St John Ambulance Australia

THE RATIONALE OF FIRST AID

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St John Ambulance Australia
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The rationale of first aid

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About this book ...

This book is intended to be read in conjunction with *Australian First Aid*, to which it adds explanations and additional background information on the injuries and illnesses which may be encountered by a practising first aider. It was designed primarily for St John instructors, many of whom have expressed a wish for additional material of this kind, not only for their own interest and further education but also to broaden the basis from which they can answer student questions and enhance their classroom teaching. *The Rationale of First Aid* is not a first aid manual, and cannot be used as such because it does not give instructions on first aid procedures. That function is performed by *Australian First Aid.*

The current edition of *Australian First Aid Volumes 1 and 2* was deliberately designed as an instructional manual for direct use by students undertaking St John Ambulance courses. To that end, it was streamlined by the omission of any material not essential to practical management of specific injuries and illnesses. *The Rationale of First Aid* contains supplementary material on the 'whys and wherefores' of recommended casualty management, which is of intrinsic interest and useful to know, but which is not necessary to the students' core training programme.

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Reference:
Australian First Aid
Volume 1,
Chapters 3 and 4

Resuscitation

The DRABC Action Plan

D Check for DANGER

Move the cause of danger from the casualty or the casualty from the cause.

- TO THE FIRST AIDER

St John teaches that the first action of a first aider at an incident is to check for danger to themselves, the casualties and any bystanders. First aiders in general have neither the training nor the equipment to carry out emergency rescues. They should not attempt heroic retrievals from cliffs or burning buildings. First aiders can only be useful to casualties if they remain uninjured. If the casualty is in a dangerous place and cannot be removed without undue risk, it is better to go for help than to risk becoming another casualty.

- TO BYSTANDERS

Bystanders may well be in danger also. In their eagerness to see what is going on, they may ignore the smell of petrol and come close while holding a lighted cigarette, or rush up to help without noticing live electric wires in their way. A crowd may spill on to the road, or lean on an unstable crashed vehicle, or walk through spilled chemicals. If there are bystanders, they can be given something useful to do, such as keeping others clear and warning approaching traffic of an accident. Bystander children require special attention.

- TO THE CASUALTY

Danger to the casualty must be considered. It is inappropriate to begin controlling bleeding or splinting fractures if at any

moment further injury is likely to happen, such as being hit by a car or a falling ladder, or being overcome by leaking gas. In such circumstances, the first aider should remove casualties from danger even before checking to see whether they are breathing. Dangers need not be life-threatening: if a person is convulsing, the first aider should quickly move any hard or sharp objects (such as a chair, or if outdoors, a rock) away, so that the casualty is not cut or bruised. If a dog has bitten somebody, it may still be nearby; take precautions in case it attacks again.

Sources of danger

Dangers at a traffic accident include other vehicles, leaking fuel, live electric cables, and particularly in the case of a vehicle which is suspended or tilted, falling or settling of heavy objects.

A person lying on the ground may have fallen from a height—tools, materials or equipment may be about to drop.

Poisons, such as carbon monoxide and cyanide, can produce multiple victims if their potential for danger is not appreciated.

Be suspicious if someone is lying in or near a garden shed: the trouble could have been caused by poisonous fumes from chemicals such as garden sprays, or carbon monoxide from the exhaust of a machine being used in an enclosed space.

Inside a building, look about to ensure that there are no electrical appliances or live wires near the casualty. If there are, use a broom or dry stick either to turn off the wall switch or to push the wires away. If the floor is wet, stand on wood, a rubber mat or newspaper. Dry wood, paper and rubber are insulators, and will give some protection from electric current. If it is not possible to remove an electric current from the casualty, find the meter box and turn the power off at the main switch.

If someone is staggering around, approach carefully. The casualty may be irrational from a head injury, from drug poisoning or from a psychological disturbance. A first aider could be hurt while trying to help: stay out of reach until assistance arrives, unless you feel confident that the casualty is not aggressive. When you do approach, stay alert for anything which could be used as a weapon, and put it out of the casualty's reach.

Damaged overhead power lines are perhaps the most dangerous situation of all. Current from a broken high voltage cable can leap across large spaces or run through damp soil; it can even run along the surface of rock. If a casualty is visible

near a fallen power line, there is nothing a first aider can do to help straight away. Get the electricity authority to cut off the power, and do not approach the casualty: **Stay at least six metres away.** If a vehicle has brought down overhead lines, shout to the people inside to stay there and not to touch anything made of metal. They should be safe until the power can be cut off so long as they do not earth the current or try to get out of the vehicle.

R Check RESPONSE

Rationale for techniques

- SHOUT AND SHAKE

St John teaches a gentle 'shout and shake' as the means of checking whether a casualty is able to respond. If there is no response, the casualty is assumed to be unconscious. The 'shake' part should be firm but gentle. Violent shaking can aggravate an injury.

It is important to touch the casualty while asking loudly such questions as 'Can you hear me? What is your name? Are you hurt? Can you squeeze my hand?' Dazed casualties may hear what is said but be too confused to realise someone is talking to them. It is fairly common for an injured person to recall later that it took some time to realise 'that the person screaming was me'. This type of disorientation may be helped by having the first aider touch as well as talk.

Some organisations teach first aiders to cause pain instead of shaking the casualty. The reason for using such checks (e.g. rubbing a knuckle hard on the sternum) is that several levels of consciousness may be distinguished by the casualty's involuntary (reflex) response to pain: eyes flicking open, flinching withdrawal, flexion or extension of arms and so on. This has no place in the St John action plan or initial assessment of the casualty. St John believes that the highest priority at this stage is to determine whether casualties will be able to keep their own airways open and clear; for this purpose, it is only necessary to know whether a casualty is able to react voluntarily.

- POSITIONING AN UNCONSCIOUS CASUALTY

St John teaches immediate turning of an unconscious casualty on the side for the purpose of clearing the airway. It may seem contrary to the principle that casualties 'should be moved as little as possible', to roll an unconscious casualty before checking

airway, breathing and circulation. However, to leave a casualty on the back while checking the airway would be to risk liquid or solid material in the mouth being inhaled and obstructing the trachea or lungs, and the tongue or any loose material in the mouth falling back and blocking the airway. Since an unconscious trauma victim should always be suspected of having a neck or spinal injury until proved otherwise, it would be dangerous just to turn the head: the whole body must be rolled over, keeping the head and neck aligned, before opening the casualty's mouth and scooping out any loose contents.

VARIATIONS OF STABLE SIDE POSITION

There are numerous methods for rolling casualties on to their sides, and numerous names for the stable side position in which a breathing, but unconscious casualty is placed. Some authorities prefer the 'coma position', others the 'lateral position'. St John teaches both as acceptable methods of putting the casualty into a stable side position because each has its own value in casualty management. Hard data comparing the efficacy of the different positions is presently lacking.

The **lateral position** is able to be achieved quickly, and is easier for returning the casualty to his or her back if resuscitation is required, because both arms remain in front. This is the preferred position for the initial assessment of the casualty. Use of the lateral position will often mean that the head may tilt sideways unless it is supported: some thin padding should be inserted between head and ground.

In the **coma position,** the lower arm is pulled behind the casualty, and the upper arm is placed so that the hand is under the cheek. This position gets the lower shoulder out of the way, allowing the cheek to rest on the casualty's hand, with the head and neck fairly well aligned. It therefore does not require support (but something soft under the hand which is bearing the weight of the head will be more comfortable). The coma position is probably the most comfortable of all the stable side positions if the casualty is to be there for more than a few minutes. The only caution is that having the lower arm behind theoretically could cause injury to the shoulder when somebody tries to turn the casualty into a supine position (flat on the back). This is the only position which may be able to be achieved quickly when a casualty is found lying prone (face down), and has an advantage when a spinal injury is suspected, because the head and neck are in better alignment.

The initial roll to clear the airway and check for breathing does not have to put the casualty into a stable position. If

breathing is present, the first aider will then stabilise the casualty, and if not, the casualty will be returned on to the back for resuscitation. However, it is important for the first aider to continue to support the casualty while clearing the airway so that he or she does not roll right over, perhaps suffering further injury.

· IF THE CASUALTY IS BREATHING

If an unconscious person is breathing adequately, the heart must be beating, but the pulse must still be checked. Its approximate rate, rhythm and strength should be noted and may give useful information about the casualty's condition. Once placed into a stable side position, the casualty can be examined head to toe for injuries. The next highest priority is to stop bleeding, then to note vital signs (pulse and respiration characteristics, colour and temperature) and finally to deal with any fractures and soft tissue injuries.

· THE GLASGOW COMA SCALE

The Glasgow Coma Scale is used to rate a casualty's level of consciousness. The advantage of using this scale is that it is widely known and enables documentation of observations in an objective manner rather than subjective descriptions of the altered conscious state. This method provides useful information to the next and subsequent care providers in a standard format so a clear picture of the casualty's pattern of conscious state is evident from the time of the first aider's initial assessment. Anything that saves time in commencing medical treatment is valuable, and may be life-saving when casualties are seriously injured.

Glasgow Coma Scale

Eyes open		Best verbal response		Best motor response (test palm of hand or foot)	
Response	Score	Response	Score	Response	Score
Spontaneously	4	Oriented	5	Obeys command to move	6
To speech	3	Confused	4	Localises response to pain	5
To pain	2	Inappropriate	3	Withdrawal to pain	4
No response	1	Incomprehensible	2	Flexion response to pain	3
		No response	1	Extension response to pain	2
				No response	1

A Check AIRWAY

Rationale for techniques

- CLEARING THE AIRWAY

The airway should always be examined and cleared with the casualty on the side. If casualties are lying on their backs, opening the mouth and pulling the jaw forward risks allowing anything in the mouth such as vomit, food or broken teeth to slide back into the airway. Unconscious people may have no 'gag reflex'. This protective reflex is a spasm of the voice muscles at the entrance to the windpipe which normally stops solids or liquids from going into the trachea by accident, thus either blocking the airway or entering the lungs.

An important point to remember when clearing the airway is that only visible material should be scooped out. Using a finger to probe blindly for obstructions may push something back into the airway and block it irretrievably, or may induce vomiting.

- THE AIRWAY STRUCTURE AND FUNCTION

The mouth and pharynx are used as an entry for both food and air. When food is eaten, the larynx is closed off so that liquids or solids enter the oesophagus (gullet) and pass down into the stomach. Rhythmic contractions of the muscles in the walls of the oesophagus push the food along—without these contractions (called peristalsis) it would only be possible to eat or drink with the body upright (think of a giraffe drinking!). Vomiting involves a reversal of peristalsis: the contents of the stomach are pushed out, sometimes quite violently.

When a gas enters the body through nose or mouth, the larynx remains open. This allows the gas (normally air, but the body does not distinguish good air from a poisonous gas such as carbon monoxide) to pass through the larynx, down the trachea (windpipe) and into the bronchi, which are tubes leading to each lung. The bronchi then subdivide into smaller branches called bronchioles, which distribute the air to the alveoli. Alveoli are like bunches of hollow grapes. They are surrounded by a network of many tiny blood vessels (capillaries), and it is here that the exchange of gases with the blood takes place. Oxygen is able to pass through the walls of the alveoli and capillaries into the blood, and carbon dioxide moves from the blood into the alveoli. The haemoglobin (the red colouring) in red blood cells binds oxygen. So when oxygen arrives, the haemoglobin seizes the oxygen and carries

it in the blood to the tissues of the body. About 95% of the oxygen in the blood is transported bound to haemoglobin. The other contents of air (nitrogen, mainly) also pass across from the lungs, but are inert in the body and are breathed out together with carbon dioxide.

Some positions of the head make it more difficult to breathe, especially for an unconscious casualty, by causing the tongue to slide back and block the pharynx. Tilting the head back in an adult enough to open the airway, and moving the jaw forward, helps to unblock the entry. When lying on the back, an unconscious casualty's tongue may obstruct breathing. When the head is tilted back, the tongue is lifted forward with the jaw, and air or oxygen can pass behind the tongue into the trachea.

• INFANTS

Because infants' heads, relative to their bodies, are larger than adults', tilting their heads right back is not necessary. For infants and small children, it is only necessary to tilt the head back to a neutral position in order to open the airway. If an infant's neck is stretched by tilting the head right back, this hyperextension can close the airway.

B Check BREATHING

Rationale for techniques

St John teaches first aiders to look, listen and feel for breathing. It may be possible to see the chest or abdomen rising and falling, but not always, especially if it is dark, if breathing is slow or shallow, or if the casualty is wearing heavy clothing. In cold weather, the breath may be visible, or a small mirror placed close to the mouth and nose may show condensation. Normal breathing is very quiet, but an ill or injured casualty may have noisy breathing, and the type of sound gives clues to what may be wrong. Even when breathing cannot be seen or heard, it may be able to be felt as warmth on the first aider's cheek or the back of the hand, although this tends to be unreliable. Placing a hand lightly on the lower chest or abdomen will also enable the first aider to feel a rise and fall if the casualty is breathing, but both hands may be needed to keep the head tilted and the jaw lifted.

Mechanics of breathing

Ventilation or breathing is controlled by the respiratory centre located in the brain stem *(medulla oblongata)*. Sensors which

monitor and measure the carbon dioxide content of the blood (called chemoreceptors) are located in the respiratory centre and in certain other areas of the body. Changes in carbon dioxide concentration in the blood are detected, and a rise triggers breathing. These chemoreceptors are very sensitive to changes in the concentration of carbon dioxide and normal breathing is a finely tuned activity to keep the concentration at a normal level. When breathing is impaired the carbon dioxide level rises and the rate and effort are increased.

The diaphragm is a sheet of muscle. It separates the chest from the abdomen. The oesophagus passes through it on its way to the stomach. In shape, the diaphragm at rest is a dome. At the beginning of every breath, the respiratory centre in the brain signals the diaphragm, which contracts downwards. At the same time, the muscles around the ribs (intercostal muscles) contract, swinging the ribs up and out (when the person is at rest, the intercostal muscles do not usually participate: their involvement is necessary for deep breathing when exercise increases the oxygen demand). The pressure inside the chest is thus reduced to less than the air pressure outside the body, so that air is drawn in to fill the lungs. The diaphragm and rib muscles then relax, squeezing the air out again. The tissue of the lungs is quite elastic, and able to expand and contract as air goes in and out. This happens about 12 to 15 times each minute in an adult at rest, slightly more often in a child. The younger the child, the higher the rate. When exercising, the body's need for oxygen is increased, and breathing becomes deeper and more rapid. Interestingly, it is not primarily the need for oxygen which triggers breathing, but rather an increase in the level of carbon dioxide in the body.

Expired air resuscitation (EAR)

Air contains around 21% oxygen by volume. In the lungs, some of this is taken out and replaced by carbon dioxide and water vapour. When the air is breathed out again, it still contains about 16% oxygen, and the carbon dioxide content has increased from about 0.4% to about 4%. The nitrogen content does not change significantly; it remains at around 78%. When casualties cannot breathe for themselves, there is thus quite sufficient oxygen in a first aider's 'used' air to supply all that is needed to keep the casualty's brain oxygenated. Expired air resuscitation (EAR) is like blowing up a balloon and letting it down again. That is why it works. The lungs expand so that the ribs are forced out and the diaphragm down when air is blown in, and as soon as the blowing stops, the elastic lung

tissue contracts, the diaphragm and ribs returning to their resting position, so that the air comes out just as it does with natural breathing.

Old fashioned methods of 'artificial respiration' involved pressing down on the back and releasing the pressure rhythmically, or swinging the arms up and around in various ways to draw air in and out. These methods were ineffective because they moved insufficient air in and out to maintain life.

Respiration

When people stop breathing, only about 4 minutes at the most can elapse before brain cells start to be damaged by the lack of oxygen. For about the first minute, the oxygen already in the lungs is able to supply some of the brain's needs. Over the next 3 minutes, the cells begin to starve for oxygen. If none is supplied, the cells will die. Oxygen is so important because the basic process of all life is respiration: this is a chemical process in which carbohydrates (which are chemical compounds of carbon, hydrogen and oxygen) react with oxygen to release energy; the by-products are carbon dioxide and water. We tend to refer to breathing as 'respiration', but breathing is only part of the respiratory process–it is the means by which the body collects the oxygen needed for the chemical reaction. Plants respire too, but green plants have the advantage over animals of being able to perform the reverse process (called photosynthesis): they are able to use energy from the sun to combine carbon dioxide and water into carbohydrates, releasing oxygen into the air as a 'waste' product.

Effect of metabolic rate variations

The rate at which the body uses oxygen and produces carbon dioxide is called the metabolic rate, and the process is called metabolism. If this rate is slow, less nutrients are needed to maintain life. People get fat when they consume more nutrients than are needed: the body takes what it requires for its activities and stores the rest as fat, which can then be removed from storage and processed if the intake of nutrients drops below the amount needed. The body responds to exercise by increasing the metabolic rate, but this also increases heat production, so the sweat glands become very active trying to keep the internal organs cool. Dehydration can be rapid during hard exercise in hot weather, and if the body continues to overheat, the internal temperature may rise out of control (called 'heat stroke'), and cause the brain to 'cook'.

The opposite effect occurs when the body is chilled: a person who is immersed in very cold water uses much less oxygen as the body cools and the metabolic rate slows. Someone pulled from cold water who is not breathing and does not have a pulse, may still be able to be saved even when they have been there for much longer than 4 minutes, because their systems have just about shut down so that they need very little oxygen to stay alive. It is therefore always worth attempting resuscitation on victims of drowning, even if they have been submerged for half an hour or more, just in case they are able to be revived. Several spectacular recoveries after long submersion times have been reported, almost all in children who fell through ice into freezing water, and who were able to be revived with few apparent ill-effects.

C Check CIRCULATION

Circulation ceases if the heart stops pumping blood. Causes may include:

- irregularity of heart rhythm
- massive blood loss
- heart disease or damage
- lack of oxygen, e.g. through not breathing, asthma, drowning or breathing toxic gases
- electric shock
- poisoning.

Goals of resuscitation

Resuscitation techniques aim to preserve life by maintaining an adequate supply of oxygen to the brain, thus preventing irreversible brain damage. Resuscitation must be started immediately. Death or serious brain damage may result after 3 to 4 minutes without breathing and circulation.

Limitations of cardio pulmonary resuscitation (CPR)

Effective resuscitation maintains an adequate supply of oxygen to the brain.

Successful resuscitation restores breathing and circulation (pulse). Consciousness may also return. Successful resuscitation almost always requires further intervention from ambulance or medical personnel trained in advanced life support.

Effective resuscitation may not be successful. The illness or injury is often too great to allow recovery. CPR alone almost never leads to spontaneous restoration of heartbeat; its value is that it maintains enough oxygen supply to the brain to keep the casualty alive until medical assistance is available.

Need for advanced life support

Whenever CPR is given by the first aider, it needs to be followed by special intensive medical care. Medical aid must be called as soon as possible. Unless there is no alternative, the casualty should not be left alone. If nobody else is there or likely to come along (for example when somebody has a heart attack at home, and only the casualty and the first aider are there), it will be necessary for the first aider to make a quick telephone call for help. The important point to remember is that once breathing and pulse stop, every second without circulation increases the risk of brain damage or death.

If CPR is done correctly, enough oxygen will reach the brain to keep it alive until medical aid arrives. In fair skinned people, a visible sign that the first aider is effective is that the casualty's facial skin will return to a more normal colour. If CPR is ineffective, the skin of the face will look bluish-grey or white. In the case of heart attacks, experienced first aiders trained in defibrillation may be successful in restarting the heart.

Defibrillation is the delivery of an electric shock to the heart. In most cases, this is the only way to restart the heart so that it beats by itself in a correct rhythm. Spontaneous recovery is unusual, and is more likely in cases of near drowning or electric shock than in cases of heart attack or poisoning. Defibrillation is most effective when carried out within 3 minutes (around 90% success rate), and its effectiveness decreases with time (after 10 minutes, the success rate is only about 3%). It is vital to get a defibrillator on its way to a non-breathing, pulseless casualty as soon as possible. The time to defibrillation is the key variable in long term survival rates following cardiac arrest.

External cardiac compression

The heart lies under the lower half of the breast bone (sternum) in adults (slightly higher in children), and is angled slightly to the left of centre in most people. The most effective site for compression is on the flat sternum, directly over the heart. It is important to compress in the right place, not only for maximum squeezing effect on the heart, but also to avoid damage to other

body structures. The fingers should be raised to reduce the risk of breaking ribs, and the heel of the hand should be located fully on the sternum. At the lower end of the sternum is a small piece of cartilage called the *xiphoid process*: if this is subjected to sudden pressure, it could break and cause damage to underlying organs. Compressions should be delivered rhythmically, with equal time for compression and release of the chest, to allow blood from the veins to refill the heart between compressions.

The heart's normal pumping action works by contraction of its muscle, which causes blood to be squirted out into the arteries. When the muscle relaxes, blood re-enters the chambers through one-way valves. External cardiac compression cannot compress the chambers as vigorously as the heart's own muscle, but enough pressure is generated to cause some blood flow, and the rhythmic compressions at close to the heart's usual rate can supply enough oxygen to prevent the brain cells from dying. In the case of heart attack victims, this 'buys time' until a defibrillator can be brought to the casualty. The actual mechanism by which external compression causes blood flow has not been determined; the increase in pressure inside the thorax may be the important factor, or it may be that there is enough direct compression of the heart itself to send blood along the arteries. Both theories have their proponents, but from the first aider's perspective, it is only necessary to know that the blood does flow when external cardiac compression is carried out correctly.

Reference:
Australian First Aid
Volume 1,
Chapter 5

2 Shock

Definition

Shock is defined as inadequate blood perfusion of the organs of the body. Perfusion is the passage of fluids through the blood vessels. Shock may be a sudden or a progressive condition depending on the cause. If the cause of shock is not controlled it will eventually lead to organ damage (especially brain and kidneys), circulatory failure and death.

Characteristics

The general characteristics of shock are a reduction in the effective volume of blood circulating (which may be due to either less blood being available or to dilation of vessels), a decrease in blood oxygen levels and/or an increase in waste products in the body. The effects of shock may be progressive; initially the body is able to compensate by speeding up the heart rate and by diverting blood flow to the essential organs, but if the cause is not relieved, the cells will starve for oxygen and toxic metabolic wastes will build up. Irreversible damage may be done to such organs as the kidneys. The combination of hypoxia (lack of oxygen) and toxins will, if not arrested, cause damage or death to the body's cells.

The most common cause of shock is blood loss. However, it may occur as a consequence of serious injuries or sudden illnesses, and should always be anticipated in a first aid incident. Because it is a life-threatening condition, it needs to be dealt with urgently, with only DRABC and control of major bleeding having higher priority.

Some casualties have an increased likelihood of developing shock: these include the elderly or the very young, those with traumatic injuries or who are bleeding heavily, casualties with heart attacks, pregnant women, and those who have injuries

which expose them to severe bacterial infection, such as burns or abdominal injuries. These last will be significant for first aiders only if medical aid is delayed, since these forms of shock develop later and do not usually present for first aiders or ambulance officers.

Types of Shock

The five main categories of shock are hypovolaemic, neurogenic, cardiogenic, septic and anaphylactic .

Hypovolaemic shock is the consequence of a reduction in the volume of blood circulating, most commonly due to major bleeding or fluid loss caused by burns. This type of shock is also caused by dehydration due to vomiting or diarrhoea, or the excessive sweating which accompanies heat exhaustion. It can also occur in people who have uncontrolled diabetes, when sugar builds up in the blood (hyperglycaemia). This causes frequent urination, which can lead to dehydration.

Neurogenic (also called vasogenic) **shock** is caused by a general dilation of the blood vessels, so that the amount of blood in the circulatory system is not enough to maintain pressure in the enlarged vessels. Fainting is an example of this type of shock. When there is a head or spinal injury, the nervous system may not be able to control the walls of the blood vessels, which dilate, causing a sudden drop in blood pressure.

Cardiogenic shock is caused by the heart's inability to pump enough blood around the body to supply the cells with their needs. Most often, this type of shock is the result of a heart attack, but it can also be caused by severe congestive heart failure, or by other conditions affecting the heart.

Septic shock is the result of severe infection. In severe infections bacteria can enter the blood stream and release a number of toxic substances, which are carried as part of the outer coat or envelope of the bacterial wall and are distributed by the circulation around the body. Through several mechanisms, these cause smaller blood vessels to dilate, resulting in a reduction of blood pressure. In addition, such substances cause the release of chemicals which can make the heart contract less efficiently. Casualties in septic shock require urgent referral to medical aid.

Anaphylactic shock classically occurs when certain individuals are rechallenged with allergic substances. The allergen enters the body by means of injection, inhalation or absorption through the skin. The casualty may have a known allergy (for example, to bee stings), or may react to a substance which previously has caused no problems.

On contact with such a substance (allergen), the body may react by initiating a local response with localised pain, swelling, itching and reddening. Alternatively, there may be a generalised reaction which may take several forms, the most serious of which is acute anaphylactic shock. In this situation, the allergen causes the release of 'allergic substances', mainly histamine, which results in general reddening and swelling of the skin and other tissues. The blood vessels also dilate causing a drop in blood pressure. The victim collapses. An acute asthma attack may occur even though the person is not known to be asthmatic. Swelling may occur around the larynx and throat, causing airway obstruction. Urgent medical assistance is required. People with known severe allergies may have medication with them, and should be assisted to use it.

Factors in Severity of Shock

The severity of shock is influenced by several factors. One of the more significant is pain. Pain control is an important part of first aid. Other factors which may aggravate shock are old age, exhaustion, chronic illness, rough handling, delay in treatment, and dehydration. Nausea and vomiting may be both a cause and effect of shock.

Rationale for Management

First aid management is directed towards controlling the cause of the injury and helping the body's own corrective mechanisms. The first priority is to ensure an adequate supply of oxygen, then control of serious bleeding. The casualty is generally placed lying down with legs raised to help get blood to the vital organs, unless there is difficulty with breathing, in which case the conscious casualty is assisted to adopt a comfortable position—usually half sitting. The legs are not raised when to do so would make an injury worse, or when the cause of the shock is a heart problem (cardiogenic). Increased blood flow would put more strain on an

already struggling heart in the case of a heart attack. St John teaches that casualties should be kept warm, but not heated, because active heating would interfere with the body's attempts to direct blood away from peripheral vessels to vital organs. Supporting an injured limb above and below the site of the injury will relieve pain and help reduce the severity of shock. Reassurance or simply staying with the casualty will provide emotional support to help them cope. The objective of first aid management of shock is to prevent the condition from progressing. The best way to do this is to anticipate that there will be shock and to take appropriate action without waiting for visible signs to appear.

3

Reference:
Australian First Aid
Volume 1,
Chapter 6

Severe Bleeding

Consequences of Severe Bleeding

Severe bleeding may lead to shock or death in a very short time, and therefore must be controlled before attending to less serious injuries.

Bleeding can be external from a cut, or internal into one of the cavities of the body, or an organ, or tissues. External bleeding is usually very noticeable, and the amount is able to be estimated fairly accurately. Internal bleeding is more difficult to assess, since it may be concealed. There may not be any obvious signs of injury to the affected part of the body. Internal bleeding into a body cavity or organ is impossible for first aiders to arrest, and may be life-threatening without expert medical intervention. Evidence suggesting internal bleeding may be obtained from the nature of the incident or history of the onset of illness (e.g. the casualty may have had a blow to the abdomen, or have a history of gastric ulcer). The first aider should be alert for indicators such as pain, rigidity of abdominal muscles, air hunger, symptoms of shock or signs of blood in body fluids.

Bleeding from a closed fracture into surrounding tissue may also be very severe, particularly from a fractured femur or pelvis. A fractured femur can cause up to 2 litres of blood to be lost into the thigh very rapidly—an amount which can cause severe shock and threaten the casualty's life. A fractured pelvis may result in even more blood loss, and is more dangerous because the blood loss is less obvious and there is no external swelling. A patient

with a fractured pelvis should be assumed to be bleeding internally in a life-threatening manner, and urgent medical aid should be sought.

The Body's Reaction

When a blood vessel is cut or torn, the body reacts:

- by constricting the cut ends of the blood vessel to reduce blood flow;
- by a general constriction of blood vessels to reduce local blood pressure and thus slow the force of the bleeding;
- by forming a blood clot to help seal off the wound;
- if bleeding continues, by increasing the intensity of blood vessel constriction and increasing heart rate and force of contraction. This maintains the blood supply to vital organs, particularly the brain, at the expense of other parts of the body, such as the limbs and the skin. This reaction is called compensation;
- if blood loss is severe and there is not enough volume left to supply the vital organs, blood pressure drops and the casualty may become unconscious. This is called decompensation.

These reactions are enough to stop some bleeding, but the body will need assistance to control severe bleeding. If bleeding continues, the casualty may die.

Precautions against Cross Infection

Whenever possible, first aiders should protect themselves and the casualty from infectious diseases by washing their hands first, wearing gloves if they might come into contact with body fluids, and washing themselves thoroughly afterwards. These precautions have been well publicised as being particularly important when giving first aid to someone whose health status is unknown, or who is known to be positive to Hepatitis B or HIV (the AIDS virus). However, there are many other infectious diseases which could theoretically be passed from one person to another, from minor nuisances such as a cold to more serious diseases. In cases of severe external bleeding, common sense should prevail, and gloves should be put on as soon as possible without hand washing. Regardless of whether gloves are worn, it is essential to wash the hands thoroughly afterwards; gloves do not provide perfect protection.

Control of Bleeding

Direct pressure

The application of direct pressure over the wound is the most simple and effective way to stop bleeding. To help prevent contamination of the wound, a dressing is placed over the site first, then a pad is used to apply pressure. St John teaches that, if blood continues to soak through the pad, the dressing should be left in place while the pad is either replaced or relocated to a more effective position. Leaving the dressing in place is important, so that any clotting that has begun is not disturbed. If dressings and pads are not immediately available, pressure should be applied with the hands; it may be possible for the casualty to do this while the first aider fetches suitable equipment. Gloves should always be worn (if available) to limit cross infection risks.

Indirect pressure

Indirect pressure may be necessary when:

- the injured area is too large for application of direct pressure
- the injury involves embedded objects (the object itself may help to control bleeding in this case, by 'plugging' the wound)
- the injury is to a bone. Direct pressure on a broken bone would cause a great deal of pain, and could cause further injury.

Pressure points are found where arteries run across single bones, as they do in the groin and upper arm, so that they can be compressed enough to stop the blood flowing. It would be of no use to try to use pressure points in the lower arm or leg, where the arteries run between two bones and are not easily accessed.

Pressure may be applied using the thumbs, closed fist or side of the hand to these points; the artery is compressed against the bone, and blood flow to the site of the injury is reduced enough to allow the body's natural defences to halt the bleeding. It is not easy for a first aider to compress arteries effectively, particularly the femoral artery, and considerable practice is needed to locate the pressure points quickly and accurately. Compression of arteries may be impossible on entrapped or obese casualties. Because the femoral artery pressure point is in the groin, first aiders need to be sensitive to the casualty's modesty and the concerns of bystanders; it is important to explain what is proposed to be done and why it is necessary.

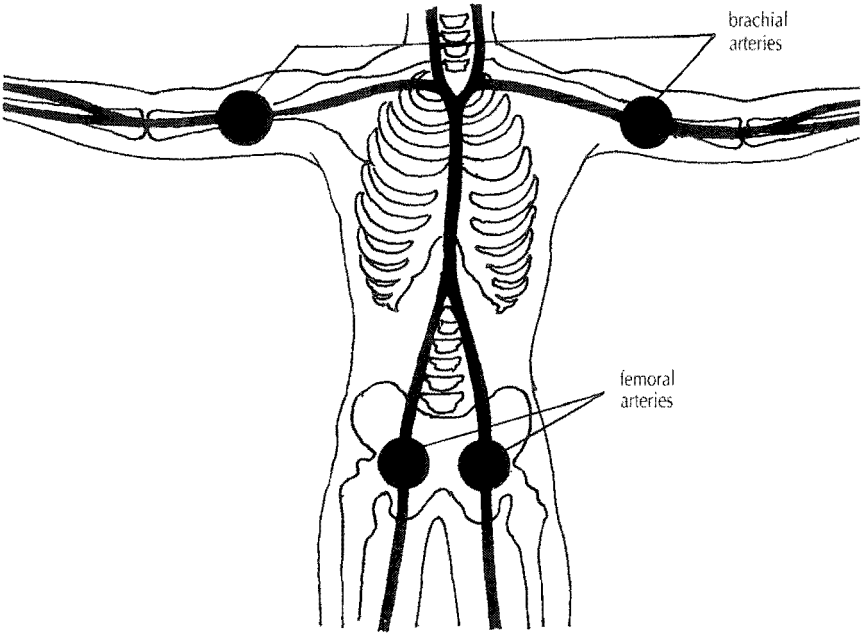

Fig. 1 Pressure points

Compression of the pressure points cannot be maintained for more than about 20 minutes, because the blood supply to the limb is cut off and the whole limb may be damaged by lack of oxygen. However, it should be maintained for several minutes after bleeding slows or stops, to enable clots to form, then gradually eased. If vigorous bleeding recommences, pressure should be reapplied for several more minutes. The process of compression and release should be continued until bleeding is controlled. If an assistant is available, a pad and firm bandage should be applied, then the pressure point should be carefully released, to determine whether the bleeding is controlled.

Constrictive bandage (tourniquet)

Major wounds, such as amputations or crater wounds from shark or crocodile bites, quite often have surprisingly little bleeding. This is due to the body's reaction to such massive trauma: the

major arteries and muscles all around the wound contract in a spasm when the tissue is torn, effectively clamping the blood vessels closed at the site of the injury. By the time the muscle spasms relax, clotting may have occurred.

Sometimes, there is dangerous bleeding from a large wound despite the muscle spasms, and neither direct pressure nor compression of the pressure point can stop it. In this case, as a last resort, a constrictive bandage is applied. The constrictive bandage squeezes the tissue around the whole limb, rather than just the artery, and reduces blood flow both in and out of the limb. Not only does this prevent oxygen getting to the cells, but since all the blood vessels are constricted, toxins cannot get out either. The result, if the constrictive bandage is left on for long enough, is that the limb will die. It must be accepted that in deciding to apply a constrictive bandage, the first aider is prepared possibly to sacrifice the limb in order to save the casualty's life. If the casualty is conscious and rational, this will be the casualty's decision; the first aider will explain what is proposed, why it is proposed and the risks involved. If the casualty is unconscious, the first aider has a duty of care to act.

If a constrictive bandage is used, it is imperative that it be very tight. It is essential that the arterial blood pumping into the limb is stopped by the encircling pressure. If the bandage is too loose, only the veins will be occluded: this makes the bleeding worse. Any time a constrictive bandage is applied, the first aider should write on the casualty an indication (e.g. the letters 'TQ' for tourniquet, or 'CB' for constrictive bandage) in some prominent place such as the forehead, together with the time of application. If this is not done, there is a risk that the constrictive bandage will be overlooked, particularly if the casualty is unconscious and/or has other injuries.

Bleeding from the Neck

Bleeding from the neck presents special problems, because the neck contains not only major blood vessels, but also the airway and the spine, all very close together. Bleeding from the carotid artery, which carries blood to the head, causes the same spurting bleeding as with any artery. There will also be bleeding from blood flowing back down the artery from the head, so both ends of the cut artery must be compressed to control blood flow. The artery can be pressed against the neck vertebrae. The carotid arteries on both sides should never be compressed at the same time; this would cut off oxygen supply to the brain. Care must

also be taken to ensure that the airway is not being compressed.

Bleeding from the jugular vein, which carries blood to the heart from the head, will be profuse but slower than that from an artery. The same method as for the carotid artery is used to stop the bleeding. But there is an additional complication in this case: a risk of air embolism. When the neck veins are open, air may be sucked into the blood stream by the heart's pumping action, and will then travel as bubbles to the heart. If the bubbles are large enough, they may affect the heart's action, or even stop it entirely. It is therefore vitally important to lay the casualty flat, on the left side if possible, and control bleeding from a jugular vein quickly, not only to prevent blood loss but to prevent air from entering.

If the casualty is positioned lying on the left side, air which has entered the vein may be able to be trapped in the right atrium (upper chamber) of the heart where its impact may be restricted.

4

Reference:
Australian First Aid
Volume 1,
Chapter 7

Wounds

The First Aider's Role

First aid is an important link in the chain of management. The drills and skills of first aid are the same whether the operator is a volunteer bystander, a salaried paramedic or a doctor. Most commonly, the first aid phase passes to the transport phase in less than an hour, and sometimes, only a few minutes elapse before ambulance officers arrive. These few minutes are of the greatest importance.

First aid basically 'holds the fort' until professional medical attention is available to the casualty. Prolonged management of serious wounds without medical assistance is only relevant to first aid in a remote setting. However, there will be many occasions when minor scratches, abrasions and cuts will require attention, and when it will be important to be familiar with normal healing processes and warning signs of infection. Parents, school teachers and anyone involved with sport or outdoor activities will encounter minor wounds which may have been seen and treated by a doctor already, but which require regular changes of dressings, or inspection to ensure that all is well. First aiders need to be able to distinguish between normal stages of healing and indications of developing infection, in order to know when further medical aid should be sought.

Objectives of Management Techniques

The goals of wound management are to prevent infection and to promote healing. Wound cleansing is the key to both and must be carried out early and meticulously, especially in remote areas when medical aid will be delayed. This is particularly so for coral cuts and abrasions.

Infection

Infection is the most common complication in wounds. First aiders should, where practicable, clean out as far as possible the dirt and debris which will be contained within the wound as a result of the injury, and take preventative steps to reduce the risk of entry of microorganisms from outside the body.

Whenever the body's protective envelope of skin is broken, even in a minor way, infection is a threat. Signs of infection may appear within a few hours, or not for several days. They include:

- pain at the site of the injury
- tenderness to the touch
- redness and swelling around the wound, or a red streak up the limb
- the area may feel hot
- the area surrounding the wound may feel hard.

The whole body may be affected as the infection gets into the system, with accompanying fever, headaches, irritability and a general feeling of being unwell.

Anaerobic bacteria

Some bacteria thrive in conditions of little or no oxygen (anaerobic conditions). Examples of anaerobic bacteria which may be very dangerous are the bacteria which cause gangrene and tetanus. A dirty wound is always vulnerable to these bacteria, especially a deep one which may have pockets of contamination remaining after the wound has been cleaned. In general, first aiders should not close wounds, especially if in remote areas where it may be some time before the wound can receive medical attention. It is better to keep the wound open with packing, so that oxygen is able to get to the damaged tissue and prevent pockets of dead tissue from acting as a breeding ground for infection; this will not only promote healing but will discourage growth of anaerobic bacteria. It is impossible to clean a deep wound perfectly in the field.

Factors in vulnerability

Wounds on the extremities–lower legs or feet, forearms and hands–have the highest risk of infection. Wounds on the face and scalp, which have an excellent blood supply, have a lower risk. The face and scalp also tend to bleed profusely, even from

minor wounds; bleeding helps to remove contaminants mechanically (but must be controlled in the usual way).

Infection is also more likely in aged people or those with poor peripheral circulation, such as diabetics, smokers, and those who are malnourished or in a cold environment. Some drugs, such as steroids, also increase the likelihood of infection developing in wounds, because they interfere with the body's healing process.

The Healing Process

Inflammation is the first step in healing. Because the heat, redness and swelling of inflammation are normal, it is not easy to identify early infection. However, these signs will persist if a wound is infected, and ease if it is healing.

The heat and redness occur because blood fills the tiny vessels around the damaged tissue, which usually contain little or no blood. This reddens and warms the skin. The blood vessels become more permeable, so that plasma moves into the surrounding tissue. More plasma escapes than can be drained by the lymphatic system, resulting in localised swelling. Various cells with immunological functions are attracted to the injury site, and go to work attacking bacteria and removing dead tissue.

Quite early in the healing process, new skin cells begin to form. Sheets of these cells move across the wound until they meet. With shallow wounds, such as superficial abrasions, this protective cover may be complete in as little as 24 hours, although a full new layer of skin may take several months to mature. This process is called epithelialisation.

New blood vessels begin to form in a wound within about 72 hours, replacing damaged vessels and bringing oxygen to the torn tissue. Until the healing process is well established, the body will continue to make extra tiny blood vessels so that the wound is richly supplied with nutrients. This process is called neovascularisation, and explains why the wound site will continue to look red after the inflammatory stage has passed.

New tissue synthesis is the final stage of healing. Cells called fibroblasts begin to produce connective tissues 48 hours after the injury. The wound is gradually filled with a gel-like material and collagen fibres, which 'knit' the wound together. For the first week or so, this new tissue is very fragile, and can be pulled apart easily. It may take months before the injured area is back to full strength. If a wound has been closed, there will be less connective tissue in the healing process, and hence less of a scar.

Open wounds require more connective tissue for repairs, and will generally have larger scars.

Bones follow the same healing process as soft tissues, but new bone cells instead of connective tissue will be formed. The bone will be weak and vulnerable to further fractures at first, but will eventually make a complete recovery. It is usual for an enlargement of the healing bone at the fracture site (a callus) to be felt, or even seen. This will usually mould back to normal shape over ensuing months. Healing of uncomplicated fractures is usually solid by 6-12 months in adults (a shorter time in children), but it may take up to 2 years for the healing process to be complete.

Factors affecting healing

Blood and nutrient supply are the critical factors in both speed and completeness of healing. Any condition which limits the supply of blood to the wound will slow the healing process. Some factors affecting the rate of healing are:

- age: as the body ages, there is a general reduction in the amount of blood vessels in body tissues
- disease: diabetes is an example of a disease which limits blood supply to surface areas of the body
- compression: when the blood vessels around the wound are compressed, less blood can get to the area. This may be due to too tight bandaging or to excessive swelling caused by infection
- dead tissue in the wound: wounds with dead tissue in them inhibit healing by blocking blood supply and promoting infection
- low blood volume: if there has been extensive bleeding, or if wounds are leaking fluid as happens with burns, there will be less blood available for transport of healing substances to the wound
- malnutrition: a low level of nutrients in the body will slow the process because there will be less left over for repairs after the body has used the amounts essential to maintain life
- oxygen: the more oxygen available to a wound, the faster it heals. At high altitudes, healing is slower due to reduced oxygen levels generally. Hyperbaric medicine (use of oxygen under pressure) has been very successful with healing of difficult wounds by increasing their oxygen supply via the blood
- drugs: some drugs such as the non-steroidal anti-inflammatory agents interfere with healing. Other examples include steroids and aspirin

- malignancy: healing tends to be poor in advanced stages of cancers. Tissues affected by malignancy may be damaged with less than usual force or by more minor mechanisms of injury. Examples include fracture through a tumour deposit in bone or a skin malignancy which affects surrounding wound healing.

5

Reference:
Australian First Aid
Volume 1,
Chapter 8

Burns

Burn injuries may be produced by exposure to hot liquids, flames, chemical agents, contact with hot objects, friction or electricity. The severity of a burn injury depends on the amount of heat applied to the tissues or generated by the tissues, and the duration of application. Prompt and appropriate first aid measures may convert a major or critical burn into a moderate or minor burn injury.

Pathophysiology of Burns

The skin is a complex organ which maintains the body's water, controls body temperature, monitors the environment through nerve endings, protects underlying tissues from trauma and keeps out bacteria. Burns, like any wound, destroy this protective layer, allowing microorganisms to invade the tissues and cause infection; fluid and temperature control are lost, and pain is caused.

The skin consists of an outer layer, the epidermis, overlying a thicker layer called the dermis. Blood vessels, hair follicles, sweat glands and sebaceous (oily) glands are in the dermis. Both layers contain cells able to resurface damaged areas. Three zones are recognised in burned tissue:

- the **hyperaemic zone** which becomes red as a reaction to heat and subsequently fades and heals in a few days
- the **zone of stasis** in which potentially reversible cell damage and blood vessel damage occurs
- the **zone of coagulation** in which the cells (including blood vessels) have been damaged and killed.

Factors in Burn Evaluation

The seriousness of a burn depends on how deep it is and on how much of the body's surface area is burned. As a general principle, medical aid should be sought for any suspected full thickness burn regardless of size or visible damage. Medical aid is advised for partial thickness burns if the burn area is larger than a 20 cent piece, if there is any blistering, or if the burn was caused by electricity or chemicals. Electrical burns may not show much on the surface, but may have caused serious damage underneath. The '20 cent piece' rule does not apply in cases of mild sunburn which may redden a large area of the skin, unless there are also extensive blisters or the casualty shows other signs of being affected by heat. If burns produce more damage than simple redness of the skin, and are more than 10% of the body surface area in an adult (5% in a child or an elderly person), the casualty is likely to need admission to a hospital for treatment. Other factors in evaluating the seriousness of a burn are the location of the burn, the age of the casualty, and any associated injuries such as toxic gas inhalation.

Depth

Burns may be either partial thickness (first and second degree) or full thickness (third and fourth degree).

First degree burns involve only the epidermis, and may be caused by sunburn, scalds of 45-50°C, minor flash burns or friction (as with rope burns). The area is red, with no blisters, painful and tender to the touch. It will usually heal in 5-10 days without leaving a scar.

Superficial partial thickness burns involve the epidermis and the upper layers of the dermis. They are commonly caused by flash injury, spill scalds of 50-70°C, or brief exposure to flame. The area is red or mottled red and white, blistered with copious tissue fluids, painful, and goes white when pressed with colour returning within 2 seconds. The burn heals in 10-21 days, usually with minimal scarring.

Deep partial thickness burns involve the epidermis and much of the dermis. They are caused by scalds of longer duration or temperature more than 70°C, flashes of higher intensity and exposure to flame. The area is dark red or pale yellow, denuded of epidermis with a moist surface, and has reduced pin prick sensation but some touch sensation. The burn takes from 3 to 6 weeks to heal, with significant scarring. To reduce scarring, skin grafting is usually performed.

Full thickness burns involve the epidermis and the entire dermis and can only heal from the edge by skin grafting. They may be caused by flames, contact with hot metal, immersion scalds, strong chemicals or electricity. The area is pearly white or charred, feels dry and leathery, and is pain free.

Fourth degree burns extend into the subcutaneous fat, muscle, and bone. They have a charred appearance with exposed muscle, and are commonly caused by prolonged exposure to flame or high voltage electric current. They require extensive plastic surgical procedures.

Size

The extent of the burn is calculated as a percentage of the body's surface area. The casualty's palm provides a ready reckoner; it represents roughly 1% of the total skin area. Another method of estimating the area burnt is the 'rule of 9s' (Figs 2 and 3). In infants and children, the rule of 9s must be adjusted to take into account that children have (proportionally) larger heads and smaller legs than adults.

Location on the body

Burns of the head and neck may be associated with burn injury to the upper or lower airway due to inhalation. This may be very serious. The airway may be compromised. Burns of the hands and feet limit the ability of a casualty to care for him/herself. Burns of the genitalia and perineal area make bladder and bowel hygiene difficult. All of these, as well as burns over joints, or which circle the limbs or trunk, require transport to medical aid as soon as possible.

Age

Infants and young children have only a small fluid reserve and become hypovolaemic very easily from burns to 5-10% of their body surface area. Morbidity and mortality increase over the age of 45 years for the same area of burn from which a 15 to 30 year old would recover. Pre-existing diseases or associated injuries may cause a smaller area burn to become life-threatening.

Associated toxic gas inhalation

Burns sustained inside a burning room or building may be associated with serious effects from inhalation of the products of

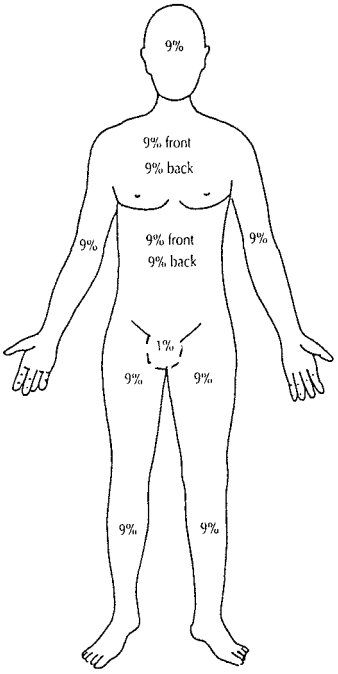

Fig. 2 Rule of 9s (adult)

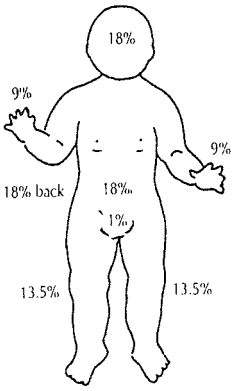

Fig. 3 Rule of 9s (infants and younger children)

Surface Area (Adults)

The body surface that is burnt is very important in determining the seriousness of the burn. An approximate but reasonably accurate estimate of the amount of body surface burnt is determined by the rule of 9s. This rule, which applies especially in adults and older children, divides the body into sections each of which constitutes 9% of the total area.

Surface Area (Infants and younger Children)

In infants and younger children, a considerably greater portion of the body is taken up by the head and the smaller portion by the lower extremities; accordingly, the rule is modified for these casualties. In each case the rule gives a useful approximation of the body surface.

partial combustion of organic materials (carbon monoxide) and/or plastics (cyanide). All such casualties require 100% oxygen as soon as possible, and transfer to hospital.

Rationale for Management of Burns

Cooling

St John teaches that burns should be cooled with running water for at least 10 minutes, or 20 minutes in the case of a chemical

burn. This not only cools the skin but reduces the pain, which can be severe in superficial burns. Thermal damage to the skin and underlying tissues continues for some time after the burning agent has been removed. Cooling also has an important role in limiting the extent of the burnt area by dissipating residual thermal energy. The worse the burn, the less the casualty will experience pain, because deep burns destroy the nerve endings which send signals to the brain. Pain will of course be felt from the superficial burns at the edges of a deep burn. Although pain from a deep burn will be less severe, the severity of shock will increase with the severity of the burn. Overcooling large burns can result in hypothermia.

Remote areas

Running water is more effective than still water as a coolant, but should always be slowly running water so that the pressure does not increase pain. Obviously, if there is no handy tap or water supply is limited, the burn will have to be immersed in whatever water is available. In remote areas, it may be difficult to obtain clean water; all creeks must be assumed to be polluted, and drinking water may not be able to be spared. First aid operates on common sense principles: it is better to use polluted creek water than nothing. Povidone iodine or a similar antiseptic solution from the first aid kit added to a bowl of creek water will kill most germs.

Avoiding the wrong treatment

An old-fashioned remedy for burns was to put butter or other fats on them. The purpose of this was to seal off the wound from the air and so reduce the likelihood of infection, but unfortunately, oils and fats retain heat, and so the effect of greasing a burn is often to make it worse. The other major problems were that butter is not an effective barrier against microorganisms, and it can be very difficult to remove from burnt skin without causing further damage and pain. There are many products available that are designed to soothe burns, some of which are very effective, but St John does not at present promote their use in first aid: it is the medical practitioner's, not the first aider's, job to treat injuries. Once the burn is cooled, a non stick dressing over it will protect it until it can be attended to by professionals; kitchen plastic cling wrap is suitable for this. Anything smeared on the burn will need to be cleaned off by the doctor so that the area can be examined. It is only when dealing with minor burns which will not require medical

attention, such as mild sunburn or a brief encounter with a hot object, that lotions or potions should be applied to the burnt area. The local pharmacist will be able to supply suitable items for this purpose.

Catering for swelling

All burns will cause swelling of the area. For this reason, it is important to remove constricting items such as rings, bracelets or tight clothing at once. Rings in particular may be difficult to remove, even if the finger is not swollen. A little soap rubbed on both the finger and the ring will often enable removal. If a ring will not come off, the doctor may have to cut it.

Special Cases

Burns caused by electricity must always be taken seriously. Even if the casualty appears to be stable after an electric shock or lightning strike, there may be damage which is not visible. Electrical burns should always be seen by a medical practitioner as soon as possible.

Respiratory tract involvement is likely when the casualty was injured in a confined space with hot gases or smoke, or when there are burns to the head and face. The main early danger is that swelling of burned tissue inside the mouth and airway may obstruct breathing. Any casualty rescued from a fire in a confined space is also likely to have sustained a respiratory or inhalational injury. In the case of a fire, poisonous gases such as carbon monoxide are present; death from fires is usually due to hypoxia as a result of carbon monoxide poisoning. **Even if no respiratory distress is apparent, 100% oxygen and urgent transport to hospital are necessary.**

Chemical burns need a longer time under running water than other burns, because the chemical must be flushed away or so diluted that it will no longer be harmful. Burns caused by some chemicals used in industry require specific management, for example hydrofluoric acid (counteract with calcium gluconate gel) and phosphorus (keep covered with a thick wet cloth to prevent it re-igniting). These substances are unlikely to be encountered by the average first aider, and the principles remain the same—cool with copious water and seek medical aid.

Bitumen burns can be particularly nasty. Bitumen stays hot and goes on burning for a long time. It also sticks to the body, so its removal should be left to experts. If the first aider tries to remove it, it will probably pull large lumps of tissue off as it comes free. For this reason, bitumen or tar should be cooled and left in place. If there is a complete circle around a limb, the bitumen should be cracked when cool, so that it will not constrict circulation as the burnt tissue swells.

6

Bone, Joint and Muscle Injuries

Reference:
Australian First Aid
Volume 1,
Chapters 9 to 11

The Skeleton

The skeleton is the supporting framework of the body. It is made up of 206 bones jointed to each other, loosely or firmly attached by means of ligaments. Muscles, which are attached to the ends of the bones by tendons, move the joints. On the ends of the bones and lining the joints is cartilage.

Causes of Injury

Muscles, ligaments and tendons may be injured by being over-stretched, as a result of a fall, or by being struck by something hard. The outcome may be a bruise, strain or sprain. Joints are vulnerable to being forced through a movement beyond their normal range, with resulting damage to surrounding tissues. Bones may be cracked or broken by a direct blow, or by indirect force where the point of impact is some distance from the break (for example, falling on a outstretched hand may cause the collarbone to break).

Fractures

Bones have a good blood supply, and bleed when broken. Whatever caused the break will usually have crushed or cut the surrounding tissues, causing bleeding and leaking of fluid from damaged cells. The area will swell rapidly. Extreme swelling may compress undamaged blood vessels and interfere with circulation in a limb, causing fingers or toes to turn blue as oxygen supply is

diminished. If this happens, the part of the limb distal to the injury (on the side away from the heart) is at risk of dying.

Secondary Damage

Other damage resulting from a fracture may be caused by sharp splinters of bone cutting into the muscles, tendons and blood vessels. The body's response to a fracture is to clench hard all the muscles around the break. This reflex may be helpful in reducing bleeding after an amputation, but in other cases, the muscle spasms may grind the broken bone ends together; or if the fractured bone is displaced, the hard ends burrow into soft tissue. Any movement is also likely to cause further damage.

Fractures of the Limbs

It must be remembered that a fracture is only one component of the injury. Other components include skin, soft tissues, muscles, ligaments or other organs, and in the case of rib fractures, the lungs.

Rationale for management techniques

First aid for a fracture is directed towards keeping the injured part still and providing support for it. Unless the joints above and below are immobilised, a fractured limb will still be able to move. In urban areas, where help is available quickly, a broken leg is sufficiently immobilised and supported by being secured to the uninjured leg. In remote areas, where medical aid is some hours away, splints are more effective at keeping the leg still, and much more comfortable for the casualty. Padding is needed on splints to prevent pressure on bony areas such as knee or ankle. Broad bandages are used to secure splints in order to avoid the 'digging in' effect of narrow ties such as string or shoe laces. If there is no other means of tying a splint than string or shoe laces, some padding should be placed between the tie and the casualty to distribute the pressure.

Traction

If the fractured leg is being tied to the other leg, the feet should be tied together to help prevent the muscle spasms from pulling the broken bones against each other or into soft tissue; as long as the uninjured leg is kept straight and still, this will provide

'passive traction'. Advanced first aiders use traction splints to counteract muscle spasms and keep the bone ends aligned, but the usefulness of traction is limited to midpoint fractures of long bones; it cannot be used for a joint or near-the-joint injury, because the joint would pull apart and cause more damage.

Reduction of fractures

St John teaches that no attempt should be made to put fractures back into place, that broken bones should only be immobilised and supported. This applies even to little ones such as fingers or collar bones. Reduction of fractures–realigning displaced bones–is not a task for first aiders; this is a job for medical experts. Broken bone may have penetrated a major blood vessel, so that pulling it free might be like pulling the cork out of a bottle. There might be a sharp end lying near an artery or nerve, ready to cut it as soon as the bone is moved. Jagged ends may not slot together in their proper position, crunching fragments which an expert could have used to help with the repair. There may be tiny chips of bone or torn tissue which get caught between the ends as they are pressed together, leading to infection, poor healing or a need to re-break and re-set the bone later. However, it is appropriate for a first aider to straighten very slightly a fractured limb if there is no distal pulse and medical aid is not expected for half an hour or more, since more damage will occur if the limb is left without a blood supply than the first aider is likely to cause by moving it carefully.

Fractures of the Trunk

Management objectives

Broken bones in the trunk are less accessible than those in the limbs. St John teachings are aimed at preventing secondary damage and keeping the casualty as comfortable as possible until medical aid arrives.

Pelvis

If the pelvis is broken, the casualty probably has other injuries caused by a fall or crushing. Supporting the casualty with rolled blankets on either side, or placing broad bandages around the pelvis, helps the casualty to overcome a horrible feeling that his or her body is coming apart, and reduces pain. Having the knees

bent takes the strain off abdominal muscles. Generally, if a casualty with a pelvic fracture can still control the sphincter, it is advisable to refrain from urinating just in case the urethra is torn and urine escapes into the abdominal cavity. In practice, it is quite likely that the bladder will have 'let go' already. First aiders should reassure the casualty that this is a consequence of the injury and nothing to be embarrassed about.

Ribs and sternum

Fractures of the ribs or sternum may be accompanied by bleeding into the chest cavity. The positioning of the casualty—half sitting, inclined to the injured side—serves two purposes. Firstly, it is easier to breathe with the upper body raised a little. Secondly, this position allows any blood and fluid to percolate to the bottom of the chest cavity on the injured side, keeping the lung on the uninjured side as free as possible from interference.

Soft Tissue Injuries

Bruises

Bruises are common, and are usually minor injuries. When a part of the body abruptly meets something which is hard but not sharp enough to cut the skin, some underlying capillaries and cells are mashed, so that blood leaks at the injury site. The area swells and goes bluish black, then after a few days gradually becomes pink, yellow, brown and green as the fluid is reabsorbed and the swelling subsides. Immediate application of cold causes the surface blood vessels to constrict, thus reducing the amount of blood escaping from the damaged vessels and helping to prevent swelling. Severe bruising requires rest, ice, compression and elevation (RICE strategy).

Bruising is important to the first aider in assessment of the casualty. It may indicate underlying injury, which should always be suspected until proven otherwise. The first aider should obtain a history of the incident to assess this possibility, and should watch the casualty carefully for any signs of injury masked by the bruise.

Haematomas

A haematoma is caused by a similar blow to a bruise, but a larger blood vessel is damaged so that quite a lot of blood may accumulate at the site. Swelling is often severe and rapid, and can

be dangerous since it may interfere with distal circulation or conceal underlying injuries. There is also a risk that the pressure on the skin over the haematoma may prevent oxygen supply, and cause an area of skin to die.

Haematoma in an area such as the thigh, hip or back, where there are very large blood vessels, may cause so much blood loss that the casualty may develop shock. In the neck, the swelling may obstruct breathing. For a large blood vessel to have broken, the force must have been considerable, so underlying fractures should be suspected. The injury should be inspected by professional medical personnel. An X-ray may be necessary for accurate diagnosis.

Strains, Sprains and Dislocations

Strains

Muscles and tendons are designed to stretch. If they are stretched past their elastic limits, the resulting injury is a strain. There may be some bleeding within the torn tissues, and swelling of the area. The casualty may report a sudden sensation of 'something giving way' and pain on stretching. RICE protocol will reduce the effects of the injury, and mild exercise within the limits of pain will promote healing. The casualty should be warned that exercising should stop at once if pain occurs.

Strains may also be caused by rapid, repetitive movements, for example in guitar playing or typing, or the classic 'tennis elbow' which may result from a variety of sports (not just tennis). Management is similar to that for acute strains—the activity should stop. Rest, ice, compression and elevation should be applied, and mild exercise should be taken over the next few days unless it causes pain.

Sprains

Sprains are injuries to a joint, caused by forcing the joint through a movement beyond its normal range. Damage is caused to ligaments, muscles and sometimes the joint capsule. Falls and sporting accidents are the most likely causes. Depending on the extent of damage, sprains may be relatively minor inconveniences or serious injuries. It is often difficult to distinguish between a sprain and a fracture, particularly at the wrist and ankle where there are numerous small bones. Some sprains may require surgical repair.

Pain when the joint is moved through a range of passive

movements indicates that there may be serious damage to the joint structure. If the joint is unstable or there is severe pain, the injury should be managed as a fracture; otherwise, rest, ice, compression and elevation will control swelling and promote healing. Medical attention is advisable for all cases of joint injury, including fairly minor sprains, due to the risk of long-term disability unless correct and often complex treatment is applied.

Dislocations

Dislocations are similar injuries to sprains, but in this case, joint ligaments are severely torn and the ends of the bones have been forced right out of the joint. Dislocations always involve considerable damage to the soft tissues in and around the joint. The displacement is quite obvious. In general, dislocations are managed as fractures of the joint and immobilised in the position found.

St John teaches that first aiders should not attempt to put a dislocated joint back into place. Fractures and damage to nearby nerves or blood vessels frequently accompany dislocations, so that reduction by other than a trained expert could cause serious damage. There are some people whose shoulder or finger joints 'pop out' quite easily and who will cheerfully put it back themselves. Except for these, dislocations should be regarded as serious. As blood vessels and nerves pass across joints in the limbs, they lie very close to bones; a bone end which is moved out of its normal place can very easily pinch an artery or nerve, either on the way out or on the way back into position. Even a little dislocation, such as a finger joint, should not be reduced in normal circumstances by a first aider (finger joints sometimes 'pop' back into place by themselves, and may then be managed as sprains).

As with fractures, the circulation may be cut off by a dislocation, so that the first aider can find no distal pulse. In this case, the fingers or toes may feel cold and be going white or blue. If medical aid is not likely to arrive within about 20 minutes, the first aider should very gently move the limb a little bit, and check again for the pulse. Once a pulse has been located, the limb may then be immobilised in position. If, even after the limb has been moved, there is still no pulse, the first aider should not persist; the dislocated bone is probably clamping the artery, and further movement may clamp it tighter instead of releasing it. A little blood may still be getting through to the limb, even though a pulse cannot be felt. In any case, there is nothing more a first aider can do to help. Expert medical assistance is needed.

Head and Spine Injuries

Structure

The brain is well protected inside the skull. The **cranium** is the bony outer covering, which can absorb a considerable impact. Under the cranium are three layers of tissue called the **meninges**, which enclose and protect the brain. Damage to the meninges can cause haematomas, which can be fatal in the confined space. The **cerebrospinal fluid** is a clear, straw coloured fluid which fills the spaces between the meninges and surrounds the brain and spinal cord. It contains nutrients for the brain, and is a shock absorber to protect the brain from damage if the head receives a blow.

The brain is made up of three main parts:

- the **cerebrum** is the largest part of the brain. It controls functions such as thinking, learning, emotions and feeling, as well as voluntary movements of skeletal muscles
- the **cerebellum** lies under the cerebrum at the back of the skull. Its functions are control of balance and voluntary muscles, and coordination of movement
- the **brain stem** is at the base of the skull, where the brain joins the spinal cord. It controls the non-voluntary functions, such as breathing and circulation.

The spine consists of the spinal column (vertebrae), the spinal cord and the supporting ligaments which hold the vertebrae in place. Between the vertebrae are discs made of cartilage, which act as shock absorbers and stop the bones from rubbing against each other. These discs deteriorate with age, so that older people are more likely to suffer from chronic back pain and are more vulnerable to back injury.

The spinal column consists of 33 vertebrae altogether: 7 cervical (neck), 12 thoracic (chest), 5 lumbar (lower back), the sacrum (5 fused bones in the pelvic area) and coccyx (4 fused tail bones).

The spinal cord is a continuation of the brain, extending from the brain stem to the upper lumbar region of the spine. Like the brain, it consists of a central core of grey matter, which contains nerve cells for spinal function, and an outer layer of white matter, which carries messages to and from the trunk and extremities. Meninges and cerebrospinal fluid surround the cord, which occupies most of the space in the hollows of the vertebrae

and is therefore vulnerable to damage if the spinal column is injured.

The ligaments around the spine provide support and help to stabilise the structure. The upper cervical vertebrae in particular are quite mobile (necessary, because the neck must be flexible if the head is to have a good range of movement). The ribcage and surrounding muscle groups help to support the thoracic spine.

From the brain and spinal cord, nerves radiate out to the rest of the body. At each level of the spinal column, nerves radiate in pairs, one to each side of the body. The nerves receive messages which are sent to the brain for interpretation (such as sensations of heat or pain). The brain sends back messages which enable muscles to move or organs to react.

Head injuries

SKULL

The diagnosis of head injuries can be very tricky, and a fractured skull is not always obvious. The big problem is that the head is almost entirely encased in bone, so that when leaking blood or fluid from an injury causes the tissues inside it to swell, there is no room to swell. When the fracture is open, this fluid may be able to escape, and depending on which part of the head was injured, some may emerge through the nose, ears or around the eyes. If the base of the skull is fractured, cerebrospinal fluid may leak from the ears. St John teaches first aiders not to plug an ear from which blood or fluid is leaking, but to cover it lightly to protect against dirt, and position the casualty lying horizontal with the leaking side down. This enlists gravity to assist the fluid to escape.

St John also teaches that after a blow to the head or a fall which causes the casualty to lose consciousness, the casualty should see a doctor even if there are no apparent after-effects. These casualties may experience ongoing problems with concentration and memory. Even though they may appear well, they need supervision and observation in a hospital or another supervised environment. There is a small, but definite, risk that such casualties may develop intracranial compression due to blood slowly accumulating inside the skull; they need special counselling about detecting the indicators of increasing intracranial pressure, or admission to hospital for observation.

FACE

Facial injuries may include fractures to the nose, jaw or bony orbits of the eyes, broken or lost teeth, dislocated jaw, or lacerations and bruising.

Facial tissues are richly supplied with blood, and even a fairly small injury may cause dramatic bleeding. The immediate danger is that blood in the mouth or nose may run back into the airway, or bits of broken bone or teeth may cause an obstruction. Facial injuries are also often associated with injuries to the head and cervical spine.

From the casualty's point of view, injuries to the face are likely to provoke an emotional reaction as they carry the threat of visible scarring and disfigurement. Wounds which would be considered insignificant on some other part of the body are often treated as more serious when they occur on the face, not from a medical but from a social perspective. First aiders need to be aware of the social connotations of facial injuries, and to be emotionally supportive towards the casualty.

The general priorities are to keep the airway clear and open, and to prevent secondary injuries. St John teaches that teeth which have been knocked out should be put back if they can be found. It is worth searching for a lost tooth, because swift replacement will often mean that the tooth re-sets itself in its socket, and even if it does not, it will be in the best place to preserve it until a dentist can attend to it, which may mean a full recovery.

It is no longer recommended that fractured or dislocated jaws be immobilised with a bandage tied around the head: the bandage holding the jaw closed may make breathing difficult, and the casualty is usually quite capable of supporting a broken jaw in place until medical attention can be reached. If the casualty is unconscious or otherwise unable to support the jaw, padding may be used to support it until medical aid arrives. In this case, the first aider should not close the casualty's mouth, and must take care that the airway is not blocked.

If the nose is injured, it will usually bleed profusely. If a head injury is suspected, the flow of blood or fluid should not be arrested. Otherwise, the injury is treated like other open wounds. A closed injury may cause swelling and airway obstruction. Cold will help to inhibit swelling and reduce pain. Foreign bodies jammed in the nostrils should not be removed by a first aider. Medical practitioners have both the training and the tools to remove foreign objects without further injury; first aiders have neither.

Gravity drainage might be vital, if there is bleeding from the mouth or nose or fractures in these areas. A conscious casualty placed with the face downwards will be able to breathe quite easily despite extensive facial injury. Such a casualty placed on the back may well suffocate and die.

EYE INJURIES

Most eye injuries are obvious and painful. However, if the casualty is unconscious, eye injuries can be overlooked. The first aider's examination should include:

- the casualty's ability to see; check for blurring or double vision (but if there are vision defects, also ask if the casualty usually wears glasses or contact lenses—the defect may be normal for the casualty!)
- the bony orbits; check for red discoloration (ecchymosis), swelling and cuts
- the pupils; check size, response to light and whether they are equal
- the eyeballs; check for cuts, bruises, impaled objects or protrusion
- the inner surfaces of the eyelids; check for cuts or foreign objects.

If the casualty is wearing glasses or contact lenses, they should be removed (by the casualty). One point sometimes overlooked by first aiders is that a casualty who normally wears glasses will find it stressful to have them taken away: this adds to the feeling of being helpless and not in control. The glasses should be given to the casualty to mind if possible, or if the casualty is unconscious, they should be placed somewhere nearby where they will not get broken or forgotten when the casualty is transported to a medical facility.

St John teaches that generally, when one eye is injured, both should be covered. This is necessary because it is impossible to move one eye without the other moving. An injured eye must be kept as still as possible to prevent further damage. Covering both eyes makes it easier for the casualty to avoid automatically moving the uninjured eye to look at something or someone, thus also moving the injured eye. The first aider should make a point of talking to a casualty whose eyes are covered, to reassure him or her that someone is still there.

Some casualties may find it terrifying to have both eyes covered and may protest strongly. In this case, reducing the casualty's agitation is important, so the first aider could cover just the injured eye, and immobilise the head with sandbags or a rolled towel. The casualty should then be asked to fix the eyes on a particular point straight ahead; this will stop eye movement. The first aider should then be careful to stand directly in front of the casualty when speaking, so that the eyes do not automatically turn to the sound.

Spinal injuries

If the spinal cord is damaged, it will not repair itself. Like the brain, its cells are not renewed. The cervical spine, because of its anatomy, is particularly vulnerable to injury. Fracture or dislocation of the bones can cut the cord or pinch it and damage nerves. The head is quite a heavy object for the neck to support, and a blow to the head or a violent movement (such as the 'whiplash' caused by a sudden stop in a car accident) may mean that it is beyond the strength of the supporting ligaments to keep the vertebrae aligned. Neck injury may occur as a fracture of one or more vertebrae, as a dislocation, or a sprain of the ligaments.

Damage to the spine will interfere with the body's communications system. No messages will be received by the brain or sent to the area served by the nerves below the injury, so that those parts of the body will be paralysed and without sensation. In giving first aid to a person with a spinal injury, it is important to examine paralysed parts very carefully for injury, since the casualty will be unable to feel pain.

First aid management of suspected spinal injuries is to ensure that the casualty can breathe—damage to the cervical spine may compromise breathing because the phrenic nerve which stimulates the diaphragm runs from the cervical spine—then to make sure no further damage is caused by movement. If the cervical spine is injured, there is often a head injury, so injury to the head should alert the first aider to the possibility of spinal damage. However, head injury is unlikely to accompany injury to the thoracic or lumbar areas of the spine.

For all spinal injuries, swift immobilisation is the highest priority. If medical aid is nearby, as it is in urban areas, placing something fairly solid such as rolled coats on either side of the casualty's head will prevent movement of the neck, which is important for any spinal injury. Sandbags would be ideal, and may be able to be made up if the accident occurs at a beach. If the casualty is conscious, the best position is lying flat on the back (supine). If the casualty is unconscious, it is essential to place him or her into a stable side position to protect the airway, but extreme care is required to maintain alignment of the spine and so avoid aggravation of the injury.

Proper immobilisation of a cervical spine injury requires application of a cervical collar. This is quite difficult to do without moving the head or neck; considerable practice is necessary. If a casualty has an obvious broken neck, e.g. with the head at an unnatural angle, the head and neck would have to be realigned in order to put the collar in place. This is a task best left for medical experts: the first aider should immobilise the casualty as

far as possible, in the position found. Supports should be placed around the head and neck (coats, cushions or blankets will do), and the casualty should be warned not to try to move.

As with other fractures, the muscles around a fractured cervical spine will be in spasm. If there are extensive spasms, it may not be possible to put on an effective collar, in which case packing supports on either side of the head and neck will be all that the first aider can do. The muscle spasms will provide partial support, splinting the spine into its abnormal position and helping to prevent movement which might cause more damage.

When placing a cervical collar on a casualty, two first aiders will be needed. One first aider must support the head in alignment with the neck, while the other positions the collar. Head support must not be released until the collar is in place and secured. A collar of the correct width pushes the head up all around, very slightly stretching the neck (inducing traction), which helps to prevent secondary injuries. Many collars, especially improvised ones, will not completely prevent movement of the head, but the presence of the collar will help to maintain the casualty's (and bystanders') awareness of the importance of not moving. Once the collar is in place, the rest of the casualty's body should be immobilised on a firm surface before being transported. Whole body immobilisation is also required for thoracic or lumbar spinal injuries. 'Log rolling', with very good support to stop any twisting or flexing of the thorax or lumbar region, should be used by first aiders if moving the casualty is essential.

7 Medical Conditions: Emergencies

Reference:
Australian First Aid
Volume 1,
Chapter 14

Anaphylaxis and Severe Allergic Reaction

The term 'allergy' covers a wide range of diseases associated with the immune system. The process by which the body identifies and eliminates foreign substances to which it is allergic, called **antigens**, is complex. Normally, the immune system identifies antigens and quietly eliminates them without fuss. An allergy is a dysfunction of the immune system: in an allergic reaction the response to an antigen causes an often violent reaction which is harmful to the body. The body is said to be **hypersensitive** to the substance which causes the reaction.

Substances (antigens or allergens) which cause an allergic reaction are many and varied, from pollens to cut grass to cats to foods to insect or animal venoms. The reaction itself may be mild, causing a rash, hay fever or a localised lump on the skin. Some people may feel sick or get a headache from eating specific foods. A person subject to asthma may get a mild or severe attack. The reaction may also be extreme and life-threatening.

Anaphylaxis is an extreme allergic reaction. It may result in lowered blood pressure and hypovolaemic shock, as well as other dangerous physiological reactions such as bronchospasm which inhibits or even totally prevents breathing. It can also cause severe soft tissue swelling of the upper airway resulting in airway obstruction. Its sudden onset is a medical emergency, and the casualty's survival may depend on early recognition and prompt management. The reaction occurs when a substance is

encountered more than once by inflammatory cells in the body, which sensitises itself to further exposure.

Mast cells are found throughout the body's connective tissue, and are numerous in the skin, respiratory system and digestive system. **Basophilic leucocytes** are found throughout the circulatory system. When the body first encounters the antigen, antibodies are produced which attach themselves to the mast cells and basophilic leucocytes. Next time the substance enters the body, the antigen reacts with the antibodies on the surface of the cells, which causes them to release chemical substances (mediators). The mediators affect the body's systems so that:

- blood vessels become more permeable, and fluid leaks out causing swelling, which may prevent breathing as the tissues around the airway become involved
- blood vessels dilate, causing a sometimes very rapid drop in blood pressure which leads to shock
- smooth muscles contract. This affects both the respiratory system (like an asthma attack) and the digestive system, and in the former may cause mechanical obstruction of the airway.

Other, less serious reactions occur. The eyes and nose may be swollen, sore, red and runny. The casualty may feel sick and have abdominal cramps, vomiting and diarrhoea. The skin may be red, itchy or feel a burning sensation. Pelvic cramps may occur in women due to the involvement of the smooth muscle in the uterus. The chest may feel tight, and the casualty may cough or wheeze.

Generally, if the symptoms occur rapidly, this is an indication of severity. All of the body's systems are not always affected; most deaths from anaphylaxis occur when the respiratory and/or cardiovascular system is involved. Symptoms develop quickly, often within a couple of seconds of encountering the dangerous substance; they may last for just a few minutes or for several hours.

Individual responses vary, and the respiratory and circulatory systems are not always affected. The first aider's major concern is to keep the airway open and get medical help. If the casualty knows about their sensitivity, it is possible they will be carrying an inhaler or a self-injector which contains adrenalin. The first aider should assist them to use it quickly, before the mouth, tongue and larynx swell and block the airway.

Disorders of Breathing

Asthma Attack

In an acute asthma attack, the smooth muscles of the bronchi contract, excess mucus is secreted into the airway, and the airways become inflamed and swollen. The airway is thus obstructed, with breathing out being more difficult than breathing in (although some say it is breathing in which is more difficult). The feeling of being unable to breathe may cause the sufferer to keep gasping in more air, and the lungs may become overinflated. If the airway is severely obstructed for a long time, the muscles will become very fatigued and there will be poor gas exchange in the lungs, resulting in low levels of oxygen in the blood. Prolonged, severe asthma attacks may be fatal.

Asthma is a common condition; Australia at present has the highest recorded incidence of asthma in the world (nobody knows why). Most asthmatics are aware of their condition and are likely to have medication with them. St John teaches that first aiders should assist someone (if necessary) to take asthma medication. The usual medication is a bronchodilator in a 'puffer' (a metered dose inhaler), which delivers measured doses and is used by pressing the container and breathing in at the same time. Unfortunately, this can be very difficult for some to do in the middle of an asthma attack, since the coordination required may not be possible. If the casualty is unable to administer his or her medication, the first aider can help by squirting the 'puffer' several times into a spacer. If a commercial spacer is not available, any suitably sized tube can be used (the inside of a toilet roll is just the right size). The medication is squirted into the tube, covering one open end (with the hand is enough), and allowing the asthma sufferer to breathe in from the other end. There will usually be enough inhalant in the tube to give some relief, so that the coordination required to use the puffer will now be possible.

Although the causes of asthma are many and varied, a factor in triggering an attack may be physical (or less commonly emotional) stress. Exercise-induced asthma is common in children, whilst a traumatic incident, such as a car accident, may cause a reaction which results in an asthma attack in some people. The attack itself induces anxiety and may be helped by relieving tension in the casualty. First aid management concentrates firstly on assisting with medication, but it is also important to help the casualty into a sitting position (the easiest

position for difficult breathing), to be reassuring, and to encourage him or her to relax and breathe slowly and deeply. People with well controlled asthma who experience an acute attack which does not respond rapidly with their usual treatment should be referred to medical aid, preferably by ambulance. Virtually every ambulance service in Australia carries salbutamol, the key medication for asthma, which is administered through an oxygen driven nebuliser.

Choking

When a foreign object, most commonly food, enters the larynx instead of the oesophagus, an automatic spasm stops it from going any further. The reaction will be to cough, which is usually enough to eject the foreign object into the mouth. However, sometimes the object becomes jammed, so that the airway is partially or wholly blocked. It is quite unusual for the airway to be completely obstructed, but even partial blockage is terrifying for the casualty. First aid techniques are directed towards helping the casualty to be calm and to use the body's own mechanisms for getting the object out.

Coughing is a very effective mechanism for removing an airway obstruction. The muscles in the throat close the airway, then the diaphragm is contracted sharply, causing a small 'explosion' of air from the lungs to be expelled. The more air there is in the lungs, the more vigorously one is able to cough. The only recorded adult deaths from choking have been in cases where the casualty was either affected by alcohol or obese.

If the choking object was inhaled at the beginning of an intake of air, particularly if the airway is wholly blocked, the casualty may not be able to generate enough force by coughing to expel it. In this case, blows to the back, timed to coincide with an attempt to cough, increase the force and will usually be enough to dislodge the offending object. Placing the casualty head down adds the support of gravity to the coughing and back blows. This position also lessens the risk of reinhaling the object if it comes free and the casualty promptly takes a huge, glad breath!

If back blows alone have not succeeded in dislodging the object, lateral chest thrusts may be tried. This involves applying pressure to the rib cage under the armpit, and provides maximum sustained pressure within the chest cavity. The technique will vary slightly according to whether the casualty is upright or lying down. When alternated with back blows, which provide maximum explosive pressure in the chest cavity, even a difficult object is usually able to be cleared from the airway. If even this

does not work, and the casualty is unconscious and not breathing, the first aider must attempt expired air resuscitation (EAR), since it may be possible to blow some air past the obstruction (this is not very likely to succeed, but as a last resort it is worth trying).

St John teaches that first aiders should **not** manage choking by any form of abdominal thrust (also known as the Heimlich manoeuvre). The principle on which abdominal thrust techniques are based is that sudden pressure applied round the middle of the body squeezes its contents, increasing pressure in the chest cavity and acting much like a cough to expel an airway obstruction. These mechanisms cannot work unless there is a total airway obstruction causing an airtight seal. Without this there is little rise in pressure. Because the rescuer is using the full strength of the arms to squeeze, the direct pressure will be high. In order to direct the force upwards, rather than just round the middle or downwards towards the pelvis, the fists are clenched together above the navel, the rescuer stands behind and jerks strongly, in and up, so that the hands sink into the soft belly.

There are several problems with abdominal thrusts. Firstly, abdomens which are fat or pregnant are hard to 'landmark' for hand placement, and the target area being rounded, the hands may slide when jerked, thus applying the pressure directly over an abdominal organ, which may rupture. The foetus is also at risk in a pregnant woman. Secondly, if the casualty is taller than the rescuer, it is difficult to direct all the force upwards, so that again there is a risk that internal organs will be damaged. Attempts at abdominal compression such as the Heimlich manoeuvre may expel stomach contents into the pharynx (many casualties are eating at the time a choking incident occurs). The vomitus may be inhaled into the lungs when the obstruction is dislodged, causing further problems. Apart from a few anecdotal reports, there is no research evidence to support the use of abdominal thrusts as being equal to or better than lateral chest thrusts, which do not risk damaging the casualty and are therefore preferable.

Disorders of Body Chemistry

Diabetes Mellitus

All carbohydrates and some proteins are reduced to glucose when digested. The glucose is stored in fat cells, in muscle and in the liver. In the brain, there is virtually no stored glucose, and a constant supply must be maintained in the blood to service it. The amount of glucose in the blood is regulated by insulin,

which is produced by **beta cells** in the pancreas. The beta cells are contained in structures called **Islets of Langerhans**, which as the name suggests, are like little spherical islands in the pancreas.

Normally, the pancreas produces a continuous, steady amount of insulin, with a larger amount being produced when needed (for example, after a meal there will be increased production). A high level of blood glucose stimulates the beta cells to produce more insulin, and a low blood glucose level inhibits insulin production.

Insulin works by enabling glucose in the blood to enter the body's cells, increasing both the oxidation of glucose and conversion of glucose by the liver into glycogen for storage. It also helps move amino acids into cells, promotes synthesis of protein, and assists storage of fats by preventing them from being broken down for energy. Until the level of insulin in the blood drops sufficiently, stored glucose is unable to be released from the cells into the blood stream. If there is too much insulin in the blood, the body will be unable to maintain the minimum level of blood glucose required to service the brain.

Insulin acts like a gatekeeper, helping glucose molecules cross from the blood into the cells, and not letting them out again. If there is not enough insulin in the blood to remove glucose molecules, the blood sugar level will be too high, and the kidneys will work overtime frantically trying to reabsorb it. At the same time, body cells which need glucose for their functioning will not be able to access it, even though they are surrounded by it, because only insulin can pass it through from the blood. Picking up the signals generated by the deprived cells, the pancreas tries to compensate by having its alpha cells produce a hormone called glucagon, which stimulates the liver to release some of its stored glucose into the blood stream. This, of course, only raises the blood glucose level higher, without getting the glucose to where it is needed. Eventually, there will be more than the kidneys can reabsorb, and glucose will be excreted in the urine, along with water and salts, in an attempt to flush out the excess. The result may be dehydration, thirst and fatigue; the blood sugar level will remain too high unless food intake is halted, and the body begins to break down fats, releasing ketones into the blood stream.

The long-term consequences of insufficient insulin include kidney damage, stroke and eye damage. Circulation to the extremities, particularly the feet, may be poor, and wounds may be slow to heal.

Diabetes mellitus, a condition in which the pancreas cannot produce enough insulin to meet the body's needs, has two types.

Type 1 diabetes means that the person is dependent on insulin injections. The condition used to be called 'juvenile diabetes' because it is usually acquired when young. Such people have an inadequate number of islet cells to produce the required amount of insulin. The cause is unknown but there are familial and genetic predisposing factors. People with Type 1 diabetes must inject insulin every day to stay alive and healthy.

Type 2 diabetes occurs primarily in adults over 45 yeas of age who are obese. Diet regulation, exercise and losing weight may be sufficient to control this type of diabetes. In Type 2 diabetes, the pancreas is continuing to produce insulin, but either there is not enough, or the insulin produced does not work as well as it should. The tablets taken for Type 2 diabetes are not insulin; they contain chemicals which either stimulate the pancreas to produce more insulin, or make the insulin more effective in transporting glucose across cell walls by enhancing the sensitivity of the receptors in the cells which recognise insulin and react to its presence.

Hypoglycaemia

Because people with diabetes, particularly those with Type 1 diabetes, depend on an external means of controlling blood sugar, anything which causes a sudden change in their metabolic rate will affect their sugar levels and require active management. The most common problem is a sudden drop in blood glucose level (**hypoglycaemia**). This may be caused by:

- too much insulin. If a diabetic person injects insulin, then forgets to eat, the insulin will take too much glucose out of the blood stream, and organs which do not have a good storage supply, most importantly the brain, will starve for glucose. It is also possible to inject an overdose of insulin;
- exercise. During strenuous exercise, insulin supply is normally suppressed, and glycogen stores are used to replenish blood glucose used by the activity. Diabetic people who take insulin have a constant amount in their blood, so that utilisation of glycogen from the liver is inhibited. Their blood sugar level is thus insufficient for the extra demand for energy generated by vigorous exercise;
- shivering. The body's response to cold is to shiver, to generate more heat. This uses energy, and just like strenuous exercise, requires more glucose than is available when a diabetic person has stocked the blood with just the right level of insulin for normal conditions.

Hyperglycaemia

People with diabetes may also suffer from **hyperglycaemia**, or too much sugar in the blood. This would happen if they forgot to take a dose of insulin when it was due, or ate too much. Hyperglycaemia can also be triggered by stress. Stress causes the adrenal glands to secrete adrenalin (epinephrine), which increases the heart and breathing rates, as well as stimulating the release of glucose from the liver into the bloodstream. More fuel is thereby made available to the brain so that the stressful situation may be dealt with. If insulin is available, it will transport excess glucose into the cells to be used or stored. Unfortunately, the pancreas of a diabetic person cannot make more available automatically, so the high blood sugar will not be found until the next blood or urine check is due. Hyperglycaemia will also be present in people with undiagnosed diabetes.

Management

For first aiders, any diabetic casualty who is behaving inappropriately, confused or unconscious, should be regarded as suffering from low blood sugar rather than high blood sugar unless the casualty is able to say otherwise. It is not easy (and it is quite unnecessary) to distinguish between diabetic coma (hyperglycaemia) and hypoglycaemia when the casualty is unconscious or losing consciousness, but unconsciousness is much more likely to be caused by lack of blood sugar than by too much blood sugar. The easy way to distinguish is by the history of the incident. If onset was rapid, it is almost certainly low sugar causing the problem. A diabetic person who is exercising will often carry glucose or a high-sugar drink for fast replacement of blood sugar. If the casualty is known to be diabetic, or has a device such as a 'Medic Alert' bracelet indicating this, and is still conscious, glucose should be given. This will not do more harm if the casualty is hyperglycaemic, and may be life-saving if the problem is hypoglycaemia. Companions may be able to alert the first aider to the casualty's medical status. Since the symptoms of hypoglycaemia are very similar to those of drunkenness, it is always a good idea to ask about diabetes if a casualty is found staggering about, confused and sweating.

An unconscious diabetic casualty presents more of a problem. Unconscious people cannot swallow, so a drink or lolly cannot be given. Generally, St John teaches that it is better to give them nothing, just to get medical help. However, in a remote area where medical aid may be hours away, the casualty may well be dead before help arrives. In this case, the casualty should be

placed in a stable side position, and a little glucose could be rubbed gently on the inside of the lower cheek using a clean finger. Provided this is not done so hard that it abrades the cheek, it may help. A little of the glucose can be absorbed through the cheek– not enough, probably, to return the hypoglycaemic casualty to consciousness, but possibly enough to protect the brain until a doctor can get glucose directly into the bloodstream.

Febrile Convulsions

Febrile convulsions are convulsions caused by a rapid rise in body temperature, as may occur with viral or bacterial infection. Infection causes the body's temperature control mechanisms to reset to a higher range, resulting in a raised core temperature. Body functions operate best when its temperature is kept within a very narrow range, from around 36°C to around 37.5°C. If the temperature rises past 41°C, the body can no longer maintain normal functions. As the thermostat in the brains resets to a higher level, the infection process causes the body to increase core temperature by constricting blood flow to the skin and uncontrollably shivering. During this period when the temperature is at its peak, the casualty feels generally unwell and becomes hot. As the temperature thermostat declines, the body sweats to liberate heat and lower the core temperature. The infective process causes the body's thermostat to swing; this explains why fever oscillates.

In young children the brain is generally less mature and is not as tolerant of rapid change to its environment as an adult brain. In particular, a rapid rise in temperature induces convulsions. The rate of rise is more important as the causal factor, than the absolute temperature to which the body rises.

Febrile convulsions are common and usually not serious in children aged between 18 months and 5 years. They usually occur only once in an illness, although there are exceptions.

Although it is frightening when they happen, febrile convulsions in children can almost always be managed efficiently and effectively. The child should be stripped, but at this time, active cooling other than fanning is discouraged. Active cooling can cause the child to shiver, which in turn increases the core temperature.

The convulsions may be expected to stop quickly. The child must be taken to a medical facility for examination and treatment by a doctor. The majority of children who have febrile convulsions do not become epileptic.

Adults may also suffer febrile convulsions, but this is much

less common than in small children and has more serious consequences.

Epilepsy

The most likely form of adult convulsion to be encountered by a first aider is an epileptic seizure. Most people with epilepsy do not have a known cause for the condition. Epilepsy is a symptom, not a disease, and not all convulsions are epilepsy. There are many conditions which may cause convulsions, including infection, brain tumours, lack of oxygen and head injuries: these may cause convulsions which may never happen again, and the person is not regarded as being epileptic. If a person has recurrent seizures, epilepsy may be diagnosed and drugs prescribed to control the tendency.

A seizure occurs when neurons in the brain suddenly fire off too many electrical discharges. Often the cause is not identified, but the seizures may occur at any age, in any circumstance where the nervous system is sufficiently irritated. An epileptic seizure often follows a pattern that the person can learn to recognise. Factors triggering epileptic seizures are many and varied, and include alcohol, undue tiredness, hormonal changes or specific sounds or smells, a flickering light, such as a poorly tuned television set or a strobe light at a disco, or even the flickering made by tree shadows across the tarmac while driving on a country road. Some people with epilepsy experience a warning aura when they are about to have a seizure, which may give them enough time to stop an activity and position themselves somewhere safe.

Epilepsy is well controlled by anticonvulsant drugs in about 80% of sufferers; for these, seizures will be rare. The other 20% will have seizures of varying types, intensity and frequency. Epileptic seizures may be just a moment's 'mental absence', or a few minutes of confusion, or a loss of consciousness and convulsions. It is the type of seizure which results in convulsions, the **tonic-clonic** seizure, that is of concern to first aiders.

A tonic-clonic seizure has two phases. In the tonic phase, the casualty suddenly loses consciousness and falls to the ground, often uttering a scream or cry as air is forced out of the lungs. The whole body goes rigid. The clonic phase follows: muscles jerk, and the casualty's legs and arms may thrash about uncontrollably. Breathing may be laboured, or may stop altogether so that the face may go blue. The casualty may become incontinent (an important distinction from hysteria attacks), and may bite the tongue or the lips. The convulsions usually last from

1 to 3 minutes, after which the casualty may be confused, and will often be exhausted.

St John teaches that first aiders should concentrate on protecting the casualty from harm by moving hard or sharp objects away, but should not interfere during a seizure. There is no advantage in forcing something into the casualty's mouth to stop the tongue being bitten: this just risks teeth being broken. There is no point in trying to hold the jerking limbs still. The best approach is to wait till the convulsions stop, then if the casualty is still unconscious, he or she should be placed into a stable side position. When consciousness returns, the casualty should be allowed to sleep for a while if desired, and any side effects, such as bleeding from the mouth, should be managed. Unless this is the first seizure, or the seizure does not stop after 10 minutes, there may be no need for the casualty to see a doctor. Some people are self-conscious about their condition, and will be concerned that others will 'know about them': the first aider should reassure them that nobody will be told. Others take it as a matter of course, and will cheerfully resume their activities once the seizure has passed.

Casualties who have had a seizure may not be in touch with reality for between 10 and 20 minutes afterwards, and should never be left unattended even though they have recovered consciousness. They must be supervised until they are fully aware of their surroundings. This recovery of awareness is progressive: at first they may look dazed and confused and do not know where they are.

A serious condition called **status epilepticus** occurs when seizures keep happening repeatedly. This can be life-threatening, because the casualty may not be getting enough oxygen during seizures due to the effect on breathing, and the brain will become deprived if the seizures cannot be stopped. If a casualty has further seizures almost immediately following recovery from the previous one, status epilepticus should be suspected. Medical aid is required urgently.

Disorders of the Circulatory System

The circulatory system consists of the blood vessels and the heart. Anything which affects the smooth operation of the system is life-threatening, because oxygen is not stored in large amounts, but must be constantly supplied by the blood. Medical causes of interruption to the circulatory system include heart diseases (such as angina and congestive cardiac failure), heart attack

(myocardial infarction), and stroke (cerebrovascular accident).

Angina Pectoris

Angina pectoris (usually just called 'angina') is a condition in which not enough blood is reaching the heart to meet its needs for oxygen and nutrients. The heart does not get its supplies directly from the blood in its chambers–this blood is pumped out into the aorta and pulmonary arteries. The heart's blood is supplied by the **coronary arteries,** which branch off from the aorta and divide into a network of blood vessels which wrap around the heart.

If the coronary arteries become 'silted up' with deposits along their walls, there may still be enough oxygen and nutrients for the heart to function when the body is at rest, but when exercise increases the general demand for oxygen, the heart must work harder to supply it. Once the heart begins to work harder, it needs extra fuel, and the narrowed coronary arteries are unable to supply enough. This is the most common cause of angina. Spasms of the coronary arteries may also cause angina; even if the coronary arteries are clear of clogging, strong contraction of the muscle in the artery walls will reduce blood flow.

An angina attack presents with similar signs and symptoms to a heart attack . If the casualty has been diagnosed with angina, he or she will usually have medication which will relieve the condition. Resting, preferably in a half sitting position (which eases the load on the heart), usually helps. The first aider should ask whether the casualty has angina, and if so, whether they are carrying medication. If so, the casualty should be assisted to take the medication.

The most common angina medication is nitroglycerin ('Anginine' is one of the better known trade names), which is administered in the form of small tablets placed under the tongue, or patches which can be stuck to the skin. There is also a nitrolingual spray, which comes in a puffer and is squirted under the tongue. Nitroglycerin dilates the blood vessels, and can provide very fast relief from angina. It has unpleasant side effects, including headache (which may be severe), nausea and a drop in blood pressure (which may make the casualty feel dizzy and weak). Angina medication should be administered with the casualty lying down, or at least supported. Nitroglycerin must never be administered to a casualty who has not been diagnosed as suffering from angina and had the medication prescribed.

Myocardial Infarction (Heart attack)

The myocardium is the muscular middle layer in the heart, and the thickest. A myocardial infarction occurs when there is a complete obstruction (occlusion) of blood flow to some part of the heart. Fatty deposits on the coronary arterial walls may be the culprit, or a blood clot (thrombosis) may be responsible. Often the casualty has a previous history of angina, but sometimes there is no previous warning. Myocardial infarction is a time-critical medical emergency.

Consequences

Effects of a myocardial infarction vary, depending on which part of the heart muscle is suddenly starved of oxygen, and how large an area is affected. If the blocked blood vessel is a small one, minimal damage may be done, but if a larger vessel is blocked, extensive death of heart muscle may occur. There is always some death (necrosis) of muscle tissue in myocardial infarction.

The function of either the left or right ventricle is affected; **arrhythmia**, which is irregularity of the heart beat, is the major cause of death in the first 72 hours following the attack. The heart rate may speed up (tachycardia) or in some cases slow down (bradycardia). If the heart's electrical conduction fails, or severe bradycardia causes the blood pressure to drop too much, the heart may stop altogether; however, **ventricular fibrillation**, a rhythm failure where the ventricle's individual muscle fibres contract erratically so that the muscle just quivers instead of beating steadily and pumping blood, is the most common cause of death.

Ventricular fibrillation is the cardiac arrhythmia in adults which responds best to treatment. First aiders when calling for help should always tell the emergency services if a heart attack is suspected, so that ambulance personnel will ensure that they have a defibrillator available. By giving the heart a controlled electric shock, the defibrillator is often able to restore its proper rhythm. CPR must be carried out as soon as a lack of pulse is noted, in order to maintain oxygen supply to the brain while waiting for the defibrillator to arrive.

If the heart has not stopped and the casualty is still conscious, the first aider should keep him or her at rest, so that the injured heart only needs to do a minimum of work. The casualty is likely to be very frightened, so staying with them and reassuring them

that help is coming is very important. The more calm and relaxed the casualty is able to stay, the less strain there will be on the heart. Fear and anxiety will cause the adrenal glands to release adrenalin—the 'flight or fight' hormone—which stimulates the heart to pump harder and faster; this is likely to make things worse for the casualty.

A small heart attack is sometimes not recognised. The casualty may insist it is just indigestion, even when there are significant identifying symptoms, such as pain radiating to the left arm. This denial is not uncommon, since many people wrongly believe that even if they survive a heart attack, their life will lose its quality from then on. A well informed and tactful first aider can be of assistance in persuading the casualty to go to hospital by ambulance.

If the myocardium is sufficiently damaged, **cardiac failure** may result.

Congestive Cardiac Failure (CCF)

Congestive cardiac failure (often just called 'heart failure' or 'cardiac insufficiency') does not mean that the heart stops; in this condition, the heart is unable to pump enough blood to supply the body, despite its best efforts. The failure may be due to damage to the myocardium following a heart attack, or to a faulty valve, or a variety of diseases which affect the heart and other parts of the circulatory system.

The consequence of reduced output from the heart will be that the system becomes congested with fluid. Blood 'backs up' in the veins, so that the pressure inside the vessels is greater than the pressure in surrounding tissues. Fluids are therefore inhibited from passing into the blood vessels from the cells, and the tissues become engorged. Either the right or left ventricle may fail with CCF. If it is the left ventricle, the lungs will be congested, breathing will be difficult, the heart rate will increase and there will be general fatigue. The casualty may have a persistent, productive cough, sometimes with bloodstained sputum. Because of the limited oxygen supply, tasks which were formerly routine require an increasing effort. Climbing stairs, or even carrying a chair to another room, may cause fatigue and breathlessness.

If the right ventricle is affected, the systemic veins will become swollen with fluid, increasing the pressure within them. There will be a reduction of blood flow to the kidneys, which means excess salts and water will be retained, raising the circulating volume even higher. Hands and feet may swell, and

the general excess fluid in the gastrointestinal tract may cause lack of appetite, nausea and constipation. The body may become generally 'puffy'; this is often quite noticeable around the ankles. There may be a feeling of being bloated in the abdomen. The extremities may become bluish from lack of oxygen.

First aider involvement with congestive cardiac failure will generally be limited to supporting the casualty until the symptoms subside or medical aid arrives. Oxygen administration will be helpful (if oxygen is available and the first aider is trained in its use). Medical treatment will include drugs to dispose of the excess fluid and correct other problems, according to the origin of the condition, but with this condition, there is no equivalent to the 'magic pill' which the casualty may take for angina; there will be no sudden relief of symptoms within minutes of taking medication. First aiders may encounter someone who has not yet been diagnosed, perhaps who is distressed after exertion, and the main service to the casualty will be to encourage him or her to see a doctor. However, if CCF becomes severe, there may be acute **pulmonary oedema** (swelling caused by fluid in the lungs), which is a medical emergency since the supply of oxygen will be severely curtailed. After the ambulance has been called, positioning the casualty so that it is not difficult to cough, and assisting with breathing where necessary, will be the first aid priorities. If available, oxygen should be given. If feasible, the casualty should sit upright, with feet lower than the heart (a dining chair is good for this) to inhibit venous return and so reduce the load on the heart; this will often help a casualty with pulmonary oedema.

Cerebrovascular Accident (CVA)

Cerebrovascular accident is a more descriptive name for what is commonly called a stroke. 'Cerebro' refers to the brain, 'vascular' to the blood vessels, and 'accident' is self-explanatory. A stroke happens when something suddenly goes wrong with a blood vessel in the head. This may be a **thrombosis**, when a clot forms in a cerebral artery (the most common cause of a stroke); a **haemorrhage**, when a cerebral blood vessel bursts; or, least commonly, an **embolism**, when a clot formed elsewhere in the body breaks free and wanders into a cerebral artery, then gets stuck.

If an artery is blocked by a clot, the part of the brain serviced by the artery will be suddenly deprived of blood, and thus of oxygen and nutrients. If the artery breaks, the leaking of blood

may cause direct damage to that section of the brain. The local blood supply will also be affected just as a leaking hose reduces the flow of water at the nozzle. As a consequence of reduced blood flow, the pressure differential between arterial and venous blood in the brain is reduced: the arterial pressure drops, so that it is closer to the venous pressure. The brain reacts by signalling to the heart for more pressure. The heart therefore tries harder, and the result is the characteristic 'full, bounding pulse' which alerts the first aider to the presence of a head injury.

Factors in vulnerability

People with a history of **atherosclerosis** (build up of fatty, cholesterol-containing deposits on the walls of the arteries) are vulnerable to obstruction of the vessels by a clot. People with diabetes have four times the risk of non-diabetics. People with a history of heart disease or heart attack have an increased risk as the damaged heart tissue may form an embolism. Disorders of the blood, such as sickle cell anaemia or very viscous (thick) blood increase vulnerability to stroke because clots form more easily, and people who have high blood pressure or who have a high cholesterol level in their blood also have an increased risk. The use of oral contraceptives, particularly if the woman is also a smoker, is thought to raise vulnerability. Smoking increases the concentration of haemoglobin in the blood, which promotes the development of atherosclerosis, and the chance of clot formation. The likelihood of stroke increases with age, most occurring in people aged more than 50 years, but a cerebral embolism or haemorrhage can occur at any age. Anyone who has already had a stroke is susceptible to further strokes.

Consequences

A stroke is likely to cause a blinding headache, although this does not always happen. If only a small blood vessel is affected, the casualty may just feel a bit dizzy or confused and weak, perhaps find that coordination is impaired, and possibly speech will be a little slurred. It is possible to have a small stroke and not recognise it. If the vessel is only momentarily blocked, so that the blood supply is quickly restored, it is called a **transient ischaemic attack**. 'Ischaemic' simply means lack of blood due to obstruction of a blood vessel. Transient ischaemic attacks are fairly common in elderly people, but should always be taken seriously as warnings that the person may be vulnerable to a full scale stroke. They may also cause falls.

An accident to a larger blood vessel in the brain will have

serious consequences. There may be weakness or paralysis, usually on one side of the body, which is often easily seen as one side of the face may sag. Speech may be very slurred, or the casualty may be unable to speak at all –this does not mean they cannot hear; hearing is usually unaffected–so the first aider should seek a response which does not require speech, such as asking them to nod, or squeeze a hand. Vision may be blurry, and in some cases the casualty may have convulsions. Because of the paralysis, the casualty may dribble saliva, and may be incontinent.

The impairment of body functions after a cerebrovascular accident may be permanent or temporary. There are some functions which may be taken over by another, undamaged part of the brain, so that speaking and walking may be able to be relearned. There are usually some permanent effects, but these may be minor, such as a slight slurring of speech, or inability to perform some of the finer motor functions (e.g. threading a needle).

The first aider's role while waiting for medical aid is to monitor consciousness and to be prepared to resuscitate the casualty if required. Food or drink should not be given, because the throat muscles may be paralysed. A stroke is very frightening, so the first aider should stay with the casualty, talking to him or her even if the person cannot respond. Physical comfort while waiting should be given a high priority, and the first aider should maintain a calm, reassuring manner. If the casualty loses consciousness, the stable side position will be appropriate, but if there is body paralysis, the casualty should not be placed on the paralysed side. Care should be taken to protect paralysed extremities from cold or contact with hard surfaces. An unconscious casualty may still be able to hear, so continuing to talk reassuringly may be beneficial.

8

Poisons, Bites and Stings

Reference:
Australian First Aid
Volume 1,
Chapters 15 and 16

Australian First Aid
Volume 2,
Chapter 21

A poison or toxin is any substance which when introduced into the body, interferes with one or more normal body functions. This is a very broad definition, and includes substances that are legal and generally accepted in the community, such as alcohol, legally controlled substances such as medicines prescribed by a doctor, and substances never meant to enter the body, such as drain cleaners, weed killers or toxic toadstools. The definition also includes illegal substances, such as heroin. Animal bites and stings frequently contain toxic substances, some of which may be fatal to humans.

Process

Poisons may enter the body by being eaten or drunk (ingested), by being breathed in (inhaled) or through the skin or mucous membranes of mouth, nose or eyes (absorbed or injected). In general, poisons which are inhaled or injected are faster acting, while those which are swallowed or absorbed act more slowly. Some poisons act directly on body functions, for example by speeding up the heart rate or paralysing muscles. Others act indirectly; the body reacts to their presence by releasing chemical mediators, which may affect one or more of the body systems. If the circulatory and respiratory systems are seriously affected, the casualty may die.

Ingested Poisons

Ingested poisons are generally not as quick to act as inhaled poisons or toxic substances injected directly into the bloodstream.

An ingested poison has to pass through the digestive system, so its effects are often countered to some extent by the liver before it reaches the bloodstream and is dispersed throughout the body. This does not mean that all ingested poisons are slow to act. Swallowing a lethal dose of cyanide may well kill someone more slowly than would inhaling an equal amount, but cyanide has such a rapid effect that the difference would be of academic interest only: the casualty would still be dead within minutes.

Some poisoning is a very slow process. For example, lead may be absorbed over several years before it is apparent that something is wrong; the lead gradually accumulates until it reaches a toxic level, and by the time the problem is diagnosed, the body may have been permanently damaged. Another example is alcohol: consumed steadily over a long period it may cause irreparable damage to the liver and brain. However, alcohol is able to be eliminated from the body provided it is only consumed in small amounts, whereas lead is not removed from the system by normal body processes. Mercury is another example of a cumulative poison. Fish from polluted water may contain high levels of mercury, which enters people's bodies when the fish are eaten. As with lead, mercury remains in the body and may build up to a toxic level. Of course, these poisons will have an immediate and deadly effect if ingested in larger amounts, and it is in such acute cases that first aiders are likely to become involved.

Alcohol overdose

Alcohol can be a fast or slow poison. Consumed over many years, it may cause silent damage to the body. Consumed in larger amounts than the body is able to cope with, it may cause sudden death (fortunately, the body often protects itself against a lethal overdose of alcohol by refusing to accept any more: the resultant vomiting effectively stops the drinking!). First aiders are not likely to become involved with long-term effects, but are quite likely to encounter a casualty suffering from an alcohol overdose. Because alcohol is a good solvent, perfume and aftershave contain fairly high concentrations, and there is alcohol in some cough medicines. Small children are at risk of alcohol poisoning if these substances are not kept out of reach.

Because alcoholic drinks are socially acceptable and widely used in the community, overdose is fairly common. The **direct** consequences of a mild overdose are not generally dangerous, and do not usually require first aid. The overdosed person may be sweating, confused and uncoordinated, sometimes aggressive

or uninhibited depending on the individual, and is likely to vomit if he or she continues to consume alcohol. The drunk at a party is a familiar figure, and the rest of the group may breathe a sigh of relief when the affected person succumbs to the poison and falls asleep. However, it is while the person is asleep that danger may arise.

Alcohol is a central nervous system depressant. Because it depresses breathing, the oxygen level in the blood may be lowered. In extreme cases, breathing may stop altogether. An unconscious drunk may vomit, and the vomitus may obstruct the airway or be inhaled. Alcohol can also lower the body temperature by dilating the peripheral blood vessels, so the person is at risk of hypothermia, especially if left to 'sleep it off' uncovered or out in the open in cool weather. A person who has lapsed into unconsciousness from alcohol should be treated like any other unconscious casualty, that is, be placed in a stable side position, kept warm, and have vital signs monitored. Medical aid should be sought if the intoxicated person cannot be roused, or is a child, or if 'vital signs' checks indicate deterioration in the casualty's condition.

The most dangerous consequences of excess alcohol consumption are usually **indirect**. A person affected by alcohol may feel perfectly in control, but reflexes, coordination and judgment are actually poor, so the person should not drive a vehicle or operate machinery. The limit for driving a vehicle in Australia is that blood alcohol content must be less than 0.05%, which only represents two glasses of wine or 'middies' of beer in an hour for men, or one glass for women. (This is not sexist—female metabolism is different from male metabolism, and the 'average sized' female body is only able to deal with half as much alcohol in an hour as the 'average sized' male body). Other indirect effects of alcohol overdose include injury to someone else due to uncontrolled actions of the intoxicated person, and injury to the overdosed person due to either lack of coordination causing bumps and falls, or to irritation of another person causing blows to be struck. Alcohol dulls pain perception.

Food poisoning

Most cases of food poisoning are due to the effects of contamination by bacteria rather than by chemicals (an example of 'chemical' food poisoning is tropical fish poisoning, or 'ciguatera'). Acute illness may occur anywhere from 1 to 36 hours after consuming the contaminated food. Severe abdominal cramps, vomiting and diarrhoea are the usual symptoms, often occurring in 'waves' or episodes lasting up to an hour, followed by short

periods when the symptoms ease. Medical aid is required urgently because food poisoning can cause death from dehydration, especially if the casualty is frail or a child.

Foods that are particularly risky include stews or casseroles that have not been refrigerated after cooking, and which are then rewarmed: some toxic bacteria can survive the slow, low-heat cooking process, and then multiply while the food is standing. Rewarming would need to be to a sustained high temperature to kill these bacteria. Foods which are often not refrigerated, including dressings and sauces containing dairy products, minced or chopped foods such as stuffings and meat loaf, can also be dangerous. Other common sources of food poisoning include home-canned products, which may not have been completely sterilised by the canning process, shellfish taken from polluted water, and any food prepared by someone who is careless with hygiene. The contaminated food may look and smell fresh; it may even taste perfectly all right. The best protection is to practise strict hygiene when handling food, avoid leaving food to stand at room temperature, be particularly careful with seafoods, especially shellfish, and never eat the contents of a can that is swollen, dented or punctured. Utensils that have been used to cut or mix raw foods (especially meats) should be thoroughly cleaned before being used on cooked foods.

Some bacteria, such as *Clostridium botulinum* (botulism) and the staphylococci, produce toxins which contaminate the food before it is consumed; others, such as *Salmonella* and some *Pseudomonas*, multiply and produce their toxins in the intestinal tract. The latter are generally responsible for slower onset of poisoning. First aid management is mostly concerned with providing comfort and support to the casualty while waiting for medical aid. The casualty should rest in any position which eases the cramps, but often the best position during an attack is sitting on a toilet with a bucket placed conveniently to hand. Rehydration of the body is the most urgent need: if the vomiting and diarrhoea persist, and the casualty cannot keep fluids down, he or she may need to be admitted to hospital and rehydrated intravenously.

Medications overdose

Pills and potions are a common cause of poisoning in the home, most often because they are left unsecured and children swallow them. Also at risk are people who are confused due to their illness, who may forget they have already taken their medication and have a second dose, or who mistake one container for another. Sometimes, people take medication after having consumed a substance which causes the medication to have an

adverse effect. For example, taking sleeping pills after having had several alcoholic drinks can multiply the effect and cause a life-threatening emergency. When any medicine is prescribed, it is always wise to check with the doctor about possible side effects and contraindications for the drug. Keeping a record of the time and dose taken will prevent accidental repeat doses, and keeping all medications in a secure place will prevent small children from being poisoned.

A deliberate overdose may be a genuine suicide attempt or a means of drawing attention to problems. There is no way a first aider can tell the difference between deliberate and accidental overdoses in an adult, and first aid always assumes that the overdose was accidental. St John teaches that the first aider should telephone the Poisons Information Centre and seek expert advice on management of all poisoned casualties. However, if there is no ready access to a telephone, delay could be fatal, especially when the casualty is a small child or is physically frail. In this case, **and only when it is known that the poison is a medication and not a corrosive substance,** the first aider should make a conscious casualty vomit by giving an emetic such as Syrup of Ipecac according to the directions on the bottle. Emetics should only be given to casualties who are fully conscious: if consciousness is impaired there is a risk that vomit could be inhaled, causing more damage.

An unconscious casualty who has been poisoned by medication should be managed according to DRABC principles, and medical aid sought urgently. The casualty's breathing and pulse need to be monitored closely while waiting for help to arrive, and the first aider should be prepared to resuscitate if it becomes necessary. Expired air resuscitation can be commenced in a breathing casualty, if there are signs that the casualty's breathing is insufficient. For example, breathing may be very slow and shallow, and the casualty's lips and extremities may be turning a bluish colour. Assistance with breathing may be necessary to keep up the oxygen supply until help arrives. The first aider should wipe the lips and nose of the casualty clean with a cloth before commencing EAR.

Plants

Poisonous mushrooms and toadstools are a favourite detective yarn poison, because they are easy to mistake for *Agaricus* sp., the edible mushrooms that are used extensively as foods. In real life, it is more likely that people will be poisoned by plants which

are less well known to be toxic, but which are found in many gardens. To give just a few examples, oleanders, commonly grown as a hedge, can be deadly in quite small amounts, and small children are likely to chew the leaves or flowers of the pink and white *Nerium* oleanders; or the fruits of the yellow or apricot *Thevetia* oleanders. Hundreds of children are poisoned by eating house plants every year, particularly those such as *Philodendron, Euphorbia* (e.g. poinsettias) and *Dieffenbackia.* These cause burning of the mucous membranes of the eyes, nose and mouth; and cause vomiting and purging if eaten. As a general principle, it is best to assume that any unfamiliar plant in the bush or the garden is not edible.

If someone is known to have eaten a poisonous plant, first aid management is similar to that for medication overdose. Because the poison is ingested, it will usually take some time to reach its full effect, and vomiting may eliminate most of the toxic substances before they can do very much harm. A doctor or the Poisons Information Centre should be telephoned for advice. It may be recommended that Syrup of Ipecac (if available) should be given to induce vomiting. The Poisons Information Centres advise against the use of any of the traditional methods of inducing vomiting, such as drinking soapy water or sticking fingers down the throat. Some of the oldfashioned methods may work quite effectively in an emergency, but may cause further injury to the casualty.

Household chemicals

Household cleaners and 'garden shed' chemicals often contain corrosive substances which damage the tissues of the mouth and throat when swallowed. If the casualty then vomits, the tissues will be burned a second time by the poison on its way out. As a general principle, anything that was not designed to be swallowed is best left where it is until experts can deal with it. Anything that is meant to be consumed such as a medicine, and any plant, can be vomited without causing more harm. St John teaches that the Poisons Information Centre should be contacted if possible as a first priority, since the Centres provide expert advice as a 24 hour service. If this is not possible, the label on the container usually has advice on how to manage a poisoning incident. For this reason, chemicals should be stored in their original containers: decanting them into cordial bottles or other containers not only increases the likelihood that they will be accidentally swallowed, but also separates them from information which could be life-saving.

Inhaled Poisons

Inhaled poisons tend to act quickly, because they enter the bloodstream directly from the lungs. They can have a double effect: the substance itself may be toxic, and the casualty may also be deprived of oxygen by breathing in the poison instead of air. The most common inhaled poison is carbon monoxide, which is formed by incomplete combustion of organic material (organic substances are those which are, or were, living; these include wood, plastics and fossil fuels such as petrol or coal). Another fairly common example occurs when a household cleaner containing ammonia is mixed with a household bleach con–taining chlorine: the resulting fumes are very poisonous, and because the casualty is expecting an unpleasant smell, smarting eyes and so on, the danger may not be recognised for some time.

Inhaled poisons may be dangerous in themselves, by having a direct effect on the body's functions. They may also be dangerous if they cause an allergic reaction in the casualty. Some inhaled substances are neutral in their effects on the body, but by occupying the atmosphere, they deprive the casualty of access to oxygen and so cause suffocation. The general principles of first aid management are to remove the casualty from the contaminated air, and to provide breathing support until medical aid can be reached. St John teaches that the DRABC Action Plan should be followed: this is particularly important in this type of incident, because rescuers have died trying to extract a casualty from a contaminated atmosphere. There is also danger to the rescuer if cyanide is the poisoning agent, whether inhaled or ingested. Before giving expired air resuscitation, the rescuer should wipe the casualty's mouth and nose. A mask should be used to reduce the risk of inhaling cyanide in the casualty's expired air. The Australian Resuscitation Council points out that cyanide is so toxic that if sufficient is absorbed to cause cessation of breathing or cardiac arrest, then the chance of survival is remote even with immediate administration of antidotes. Some of the more common inhaled poisons are described below.

Carbon monoxide

Carbon monoxide is a colourless, odourless, tasteless, non-irritant gas which is formed when an organic substance is not completely burned. Motor vehicles and all internal combustion engines emit carbon monoxide from their exhausts, and there is a lot of carbon monoxide in the smoke from house fires. The most common cause of death in a fire is not burning, but carbon

monoxide poisoning. Other high risk occasions are using a camp stove in a closed space, for example cooking in a tent in wet weather, and using a gas heater in a poorly ventilated room. Internal combustion engines in closed spaces (e.g. forklifts in freezers or ships' holds) are also potentially dangerous. Early warning signs are usually a headache and slight dizziness; nausea may occur. At this stage, recognition of the danger and getting into fresh air at once will usually prevent any serious poisoning. If children announce that they feel sick in the car, it should always be considered possible that exhaust fumes are entering the cabin, particularly in a station wagon or any hatchback type of vehicle with a door at the rear which may be ineffectively sealed. Exhaust pipe holes are particularly dangerous.

When breathed in, carbon monoxide attaches itself to the haemoglobin in the blood as well as diffusing into the plasma. Haemoglobin finds it much more attractive than oxygen (about 250 times greater affinity), and will cling to carbon monoxide in preference to oxygen molecules. Once in the blood, carbon monoxide is not readily released and prevents the haemoglobin from taking up oxygen. It may also inhibit utilisation of oxygen by the tissues. The organs most readily affected are the central nervous system and the cardiovascular system. The central nervous system is the first to be affected. However, carbon monoxide's most dangerous effect is as a tissue poison.

The big problem with carbon monoxide poisoning is getting it out of the tissues. With many other common inhaled poisons, the casualty will recover fairly quickly once clean air is available again, but carbon monoxide takes a long time to be eliminated from the tissues, and meanwhile it continues to do damage. Without intervention, it takes 8 to 12 hours of breathing fresh air for a casualty to get rid of carbon monoxide in the blood (but this will not clear it from the tissues); if 100% oxygen is breathed, it still takes around 3 hours to clear the blood. The use of a hyperbaric chamber at 3 atmospheres pressure reduces this time to around 40 minutes, but clearing the tissues may take several daily hyperbaric treatments. Because of the long recovery time, any casualty suffering from carbon monoxide poisoning requires medical aid. A level of the gas which may have no appreciable effect on a fit and healthy adult may have serious effects on a person who has heart disease or a chronic lung condition, or who is pregnant.

Carbon dioxide

Carbon dioxide is a very small component of air. In unpolluted air, its concentration is about 0.04%. A by-product of respiration,

carbon dioxide is expelled from the body via the lungs when breathing out. In expired air, its concentration is about 4%. It is a colourless, odourless, tasteless gas, and is not toxic. Dry ice, used to keep food and drink cold when powered refrigeration units are not available, is the solid form of carbon dioxide, manufactured by chilling the gas. Carbon dioxide is also found in exhaust gases from machinery and smoke from burning organic material. It is the normal presence of carbon dioxide in the blood which stimulates the respiratory centre of the brain to initiate breathing.

In a closed space, carbon dioxide can accumulate, and being heavier than air, will collect at floor level. A concentration of 3.5% or 35 000 ppm is injurious if breathed for an hour. By displacing the normal air, carbon dioxide limits access to oxygen, so that the casualty may suffocate, but unlike its more lethal cousin carbon monoxide, carbon dioxide is eliminated quickly from the body as soon as clean air is available. Sealed areas such as submarines and space ships, which cannot be ventilated to the outside, usually have 'scrubbers' which filter carbon dioxide from used air before it is re-oxygenated and returned to be breathed again by the crew.

Rescuers should be wary of any closed area, such as a hold, tank or brewery vat where carbon dioxide may accumulate from a chemical process or where dry ice is being used as a refrigerant. Warning symptoms include laboured breathing and a feeling of being suffocated. Unconsciousness may follow, and eventually breathing and circulation will fail. If entering a confined area, especially where there are a lot of other people, a candle or match flame can indicate that carbon dioxide has accumulated to danger level: the flame will go out if the oxygen level is insufficient to sustain it. A naked flame should naturally be avoided if there is any risk of explosive gases or vapours. First aiders should not attempt to rescue anyone from a closed space without self-contained breathing apparatus.

Dry ice will 'burn' skin with the cold, causing severe blisters, so it should always be handled with gloves or tongs. First aid management is as for heat burns.

Hydrogen sulphide ('rotten egg gas')

Hydrogen sulphide is one of several toxic gases produced by rotting organic material. Others include methane ('marsh gas') and hydrogen cyanide. Many people will be familiar with accounts of miners carrying a canary into coal mines as a gas detector: the canary was affected by lower concentrations of toxic gases than would affect the humans, so if the bird collapsed, the miners

knew they must get out at once. There are now better warning devices for miners, but industrial development has brought more hazardous situations.

It is hydrogen sulphide which gives the characteristic bad smell to sewers and septic tanks. This gas is a hazard when cleaning tanks used to store or transport organic wastes such as liquid manure. It is also a risk in storage facilities for plant material such as hay: in the enclosed space of a silo, hydrogen sulphide produced by hay which has deteriorated due to moisture will not be dispersed. When the farmer enters, he or she may collapse before realising there is anything wrong. Unfortunately, such a collapse from an observer's perspective is not obviously due to bad air, and there have been many cases reported of rescuers rushing to help and also being overcome.

The problem here is that 'everyone knows' what hydrogen sulphide smells like, or at least that it has a nasty odour. In fact, hydrogen sulphide only has its characteristic 'rotten egg' smell at very low concentrations; at levels above 150 parts per million (150 ppm), the sense of smell is paralysed. Levels of 250 ppm cause irritation to lungs and mucous membranes generally, and at 500 ppm the gas causes headache, nausea, mental confusion and unconsciousness. Levels over 500 ppm can be fatal. From this, it is apparent that the gas is only detectable when its concentration is too low to do any harm. The important lesson for first aiders is that rescuers should never enter a confined space which might contain toxic gases without self-contained breathing equipment, a safety line, and an observer who is strong enough to pull the rescuer out if there is trouble. One hundred percent oxygen should be administered as soon as possible to all such casualties.

Injected Poisons

Poisons may work very fast if they are injected directly into the bloodstream (intravenous injections) because they will then be transported quickly around the body. Injection into the tissues (intramuscular injections) will mean that the poison must first move from the cells into the blood, so that it will take a little longer to reach its full effect. Poisons that are injected just beneath the skin (subcutaneous injections) are likely to act slowly: first they must enter the body cells, then be collected by the blood vessels for distribution.

It is not only the bloodstream which distributes injected poisons. Paralleling the blood system is the lymphatic system, which also transports the poisons from their entry site to the rest

of the body. The lymphatic system does not have its own pump to help keep its contents moving, so penetration of poisons through this system will be slow if the body remains still, but accelerated by limb muscle contractions. The heart is a powerful pump and only takes a few minutes for complete circulation of blood.

Any substance in high enough concentration can be toxic. Even water, if there is enough of it to dilute the blood, can cause problems. An example might occur during surgery, when the 'work area' is washed out; the combination of excess water (which is absorbed by the tissues) and loss of blood through bleeding can affect the patient's body systems. Thus saline that matches body fluids is usually used.

Injected poisons that are most likely to be encountered by first aiders include drug overdoses and venoms from animal bites or stings.

Snake bites

The worst effect of a snake bite may well be the sheer terror it induces in the casualty. Often, the offending snake has injected little or no venom, and what there is may barely have made it through the skin, so that the casualty has plenty of time for counter measures to be taken. If the general principles for management are followed– stay calm, keep still and use a pressure bandage early to inhibit spreading of the poison– the bite is very unlikely to be fatal. The snake antivenoms, which are available at medical facilities all over Australia, work very effectively, and traces of venom on the skin around the bite provide an accurate means of identifying the snake so that the appropriate antivenom can be used.

To stay calm when bitten by a snake is not easy. Most people are afraid of snakes, and some fear them with an intensity that amounts to a phobia. When bitten, they experience a rush of adrenalin which speeds up the heart rate and raises the blood pressure. This is the 'flight or fight' response and must be checked, because either beating up the snake or running from it will only spread the poison faster. St John teaches that re-assurance and helping the casualty to relax are priorities in managing snake bites; once the casualty is lying down and making an effort to both control the breathing rate and relax the muscles, the spread of the poison is already being slowed.

Application of a pressure bandage over the whole limb replaces previous techniques which concentrated on the bite site only. The bandage should not cut off the circulation; it should

just compress the tissues so that the small blood and lymph vessels are squeezed and their fluid transport function will be slowed down. If the finger or toe tips become blue and cold, the bandage is too tight. The bandage starts at the bite, so that the poison-containing tissue is compressed first, then goes down to the end of the limb; this prevents the lower part of the limb from swelling. By then taking the bandage right up to the armpit or groin, the whole limb is evenly compressed, and fluids will move very slowly through it. Then splinting and bandaging the limb as if it were fractured, is ideal. Snake poison travels mainly through the lymphatic system rather than through the blood, so the position of the limb will not make any significant difference to the flow, and it is not necessary to keep the limb horizontal. The main inhibitor will be to avoid movement: the casualty should not walk to medical aid. If medical aid cannot be brought to the casualty, then the casualty must be carried.

If the casualty has been bitten on the trunk or head, it is obviously not possible to apply a compression bandage around the part. Fortunately, this is uncommon, accounting for only 10% of bites. Keeping the casualty still and getting medical aid even faster are the main priorities. In this case, the casualty is likely to be even more frightened, so reassurance and helping to control the panic reaction are particularly important.

Since antivenoms were developed, the only fatalities from snake bites in Australia have occurred as a result of delay in commencing first aid or because the casualty has developed an allergy to the venom (rare). Snake handlers are likely to have sustained many bites during their careers, often without any serious effects, but once they have experienced an allergic reaction, even a mild one, they must never come into contact with snakes again. The first encounter with a toxin does not usually cause an allergic reaction, but it may set one up so that a subsequent encounter will trigger it. Allergic reactions are described in Chapter 7.

Jellyfish stings

Beach goers are likely to be familiar with bluebottles, which may be found in a line along the high water mark at any beach in Australia. They have an irregularly cylindrical float, and one tentacle which is long and dark blue in colour; there may be many small, lighter tentacles, which are difficult to see. If bluebottles are on the sand, they are likely to be in the water also, so swimming may not be a good idea that day. They sting if the tentacles are bumped in the water or stepped upon on the sand, and it hurts, but the stings are not lethal and may only cause

minor discomfort. A new, more dangerous, bluebottle has been identified in Australian waters. It looks like the ordinary bluebottle (*Physalia utriculus*) except that it has up to five of the long, dark blue tentacles, and is around twice the size of the common bluebottle; its stinging power is commensurately greater. This new bluebottle is called *Physalia physalis*, the same name as the well known Portuguese Man O'War which is found in the Atlantic and which has been known to cause death. The new bluebottle may cause systemic reactions, but is not lethal. There is some research evidence that application of vinegar, which had previously been thought to be appropriate for all jellyfish stings, may cause the stinging cells of *Physalia physalis* to fire instead of inhibiting them. Consequently, vinegar is now only recommended for box jellyfish stings, and should not be used for any bluebottles.

Box jellyfish (*Chironex fleckeri*) have a much more serious effect. These jellyfish are enormous (their tentacles can trail for several metres), and are almost transparent, which makes them very difficult to see in the water despite their size (as large as a human head). They inhabit tropical waters, and are a hazard all around the coast of the top half of Australia (from about Gladstone in the east to Broome in the west, but may sometimes be found a little further south). From October to May, when they are most numerous, residents generally avoid swimming at open beaches, and local Councils often erect signs warning of the danger. Some areas have 'stinger proof enclosures'; these and the lycra 'stinger suits' significantly reduce the risk of a serious sting. Every year, there are cases reported of people being stung by box jellyfish. When entering the water in a box jellyfish zone, a swimmer should go slowly: if stung, thrashing around or running for the beach is liable to mean more stings, so backing out carefully is best. The casualty should scream loudly for help, because the faster treatment is begun, the better will be the chances of survival: box jellyfish can kill, and if there are extensive stings, death can come within minutes.

The first priority for box jellyfish stings is to douse the stung area with vinegar. Vinegar contains a weak solution of acetic acid, which prevents the nematocysts (stinging cells) on the tentacles from firing. The tentacles are covered with millions of nematocysts, which 'shoot' poison into the casualty when stimulated. Not all the stinging cells fire at first contact, and any bits of tentacle stuck to the skin will contain many unfired cells which must be neutralised at once. Many residents of northern Australia carry a large container of vinegar with them whenever they go to the beach. Vinegar has no effect on the pain of a sting, which can be extreme, but because it stops any more nematocysts firing, it may be life-saving. There is some research

that suggests that the dried stung area should not be washed with fresh water, because this may trigger **all** the nematocysts to fire, and may thus turn a minor sting into a fatal one. Other researchers have found no difference between fresh and sea water; in any case, washing will not remove tentacles which have stuck to the skin, they must be carefully picked off.

St John teaches that, once vinegar has been applied, the remaining tentacles may be picked off with the fingers, provided the sting is not a major one. If it is, the tentacles should be left on the skin. The finger tips have thick skin which the stinging cells cannot penetrate, so this is quite safe, although there may be some minor stinging sensations. Then the limb (people are usually stung on the legs) should be bandaged as for snake bite, right over the vinegar-treated tentacles in a major sting. If there is no vinegar available, the tentacles should still be picked off, but the compression bandage should only be applied above the stung area, in case there are still some active nematocysts present which may be stimulated to fire by the bandaging. Ice packs over the stung area are beneficial in relieving pain in many cases.

Box jellyfish toxins can stop the heart, and the first aider should be prepared to perform CPR or assist with breathing when respiratory distress becomes apparent. If breathing has slowed to the point where the casualty is unconscious and hypoxic—not getting enough oxygen—there will be signs such as the lips turning bluish. The first aider should not wait until breathing stops altogether, but should start expired air resuscitation straight away. If alone with an unconscious casualty, it is going to be very difficult for the first aider to comply with both the imperative need to get help and the equally imperative need to stay with the casualty in case breathing stops; the best way to avoid this dilemma is to avoid isolated beaches unless there are at least three people in the group. If there is no third person, the action taken will depend on the circumstances. It may be possible to drag or carry the casualty to a vehicle (the casualty must not walk), or the stung area may not be extensive and the casualty may be able to cope while the first aider runs to the nearest house, or the first aider may just have to stay with the casualty and hope somebody comes by. There is no 'proper course of action' which can be applied to all circumstances. North Queensland ambulance personnel are specially trained and equipped to deal with box jellyfish stings on the beach, including administration of antivenom.

Spider bites

Most spider bites are poisonous, but the only ones likely to kill an adult human are funnel webs, of which the Sydney funnel

web (*Atrax robustis*), the Queensland tree funnel web (*Hadronyche formidabilis*) and the Toowoomba funnel web (*Hadronyche infensa*) are the most dangerous known. There are other species of funnel web spider along most of the east coast from Queensland down to north-east Victoria, but these have caused no known deaths. In almost 40 years, the only spider known to have killed is the male Sydney funnel web.

Redback spiders (*Latrodectus hasseltii*) could perhaps kill a child, and will probably make the casualty quite ill, but their poison acts slowly and is not usually considered lethal (the last death was in 1955). There have been cases reported of severe reactions to several spiders, such as the White Tailed spider and the Fiddleback, but there are no known deaths recorded from these.

Redback females, which are very pretty spiders, with their black velvety bodies and red markings, are commonly seen around houses and yards. The males are smaller, dull in colour, and do not bite. They are unlikely to be seen, since the females eat them after mating. The females are only aggressive when they are guarding their egg sacs, and even then they are more likely to retreat than to bite. The redback attacks its prey by backing up to it, squirting sticky web over it to immobilise it, then biting it to paralyse it while the spider sucks out the juices. If a person is bitten there will probably be a sharp stinging pain, but the bite is not always painful and may not be noticed immediately. The area at the site of the bite quickly swells and within about 5 minutes becomes extremely painful. Because of the localised swelling and the slowness with which the poison acts (it may be several hours before the full effects are felt), St John teaches that first aiders should not bandage the bite, but should try to reduce the pain and swelling with cold compresses and get the casualty to medical aid. Redback spiders have only small fangs, and usually do not penetrate very deeply when they bite. Gardening gloves are sufficient to protect the hands.

Funnel web spiders look as nasty as they are. Big, black or dark brown spiders, they are aggressive, and will rear back to bite at the slightest provocation. Funnel webs bite by bending the thorax back so that their fangs are vertical, then plunging them down into the prey. They have large, strong fangs which can penetrate clothing, and which bite deeply through bare skin. They hang on, and often have to be forcefully dislodged. Unlike most spiders, the male funnel web, even though smaller, is more deadly than the female. All of the deaths from funnel web bites in which the sex of the spider has been able to be identified were caused by male spiders. The good news is that since Dr Struan

Sutherland of the Commonwealth Serum Laboratories developed an antivenom in 1981, there have been no deaths from funnel web bites. Contrary to popular misconception, funnel web spiders are not restricted to the Sydney area; there are varieties found all along the east coast of Australia and in the southern highlands of New South Wales. There is a Queensland variety which lives in trees. All of them are aggressive, all of them cause serious systemic reactions, and any of them could kill a small or weak human; but the Sydney funnel web has the greatest capacity to kill and is by far the most dangerous.

In the spring and summer, the male funnel webs go wandering. They enter houses, and may hide in cosy places such as someone's shoe or clothing. On Sydney's North Shore and the South Coast area around Nowra, where they are prolific, it is wise to shake out clothing and check shoes before putting them on. The spiders also fall into swimming pools, and can survive for days under water, so if there is a big black spider on the bottom of the pool, it should not be assumed to be dead: it might be a live funnel web.

The bite is painful, and the poison acts quickly. It can kill a child in minutes and an adult in a few hours if not treated. Unlike a snake, which usually bites and runs, funnel webs may bite again and again. Fortunately, they have a limited supply of poison, and because the bite hurts, it is noticed straight away (unlike the redback or the blue-ringed octopus, whose bites may only be discovered later). Interestingly, primates (humans and monkeys) are the only large mammals susceptible to funnel web poison. This is the main reason it was so difficult to develop an antivenom; animals such as rabbits had very little reaction to the venom, so a serum with protective antibodies could not be easily obtained.

By assuming all bites by a big black spider are funnel web bites until proven otherwise, and managing the casualty in the same way as for snake bites, first aiders can prevent death from this spider. Hospitals have antivenom available, and have the facilities to support life until the casualty recovers, which may take a few hours or several days, depending on the amount of poison injected and the delay between the bite and effective first aid. Antivenom should only be administered in a hospital environment, because the casualty can have a reaction to the antivenom which requires medical support. The first aid priorities are pressure immobilisation and getting medical aid urgently.

Venomous Creatures

Creature	First aid management	Medical attention essential?
Bee	Cold pack; do not squeeze sting	If allergic reaction
Blue-ringed octopus	Pressure immobilisation	yes
Bluebottle	Cold pack	yes
Box jellyfish	Vinegar & pressure immobilisation	yes
Bullrout	Hot water	yes
Centipede	Cold pack	not usually
Cone shell	Pressure immobilisation	yes
Funnel web spider	Pressure immobilisation	yes
Redback spider	Cold pack	yes
Scorpion	Cold pack	not usually
Snakes	Pressure immobilisation	yes
Stingray	Hot water	yes
Stonefish	Hot water	yes
Wasps and hornets	Cold pack	not usually

Poisons Information Centres

Australian Capital Territory	06 285 2852
New South Wales	02 692 6111 or 008 25 1525
Northern Territory	089 22 8842
Queensland	07 253 8233 or 008 17 7333
South Australia	08 204 6117 or 008 18 2111
Tasmania	002 38 8485 or 008 00 1400
Victoria	0055 15 678
Western Australia	09 381 1177 or 008 11 9244
Marine Envenomation emergencies (user-free, Australia-wide)	008 088 200

9

Environmental Injury

Reference:
Australian First Aid
Volume 1,
Chapter 17

The human body functions within a very narrow temperature range. In an adult, the normal operating temperature is approximately 37°C (98.4°F), with individual variation. The 'normal' range is usually quoted as 36.1°C-37.1°C. This temperature is just right for the body's electrical activity and chemical reactions required for metabolism and energy production. Blood and other body fluids have the optimum viscosity (amount of runniness) to perform their functions. A variation by even 1°C is enough to sound alarm bells and start the body's defence mechanisms (mostly controlled by the *hypothalamus* in the brain) going. Heat is produced at the rate of about 300 kilojoules an hour by normal body metabolism at rest, which means that in order to sustain a core temperature of 37°C, the body sheds heat at this rate, mainly through the skin. As well as being the main vehicle for disposing of excess heat, the skin and the layers of fat beneath it act as insulators to prevent too much heat loss, and to give some protection against extreme air temperatures. Nerve endings at the surface send back continuous environmental messages to the brain, alerting it to changing conditions outside. The outside temperature is more significant to humans than to furry animals, which also have a thick pelt to insulate them.

Hyperthermia (too much heat)

When its temperature rises, the body reacts by dilating the peripheral blood vessels so that more of the blood passes through the thin capillaries near the surface, spreading the blood in a thin layer and thus allowing it to shed heat more easily. Sweat glands

are activated and expel water to the surface, where its evaporation helps to cool the skin. Evaporation of water uses up heat. To convert a liquid to a gas, heat (called '**latent heat of evaporation**') is needed: the liquid takes in extra heat without becoming hotter. This heat comes from the surroundings, so that the layer of air over the skin (as well as the skin itself) is cooled in the process. Moving air, caused either by a breeze or a fan, speeds up the process because heat is more readily captured as the air rushes over the skin. The faster the air is moving, the quicker the sweat can evaporate, and therefore the faster the body cools. Where humans are hairy, especially head, armpits and groin, water can run along the hairs, allowing a greater surface area to be exposed to the air and so speeding up evaporation. Long, thick hair has a counter-effect, by trapping layers of air which become saturated with moisture and prevent further evaporation of sweat. If the air is very dry, as it usually is in inland Australia, it can take up a lot of water, so evaporation is very fast and the person can tolerate higher temperatures. When the air is humid, as in coastal areas, the air is already carrying a lot of moisture, so evaporation is more difficult. People can experience more discomfort at 25°C in Cairns, (which is hot and humid), than at 35°C in Bourke, which is even hotter but very dry).

Fluid balance

Heavy sweating uses up a lot of water and variable amounts of body salts. The body also continually loses water to the atmosphere through breathing due to the air passing over the moist membranes of the respiratory system. This leaves less fluid available for the **plasma** – the fluid component of the blood– so that total blood volume decreases. When blood volume is reduced, the pituitary gland in the brain produces hormones which signal the kidneys to absorb more salt and water from their fluid collecting system. This inhibits the rate at which they filter the blood. Urine therefore collects in the bladder more slowly, and because it contains less water, it contains a higher concentration of waste products which gives it a darker yellow colour. This is a warning sign that the plasma volume is becoming concentrated. If this is not rectified, the body becomes dehydrated. To compensate, the person in a hot environment needs to take in more fluid than normal. Around 6 to 8 litres a day may be needed to keep the average adult body properly hydrated in hot areas, compared with about half that amount in a more temperate climate. Body salts, such as sodium and potassium chlorides, are also depleted because they are dissolved in the

water which is expelled as sweat. A proper balance of these electrolytes (solutions which conduct electricity) is required for the normal electrical activity of the body. If fluid is replaced but body salts are not, the concentration of sodium chloride in particular remains too low and impairs normal functioning.

Dehydration

When fluid intake does not balance fluid output and the body becomes dehydrated, blood volume is reduced, and the cells which are normally plump and round begin to sag. Skin which is pinched up takes several seconds to resume its normal position. **Hyperthermia** (*hyper* means excess, and *therm* is heat) is the condition caused by a too-high body temperature.

Drinking cool fluids has a double effect—the body is rehydrated, and the intake of cool liquid may help to lower the overall temperature. This treatment is supplemented by damping the skin and fanning to increase the cooling effect of evaporation. Icy cold showers or baths defeat the purpose to some extent. The reflex reaction to cold on the skin is to constrict the surface capillaries, which inhibits the cooling effect of having the blood dispersed in small vessels. Too rapid chilling of the skin may also cause a 'too cold now' message to be sent to the brain, so that the casualty begins to shiver and thus generates more heat at the core, where the vital organs are still too hot.

Dehydration is a consequence of losing more fluid than is being taken into the body. A hot environment is only one factor in this disruption of fluid balance. Respiration, which is technically the whole process of using oxygen to convert sugars to energy, generates heat. This heat is essential to keep the body at the optimum operating temperature, but if too much is generated it must be dispersed or the body will overheat. Vigorous working of muscles requires a great deal of energy, so that an athlete performing a hard workout, or perhaps just someone chopping wood for the barbecue, will feel hot very quickly and begin to sweat. In a person who is not accustomed to the level of exercise being performed, or who is overweight and unfit, the effects are multiplied. Experienced athletes who are working their bodies only to their normal training level and in a familiar climate, will not usually overheat significantly. But the body of someone who goes from Thredbo to the Gold Coast for a holiday after a sedentary year in the office, then plays a sport such as squash, may be unable to cope with the excess heat generated by the unusual exertion in a hotter, more humid climate.

Hyperthermia (also called heat stress) is often considered as consisting of three stages—heat cramps, heat exhaustion and heat

stroke. There is no distinct point at which one stage ends and the next begins. A person may suffer from heat exhaustion without having had cramps, and it can be difficult for an observer to identify the moment when a casualty passes from any one stage to another. Heat injury is progressive, and the categorisation of it into stages is a convenience based on the seriousness of the outcome if it is not treated. The management of heat exhaustion and heat stroke is similar, so it does not greatly matter if first aiders are unable to tell whether the casualty is suffering from severe heat exhaustion or the onset of heat stroke. St John teaches that for heat exhaustion, sponging down will cool the casualty sufficiently, but for heat stroke, application of ice to pulse points and fanning are also advised. This escalation in efforts to cool the casualty reflects the danger of heat stroke: the temperature control mechanisms of the body have failed, the casualty may have reached the stage where sweating stops, the skin becomes flushed and dry, and the core temperature is rising out of control. Urgent counter-action is required to stop delicate internal organs such as the brain from literally cooking. Damage may begin to occur when the temperature rises past 41°C; by 42°C convulsions are likely. Death can occur in as little as 15 minutes from heat stroke, and between 25% and 50% of heat stroke cases die. Permanent, crippling damage may also be the result of overheating. In extreme cases, muscles have been known to 'melt' (**rhabdomyolysis**), requiring amputation of affected parts.

If the casualty is conscious, cool drinks help to get something cold right inside the body, and may have an immediate benefit (so long as the casualty is also removed from the excessively hot environment). In mild cases of hyperthermia, salts will be replaced rapidly through normal diet as the casualty recovers. In more severe cases, active replacement to balance the electrolytes may be necessary. St John teaches that first aiders should not normally attempt to replace salts, since the requirements of the individual are best determined by medical practitioners, and re-balancing of fluids forms part of ongoing treatment rather than first aid. In a remote area, where medical advice is not readily accessible, common sense should be used. Many bushwalkers and sportspeople carry 'sports drinks' which contain electrolytes, and when feeling a little affected by the heat, or after strenuous exercise, will prefer them to plain water. Drinks are often formulated individually for athletes such as long distance runners, and it would be inappropriate for a first aider to attempt to restrict a casualty to water when his or her 'own special drink' is available.

It should not be supposed that hyperthermia only occurs when the weather is hot. Even when the temperature is low, the

body can become overheated through exertion if the heat generated by exercise cannot be eliminated. This can occur for example at a ski resort, where skiers may rug up against the cold and cover themselves with waterproof outer clothing. As they exercise, heat is generated and trapped against the skin by the impermeable barrier of the clothing. The body steps up sweat production, but to no avail because the sweat cannot evaporate. The result is hyperthermia, and by the time the casualty becomes thirsty, dehydration may be quite advanced. For this reason, skiers are usually advised to wear layers of clothing which can be shed as they become hot while exercising, then put back on when they are resting.

A core temperature which is rising is not reversed instantly when the skin is cooled. The casualty should rest in a cool place for at least half an hour and drink lots of cool fluids. The leader should not permit the group to resume activity until the casualty reports that urine is clear or a pale straw colour.

Hypothermia (too little heat)

Cold injury is not as familiar a danger in Australia as heat injury, but is nevertheless a risk. Even in the hot deserts of the Centre, the temperature at night often drops below zero, and the south-east has areas where there are cold winters. High in the mountains, even in summer, cold winds can strip the heat from a bush walker, and the weather can change in minutes from warm to cold. Wind lowers the effective temperature considerably (see Wind Chill Factor table). In temperate climates, elderly people, small children and those affected by alcohol can become hypothermic in mild weather that would not affect a healthy adult. Elderly people may have an inefficient heat control mechanism and are often less active physically than young adults so that they generate less heat. Small children have a greater surface to volume ratio than adults, so they lose heat more easily. Alcohol is a sedative which depresses the metabolic rate, causing less heat to be generated; it also dilates the surface blood vessels so that heat is lost faster from the body (hence the flushed face of the inebriated person). Alcohol also lowers blood sugar levels, so that hypoglycaemia may contribute to an insufficient supply of glucose, consequent fatigue and lack of heat energy to keep the body warm. Because it causes mental confusion and an inclination to sleep, a person affected by alcohol may 'pass out' without taking precautions to keep his or her body warm. Anyone who is immobilised by injury or illness needs to be protected against the risk of hypothermia.

The process of cooling

The body's first reaction to a signal from the nerves that the environment is cold is to constrict the peripheral blood vessels so that less blood is near the surface and exposed to the cooling effect of the air, while a larger volume is at the core protecting vital organs from becoming chilled. The hairs stand up on end – so-called 'goose bumps' – in order to trap air as an extra insulating layer. The body may then reverse this process, so that the blood vessels are dilated and the skin may become flushed. The casualty may feel too hot and remove clothing. This cycle of vasoconstriction followed by vasodilation may recur several times, so that it will not always be apparent that a person is becoming hypothermic. A possible explanation is that the **hypothalamus**, which is in charge of regulating body temperature, may malfunction when the temperature falls below normal operating level.

If the core temperature continues to drop, the large muscles first tense up, then start to quiver, in an effort to generate more heat. This is the familiar sensation of shivering, which becomes visible below 35°C, the point at which clinical hypothermia is defined to be present. Shivering can increase heat production by up to 500%. At around 35°C, the metabolic rate is higher also–between three and six times the normal rate–and the combination of shivering with an increased metabolic rate uses up stored energy very quickly, so that the casualty becomes excessively fatigued. Eventually, shivering stops as the supply of glycogen (the stored form of glucose) runs out. The benefits of shivering are limited to a maximum of perhaps two or three hours, while the body still has plenty of energy and oxygen available to the muscles. After this time, as supplies dwindle and heat production becomes less effective, the disadvantage of greater vasodilation (and thus reduced heat retention) caused by the muscles' activity becomes significant.

As the core temperature drops still lower, the body systems also slow; the blood and fluids become more viscous (thick and slow moving), and their electrical conductivity is reduced. Breathing and heart beat slow down, the senses are less alert, the casualty will be uncoordinated and will have an altered mental state. The effect is that the casualty may be the last to realise that hypothermia is progressing to a life-threatening level. Below about 32°C, the casualty may no longer be able to maintain consciousness. Once the core temperature drops below about 30°C, the heart beats very slowly and is sensitive to any bump, which may cause it to go into ventricular fibrillation. In this state it merely quivers instead of beating regularly, so that it cannot

pump blood and the casualty dies. Atrial fibrillation is also common at this temperature, and while not stopping blood flow altogether, will limit the amount pumped so that the casualty has insufficient oxygen even at the reduced need level caused by the lowered temperature. A core temperature of 25°C is regarded as the limit for sustaining life.

Management of hypothermia

One potential advantage in being a hypothermic casualty is that because the body systems slow down as they cool, less oxygen is needed to maintain life. This means that in an environment where there is little or no oxygen, the casualty may survive longer than the usual 3 or 4 minutes before brain damage occurs. For this reason, resuscitation of someone who has fallen into very cold water is a must, even if they have been submerged for 30 minutes or more. Rescue services have a principle that 'He's not dead until he's warm and dead'. There have been remarkable cases of revival of cold casualties who were apparently dead, some with little or no brain injury in spite of long periods without breathing.

First aiders will most commonly encounter someone who is only mildly hypothermic. In any cold environment, it is most important to be constantly alert for early warning signs, such as stumbling, going quiet, and being slow to respond. Unusual tiredness and slurred speech may also be present. As soon as somebody in the group **might** be hypothermic, the party should stop, get into shelter and have something hot to eat or drink. A good rest, warmth and food may solve the problem. It is vital to be sure that the casualty has fully recovered before resuming the group's activity. The only way to be sure that the core temperature is normal is to take the casualty's temperature; since the core temperature cannot be measured accurately in the mouth or armpit, this must be done rectally, which is not a first aid procedure. The casualty should have been reporting feeling warm and 'normal' again for at least half an hour before the leader permits the group to go on. When the core temperature is dropping, it continues to drop for a time after the casualty has been removed from the cold environment and re-warming measures have commenced. Even when the peripheral temperature has begun to rise again, the core temperature may still be falling. For this reason, the first aider should not assume all is well as soon as the casualty's skin resumes its warm pink character. Half an hour is the minimum recovery time; if activity is resumed too soon, there is a high risk of relapse into hypothermia.

When shelter is reached, a person who is feeling chilled may

find the classic remedy of a 'nice hot bath' beneficial. However, if the core temperature has dropped significantly, to 34°C or lower, rewarming should be slow. For someone who is only mildly hypothermic, a warm bath (at about 38°C, never over 40°C) in which the body can be immersed, will provide a warm environment which, by inducing all the surface vessels to dilate, will warm the chilled blood quickly. The temperature of the bath can be tested with the elbow and forearm, as is done with babies' baths, but should not be tested with the hand because hands are less sensitive to heat than other parts of the body. Temperatures over about 42°C can burn human skin. It takes at least 20 minutes to get the warmth right through an adult body; less for a child. This means that bath water may need to be 'topped up' several times to keep it at the right temperature. Many ski lodges and hotels now have spa pools which are thermostatically controlled and maintained at 38-40°C; if available such a pool would be better than an ordinary bath. As a general principle, if the casualty is still at the shivering stage hypothermia is mild enough to allow quick rewarming by immersion.

St John teaches that direct heat should not be used to rewarm a cold casualty. Radiators, fires, heater fans and hot water bottles all direct concentrated heat to a limited area of the body. Because cold skin is less sensitive than warm skin, it is easy for the casualty to remain too close to the heat source and suffer burns. Also, because the blood vessels in the heated area will dilate, precious warmth may be lost from the core as the blood volume there is reduced, while the amount of blood from the area of dilated vessels is insufficient to maintain any extra warmth it has gained on the surface, during its journey back to the centre through the cold tissues. The other major problem is that when the circulation is sluggish, as it is in a hypothermic casualty, the heat from the heat source is not able to be dispersed efficiently. The heat will accumulate in the immediate area which is being heated, and may cause serious burns to the skin or underlying tissues. A hot water bottle or heated brick which is normally just a pleasant source of warmth may become a dangerous source of burn injury as the temperature of the skin which is in contact with it rises to the temperature of the heat source.

The safest way to warm a cold casualty in the field is skin to skin contact. The casualty should be placed in a sleeping bag if available, or otherwise insulated against further heat loss. Then someone who is warm should remove as much clothing as modesty allows, and get in with the casualty so that the whole length of the warm body is in contact with the cold body. This is an effective and safe way to rewarm the casualty, but will take some time. If the warm person starts to feel cold, another

member of the group should take his or her place. When insulating a person against heat loss, it is important to keep the head well covered, because humans can lose a lot of heat through their heads; various sources give percentages ranging from 50% to 75% of all heat lost from the body as being dissipated *via* the head.

Wind Chill Factor

Ambient temperature (°C)	Equivalent chill temperature (°C) when wind speed is ... (km/h)				
	8	16	24	32	40
5	2	0	-4	-7	-9
0	-5	-9	-12	-15	-20
-10	- 12	-20	-23	-26	-29
-20	-24	-31	-40	-43	-45
-30	-34	-45	-54	-60	-62
	Danger high			Danger extreme	

10

Traffic Accidents

Reference:
Australian First Aid
Volume 1,
Chapter 18

One of the first aid incidents most likely to be encountered is a road accident. Statistically speaking, everybody who travels in a motor vehicle will either see or be involved in at least one accident in which somebody is injured. Fifty percent of all trauma deaths and severe injuries are a result of road traffic accidents. The Road Trauma Committee of the Royal Australasian College of Surgeons estimates that 'for every road death, about another 30 road users are injured–at least one third of them so severely that they require hospital in-patient care'(RACS, 1983, *A Survey of Australian Road Crash Statistics*). Most of those who die in road accidents do so in the first hour, many before medical aid arrives. Early and effective first aid is a big factor in preventing survivable injuries from becoming fatal injuries.

Often the first aider does not actually see the accident happen, but arrives a few minutes later after hearing the crash or coming upon it unexpectedly. In this case, it is important to pause and assess the situation before taking any action. DRABC is still the first priority, but a traffic accident brings in other factors which must be considered. For example, there may be more than one vehicle involved, and there may be several people in the vehicles. Accurate assessment of the situation may be vital: which vehicle is more likely to contain serious injuries, and which of the injured are most likely to need urgent attention? Severity of the injuries does not always correlate with urgency when assessing priorities for first aid. A spinal injury may be crippling, but a cut on the leg is more urgent if it is spurting blood. If the spinal case is conscious, no action is necessary until the bleeding casualty has been assisted. Internal abdominal injuries may be life-threatening, but the first aider cannot do much more than position the casualty for comfort and expedite

transport to hospital, whereas someone who has merely fainted may vomit and block his or her airway if not immediately looked after.

Accident Statistics

Most available statistics deal with fatal crashes; it is possible to infer from these the kinds of injuries most likely to occur according to the type of accident and the direction of impact. There are four main variables for motor vehicle crashes: rural, urban, single or multiple vehicle involvement.

The most common accident in an urban area involves more than one vehicle, occurs at an intersection, the direction of impact is front-to-front or front-to-rear, and the most common serious injuries are to the head and chest for adults, to the head for children.

The Federal Office of Road Safety (FORS) reports *(Fatal Crash Types: Analysis of 1988 Fatality File, March 1992)* that fatal rural accidents usually occur in locations with no intersections and with loose shoulders. More persons than in urban crashes die before medical assistance arrives. Drivers in rural high speed crashes tend to be older, in single and multiple vehicle crashes, than in urban accidents (which usually occur at lower speeds).

FORS also found that fatal single vehicle accidents occur most frequently at night on the weekend, are not at intersections, and the car runs off a level road. The drivers are generally young males, returning from recreational activities, not wearing seat belts and often affected by alcohol. They account for more fatal crashes (28%) and more fatalities (28%) than multiple vehicle crashes (18% of fatal crashes and 20% of fatalities).

Multiple vehicle accidents tend to occur on week days, in daylight, at intersections. The drivers are of a higher average age and have longer experience than for single vehicle crashes, but driver error is often a contributing factor. Bad visibility is more likely to be reported as a factor than for single vehicle accidents. Chest injury as the cause of death is high (19%) compared with other crashes (10.5%).

Pedestrians frequently have multiple injuries. The head often hits the road or another hard object. If the vehicle runs over the pedestrian, the wheels may crush the chest, abdomen or pelvis, and there may be injuries from being dragged along under the car. If 'run under' —when the car hits and the pedestrian goes over the top—the lower legs are often broken at the point of impact, just below the knee. The casualty may bounce over the bonnet and roof, and the car behind may run over and kill him

or her. If thrown aside, the head will hit hard, and there is a high risk of a fractured pelvis. Spinal injuries are common (28% of child fatalities, 12% of adult fatalities). The Road Trauma Committee (RACS) reports: 'A pedestrian is more likely to be killed in a road crash than any other class of road user'. Among pedestrians, 10% of all head injuries are fatal compared with 3% in other categories.

Pedal cyclists have a high risk of head injury, especially if not wearing a helmet, and are often struck by a following or oncoming vehicle, in which case they sustain similar injuries to pedestrians. They often have severe arm and leg injuries, and can be thrown a considerable distance from the site. Most pedal cyclists killed or severely injured in road accidents are children, and the child's inexperience is often a contributing factor. FORS reports that 81% of the child pedestrians and 94% of the child cyclists killed were considered responsible for the crashes. Cycling helmets do not protect the face and jaw, and many are too high cut to protect the back of the neck; an additional problem with children is that they may be fastened insecurely, and therefore dislodge on impact.

Motor cyclists and pillion riders struck by a car can sustain severe leg injuries, and may be crushed if the heavy cycle falls on them; sometimes the hot exhaust pipe causes severe burns. The type and extent of injury in an accident depends on whether the motor cycle collides with a car or truck, or runs off the road and strikes something solid, or loses grip on a curve, falling and throwing the rider who then slides along the ground. The protective clothing and equipment worn is a significant factor in severity of injury. The greatest number of spinal injuries resulting in paralysis among all road user categories occur to motor cycle riders. However, motor cyclists have the lowest incidence of head injury of all road users, probably because they wear helmets. If not wearing strong clothing, such as leathers, a slide along the road or other hard surface can strip large areas of skin, causing friction burns similar to severe flame burns. Such wounds are particularly prone to infection, because they have a lot of embedded dirt, debris or cloth fibres.

Direction of Impact and Patterns of Injury

A first aider coming upon the scene of a road accident will need to be alert for hidden injuries. Having ensured that casualties are breathing and brought under control any deadly bleeding, a meticulous head to toe check is necessary, especially if medical aid is likely to be delayed. The injury of which the casualty is most aware is not necessarily the most serious or the most urgent.

If there has been an impact to either end of the vehicle, seat belts are likely to have caused chest or abdominal injuries, so the position in which the casualty is placed while awaiting medical aid should reflect this possibility even if no trauma to these areas is readily apparent. Pedestrians and cyclists often have broken bones at the point of impact after being struck by a vehicle; after head injuries, these are the most common serious injuries in this type of accident. If a vehicle has been struck on the side, the seat belts do not generally cause chest injuries, but the vehicle's side will have struck the passengers and their heads will have been jerked sideways as well as forwards as the vehicle is hit. Rear seat passengers have less head injuries than front seat passengers, because they impact on the soft front seats instead of the dashboard, windscreen and steering wheel. The Australian Spinal Unit Statistics report that the most common spinal injury is due to flexion rotation of the head on impact.

Occupants are most likely to have been thrown out of the vehicle when it rolls over; if the shell of the vehicle is broken or a door is torn off, or if anyone in the vehicle is not wearing a seat belt, the first aider should ask at once how many were in the car, just in case there is another casualty lying out of sight (if there is a passenger inside the vehicle without a seat belt, it is quite possible that someone else in the car was also not wearing a belt, and is no longer inside). A check on the total number of passengers is always particularly important when the vehicle's frame is distorted by the crash, because passengers, especially small children in rear seats, can be concealed behind twisted seats or under buckled panels. 'Rollover' crashes are the most likely of all vehicle accidents to cause multiple injuries.

Accident Site Management

Unless on an isolated road, a road accident will usually attract onlookers. This is an advantage to the first aider, since spectators are nearly always willing to act as lookouts and direct traffic around the site, to call an ambulance, record observations and generally assist with casualties. If spectators are already there when the first aider arrives, it is best to ask if emergency services have been called, and if so, try to find out what information was given. If the information was incomplete (for example if the ambulance service was not told that there are several casualties, or that someone is trapped), a further call to add this information will be useful. In an isolated area, where a passing motorist is enlisted to get help, a list of information to be given will only take a few seconds and will make sure nothing important is left out. Remind the motorist to count the exact kilometres to the

nearest town; a guess may mislead the ambulance crew, and a serious underestimate could make the crew think they have been hoaxed and turn back. It is a good idea to send a second message with another motorist (perhaps one travelling in the opposite direction), just to be sure that the information arrives.

Casualties should not be removed from a crashed vehicle unless there is danger, such as a risk of fire from leaking petrol, a risk that an unstable vehicle or other object could fall and cause further injury, or the casualty's condition makes it necessary. This last will be up to the first aider to judge: a casualty who needs breathing support may be able to be managed while still in the vehicle, but if cardiac compression is to be given, the casualty will need to be lying flat on a hard surface. If there is serious bleeding, it may be able to be controlled without moving the casualty, especially if the casualty is conscious and can help to apply pressure him/herself, but sometimes access may be too difficult. Casualties who are conscious and mobile should not be coerced into staying in a vehicle which contains grisly sights: they will be shocked and frightened, and may be better off outside. In any case, a first aider is unlikely to be able to dissuade casualties who are able and wish to do so from leaving the vehicle. A bystander should be enlisted to help look after any casualties who are uninjured or who have only minor injuries, just in case they are dazed and wander away; the first aider cannot attend to injuries as well as keep an eye on the 'walking wounded'.

When there are several people injured, it will be necessary to attend to them in order of priority. If the first aider is alone, this means that some difficult decisions may have to be made. For example, if the driver has no breathing or pulse, and another occupant of the vehicle is bleeding profusely, the first aider cannot afford to start CPR on the driver. To do so would mean giving all the attention to someone who may be irretrievably dead, while ignoring someone else who could have been saved but who may therefore die. All casualties will need to be quickly assessed for signs of life, airway (to ensure it is open and clear) and severe bleeding (which should be controlled) before any of them receive further treatment. In the example given, the first aider would probably give five quick breaths to the apparently dead driver, then go to the passenger. It is possible that the casualty who is bleeding could be quickly shown how to exert pressure on the wound, and may be able to do so effectively. The first aider would then check for other life-threatening injuries, and if there are none, return to assist the driver. If the passenger is unable to control the bleeding without assistance, the first aider must leave the driver in favour of the **known** living, who must always have priority over the **possibly** living in any incident with multiple casualties.

11

Oxygen and Inhaled Analgesics

Reference:
Australian First Aid
Volume 2,
Chapter 30

In the vast majority of first aid incidents, the only equipment available will be whatever first aid kit is nearby. For accidents at work or at home, there may be a well stocked kit, and for car accidents, most trained first aiders might be expected to have at least a small kit which is always carried in the vehicle. However, a high emphasis is placed in first aid training courses on improvisation, because accidents are by definition unexpected. In the course of normal living, it is not possible to carry around everywhere all the equipment which could be useful for any eventuality.

Fortunately, the most valuable weapon in a first aider's armoury requires no additional equipment. This 'weapon' is cardiopulmonary resuscitation, which requires only that the first aider have a functioning pair of lungs and two hands for compression of the casualty's chest. The ability to react fast and effectively to restore oxygen supply to the casualty's brain is the primary skill in first aid. To a non-breathing casualty, a supply of 16% oxygen as supplied in expired air resuscitation is better than none at all; this is only 5% less than the 21% the casualty usually has available from air.

There are circumstances where it is possible to predict that people will be injured or suddenly become ill. Workplaces, theatres and stadiums where large crowds gather for exciting events, hazardous sports such as skiing, body contact sports such as football or martial arts, which are dangerous to unskilled participants: all these are sites where the likelihood of accidental injury or sudden illness is high. These sites usually have first

aiders in attendance, as either paid staff or volunteers. Equipment available in workplaces or sporting venues frequently includes oxygen equipment, and may include inhaled analgesics.

Oxygen Therapy

Administration of oxygen to a casualty who is breathing spontaneously is not difficult; the procedures are easily mastered in a first aid course. For most people, there will be few opportunities to actually use these skills, so retraining regularly (preferably every six months, and certainly no less than annually) is essential to ensure that the first aider is ready when called upon to act. Any injury or condition which causes hypoxia (lack of oxygen)—through inadequate breathing or inadequate perfusion of the tissues – can be relieved by administration of oxygen. People with chronic medical conditions which inhibit their intake of oxygen, and their carers, are often trained to use oxygen at home when the need arises. Of all drugs, oxygen is perhaps the most useful and the least harmful. It can be self-administered, and there is a wide variety of equipment designed to be user-friendly and safe.

The main danger with using oxygen is that a spark may cause a fire or explosion. Combustion (burning) is technically called oxidisation: it is a chemical reaction whereby oxygen combines with another substance, producing heat (and often light) as a by-product. Given plenty of oxygen and enough heat to start the reaction off, anything at all will burn or be oxidised, even metal and rocks. In the absence of oxygen, nothing is combustible, not even petrol or hydrogen. There are therefore very strict regulations governing storage and procedures for use of oxygen, and the cylinders in which is it transported or stored are required to be distinctively coloured (black with white shoulders) and clearly labelled. For first aid, only medical oxygen should be used, because industrial oxygen may contain impurities which could be harmful to the casualty.

Indications for use

The presence of indicators of hypoxia will alert the first aider to consider administering oxygen to a casualty. These include:

- signs of shock, such as pale, sweaty skin, fast, weak pulse
- difficult, noisy or irregular breathing
- a blue tinge to fingertips, feet and lips
- drowsiness, confusion or loss of consciousness.

The conditions which may cause hypoxia include injury to the head or chest, stroke, heart conditions, loss of body fluids from burns, wounds or dehydration, anaphylactic shock and reactions to venom from a bite or sting, poisonous gas inhalation, submersion, and airway obstruction by a foreign body. This list covers rather a high proportion of first aid scenarios. In fact, there are few serious injuries or illnesses in which oxygen is not of some benefit.

Cautions

Oxygen should not be used if there is fire danger, or if time would be wasted getting the equipment when the casualty is not breathing, or if the equipment available is of a type with which the first aider is unfamiliar. Before using oxygen, it is essential to ensure that the airway is clear, and if a mask is to be used for delivery, that there is no injury to the face which would prevent a good seal being achieved. Oxygen from a cylinder is very dry, and may irritate the surface tissues of the casualty's airway, particularly when administered at a high flow rate. To counter this, some oxygen kits come with humidifiers, but these are not very efficient and are easily contaminated; they must be cleaned thoroughly after each use. If a conscious casualty seems frightened of having a mask over his or her face, the first aider should take the time to explain the purpose of the mask, and if possible, the casualty should be given the mask to experiment with. The oxygen therapy should not commence until the conscious casualty feels relaxed with the mask.

Oxygen is generally safe. Rarely, patients with certain conditions may be adversely affected. Chronic obstructive pulmonary disease, for example emphysema or chronic bronchitis, will cause high levels of carbon dioxide to be present in the blood all the time. The brain gradually becomes less sensitive to carbon dioxide as a result, so that it takes higher than normal levels to trigger the breathing reflex. Eventually the normal pattern changes, so that instead of the presence of too much carbon dioxide being the stimulus for breathing, the trigger becomes low oxygen content in the blood. In this circumstance, the oxygen concentration must fall to just above half its normal concentration before the respiratory centre signals 'Breathe'. If extra oxygen is administered there may be no stimulus to breathe, and the casualty may slow down or even stop spontaneous respiration. Carbon dioxide then accumulates, and before the brain realises it is running short of oxygen, the casualty may have become confused or unconscious. In spite of this, most

recent studies have shown that there are few problems, and casualties require oxygen at the usual flow rate of 6-8 litres per minute; this should be maintained en route to hospital. Fine tuning to achieve measured levels of carbon dioxide and oxygen in the blood will occur at the hospital. The first aider may start at a lower flow rate, gradually increasing to the normal rate.

Inhaled Analgesics

Pain always makes an injury worse. First aid does not generally treat an injury or medical condition, it is basically a 'holding action' pending access to medical aid. For this reason, first aid techniques are directed towards preventing the injury or condition from becoming worse while the casualty is waiting for medical treatment. Pain relief, including the use of pain relieving drugs (**analgesics**), plays an important part in preventing the casualty from deteriorating. The primary means of pain relief for a first aider is to place the casualty or the injured part in the most comfortable position according to the type of injury. This may involve actively arranging the casualty's body, for example bending the knees to relieve strain on an injured abdomen, or just providing support and immobilising the injury, for example tying a broken leg to its unbroken mate or putting a sling on an injured arm.

Increasingly, in circumstances where injury is likely and pain will surely be a consequence, first aid equipment made available on site includes analgesics which may be inhaled to give almost instant relief, such as penthrane (methoxyflurane) and Entonox (a gas which is a 50:50 mixture of nitrous oxide and oxygen). An example is at the ski resorts, where members of the Ski Patrol are trained to use both these analgesics, because pain control is an important aspect of the management of bone and joint injuries, which are common in skiing accidents. Another example is in the mining industry, where Entonox is often available on site. It is doubly useful since it not only relieves pain but also supplies a high level of oxygen (50%, compared with 21% in air). The first aider should not be tempted to use both these analgesics if they happen to be available. One or the other should be chosen according to the injury; the effect of penthrane followed by Entonox is to give the casualty a general anaesthetic.

Entonox

Because it supplies pain relief and extra oxygen, and because it does not cause adverse reactions when the casualty is later

anaesthetised for surgery, Entonox is the most commonly used analgesic to temporarily control pain due to trauma and during childbirth. It is colourless, almost odourless (there is a slightly sweetish taste), and acts quickly. Nitrous oxide, the analgesic component, is commonly known as 'laughing gas', and has been used for many years to relieve pain in dentistry and childbirth. Its use by first aiders is fairly recent and is still considered controversial; it is not permitted in some States in Australia.

Entonox cylinders are blue with white quadrants on the shoulders. Because the analgesic is administered using a demand valve through a mask held by the casualty, loss of consciousness will automatically stop the flow (the casualty will drop the mask). Reactions vary considerably, with some people (about 10%) feeling no effect at all from use of the gas, while at the other extreme, some people obtain instant, complete relief of their pain. About 30% will get substantial relief, and an estimated 3% will not be able to use the mask, either because they are afraid of it or because they are unable to follow instructions.

Entonox has some side effects: a minority of people can become irrational, some feel nauseated or dizzy, and some become drowsy once the pain stops. Blood pressure can be affected. Side effects disappear quickly when use of the gas is halted. It is potentially habituating, and its handling and use are therefore regulated. Dangers in handling include the higher risk of fire (because of the concentration of oxygen), for which similar precautions should be taken to those taken with oxygen. Nitrous oxide also presents a low temperature hazard and skin or clothing could stick to the cylinder. The cylinder should not be allowed to become too cold, because the mixture of gases inside it will tend to settle when chilled and will separate at low temperatures (somewhere between 3°C and 0°C), with the heavier nitrous oxide on the bottom. Using it in this state could mean that the casualty inhales first 100% oxygen, then as the level drops, only nitrous oxide, with potentially disastrous results. If frost has formed on the lower half of the cylinder, it should be first warmed at 20°C, then slowly inverted three times to re-mix the gases. Cylinders should be stored horizontally.

Contraindications for use of Entonox include:

- any altered state of consciousness including head injury
- chest injury where pneumothorax is suspected, or chronic lung disease
- major face or jaw injuries (the casualty cannot hold the mouth piece in place)
- casualties affected by sedatives or alcohol
- abdominal distension
- any diving injuries.

Entonox is never given to people with serious chest or abdominal injuries, or to divers. Nitrous oxide diffuses rapidly throughout the body and into gas-containing spaces faster than nitrogen diffuses out. This causes increased pressure in injuries such as pneumothorax. It will increase the effects of barotrauma (pressure injury) and decompression sickness in divers, both of which are caused by excess nitrogen dissolving in the blood due to pressure when diving in deep water. When the diver returns to the normal atmospheric pressure on the surface too quickly, the dissolved nitrogen bubbles out into the blood and any available space between tissues, causing pressure injury to ears, sinuses, lungs and joints (as well as generating the risk of a large bubble blocking an artery, which can be fatal). Nitrous oxide will make this worse, so only 100% oxygen is given to injured divers.

People with chronic lung diseases have the same problems with Entonox as they do with oxygen therapy. The general principle which first aiders should follow is 'when in doubt, **don't**'. In most cases, let the doctor decide which analgesic is appropriate. If medical advice is likely to be unavailable for some time, and the casualty is in severe pain from an injury, the first aider should follow the same principle as for administering oxygen to a casualty with a chronic lung disease—start slowly and see how they go.

Entonox is not given to people who have an altered concious state, due to head injury, sedation, alcohol or drug overdose. The casualty controls the administration, and should be fully conscious and able to follow instructions.

Penthrane (methoxyflurane)

Penthrane is usually supplied for field use in small amber bottles (3 ml capacity). A disposable 'analgiser', which is a lightweight cylinder made of polyethylene, containing a polypropylene felt wick, is used to administer the drug. To use it, the bottle is emptied into the analgiser, and the casualty inhales the vapour through a mouthpiece. There is an opening in the side of the analgiser which can be covered by the casualty's finger to increase the concentration being inhaled. The analgesic effect lasts for about 15 minutes following withdrawal, and the 3 ml dose should last about 1 hour. The casualty may have a second dose, but no more than two doses (total of 6 ml) should be administered in the field. Pain is reduced rather than eliminated altogether; most casualties obtain substantial relief.

The use of penthrane is well established for pain relief in trauma, obstetrics and cardiac pain. Like Entonox, it does not have

any adverse effects on subsequent administration of a general anaesthetic. In first aid, the use of any drug for pain relief is viewed with caution; however, the analgisers are carried by the Ski Patrol in the New South Wales snowfields, where they have been used for some years particularly for alleviating pain caused by fractures. In the snow, casualties almost always have to be moved to medical aid, and the process of getting the casualty on to the 'banana boat' (Akja) for the ride down the mountain inevitably exacerbates pain. Penthrane is the preferred analgesic when the casualty is in a location that precludes carrying of larger apparatus, or where access is difficult (e.g. when the casualty is down a cliff, or trapped in a crashed vehicle).

The vapour smells like 'juicy fruit' flavoured chewing gum. To assist the casualty, who must self-administer the drug, the analgiser is usually strapped to one wrist. Penthrane is not administered to any casualty who is not fully conscious or who, in the opinion of the first aider, is not able to follow instructions.

Adverse reactions to penthrane are uncommon, but have been reported. These include nausea and vomiting, shivering, and renal dysfunction; and rarely, depression of respiration, cardiac arrest and malignant hyperpyrexia (body temperature rising out of control). Penthrane should not be used for casualties who have a history of renal disease or dysfunction, and the limit of 6 ml must be adhered to strictly. Other casualties for whom penthrane is contraindicated include pregnant women or nursing mothers, people affected by sedatives or alcohol, and people who are taking tetracyclines.

12

Emergency Childbirth

Reference:
Australian First Aid
Volume 2,
Chapter 24

Most women who are about to give birth have plenty of time to reach a hospital or summon professional medical assistance. Occasionally, due to isolation or unexpectedly speedy progression of labour, a first aider will be the only assistance available at the birth. Taxi drivers and police seem to deliver more than their share of impatient babies in the cities, and anyone living on a rural property some distance from town may be called upon to act as midwife. The most difficult situation for a first aider would be when the pregnant mother has been involved in an accident, and the birth begins as a result of stress or trauma. If the mother has injuries, these will need to be attended to before preparing to assist with the birth. If she is uninjured but there are other casualties, there will be plenty of time to manage the injuries: birth usually takes several hours after onset of labour, and there is not much the first aider can do to assist in the early stages except to provide reassurance and comfort.

A mother having her first baby is likely to be apprehensive, especially at the prospect of giving birth in an unplanned location, with only a first aider to help. The first aider may well share her apprehension. However, the advantage with the first timer is that if labour has only just started, it is likely to take long enough so that professional assistance will arrive before the baby does. First babies take anywhere from 6 to 24 hours after the first labour pain to be born; the average is around 10-12 hours. Second and subsequent babies are not so considerate, and may emerge anywhere from a few minutes to several hours after onset of labour. In this case, at least the mother has some experience (even if the first aider has not), but she may still be frightened about having the baby outside a hospital and without pain relieving drugs.

First Stage

During the first stage of labour, the first aider's attention should be directed towards helping the mother to stay calm, and preparing a delivery place for her which is as clean and comfortable as possible under the circumstances. The mother may have decided views on this, and should be heeded. She is not ill, and knows better than the first aider how she feels and in what position she is most comfortable. Contractions are usually about 10-15 minutes apart to start with, gradually getting closer together as labour progresses. They last from 30 seconds up to about 1 minute, and follow a wave pattern with the pain increasing to a peak then tapering off. The mother may wish to walk around in between, but will usually want to sit or crouch during the contraction.

Inside the uterus, the baby is getting cramped and uncomfortable. The head is pressing against the cervix, which is thinning and stretching to make space for the baby to pass through. The plug of mucus which has been blocking the cervix during pregnancy falls free, and the amniotic sac around the baby ruptures, letting the clear fluid inside escape. This is referred to as 'the waters breaking', and usually does not occur until labour is established, but may happen earlier, even before the mother is conscious of any contractions. It may help to distract the mother from her discomfort if she is involved in the preparations: she could time the contractions and note how long they last and how long between them. When they are 3-5 minutes apart, it is time to give up on help arriving and get ready for the birth. When the first contractions are felt, mothers are often advised by well-meaning friends to have hot drinks to help them relax. This may be good for some, but others find that their stomachs will reject food or drinks and the consequence of a 'nice cup of tea' may be that the mother promptly vomits. At this stage also, the body tends to clear the bowels (probably due to the pressure). If the location is a house, a hot shower will help to ease pain and clean the mother's skin. If no shower is available, the first aider could assist the mother to wash the vaginal area, preferably with soap and water, as a preventative measure against infection.

Second Stage

By the time the cervix is fully dilated and the second stage of labour begins, contractions will be coming about 1 minute apart and lasting longer. They will also be increasing in strength and

will therefore be more painful. However, they still last only about 1-1½ minutes, and if the mother reminds herself of this, they will be more bearable.

The baby's head is now moving down the vagina with every contraction. If the mother responds to the powerful urge to push, which is the distinguishing feature of second stage labour, she is likely to tear the perineum (the skin around the entrance to the vagina). The perineum begins to bulge as the baby's head pushes hard against it. The mother should start panting during contractions to help her resist pushing. The first aider, having helped the mother into whichever position she finds most comfortable, and made sure there is something handy in which to wrap the baby, can now concentrate on giving the mother support. She may wish to have her back rubbed, or her knees supported if she is reclining with knees bent. Gently massaging the perineum will help it to stretch wide enough to let the baby's head through without tearing. If it does tear, the doctor will stitch it up later, so it is not a big problem, but there will be some bleeding. The mother will not feel pain from the tear until later, she is too busy ejecting the baby to be concerned with minor injuries.

Delivering the head is the most difficult part for the mother. Some feel the pressure more to the front, and may become afraid that their bladder or urethra is ripping. Others, probably the majority, feel the pressure to the rear, and may be concerned that they will have a bowel movement and soil the birth area. Generally, they do not, because the rectum has been emptied of any faeces during first stage, but if there is some soiling, the first aider should simply clean it away and reassure the mother that this is natural and not something to worry about (the first aider should be aware that giving birth feels rather like trying to pass a watermelon, so fears that she is being torn apart by the baby are not surprising). Constant reassurance that everything is all right (provided it **is** all right, of course!) and a commentary on what the first aider can see from his/her end, will help the mother considerably. From the time labour began, she has not felt in control of her body (and indeed she is not!), she is in pain, and she cannot see what is going on, all of which can be disorienting and even terrifying.

After the head is clear, the next big contraction will probably deliver the rest of the baby. The first aider needs to be ready for this – it would not be good for the baby to land with a thud on the ground, and it will be extremely slippery. The baby should be supported, and lifted towards the mother's abdomen as it emerges. Some babies will start roaring their disapproval of the

whole process as soon as their heads are out, but most will wait until they are completely out before they start to breathe. It is an incredible relief to the mother to feel the baby slide free: suddenly the pain and pressure stop. Especially for a first time mother, there may be a surge of triumph that she has 'made it' through the birth. The first aider may be a bit busy to congratulate her yet, but should tell her straight away whether the baby is a boy or girl.

Third Stage

Once the baby is breathing, patted dry and relatively clean and wrapped up warmly, the best place for it is on the mother's abdomen (provided the cord will reach) while waiting for the placenta to be delivered. The cord will continue to pulse for 2 or 3 minutes; when it stops it should be tied off but not cut unless it is necessary to move the baby further than it will allow (e.g. for resuscitation). Once the cord is securely tied, the risk of an accidental tug causing bleeding is eliminated.

The mother will probably be as exhausted as if she has just run a marathon. She may feel messy and sweaty, and will welcome a sponge with a wet cloth – use warm water if available. Gentle massage of her abdomen will assist with bleeding control. The placenta generally takes 10 minutes or more to be delivered. It should be kept for the doctor's inspection, even if it is no longer attached to the baby, because sometimes part of the placenta is left behind; if this happens, a serious haemorrhage could result days or weeks later. If the mother has not fallen asleep, she could now put the baby to her breast: its sucking stimulates the release of a hormone (**oxytocin**) which helps the uterus to contract back to its normal size and reduces bleeding. In hospitals, mothers are sometimes given oxytocin to speed up this process. The contractions will sometimes be painful, less so in a first time mother.

The first aider can now clean up, collecting all bloodstained or otherwise contaminated material for safe disposal. After washing the mother, a pad should be placed over the vulva to absorb blood. Disposable baby napkins are better for this than sanitary pads, which become saturated too quickly. If pads or napkins are not available, a rolled towel or other absorbent cloth will do. If medical assistance has still not arrived, a warm, secure place could be found for the baby so that the mother can relax, have a cup of tea and perhaps sleep. Pulse and respiration for both mother and baby should be checked regularly and written down.

Problems

Cord around neck

When the baby's head is clear, if the cord is around the neck, it can generally be eased very carefully over the head. At this time, it is still carrying blood between the placenta and the baby. It should not be crimped, which would stop the blood flowing, or pulled, which could tear it and possibly cause the baby to bleed to death. If there is not enough slack to get it over the baby's head, but a pulse is still able to be seen or felt, the first aider should wait a little longer: it will be able to be loosened more as the baby is born.

Anterior presentation

The baby usually starts to emerge with its face towards the mother's anus, then rotates to the side for delivery of the shoulders. If the face is to the front, this is not likely to cause a problem. Left to itself, the baby will be born without difficulty.

Breech presentation

If instead of a head, a foot or buttocks appears, the baby may well be in trouble. There is no way it can be turned around; all the first aider can do is hope that the doctor arrives soon. A breech birth baby is not only more difficult for the mother to push out, but is at risk of being starved of oxygen. Its body is squeezed tighter than a sausage in its skin by the birth canal, and its head will be jamming the cord hard against the vaginal wall. Since the cord is attached at the baby's navel and the other end is still within the uterus, some compression of the cord is inevitable. Blood from the placenta may not be able to get through at all, and even if it is not entirely stopped, the flow will certainly be limited by the compression. However, if the birth is completed quickly, the baby may be all right. The first aider generally should not interfere (there may be a temptation to pull on a foot to hurry it up: this should be resisted), but may be able to get the fingers into the vagina once the lower half of the baby is free, and ease the pressure on the cord where the head is compressing it. This is only likely to be possible if the first aider has slim fingers and the mother's vagina is fairly large and elastic. The effect on the baby will depend on how long the cord has been compressed, and the extent to which the flow of blood has been constricted.

Non-breathing baby

Give the baby a minute to start breathing; meanwhile mucus should be gently cleared from its mouth and nose. If it does not breathe, but has a pulse of at least 60, encourage it by patting the back or flicking the soles of the feet while keeping the baby's head slightly lower than its feet to promote drainage of fluids. If a second minute goes by without the baby breathing, expired air resuscitation should be started. If the pulse rate is less than 60, the baby needs cardiopulmonary resuscitation. The normal heart rate of a newborn baby is 120-140 beats per minute. A rate of 60 is too slow to provide adequate oxygen to the brain.

Severe blood loss

Normal postpartum bleeding may seem frighteningly profuse to a first aider who has not attended a birth before. At first, sanitary pads may become saturated within a few minutes. Gentle massage of the abdomen over the uterus will help to control bleeding. There is unlikely to be cause for concern unless the bleeding continues unabated, even after resting and massaging the mother, for more than about 20 minutes.

If there is a sudden gush of bright blood or the flow seems to be increasing instead of reducing, the mother is in danger of bleeding to death. Emergency medical attention is essential. If an ambulance has already been called, but has not yet arrived, a further call should be placed (if possible) to alert the ambulance service to the changed situation: it will now be a 'priority one' call and the ambulance will use lights and sirens if necessary to get there as fast as possible. While waiting, the first aider should treat the mother for shock, reassure her, and keep a frequent check on the vital signs of both mother and baby.

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Lifting and Transporting

Reference:
Australian First Aid
Volume 2,
Chapter 27

In an urban first aid incident, it will not usually be necessary to move a casualty until medical aid arrives. There are some circumstances where the casualty is in danger of further injury, and so must be carried or dragged to a place of safety, in which case removal from danger takes priority over any injury, even a spinal injury. Such circumstances include a burning or collapsing building, and a motor vehicle accident where there is danger from leaking petrol (which may ignite) or from spilled chemicals (which may poison the casualty).

Outside the cities, there is more often a need to move the casualty. A boating or diving accident will often require removal of casualties from the water, and a casualty injured in a wilderness accident may have to be moved to protect him or her from the weather, or to a suitable location for a helicopter pickup to take place. In an isolated or inaccessible place, it may be better to carry the casualty out than to wait for aid. This will depend on the nature of the injuries, the time expected for a runner to summon help and then for help to arrive, and pragmatic factors such as the number of uninjured people available for carrying, the equipment available to make a suitable stretcher, and the terrain to be crossed, which can sometimes be impossible while carrying a casualty. There may also be the need to consider the possibility of injury to the rest of the group if the party remains at the accident site. The decision to go or stay is a leadership decision, and forms part of the situation assessment and action planning which are the leader's responsibility.

Decision Factors

Ambulance is an option

As with any other general principle, first aiders should not adhere blindly to the principle of not moving casualties, but should be guided by it. For example, if a child falls at home or at a sporting venue and breaks an arm or hand, there is no good reason for calling an ambulance unless other transport is not available. Supported in a sling, and splinted comfortably, the broken arm will not be harmed during the journey to the nearest doctor or hospital for treatment. This is true also of a suspected fracture to the foot or ankle, except that in this case, the casualty should not walk but must be carried to the vehicle. When in a location where a properly equipped ambulance is able to be obtained, the main indicators for staying put and waiting for an ambulance include:

- the casualty is unconscious or appears to be losing consciousness
- there is a suspected fracture to the skull, spine, pelvis, hip or thigh
- there is suspected internal damage to the chest or abdomen
- heart attack or stroke is suspected
- the casualty is having difficulty breathing
- the casualty has nearly drowned, and has lost consciousness at some stage
- there are multiple injuries
- there is a large impaled object embedded in the trunk or head
- the casualty has been bitten by a snake, funnel web spider, or blue-ringed octopus, or has been stung by a box jellyfish
- the casualty refuses private transport and asks for an ambulance to be called.

If none of these indicators apply, and the casualty agrees, a private vehicle may be used to go to a medical facility. In the case of poisoning by a venomous creature, where speed of access to antivenom is a factor in the outcome, it may sometimes be best to take the casualty to medical aid: other factors may counteract the value of keeping the casualty totally still. For example, if someone must drive to the nearest town to seek help, and the vehicle has room enough for the casualty to lie down inside, it may be more sensible to save the time which would be required for the ambulance to make the return journey. In this case, the pressure immobilisation bandage and splint must be put in place

first, and the casualty must not walk to the vehicle, but must be carried.

Any movement will increase the rate at which the heart beats and raise blood pressure; so will anything which causes pain, anxiety or stress. Being lifted and carried, whether by people or on a stretcher, is stressful and more painful than lying still, and may have a deleterious effect on the casualty's condition. During transport, whether by vehicle or carrying, there will be some bumping, lurching or swaying due to the terrain. Ambulance vehicles are designed to minimise this, and the casualty will have the comforting knowledge that the ambulance and its crew are fully equipped to deal with anything that goes wrong. If the leader decides that circumstances warrant bringing the casualty to medical aid instead of waiting for aid to arrive, time and effort should be invested in preparing the casualty for the journey, emotionally as well as physically. Knowing what to expect will help the casualty to remain calm and in control.

Ambulance cannot access casualty

If the location of the casualty is such that there is no vehicle access to the site, the decision will be whether to move the casualty to a more accessible location, or to call in professional rescue services to do the moving. Sometimes the answer is obvious: if the accident occurred half way down a cliff, or 20 kilometres from the trail head, it may not be possible for the group to bring the casualty out. Alternatively, a casualty with an upper limb injury may be able to walk quite well, or it may be that there is greater danger in staying at the accident site than in moving a short distance to an access point. In those areas with reception, a mobile phone is an invaluable piece of equipment for all such parties.

When one member of a group is injured or becomes ill in a remote area, the safety of the whole group may be put at risk as a result. It may be 3 days to the trail head while everybody is fit and well, but may be a week or more if somebody has to be carried. A casualty suffering from gastroenteritis can infect the whole group. There may not be enough food and water for a journey which is extended much longer than intended. The leader will have to decide whether the whole group should remain and wait for rescue, or whether the whole group should take the casualty and move part or all of the way out, or whether some should remain while others go for help. The factors involved in deciding will include the nature of the injury or illness, the number in the group, the safety of the site and how far it is from the trail head, and the terrain to be covered. If help has to be summoned, as a general principle the most capable first aider should be the one who remains with the casualty.

NATURE OF THE INJURY

Considerations include whether the casualty is able to walk (alone or assisted), how urgently medical aid is needed, whether moving or staying is likely to be the more harmful option, and whether the casualty is fully conscious and able to cooperate. Any diver with an impaired conscious state must be kept horizontal until expert medical treatment is available.

NUMBER IN THE GROUP

At least six people are needed to carry a stretcher if the distance to be travelled is more than a few hundred metres. If there are less, and the casualty must be carried, another option should be preferred. If there are six people or more, and the distance is no more than 1 or 2 kilometres over easy or moderate terrain, a stretcher is an option provided there are materials to construct a suitable one.

If there are only three in the party, and one is injured, it is risky to send someone alone to get help, but somebody must stay with the casualty; unless there is a clearly marked trail and the distance is fairly short, it is safer to stay and wait for rescue in most cases. Two people could not carry another very far over rough terrain, so another option should be chosen.

SITE OF THE INCIDENT

The site at which the casualty was injured or became ill will be an important factor in the decision. A steep or exposed site is not suitable for the party to remain for any length of time; if the casualty is not to be carried out, the group may still have to move to a better position while awaiting rescue. Aspects of the site which need to be considered include whether the group will be found easily if they stay put, whether there is shelter, whether the casualty can be made comfortable while waiting, how far it is to a better site, and whether the site is safe (e.g. a dry creek bed may be level and sheltered, but unsafe because flash floods are unpredictable).

TERRAIN

Accidents may happen anywhere, and the terrain to be crossed in an evacuation will be an important factor. The casualty may have to be extricated from a cave, or carried down a mountain, through thick scrub, or across water. Occasionally, the way out may be over level ground on a well marked trail. If the terrain is difficult, the distance a casualty can be carried is very limited and the risk of injury to other members of the group is high. Except for short distances, difficult terrain is an indicator against carrying the casualty and in favour of sending part of the group for help. In rough country rescuers may find it hard to locate the party

without guidance. This is an indicator against having the whole group remain, unless there are too few for the party to be split safely.

TRAVELLING TIME

The time required to reach help may be well known when estimates are based on people in good condition. It is impossible to estimate accurately the time required to carry a stretcher over the same distance, except that it always takes longer than anticipated. If the group is deep in wild country – perhaps several days away from help – it will generally be better to send two or three members to get aid, while the rest wait with the casualty. In a large group (say, ten or more people), the leader will need to consider whether it would be better to carry the casualty out, since there are plenty of helpers; however, if it is a long way, the time to reach help will be extended and supplies of food and drinks will become significant. In this case, it will probably be more efficient to send most of the group out, leaving perhaps two to look after the casualty.

RELATIVE SIZE AND STRENGTH

Six cub scouts would not be able to stretcher their scoutmaster even a few hundred metres out of the bush. Two scoutmasters could probably stretcher one cub for several days. It is always an advantage when the casualty is the smallest and lightest member of the group. Unfortunately, Murphy's Law operates in first aid too, and the casualty always seems to be the largest and heaviest. If an accident happens late in a difficult excursion, other members of the party may have impaired strength and fitness; this needs to be taken into account when deciding whether to go or stay. Members of the group may be fit enough to finish the trip without problems, but the additional effort required to carry the extra weight of the casualty, perhaps splints, a stretcher and all the casualty's pack may be just too much for them. If the group is tired, this is an indicator that waiting for help is preferable to attempting to take the casualty out.

Repositioning the Casualty

Whether in an urban or bush setting, the casualty will sometimes have to be repositioned even when remaining at the site to wait for medical aid. Real casualties, unlike simulated casualties in training classes, are rarely found lying neatly on their backs in a convenient position for examination and management of injuries. In a road accident, the majority will probably be sitting in their

seats, perhaps supported by seat belts, and unless the vehicle's frame is distorted the first aider will be able to access injuries; these casualties will usually not need to be moved. The car seats are comfortable, the casualties are protected from weather and the risk of further injury, and if the head of an unconscious casualty is tilted, the seat back is high enough and at an angle which will support the neck and head in a suitable position to keep the airway open.

An injury at an indoor sporting venue or a playing field will not present too much of a problem; the ground is likely to be level, there will be others to help, and since the most common injuries are to limbs, it is likely that the whole body will not have to be moved. If the casualty has been 'knocked out', the only movement necessary will be to place him or her on the side, but the technique for this may have to be adapted to roll the casualty from prone, instead of from supine. In this case it will be easier to use the coma position than the lateral position, because the coma position will only require that the upper arm and leg be adjusted, whereas the lateral position will require rolling the body over the lower shoulder and pulling the arm underneath.

If the casualty has fallen from a height (e.g. off a roof, or down a cliff), the position of the body is just as likely to be folded or prone as supine. There is also a chance that the casualty may be lying over a large object, such as a boulder or piece of machinery: this is not a desirable position in which to await medical aid. For a start, it will be painful as the hard object presses into the underside of the casualty; the chest may also be compressed causing breathing difficulty, and it will be impossible for the first aider to check for concealed injuries without repositioning the casualty's body. Check, if necessary by feeling under the casualty, for anything which might be impaled. If the casualty is impaled on a large or immovable object (such as a fence), the first aider should not attempt to move the person, but should wait for expert rescuers to arrive.

Relocating the Casualty

A casualty who has been injured during an activity such as bushwalking may finish up in a bush or tangled in scrub. There may be trees and rocks which prevent him or her from resting comfortably. The anticipated wait may be several hours, and the casualty may be exposed to cold winds or burning sun, or it may be raining. In these cases, a more suitable place for administering first aid and waiting for help will need to be found. Generally, if medical aid will be delayed for more than a few minutes, some

insulation will always be needed between the casualty and the ground. In severe weather conditions, such as in the snow where the ground is cold and wet, or in the outback, where the ground is hot and biting insects such as ants are abundant, a mat of some kind should be placed under the casualty straight away. Relocation will also be required when the casualty or rescuers may be endangered, for example by falling rocks in a climbing accident, or approaching vehicles in a road accident.

When medical aid is delayed, the casualty must be protected from the weather to prevent deterioration in his or her condition. Sometimes it is possible to construct a shelter around the casualty; often the casualty must be moved to a more easily protected place. To do so will mean that the casualty must be lifted, carried and lowered without making the injuries worse or putting the carriers at risk of injury.

Casualty horizontal

It is particularly important when there is a possible spinal injury to keep the whole body straight and immobile. When the casualty is a diver, his or her body must be kept horizontal. For either of these injuries, lifting should only be attempted if there are enough people available to do the lifting safely, and if the right equipment is available to maintain the necessary position.

For other injuries, two adults can lift a light casualty if necessary, although three would be better. If there are only two, and the casualty is to be carried, the lifters kneel on one knee on the same side, inserting their forearms underneath and lifting in unison (like a forklift truck). The casualty's body can be kept straight if necessary during the lift, and rolled against the chests of the carriers who can then move a short distance to the target position before reversing the lifting procedure to lower the casualty. When there are three or four carriers, they will be positioned alternately on either side of the casualty, and will find it easier to walk with the casualty held at shoulder level. If the lifters are not of similar heights, the shorter lifters should be placed at the feet end. If the casualty is just being lifted a little so that insulation or a stretcher may be put underneath, the lifters are all positioned on the same side of the casualty, who is supported on the lifters' thighs while this is done. This minimises movement of the casualty, but is only possible if there are enough helpers so that one is not needed to lift. For all lifts, a leader should be designated to give set commands for the lift. The procedure should always be rehearsed several times; a mistake can result in the casualty being dropped.

If the casualty does not have to be kept absolutely straight, and a blanket (or similar large piece of material, such as a tarpaulin) is available, the casualty can be rolled to one side while the blanket is placed under one half, then rolled to the other side while the blanket is pulled the rest of the way across. This is a standard technique which then allows the casualty to be carried using the edges of the blanket as handles, and is fairly comfortable for the casualty. Because the rolled edges of a blanket do not provide very good grip for the carriers, this method should only be used for short distances.

When the casualty is in a confined space which does not permit multiple lifters (e.g. in a cave), or when it is necessary to keep low (e.g. in a tunnel or pipe, or in a fire), a casualty who is not mobile will probably have to be dragged along. If conscious, the casualty will be able to help by clasping his/her wrists over one of the rescuer's shoulders and under the other; if unconscious, the wrists may be tied together and put into this position. The rescuer crawls along, straddling the casualty. This is a most uncomfortable position for both casualty and rescuer and would only be used when no other method is suitable, and then only for short distances.

If the first aider is alone, it may be necessary to pull the casualty clear of danger. If strong enough, the first aider can accomplish this by gripping the casualty around the body under the armpits and walking backwards. This is exhausting, and can only be sustained for a very short distance. It is easier, as well as more comfortable for the casualty, if a blanket or other material (even a towel will do) can be placed underneath, and the blanket pulled like a sled.

Casualty upright

Single person carries can only be used when the casualty is lighter than the rescuer. A child can be cradled in an adult's arms, or carried 'pickaback', an adult can be supported ('human crutch') or carried on the back if the rescuer is strong and the distance is short. The 'fireman's lift' is no longer recommended by St John because it may inhibit the casualty's breathing, and the rescuer may strain the back while getting the casualty into position. Another position which is only recommended by most authorities for carrying conscious casualties who are much shorter than the rescuer is the 'potato sack lift'. The casualty and rescuer are face to face, the casualty puts his or her arms around the rescuer's shoulders, then the rescuer embraces the casualty around the hips and lifts. The casualty would ideally grip the rescuer's waist with the knees, but in practice may be unable to do so, in which

case this position puts too much strain on the rescuer's back (because all the weight is hanging forward from the shoulders). This position is suitable for carrying an older child, and is the usual method used by mothers to carry their children once the child is too big to be cradled. With a tall casualty, the rescuer's sight will be obstructed.

Two, three and four person carries are used when the casualty does not need to be kept horizontal, and the terrain is suitable. On a narrow trail, only a fore-and-aft carry may be possible, while in open areas, a four-handed-seat puts the least strain on the carriers. The main problem with all multiple person carries is that the link, which bears the casualty's weight, consists of the rescuers' hands and wrists. The rescuers may be at risk of losing their balance on rough ground and falling, and the supporting hands will tire very quickly. These carries are therefore suitable for short distances only, but have the advantage of being quick to perform.

Principles for Lifting and Carrying

Mechanical handling principles should always be applied when lifting a casualty. The general principles are to align the feet, hips and shoulders and lift vertically, so that the force is in the direction of the long bones. The human skeleton is designed for vertical strength. The most powerful muscles are laid along the bones, and achieve maximum power when the force against which they are working is directly opposed to the direction of their contraction. The lifter should not lean forward or twist the body: this may cause injury to joints, especially in the back.

When carrying a stretcher for more than a short distance, it is better to rig up carrying-straps using packs or rope than to hold the stretcher with the hands. Using the hands tilts the carrier's body, and the heavy weight causes the hand muscles to cramp, as well as impairing circulation to the fingers. Nylon webbing from a backpack is an ideal carry strap, or the end of the stretcher may be able to be fixed to the waist strap of the pack. The carry strap is fastened to the stretcher and looped over the carrier's opposite shoulder like a bandolier. This spreads the weight more evenly on back and shoulders, and leaves the hands free. Furniture removalists always use shoulder straps to lift and carry heavy objects.

A one or two person carry can be made easier by using straps or a coiled rope. By looping the strap or rope over the shoulders, the carrier may be able to distribute the weight and make the journey more comfortable for the casualty. For example, in a two

person carry where a coiled climbing rope is available, the coil is divided to make a figure eight shape. With the knot between the carriers, and the loops placed over the carriers' outer shoulders, a reasonably comfortable seat is made between them for the casualty. The rescuers' hands are free, and because the weight is across the shoulders and back instead of all on one side, they will tire less quickly and are less likely to strain any muscles.

A single carrier can loop a strap across the shoulders and under the arms, making a sling type support for carrying a casualty on his or her back. This position is less likely to impair the casualty's circulation, and will be more comfortable, than a back carry without straps.

14 Major Incidents

Reference:
Australian First Aid
Volume 2,
Chapters 22 and 27

It does not happen often, but when a major accident occurs and a first aider is in charge for some time, it is vital to know how the incident should be managed and to have a plan. If a disaster occurs in an urban area, first aiders will at most be helpers; emergency services will quickly be on the scene and will take charge. It is only in remote rural locations that a first aider may have to cope without assistance for an hour or more. Possible examples could be a tour bus or plane crash in the outback, a mine accident such as an underground explosion or cave-in, or an explosion on a pleasure boat or ship at sea. In these examples, there may be dozens of casualties, many with serious injuries. Of less magnitude, but of no less importance, are incidents which could occur to a group involved in recreational activities in remote areas. Examples include climbing accidents where several people fall, or are injured by a rock fall, vehicle collisions where there are multiple casualties, and treks where an illness such as food poisoning strikes the whole party.

Triage

Triage is a concept devised originally by the French for military purposes. The system was intended to return as many wounded soldiers as possible to active duty in the least possible time. When organising the evacuation of the wounded from a battlefield, the medics selected those with minor injuries which would respond quickly to treatment to go first; next came those whose injuries were such that they could recover if treated, but who would be slower to heal and who would tie up more resources; then those who could live with treatment, but who would be of no use to the army in future, such as those with permanent damage to limbs or spine; and finally those who were unlikely to survive even with treatment, such as those with severe damage to head, chest or abdomen, and those who were already dead or nearly so. This approach is still used in disasters such as major earthquakes (such

as the one which occurred in Mexico City), where the number of casualties exceeds the facilities available to treat them, and the rescuers will not be able to get everybody out. It would also be applied in a situation such as a nuclear bomb attack on a city, where there would be thousands or even millions of people injured, and rescuers would have to give priority to those most likely to survive if rescued.

The original concept of 'minor injuries first' is now known as reverse triage. Triage has now come to mean any system by which casualties are classified into priority order for treatment or evacuation. Hospital emergency departments have a triage officer who assesses incoming patients and classifies them according to how urgent it is for them to receive medical attention. Those whose illness or injury will not be made significantly worse if they have to wait, go to the bottom of the list. Those who need urgent attention if they are to survive, for example a patient with a torn artery, or who has an obstructed airway, receive immediate attention.

At an accident scene, if there are too many casualties to be evacuated to a hospital in one lot, triage is applied to determine which should have priority. Again, urgency takes priority over seriousness of injury. A casualty with a fractured spine generally has lower priority for evacuation than a casualty with internal abdominal bleeding. The latter will perhaps recover fully with immediate surgery in a hospital, but may die if left for an hour or more, while the former may be paralysed for life regardless of whether treatment begins at once or several hours later. The spinal injury is the more serious in terms of outcome, but the internal bleeding is more urgent in terms of the need for medical treatment. A casualty struggling to breathe through a damaged windpipe would have priority over a casualty with a severed limb: in this case, both require urgent surgery, but a life takes precedence over a limb.

The principles of triage do not only apply when there are very large numbers of casualties. In a road accident, there may be only three or four people involved, but triage must still be applied because the casualties outnumber the rescuers. It is in a situation like this that a first aider may find it very difficult to maintain a logical and objective viewpoint. Someone who is not breathing and has no pulse could possibly survive if effective CPR could be carried out until an ambulance arrives with a defibrillator. But someone who is now living might die if the first aider denies them treatment in order to start CPR on someone who may be irretrievably dead. The first aider does not know what caused casualty X's heart to stop beating: there may have been a major heart attack or stroke, and casualty X could have been dead even before the collision occurred. But casualty Y, who has serious bleeding from a broken femur, and casualty Z,

who has a broken nose and is lying back unconscious and making gurgling sounds, are certainly alive. They must take precedence over casualty X. Such scenarios loom large in the imagination of many first aiders, but fortunately are rare in practice.

Taking Control of the Scene

The first aider who comes upon an accident where there are multiple casualties should first take a few seconds to assess the scene. What seems to have happened? Are there people looking on who do not appear to have been involved in the accident, and who may be able to be recruited as helpers? Were many people involved, and if so, how many seem to be injured? Is anyone trapped so that the emergency services will need to bring equipment to extricate them? Does anyone seem to be taking charge? Is there a source of danger, such as fallen power lines or leaking petrol?

It may be helpful to announce clearly that one is a first aider, and ask whether any bystanders have first aid training. If so, they could be asked to assist with a primary assessment of the casualties. Each helper should be directed to specific casualties. A bystander could be selected to collect information from the helpers about the number of casualties, major injuries, and whether any are trapped. The bystander should then be asked to go through the information which is to be given to emergency services, before sending or telephoning for help. Bystanders may also be useful even if untrained, in checking that no casualties are overlooked, in helping to roll unconscious people on to their sides, and assisting with application of pressure to stop bleeding.

Organisation of the scene will depend on the location of the accident and the first aider's judgment of how long it is likely to take medical aid to arrive. If there are a lot of casualties who will need to be taken to hospital, for example when a bus or train has crashed, they may need to be sorted according to triage principles, because they will not all fit in the first available ambulance. If aid is likely to be delayed for an hour or more, the casualties may need to be moved, either for shelter or comfort. In this case, they should be grouped according to their injuries (as far as possible: any attempt to separate families would not be appropriate).

When medical aid arrives, ideally the first aider should be able to supply to the doctor or ambulance crew basic details for each casualty, covering injuries identified or suspected, vital signs observations, exactly what has been done for each, and any critical information such as known allergies, medications currently being taken, and the time at which the casualty last ate or drank. If this

information travels with the casualty to hospital, it could save the doctors vital time in commencing treatment. Recorded neatly and clearly, such information could save a life, but if it is scrappy and illegible, the doctor will discard it as useless. It is a good idea to carry a supply of suitable casualty record forms in the first aid kit: drawing them up amidst an accident scene may be difficult.

As soon as a more qualified person arrives at the scene, the first aider will be able to hand over leadership of the rescue effort to that person, together with a report on what has been done so far. Occasionally, when the emergency services arrive, the first aider may feel 'brushed aside', particularly if he or she has been in charge for some time, and is tactlessly ordered to stay back with the spectators. This is less likely to happen if the scene is calm and well organised when aid arrives, and the first aider has casualty reports ready. If it does happen, the first aider should offer to continue giving assistance, but if this is refused, must cede the field to the more qualified rescuer.

Emotional Distress

Uninjured, irrational people

Any traumatic event is sure to have a significant emotional effect on those involved, on those who helped, and even on those who just saw what happened. People who are irrational from fear or fright at an accident scene present some difficulties for first aiders. There may be seriously injured people to assess and manage urgently. The last thing needed is distraction or interference by an uninjured person who is highly agitated.

Contrary to the stereotype, a hysterical person is not always female. Males are just as susceptible to the effects of a serious accident, and are harder to control because they are frequently bigger and stronger than females. There may be good reason for the agitation: a loved one may be hurt badly, perhaps dead, or trapped inside a crashed vehicle. The distressed person may not realise that someone is helping, or may regard the first aider's priorities as wrong. Sometimes there is no obvious reason for the hysteria: it may be the result of a traumatic event in the past, which now surges back to overwhelm the person ('flashback').

If an uninjured, but very agitated, person is preventing the first aider from concentrating on attending to serious injuries, his or her removal from the scene has a high priority. A calm bystander should be recruited if possible, to remove the nuisance gently but firmly. The bystander should remain with the distressed individual, speaking soothingly and giving continual reassurance that everything possible is being done. As soon as the first aider has time, he or she should make a point of

explaining what has been happening, telling the person what injuries there are to friends or family members, and asking for cooperation in looking after them until the ambulance arrives. Sometimes, giving a person something useful to do will help to control rising hysteria. Even if it is only to hold a casualty's hand, or to write down observations of skin colour etc. at regular intervals, action is the best remedy for emotional lack of control.

A person who is screaming and shouting, and perhaps trying to get to a casualty, may resist being led away. It is possible that two or three helpers will be needed to manage the screamer, and to keep him or her away until some measure of self control is regained. If there is nobody to help, the first aider may have to leave a casualty unattended for a moment, to try to stop the hysteria. It may help to point out that the casualties need help, and this behaviour is preventing them from getting it; then suggest tasks which 'could be done, but only if you calm down and stop frightening the casualties'. If nothing works, the first aider will simply have to carry on as well as possible, constantly watching for any attempt to do something which could endanger a casualty.

After effects

When the emergency services have arrived, the casualties have been taken away and the crowd disperses, the first aider may find that a reaction sets in. After being calm and controlled, and managing others who are distressed and injured, the first aider now usually needs a little 'minding'. Sitting down in a relaxed atmosphere with friends or colleagues, and telling them all about it, may provide relief. Sometimes, this is not enough. Members of emergency services, including police and ambulance officers who attend traumatic scenes frequently, are now automatically scheduled for counselling after assisting at such a scene. For the first aider, who is not used to dealing with major accidents, and may have been terrified the whole time, perhaps only keeping going by exerting enormous self-control, the post-trauma distress may be unanticipated and overwhelming. He or she may not know where to go or who to ask for help, may feel guilty at wanting help and embarrassed at needing it.

Sometimes, first aiders may not recognise that they are suffering from post-trauma stress. The accident scene may be returning in dreams, they may find themselves constantly going over the incident, worrying about what was not done, or what could have been done better. They may have made mistakes at the time, and now be feeling guilt at 'getting it wrong'. They may withdraw from friends who 'were not there and don't understand', or may talk about nothing but the accident until their friends start

to hide when they see them coming. All these are symptoms of stress, and are similar to a grief reaction. Such a reaction is normal, and can be overcome. Debriefing is always helpful; post-trauma stress is better prevented than cured. It may be possible for the first aider to attend debriefing along with professional emergency services personnel. If this is not possible, and if professional counselling is not available through an employer, the centre where first aid training was undertaken will be able to help, and should be contacted even before indications of stress become apparent.

15

First Aid in Remote Areas

Reference:
Australian First Aid
Volume 2,
Chapter 25

In any area where there is ready access to medical facilities, it is not the first aider's place to diagnose and treat illnesses and injuries, but rather to manage the illness or injury until a doctor can take over and treat it. When isolated from medical assistance, the first aider may need to deal with illness or injury, not only at the onset, but sometimes for hours or days. A remote area does not have to be in the outback. Any area which is isolated in terms of time as well as distance from aid is remote. This could mean a hiking excursion in a national park, where because the only transport is one's feet, and the country is rough, it could take days to reach aid when the group is slowed down by an ill or injured member. Even in fairly closely settled areas, a person going to get help for an injured companion could take several hours to reach the trail head, contact emergency services, and bring the rescuers back to the accident site. In areas which are isolated by distance as well as time, it may be days before help arrives.

Techniques for managing first aid incidents in remote areas are similar to urban techniques, but extra or extended skills are called upon. A casualty's condition is not static, and observation and recording of changes become significant. Decisions may have to be made by the group leader about whether the casualty can continue on the activity, or whether the activity should be abandoned in order to get the casualty to medical aid. Minor problems, such as a cold, are usually self-treated at home, and may not interfere with a person's daily activities. When hiking in the mountains, a 'mere cold' will cause some interference, and may cause the expedition to be abandoned. At best, the group will be slowed down because the casualty will become fatigued more easily. At worst, someone may be seriously injured because

the person with a cold is not fully fit, and loses concentration or becomes careless at a critical time.

If the decision is that the casualty's condition is minor enough to be managed while the expedition continues, or so serious that the group must stop and send for help, there are general principles which apply to all treatment in the field. These include:

1 Always tell a casualty who is a stranger that you are a trained first aider and ask for consent before starting any treatment. Consent must be assumed if the casualty is unconscious or the casualty is a minor and you are *in loco parentis* (e.g. a teacher in charge of a school excursion). If a conscious adult refuses help, any treatment could be interpreted as an assault.
2 Always explain what you are doing and why; even an apparently unconscious person may be able to hear.
3 Do not attempt a procedure beyond your training unless directed by a doctor (e.g. giving an injection on instruction *via* mobile telephone or radio by the Royal Flying Doctor Service).
4 Stick to the methods you have been taught; creative treatment may become 'unusual medical treatment' or 'practising medicine without a licence', and can often do more harm than good.
5 Generally, give no new medication that the casualty has not been previously prescribed. A casualty who has a chronic condition such as angina or asthma will usually be carrying medication on an expedition to a remote area. Assistance with administration may be needed if the attack is severe and the casualty requests it.
6 In remote areas, the general principle is still to move a casualty only if necessary. In practice, it will rarely be possible to avoid some moving. In the outback, there are ants and other insects; in the mountains, the ground is likely to be cold. In forests, people are inconsiderate enough to have accidents in uncomfortable or inaccessible spots. In any remote area, shelter is the first consideration for survival. The principle for remote areas is thus to **minimise** movement.
7 Document **everything**. Whatever aid is given, write down what was done, what time it was done, and what it was for.
8 Any unconsciousness, except simple fainting, requires assessment by a doctor, even if the casualty seems to be fully recovered.
9 Any burn where blistering or charring occurs, which is larger than a 50 cent piece, requires removal to medical aid. This is especially important if the burn is to the hands, face, feet, over skin creases, or around genitalia.

10 Until proved otherwise, an unconscious person is assumed to have a spinal injury, and should be managed accordingly.
11 A dislocation should never be reduced in the field unless:
- it is a finger or toe
- the person has a history of frequent 'popping out' of the joint and asks you to help
- there is no distal pulse and medical aid cannot arrive for more than 30 minutes
- there is a distal pulse, but medical aid is more than 24 hours away

and then only if:

- the first aider has been trained in correct techniques.

Steps in Casualty Assessment

The steps in casualty assessment are:

1 Primary assessment
- check for danger
- check for response from casualty
- check airway, breathing and circulation
- check for major bleeding.

2 Secondary assessment
- examine head to toe
- note vital signs
- SHAM (Symptoms, History, Allergies, Medications).

3 Take action
- manage shock
- make a plan
- treat injuries
- organise evacuation where necessary.

Minor Illnesses and Injuries

The key skill needed by first aiders encountering minor illnesses and injuries is the ability to distinguish between situations where medical assistance is needed and situations where home remedies are sufficient. St John teachings usually concentrate on emergencies, where there is a serious illness or injury and skilled first aid administered at once may have a beneficial effect on the casualty's recovery. The distinction is sometimes made between

management, which is the first aider's role, and treatment, which is the prerogative of professional medical personnel. If medical attention is readily available, it is not the first aider's role to 'play doctor'.

Such a decision is more of a problem when medical aid is a long way away or hard to access. A stomach upset or a 'bit of the runs' may seem insufficient reason to terminate a week's bushwalking trip only two days out, and blisters are unlikely to be considered a good reason to spoil the whole party's fun. A small cut or scratch, a localised rash or chafing of the thighs generally would not require professional attention, but can ruin an excursion if untended. In any group, someone always seems to get a cold while on holiday, and in every family there seems to be a child who is always scraping a knee.

Management of Wounds

Wounds can be defined quite simply as a break in the continuity of a tissue. Whilst a high percentage of wounds involve the skin and are thus able to be seen as an open bleeding wound or a bruise, wounds of underlying tissue such as muscle or bone can be more difficult to detect.

Management considerations

With all wounds, prevention of cross infection is a high priority. There are several important considerations for the first aider regardless of the type of wound.

BLOOD LOSS CONTROL

Some wounds will bleed much more than others depending on their size, depth and location. The critical element where bleeding is present is that it must be stopped as quickly as possible.

INFECTION

Wound infection is potentially as serious a threat today as it was in the past. It has the potential to prolong wound healing, cause the individual to become generally unwell through the toxins produced by bacteria, and in some cases may result in death. Extensive wounds that are impregnated with dirt are perceived by most people to be at risk of infection, but small penetrating injuries, such as may be sustained when one treads on a nail, are potentially as dangerous.

All penetrating wounds and deep wounds, no matter how small, are at risk of infection. In these wounds, dirt and other

debris can be carried into the wound at the time of injury and remain there, often covered by folds of tissue. The risk of infection in these cases is quite high and includes such infections as tetanus and gas gangrene. The organisms causing these thrive in an environment that is low in oxygen. Penetrating and deep wounds often 'close over' themselves, creating areas where little oxygen is present and thus enhancing the risk. These wounds, as a matter of urgency, need to be assessed and treated definitively by doctors.

INJURY TO UNDERLYING STRUCTURES

Damage to underlying structures such as muscles, tendons, nerves, joint cavities and organs may occur as a consequence of some wounds.

Crush injuries and deep or penetrating wounds should be suspected as having caused underlying tissue damage. The remote area first aider in particular must recognise that injuries which are not visible may have occurred and that these injuries may be life-threatening or capable of severely disabling the casualty. Professional help must be obtained as soon as possible. It must be borne in mind that definitive examination of a deep or penetrating injury can only be undertaken by a physician who has adequate equipment available.

Types of wounds

For the first aider the most important distinction that must be made about the type of wound is that between a superficial and deep wound.

SUPERFICIAL WOUNDS

Superficial wounds are those that involve the skin only. They do not penetrate through to the underlying fat layer.

Whilst first aiders can manage small superficial wounds (that is, in the case of a cut, one that is no greater than 2 cm long) it must be acknowledged that superficial wounds do pose dangers to the casualty. Superficial wounds, like any other wound, can become infected. In the case of a cut which is longer than 2 cm, the wound may require definitive cleaning and closure.

Abrasions, though superficial, can be dangerous due to infection and shock when they involve large areas of the body.

DEEP WOUNDS

Deep wounds are those where the wound has penetrated through the skin into the fatty layer. All deep wounds need to be investigated by a doctor.

First aid management of wounds

SUPERFICIAL WOUNDS

Superficial wounds where bleeding is not a problem should be thoroughly cleaned by washing them under running water with soap or a proprietary cleaning agent.

The first aider should wherever possible wash his or her hands thoroughly before attending to the wound. Disposable gloves should be worn. Ideally the wound dressing should be non-stick and sterile but in the absence of such dressings the wound should be covered by any clean material, for example an unused handkerchief. Small superficial wounds where the edges are separated may, after cleaning, be closed by applying suture strips or thin pieces of tape across the wound and pulling the edges together. A risk of infection prevails where there is any break in the skin and it is recommended that an antiseptic such as Hibitane, Savlon or Betadine (Povidone Iodine) should be applied. Betadine is a slow release iodine based solution that needs to be reapplied when it begins to fade from dark brown to a lighter colour. Some people may be allergic to iodine, so if it is to be used, it is wise to apply a small amount of Betadine to a small patch of skin on the forearm as a test. If they are going to occur, most reactions will do so within a 30 minute period.

DEEP WOUNDS

The most pressing problem with many deep wounds is blood loss which must be stopped as a matter of urgency. In those deep wounds where bleeding is not a problem, the remote area first aider, to help protect the casualty from infection, may have to start cleaning the wound. It must be emphasised that in principle the wound should be interfered with as little as possible, but if aid is going to be delayed and the wound is contaminated with obvious dirt and debris, cleaning is important. Deep wounds are often best cleaned by irrigating them with water. Boiled water that has been allowed to cool can be poured over the wound to wash out dirt and debris.

Hydrogen peroxide in a 3% solution is viewed by many as a good cleaning solution. When poured on to a wound the peroxide solution begins to disintegrate causing a bubbling to occur. The mild agitating effect of the bubbling can loosen and remove dirt in a deep wound. Once the bubbling stops (this takes only a few seconds) a scumming residue is often seen.

This residue can be removed by irrigating the area with a small volume of water. Again it must be emphasised, if during cleaning of a wound bleeding is noticed, stop the cleaning procedure and stop the bleeding. No attempt should be made by

a first aider to close a deep wound regardless of how small the surface area may be. The danger of infection, which can be potentially life-threatening, cannot be overemphasised. Deep wounds are extremely difficult to clean, and history has shown that failure to clean a deep wound completely has an associated risk of infection.

Wound infection

Wound infection is more of a risk in penetrating and deep wounds, but can occur in any wound, causing in some cases discomfort and debilitation out of all proportion to the initial injury. These infections can develop within hours of the injury. In remote areas all wounds must be cleaned and wherever possible an antiseptic solution should be applied and the wound protected from further trauma and contamination by the application of a dressing.

FEATURES OF WOUND INFECTIONS

Any person with an infected wound may develop local and systemic symptoms, including:

- redness and swelling around the wound
- the affected area is tender and hot to touch
- there may be pus or an offensive smelling discharge
- the individual may complain of pain from the nodes in the groin or armpit
- a general feeling of being unwell with headache, lethargy, loss of interest and elevated temperature.

A casualty with an infected wound who is complaining of feeling unwell and is hot to touch must be viewed as being seriously ill. Urgent medical aid is required.

MANAGEMENT

In caring for the casualty the remote area first aider must:

- rest the casualty
- keep the wound as clean as possible and change the dressing regularly if it is becoming soaked with drainage. Treat the used dressing as infective
- elevate and splint the area if the infected wound involves an arm or leg
- if treatment is to be delayed longer than 4 hours give the casualty small frequent sips of water, for example 50–100 ml (1/2 cup) hourly

- in the event of an elevated temperature sponge the casualty with cool water to bring the temperature down.

Summary

All wounds in remote areas must be treated appropriately as soon as possible after they occur. The risk of infection and the debilitation that it may cause are always there and must be anticipated by the first aider. All deep and penetrating injuries should be investigated by a doctor and appropriate medical care given as soon as possible after the injury. Closure of deep or extensive wounds, e.g. wounds over 2 cm long, is not done in the field. This type of wound always requires medical attention.

Minor Illnesses: Management in the Field

In the comfort and security of our own homes, with all that we may need readily available to us, the so-called minor illnesses, whilst uncomfortable and at times painful, are generally easily managed, pass quickly and pose little, if any, danger to the individual. In remote areas, where a person suffering from a minor illness has to contend with foul weather, limited resources and perhaps the need to travel over difficult terrain, the situation can quickly become quite different. The casualty may tire more easily, have poor concentration and lose interest and motivation for the task at hand. The minor illnesses in remote areas have the potential to incapacitate, promote errors of judgment and in some cases progress to more serious conditions. It is prudent to deal with them early.

Included in the minor illnesses are:

- head colds
- sinus congestion
- earache
- styes and inflammation of the eyelids
- toothache
- sore throat
- skin irritation
- urinary tract infections.

Casualty assessment

Assessment of the casualty's condition is critically important. It is from the information gained by the first aider that decisions

concerning what is the most appropriate course of action can be made.

When assessing a casualty the acronym SHAM may help to ensure that everything is covered. SHAM stands for Symptoms (and Signs), History, Allergies, Medical conditions.

General observations will supply information about symptoms and signs.

SYMPTOMS

Note the general demeanour, for example:

- Are they in obvious pain? If so, where does it hurt?
- Are they distressed?
- Do they look tired or ill?
- Do they have a fever?

HISTORY

Ask the casualty for the history of the incident:

- What is wrong?
- When did it start?
- Have you had anything like it before?

ALLERGIES

Ask about known or possible allergies:

- Do you know of anything to which you are allergic or particularly sensitive (tablets, creams, lotions or tape)?

MEDICAL CONDITIONS

Ask about medical conditions, and check whether they have any medications which they have been taking, or which they should take but have not:

- Do you have any medical conditions?
- Do you currently have any medication, either prescribed by a doctor or 'over the counter'?
- If they have medication, when is it supposed to be taken, and when was it taken last?

Caring for the Casualty

In caring for a casualty in a remote area the first aider may have to use techniques that are not taught in general first aid courses.

HEAD COLDS AND SINUS CONGESTION

The individual with a head cold is best advised to rest and drink

plenty of fluids, preferably clear fluids in preference to tea and coffee. Paracetamol may offer some relief for headaches, general aches, pains and fever.

Prior to the casualty taking the drug the first aider should determine whether or not they have taken the drug before and if so, that there were no side-effects, for example, skin rash, itchiness, breathlessness, etc. In principle, if people are to take an analgesic they should take something that they have taken before.

To relieve a blocked or 'stuffy' nose and blocked sinuses, inhalations can be of assistance. By adding small quantities of eucalyptus oil or proprietary substances to hot water, the first aider can provide a warm, moist inhalation that soothes the membranes of the nose and sinuses, providing comfort and in some cases allowing blocked sinuses to drain. The process is most effective when the person places a towel over the container of hot water, lifts one edge to surround the nose, and breathes in the fragrant steam.

Care must be taken to prevent burns from the hot water, particularly in the case of children (who must always be supervised by an adult).

SORE THROAT

Relief can often be achieved by frequent gargling (every 4-6 hours) with:

- a teaspoon of salt to a cup of water (do not swallow)
- 4-5 drops of Povidone Iodine to half a cup of warm water
- 2 soluble aspirins to half a cup of warm water.

(Take note of allergies and history, for example, asthma, and do not give aspirin to children.)

INFLAMED EYES

An inflamed and painful eye generally indicates the presence of an infection which, particularly in a remote area, should be considered contagious. Before and after handling the casualty's eye the first aider should wash his or her hands thoroughly with soap and water.

Bathing the eye(s) at frequent intervals can provide relief and may prevent the condition worsening before medical help can be obtained.

Solutions that can be used to bathe the eye(s) include:

- warm salty water (a level teaspoon of salt to 600 ml of warm water)
- warm tea (tea contains tannic acid which has a mild antiseptic effect).

STYES

A stye is an infected eyelash which appears as a red, painful and swollen area on the eyelid. There may be an obvious pustule tip on the 'head' of the inflamed area. Compresses soaked in warm water should be applied frequently to the stye in an attempt to draw it to a head, whereupon it generally bursts and drains.

If, on looking closely, the first aider can identify the eyelash coming from the stye, it may be grasped firmly with the fingers and pulled gently. The lash will generally just come out of the stye and thereby allow any pus or other material to drain. By continuing to apply warm compresses to the eye, the first aider can assist in the removal through drainage of infected material and reduce the pain and discomfort felt by the casualty.

TOOTHACHE

Toothache, in a high percentage of cases, is preventable through daily dental care and regular dental checks. A lost filling can be so painful that the casualty's ability to perform simple tasks is impaired. To relieve the pain, the casualty should avoid those things that may make the pain more intense, for example, very hot or cold drinks. Minor analgesics such as paracetamol can be of assistance, but the casualty should be discouraged from placing aspirin tablets alongside the tooth. Aspirin used this way is no more effective than when swallowed, and it can cause quite serious burns to the gums and cheeks. Toothache can also be relieved for short periods by the application of solutions such as Dentite which contain small amounts of local anaesthetic and are applied with a cotton bud to the affected tooth. Alcohol such as whisky, applied in small quantities to the tooth, is claimed by many to relieve the pain for short periods. This may be acceptable in adults, but it is potentially dangerous for small children because a dangerous amount of alcohol may be absorbed through the mouth.

Skin disorders

Many skin disorders can be prevented through maintenance of personal hygiene and careful selection of clothing.

CHAFING

Nylon underwear is quick drying, but does not absorb moisture. Sweat is trapped and in combination with the friction of the material against the skin, can result in chafing and peeling. The inner thighs are particularly vulnerable if tight shorts are worn, and the bare thighs rub together during walking. Skin which is continually damp from sweat is easily inflamed by friction, and

can be extremely painful. As soon as a skin irritation or break to the skin is noticed it should be attended to; if left untreated large areas of skin can become damaged, quickly reaching the stage where the chafing is so painful that the casualty cannot walk. If unsuitable clothing for the activity is the problem, the casualty should change the clothing at once (e.g. remove nylon underwear – put cotton underwear on if available, otherwise the person is better off with none; exchange shorts for long pants). Treat the reddened skin as described below.

SKIN IRRITATION

Irritation of the skin is characterised by redness, localised heat, itchiness and at times a rash or area of blistering. Whilst a small area may be little more than an annoyance, a larger area can be serious from the point of view of infection, fluid loss and general distress to the casualty.

Relief can often be achieved by:

- applying cold compresses, for example a towel or wet handkerchief, to the affected area;
- oatmeal baths: oatmeal has a soothing effect on the skin and can often provide relief from skin irritations. To make an oatmeal bath place 1-2 cups of oatmeal in a sock or the foot section of a stocking and swish it around in the bath. The water will turn milky. The affected part should be immersed in the water and on removal, be gently patted dry. A fine layer of oatmeal will be left on the skin and it is this which will provide relief;
- calamine lotion: calamine, like oatmeal, has a soothing effect on the skin. Before applying calamine the bottle should be shaken vigorously, to ensure that the calamine has not settled at the bottom of the bottle. Apply the calamine generously to the affected area making sure that the whole area is covered.

These remedies can provide temporary relief from skin irritations. As soon as possible, any persistent skin irritation should be examined by a doctor so that diagnosis can be made and where necessary, definitive treatment can be implemented.

SMALL SCRATCHES AND ABRASIONS

These should where possible be washed with soap and water as soon as practicable. Once cleaned an antiseptic solution such as Betadine should be applied and where necessary the wound covered and protected with an adhesive dressing strip.

Betadine has the useful characteristic of changing colour

(from dark brown initially to faded caramel) as the solution loses its effectiveness. When it fades, it is time to reapply it.

BLISTERS

Blisters on the feet are one of the most commonly seen maladies in outdoor activities. Although simple, they can be painful and handicap the walker to the point where walking becomes impossible. Rubbing on the feet should be investigated as soon as it is noticed. It may be remedied simply by adjusting a sock or placing a piece of elastoplast over the part of the foot which is being rubbed (sometimes called a 'hot spot'). Once a blister has developed a dressing should be applied which is just sufficient to cover the blister, and elastoplast or similar tape should be applied firmly over the area. Failure to change damp or wet socks can result in excessive movement of the foot inside the boot (because a wet sock loses its thickness), causing friction and thus blisters.

Urinary tract infections

Urinary tract infections are more common in women than in men and in many cases tend to recur. Although the casualty may believe the burning sensation when urinating and the increased incidence of urinating, along with a general feeling of being unwell, are a recurrence of a previous infection, only a doctor can say for sure. First aiders must never assume that simply because a complaint from a casualty sounds similar to another diagnosed previously, they are the same. The person with a suspected urinary tract infection should be encouraged to rest and drink plenty of clear fluids. This has the effect of diluting the urine and lessening the burning as well as promoting frequent urination which helps to flush out bacteria from the bladder. Urinary tract infections must be treated seriously. They can develop into quite serious illnesses.

Earache

Earaches may be relieved by the application of either hot or cold compresses and by taking analgesics such as paracetamol. Earaches may also be experienced as a consequence of head colds, in which case relief may be achieved by using an inhalation as a decongestant, thus allowing the eustachian tube to drain.

If blood or pus is draining from the casualty's ear, nothing should be introduced into the ear. Simply place a pad over the

outside of the ear and encourage the casualty to lie with the affected side down to promote drainage. The casualty needs medical attention as soon as possible.

Gastrointestinal disorders

Gastrointestinal disorders in remote areas are potentially dangerous due to the debilitating effects which can occur, especially in babies, children and the elderly.

It is a physician's responsibility to diagnose these disorders, but the first aider may be able to establish the source of the problem. Gastrointestinal infections may pose a threat to other members of the group. Some possible causes include:

- food allergies/intolerances
- medical conditions, e.g. appendicitis, ulcers, colitis, enteritis, diverticulitis
- medications. These can often cause nausea and/or diarrhoea. Examples include vitamin E, aspirin, anti-inflammatory medications for arthritis, and antibiotics
- gastroenteritis due to contaminated food or drinking water, or a human carrier.

The SHAM sequence will generally indicate which possible causes of the problem can be ruled out. It is important to determine as quickly as possible whether an infection may be present, because certain gastrointestinal infections can be easily spread throughout the group.

SIGNS AND SYMPTOMS

The casualty may display some or all of the following signs and symptoms:

- nausea
- diarrhoea
- thirst
- fever
- indigestion
- vomiting
- abdominal pain
- sweating
- chills
- decreased urinary output.

HISTORY

A history should also be obtained from the casualty. Questions

to ask include:

- Have you had this problem before?
- Are you on any medications?
- What have you eaten? When did you last eat?
- What have you had to drink? When did you last drink?

Similar symptoms can occur if the casualty is dehydrated, but if food and drinks have been consumed recently, this is probably not the cause of the problem. If there is a gastrointestinal disorder, vomiting only may occur at first, to be followed hours later with diarrhoea. The first aider needs to be alert, and if there is any reason to suspect infection, take adequate precautions to prevent it from spreading to others in the group.

ALLERGIES

The symptoms may be consistent with allergic reactions. The casualty should be questioned about any allergies, and also about any recent contact with plants, animals or substances which could have caused a reaction.

MEDICAL CONDITIONS

If the casualty has been taking any medication, this should be considered as a possible cause. Many people do not think of vitamins as medications, so these may need to be mentioned specifically. If the casualty has been prescribed medication which should be taken regularly, and has missed a dose, this should be considered as a possible cause.

COMPLICATIONS

If diarrhoea and vomiting are frequent, of large amounts, or continue for an extended period of time the following complications may occur:

- dehydration: dry skin, mouth, lips; inelastic skin
- shock: pale, cold clammy skin; rapid pulse and respiration
- fatigue and exhaustion
- cross infection to other group members.

Medical help must be obtained for diarrhoea and vomiting which continue for more than one day. These conditions can be fatal if untreated, due to fluid loss.

Prevention of cross infection

If an infection is suspected, there are standard precautions which should be taken to protect the rest of the group:

- a high standard of personal hygiene for the casualty and all group members
- strict handwashing after attending the casualty
- if possible the cook and care-giver should be different persons
- bury all the casualty's excretions
- check food storage, handling and coverings
- check the water source. If dubious, use purifying tablets or boil the water (for 5 minutes plus 1 minute for each 300 metres above sea level)
- keep separate eating utensils for the casualty
- wear gloves if possible when handling body fluids.

Management

DIET

The casualty should have clear fluids only, i.e. water with sugar, or sports drinks. Resume food gradually as diarrhoea decreases. Give small frequent amounts. Give food which has low fibre and low fat content. Instruct the casualty to eat slowly. Avoid hot, very cold or carbonated drinks. Encourage foods containing pectin, e.g. bananas, apple sauce.

PAIN RELIEF

The casualty should rest in the most comfortable position, usually in a semireclining position with the knees drawn up. Rest as much as possible. Apply warmth to the abdominal area. Relaxation and/or distraction techniques may be beneficial. Medication will relieve symptoms but does not treat the underlying cause, so oral fluids must be continued. Many travellers carry some form of medication, either prescribed by a doctor or one of the many over-the-counter drugs, for relief of diarrhoea and vomiting.

OBSERVATION

Ongoing observation and recording of the casualty's signs and symptoms will indicate to the first aider and medical personnel the severity of and changes to the casualty's condition over time. Observations should include:

- level of hydration – dry skin, mouth, lips
- level of fatigue/exhaustion
- skin colour and temperature
- pulse and respirations
- all fluid intake and output should be carefully measured and recorded
- observation and recording of vomit and faeces should include

the frequency, amount, odour, colour and consistency. Black faeces may indicate the presence of blood. Green or yellow faeces indicate infection.

HYGIENE

A casualty who is debilitated may be unable to attend to personal hygiene. The first aider should assist by:

- removal and if possible, washing, of soiled clothing
- sponging the casualty to keep the skin as clean as possible
- offering mouth washes, or toiletries to clean teeth
- assisting with toileting and disposal of excretions.

EMOTIONAL SUPPORT

This can be a painful and embarrassing time for the affected person. The first aider should make every effort to provide privacy (when required), assistance and emotional support. To give this support the first aider should be confident, calm and in control.

Dealing with Death

When involved in a group activity in a remote area, it is possible that an accident or sudden illness may lead to the death of a member of the group. This will generate a great deal of stress for the rest of the group, and may pose many practical problems.

Generally, the dead body should not be left alone while the group walks out to report the death and get help. Wild animals may interfere with it, and the exact location may be difficult to find again. Normally, when there is a sudden death the body should not be moved until the police have viewed it and the site. However, the wellbeing of the group may be affected, and takes first priority. The body should be covered, perhaps protected from the weather by being placed in a tent, and treated at all times with respect. If members of the group wish to do so, they should be able to go and sit privately with their dead friend to say goodbye or just to be there. If possible and safe, the group should split, with a party going ahead to get help while the rest of the group stays at the accident site. If the wait is likely to be several days, it may be necessary to take pre-cautions against infection, and to prevent further distress to the group from upsetting smells and sights as the body decays. Wrapping it tightly in an impermeable material, such as the dead person's groundsheet, may be effective.

If the group is too small to split, all remaining members may have to go, and the body may have to be left behind. In this case, the body should be protected by something solid and heavy, such as rocks, and the location should be prominently marked, perhaps with a brightly coloured article of clothing, to make it identifiable – especially from the air. The trail should be marked clearly if it is at all difficult to find, so that rescuers will not be delayed by searching.

All sudden deaths must be reported at the first opportunity to the police, so when a telephone is reached, the police should be called at once. It is a police responsibility to notify relatives of the deceased, and they have experience at this task, so unless asked to do so by the police, it would not be appropriate for a group member to call the dead person's family. Naturally, nobody else should be informed until the family has been notified. Premature approaches by the media should be resisted as far as possible.

16 Sports Injuries

Reference:
Australian First Aid
Volume 2,
Chapter 23

Athletic activity places considerable stress on the body. All systems must work assiduously to sustain the supply of energy needed to keep muscles working harder and faster, to shed the additional heat generated by the increased activity, and to perform precise balance and coordination tasks at high speed. When the activity involves repeated impact with the ground or with other athletes, the musculoskeletal system must cope with the effects of frequent, sudden force on joints, bones and supporting structures. In endurance events, the effects of friction on joints, impact of hard ground on feet and legs, and the production of heat and metabolic wastes are all multiplied, while the continuing demand on the supply of glycogen (the stored form of carbohydrates) and oxygen taxes the body's resources.

Injury to athletes is common. This is hardly surprising considering that an estimated four million Australians participate in some form of organised sport annually. The Australian Sports Medicine Federation estimates that there are 200 000 serious sports injuries in Australia each year, with about 40 000 requiring hospital treatment or surgery. The Federation believes that between 30 and 50% of these injuries could be prevented, and that the best approach to prevention of serious injury is education of coaches, sports trainers and parents. Football, counting all four codes, is perhaps the most dangerous of all the popular sports; a study carried out in 1990 found that one in two players suffered injuries in a single season. In general, injury rates for children under 12 years are low, but the rate doubles over that age and increases almost seven times after the age of 16 years.

Netball players were found by researchers to suffer less serious injuries than other sports with a similar high participation rate, but accounted for 20% of all knee injuries. Netball players are vulnerable to leg injuries, particularly to the knee and ankle.

This sport requires sudden stops, often accompanied by twisting in order to pass the ball forward or back. It is played usually on a hard, unyielding surface such as asphalt, so that every leap causes jarring to the feet and legs. Basketball is a similar sport, but is played indoors, generally on a sprung wooden floor which reduces the impact on knees, ankles and hips; also, because sudden stops are not required in basketball, the players are less likely to damage their leg joints.

Athletes competing at a high level in their sport are statistically less likely to be injured than 'weekend amateurs'. This is partly due to better preparation and a higher level of fitness, and partly due to their more regular use of protective equipment. However, even top athletes are injured frequently, sometimes due to the exceptional effort expended for a premier event, sometimes due to over training in their eagerness to excel, and sometimes due to the nature of the event. Injuries are inevitable in contact sports such as football and martial arts, regardless of the quality of the competitors' ability, preparation and level of fitness.

The most common minor sporting injury is bruising, followed by strains and sprains. Footballers are vulnerable to a 'corked thigh', which is a painful bruise to the large muscles on the front of the thigh, caused by a heavy blow. Many footballers now wear lycra tights on the upper legs, which provide some protection against corked thighs. Athletes who ride skateboards, roller skates or in-line skates are most susceptible to knee, elbow and hand injuries, because they move fast over hard surfaces, so that falls inevitably cause some damage to the skin or underlying structures; for these athletes, pads on the vulnerable areas provide a buffer between the rider and the ground. Helmets are very important for any rider, whether mounted on a bicycle, motor cycle or skates. Recreational skiers and ice skaters rarely wear helmets, although these are standard equipment when racing or when playing a fast-moving game such as ice hockey.

Most sports injuries are the result of a direct blow producing bruising, or indirect dynamic force resulting in sprains, strains and tears. An increasing number of injuries are the consequence of over-use activities, e.g. joint, bony or tendon pain, such as may be seen following excessive participation in aerobic exercise sessions.

Physiology of Exercise

When exercising, the body's fuel supply, distribution and waste disposal systems are subject to increased demand. Comparative

performance in a sport, particularly in an endurance athletic event, will be determined by the efficiency and effectiveness of these systems. Training enables an athlete's body to attain peak functioning in terms of:

- body composition
- muscular function
- energy and oxygen consumption
- respiratory system
- heart performance and blood flow
- sweating and heat generation
- efficiency of heat dispersal

within the limits set by his or her genetic makeup.

Fuel supply

Trained athletes have more muscle and less fat than non-athletes. The fat content of a male of normal weight for height is around 15%, and for a female around 26%. In an endurance athlete, fat content may be as little as 4% in males and 6-8% in females. Muscle is heavier than fat, so when a person commences training, although the shape of the body may change to give a leaner silhouette, the person may actually gain weight.

A male body of the same height and weight as a female body will generally still be able to out-perform the female, because female muscle strength, cardiac output and respiration are between two thirds and three quarters of the same functions in an equivalent sized male. Sex hormones play an important role in these differences. The male sex hormone, **testosterone**, increases protein deposition in the body tissues, particularly in muscle, and increases aggression. **Oestrogen**, the female hormone, affects the accumulation of fat over the whole body, but causes deposits specifically on breasts, hips and thighs, and beneath the skin. Due to hormonal differences, there is a predictable pattern of muscle development and fat storage which accounts for the difference in body shape between the sexes (leaving aside obvious secondary sexual characteristics). A typical obese male becomes 'apple shaped' with fat accumulating at waist and abdomen, and an obese female generally becomes 'pear shaped', with fat deposited at the hips and upper legs. Male-pattern fat deposits have been found to be associated with a higher risk of heart disease than female-pattern fat deposits, but are easier to shed than the female-pattern deposits. Apple shaped females have been found to have a statistically similar risk to males, and pear shaped males to have a lower risk, similar to females. Male

body builders typically have 'V' shaped torsos, while a female body builder will rarely be able to develop her shoulders enough to get her torso past an 'H' shape. Males are designed to have more and heavier muscle than females over the chest, shoulders and upper arms.

Muscular function has three aspects: strength, power and endurance or stamina. Strength is related to size, which is increased by testosterone and training. Power is the amount of work a muscle can do in a given time, and is an outcome of strength, the speed with which the muscle can contract, and the number of times it is able to contract per minute. Endurance refers to the length of time an activity can be sustained, and is primarily a function of the amount of energy that can be produced by utilising the **glycogen** stored within the muscle, as well as of the continuing availability of nutrients.

Glycogen is the form in which carbohydrates are stored in the liver and in skeletal muscle. Insulin plays a major role in enabling glycogen to be stored. The average amount of energy available from stored carbohydrate is around 200 kcal, which would provide enough fuel for an athlete to run 40 kilometres. An untrained person stores about 80-90 mmol/kg of glycogen, while a highly trained endurance athlete may have as much as 130-135 mmol/kg. Stored fat contains twice as much energy as stored carbohydrate or protein; although an endurance athlete may have a very low percentage of body fat, there would still be enough to run about 1200 km if it could be fully utilised. The amount of fuel required by the body for exercise depends on the duration and intensity of the activity. A high level of fitness and carefully controlled nutrition enables an athlete to use the fuel more efficiently.

Short, high intensity exercise

Activities in this category include the 'power' sports, such as throwing, lifting, jumping and sprinting. For exercise which lasts no more than 1-1½ minutes, muscles utilise glycogen without oxygen (**anaerobic exercise**). The waste products, mainly **lactic acid**, build up rapidly. Lactic acid obstructs the movement of fat from fat cells, so that once it has accumulated, the muscles can only use glycogen as a fuel source. The maximum distance which could be run anaerobically would be a 200 metre event (a high level athlete could perhaps run a little further, but the next distance usually contested is 400 metres, which is too far). By the end of a 200 metre race, a top athlete is unlikely to be gasping for breath, but may well have painful, stiff muscles due to lactic acid accumulation. Oxygen and glucose are the main energy-

providing compounds for maintaining performance in longer events. Oxygen is required for efficient breakdown of glucose (as well as to deal with the lactic acid produced in the anaerobic phase at the commencement of exercise). Through a complex process, the interaction of oxygen with glucose produces large quantities of *adenosine triphosphate*, the compound which initiates muscle contraction. Oxygen is stored in most areas of the body, and will need to be replaced after an intense competitive effort before the athlete can compete again.

Fat takes too long to break down to be available as an energy source to an athlete participating in high intensity events. It is used in the form of free fatty acids, and takes over half an hour to be released from storage and converted into this form, so is of use mainly in events requiring low to moderate intensity of effort over a long time.

Endurance exercise

When an athlete exercises at moderate intensity, adrenalin and growth hormone levels increase, and insulin production decreases. These changes in body chemistry allow fat to be broken down into free fatty acids and ketones, which are released into the bloodstream. The body derives energy from fatty acids as its glucose stores are depleted. Amino acids, which are the building blocks of proteins, are also used as a fuel source, but contribute only about 5-10% of the total energy used.

In an appropriately trained athlete, glycogen stores can last for about 4 hours, after which glucose is obtained by absorption from the digestive tract. A glucose solution of approximately 2-2.5% taken frequently during an endurance event can provide 30-40% of the energy needed to continue. After the first 4 hours, fat is able to provide about 50% of the energy required.

Fuel distribution

As an athlete trains, the heart and lungs become stronger and the circulatory system becomes generally more efficient at delivering nutrients and oxygen to the exercising muscles. The body stores some oxygen :

- about 300 ml in muscles
- 500 ml in the area of the lungs
- 250 ml dissolved in body fluids
- about 1 litre attached to haemoglobin in the blood.

The lungs are the 'loading dock' for oxygen, and the blood vessels are the distribution network. The muscles are 'major customers' during exercise, although the rest of the body still needs to maintain its regular supply. The quantity of oxygen required at the end of exercise to dispose of waste products and replenish stores is called **oxygen debt**. The oxygen debt can be as much as 10-15 litres, and the time taken to fully satisfy the debt can be as much as 2 hours.

Muscle blood flow is markedly increased during exercise. The normal blood flow is approximately 3.6 ml per 100 g of muscle tissue. During strenuous activity it is increased to 90 ml per 100 g of tissue, or 25 times more than at rest. Arterial blood pressure tends to rise by up to 30%, and contributes to increased muscle blood flow.

The heart normally pumps between 5 and 5.5 litres of blood per minute in an average healthy adult male. During exercise, this rises to about 23 litres per minute. In a conditioned endurance-trained athlete, outputs of 30 litres per minute, or six times the resting flow, can be achieved.

Training and conditioning can increase heart chamber size and muscle mass by up to about 40%. In exercise, both rate and stroke volume – the volume ejected from the heart with each beat – are increased to 95% of maximum function.

Waste disposal

Apart from the need for oxygen, the other main demand on the body during exercise is to dispose of the excess heat generated by the high level of muscle activity. The most effective mechanism is to increase sweat production; as athletes train to a higher level of fitness, they take longer to commence sweating and sweat less copiously than less fit people performing the same activity. The composition of sweat is also different in an acclimatised, endurance-trained athlete, containing only about one sixth of the amount of salt found in an unacclimatised athlete.

Most of the energy produced by the processing of nutrients through the body's various chemical reactions is converted to heat. Only 20-25% of the total energy generated is used in muscular work. Oxygen consumption can be increased up to 20%, and the heat production is directly proportional to the oxygen consumption.

Efficient sweating (when the humidity is low) can result in a loss of 2-3 litres of fluid during an endurance event. Every litre lost reduces body weight by 1 kilogram. A 3% loss of body

weight can impair performance and a 10% loss can lead to nausea, muscular cramps and other symptoms of heat illness.

Management of Injuries

From the first aider's perspective, an injury caused by sport is no different from the same injury caused by any other type of incident. However, a feature of injuries to athletes is that in many cases, the casualty may be more concerned about how long it will be before he or she will be able to resume activity than about other aspects of the injury. Key decisions when an incident occurs (decisions which are the coach's responsibility but about which the first aider's view may be sought), are whether the athlete may continue to participate or should be withdrawn from the field, and whether a player with a minor injury should be allowed to return to the game after treatment. Many sports have rules which must be followed for competition, for example that a player who is bleeding must come off the field, or that a player who has suffered concussion may not participate for 2 weeks.

Injury prevention is increasingly being emphasised in sports. Most athletes are familiar with the necessity to warm up and cool down properly, to stretch, to have an adequate balanced diet and to improve flexibility. One must also be physically fit for the sport to be performed. Fitness includes both general fitness and any special skills training required by the sport (e.g. soccer skills – it takes a hard head and strong neck to butt the ball and hurl it down the field; or gymnastics, where athletes turn somersaults in the air and land neatly on their feet). The proper clothing and equipment are also key factors in preventing injury. For long distance runners, shoes which suit the individual's feet are essential; fencers always compete wearing a face mask; and no Formula 1 driver would enter the car without a helmet and flame-resistant clothing.

In some cases, protective strapping of a vulnerable part such as an ankle may be helpful in preventing injury. St John does not include strapping in first aid courses, because such specific preventive measures are more the province of a sports trainer than of a first aider.

Once an injury has occurred and first aid has been applied, it will often be up to the athlete to ensure that ongoing management is appropriate. A useful acronym for what must be avoided is 'HARM',

H	Heat increases bleeding and swelling
A	Alcohol increases bleeding and swelling
R	Running (or exercise too soon) causes further injury
M	Massage in the first 24-48 hours causes bleeding and swelling.

No competitor should participate in an event while an injury remains painful. Pain implies that healing is incomplete, and to compete would be to risk further aggravation of the injury. When an athlete has been sidelined by a soft tissue injury, such as a sprain or strain, there is a temptation to return too soon, or at too high a level of training. The injured muscle or joint needs to be reintroduced gradually to a full workload and range of movement. After a common injury, such as a sprained ankle, the ligaments may take months to regain their full strength, and if the athlete competes too soon, are likely to be damaged again. Too much stress too early can cause chronic weakness, and may result in forced retirement from the sport.

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