infection or illness. In adults and older children this does not cause any severe problems unless the infection is out of control. When a fever does become a problem it usually takes a day or so for the casualty to become ill and most often this problem is being managed by a medical practitioner. Thus fever is not a problem that you will be required to treat without assistance from a medical practitioner.

In most cases the treatment of high temperature in adults or older children is bed rest and the administration of Paracetamol and other medication on the medical practitioner’s directions.

**LOW TEMPERATURE DUE TO INJURY OR ILLNESS**

Any casualty who suffers a severe injury or illness can, if left exposed, suffer from low body temperature. Remember that an environmental temperature of 34°C is regarded as quite hot, however the same temperature in the core of a casualty’s body is very low and will lead to serious problems. When caring for injured, ill or infirm casualties always ensure that they are protected from wind, rain and cold. Use blankets and other coverings to insulate the casualty and ensure their removal to a protected environment as soon as possible.

**EXPOSURE TO TEMPERATURE CHANGES**

In Australia physical problems due to exposure to temperature are usually associated with thirst and heat. This is only half the story. Australia is a continent and temperatures range from very hot, above 45°C, to very cold, below 0°C. This range of temperature is not simply a result of the geographical distance Australia extends from the equator, it is also seasonal, with many parts of Australia experiencing a wide range of temperatures over a year. Thus you may encounter casualties suffering heat related conditions in summer and cold related conditions in winter.

In looking at the effects of temperature change on the human body we need to consider three things:

- how the body maintains a constant core temperature,
- what impact high environmental temperature has on the body, and
- what effect low environmental temperature has on the body

**EXPOSURE TO HEAT**

As we have noted the body maintains its core temperature at close to 37.6°C through a complex system of balancing heat production and loss. This system is regulated from the hypothalamus in the brain. If any part of this system is unable to operate then the body temperature will rise or drop to the environmental temperature and if this temperature is above 37.6°C the casualty will suffer hyperthermia (Hyper = High and thermia = temperature). Hyperthermia is a progression from the normal body temperature through to a temperature where death occurs. Along the way the casualty will suffer from heat cramps, heat exhaustion and heat stroke.
HEAT CRAMPS

Heat cramps are characterised by severe muscle pains and cramps, especially in the lower limbs and abdomen. Because heat cramps are often ignored by the casualty it is likely that you will be aware of their onset. However, where a casualty suffers heat cramps it is important to treat them before they progress to heat exhaustion.

PROVISIONAL DIAGNOSIS OF HEAT CRAMPS

HISTORY
a. Physical activity in a hot environment
b. Complains of cramps in calf muscles and abdomen

SIGNS
a. Cramping of muscles
b. Pink, warm and sweaty skin

SYMPTOMS
a. Possible altered conscious state
b. Weakness

TREATMENT OF HEAT CRAMPS

1. Stop casualty exerting themselves and remove to cool environment
2. Give water with added salt to drink (Ratio of one teaspoon of salt to 1000ml of water) or use a sports drink
3. Gently stretch cramped muscles
4. Apply ice packs to the cramped muscles

HEAT EXHAUSTION

This condition results from over-exposure to high temperature and/or high humidity, especially where the casualty has been exerting themselves. In a hot humid environment heavy work or exercise can result in the loss of between 8 and 14 litres of water and 28 grams of salt (NaCl) per day (each litre of sweat contains 2 grams of salt).

PREVENTION OF HEAT EXHAUSTION

If you find yourself working in such an environment it is important that you ensure that you and others have enough fluid and salt. The most effective way of preventing dehydration is to buffer your system as follows:

1. Before going to bed drink about a litre of water. This allows the water to be absorbed into the cells of the body during the cool of the night when you are not exerting yourself
2. On rising drink another litre of water. This ensures that water outside of the cells is available for the body to sweat during work
3. During the day drink frequent sips of water, one sip every 15 minutes, to provide the body with water for sweating during the day
PROVISIONAL DIAGNOSIS OF HEAT EXHAUSTION

HISTORY
a. Exertion in a hot environment
b. May complain of cramps in calf muscles and abdomen

SIGNS
a. Cramping of muscles
b. Pale, warm and sweaty skin
c. Pulse >100, weak
d. Respirations >20

SYMPTOMS
a. Altered conscious state
b. Weakness
c. Headache
d. Nausea

TREATMENT OF HEAT EXHAUSTION

1. Stop casualty exerting themselves and remove to a cool environment
2. Airway, breathing and casualty’s perfusion status
3. If conscious, give salt water (of one teaspoon of salt in 1 litre of water) or a sports drink
4. Strip and wash casualty with cool water
5. Cover with wet sheet and fan casualty
6. If casualty unconscious place on side and raise legs above their head
7. Call ambulance

HEAT STROKE

Heat stroke occurs when the casualty’s body is no longer able to cope with its rising core temperature, usually above 41°C. At 42°C the hypothalamus in the brain fails and the casualty’s temperature will rise even more rapidly. It takes about 15 minutes for the temperature to rise from 41°C to 42°C. Heat stroke is a medical emergency and rapid, effective treatment must be implemented if the casualty is to survive. Heat stroke has a mortality of 10-75%, depending upon the duration of the condition and the effectiveness of the treatment. With effective treatment 90% of casualties will recover.

The onset of heat stroke is quite sudden and the casualty often appears to be no more affected by the heat than everyone else, although they have hot dry skin in a very hot or humid environment. They may also display the Signs and Symptoms of heat exhaustion.

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PROVISIONAL DIAGNOSIS OF HEAT STROKE

HISTORY
a. Working in a hot environment
b. May complain of discomfort

SIGNS
a. Cramping of muscles
b. Hot, flushed, dry skin
c. Pulse >100, strong
d. Respirations >20
e. Fitting

SYMPTOMS
a. Altered conscious state
b. Weakness, headache and nausea

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<tr>
<th>TREATMENT OF HEAT STROKE</th>
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<td>1. Stop casualty exerting themselves and remove to a cool environment</td>
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<td>2. DRABCD</td>
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<td>3. Strip casualty of all clothing</td>
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<td>4. Cover with a sheet and soak with water</td>
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<td>5. Ensure cool air is fanned over casualty</td>
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<td>6. Immediately call ambulance</td>
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<td>7. Place ice packs around throat, in groin, armpits, on ankles, knees, wrists and elbows</td>
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<td>8. Constantly monitor casualty’s temperature and immediately stop all cooling when casualty feels comfortable</td>
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COOL ENVIRONMENTS AND COLD EMERGENCIES

Those most at risk from the cold are babies, the elderly, those affected by alcohol and those who are cold, wet and in the wind. The effects of cold on the human body are insidious and very often the casualty is unaware any problem

EXPOSURE TO COLD

Cold by itself is usually not a problem unless you are scantily clad, ill, injured, undernourished, exhausted, elderly or the cold itself is extreme
**WIND CHILL CHART**

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<th>Wind Speed Mls</th>
<th>Thermometer Reading in Celsius</th>
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**Wind speeds greater than 30-50 Knots have little effect**

**Little danger of hypothermia in fit, well fed, and properly clothed persons**

**Increasing danger of hypothermia in fit, well fed, and properly clothed persons**

**Great danger of hypothermia in fit, well fed, and properly clothed persons**

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**EXPOSURE TO COLD AND WIND**

Where the environmental temperature is low and wind speed is high heat loss from the body is dramatically increased due to cold air passing through clothing and across the skin surface. The indication of just how dangerous wind and cold are when combined is shown by the Siple-Passel Wind-chill formula which was developed by P. Siple and C.F. Passel from their research in the Antarctic between 1939 and 1940. The formula reads as 

\[ K_0 = \sqrt{V \times 100 + 10.45} - V \] \(133-Ta) \]

Where \(V\) = wind velocity is measured in metres per second, \(Ta\) = temperature of air in degrees centigrade. Skin temperature under calm conditions and assuming an average outgoing radiation plus average convection.

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**EXPOSURE TO COLD, WIND AND RAIN**

Where cold is uncomfortable, cold and wind can be dangerous and cold, wind and rain are lethal, even for those who are well prepared. The reason for this increased danger is the ability of water to destroy the insulatory value of your clothing by filling up the air pockets in the clothing and coming into contact with the warm surface of the skin. Once in contact with the skin surface the water rapidly absorbs heat and conducts it through the clothing to the exterior where wind strips the heat away.
The possible problems you face when treating hypothermia are:

- lowered core temperature and decreasing metabolic function
- fluid shift and increased urine output leading to dehydration
- hypoglycaemia and loss of calorific reserve
- enzyme system dysfunction
- hypoxia and transfer to anaerobic metabolism
- metabolic acidosis
- renal dysfunction
- increasing loss of neuro-function

**TYPES OF ACCIDENTAL HYPOTHERMIA**

There are three types of hypothermia\(^2\): Acute (immersion), Subacute (exhaustion) and Subchronic (urban) hypothermia.

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ACUTE (IMMERSION) HYPOTHERMIA

This occurs when the cooling of the body is so rapid that heat production is overwhelmed before the energy reserves of the body are exhausted. The most common causes of this type of hypothermia are immersion in cold water or where the casualty is subjected to severe cold and their body defences are disabled through injury or poisoning.

PROVISIONAL DIAGNOSIS OF ACUTE (IMMERSION) HYPOTHERMIA

HISTORY
a. Immersion in cold water

SIGNS
a. Lethargy and slurred speech
b. May have violent shivering fits
c. Respirations 10 per min or less
d. Patient's axilla (armpit) or groin is very cold to touch
e. Pale, cyanosed, very cold, marble like skin
f. Hypotension (low pulse pressure)

SYMPTOMS
a. Altered conscious state
b. Weakness
c. Headache
d. Nausea

TREATMENT OF ACUTE (IMMERSION) HYPOTHERMIA

1. Rescue casualty ASAP
2. Keep casualty as flat as conditions will allow
3. Aggressively treat airway, breathing and casualty's perfusion status
4. Do not give up on casualty until they are in hospital
5. Limit touching or moving casualty to an absolute minimum
6. Get casualty to a warm, dry environment ASAP
7. Ensure casualty is completely insulated from atmosphere and ground
8. Cut off all clothing
9. Place casualty’s hands by their sides and keep them cool
10. If possible administer warm and humidified oxygen

SUBACUTE (EXHAUSTION) HYPOTHERMIA

Hypothermia is a dangerous and insidious problem. This can be particularly true when people are exerting themselves in remote, cold and wet locations. In such conditions hypothermia results from the lowering of energy levels amongst the group and is not simply a problem for one member of that group. If one member of a group seems to be hypothermic then you must assume that everyone, including yourself, is affected. It is vital that as soon as any member of a group shows the effects of hypothermia no further physical exertion, with the exception of getting shelter, cooking food and getting people into a dry warm environment, should be risked.

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3 E.L. Lloyd, Accidental Hypothermia, Resuscitation, 32 (1996), p. 116 ‘Warm hands and feet reduce the stimulus for heat production and will allow reduction of vasoconstrictor tone thus increasing heat loss and increasing the risk of vasomotor collapse.’
PROVISIONAL DIAGNOSIS OF SUB-ACUTE (EXHAUSTION) HYPOTHERMIA

HISTORY
a. Heavy physical effort in cold, wet and windy environment

SIGNS
a. Slurred speech
b. Aggressive, unreasonable, violent or drunken behaviour
c. May have violent shivering fits
d. Respirations 10 per min or less
e. Patient’s axilla (armpit) or groin is very cold to touch
f.. Pale, cyanosed, very cold, marble like skin
g. Hypotension (low pulse pressure)

SYMPTOMS
a. Altered conscious state
b. Lethargy and weakness
c. Headache
d. Nausea

IMMEDIATE ACTION ON DISCOVERING EXHAUSTION HYPOTHERMIA IN A GROUP MEMBER
All activity must be concurrent - Do not waste precious energy

1. Stop immediately
2. Get everyone into shelter from wind
3. Immediately insulate casualty, especially the head, from the atmosphere and ground
4. Get tents up and everyone under them
5. Cook warm drinks and a meal - all food in one pot on one fire
6. Get group into sleeping bags
7. Eat meal and sleep until group recovers
8. Do not try to walk for help, no matter how close it may be

The fundamental rule is to prevent hypothermia at all costs and always treat the group

TREATMENT OF A SEVERELY HYPOTHERMIC CASUALTY

1. Immediately treat whole group as above
2. Get casualty out of wind and rain
3. Immediately insulate casualty, especially the head, from the atmosphere and ground using vegetation, clothing, sleeping bag and other material
4. Keep hands and feet cool
5. Get casualty a warm, sweet drink ASAP
6. Handle casualty as little as possible and avoid rough handling
7. Get casualty to eat a meal and sleep
8. If there is no airway problem get casualty to inhale warm, moist air from near own body or use a heat and moisture exchanger
9. Perform CPR only as a last resort and only for as long as the safety of others permits

STRIPPING THE CASUALTY AND PUTTING A RESCUE INSIDE THE SLEEPING BAG
This technique has a number of major flaws:

1. It requires the casualty be stripped and this may induce cardiac arrest through the need to roughly handle the casualty, especially if they are unconscious
2. Most sleeping bags will not take two bodies
3. No rescue party can carry two people
4. Surface warming of a severely hypothermic casualty may kill the casualty
5. The group cannot afford the energy required
6. Because warming the casualty requires the transfer of energy from the other group members and because you do not know the energy reserves of the individual group members you cannot leave one person with the casualty for too long. Thus you have to rotate the entire group through the casualty’s sleeping bag leading to dangerous movement and loss of rest to all members of the group.

7. You cannot risk leaving one or two individuals to re-warm the casualty as they may also be quite badly affected themselves and the extra heat loss involved in re-warming the casualty will place them at serious risk. For these reasons stripping off to warm a hypothermic casualty should be regarded as ‘rescue fantasy’.

ON CPR

If you are unfortunate enough to be a member of a group where a casualty appears to have suffered a cardiac arrest from the cold, unless professional help arrives quickly, the casualty will die. A group of cold and tired people cannot perform effective CPR and to make the attempt risks the safety of the other group members who may be seriously ill themselves.

SUBCHRONIC (URBAN) HYPOTHERMIA

This type of hypothermia occurs where the casualty has been exposed to moderate cold over a prolonged period, usually days. Those most commonly affected are the elderly, young children, or those who are ill or malnourished.

A major physiological problem faced by these casualties is very large fluid shifts and when the casualty is warmed they suffer severe pulmonary oedema. Active warming outside of an intensive care unit or without intermittent positive pressure ventilation will result in death (100% mortality)\(^4\).

PROVISIONAL DIAGNOSIS OF SUB-CHRONIC (URBAN) HYPOTHERMIA

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FROSTBITE
Like burns, frostbite is either superficial or deep. Frostbite occurs at the body's extremities, such as the toes and fingers, and exposed skin, particularly the nose, cheeks and ears.

PROVISIONAL DIAGNOSIS OF FROSTBITE

HISTORY
   a. Very cold environment
   b. Limited clothing over the part
   c. Tight bootlaces, wrist watch or clothing ties

SIGNS
   a. Grey, mottled or white wax like skin on part

SYMPTOMS
   a. Pins and needles and Stiffness
   b. Pain

TREATMENT OF SUPERFICIAL FROSTBITE
1. Treat for hypothermia
2. If face or ears are affected remove glove and cover affected part until warm and normal colour returns
3. If fingers or toes
   - remove wet gloves or socks
   - place fingers in groin or armpits until warm and colour returns
   - cover toes with hands until colour returns
   - replace wet gloves and socks with dry
   - ensure laces and straps are not too tight

TREATMENT OF DEEP FROSTBITE
1. Treat hypothermia
2. Gently remove clothing from affected area
3. Remove all constrictions from limbs
4. Do not re-warm in field unless you can guarantee part will not re-freeze
   - if part re-freezes then gangrene will develop
   - re-warming is extremely painful
5. If unable to send casualty to hospital and risk of re-freezing is small rapidly warm the part for 20-30 minutes in water with temperature of 41-45°C
6. Cover area with dry, sterile dressing
7. Do not allow casualty to smoke as nicotine reduces the blood flow to extremities